Transport Roads & Maritime Services

Oxley Highway to Kempsey EPBC 2012/6518

Condition 8 Annual Report 2017

Document control

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Contents

1 Introduction

1.1. Purpose of this document

The purpose of this report is to address EPBC (2012/6518) Approval Condition 8, which requires the preparation of a report addressing compliance with each of the conditions of approval, including implementation of the:

- Biodiversity Offset Management Plan (BOMP)
- Flora and Fauna Management Plans (FFMP)
- Ecological Monitoring Plan (EMP).

This report covers the third period from 22 July 2016 to 21 July 2017.

The timing for compliance with certain approval conditions is linked to specific dates as follows:

- Date of the approval decision under sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999* – 24 January 2015
- Commencement of the action – 22 July 2014
- Expiry of Commonwealth approval – 31 December 2063

1.2. Project staging

The Oxley Highway to Kempsey Pacific Highway Upgrade project is being constructed in three main stages:

- Stage 1: The Sancrox Traffic Arrangement works located about two kilometres north of the Oxley Highway / Pacific Highway intersection. Note that the construction of Stage 1 was completed in November 2015
- Stage 2: Kundabung to Kempsey (K2K) consisting of about 14 kilometres of dual carriageway, commencing north of Barrys Creek near Kundabung (chainage 24,000) and connecting to the Kempsey Bypass at Stumpy Creek (Chainage 37,800)
- Stage 3: Oxley Highway to Kundabung (OH2Ku) consisting of about 24 kilometres of dual carriageway, commencing just north of the Oxley Highway / Pacific Highway intersection (chainage 700) and connecting with the Kundabung to Kempsey stage just north of Barrys Creek (chainage 24,000).

In addition, there is an ultimate upgrade to the four lane Class M (motorway) standard highway. Due to estimated traffic volumes and availability of funding some sections of the Project will initially be constructed and operated as a Class A (arterial) standard highway. Upgrade of those sections of the Project from Class A to Class M standard will occur when it is warranted by an increase in traffic volumes, and when funding becomes available.

1.3. Modifications to the Conditions of Approval

No modifications to the Conditions of Approval were requested or approved during this reporting period.

2 Conditions of Approval

2.1. Condition 1

Condition 1

The person taking the action must not clear more than 211 hectares of Koala (Phascolarctos cinerea) habitat, 232 hectares of Grey-headed Flying-fox (Pteropus poliocephalus) habitat, 215 hectares of Spotted-tail Quoll (Dasyurus maculatus) habitat and 7.7 hectares of Giant-Barred Frog (Mixophyes iteratus) habitat within the project corridor of the proposed action.

Roads and Maritime is undertaking a progressive review of the total clearing area for the Oxley Highway to Kempsey project, incorporating the clearing for all three stages. Clearing for the three initial stages of the project (see Section 1.2) is now complete.

A progress report on the clearing quantities against the limits outlined in Condition 1 is detailed in Table 1.

Table 1 Clearing quantities as at July 2017

EPBC Species	Total clearing	EPBC Condition 1
Koala	196.7744	211
Grey-headed flying fox	206.8604	232
Spotted-tail Quoll	196.9630	215
Giant-barred Frog	2.8352	7.7

2.2. Condition 2

Condition 2

To assist in mitigating the impacts of the proposal on the Koala, Grey-headed Flying-fox, Spotted-tail Quoll and the Giant-Barred Frog during construction, the person taking the action must prepare and submit a Flora and Fauna Management Plan for each **stage** of the action, for the **Minister**'s written approval prior to **commencement** of each **stage** of the action. The Flora and Fauna Management Plan for each **stage** must be approved by the **Minister** in writing prior to **commencement** of the relevant **stage**. These plans must include:

- **a.** Measures to be implemented to avoid, suppress and control the spread of weeds, plant pathogens and invasive species;
- **b.** Measures to avoid and minimise other indirect impacts that may result from the proposal during and after construction, including erosion and sedimentation;
- **c.** Measures to manage aquatic habitat on-site to at least maintain habitat values for the Giant Barred Frog;
- **d.** A detailed description of the pre-clearance surveys to be undertaken by a **suitably qualified expert** within all areas proposed for disturbance, including: hollow bearing trees, logs, existing culverts and bridges, no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the Koala, Giant-Barred Frog, Grey-headed Flying-fox and Spotted-tail Quoll.

Condition 2

e. Measures to relocate and/or ensure the **appropriate care of** individuals of the Koala, Giant-Barred Frog, Grey-headed Flying-fox and Spotted-tail Quoll that are identified during searches referred to in condition 2d; and

f. Clear key milestones, monitoring, performance indicators, corrective actions and timeframes for the completion of all actions outlined in the plan.

A Flora and Fauna Management Plan has been prepared for each stage of the project. These plans were approved by the Minister on the following dates:

- Stage 1: Sancrox Interchange – 24 June 2014
- Stage 2: Kundabung to Kempsey – 22 October 2014
- Stage 3: Oxley Highway to Kundabung – 10 October 2014

The compliance status of the implementation of the Flora and Fauna Management Plans for each stage is detailed in Appendix A.

2.3. Condition 3

Condition 3

To assist in mitigating the impacts of the proposal on the Koala, Spotted-tail Quoll and the Giant-Barred Frog, the person taking the action must construct and maintain **fauna crossings** and **fencing** in all **areas that are likely to benefit** these species for the duration of the impact of the action.

a. The **fauna crossings** must:

i. be **effective** for the Koala, Spotted-tail Quoll and/or Giant Barred Frog (the relevant species targeted to use the **fauna crossing**);

ii. provide dry passage up to a 1 in 100 year Average Recurrence Interval (ARI) event for **dedicated fauna crossings** and up to a one in 1 year 72 hour ARI event for **combined fauna crossings**;

iii. include a minimum of 11 **dedicated fauna crossings** and 30 **combined fauna crossings** for the project;

iv. not increase in length more than 10 per cent from the lengths provided in Schedule 2 of this notice, and not reduce in width and height from the values provided in Schedule 2 of this notice without the written consent of the **Minister**;

v. be bridges in **areas that are likely to benefit** the Giant-Barred Frog.

b. If a change to the **fauna crossing** design is proposed that does not meet the parameters described in Condition 3a), the person taking the action must:

i. provide evidence to the **Minister** that these will remain **effective** for the Koala, Spotted-tail Quoll or Giant-Barred Frog (as relevant for the **fauna crossing**) for the **Minister's** written approval prior to **commencement** of the **stage** relevant to that fauna crossing; or

ii. provide written evidence to the **Minister** detailing how the resulting loss in connectivity will be compensated for with increased connectivity for the impacted species. This must be

Condition 3

approved in writing by the **Minister,** prior to **commencement** of **stage 2** and **stage 3**.

c. **Fencing** must be constructed at a minimum the locations identified in Schedule 3 of this notice.

Detailed design for all fauna crossings on the project is now complete and this design demonstrated that all fauna crossings complied with the parameters listed in Condition 3(a). As such, no submissions have been made to the Minister in accordance with Condition 3(b).

No changes to culvert design parameters have been made during this reporting period in either Stage 2 or Stage 3. As such, the current fauna crossing design is as per Table 2 in Oxley Highway to Kempsey EPBC 2012/6518 Condition of Approval 8 Annual Report 22 July 2014 – 21 July 2015 for Stage 3, and Schedule 2 of the EPBC approval for Stage 2. None of the fauna crossings in Schedule 2 fall within Stage 1, Sancrox Traffic Arrangement.

Fencing is being constructed at a minimum at the locations identified in Schedule 3 of the approval. Fauna fencing is largely complete, due to the upcoming opening of Stage 2 and the partial opening of Stage 3.

During the last reporting period, additional permanent fauna fence was also added to the design at the following locations:

- Ch. 12300 – 12950 (southbound) – fauna fence on one side and not the other. In an open, paddock landscape, and therefore to protect kangaroos.
- Ch. 24040 – 24170 (northbound) – to bridge a small gap in the fauna fence, near Barrys Creek.
- Ch. 29600 – 29850 (northbound) – to bridge small gaps in the fauna fence, between Smiths Creek and Pipers Creek.
- Ch. 30260 – 30440 (northbound & southbound) – to bridge small gaps in the fauna fence, between Smiths Creek and Pipers Creek.

2.4. Condition 4

Condition 4

Prior to **commencement of stage 2** and **stage 3** of the action**,** the **person taking the action** must submit an Ecological Monitoring Program for approval by the **Minister** that determines the effectiveness of the mitigation measures implemented as part of the project. The Ecological Monitoring Program must be approved in writing by the **Minister** prior to **commencement** of **stage 2** and **stage 3,** and must include:

a. The baseline data collected from surveys undertaken by a **suitably qualified expert** on the Koala, Spotted-tail Quoll and Giant-Barred Frog within all habitat areas outside areas to be cleared of vegetation for the proposed action, that are likely to contain these species and that are likely to be adversely impacted by the action (as determined by a **suitably qualified expert**).The data must address the densities, distribution, habitat use and movement patterns of these species;

b. The methodology to be implemented for the ongoing monitoring of road kill, the species densities, distribution, habitat use and movement patterns, and the use of **fauna crossing** during construction and operation of the action, including the timing, and duration of the methodology;

c. Goals and performance indicators to measure the success of proposed **fauna crossings**, which must be specific, measureable, achievable, realistic and timely (SMART), and be compared against baseline data described in condition 4a)

d. Details of contingency measures that would be implemented in the event of changes to densities, distribution, habitat use and movement patterns that are attributable to the construction or operation of the project.

Monitoring must continue until mitigation measures can be demonstrated to have been **effective** for the Koala, Spotted-tail Quoll, and Giant-Barred Frog.

Should monitoring associated with this condition demonstrate that the use of **fauna crossings** and/or **fencing** is not achieving its intended purpose or is having a detrimental effect upon Koala, Spotted-tail Quoll, and Giant-Barred Frog (as determined by **the Minister**), **the Minister** may require that the person taking the action implement alternative forms of mitigation and/or corrective actions to address the relevant impacts to Koala, Spotted-tail Quoll, and Giant-Barred Frog,. Such measures must be implemented as requested.

The Ecological Monitoring Program for the project was submitted to the Minister in a letter dated 29 April 2014 and approved by the Minister on 10 October 2014. Commencement dates for Stage 2 and Stage 3 were early to mid-November 2014.

The compliance status of the implementation of the Ecological Monitoring Program is detailed in Appendix B.

2.5. Condition 5

Condition 5

To compensate for the loss of 240 hectares of threatened species habitat the person taking the action must prepare and submit a Biodiversity Offset Management Plan (**BOMP**) for the **Minister's** written approval within 12 months of approval of the action. The BOMP must be approved in writing by the **Minister** within 12 months of approval of the action. The **BOMP** must include:

a. the identification of the portions of the lands described as the "Proposed Biodiversity Offset Areas" in the Map at Schedule 1 of this notice that are necessary to achieve

Condition 5

the outcomes required by the *Environmental Offsets Policy 2012* (or subsequent published revisions). This must include **offset attributes**, **shapefiles**, textual descriptions and maps to clearly define the location and boundaries of the offset area(s);

b. the results of targeted field surveys within the offset sites (undertaken at any ecologically appropriate time of the year) to assess and describe habitat suitability and presence / absence of individuals in relation to the Koala, Grey-headed Flying-fox, Spotted-tail Quoll and Giant Barred frog;

c. an assessment of the baseline population for the Koala, Spotted-tail Quoll, Giant-Barred Frog, and Grey-headed Flying-fox which are detected within the offset area during field surveys;

d. a description of the current **quality** (prior to any management activities) of the offset area(s) identified in Condition 5a with reference to the Koala, Spotted-tail Quoll, Giant-Barred Frog, and Grey-headed Flying-fox;

e. an assessment demonstrating how the offset area(s) achieve the outcomes required by the *Environmental Offsets Policy 2012* (or subsequent published revisions) and user guide;

f. Should the offset sites identified in 5a not be sufficient to achieve the outcomes required by the *Environmental Offsets Policy 2012* (or subsequent published revisions) and user guide, as determined in writing by the **Minister**, the person taking the action must provide further suitable offset sites and include these as part of the **BOMP**;

g. information about the Koala, Grey-headed Flying-fox, Spotted-tail Quoll, Grey-headed Flying-fox, and Giant Barred frog (in relation to ecology, biology and conservation status) to inform appropriate management actions;

h. targeted management actions, regeneration and revegetation strategies to be undertaken on the offset area(s) to improve the ecological quality of these areas for the Koala, Grey-headed Flying-fox, Spotted-tail Quoll and Giant Barred frog

i. clear performance objectives for management actions that will enable maintenance and enhancement of habitat within the offset area, as well as contribute to the better protection of individuals and / or populations of Koala, Spotted-tail Quoll, Giant-Barred Frog, and Grey-headed Flying-fox onsite;

j. anticipated timeframes for achieving performance objectives.

k. performance and completion criteria for evaluating the management of the offset area, including contingency actions, criteria for triggering contingency actions and a commitment to the implementation of these actions in the event that performance objectives are not met;

l. a program to monitor and report on the effectiveness of these measures, and progress against the performance and completion criteria;

m. details of who would be responsible for monitoring, reviewing, and implementing the **BOMP**.

n. a description of funding arrangements or agreements including work programs and responsible entities;

The approved **BOMP** must be published on the NSW Roads and Maritime Services internet web site, within 1 month of the BOMP being approved.

The approved BOMP must be implemented.

The BOMP was submitted to the Department of the Environment for the approval of the Minister in a letter dated 16 January 2015. Approval from the Minister remains outstanding. See Section 3 for further detail.

2.6. Condition 6

Condition 6

If an offset site proposed as a part of Condition 5 is already required to be protected as a result of a separate EPBC Act approval, only the management actions which can be demonstrated to be additional to those required for the separate approval, can be considered as an offset for this project. The legal protection of the site and management measures required for a separate approval cannot be considered a part of the offset, in accordance with the *Environmental Offsets Policy 2012* (or subsequent published revisions).

This requirement has been noted as part of the preparation of the BOMP, required under Condition 5.

2.7. Condition 7

Condition 7

Within 12 months of approval of the Biodiversity Offset Management Plan (BOMP), the person taking the action must secure the offset area(s) identified in Condition 5a), under relevant conservation legislation. The legal instrument chosen must be registered on title, and must prevent any future development activities from occurring on the land protected, and ensure the active management of that land for the better protection of matters of national environmental significance for the duration of the impact of the action. Evidence of compliance with this condition must be provided to the **Department** within 30 days after the land(s) have been secured.

Approval from the Minister of the BOMP remains outstanding; as such compliance with this condition is not yet applicable.

2.8. Condition 8

Condition 8

Within three months of every 12 month anniversary of the **commencement** of the action, the person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of the BOMP, Flora and Fauna Management Plans and Ecological Monitoring Plan as specified in the conditions. Documentary evidence providing proof of the date of publication must be provided to the **Department** at the same time as the compliance report is published. Noncompliance with any of the conditions of this approval must be reported to the **Department** within 2 business days of becoming aware of the non-compliance. At any time within the life of this approval the **Minister** may agree, in writing, that further reporting is not required if compliance with all requirements has been demonstrated to the **Minister**'s satisfaction.

This report has been prepared to satisfy the requirements of this condition. Evidence of the date of publication will be provided to the Department when this report is published on the Roads and Maritime project website.

All previous reports, and this report once published, can be found at the following link:

http://www.rms.nsw.gov.au/projects/northern-nsw/oxley-highway-to-kempsey/project-documents.html

2.9. Condition 9

Condition 9

Within 30 days after the **commencement** of the action, the person taking the action must advise the **Department** in writing of the actual date of **commencement**.

In a letter to the Department, dated 19 August 2014, Roads and Maritime advised the Department of the actual date of commencement, being 22 July 2014.

2.10. Condition 10

Condition 10

The person taking the action must maintain accurate records substantiating all activities associated with or relevant to these conditions of approval, including measures taken to implement the **BOMP,** Ecological Monitoring Plan and Flora and Fauna Management Plans, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the **Department's** website. The results of audits may also be publicised through the general media.

Roads and Maritime and its construction partners are maintaining accurate records for all activities relating to the conditions of approval, and the implementation of the BOMP, EMP and FFMPs. The potential audit by the Department is noted.

2.11. Condition 11

Condition 11

Upon the direction of the **Minister**, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the **commencement** of the audit. Audit criteria must be approved by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.

The requirements of this condition are noted. A direction from the Minister under Condition 11 has not been received by Roads and Maritime during this reporting period.

2.12. Condition 12

Condition 12

If the person taking the action wishes to carry out any activity otherwise than in accordance with the **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans as specified in the conditions, the person taking the action must submit to the **Department** for the **Minister's** written approval a revised version of that Plan. The varied activity shall not commence until the **Minister**

Condition 12

has approved the varied Plan in writing. The **Minister** will not approve a varied Plan unless the revised Plan would result in an equivalent or improved environmental outcome over time. If the **Minister** approves the revised Plan, that Plan must be implemented in place of the Plan originally approved.

Roads and Maritime submitted an update to the Ecological Monitoring Plan to the Department for approval on 3 May 2016. This update was approved by the Minister on 15 November 2016.

A minor update to the Stage 3 Flora and Fauna Management Plan was submitted to the Minister in a letter dated 16 November 2016 and approved by the Minister on 27 March 2017.

No updates to the Stage 2 Flora and Fauna Management Plan have been submitted to the Department for approval during this reporting period.

The BOMP has not yet been approved by the Department, and therefore the requirements of this condition are not yet applicable to this plan.

The status of compliance with these plans can be found in Section 3, 4 and 5 respectively.

2.13. Condition 13

Condition 13

If the **Minister** believes that it is necessary or convenient for the better protection of listed threatened species and ecological communities to do so, the **Minister** may request that the person taking the action make specified revisions to the **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans, as specified in the conditions and submit the revised **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans for the **Minister's** written approval. The person taking the action must comply with any such request. The revised approved **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans must be implemented. Unless the **Minister** has approved the revised **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans then the person taking the action must continue to implement the **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans originally approved.

Noted.

No requests from the Minister under Condition 13 were received by Roads and Maritime in this reporting period.

2.14. Condition 14

Condition 14

If, at any time after 5 years from the date of this approval, the person taking the action has not **substantially commenced** the action, then the person taking the action must not substantially commence the action without the written agreement of the **Minister**.

Commencement of the action occurred on 22 July 2014.

2.15. Condition 15

Condition 15

Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all plans referred to in these conditions of approval on their website. Each plan must be published on the website within 1 month of being approved.

The most recently approved versions of the Flora and Fauna Management Plans for each stage, and the Ecological Monitoring Plan, have been published on the project website, which can be found at the following address:

http://www.rms.nsw.gov.au/projects/northern-nsw/oxley-highway-to-kempsey/project-documents.html

3 Biodiversity Offset Management Plan

The BOMP was submitted to the Department of the Environment for the approval of the Minister in a letter dated 16 January 2015. Approval from the Minister remains outstanding.

Roads and Maritime is currently responding to comments from the Department on the BOMP. Responses to these comments are currently being finalised, and the BOMP is due to be re-submitted by the end of October.

4 Ecological Monitoring Plan

Table 2 outlines the monitoring requirements from the Ecological Monitoring Plan, relevant to matters of National Environmental Significance that were required to be conducted during the last reporting period

Table 2 Ecological monitoring requirements during the last reporting period

Species monitored	Timing
Koala	Spring/Summer
Giant Barred Frog	Spring, Summer and Autumn
Road kill	Weekly during construction
Pre-Clearing / Clearing	Pre- and during clearing

This monitoring was conducted in accordance with the abovementioned timing requirements. The results of these monitoring events, including evaluation of the project's compliance with the performance indicators, have been included in Appendix B.

Table 3 lists the title of each of the monitoring reports where each of the EPBC reporting requirements under the Ecological Monitoring Plan have been addressed. These can all be found in Appendix B.

Table 3 EPBC monitoring reports in Appendix B

Species monitored	Report title in Appendix B
Giant Barred Frog spring, summer and autumn monitoring	Giant Barred Frog Monitoring 2016/2017
Road kill construction monitoring conducted in this reporting period	Road Kill Monitoring 2016/2017
Koala Spring/Summer (Year 2) monitoring	Koala Monitoring 2016
Pre-Clearing / Clearing	Oxley Highway to Kundabung Clearing Report, 8 August 2017 OH2K Phase 2 Clearing Report – September 2015 – June 2017

Table 4 outlines the monitoring requirements for the remainder of Year 3 (2017) that did not fall within this reporting period, and as such will be reported in the 2017/18 annual report.

Table 4 Remaining monitoring requirements for Year 3

Species monitored	Timing
Giant Barred Frog	Spring
	Summer
Koala	One monitoring event in Spring / Summer

Clearing for Stage 3 was completed during the last reporting period, however clearing for Stage 2 was ongoing at the end of the last reporting period. As such, a report detailing the results of the pre-clearing and clearing monitoring and mitigation measures for Stage 3 has been provided in Appendix B (as per Table 3) and the report for Stage 2 will be prepared at the completion of all clearing, and will be included in the 2017/18 annual report.

There was one non-compliance with the Ecological Monitoring Plan identified during the preparation of this report, as follows:

- The GPS location was not recorded for all fauna within the clearing footprint on OH2Ku, as required by Section 4.1.3 of the Ecological Monitoring Program. GPS locations were generally recorded for all threatened species. A general location (often a chainage) and habitat tree number (where applicable) was recorded for all fauna. Clearing was complete by the time this issue was identified, and as such no corrective actions have been recommended.

All the Ecological Monitoring Program performance measures for the monitoring events listed in Table 3 were met for the 2016/2017 reporting period, except:

- There was one instance, at Maria River, where the median downstream value exceeded the 80th percentile upstream value and this was found to be attributable to construction. Further details can be found in the Giant Barred Frog Monitoring Report in Appendix B.

5 Flora and Fauna Management Plans

The Flora and Fauna Management Plans for each stage were approved by the Minister on the following dates:

- Stage 1: Sancrox Traffic Arrangement – 24 June 2014
- Stage 2: Oxley Highway to Kundabung – 10 October 2014
- Stage 3: Kundabung to Kempsey – 22 October 2014

Table 3.3 of the Stage 2 Flora and Fauna Management Plan and Table 3.4.1 of the Stage 3 Flora and Fauna Management Plan contains the EPBC Act management measures to be complied with during these stages of the project. Accordingly, a summary of compliance with the mitigation measures outlined in these tables is included in Appendix A.

Construction of Stage 1 was completed in November 2015, and as such, compliance with the requirements of this FFMP are no longer being reported in Appendix A.

Appendix A Flora and Fauna Management Plans

Stage 2: Kundabung to Kempsey

EPBC CoA	Related Table 5-1 ID	Management Measure and/or Evidence of Compliance	Performance Indicator/Target	Timeframe	Responsibility	Compliance Status
CoA 2a.	FF13	Weeds will be managed in accordance with the Weed and Pathogen Management Plan (Appendix K).	**Performance indicator:** As per Weed and Pathogen Management Plan (Appendix K) **Performance target:** Completion of all mitigation measures outlined in the Weed and Pathogen Management Strategy within the prescribed timeframes.	As per Weed and Pathogen Management Plan (Appendix K).	Environmental Manager	A baseline noxious weed survey was conducted during the pre-construction surveys. The full results of which will be outlined in the Pre-Clearing / Clearing Report for this stage, to be included in the 2017/18 Annual Report (due to the fact that clearing was still ongoing at the end of this reporting period). All Class 3 noxious weeds identified during the survey (groundsel bush and coral tree) were sprayed in accordance with the Weed and Pathogen Management Plan, and recorded on weed spraying sheets. The Chytrid Fungus washdown procedure has been implemented at the known area of Chytrid infestation (Smiths Creek). This includes the washing down of both footwear and machinery entering this area using a disinfecting agent. Chytrid Fungus has was identified at Pipers Creek during the last reporting period, however no works have been required in this area since. Additional weed spraying and or weed removal is also being conducted in areas of retained vegetation within the project boundary. See image 1. Weed monitoring is part of the weekly environmental checklist.
	FF37	Washing procedures will be implemented to ensure that insect pests and their eggs/larvae are not present on equipment. The washing procedure will be undertaken in accordance with the process described in Guide 7 of the Roads and Maritime *Biodiversity Guidelines*.	**Performance indicator:** Washing procedures implemented in accordance with Guide 7 of the Roads and Maritime Biodiversity Guidelines. **Performance target:** All plant and equipment is washed in accordance with Guide 7 of the RMS Biodiversity Guidelines prior to exiting known areas of pathogens	Immediately prior to exiting known areas of pathogens.	Environmental Manager Project Ecologist / suitably qualified expert	All machinery is washed down at the main compound before it enters site, to prevent the spread of insect pests and larvae. This is recorded on the plant checklist as the plant arrives at site. Prior to leaving Smiths Creek and before moving to other areas of site, all plant and footwear are washed down with a disinfecting agent. All works are now complete in Smiths Creek. No further works have been required at Pipers Creek during this reporting period, and as such a washdown procedure has not been implemented at this location.
	FF38	The spread of bacteria, viruses and diseases such as *Phytophthora cinnamomi*, amphibian chytrid fungus, myrtle rust and beak and feather disease will be addressed using the processes described in Weed and Pathogen Management Plan (Appendix K).	**Performance indicator:** As per Weed and Pathogen Management Plan (Appendix K) **Performance target:** Completion of all mitigation measures outlined in the Weed and Pathogen Management Strategy within the prescribed timeframes.	As per Weed and Pathogen Management Plan (Appendix K).	Environmental Manager	The Chytrid Fungus washdown procedure has been implemented at the known area of Chytrid infestation (Smiths Creek). This includes the washing down of both footwear and machinery entering this area using a disinfecting agent. Chytrid Fungus has was identified at Pipers Creek during the last reporting period, however no works have been required in this area since. *Phytophthora cinnamomi* was found to be present across the entire length of the site. As such, the process described in the Weed and Pathogen Management Plan (which predominantly focuses on preventing the spread throughout the site) is not considered relevant. Despite this, machinery is washed down prior to it leaving site.
CoA 2b.	FF10	Revegetation/rehabilitation of all areas disturbed as part of the Project (that do not form part of permanent pavement or structures) will be undertaken progressively during construction to maintain and enhance key habitat areas in order to minimise the impact on Koala, Grey-headed flying fox, Spotted-tail Quoll and Giant Barred Frogs.	**Performance indicator:** Stabilisation of disturbed areas following completion of the works within that area. **Performance Target:** Stabilisation of all disturbed areas within 14 days of completion of the works within that area.	14 days after the completion of works within an area.	Environmental Manager Construction Manager Project/ Site Engineer	Revegetation/rehabilitation is being undertaken progressively throughout the site as areas are completed. See image 2.
	FF9	Native vegetation cleared from the construction footprint will be mulched and used along with retained topsoil for reuse in rehabilitation works and erosion control, as merchantable timber or for fauna habitat where appropriate.	**Performance indicator:** Use of timber as a result of clearing in rehabilitation works and erosion and sediment control (mulch), as merchantable timber or for fauna habitat, where appropriate. **Performance target:** Mulch is utilised for rehabilitation works in all areas nominated in the landscape plans and for erosion and sediment controls.	Daily (or as required).	Environmental Manager Construction Manager Project/ Site Engineer	Merchantable timber recovered from State Forest areas was transferred to the Forestry Corporation, and suitable fauna habitat was relocated to adjacent vegetation. Some timber was recovered for use as fauna furniture in combined and dedicated fauna underpasses. The remaining vegetation was mulched and the majority is being used for erosion and sediment control, landscape beds, and mixed with topsoil for revegetation works. The remaining portion of mulch has been stockpiled for later re-use, or transported offsite for re-use by various landowners for rehabilitation works.
	SW10	The development of Environmental Work Method Statements (EWMS) to provide detailed guidance on	**Performance indicator:** All works carried out in accordance with approved	Prepared and provided to relevant parties10	Environmental Manager	Where Environmental Work Method Statements are required these are developed prior to the specific work activity commencing, and detail the

	construction methodologies and will meet the requirements of the specifications and Conditions of Approval. They will detail the controls to be implemented, responsibilities, location, timing and details on how to implement controls.	EWMS. AND All high risk EWMS to be developed in consultation with relevant agencies. **Performance target:** 100% of works carried out in accordance with approved EWMS AND Relevant agencies consulted in the development of all high risk EWMS	days prior to commencement of the activity.	Environmental Manager	controls to be implemented, responsibilities, location, timing and details on how to implement controls. To date, environmental work method statements have been developed for: • Early works • Surveying • Site compound establishment • Design, construction and decommissioning of sediment basins • Clearing, grubbing and mulching • Concrete batch plant establishment and operation • Managing Phytophtera • Sealing and paving • Temporary waterway crossings • Topsoil stripping and stockpiling • Working near waterways • Smiths Creek bridge demolition • Water blasting and surface treatments at Maria River and Stumpy Creek All high risk EWMSs have been subject to agency consultation, generally through ERG meetings. Not all work within this reporting period was carried out in accordance with the approved EWMS. Non-compliances with EWMSs included being unable to return a basin to capacity within 5 days, not following the appropriate clearing flagging procedures, dewatering without a permit, and not conducting concrete washout activities in accordance with the EWMS.
SW17	Works will be programmed to minimise the extent and duration of disturbance to vegetation. This will include leaving clearing (undertaken by manual means) and initial earthworks in intermittent and permanent watercourses until subsequent works are about to commence.	**Performance indicator:** Vegetation retained in intermittent and permanent water courses until immediately before works are scheduled to commence. **Performance target:** 100% of vegetation is retained in intermittent watercourses until immediately prior to construction in those areas.	Immediately prior to works scheduled to commence. As detailed in location specific Progressive Erosion and Sediment Control Plans (PESCPs).	Superintendent Foreman Environmental Advisor	Works were programmed to retain vegetation in intermittent and permanent watercourses until subsequent works were about to commence. When clearing was conducted in these areas, the cut stump method was used to retain groundcover and stumps in situ until subsequent works were about to commence. The need to conduct cut stump tree clearing in this areas is detailed on the ESCPs.
SW25	Catch drains, contour and diversion drains across exposed areas will be installed immediately (i.e. within 24 hours and prior to forecast rain events) following clearing, and re-established and maintained during topsoil removal and earthwork operations.	**Performance indicator:** Installation of erosion and sediment controls following clearing. **Performance target:** 100% of the erosion and sediment controls on the ERSED plan installed within 24 hours or prior to forecast rain following clearing	Installed within 24 hours of clearing and prior to forecast rain events.	Superintendent Foreman Environmental Advisor	Erosion and sediment control plans are prepared progressively and regularly updated to reflect the stage of construction. Controls to be implemented during the clearing phase generally include windrowed vegetation and mulch, with priority around access to, and construction of, sediment basins. As such, these early erosion and sediment controls for the clearing phase were installed within 24 hours of clearing or prior to forecast rain, and then updated as the project moved into topsoil stripping. These controls have been reviewed during topsoil stripping and earthworks operations through the progressive erosion and sediment control plan process. Controls are then installed and maintained in accordance with the approved PESCP.
SW28	Erosion and sediment control structures will remain installed and maintained until sufficient vegetative cover is achieved. (i.e. 70% cover over 90% of the erodible catchment).	**Performance indicator:** All erosion and sediment controls maintained as 'Blue Book' requirements. **Performance target:** 100% of all erosion and sediment controls maintained to the 'blue book' standard.	Weekly inspection until there is 70% cover over 90% of the erodible catchment.	Superintendent Foreman Environmental Advisor	Erosion and sediment controls are not removed (unless to be upgraded, improved or replaced) until sufficient vegetative cover is achieved. The erosion and sediment control plans demonstrate this constant upgrading and improvement of controls, in accordance with the Blue Book. On 15 May 2017, erosion and sediment controls were removed before the batter had achieved sufficient vegetation cover. This resulted in sediment laden water leaving site and entering a neighbour's dam. The erosion and sediment control plan was updated and all controls installed and maintained as per that plan. As this stage of the project approaches operation, erosion and sediment controls are being removed in accordance with this requirement.
SW35	Temporary crossings will: • Be used for the shortest time required to complete their designed operational function and affected riparian vegetation will be rehabilitated as soon as possible to existing or better condition. • Use material that will not result in fine sediment material entering the waterway. • Where rock crossings are used, the rock will be of	**Performance indicators:** Temporary creek crossing EWMS to be developed in consultation with relevant agencies AND Temporary Creek Crossing EWMS meets the requirements of SW 35.	EWMS prepared and provided to relevant agencies at least 10 days prior to construction of temporary creek crossings commencing.	Environment Manager Temporary Works Manager	On this stage of the project, sacrificial pipes were installed at a number of permanent watercourses that require a culvert crossing. This allowed early removal of a number of temporary waterway crossings and significantly reduced the risk associated with maintaining clean water diversions through an active construction site. Pipe sizes in Class 1, 2 and 3 waterways have been agreed with the Department of Primary Industries (Fishing & Aquaculture) representative on site.

	suitable size to prevent/reduce the likelihood of the material being washed away in a storm or flood event, with large sized rock on the lower side of crossings where water velocity increases. • Pipes of sufficient size shall be used to provide fish passage in Class 1, 2 and 3 waterways. • Hydrocarbon booms shall be placed downstream of platforms and temporary crossings to intercept oil and grease.	**Performance targets:** No temporary creek crossing work to commence until relevant agencies have been consulted in development of the Temporary Creek Crossing EWMS. AND Temporary Creek Crossing EWMS contains and meets all the requirements of SW35			Hydrocarbon booms are installed in Pipers, Smiths, and Stumpy Creeks and Maria River during active construction works. These are shown on the ERSED plans for this stage of works. No temporary crossing work commenced until agencies were consulted on the EWMS (the EWMS was subject to consultation in October 2014 and work commenced in November 2014). The Temporary Creek Crossing EWMS contains all the requirements of SW35. All temporary waterway crossings have now been removed.
SW36	Scour protection will be installed at the base of permanent and temporary drainage outlets, and will be integrated where feasible into current banks to minimise impacts.	**Performance indicator**: Scour protection installed at the base of permanent and temporary drainage outlets. **Performance target:** All permanent and temporary drainage outlets have scour protection installed at the base	Prior to basin commission.	Foreman Environmental Advisor	Outlets of temporary controls are installed as per an approved design, or in accordance with Blue Book requirements, which includes scour protection. For example, basins are designed in accordance with the blue book, and include scour protection on the outlets. All permanent drainage outlets will have scour protection. The finalisation of permanent drainage is ongoing. See image 3.
SW37	Drainage works will be stabilised against erosion by appropriate selection of channel dimensions, slope and lining, and the inclusion, if necessary, of drop structures and energy dissipaters.	**Performance indicator:** Stabilisation of drainage works where required, by appropriate means. **Performance target:** Where required, all drainage work is stabilised by appropriate means.	Prior to any rainfall (events exceeding 10mm) event.	Foreman Environment Advisor	All clean water drainage works on the project are stabilised through measures such as geofabric and/ or plastic, rock, temporary cover crop, or through permanent revegetation or other permanent finishes such as concrete. See image 4.
SW38	Culverts and permanent stream protection measures will be installed as early as possible in the construction program to facilitate transverse drainage during the early stages of construction.	**Performance indicator:** Installation of culverts and permanent stream protection measures. **Performance target:** All culverts and permanent stream protection measures are installed during the early stages of construction.	Prior to clearing within that catchment.	Foreman Environment Advisor	On this stage of the project, sacrificial pipes were installed at a number of permanent watercourses that require a culvert crossing. This has allowed early removal of a number of temporary waterway crossings and significantly reduces the risk associated with maintaining clean water diversions through an active construction site. Additionally, permanent culvert structures were prioritised in the early stages of construction. All culverts and bridges across the main alignment have now been completed.
SW50	Sediment basins will be retained for a minimum of six months or until a 70% vegetative cover is achieved in its catchment; other satisfactory controls are in place and approved by the EM or the basin is otherwise redundant.	**Performance indicator:** All erosion and sediment controls maintained as 'Blue Book' requirements. **Performance target:** All erosion and sediment controls maintained to the 'blue book' standard.	Weekly inspection until there is 70% cover over 90% of the erodible catchment.	Environmental Manager	A small number of sediment basins are still in place and in use on the project. In some instances basins have been removed prior to achieving 70% vegetation cover. However in all cases this was due to the basin being redundant (ie too high compared to the surrounding cut), or because the progress of earthworks allowed this basin to be diverted to a larger sediment basin nearby. Suitable erosion and sediment controls are implemented in place of these basins, as approved by the soil conservationist and the Environmental Manager through the PESCP process.
SW65	Erosion and sediment controls will be inspected at least daily (with maintenance and/or modifications made as necessary). Inspections and/or maintenance during wet-weather maybe increased where necessary.	**Performance indicator:** All erosion and sediment controls maintained as per 'Blue Book' requirements. **Performance target:** All erosion and sediment controls maintained to the 'blue book' standard.	Daily Visual Inspection Weekly Environmental Inspection Post Rainfall Inspection (where required)	Foreman Environmental Advisor	Informal inspections are undertaken daily during construction by the environmental team. Inspections are conducted by the environment team weekly, and during and post-rainfall. These inspections are captured on a weekly environmental checklist and provide to site teams for actioning. Roads and Maritime and the Project Environmental Representative conduct fortnightly inspections, and agency representatives from the EPA and the Department of Primary Industries (Fishing and Aquaculture) conduct monthly inspections. During these inspections poorly operating controls are identified and their replacement actioned as part of the inspection close-out process. Actions required to ensure controls are maintained to Blue Book standard, must be completed for the inspection report to be closed out.
SW67	Watercourse bed and banks to be monitored weekly and post rainfall during construction for indications of instability. Attention to monitoring for channel erosion will be completed during and following higher than normal flow conditions. Protection measures will be installed should increase intensity or erosion be identified. Where increased intensity of erosion is identified that may have an impact on EPBC species or their habitat,	**Performance indicator:** Monitor instability in watercourse beds and banks. **Performance target:** All watercourse beds and banks inspected every week and after all rainfall	Weekly Environmental Inspection Post Rainfall Inspection (where required) Within 5 days or 1 day of identification depending on the risk.	Foreman Environmental Manager	Watercourse bed and bank monitoring is included in both informal inspections, and weekly, during and post rainfall environmental inspections by the environment team. See SW65 for frequency of environmental inspections, which includes inspections both during and post rainfall events.

		these will be rectified within 5 days. If there is an immediate risk of impact on EPBC Act listed species, temporary rectification works will occur within 1 day.	**Performance indicator:** Rectification of identified increased intensity of erosion within watercourse beds and banks that may impact on EPBC species or their habitat. **Performance target:** All areas of increased intensity of erosion within watercourse beds and banks that may impact on EPBC species or their habitat rectified within 5 days or 1 day (immediate risk).			
CoA 2c.	N/A	Measures to manage aquatic habitat on-site will be implemented as per the Giant Barred Frog Management Strategy (App C). These include: **3.2 Management Strategies** 1. Identification and protection of Giant Barred Frog habitat; 2. Pre-clearing Surveys to be implemented in four stages of: a. Early works when establishing site controls (i.e. clearing limits for clearing and grubbing) including ; b. Pre-clearing survey within 5 days of commencing the clearing and grubbing program; i. All Giant Barred Frogs captured will be relocated to the nearest side of the clearing limit: A permit is not required by NSW authorities for relocation of frogs and tadpoles). c. Clearing supervision during the clearing and grubbing program; and d. De-watering procedures within areas identified as Giant Barred Frog habitat (i.e. creek diversions). The dewatering process will be conducted in accordance with an Environmental Work Method Statement (EWMS) and the DECC (2008) Hygiene protocol for the control of disease in frogs Information Circular Number 6 (DECC 2008). All waterways and dams within those areas identified as Giant Barred Frog habitat will be subject to this dewatering process. Environmental Work Method Statement (EWMS) developed for all dewatering activities incorporating all measures outlined in section 3.2.2 iv of the GBF management strategy. Please note that the EWMS is a construction document and will be developed during construction. These will be developed by the environmental manager in consultation with the environmental review group (NSW EPA, fisheries, RMS and the JV) 3. Frog fencing in areas of Giant Barred Frog habitat considered in the context of: a. Temporary frog fencing; and b. Permanent frog fencing. 4. An unexpected finds procedure to address instances where Giant Barred Frogs are detected during routine pre-clearing surveys or at other times during the project. 5. Suitable land is identified within the Biodiversity Offset Package which contains a population of Giant barred Frogs. Note: The criteria for determining offset / compensatory habitat for the GBF will be contained in the Biodiversity Offset Management Plan and will comply with condition 5.	**Performance indicators:** Identify all known GBF habitat AND Implement frog fencing. AND All pre-clearance surveys undertaken by a suitably qualified ecologist as outlined in the definition provided in the EPBC approval. AND All pre-clearing surveys carried out within 5 days and no greater than 48hrs prior to clearing and grubbing activities within known GBF habitat. AND Project Ecologist / suitably qualified expert supervise clearing and grubbing operations in known areas of GBF habitat. AND Dewatering eWMS developed in consultation with the project ERG AND Implement frog fencing around known areas of GBF habitat AND Implement procedure following positive find of GBF AND Identification of suitable land within the Biodiversity Offset Package which contains a population of GBF's. AND As per GBFMP AND As per the Water Quality Monitoring Plan AND Surveys for GBF and habitat carried out. **Performance target:** 100% of the K2K sensitive area plans identify GBF habitat. AND All areas of known GBF habitat fenced at least 5 days prior to clearing commencing. AND All pre-clearing surveys carried out by a suitably qualified ecologist. AND	5 days prior to clearing in known areas of GBF habitat Within 5 days but no later than 48hrs of commencing clearing and grubbing in known areas of GBF habitat Daily in know areas of GBF habitat. 10 days prior to commencement of de-watering activities in known areas of GBF habitat 5 days prior to working in known areas of GBF habitat Immediately after positive finding GBF Prior to implementation of the Biodiversity Offset Package As per GBFMP As per the Water Quality Monitoring Plan Bi-annually during construction 5 days prior to clearing	Environmental Manager Environmental Advisor Foreman Engineer RMS	Giant Barred Frog habitat was identified as part of the pre-construction surveys. Frog fencing was implemented in these areas at least 5 days prior to the commencement of any construction works in these areas. This is progressively being replaced with permanent frog fence. All pre-clearing surveys were undertaken by the Project Ecologist, who meets the definition a suitably qualified expert in EPBC 2012/6518. Pre-clearing surveys for the Giant Barred Frog were carried out on two non-consecutive nights at least 5 days prior to clearing. This will be detailed in the Pre-clearing/ Clearing report to be submitted as part of the 2017/18 annual report (due to the fact that clearing was ongoing during this reporting period). Pre-Clearing surveys for the Giant Barred Frog were then conducted no greater than 48 hours prior to clearing, and these surveys and any relocations recorded on the Permit to Clear. This information will also be collated in the Pre-clearing/ Clearing report. All clearing within areas of known Giant Barred Frog habitat was supervised by the Project Ecologist. This is recorded on the Permit to Clear for these areas. A dewatering EWMS has been prepared in consultation with the ERG. Consultation took place in October 2014, and construction commenced in November 2014. There have been no unexpected finds of Giant Barred Frogs within the construction area to date. As such, the unexpected finds process has not been required to be implemented. As required, water quality monitoring has continued as per the Water Quality Monitoring Program in areas of known Giant Barred Frog habitat, specifically Smiths Creek, Pipers Creek and Maria River. A number of results that exceed the trigger values were considered not attributable to construction (eg Pipers Creek), as a close look at the raw data indicated that the upstream values were very similar to the downstream values during these individual monitoring events. The monitoring result at Maria River in March 2017 was found to be attributable to construction. In this instance, it was found that a low-flow valve had not been fully closed, and some water had been draining from the basin prior to it being treated and discharged in accordance with the EPL. The basin valve was closed immediately and the cause investigated. The sediment basin checklist now includes a requirement to inspect the low-flow valve during all basins inspections, and specifically after completion of a discharge. The issue was raised as an incident in accordance with the CEMP and the EPA notified as required under the EPL. See the Giant Barred Frog Monitoring Report in Appendix B for detailed water quality monitoring results. Giant Barred Frog monitoring is being conducted tri-annually during construction (to allow direct comparison with operational monitoring, which is tri-annually, rather than bi-annually). The results of this monitoring can be found in Appendix B.

		Monitoring of the Management Strategies The monitoring program will be limited to Smiths Creek, Pipers Creek and Maria River. Between 1-2 reference sites will also be incorporated into this monitoring program. Alternative reference sites could include upstream locations where Smiths Creek Road crosses Smiths Creek and Old Coast Road where it crosses Pipers Creek. **Frequency of Surveys** The surveys will be undertaken in spring, summer and autumn following operation of the project, between Year 4 and Year 8 (i.e. 5 years; Table 4-1. Year 4 represents the commencement of operation of either stage of the project – Oxley Highway to Kundabung or Kundabung to Kempsey). A baseline survey will be undertaken prior to construction and consist of one survey in spring, summer and autumn (i.e. three surveys). This approach will provide cues on habitat use within and adjacent to the road corridor leading up to construction and provide the basis for comparing the overall performance of the project. The baseline survey and (survey report) is to be completed prior to the commencement of clearing and grubbing within 500 m of Giant Barred Frog habitat identified at Smiths Creek, Pipers Creek and Maria River. Baseline monitoring data for the GBF has been included in the updated Ecological Monitoring Program. Refer to App A of the CEMP for detailed maps of GBF habitat and 'no-go' zones. **Frog and Tadpole Surveys** Frog and Tadpole surveys provide an additional means to assess population structure and as to whether frogs are breeding at the site. The survey procedure is outlined in the GBFMP **Habitat Surveys** Habitat surveys provide an opportunity to measure changes in the receiving environment over the life of the monitoring program. Habitat data would initially be collected each year during the spring sampling period and the need for additional habitat monitoring would be subject to review. A water quality monitoring program is in place. Implementation of the program has commenced and will continue for the duration of construction. This program includes water quality monitoring in GBF habitat, specifically Smiths creek, Pipers Creek and Maria River. During construction, habitat and frog survey data would be collected each year biannually.	All pre-clearing surveys carried out within 5 days and no greater than 48hrs prior to clearing and grubbing activities within known GBF habitat. AND All clearing and grubbing activities within known GBF habitat supervised by suitably qualified ecologist AND No dewatering works to commence until ERG is consulted on the Dewatering EWMS. AND Fencing installed around all known areas of GBF habitat at least 5 days prior to commencing work in GBF habitat. AND All unanticipated discoveries of the GBF immediately follow GBF finds procedure AND Biodiversity Offset strategy contains population of GBF or suitable habitat. AND All mitigation measures carried out as specified in the GBFMP AND All mitigation carried out as specified in the Water Quality Monitoring Plan AND All surveys for GBF and GBF habitat completed bi-annually during construction.	in known areas of GBF habitat Within 5 days but no later than 48hrs of commencing clearing and grubbing in known areas of GBF habitat Daily in know areas of GBF habitat. 10 days prior to commencement of de-watering activities in known areas of GBF habitat 5 days prior to working in known areas of GBF habitat Immediately after positive finding GBF Prior to implementation of the Biodiversity Offset Package As per GBFMP As per the Water Quality Monitoring Plan Bi-annually during construction	Environmental Manager Environmental Advisor	

					RMS	
	FF18	The measures identified in the Giant Barred Frog Management Plan will be implemented and include: Surveys will be undertaken 24 hours in advance of clearing to determine the presence of individuals within localised clearing areas in the form of a clearing survey. Frog fencing will be installed at least 5 days prior to the commencement of clearing in Giant Barred Frog Habitat Areas. Dewatering will be undertaken in accordance with the hygiene protocol described in CoA 2(a).	**Performance indicators:** Surveys of GBF habitat undertaken in advance of clearing AND Frog fencing installed prior to the commencement of clearing in suitable areas. AND Dewatering undertaken in accordance with the hygiene protocol described in CoA 2(a). **Performance targets:** All surveys for GBF are completed prior to clearing GBF habitat AND All frog fencing installed around GBF habitat prior to clearing AND All dewatering of known GBF habitat undertaken in accordance with the hygiene protocol described in CoA 2 (a)	24 hours prior to clearing 5 days prior to the commencement of clearing As required	Environmental Manager Project Ecologist / suitably qualified expert	Pre-clearing surveys for the Giant Barred Frog were carried out 24 hours prior to clearing and are recorded on the Permit to Clear. Frog fencing was implemented in these areas at least 5 days prior to the commencement of any construction works in these areas. Pre-clearing permits for the installation of frog fencing demonstrate that this occurred at least 5 days prior to clearing in these areas (it was done prior to Stage 1 clearing). This fencing is progressively being replaced with permanent fence. No dewatering is conducted into GBF habitat from another area of site; therefore no hygiene protocols have been required for this activity.
	FF6, FF34	The limits of clearing are to be clearly marked on all relevant work plans and protective fencing erected to mark these limits (i.e. 'no-go' areas). Fencing will be installed 5 days prior to vegetation clearing activities occurring. Riparian and aquatic habitat (including known GBF habitat) will be protected from construction works through the installation of protective fencing prior to works commencing in the vicinity.	**Performance indicators:** The limits of clearing clearly marked on all relevant work plans and protective fencing erected to mark these limits. AND Installation of protective fencing around riparian and aquatic habitat. **Performance targets:** 100% of relevant work plans contain clearing limits, an protective fencing erected along all limits of clearing at least 5 days prior to clearing commencing in that area. AND All riparian and aquatic protection fencing installed at least 5 days prior to construction works commencing within the vicinity.	5 days prior to vegetation clearing activities occurring 5 days prior to vegetation clearing activities occurring near riparian and aquatic habitat	Project / Site Engineers Foreman / Leading Hands Environmental Manager	Clearing limits are marked on the sensitive area plans. The installation of clearing fencing occurred as part of the pre-construction surveys. Clearing fencing, including fencing to protect riparian, aquatic and Giant Barred Frog habitat, was installed in each area at least 5 days prior to clearing commencing in these areas (see above).
	FF23	Removal of frog habitat along drainage lines will not be undertaken during wet weather (i.e. during or within 48 hours of rain events exceeding 10 millimeters).	**Performance indicator:** No removal of frog habitat along drainage lines during 'wet weather'. **Performance target:** All frog habitat removal to be completed during dry weather (i.e. not during or within 48 hrs of rain events exceeding 10 millimeters)	During or within 48 hours of rain events exceeding 10 millimetres.	Foreman/ Leading Hands Environmental Manager Project Ecologist / suitably qualified expert	No frog habitat was removed during wet weather. Clearing in Giant Barred Frog habitat areas during this reporting period was undertaken on the following dates: • Maria River – minor clearing over a number of days between 27 July and 1 August Rainfall records during this time indicate that there was no rainfall exceeding 10mm during or within 48 hours of these dates.
	FF33	Waterways (including known GBF habitat) will be protected from sediment impacts during construction, in accordance with the mitigation measures listed in the CSWMP and included within this table below (denoted by the 'SW' ID reference). Measures designed specifically to protect aquatic flora and fauna may include: • Installation of in stream sediment curtains	**Performance indicator:** If required, installation of in stream sediment curtains AND If required, construction of temporary diversions **Performance targets:**	Any time prior to the commencement of in-stream works Any time prior to the commencement of in-stream works	Environmental Manager Project Soil Conservationist Foreman	In stream works are now complete in all waterways. See image 5.

		• Construction of temporary diversions	Installation of sediment curtains in all streams where prescribed AND Installation of temporary diversions in all waterways, where prescribed			
	FF35	Existing trees, grasses and ground cover will be retained within 15 meters of watercourses (including known GBF habitat) until immediately before construction commences in that area (i.e. 48 hours). All trees in these areas will be felled manually, leaving grasses and small understory species wherever possible.	**Performance indicator:** Retention of trees, grasses and groundcovers within 15 metres of watercourse **Performance target:** All vegetation within 15 metres of a watercourse retained until immediately prior to construction	At least 48hrs prior to clearing operations within 15 meters of a watercourse	Environmental Advisor Foreman	Existing trees, grasses and groundcovers were retained within Pipers Creek and Smiths Creek until immediately prior to construction commenced in those areas. All trees in these areas were felled manually, and groundcovers retained where possible. Clearing was completed in these areas during the last reporting period. No clearing is required within Maria River.
	SW67	Watercourse bed and banks to be monitored weekly and post rainfall during construction for indications of instability. Attention to monitoring for channel erosion will be completed during and following higher than normal flow conditions. Protection measures will be installed should increase intensity or erosion be identified. Where increased intensity of erosion is identified that may have an impact on EPBC species or their habitat, these will be rectified within 5 days. If there is an immediate risk of impact on EPBC Act listed species, temporary rectification works will occur within 1 day.	**Performance indicators:** Completion of Weekly Environmental Inspection and Post Rainfall Inspection as required and following higher than normal flow conditions. AND Rectification of identified increased intensity of erosion within watercourse beds and banks that may have an impact on EPBC species or their habitat. **Performance targets** Completion of Environmental Inspections every week; and after all rain events, in all areas of work in and adjacent to watercourses AND All areas of increased intensity of erosion within watercourse beds and banks that may impact on EPBC species or their habitat rectified within 5 days or 1 day (immediate risk). .	Weekly Environmental Inspection Post Rainfall Inspection (as required). Within 5 days of identification (within one day when there is an immediate risk).	Environmental Advisor Environmental Advisor / Foreman	Watercourse bed and bank monitoring is included in both informal inspections, and weekly, during and post rainfall environmental inspections by the environment team. See SW65 for frequency of environmental inspections, which includes inspections both during and post rainfall events.
CoA 2d.	FF7	Prior to vegetation clearing, a suitably qualified ecologist will survey all areas to be cleared and will mark out any areas of significant vegetation (EECs, threatened species, riparian vegetation and mangroves) to be fenced and protected, in accordance with the methodology outlined in Section 4.3.1.	**Performance indicators:** Completion of Pre-Construction Surveys. AND Completion of Pre-Clearing Surveys. **Performance targets:** Completion of pre-construction surveys in all areas of clearing 20 days prior to clearing. AND Completion of pre-clearing surveys in all areas of clearing at least 24 hours but no greater than 48 hours prior to clearing.	20 days prior to clearing At least 24 hours but no greater than 48 hrs prior to clearing.	Environmental Manager Project Ecologist / suitably qualified expert	At least 20 days prior to all clearing, the Project Ecologist (who is suitably qualified), completed the pre-construction survey and surveyed all areas to be cleared. The survey included: • Confirmation of the accuracy of the sensitive area mapping, which includes areas of significant vegetation. No additional areas were identified for protection • Noxious weed survey including, location of weed infestations, species of weed, weed class, patch size and weed mapping. The results of these surveys will be included in the Pre-Clearing & Clearing Report for Stage 2, which has not been prepared as clearing was still underway during the last reporting period. This will be included in the 2017/18 annual report. The Project Ecologist also completed pre-clearing surveys in all areas to be cleared at least 24 hours, but no greater than 48 hours, prior to clearing in that area. These surveys are recorded on the Permit to Clear for each area, and will be collated in the Pre-Clearing / Clearing Report.
	FF24	A suitably qualified expert will undertake pre-clearance surveys for native fauna immediately prior to clearing activities. Searches will be undertaken on, hollow bearing trees, logs, existing culverts and bridges. Searches will take place no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the Koala, Giant-Barred Frog, Grey-headed Flying-fox, Spotted-tail Quoll, Little Eagle and other hollow dwelling species.	**Performance indicator:** Completion of Pre-Clearing Surveys. **Performance target:** Completion of pre-clearing surveys in all areas of clearing at least 24 hours but no greater than 48 hours prior to clearing.	At least 24 hours but no greater than 48 hrs prior to clearing.	Environmental Manager Project Ecologist / suitably qualified expert	The Project completed pre-clearing surveys in all areas to be cleared at least 24 hours, but no greater than 48 hours, prior to clearing in that area. These surveys are recorded on the Permit to Clear for each area, and will be collated in the Pre-Clearing / Clearing Report. The surveys included hollow bearing trees, logs, existing culverts, and bridges. These surveys also ensured that the area to be cleared was free of the Koala, Giant-Barred Frog, Grey-headed Flying-fox, Spotted-tail Quoll, Little Eagle and other hollow dwelling species.
	FF27	A two-stage clearing process will be implemented in all areas supporting identified fauna habitat such as hollow bearing trees, habitat trees and bushrock. • Non-habitat trees will be removed before habitat	**Performance indicator:** Completion of two-stage clearing in identified fauna habitat.	At least 24 hours but no greater than 48 hrs	Environmental Manager Project Ecologist /	All clearing was conducted in accordance with two stage clearing process. This is recorded on the Permit to Clear, and will be collated in the Pre-Clearing / Clearing Report.

		trees, allowing fauna an opportunity to move from the habitat trees. • Non-habitat trees will be removed at least 48 hours before habitat trees are removed (unless otherwise agreed by the EPA). • Felled (habitat) trees will be left for a short period of time (i.e. at least one hour except in instances approved by the Project Ecologist / suitably qualified expert) on the ground, to give any fauna remaining in the trees an opportunity to escape before further processing of the trees occurs. The Project Ecologist/ suitably qualified expert or wildlife handler will inspect the felled trees for resident species or injured wildlife. These will then be treated or relocated. Relocated wildlife will be moved the shortest possible distance to improve the likelihood of survival given this area is probably within the animals home range.	**Performance target:** Two-stage clearing conducted in all areas of fauna habitat.	prior to clearing.	suitably qualified expert	
CoA 2e.	N/A	Procedures shall be implemented to ensure that fauna identified during pre-clearance surveys are treated and handled in an appropriate manner. These procedures are outlined in Appendix I of this CFFMP, the Fauna Handling and Rescue Procedure.	**Performance indicator:** Implementation of the Fauna Handling and Rescue Procedure (Appendix I of this CFFMP). **Performance target:** Implementation of the Fauna Handling and Rescue Procedure in all cases of identified fauna during pre-clearance surveys.	As required	Environmental Manager Project Ecologist / suitably qualified expert	Number and type of fauna rescued during pre-clearing surveys has been recorded on the Permit to Clear, and will be collated in the Pre-Clearing /Clearing Report. The Fauna Handling and Rescue Procedure was implemented for all fauna rescues during pre-clearing surveys and throughout construction.
	FF4	A Project ecologist/ suitably qualified expert specific to the known threatened species found on site will be appointed prior to the commencement of construction.	**Performance indicator:** Presence of project ecologist/ suitably qualified expert during construction activities which have the potential to impact upon known locations of GBF. **Performance target:** Project ecologist/suitably expert present during all construction activities that have the potential to impact upon known locations of GBF	Appointment prior to the commencement of construction.	Environmental Manager Project Ecologist/ suitably qualified expert	The Project Ecologist (who meets the definition of a 'suitably qualified expert' in EPBC 2012/6518) was engaged in June 2014. Construction of this stage of the project commenced in mid-November 2014. The Project Ecologist appointed has specific experience in a range of threatened species, including but not limited to Giant Barred Frogs, Quolls and Koalas. The Project Ecologist was present for all clearing works that have the potential to impact on known locations of GBF, as documented in each Permit to Clear.
	FF26	During the proposed clearing works, the Project Ecologist/ suitably qualified expert or an experienced wildlife handler under the supervision of the Project Ecologist / suitably qualified expert will be present to retrieve and provide appropriate care of any displaced fauna and release the fauna into adjacent habitats safe from construction work.	**Performance indicators:** Implementation of the Fauna Handling and Rescue Procedure (Appendix I). AND Presence of suitably qualified individual during clearing activities. **Performance target:** Implementation of the Fauna Handling and Rescue Procedure in all cases of identified fauna during all clearing works AND Suitably qualified individual present during all clearing activities	At all times during clearing activities.		The Project Ecologist was present during all clearing works conducted on the project to retrieve and provide appropriate care of any displaced fauna. Full detail of these works will be included in the Pre-Clearing / Clearing Report. All rescued fauna were released into adjacent habitat, at the discretion of the Project Ecologist, to ensure they remained safe from ongoing construction work.
	FF28	Contact details for the Project Ecologist / suitably qualified expert, FAWNA, the Port Macquarie Koala Hospital and local veterinary hospitals will be maintained and kept at a convenient location on the Construction Site and must be available to the relevant management and supervisory personnel at all locations where clearing is being undertaken, to enable quick contact in the event of a fauna rescue.	**Performance indicators:** Contact details of details for the Project Ecologist / suitably qualified expert, FAWNA, the Port Macquarie Koala Hospital and local veterinary hospitals placed on notice boards in main office and crib sheds. AND	Prior to the commencement of construction.	Environmental Manager	Contact details for the Project Ecologist / suitably qualified expert, FAWNA, the Port Macquarie Koala Hospital and local veterinary hospitals can be found on notice boards at the main compound and crib sheds. These are now being progressively decommissioned. These contact details are also included in the Fauna Handling and Rescue Procedure. The Clearing and Grubbing EWMS contains the contact details of the Project Ecologist, FAWNA, the Port Macquarie Koala Hospital and local veterinary hospitals.

			Contact details of details for the Project Ecologist / suitably qualified expert, FAWNA, the Port Macquarie Koala Hospital and local veterinary hospitals incorporated in the Clearing and Grubbing EWMS. **Performance targets:** Contact details for the Project Ecologist / suitably qualified expert, FAWNA, the Port Macquarie Koala Hospital and local veterinary hospitals placed on all notice boards in main office and crib sheds prior to clearing. AND Contact details of details for the Project Ecologist / suitably qualified expert, FAWNA, the Port Macquarie Koala Hospital and local veterinary hospitals incorporated in the Clearing and Grubbing EWMS prior to clearing.	Provided to the relevant parties 10 days prior to clearing.		
FF22	Specific measures identified in the Pre-clearing checklist/Fauna Handling and Rescue Procedure will be followed. Specifically: • Clearing will be conducted in two stages (felling of non-habitat trees followed by habitat trees at least 24 hours later). • Felling of habitat trees within koala habitat will only be undertaken in the presence of a suitably qualified koala spotter.	**Performance indicators:** Clearing conducted in two stages (felling of non-habitat trees followed by habitat trees at least 24 hours later). AND Felling of habitat trees within koala habitat undertaken in the presence of a suitably qualified koala spotter. **Performance targets:** All clearing conducted in 2 stages (felling of non-habitat trees followed by habitat trees at least 24hrs later) AND Presence of a suitably qualified koala spotter present for all felling of habitat trees within koala habitat	All clearing activities.	Site Engineers Foreman Environmental Advisor Project Ecologist / suitably qualified expert	All clearing was conducted in two stages in accordance with the Fauna Handling and Rescue procedure. This is recorded in the Permit to Clear and will be included in the Pre-Clearing / Clearing Report. Felling of all habitat trees, within and outside koala habitat areas, was conducted under the direct supervision of the Project Ecologist, who is considered to be a suitably qualified koala spotter.
CoA 2f.	N/A	Key milestones, monitoring actions, performance indicators and timeframes are identified in this table relating to Conditions 2.a and 2.e inclusive. All nonconformities identified during surveillance, monitoring, inspections and audits must be closed out and signed off within the timeframe agreed with the Principal, the Project Environmental Representative, and relevant Authorities. Written responses to non-conformities identified must be provided to: • The Principal, the Project Environmental Representative and relevant regulatory Authorities within 5 working days; except • Non-conformities identified in audits where a response must be provided within 7 working days.	**Performance indicators:** Compliance with all mitigation measures (including timeframes) outlined within this table and approved Construction Environmental Management Plan. AND All non-conformities be closed out and signed off within the timeframe agreed with the Principal, the Project Environmental Representative, and relevant Authorities **Performance targets:** Compliance with all mitigation measures outlined within this table (including timeframes) and approved CEMP AND All non-conformities closed out within the timeframe agreed with the Principal, the Project Representative and relevant authorities	As outlined in this table.	Environmental Manager RMS Project Environmental Representative	There were no non-conformities with the mitigation measures outlined in the Flora and Fauna Management Plan raised during this reporting period.
		For each non-conformance identified, a corrective/preventative action (or actions) must be implemented. In addition, any environmental management improvement opportunities can be initiated because of incidents or emergencies, monitoring and measurement, audit findings or other reviews. Improvement opportunities may also result in the	**Performance indicator:** Written responses to non-conformities identified provided to: • The Principal, the Project Environmental Representative and relevant regulatory Authorities; except	Provided to the Principal within 5 working days Non-conformances		There were no non-conformities with the mitigation measures outlined in the Flora and Fauna Management Plan raised during this reporting period.

		implementation of corrective / preventative actions.	• Non-conformities identified in audits **Performance target:** All identified non-conformities responded to in writing and provided to: • The Principal, the Project Environmental Representative and relevant regulatory Authorities; except • Non-conformities identified in audits	identified and recorded in Monthly audits.		
		Corrective / preventative actions and improvement opportunities will be recorded and managed via the Project Commitments Register, or other suitable designated database. Details entered will include detail of the issue, action required and timing and responsibilities. The record will be updated with date of close out and any necessary notes. The database will be reviewed regularly to ensure actions are closed out as required. Procedures for rectifying any non-compliance identified during environmental auditing, review of compliance or incident management are also documented in the Compliance Tracking Program.	**Performance indicators** Up to date project commitments register, or other suitable designated data base. AND Non-compliances documented in the compliance tracking program. **Performance targets:** Project commitments register or other suitable designated data base kept up to date at all times. AND All non-conformances documented in the compliance tracking program	Quarterly (otherwise as required).		A database (Incident Register in iTWOcx) has been established to record all non-conformances and includes detail of the issue, action required and timing and responsibilities. All non-conformances are identified in the six-monthly compliance reports prepared as part of the compliance tracking program. Six-monthly reports have so far been prepared in March (July 2014 – January 2015), September 2015 (January 2015 – July 2015), March 2016 (July 2015 – January 2016), September 2016 (January 2016 – July 2016), March (July 2016 – January 2017), and September (January 2017 – July 2017) and provided to the EPA, DPI (Fishing & Aquaculture) and the Department of Planning & Environment. The reports are also available on the website at the following link: http://www.rms.nsw.gov.au/projects/northern-nsw/oxley-highway-to-kempsey/project-documents.html

Stage 3: Oxley Highway to Kundabung

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
General Measures					
EPBC 1 FF 1	Training will be provided to all project personnel, including relevant sub-contractors on matters of NES as identified in section 3.4.2.	**Performance indicator:** Induction of staff on NES matters prior to commencement of works on site. **Performance target:** 100% of all staff inducted on NES matters prior to commencement of work on site.	Site induction prior to work on-site	Environmental Manager	The induction is undertaken by all staff prior to the staff member commencing work. The induction room contains training resources including sensitive area plans, examples of different flagging tape and key environmental issues. Section 5.4 of the induction details flora and fauna requirements. Specifically: ❍ Report native fauna onsite and not to handle fauna ❍ All plant to be inspected and signed off as weed free. Need to clean down plant when changing location ❍ EWMS, staying within flagging tape, clearing permit, ecologist onsite during clearing, reporting koala sightings, Chytrid fungus washdown procedure. Induction includes an Environmental Induction Question sheet which all participants complete.
EPBC 2	Sensitive Area Plans showing site constraints (including matters of NES) shall be prominently displayed across the site. Sensitive Areas Plans form Appendix A6 of the CEMP.	**Performance indicator:** Display of Sensitive Area Plans at all primary and satellite compounds. **Performance target:** 100% of primary and satellite compounds have Sensitive Areas Plans displayed.	Prior to construction and for duration of construction.	Environmental Coordinators	A large full site sensitive area plan is provided within the training room at the main compound and is also available on the project drive, Environmental Manager's Office and design package EN01. See image 6. In satellite compounds, sensitive area plans are available on the desks of the Foreman for those areas. Satellite compounds are being progressively decommissioned.
EPBC 3 FF 7	Prior to vegetation clearing, a suitably qualified ecologist/expert will survey all areas to be cleared and will mark out any areas of significant vegetation (EECs, threatened species, riparian vegetation and mangroves) to be fenced and protected. Areas of weed infestation will also be identified and documented. These surveys will be completed no later than 20 working days prior to the commencement of clearing and will be limited to the time required to complete these surveys.	**Performance indicator:** Completion of pre-clearing survey including mark-out of clearing extents and identification of weed infestation prior to construction. **Performance target:** Completion of pre-clearing survey prior to construction including mark-out of clearing extents and identification of weed infestation in 100% of clearing areas.	No later than 20 days prior to commencement of clearing.	Environmental Manager Project Ecologist Environmental Coordinators	At least 20 days prior to clearing, the Project Ecologist (who is suitably qualified), completed the pre-clearing survey and surveyed all areas to be cleared. The survey included: • Confirmation of the accuracy of the sensitive area mapping, which includes areas of significant vegetation. No additional areas were identified for protection • Noxious weed survey including, location of weed infestations, species of weed, weed class, patch size and weed mapping.
EPBC 4 FF4	A Project ecologist / suitably qualified expert (an individual with tertiary qualifications and/or a minimum of three years demonstrated experience relevant to the task in question) will be appointed prior to construction where matters of NES are involved.	**Performance indicator:** Appointment of project ecologist/suitably qualified expert. **Performance target:** Appointment of project ecologist/suitably qualified expert prior to commencement of works.	Prior to the commencement of construction	Environmental Manager	Dr David Rohweder is the Project Ecologist. David has 18 years ecological experience and holds a PHD in applied science. David was appointed in August 2014, works commenced on this stage of the project in early November 2014.
EPBC 5 FF 5	Lend Lease will implement the construction ecological monitoring requirements for matters of NES during the construction phase as stipulated within the Ecological Monitoring Program.	**Performance indicator:** Completion of construction ecological monitoring requirements. **Performance target:** Completion of construction ecological monitoring requirements in accordance frequency stipulated in the EMP.	Timing and roles identified as per table 19 of the Ecological Monitoring Program found in Appendix K. Giant Barred Frog Monitoring will occur bi annually throughout construction.	Environmental Manager/ RMS	See Section 4 and Appendix B.
EPBC 6 FF 6	The limits of clearing are to be clearly marked on all relevant work plans and protective fencing erected to mark these limits (i.e. 'no-go' areas).	**Performance indicator:** Inclusion of sensitive areas on Sensitive Area Plans and limits of clearing on clearing drawings AND Completion of pre-clearing survey including mark-out of clearing extents and identification of weed infestation prior to construction. **Performance target:** 100% Sensitive Area Plans identify sensitive areas and 100% of clearing drawings identify clearing extents.	Limits of clearing will be marked out prior to clearing commencing in that area. Fencing installed prior to vegetation clearing activities commencing in that area. Fencing and no-go signage inspected	Project / Site Engineers Foreman / Leading Hands Environmental Coordinators	Sensitive areas are shown on the sensitive area drawings and clearing limits are shown on ESCP, plans attached to pre-clearing permits, and on CT01 drawings (clearing drawings). All clearing extents were marked out in the field using clearing flagging prior to the commencement of clearing in these areas. See EPBC 3 for discussion on completion of the pre-clearing survey.

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
		AND Completion of pre-clearing survey prior to construction including mark-out of clearing extents and identification of weed infestation in 100% of clearing areas.	weekly, Until construction completion.		
CoA 2a.					
EPBC 7	Weeds will be managed in accordance with the management actions detailed in Section 7 of the weed and pathogen management plan (Appendix J)	**Performance indicator:** Completion of weed management actions outlined in Appendix J. **Performance target:** Completion of all weed management actions outlined in Appendix J in the timeframes specified.	As outlined in Appendix J.	Project / Site Engineers Foreman / Leading Hands Environmental Coordinators	Hire plant inspection reports are completed for all incoming plant and equipment onto the project. This includes a check for weed and pest infestation. Weed monitoring is documented in the weekly environmental inspection checklist. Weed mapping identifies areas of weed infestation and weed free areas. Topsoil outside of the high weed infestation areas has been identified for reuse Weed control is being undertaken as part of revegetation works.
EPBC 8 FF36	Washing procedures for plant and equipment will be in accordance with the process described for machinery in Table 8.1 of Appendix J.	**Performance indicator:** Wash down of plant and equipment before entering site. **Performance target:** 100% of plant and equipment are washed down before entering site.	All plant prior to use on site.	Project / Site Engineers Foreman / Leading Hands Environmental Coordinators	A vehicle wash down facility is provided at the workshop. Boot washdown facilities were available at areas of GBF habitat prior to hardstand tracks and parking areas being implemented. A boot washdown facility has recently been established at Barrys Creek as part of Stage 2 clearing (the western side of the highway following the traffic switch).
EPBC 9 FF37	The spread of bacteria, viruses and diseases such as Myrtle rust, *Phytophthora cinnamomi*, amphibian chytrid fungus and beak and feather disease will be addressed through washing of equipment. The washing procedure will be undertaken in accordance with the process described in Table 8.1 of Appendix J.	**Performance indicator:** Wash down of plant and equipment before entering site. AND Implementation of Chytrid Fungus wash down procedure in Appendix J. **Performance target:** 100% of plant and equipment washed down before entering site. AND Chytrid Fungus washdown procedure is implemented prior to the commencement of work in all areas required in the procedure.	All plant during construction prior to use on site. As outlined in Appendix J.	Project Engineers Foreman / Leading Hands Environmental Coordinators	See EPBC 8.
EPBC 10	Weed management training will be provided to key staff on-site.	**Performance indicator:** Provision of weed management training to key staff on site. **Performance target:** 100% of key staff provided with weed management training during construction.	Induction for all personnel prior to commencing work on site.	Environmental Manager	Weed management training is provided through inductions, which is compulsory for all staff prior to commencing work. Further training is provided to key staff (eg clearing contractors) via toolboxes on the EWMS.
EPBC 11 FF 9 FF10	Revegetation/rehabilitation of areas disturbed as part of construction of the project that do not form part of the permanent pavement or structures will be undertaken progressively during and following construction to maintain and enhance habitat, particularly in identified regional corridors and key habitat areas. Re-vegetation and rehabilitation works will be completed as soon as possible following the completion of earthworks, with a preference for progressive stabilisation of works. Vegetation species selected for rehabilitation will be representative of the vegetation communities adjacent to the specific area of works. Rehabilitation works shall be completed in accordance with the approved Landscape design and evidence of the application of native vegetation species shall be recorded and maintained throughout construction. Following completion of construction of the OH2Ku project, re-vegetation/rehabilitation areas should achieve a species diversity and quality similar to the vegetation community adjacent to the works.	**Performance indicator:** Direct seeding (hydromulch) of disturbed areas following completion of all construction activities. AND Completion of rehabilitation works in accordance with the approved Landscape design. AND Use in landscaping works seed mix representative of the vegetation community adjacent to the works. **Performance target:** Direct seeding (hydromulch) of disturbed areas within 14 days of completion of all activities required to finalise and rehabilitate disturbed areas, including the placement of topsoil. AND Completion of all rehabilitation works in accordance with the approved Landscape	Direct seeding will be completed 14 days from completion of works (completion of all activities required to finalise and rehabilitate disturbed areas, including placement of topsoil). Rehabilitation works will be completed prior to construction completion. Seed mixes will be selected prior to commencement of revegetation works in each area. Revegetation/rehabilitation areas will be assessed Six-monthly; during	Project / Site Engineers Foreman / Leading Hands Environmental Manager	Rehabilitation and revegetation is occurring progressively. These areas are being hydromulched in accordance with the approved landscape design. See image 7. Tubestock planting has also commenced across most of the site, in accordance with the approved landscape design. Seed mixes in the approved landscape design are broadly representative of the adjacent vegetation communities. All landscaping works use the seed mix outlined in the approved landscape design. Additional seed, or different species of seed, is being added in some locations where revegetation outcomes can be improved.

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
	The success of re-vegetation of the disturbed areas will be assessed by the Landscape Representative and collated into a Landscaping Review to be completed following construction completion and provided to RMS. Where the works do not meet the standards specified above additional landscape planting or native seeding may be required to achieve the desired outcome.	design prior to Construction Completion. AND 100% of landscaping works use seed mix representative of the vegetation community adjacent to the works.	construction period and 36 month landscape maintenance period. As required by Landscape Review.		
CoA 2b.					
EPBC 12 FF8	Native vegetation cleared from the construction footprint will be mulched and used along with retained topsoil for reuse in rehabilitation works and erosion control. Mulch and topsoil will not be stockpiled in 'no-go' areas and cleared vegetation will not be pushed into 'no-go' areas.	**Performance indicator:** Use of mulch in accordance with landscaping plans and erosion and sediment control plans. AND Storage of mulch and topsoil within approved stockpile areas outside no-go areas. **Performance targets:** Mulch is utilised in all areas nominated in landscaping plans and erosion and sediment control.	Use of mulch for landscaping and erosion and sediment control will be monitored progressively. Locations of stockpiles will be checked as part of weekly inspections.	Project / Site Engineers Foreman / Leading Hands Environmental Coordinators	Mulch has been used extensively across the site for erosion and sediment controls including perimeter bunds and blended with topsoil for rehabilitation. No mulch or topsoil has been stored in no-go areas nor has cleared vegetation been pushed into no-go areas.
EPBC 13 FF 31	Permanent water quality control measures will be installed as early as possible in the construction program and at least prior to construction completion. The timeframe for 'construction completion' is variable and will depend on a range of construction delays such as weather and other unforeseen delays. As per SW25 temporary controls will be installed within 24 hours and prior to forecast rain events following clearing. Installation of permanent water quality control measures includes stormwater pits, kerbs and pipes, and permanent erosion protection measures such as scour protection and must be completed prior to construction completion. With the exception of temporary water quality basins installed in accordance with SW25, permanent water quality controls are linked to the completion of permanent built works. While a construction program can be submitted that outlines indicative timeframes for installation of some of these measures, Lend Lease cannot accurately predict a specific milestone for their installation in the construction program as it may be subject to construction delays due to a range of issues including weather, plant and machinery availability, and other unforeseen construction difficulties.	**Performance indicator:** Permanent controls installed and operating prior to completion of construction. AND Temporary controls in place and maintained during construction as per ESCP. **Performance targets:** 100% of permanent controls installed and operational prior to the completion of construction. AND All temporary controls installed within 24 hours of clearing completion in that area and maintained as per ESCP.	Permanent controls prior to completion of works (completion of all activities required to finalise and rehabilitate disturbed areas, including placement of topsoil). Temporary controls installed within 24 hours and prior to forecast rain events following clearing.	Project / Site Engineers Foreman / Leading Hands	Nearly all permanent water quality control measures have been installed. This work will be ongoing until construction completion. All temporary controls are installed and maintained as per the ESCP. Controls were implemented within 24 hours of clearing, or sooner if rain was forecast. This was documented on the ESCP and checked during follow up environmental inspections.
EPBC 14 FF32	Waterways will be protected from sediment impacts during construction, in accordance with the CEMP. Measures designed specifically to protect aquatic flora and fauna may include: • Installation of in stream sediment curtains. • Construction of temporary diversions.	**Performance indicator:** Erosion and Sediment controls installed as per ESCP. AND Controls in waterways inspected and poorly operating/damaged controls repaired. **Performance targets:** All erosions and sediment controls installed as per ESCP. AND All controls in waterways inspected weekly and all poorly operating controls replaced.	Progressively. Weekly	Project / Site Engineers Foreman / Leading Hands Environmental Coordinators	Erosion and sediment controls on-site are installed as per the Progressive Erosion and Sediment Control Plans. Inspections are conducted by the environment team weekly, and during and post-rainfall. Roads and Maritime and the Project Environmental Representative conduct fortnightly inspections, and agency representatives from the EPA and the Department of Primary Industries (Fishing and Aquaculture) conduct monthly inspections. During these inspections poorly operating controls are identified and their replacement actioned as part of the inspection close-out process.
EPBC 15	Water quality monitoring of matters of NES Habitat in Cooperabung Creek for the following parameters: • pH, • Dissolved oxygen, • Electrical conductivity, • Temperature, • Turbidity, • Total Suspended Solids,	**Performance indicator:** Water quality monitoring outlined in the Water Quality Management Plan. **Performance target:** 100% of water quality monitoring results are within trigger values in section 5 of Water Quality Management Plan (identified below). *High values:* if median values at the downstream site is *above*	Two wet events (where trigger rainfall events occur) and one dry event per month.	Roads and Maritime	Water quality monitoring was conducted in accordance with the Water Quality Monitoring Program during this reporting period. There were no instances where an exceedence of a trigger value at Cooperabung Creek was considered to be attributable to construction, and not a result of a licenced discharge under the EPL.

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
	• Hydrocarbons, • Trace metals, • Nitrogen, and • Phosphorous	80% of the recorded background water quality records (80th percentile). *Low values:* if median values at the downstream site are *below* the 20% of the recorded background water quality records (20th percentile). *Both values:* both the 80th and 20th percentile values of the upstream site can be compared with the median values of the downstream site.			
EPBC 16 FF34	Existing trees, grasses and ground cover will be retained within 15 metres of watercourses of known habitat of matters of NES (Cooperabung Creek) until immediately before construction commences in that area Works will be programmed to minimise the extent and duration of disturbance to vegetation where possible. This will include leaving clearing (unless undertaken manually or by other means that cause minimal disturbance (i.e. felling trees and leaving the stump in situ) and initial earthworks in intermittent and permanent watercourses until subsequent works are about to commence.	**Performance indicators:** Retention of vegetation in Cooperabung Creek. AND Avoidance of clearing in all watercourses until subsequent works are about to commence, or felling of vegetation manually or with minimal disturbance. **Performance targets:** No less than 15m of vegetation retained within Cooperabung Ck until construction commences in those areas. AND 100% of clearing in all watercourses left until works are about to commence unless all vegetation is felled manually / with minimal disturbance.	Prior to construction commencing in that area. Prior to construction commencing in watercourses.	Construction Manager Environmental Coordinators	Existing trees, grasses and ground cover were retained within 15 metres of Cooperabung Creek until immediately before construction commenced in that area and clearing was conducted manually. The need to retain stumps and groundcovers in these waterways was shown in ESCP for these areas, and confirmed through subsequent environmental inspections. The area of disturbance at Cooperabung Creek was greatly reduced during clearing, resulting in the retention of riparian vegetation under the footprint of the new Cooperabung Creek Bridge.
EPBC 17 SW1	The potential for erosion during the construction of the Proposal would be appropriately managed in accordance with the measures contained within Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Managing Urban Stormwater: Soils and Construction Volume 2D, Main Road Construction (DECC 2008b).	**Performance indicators:** Erosion control measures within the ESCPs are in accordance with the Blue Book. AND Controls inspected and poorly operating/damaged controls repaired. **Performance targets:** All erosion control measures nominated in the ESCPs are in accordance with the Blue Book. AND All controls inspected weekly and all poorly operating/ damaged controls repaired.	Prior to the commencement of construction in that area, or prior to changed work activities in that area. Weekly.	Construction Manager Environmental Coordinators	Erosion and sediment controls within the ESCPs are in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Managing Urban Stormwater: Soils and Construction Volume 2D, Main Road Construction (DECC 2008b) (the Blue Book). Inspections are conducted by the environment team weekly, and during and post-rainfall. Roads and Maritime and the Project Environmental Representative conduct fortnightly inspections, and agency representatives from the EPA and the Department of Primary Industries (Fishing and Aquaculture) conduct monthly inspections. During these inspections poorly operating controls are identified and their replacement actioned as part of the inspection close-out process.
EPBC 18 SW10	The following EWMS will be prepared where required and implemented to manage soil and water impacts which have a risk of impact on matters of NES : • Temporary waterway crossings; • Culvert and transverse drainage construction; • Managing runoff from curing processes; • Clearing and grubbing; • Sediment basin design, construction and management; • Dewatering; • Construction of temporary creek diversions. • In stream works.	**Performance indicators:** Preparation of EWMS for nominated activities. AND Construction activities undertaken in accordance with EWMS and staff tool boxed on requirements. **Performance targets:** No works commencing in these areas until an EWMS has been prepared for the activity. AND All construction activities conducted in accordance with the EWMS. AND 100% of staff toolboxed on EWMS requirements before starting work in those areas.	Prior to the commencement of the activity. Ongoing.	Superintendent/Environment Manager/Foreman	Environmental Work Method Statements have been prepared and implemented for temporary waterway crossings, culvert construction, clearing & grubbing, sediment basin design, construction & management, dewatering, and concrete paving (which covers curing runoff). Construction of temporary creek diversions and in stream works is covered in the Minor Temporary Waterway Crossings and Minor Working Platforms EWMS. Construction Work Method Statements are also prepared for specific areas, for example Cooperabung Creek. These work methods are in accordance with the EWMS for the type of construction activity being undertaken, and also contain detailed information specific to the site under construction. Relevant staff are toolboxed on the requirements of the EWMS prior to work commencing.
EPBC 19 SW25	Catch drains, contour banks and diversion drains across exposed areas will be installed immediately following clearing as per the ESCP, and re-established and maintained during topsoil removal and earthworks operations.	**Performance indicators:** Installation of controls in accordance with the ESCP.	Within 24 hours of the completion of clearing in that area.	Superintendent Foreman	See EPBC 14.

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
	Temporary Erosion and Sediment (ERSED) controls will be installed within 24 hours and prior to forecast rain events following clearing.	AND Inspection of controls and identification of poorly operating/damaged controls. **Performance target:** 100% of controls in ESCP installed within 24 hours of completion of clearing in that area. AND All controls inspected weekly and all poorly operating/ damaged controls repaired.	Weekly.		
EPBC 20 SW28	Erosion and sediment control structures will remain installed and maintained until a minimum of 70% vegetative cover is achieved. This will be determined through consultation with a suitably qualified professional (Certified Professional in Erosion and Sediment Control).	**Performance indicators:** Installation of temporary erosion and sediment controls in accordance with ESCP. AND Inspection of controls at least weekly to identify operating/damaged controls. AND Removal of controls following consultation with suitably qualified professional. **Performance targets:** 100% of controls are installed as per the ESCP. AND All controls inspected weekly and all poorly operating/ damaged controls repaired. AND No controls are removed until suitably qualified professional has been consulted.	Ongoing during construction Weekly Ongoing	Superintendent Foreman	See EPBC 19 for compliance with the installation of controls as per the ESCP and inspection compliance. Controls are only removed once these catchments have been reviewed, and an updated PESCP prepared in consultation with the Soil Conservationist.
EPBC 21 SW17	Works will be programmed to minimise the extent and duration of disturbance to vegetation. This will include leaving clearing (unless undertaken manually or by other means that cause minimal disturbance(i.e. felling trees and leaving the root ball ,soil structure and existing groundcovers in situ) and initial earthworks in intermittent and permanent watercourses until subsequent works are about to commence.	**Performance indicator:** Clearing in all watercourses. **Performance target:** 100% of clearing in all watercourses left until works are about to commence unless all vegetation is felled manually / with minimal disturbance.	Prior to construction commencing in watercourses.	Superintendent Foreman	Existing trees, grasses and ground cover were retained within 15 metres of watercourses until immediately before construction commenced in that area and clearing was conducted manually. The need to retain stumps and groundcovers in these waterways was shown in ESCP for these areas, and confirmed through subsequent environmental inspections.
EPBC 22 SW35	Where temporary crossings are required, these shall be designed, constructed and maintained in accordance with Managing Urban Storm water Soils and Construction Volumes 2A and 2D Main Road Construction (DECC 2008) and section 5.3.4 of the guideline Managing Urban Storm water 4th edition March 2004, Volume 1 Soils and Construction (the 'Blue Book') and subject to the preparation of an EWMS identified in SW10 and SW33. Temporary crossings will: • Be 'fish friendly' with a lower section of the temporary crossing provided to act as an emergency spillway. Including the use of the adequate size and number of pipes set at bed level to facilitate fish passage in Class 1 -3 waterways. • Be used for the shortest time required to complete their designed operational function and affected riparian vegetation will be rehabilitated as soon as possible where the permanent design footprint does not overlay the temporary crossing location. • Use material that will not result in fine sediment material entering the waterway. Where rock crossings are used, the rock will be of suitable size to reduce the likelihood of the material being washed away in a storm or flood event, with large sized rock on the lower side of crossings where water velocity increases.	**Performance indicators:** Design of temporary crossings. AND Construction and maintenance of temporary crossings. AND Rehabilitation of temporary crossings **Performance targets:** 100% of temporary crossings designed in accordance with the Blue Book. AND 100% of temporary crossings constructed and maintained as per design. AND 100% of temporary crossings rehabilitated within 24 hours of removal.	Prior to construction of temporary crossing Ongoing Within 24 hours of the removal of the temporary crossing.	Environment Manager Superintendent Engineers	All temporary waterway crossings have been designed in accordance with the Blue Book. The initial construction of the Cooperabung Creek stage 2 crossing was not in accordance with the design. This was immediately rectified and has since complied with the design requirements. All other crossings have been constructed and maintained as per the design, including the use of suitably sized rock to prevent the material being washed away in a flood or storm event. Where temporary crossings were removed during this reporting period, rehabilitation commenced within 24 hours of complete removal. Staged crossing removal, or removal of a crossing that spanned several days, resulted in temporary ERSED controls being installed. See Image 8.
EPBC 23 SW 36	Scour protection shall be installed at the base of permanent and temporary drainage outlets, and will be integrated where feasible into existing banks to minimise impacts.	**Performance indicator:** Installation of scour protection installed at the base of all drainage outlets.	Prior to commissioning these structures.	Engineers	Scour protection has been installed at the base of all drainage outlets prior to commissioning, as per the approved design drawings. Outlets of temporary controls are installed as per an approved

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
		Performance target: Scour protection installed at 100% of drainage outlets prior to commissioning.			design, or in accordance with Blue Book requirements, which includes scour protection. For example, basins are designed in accordance with the blue book, and include scour protection on the outlets.
EPBC 24 SW 37	Drainage works shall be stabilised against erosion by appropriate selection of channel dimensions, slope and lining, and the inclusion, if necessary, of drop structures and energy dissipaters.	**Performance indicators:** Preparation of ESCPs inclusive of erosion control measures. AND Erosion controls installed and maintained as per ESCPs. **Performance targets:** All erosion and sediment control measures installed are in ESCPs. AND 100% of erosion and sediment control plans prepared prior to works commencing in that area. AND 100% of erosion and sediment controls installed and maintained as per ESCPs.	Prior to commencing works in that area. Ongoing.	Engineers	The PESCPs outline all ERSED controls to be implemented within that section of the site. All PESCPs are prepared prior to work commencing in that area, as they are subject to a hold point process with Roads and Maritime. See EPBC 14. Onsite, controls can be found to be the appropriate width, depth and slope to prevent erosion. See image 9.
EPBC 25 SW 38	Culverts and permanent stream protection measures shall be installed as early as possible where the construction program permits, to facilitate transverse drainage during the early stages of construction.	**Performance indicator:** Timing of culvert construction. **Performance target:** Where traffic staging permits, 100% of culverts are constructed within the first 12 months of the construction programme.	Within 12 months of clearing in that location.	Superintendent Foreman Engineers	All of the structural aspects of the drainage culverts identified in Schedule 3 of EPBC 2012/6518 approval are complete, with finishing works such as scour protection and landscaping remaining on some culverts. Not all culverts were completed within the first 12 months of the construction programme, however this was due to traffic staging (ie the traffic needs to be switched off the existing highway onto the new road for these to be completed). Construction of all bridge structures are complete. See image 10.
EPBC 26 SW 45	Operational water quality basins shall be constructed for use during construction of the project. Prior to the completion of construction, these, shall be converted to provide operational phase water quality management.	**Performance indicators:** Construction of operational water quality basins. AND Conversion of permanent basins to operational basins. **Performance targets:** 100% of operational basins constructed for use during construction. AND 100% of permanent basins are converted to operational basins prior to the completion of construction in that area.	During construction. Prior to the completion of construction.	Engineer Superintendent	All operational basins will be used at some stage during construction to manage water quality (the timing of which is subject to access and construction staging). All basins have now been fitted out with permanent basin furniture and are ready for operation. Construction is still ongoing across the project.
EPBC 27 SW 50	Sediment basins shall be retained for a minimum of six months or until a 70% vegetative cover is achieved in its catchment; other satisfactory controls are in place and approved by the EM in consultation with a suitably qualified soil conservationist or the basin is otherwise redundant.	**Performance indicator:** Retention of sediment basin. **Performance target:** No sediment basins are removed until management action criteria are achieved.	Minimum of six months or until management action criteria achieved.	Environmental Manager	All basin decommissioning requests have been approved by the project Soil Conservationist. These were generally removed as 70% cover had been achieved in the catchment, they were redundant controls (ie no water could reach the sediment basin due to, for example, it being perched above construction works after the completion of a cutting) or no longer required under the Blue Book. Other satisfactory controls were installed after approval by the EM and review by the Soil Conservationist through the PESCP sign-off process. The EPA is also notified of basin decommissioning prior to this occurring. This notification includes the revised PESCP.
EPBC 28 SW 65	Erosion and sediment controls shall be inspected informally at least daily (with maintenance and/or modifications made as necessary). Formal inspections will be conducted weekly with maintenance and/or modifications made as identified. Inspections and/or maintenance will also be undertaken daily during	**Performance indicators:** Completion of informal and formal inspections. AND Completion of maintenance of erosion and	Informal inspections daily and formal inspections weekly for the duration of construction.	Environmental Coordinators	Informal inspections are undertaken daily during construction, by the environmental team. Inspections are conducted by the environment team weekly, and during and post-rainfall. These inspections are captured on a weekly environmental checklist and provide to site teams for

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
	periods of rainfall and within 24 hours of the cessation of a rainfall event causing runoff to occur on or from the premises.	sediment controls. **Performance targets:** Informal inspection conducted on 100% of work days. AND Formal inspections undertaken every week during construction. AND 100% of maintenance actions in inspection reports are undertaken.	Ongoing.		actioning. Roads and Maritime and the Project Environmental Representative conduct fortnightly inspections, and agency representatives from the EPA and the Department of Primary Industries (Fishing and Aquaculture) conduct monthly inspections. During these inspections poorly operating controls are identified and their replacement actioned as part of the inspection close-out process. Actions must be completed for the inspection report to be closed out.
EPBC 29 SW 66	A Project soil conservation specialist shall inspect the work areas, assess drainage and riparian conditions, prepare and /or review erosion and sediment control plans and provide advice to the Project team to maintain a high standard of erosion and sediment practices on site. Inspections will be undertaken typically on a fortnightly basis, or as required where high-risk activities are proposed, or where sensitive areas have the potential to be affected (SEPP 14 wetland, heritage sites). Inspections and timing will be reviewed regularly by the Environmental Manager in response to site conditions, risk profile and stage of the project.	**Performance indicators:** Engagement of project soil conservation specialist. AND Preparation and review of ESCPs by soil conservationist. AND Completion of inspections by soil conservationist. **Performance targets:** No construction works commence until soil conservation specialist engaged. AND 100% of ESCPs are prepared or reviewed by the soil conservationist prior to the commencement of work in that area. AND Soil conservationist inspections conducted every fortnight during construction. AND No high risk activities commence until soil conservation inspection has been conducted.	Prior to the commencement of construction. Prior to the commencement of work in that area. At least fortnightly.	Soil Conservation Specialist Environment Manager	Soil conservation specialist was engaged on 21 May 2014, construction commenced on this stage in early November 2014. All PESCPs are reviewed by the soil conservationist prior to be implemented. Inspections by the soil conservationist are being conducted as required, due to the lower risk profile of the project now that paving is nearing completion and large areas have been rehabilitated. During this reporting period inspections were conducted prior to commencing high risk activities, eg stage 2 bridge construction works at Cooperabung Creek.
CoA 2c.					
EPBC 30 SW 67	Watercourse bed and banks shall be monitored weekly and post rainfall during construction for indications of instability. Attention to monitoring for channel erosion will be completed during and following higher than normal flow conditions. Protection measures may be required should increased intensity or erosion be identified as a result of construction activities.	**Performance indicators:** Inspections for instability of watercourse bed and banks completed weekly and post rainfall. AND Protection measures implemented as recommended by these inspections. **Performance targets:** All watercourses inspected every week and after all rainfall events. AND 100% of the recommendations from these inspections implemented within 5 days (likely impact) or 48 hours (immediate risk).	Weekly and post rainfall Where increased erosion is observed and is likely to impact matters of NES in Cooperabung Creek, the erosion will be rectified within 5 working days. This timeframe may be extended if the cause of erosion is highly complex and requires detailed analysis, in this case a temporary preventative solution will be installed and maintained in lieu of final rectification. If an immediate risk of impact to matters of NES species in Cooperabung Creek, i.e temporary rectification will be undertaken within 48 hours of the risk being	Soil Conservation Specialist Environmental Coordinators	Watercourse bed and bank monitoring is included in both informal inspections, and weekly environmental inspections by the environment team. The weekly environmental inspection checklist includes a requirement to check “are beds of watercourses or banks showing signs of erosion caused by construction?” See EPBC 28 for frequency of environmental inspections, which includes inspections both during and post rainfall events. No increased intensity or erosion has been identified in any of these inspections, so there have been no recommendations from this part of the inspection to date.

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
			identified.		
EPBC 31 FF7	Prior to vegetation clearing in areas of known or potential Habitat for matters of NES, suitably qualified ecologist/expert will survey all areas to be cleared and will mark out any areas of significant vegetation (EECs, threatened species, riparian vegetation and mangroves) to be fenced and protected. Areas of weed infestation will also be identified and documented.	**Performance indicators:** Suitably qualified expert surveys area to be cleared and marks significant vegetation no later than 20 working days prior to clearing commencing. AND Weed infestations identified and documented as part of these surveys. **Performance targets:** No clearing commences until surveyed by a suitably qualified expert no later than 20 working days prior to clearing. AND 100% of weed infestations identified during these surveys are documented.	These surveys will be completed no later than 20 working days prior to the commencement of clearing and will be limited to the time required to complete these surveys.	Environmental Manager Project Ecologist	At least 20 days prior to clearing, the Project Ecologist (who is suitably qualified), completed this survey and surveyed all areas to be cleared. The survey included: • Confirmation of the accuracy of the sensitive area mapping, which includes areas of significant vegetation No additional areas were identified for protection. • Noxious weed survey including, location of weed infestations, species of weed, weed class, patch size and weed mapping. The results of these surveys are included in the Pre-Clearing & Clearing Report for Stage 3, which is included in Appendix B.
EPBC 32	Pre clearing surveys for Giant Barred Frog at Cooperabung Creek shall be undertaken in accordance with the following (as identified in section 3.2.2 of Appendix B): a) Within 48 hours of scheduled clearing/ground disturbance operations, the Project Ecologist will perform pre-clearing surveys over a minimum of two non consecutive nights (i.e. before clearing). b) Surveys are to last 1 person hour per hectare of habitat to be disturbed/removed and involve the use of call broadcast, spotlighting and active searches of litter, debris and logs. c) All Giant Barred Frogs captured will be relocated to the nearest side of the clearing limit with information collected on sex, breeding condition and snout-vent length. Alternative relocation sites may be considered provided they occur within the same drainage line. As a general rule, frogs should not be relocated further than 300 m from the capture site which should theoretically remain within an individual's home range. d) Frogs with a snout-vent length >40 mm will be PIT3 tagged to document the performance measure of this as a suitable relocation strategy. Juvenile/sub adult frogs may be marked in accordance with the animal care and ethics licence of the Project Ecologist. e) A frog hygiene protocol will be adopted at sites with known Giant Barred Frog habitat. This protocol will be in accordance with Department of Environment and Climate Change DECC (now EPA) Hygiene protocol for the control of disease in frogs Information Circular Number 6 (DECC 2008). As part of this hygiene protocol the status of Chytrid fungus will be assessed by taking swab samples of captured frogs.	**Performance indicators:** Completion of pre-clearing surveys for the Giant Barred Frog. AND Relocation of captured Giant Barred Frogs outside the clearing limit. AND Implementation of Chytrid Fungus washdown procedure in Appendix J. **Performance targets:** No clearing / ground disturbance in Giant Barred Frog habitat unless pre-clearing survey conducted within 48 hours. AND 100% of Giant Barred Frogs captured are relocated outside clearing limit. AND Chytrid Fungus washdown procedure is completed in all areas identified in Appendix J prior to work in those areas.	48 hours prior to clearing in Cooperabung Creek. During pre-clearing surveys. As outlined in Appendix J.	Environmental Manager Project Ecologist Environmental Coordinators	All pre-clearing surveys were undertaken in accordance with the requirements of the Giant Barred Frog Management Plan (in Appendix B of the FFMP). Chytrid fungus washdown is not required at Cooperabung Creek, as this creek was identified as being infected prior to the commencement of construction. Two Giant Barred Frogs were relocated during surveys for stage 2 works at Cooperabung Creek. These frogs were relocated 120m and 190m upstream, outside the clearing limit. Further information can be found in Appendix B.
EPBC 33	Relocation of Giant Barred Frogs shall be undertaken by a suitably qualified expert.	**Performance indicator:** Captured Giant Barred Frog relocated suitably qualified expert. **Performance target:** 100% of Giant Barred Frog relocations undertaken by a suitably qualified expert.	During pre-clearing surveys.	Project Ecologist Environmental Manager Environmental Coordinators	All Giant Barred Frog relocations have been undertaken by the Project Ecologist who qualifies as a suitably qualified expert under EPBC 2012/6518. These have all been at Cooperabung Creek.
EPBC 34 FF22	Clearing in Cooperabung Creek will be conducted outside of periods of wet weather to minimise impacts to habitat values consistent with the Giant Barred Frog Strategy.	**Performance indicator:** Clearing in Cooperabung Creek. **Performance target:** No clearing in Cooperabung Creek conducted in wet weather.	Prior to clearing commencing in these areas.	Project Ecologist Superintendent Environmental Coordinators	No clearing in Cooperabung Creek for stage 2 works (the western side of the highway following the traffic switch) was conducted on the following dates: • 11/01/17 • 13/01/17 • 20/01/17 • 24/03/17 Rainfall records during these times indicate that there was no rainfall exceeding 10mm during these periods (ie at least 48 hours prior to these dates).

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
EPBC 35 FF 33	Riparian and aquatic habitat in the vicinity of Cooperabung Creek shall be protected from construction works through the installation of protective temporary frog fencing and signage prior to works commencing. Protective fencing will be maintained until construction activities in that area are complete Riparian vegetation impacted by construction would be rehabilitated.	**Performance indicators:** Installation of temporary frog fencing and signage adjacent to Cooperabung Creek. AND Commencement of rehabilitation of impacted riparian vegetation. **Performance targets:** No works commence in Cooperabung Creek until temporary frog fence and signage is installed. AND 100% of riparian vegetation rehabilitation commences within 24 hours of construction completion in that area.	Prior to works commencing in these areas. Within 24 hours of construction completion in that area.	Project / Site Engineers Foreman / Leading Hands Environmental Manager Environmental Coordinators	Temporary frog fencing and signage was installed at Cooperabung Creek prior to work commencing in this area. Works in this area are ongoing on the southbound carriageway and therefore fencing remains in place on the eastern side of the project. Permanent fencing has been installed on the western side now that works are complete on the northbound carriageway. Revegetation has been conducted on the western side through hydromulching and landscape planting.
EPBC 36	Dewatering procedures in Cooperabung Creek shall be in accordance with section 3.2.2(iv) of the Giant Barred Frog Management Strategy: a) In accordance with an Environmental Work Method Statement (EWMS) and the DECC (2008) Hygiene protocol for the control of disease in frogs Information Circular Number 6 (DECC 2008). b) Where the water body is to be pumped dry, the intake pipe must be positioned in the deepest section. This will avoid further disturbance of the aquatic habitat prior to capture and relocation of aquatic fauna. c) Screening of the pump intake (5mm mesh size) will be installed to prevent tadpole entrainment. d) Dip netting will be undertaken to remove as many aquatic fauna as practical once the water body is shallow enough to be effectively waded through by field personnel. e) All tadpoles will be identified and sorted by species and/or genus and placed into separate holding containers. The size of these containers will be left to the discretion of the qualified expert. f) All tadpoles will be released into permanent/semi-permanent pools in adjacent habitats by the qualified expert. Tadpoles will be first acclimatised to the recipient sites water temperature by immersing bags or aquaria in the release pools to allow a gradual equilibrium of water temperature prior to release. g) In instances where there are numerous tadpoles from a wide range of species, preferential treatment will be given to Giant Barred Frog tadpoles due to their legislative status as an endangered species. The release of predatory species (i.e. eels) will not occur in areas where Giant Barred Frog tadpoles are being released. This will reduce the risk of additional predation and/or competition.	**Performance indicators:** Development of dewatering EWMS for Cooperabung Creek. AND Implementation of Chytrid Fungus wash-down procedure in Appendix J. AND Dewatering works in these areas. **Performance targets:** No dewatering works conducted in Cooperabung Creek until dewatering EWMS developed. AND Chytrid Fungus washdown procedure is completed in all areas identified in Appendix J prior to work in those areas. AND 100% of dewatering activities in Cooperabung Creek conducted in accordance with the EWMS.	Prior to dewatering commencing in these areas. As per Appendix J. Ongoing.	Project / Site Engineers Foreman / Leading Hands Environmental Coordinators Qualified expert (for tadpole relocation)	Dewatering EWMS was subject to agency consultation in October 2014. No dewatering in Cooperabung Creek was conducted prior to this time and all dewatering in these areas was conducted in accordance with this EWMS. In addition the EWMS for Minor Temporary Waterway Crossings and Minor Working Platforms includes these specific requirements for Cooperabung Creek. All dewatering activities within Cooperabung Creek have complied with these requirements. Chytrid fungus washdown is not required at Cooperabung Creek, as this creek was identified as being infected prior to the commencement of construction.
EPBC 37	The sensitive area plans and clearing plans for the project in the vicinity of Cooperabung Creek shall identify clearing extents and known and potential Giant Barred Frog Habitat.	**Performance indicator:** Inclusion of Giant Barred Frog habitat and clearing extents for Cooperabung Creek in Sensitive Area Plans and clearing plans. **Performance target:** 100% of sensitive area plans identify Giant Barred Frog habitat, and 100% of clearing plans identify clearing extent in Cooperabung Creek.	Prior to construction commencing in these areas.	Environmental Manager	The CT01 design package (clearing plans) identifies the clearing extents in Cooperabung Creek. Giant Barred Frog habitat at Cooperabung Creek is identified on the Sensitive Area Plans.
CoA 2d.					
EPBC 38 FF 23	A suitably qualified expert will undertake pre-clearance surveys for matters of NES immediately prior to clearing activities. Searches will be undertaken for nests, hollow bearing trees, logs & bat roosts within existing culverts and bridges. Searches will take place no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the Koala, Giant-Barred Frog, Grey-headed Flying-fox, and Spotted-tail Quoll.	**Performance indicator:** Completion of pre-clearance surveys for matter of NES. **Performance target:** 100% of pre-clearance surveys are conducted no earlier than 48 hours prior to clearing commencing in that area.	No earlier than 48 hours prior to clearing	Project / Site Engineers Construction Manager Project Ecologist Environmental Coordinators	Pre-clearing surveys for matters of NES were conducted no earlier than 48 hours prior to clearing commencing in that area. These surveys will be documented in the Pre-Clearing/ Clearing Report for this stage, included in Appendix B.

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
EPBC 39 FF24	During the proposed clearing works, the suitably qualified expert or an experienced wildlife handler under the supervision of the suitably qualified expert will be present to retrieve and provide appropriate care of any displaced matters of NES and release the fauna into adjacent habitats safe from construction work.	**Performance indicators:** Clearing works undertaken with suitably qualified expert or experienced wildlife handler present. AND Relocation of fauna relocation conducted by suitably qualified expert or an experienced wildlife handler. **Performance targets:** Suitably qualified expert or experienced wildlife handler present for 100% of clearing works. AND 100% of fauna relocation conducted by suitably qualified expert or wildlife handler.	During all clearing. During all clearing.	Environmental Manager Superintendent Project Ecologist Environmental Coordinators	A suitably qualified expert or experienced wildlife handler was present during all clearing works. All Giant Barred Frog relocations have been conducted by a suitably qualified expert. Two Giant Barred Frog relocations were conducted during this reporting period and further details can be found in Appendix B.
EPBC 40 FF25	Clearing activities for the project will be undertaken in accordance with the following two stage process in all areas supporting identified matters of NES and fauna habitat such as hollow bearing trees, habitat trees and bushrock. This process will include but not be limited to: • Non-habitat trees will be removed before habitat trees, allowing fauna an opportunity to move from the habitat trees; • Habitat trees will be retained for a minimum of two night's after initial clearing, unless the Project Ecologist determines the tree can be removed one night after initial clearing safely; and • Felled habitat trees will be assessed by the Project Ecologist to determine if there is fauna remaining in the tree(s). Resident species or injured wildlife will be treated or relocated. In the event that a hazardous habitat tree is identified (a risk to the safety of workers and/or flora and fauna), an assessment will be under taken to identify any need for removal of the habitat tree prior to the minimum requirements stipulated above. This assessment will be undertaken with the Project Ecologist, the Clearing contractor, Lend Lease Environmental Manager, Lend Lease Safety Manager and a designated RMS Representative. If the tree is deemed a hazard to safety the following actions may be taken: ▪ Removal of the tree immediately (if there is low risk to injury of wildlife during felling). ▪ Removal of the tree within 24hrs of initial clearing if there is a high potential for significant fauna occupation. ▪ Establishment of an exclusion zone around the tree, and felling 48hrs after initial clearing (if there is a high potential for significant fauna occupation and a high risk of injury to fauna during felling). Dead or hazardous trees identified on the clearing boundary or with the potential to cause construction and/or operational safety concerns will be subject to an assessment for removal. If the tree is deemed to unsafe to remain it will be felled following the initial clearing front in accordance with approved clearing methodologies. If the tree is identified as a habitat tree and compensatory habitat assessments (i.e additional nest boxes) will be investigated and implemented where required.	**Performance indicator:** All clearing done in accordance with two stage clearing procedure and hazardous tree protocol. **Performance target:** 100% of clearing done in accordance with two stage clearing procedure and hazardous tree protocol.	During all clearing.	Environmental Manager Construction Manager Project Ecologist Environmental Coordinators	All clearing was conducted in accordance with the two stage clearing procedure and hazardous tree protocol. This clearing, and the clearing of any hazardous trees, is captured in the pre-clearing / clearing permits, and this information has been collated in the Pre-Clearing/ Clearing Report for this stage, included in Appendix B.
CoA 2e.					
EPBC 41 App H	Fauna handling and rescue activities involving matters of NES shall be undertaken in accordance with Appendix H of this FFMP.	**Performance indicator:** Fauna handling and rescue conducted as per Appendix H. **Performance target:** All fauna handling and rescue done in accordance with Appendix H.	As per Appendix H.	Environmental Manager Construction Manager Project Ecologist Environmental Coordinators	See EPBC 39.

ID	Management Action	Performance Indicator/Target	Monitoring/Timing	Responsibility	Compliance Status
EPBC 44 FF 27	Contact details for the suitably qualified expert, local NPWS officers, FAWNA, RSPCA, the Port Macquarie Koala Hospital and local veterinary hospitals will be made available at the main site compound and should be attached to clearing permits for Clearing and Grubbing, These documents will be held by supervisory personnel at all locations where clearing is being undertaken, to enable quick contact in the event of a fauna rescue.	**Performance indicator:** Inclusion of contact details at main site compound and attached to clearing permits. **Performance target:** Contact details always available at main site compound and attached to 100% of clearing permits.	Prior to commencement of clearing each day.	Environmental Coordinators Foreman	Relevant contact details are provided on all Clearing and Grubbing permits. Contact details are also available on the Environmental Manager's Office door and in induction room, both of which are located at the main site compound. Clearing and Grubbing permits were held by supervisory personnel during clearing, to ensure these contact details were on hand if needed.
EPBC 45 FF21	Where clearing activities coincide with the Koala breeding season and a Koala with joey are identified in the clearing footprint, the following will be employed in consultation with the suitably qualified expert: - Temporary no go area; - Use of appropriate fencing to direct the Koala and Joey in a single direction outside the footprint; - Follow procedure identified in Section 5 of Appendix H	**Performance indicator:** Establishment of no go areas and provision of safe passage where a Koala with joey is identified during the breeding season. **Performance target:** No-go area established and safe passage provided immediately once Koala and Joey detected.	Immediately once Koala and Joey are detected in work area.	Project Ecologist Foreman / Leading Hands Environmental Coordinators	No koalas with joeys were identified within the clearing footprint during clearing.

Images

#	Description	Image
	Stage 2	
1	Lantana removal at Maria River	
2	Revegetation planting at Smiths Creek	

#	Description	Image
3	Permanent scour protection works at a culvert inlet and on drains feeding into the culvert	
4	Clean water drainage works stabilised with jute mesh, rock checks and hydromulch	

#	Description	Image
5	Completed works at Smiths Creek	
	Stage 3	
6	Environmental resources within the training / induction room	

#	Description	Image
7	Revegetation through tubestock planting (within the drain) and hydromulching in the background. This photo also shows the progressive installation of fauna fence	
8	Barrys Creek progressively rehabilitation (with jute mesh and seeding). Photo was taken within 24 hours of temporary crossing being removed and as such, the area has not yet been planted with tubestock.	

#	Description	Image
9	Permanent drainage works that have been stabilised against erosion by appropriate selection of channel dimensions and lining, and the inclusion of an energy dissipater.	
10	The completed Wilson River bridge	

Appendix B Ecological Monitoring Program

Species monitored	Report title
Giant Barred Frog spring, summer and autumn monitoring	Giant Barred Frog Monitoring 2016/2017
Road kill construction monitoring conducted in this reporting period	Road Kill Monitoring 2016/2017
Koala spring/summer 2016 (year 2) monitoring	Koala Monitoring 2016
Pre-Clearing / Clearing	Oxley Highway to Kundabung Clearing Report, 8 August 2017 OH2K Phase 2 Clearing Report – September 2015 – June 2017

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Giant Barred Frog Monitoring 2016/2017

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Roads and Maritime Services

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Cover photograph: Giant Barred Frogs (Photos: Frank Lemckert)

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Executive summary

Context

This report documents findings for the 2016/2017 monitoring period (including spring 2016, summer 2017 and autumn 2017 surveys) for the Giant Barred Frog (*Mixophyes iteratus*), as required by the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, RMS 2016).

The Giant Barred Frog is one of the threatened species identified as requiring mitigation and monitoring throughout the course of the construction and operational periods of the Oxley Highway to Kempsey (OH2K) Pacific Highway upgrade (the Project).

Aims

The aim of the Giant Barred Frog monitoring program is to determine whether the Project is meeting the performance indicators for the species, and provide corrective actions where required.

Methods

Six sites (two reference and four impact) have been monitored. Each monitoring location was surveyed in accordance with the monitoring method and design specified in the EMP.

Key results

A total of 149 Giant Barred Frogs were recorded during the 2016/2017 monitoring period and 32% (n = 40) of those captured were recaptures. Frogs were recorded at all sites during all seasons with the exception of Pipers Creek impact site where no frogs were recorded during the autumn survey.

All sites showed evidence of breeding via presence of juveniles or sub-adults, gravid females or reproductive males during at least one survey event.

Chytrid fungus was detected for the first time at the Cooperabung Creek impact site. Chytrid fungus is now therefore considered to be present at all monitoring sites.

All sites had at least one water quality parameter for one or more monthly results for which the median downstream value exceeded the 80th percentile of the upstream value.

Conclusions

Monitoring related performance measures and Giant Barred Frog population and habitat use related performance measures have to date been met.

The performance measure related to continued presence of Giant Barred Frogs during each survey event where it was identified during baseline surveys was met for 5 of 6 sites. Giant Barred Frogs were not recorded at Pipers Creek impact site during the autumn survey where it was recorded during baseline surveys. However, as autumn surveys have shown reduced activity during almost all survey events and frog detection can vary between survey events, the absence of records of the species during this single survey cannot yet be considered as indicating the absence of this species from this site, where it was detected spring and summer surveys.

The water quality performance measure was was met for all sites except Maria River. Other values above the 80Th percentile trigger value were not considered to be attributable to construction activities. The incident at Maria River was addressed immediately and procedures were put in place to avoid reoccurrence.

Management implications

A number of general recommendations have been made including consideration of continued Lantana control to improve monitoring efficiency, implementation of Chytrid fungus hygiene protocol at all impact sites and the cessation of Chytrid swabbing of frogs.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Environment (DoE) for matters of national environmental significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (RMS 2016) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project. The Giant Barred Frog (*Mixophyes iteratus*) was one threatened species identified as requiring mitigation and monitoring through the course of the Projects' construction and post construction period.

1.1.1 Legal Status

The Giant Barred Frog is listed as endangered by the New South Wales Biodiversity *Conservation Act 2016* (BC Act) and Commonwealth EPBC Act. Monitoring of the species is required under the Project's approval.

1.1.2 Monitoring Framework

The design, methods and performance indicators that define the Giant Barred Frog monitoring program are specified in the EMP and Giant Barred Frog Management Strategy (GBFMS, Lewis 2013). Where there are discrepancies between the EMP and the GBFMS, the EMP takes precedence (Section 1.2 RMS 2016).

The EMP requires monitoring of the Giant Barred Frog three times a year (spring, summer and autumn) in years 1, 2 and 3 once substantial construction commenced. Following the completion of the project, monitoring will continue in the same manner for a further five consecutive years, or until the mitigation measures can be demonstrated to be effective. To date, these monitoring events have been reported as follows:

- *Autumn 2015*: Niche 2015a.
- *Spring 2015, summer and autumn 2016*: Niche 2016.
- *Spring 2016, summer autumn 2017*: current report.

To complete the required three cycles of construction monitoring, a spring and a summer survey remain. These surveys will be undertaken in spring 2017 and summer 2018 and be the subject of the final report for construction monitoring for the Giant Barred Frog. This report therefore represents the third of four necessary construction monitoring reports for the Giant Barred Frog. Operational monitoring is projected to commence in autumn 2018.

1.1.3 Baseline Data

The EMP specifies the following regarding the Giant Barred Frog:

"The Giant Barred Frog was recorded at Maria River and suitable habitat was identified at Smiths Creek, Pipers Creek and Cooperabung Creek during surveys undertaken to inform the Environmental Assessment (GHD 2010). Targeted surveys undertaken over eight nights between late November 2012 and late January 2013, involving spotlighting, call- playback and tadpole searches, identified the Giant Barred Frog at Cooperabung Creek (south), Cooperabung Creek downstream at Haydons Wharf Road, Smiths Creek, Pipers

Creek and Maria River. Areas of suitable habitat for the Giant Barred Frog were also identified at both Stumpy Creek and Barrys Creek"

The EMP lists six sites to be monitored:

- Four impact sites: Cooperabung Creek, Smiths Creek, Pipers Creek, and Maria River.
- Two reference sites: Sun Valley Road (where it crosses Cooperabung Creek), and Old Coast Road (where it crosses Pipers Creek).

Baseline surveys (Niche 2015b) recorded a total of 152 Giant Barred Frogs, at all six monitoring sites in spring and summer and at four sites in autumn. Frogs were absent from the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey.

1.1.4 Purpose of this Report

This report details the findings obtained from the third monitoring report for the construction phase of the Project.

The aims of this report are to summarise the methods and results of the spring 2016, summer 2017 and autumn 2017 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance measures

The EMP specifies the following performance measures for the Giant Barred Frog:

- *Monitoring is undertaken during baseline surveys and Years 1 – 8 or until monitoring can demonstrate that mitigation measures are effective.*
- *Monitoring during Years 1 – 8 is undertaken at the Impact and Control sites where baseline monitoring was undertaken, subject to landowner agreement.*
- *Continued presence of Giant Barred Frogs during each survey event in Years 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.*
- *Mitigation measures are effective as defined in the EPBC approval when all monitoring events are considered at Year 8.*
- *Median values of all downstream water quality monitoring at GBF habitat or potential habitat locations during construction and operation (Year 1 – 6) is less than the 80th percentile value of the upstream site (where 80th percentile is the value at which median values at the downstream site are above 80% of the recorded background water quality records), where this change is found to be attributable to construction or operation.*
- *No change to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Years 1 – 8, and then when all monitoring events are considered at Year 8.*

1.3 Monitoring timing

Monitoring is to occur three times a year: spring summer and autumn. Monitoring is to occur in the middle of the season, within one week of rainfall of 10 mm within a 24 hour period.

1.4 Reporting

Annual reporting of monitoring results will outline:

- Detailed description of monitoring methodology employed.
- Results of the monitoring period.

- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations.
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the Director General of the Department of Planning and Environment and the Environment Protection Authority.

1.5 Limitations

The following limitations to the monitoring procedure were encountered:

- An increasing density of Lantana (*Lantana camera*) at a number of sites, notably Maria River impact site and Pipers Creek impact site, is hampering survey efforts. Safe navigation of the creek lines has become difficult due to low vision and steep creek beds. Giant Barred Frogs were not detected during autumn surveys at Pipers Creek impact site.

2. Survey Methods

2.1 Monitoring sites

Monitoring was undertaken at the four impact and two reference sites. Each site consists of a one kilometre transect along the creek line.

Where possible, impact site transects extend 450 metres upstream and 450 metres downstream of the Project footprint (assumes project boundary width of 100 metres) and are divided into 10 x 100 metre zones, resulting in four to five zones downstream of the Project footprint, one within the Project footprint, and four to five upstream of the Project footprint. As for previous monitoring events, he Cooperabung Creek impact site was not surveyed for the full kilometre as access agreements with landowners could not be obtained for the final zone downstream, and for the first three zones upstream.

Reference sites are located several kilometres upstream of the Project footprint.

The locations of all monitoring sites are shown in Figure 1, with detailed locations for each site transect provided in Figure 2 to Figure 7.

2.2 Giant Barred Frog survey method

Surveys were undertaken in accordance with the EMP.

A 2 hour minimum search time at each site was employed, however access and movement difficulties due to dense vegetation often resulted in increased survey time. Surveys involved passive listening, call playback (upon arrival and at intervals during searches), active searching (within 20 m of creek bank) and habitat surveys. In accordance with the EMP, the following habitat data was collected within each of the 100 m zones:

- Overstorey vegetation cover (OS, expressed as a cover percentage out of 100%).
- Shrub cover (expressed as a cover percentage out of 100%).
- Ground cover (expressed as a cover percentage out of 100%).
- Leaf litter cover (expressed as a cover percentage out of 100%).
- Bare soil/earth (expressed as a cover percentage out of 100%).
- Presence of cattle (based on hoof marks, manure and whether it is recent or aged evidence).
- Number of pools and riffles within the zone.
- Approximate depth of the deepest pool within the zone.
- Number of breaches in frog fencing, if applicable.

The position of all observed Giant Barred Frogs was recorded and, where possible, individuals were captured. Captured frogs were checked for recapture status and fitted with a Passive Integrated Transponder (PIT) tag if the individual was previously unknown. In accordance with the EMP, the following data were collected for captured frogs:

- Location according to demarcated survey zone.
- Distance from stream edge.
- Sex (male, female, unknown).
- Breeding condition with:
    - Males assessed on the colouration of their nuptial pads (i.e. no colour, light, moderate, dark).
    - Females based on whether they are gravid or not gravid (egg bearing).

- Snout-vent length (millimetres).
- Weight (grams).
- General condition of the frog, including a swab sample to test for the presence of Chytrid fungus.

The weather conditions recorded for each survey included temperature and humidity (either by windwatch or hygrometer), % cloud cover and broad wind level (scale of 0-3 where 0 = no wind). Rainfall (mm) within the previous 24 hours, 7 days and 30 days was recorded from the Roads and Maritime Services Weather Stations Oxley Highway to Kempsey upgrade – Telegraph Point (station code RMSN1AWS). This data was collected to indicate the suitability of the weather conditions at the time of the surveys.

2.3 Water quality

Water quality monitoring was undertaken by Roads and Maritime Services between 22 July 2016 and 21 July 2017 and is presented in two six-monthly reports (RMS 2017a, 2017b). At the time of this report, the second six-monthly report (RMS 2017b) was not available, however analysed data and highlighted issues were provided to Niche by Roads and Maritime Services. This report summarises water quality data from both upstream and downstream sites for Cooperabung Creek, Smiths Creek, Pipers Creek, and Maria Creek.

The median water quality value for downstream sites was compared with the site specific trigger values developed for the upstream site based on the 80th percentile and, where relevant, the 20th percentile (where parameters have a lower acceptable limit e.g. EC, DO, pH, NTU), as well as the ANZECC default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems for freshwater systems. Trigger values were derived from 24 sampling events up to and including the month indicated, where data was available.

2.4 Analysis

The Minimum Known to be Alive (MKTBA) was also calculated (see Sutherland 2006) to provide a simple comparative measure of population size. This index is based on the number of new individuals encountered over multiple visits, where any new animals are summed, providing an aggregate total. Limitations of this method are that it does not account for any migration out of the population or any death, so may over-estimate the total population size if counts are completed over a long period of time.

3. Results

3.1 2016/2017 Giant Barred Frog monitoring results

Field data are presented in Annex 1 and Annex 2.

3.1.1 Survey results

A total of 149 Giant Barred Frogs were recorded during the 2016/2017 monitoring surveys. Frogs were recorded at all six sites during all but one monitoring event (Table 1). Of the 149 frogs recorded, 126 were captured, of which 40 were recaptures (32%). During construction one tagged Giant Barred Frog was relocated from the construction footprint to a suitable release site 190 m upstream along Cooperabung Creek.

As in previous surveys, captures were higher during summer surveys than spring and autumn at four sites. Pipers Creek reference site recorded the greatest mean number of frogs, while Cooperabung Creek reference site recorded a mean number of frogs similar to the impact sites.

The MKTBA count was the highest at the Pipers Creek reference site (n = 38), while the estimate for the Cooperabung Creek reference site (n = 8) was lower than the impact sites (n = 11 – 26).

Table 1: Giant Barred Frogs recorded at each site during 2016/2017 surveys

	Cooperabung Creek impact	Smiths Creek impact	Pipers Creek impact	Maria River impact	Cooperabung Creek reference	Pipers Creek reference
Spring	8	3	7	13	3	17
Summer	9	21	5	13	7	30
Autumn	2	5	0	1	3	2
Mean number of frogs per survey	6.33	9.67	4.00	9.00	4.33	16.33
Standard Error (SE)	2.19	5.70	2.08	4.00	1.33	8.09
MKTBA	15	26	11	24	8	38

3.1.2 Evidence of breeding

Table 2 presents breeding evidence records. All sites showed evidence of breeding via the presence of juveniles or sub-adults, gravid females or reproductive males during at least one survey event.

Table 2: Breeding evidence records

		Juveniles	Sub-adults	Gravid females	Nuptial pads
Cooperabung Creek impact	Spring		2		Light to dark
	Summer	2	1	2	Dark
	Autumn		1	1	
Maria River impact	Spring		2	5	Mostly light
	Summer			6	Mostly dark
	Autumn			1	
Pipers Creeks impact	Spring	2	2	2	
	Summer			1	Light
	Autumn				
Smiths Creek impact	Spring		1		Light
	Summer		3	3	Light to dark
	Autumn	1	1		Moderate
Cooperabung Creek reference	Spring			3	
	Summer				Dark
	Autumn		1	1	Moderate
Pipers Creek reference	Spring	2		3	Dark
	Summer	1	1	8	Light to dark
	Autumn		1		

3.1.3 Weather conditions

The prevailing weather conditions encountered during the field surveys are summarised in Table 3. More details of the prevailing micrometeorological conditions at the six sites during the field surveys are presented in Annex 1. Conditions were similar to those recorded during the baseline surveys.

Table 3: Weather conditions: spring 2016, summer 2017 and autumn 2017 surveys

Date	Min temp (˚C)	Max temp (˚C)	Humidity (%)	Rainfall 24 hours (mm)	Rainfall 7 days (mm)	Rainfall 30 days (mm)
26/10/2016	8.5	29.9	48-30	0	20.6	33.4
27/10/2016	11.3	31.6	47-29	0	20.6	33.4
28/10/2016	13.3	25.9	74-59	0.6	16.6	34
31/10/2016	15.8	29.6	80-68	1.8	29	60.2
17/01/2017	17.8	34.6	70-47	1.6	16.2	35.2
18/01/2017	19.7	42	35-22	0	16.2	35
19/01/2017	20.4	24.6	76-84	0.2	12.4	35.2
26/04/2017	16.8	20.9	87-77	0.2	11.4	91.6
27/04/2017	7.4	20.8	56-49	1.4	12.6	92.6

Date	Min temp (˚C)	Max temp (˚C)	Humidity (%)	Rainfall 24 hours (mm)	Rainfall 7 days (mm)	Rainfall 30 days (mm)
28/04/2017	13.2	21.6	61-53	1.2	12.6	92.6

3.1.4 Chytrid Fungus

Chytrid fungus sampling was carried out in all three monitoring events. Sampling has again indicated that this pathogen is present in the study area, but that its prevalence varies between sites and times of sampling. Table 4 presents current and previous monitoring event results. During the current monitoring period Chytrid fungus was detected during spring and summer at the Piper Creek reference site and, for the first time, at the Cooperabung Creek impact site (previously detected at the upstream Cooperabung Creek reference site). It was also detected at the Cooperabung reference site during spring. Chytrid fungus was not detected during the autumn monitoring surveys.

Chytrid fungus was not detected at three sites in the 2016/2017 monitoring, however it has been previously detected at these sites during either baseline surveys or previous monitoring events. It is presumed however that this pathogen will remain at a location on a permanent basis.

Chytrid fungus is therefore considered to be present at all monitoring sites.

Table 4: Chytrid fungus detection/present within the Project sites.

	Cooperabung Creek Impact	Smiths Creek Impact	Pipers Creek Impact	Maria River Impact	Cooperabung Creek Reference	Pipers Creek Reference
Baseline	not detected	detected	not detected	not detected	detected	not detected
2015/2016	not detected	not detected	detected	detected	not detected	detected
2016/2017	detected	not detected	not detected	not detected	detected	detected

3.1.5 Habitat survey information

Habitat information collected for each site is presented in Annex 1. Microhabitat use was highly variable. Frogs were recorded on and buried within leaf litter, using flood debris as shelter, within the creeks, on rocks and under logs and vegetation. During inspection of the frog fence a number of maintenance issues were noted where the fence was considered unlikely to impede frog movement in its current condtion, notably vegetation growth and fence gaps. For the purpose of this report these issues have been recorded in Annex 1 as a fence breach. No frogs were found to have breached the frog fences at any sites (i.e observed on the wrong side of the fence). It is also noted that no exotic fish have been observed at any of the sites during the 2016/2017 monitoring period.

Of particular relevance however is the increasing density of Lantana (*Lantana camera*) at a number of sites, notably Maria River impact site and Pipers Creek impact site. At the eastern end of Maria River and the western side of the Pipers Creek impact site, the lantana is now thick enough to substantially hamper survey efforts. Walking along the banks is difficult and vision is obscured. Safe navigation of the creek lines has become difficult due to low vision and steep creek beds.

3.2 Comparison with baseline surveys

Graph 1 and Table 5 present the Giant Barred Frog records for baseline and the 2016/2017 monitoring period.

Baseline surveys recorded the Giant Barred Frog at all six monitoring sites in spring and summer and at four sites in autumn. Frogs were not recorded at the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey.

The 2016/2017 monitoring recorded Giant Barred Frogs at all six monitoring sites in spring and summer and at five sites in autumn. Frogs were not recorded at Pipers Creek impact site during the autumn 2017 survey.

Frogs were therefore recorded during 2016/2017 surveys at the two sites where they were not recorded during the autumn baseline surveys, however they were not recorded at the Pipers Creek impact site in the autumn 2016/2017 surveys, where they were recorded during baseline surveys.

MKTBA for the baseline survey and 2016/2017 surveys are relatively similar for the impact sites. The MKTBA for the Cooperabung Creek reference site is lower than the baseline survey, while Pipers Creek reference is greater.

Graph 1: Giant Barred Frog records: baseline and 2016/2017 monitoring

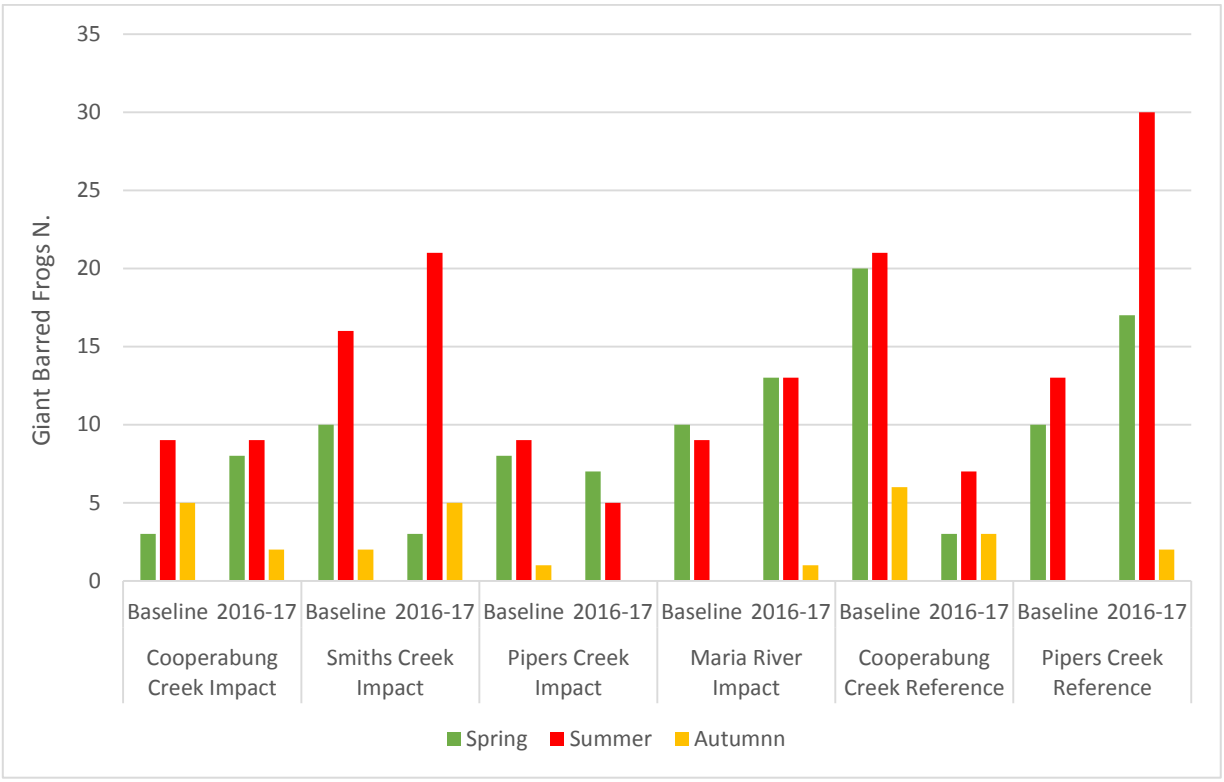

Table 5: Comparison of baseline and 2016/2017 survey results

	C. Creek (I)		S. Creek (I)		P. Creek (I)		M. River (I)		C. Creek (R)		P. Creek (R)	
	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017

	C. Creek (I)		S. Creek (I)		P. Creek (I)		M. River (I)		C. Creek (R)		P. Creek (R)	
	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017	Base-line	2016 2017
Mean number of frogs per visit	5.67	6.33	9.33	9.67	6.00	4.00	6.33	9.00	15.67	4.33	7.67	16.33
Standard Error (SE)	1.76	2.19	4.06	5.70	2.52	2.08	3.18	4.00	4.84	1.33	3.93	8.09
MKTBA	15	15	26	26	14	11	15	24	45	8	23	38

3.3 Water quality

Water quality monitoring was undertaken by Roads and Maritime and is presented in two reports (RMS 2017a, 2017b). Presented here is a summary of the data collected for Cooperabung Creek, Smiths Creek, Pipers Creek and Maria River, for the purpose of assessing the outcomes against the water quality performance measure specified in the EMP. Annex 3 presents data extracted from the water quality reports and shows only those sampling results where the calculated median value was either above the 80th percentile or below the 20th percentile at the downstream site.

3.3.1 Parameters

Table 6 presents the number of occasions downstream (DS) median values were greater than the 80th percentile, and of these, the number that exceeded the ANZECC trigger value. All sites had at least one parameter for one or more monthly results for which the median downstream value exceeded the 80th percentile of the upstream value. These are discussed below.

Electrical conductivity: Higher than the upstream trigger value regularly throughout the 12 months. These values, while slightly elevated, were well within ANZECC guideline trigger values and mostly reflected upstream values. Water quality monitoring reporting considered impacts attributable to construction to be negligible to minor.

Dissolved oxygen: Variable results throughout the year and for sites, which may be due to algae outbreaks triggering fluctuations in dissolved oxygen. Water quality monitoring reporting considered impacts attributable to construction to be negligible.

Turbidity: Variable results throughout the year and for sites. A particularly high turbidity recorded at Maria River was reported and this is discussed in Section 3.3.2. Other events of high downstream turbidity occurred during periods when there was little to no flow between upstream and downstream. Water quality monitoring reported no obvious signs of construction activities causing elevated turbidity.

Nitrogen and Phosphorus: Variable results throughout the year and for sites. Levels were generally consistent with upstream values. Differences between upstream and downstream was generally when the sampling points were isolated ponds. Water quality monitoring reporting considered impacts attributable to construction to be negligible.

Metals: Variable results throughout the year and for sites. Limited variation occurred with the exception of aluminium, iron, magnesium and zinc. Levels were generally consistent with upstream values. Differences between upstream and downstream was generally when the sampling points were isolated ponds. Water quality monitoring reporting considered elevated metal parameters unlikely to be attributable to construction related activities.

Water quality monitoring reporting suggested that results were not inconsistent with the variability and levels experienced during the pre-construction and previous construction monitoring periods.

Table 6: Triggered water quality parameters per site

Parameter	No. of samples where DS median value > 80th % *			
	Cooperabung Creek	Smiths Creek	Pipers Creek	Maria River
Temperature ˚C	4	2	3	3
Electrical Conductivity uS/cm	8	6	0	8
Dissolved oxygen %	3 (1)	2	3 (2)	5 (5)
pH	0	0	0	0
Turbidity (NTU)	0	2 (2)	0	1 (1)
Total suspended solids mg/L	0	3	0	0
Aluminium mg/L	2 (1)	3 (3)	1	2 (2)
Arsenic mg/L	0	0	0	3
Cadmium mg/L	0	0	0	0
Chromium mg/L	0	0	0	0
Copper mg/L	0	1 (1)	0	2 (2)
Iron mg/L	0	0	2	4
Lead mg/L	0	0	0	0
Manganese mg/L	4	3	2	4
Mercury mg/L	0	0	0	0
Nickel mg/L	2	3	0	3
Silver mg/L	0	0	0	0
Zinc mg/L	4 (4)	2 (2)	2 (2)	3 (3)
Total nitrogen mg/L	0	2 (2)	1 (1)	3 (3)
Total phosphorus mg/L	0	0	2	3 (3)

*** where (# DS value exceeds ANZECC trigger)**

3.3.2 Incident

In March 2017 there was a reported incident involving a basin. Water quality monitoring reported the following regarding the incident: "*The monitoring result at Maria River in March 2017 was found to be attributable to construction. In this instance, it was found that a low-flow valve had not been fully closed, and some water had been draining from the basin prior to it being treated and discharged in accordance with the EPL. The basin valve was closed immediately and the cause investigated. The sediment basin checklist now includes a requirement to inspect the low-flow valve during all basins inspections, and specifically after completion of a discharge. The issue was raised as an incident in accordance with the CEMP and the EPA notified as required under the EPL"*

4. Discussion

4.1 Performance Measures

A summary of 2016/ 2017 survey results in relation to the performance measures are provided in Table 7.

Table 7: Performance measures and discussion of 2016/2017 results.

Performance measure	Discussion
Monitoring is undertaken during baseline surveys and Years 1 – 8 or until monitoring can demonstrate that mitigation measures are effective.	**This performance measure has been met for Year 1 (2015/2016) and Year 2 (2016/2017).** Giant Barred Frog monitoring has been undertaken at all six sites according to the EMP to date.
Monitoring during Year 1 – 8 is undertaken at the Impact and Control sites where baseline monitoring was undertaken, subject to landowner agreement.	**This performance measure has been met for Year 1 (2015/2016) and Year 2 (2016/2017).** Giant Barred Frog monitoring has been undertaken in all six baseline sites, where landowner agreement permitted.
Continued presence of Giant Barred Frogs during each survey event in Year 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.	**This performance measure has been met for all sites in Year 1 (2015/2016) and 5 of 6 sites in Year 2 (2016/2017).** Baseline: recorded at all six monitoring sites in spring and summer and at four sites in autumn. Frogs were not recorded at the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey. 2015/2016: detected at all six sites during all surveys. 2016/2017: detected at all six sites in spring and summer and five sites in autumn. Not recorded at Pipers Creek impact site during the autumn 2017 survey where it was detected during baseline surveys.
Mitigation measures are effective as defined in the EPBC approval when all monitoring events are considered at Year 8.	This performance measure is not yet applicable.
Median values of all downstream water quality monitoring at GBF habitat or potential habitat locations during construction and operation (Year 1 – 6) is less than the 80th percentile value of the upstream site (where 80th percentile is the value at which median values at the downstream site are above 80% of the recorded background water quality records), where this change is found to be attributable to construction or operation.	**This performance measure has been met for all sites except Maria River.** All sites had at least one parameter for one or more monthly results for which the median downstream value exceeded the 80th percentile of the upstream value. However, water quality monitoring considered impacts attributable to construction to be negligible to minor for all parameters excluding the incident at Maria River.
No change to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 8, and then when all monitoring events are considered at Year 8.	**This performance measure has been met for all sites in relation to Giant Barred Frog presence and habitat use.** Recorded numbers and recorded locations vary between season and year at all sites and no clear decline in numbers or changes in habitat use has been observed. The data collected however does not allow for discussion of movement patterns.

5. Recommendations

5.1 Contingency Measures

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered to be relevant to the Giant Barred Frog monitoring program are listed and discussed in Table 8.

Table 8: Contingency measures

Potential problem	Contingency measure proposed in EMP	Discussion of proposed measure
Decline in presence of target species recorded at Impact sites after the upgrade has been completed, when compared to change in Control sites.	The cause of the decline in populations at impacts sites will be investigated in consultation with EPA and DoTE within two weeks of results reported by ecologist. If the cause of decline is considered most likely attributed to the upgrade of the highway (and not another event such as bushfire), mitigation measures, such as the location and types of fauna crossings and fauna fencing will be reviewed within two months of the above consultation being completed.	**This contingency measure is not yet relevant as the upgrade is not yet complete.** However, to date, no obvious, decline in the presence of Giant Barred Frogs has been observed during construction monitoring.

5.2 Corrective action to meet performance criteria

A summary of those performance indicators that were not met in the 2016/2017 monitoring period and recommended corrective actions are provided in Table 9.

Table 9: Corrective actions

Performance measure	Action
Continued presence of Giant Barred Frogs during each survey event in Year 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.	**This performance measure has been met for 5 of 6 sites in Year 2 (2016/2017).** Giant Barred Frogs were not recorded at Pipers Creek impact site during the autumn 2017 survey, where it was detected during baseline surveys. Autumn surveys have shown reduced activity during almost all survey events and frog detection can vary between survey events, as such, no records of the species during this single survey cannot yet be considered as indicating the absence of this species from this site, where it was detected in the spring and summer surveys. It is worthwhile noting that Pipers Creek impact site has been highlighted as a site where Lantana is substantially hindering monitoring efforts. It is recommended that monitoring continue as per the EMP. If further monitoring fails to detect the species at this site, corrective actions will be required.
Median values of all downstream water quality monitoring at GBF habitat or potential habitat locations during construction and operation (Year 1 – 6) is less than the 80th percentile value of the upstream site, where this change is found to be attributable to construction or operation.	**This performance measure has been met for all sites except Maria River** . All sites had at least one parameter for one or more monthly results for which the median downstream value exceeded the 80th percentile of the upstream value. Short-term elevations are reflective of environmental variability and ongoing weather conditions and are therefore considered unlikely to have an impact on Giant Barred Frogs. Water quality monitoring considered impacts attributable to construction to be negligible to minor for all parameters excluding an incident at Maria River. Immediate actions were taken at Maria River and procedures put in place to avoid reoccurrence. Recommendations are therefore to continue construction management measures to minimise impacts, ongoing review of water quality results and amend activities where necessary.

5.3 General Recommendations

Issues encountered and considerations for ongoing monitoring are discussed in Table 10.

Table 10: Recommendations

Consideration	Recommendation
Lantana density along creek lines	While Lanatana control has been previously undertaken within these areas, consideration should be given to continued Lantana control, notably along Maria River and Pipers Creek impact sites. Current density is hindering monitoring efforts. Frogs were not recorded at Pipers Creek impact site during autumn surveys. Control efforts should include progressive bush regeneration works, targeting the progressive removal of Lantana. It is recommended that such work be undertaken by suitably qualified bush regenerators, using a combination of hand weeding and cut and paint techniques. Initial works would need to be followed-up at suitable intervals to ensure that all Lantana is removed. Given the location of Lantana along the banks of the creek, the removal of lantana should be strategic (i.e. not removing all lantana at once) to avoid the risk of erosion and loss of fauna habitat e.g. bird habitat. It is recommended that initial works begin within areas least affected by Lantana and progressively working toward the most infested areas.
Chytrid fungus hygiene protocol	Chytrid fungus is considered to be present at all six sites. To contain the spread of the Chytrid fungus infection, it is important that the hygiene protocol for the control of disease in frogs Information Circular Number 6 (DECC 2008) be methodically and rigorously followed for footwear but also for all vehicles that enter Giant Barred frog site/habitat. Wash-down procedures should now be implemented at all impact sites. It is recommended to keep and review periodically a register of the wash down stations/procedures. This is not necessarily to consider exchange between Giant Barred Frog sites, where Chytrid fungus is present, but between these sites and other construction sites throughout the Project footprint.
Chytrid fungus swabbing	As Chytrid fungus is present at all monitoring sites, consideration should be given to discontinuing the additional swabbing process to reduce the time and handling of individuals of this species. The swabbing of frogs has been conducted to inform the presence of the fungus and implement control measures to prevent its transfer from infected sites to non-infected sites. Given that it has now been recorded from all sites this attempt to control its spread within Giant Barred Frog sites is no longer relevant, and monitoring of the sites to inform where control measures need to be employed would not be of any value.

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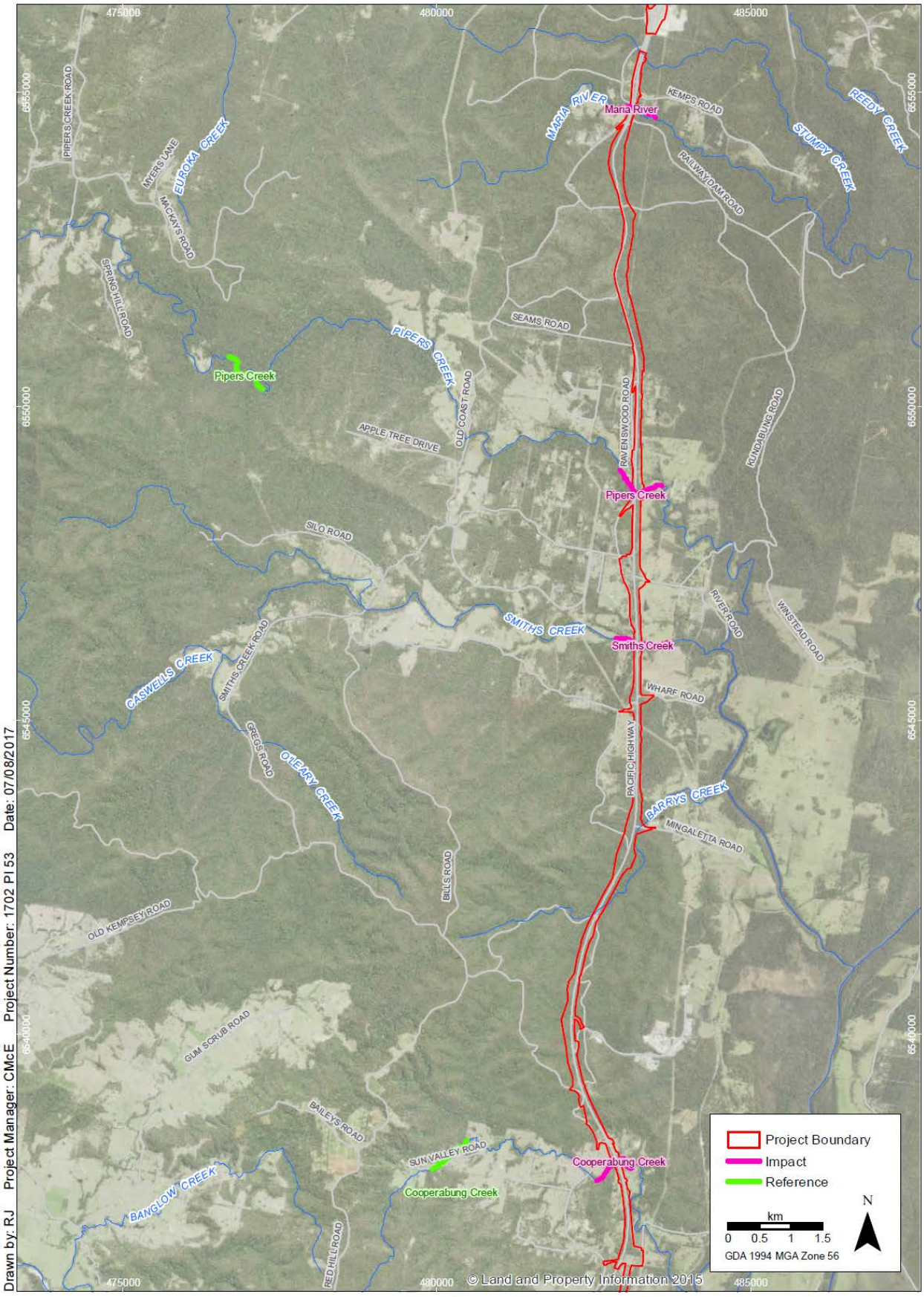

Giant Barred Frog 2016 - 2017 monitoring: sites overview

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 1

Imagery: (c) LPI 2014-10-06

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Giant Barred Frog 2016 - 2017 monitoring: Cooperabung Creek Impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 2

niche Environment and Heritage

Imagery: (c) LPI 2014-10-06

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Giant Barred Frog 2016 - 2017 monitoring: Smiths Creek Impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 3

niche Environment and Heritage

Imagery: (c) LPI 2014-10-06

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Giant Barred Frog 2016 - 2017 monitoring: Pipers Creek Impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 4

niche Environment and Heritage

Imagery: (c) LPI 2014-10-06

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Giant Barred Frog 2016 - 2017 monitoring: Maria River Impact Site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 5

niche Environment and Heritage

Imagery: (c) LPI 2014-10-06

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Drawn by: RJ Project Manager: CMcE Project Number: 1702 PI 53 Date: 07/08/2017

Giant Barred Frog 2016 - 2017 monitoring: Cooperabung Creek Reference Site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 6

niche Environment and Heritage

Imagery: (c) LPI 2014-10-06

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Giant Barred Frog 2016 - 2017 monitoring: Pipers Creek Reference Site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 7

niche Environment and Heritage

Imagery: (c) LPI 2014-10-06

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Annex 1 – 2016/2017 data summary for each monitoring site

Cooperabung Creek Impact

Table 11: Summary of field work and prevailing abiotic variables: Cooperabung Creek impact site

Date	Time		Air Temp. °C	Water Temp. °C	Humidity %	Stream Depth (cm)	Wind (0-3, 0=no wind)	Cloud Cover %	Rain (mm)
27/10/2017	Start	9:45:00 PM	20.8	19	77	20	1	60	1
27/10/2017	Finish	12:30:00 AM	17.2	19	89	45	0	100	0
19/01/2017	Start	10:45:00 PM	22.5	23	78.2	50	0	100	0
19/01/2017	Finish	1:00:00 AM	23.9	23	77.9	25	0	100	0
28/04/2017	Start	7:20:00 PM	17.5	17.9	65	30	1	0	0
28/04/2017	Finish	8:22:00 PM	16.6	16	83	30	0	0	0

Table 12: Habitat details: Cooperabung Creek impact site

Zone	OS %	Shrub %	Ground cover %	leaf litter %	Bare Earth %	Cattle	Pools	Riffles	Depth of deepest Pool (cm)	Fence breaches (if applicable)	Frogs detected
Clz6	60	40	80	10	20	No	1	0	150	0	Yes
Clz7(A)	60	30	40	20	30	No	2	0	80	n/a	Yes
Clz7(B)	80	30	60	20	10	No	1	0	50	n/a	Yes
Clz8	70	15	75	15	10	No	1	2	45	n/a	
Clz9	45	35	70	15	30	No	2	2	20	n/a	Yes
Clz5	85	10	60	30	20	No	2	0	30	3	Yes
Clz4	65	10	40	45	10	No	1	0	60	n/a	Yes
Clz3	80	10	75	15	5	No	1	1	80	n/a	
Clz2	20	20	50	5	40	No	2	1	80	n/a	Yes

Table 13: Summary of captures: Cooperabung Creek impact site

	Spring 2016	Summer 2017	Autumn 2017
Number of frogs recorded	8	9	2
Number of adult males	5	3	0
Number of adult females	1	3	1
Number of sub-adults	2	1	1
Number of juveniles	0	2	0
Number of recaptures	1	4	0
Number of frogs with Chytrid/ swabbed	0/7	1/9	0/2

Habitat: Microhabitat within these zones included flood debris as overhang shelter, grass and leaf litter. Frogs were located on litter.

Water Levels: Mean depth 62.5 cm west and 73.3 cm east.

Smiths Creek Impact

Table 14: Summary of field work and prevailing abiotic variables: Smiths Creek impact site

Date	Time		Air Temp. °C	Water Temp. °C	Humidity %	Stream Depth (cm)	Wind (0-3, 0=no wind)	Cloud Cover %	Rain (mm)
31/10/2016	Start	11:00:00 PM	18.3	29.8	76	50	0	50	0
31/10/2016	Finish	1:45:00 AM	18.2	18	79	70	0	50	0
18/01/2017	Start	11:30:00 PM	25.6	26.2	77.8	50	1.5	100	1
18/01/2017	Finish	2:30:00 AM	23.6	26.2	83.6	100	1.5	100	0
27/04/2017	Start	7:30:00 PM	17.2	16.8	53	50	1	40	0
27/04/2017	Finish	9:00:00 PM	16.7	16.8	79	50	2	0	0

Table 15: Habitat details: Smiths Creek impact site

Zone	OS %	Shrub %	Ground cover %	leaf litter %	Bare Earth %	Cattle	Pools	Riffles	Depth of deepest Pool (cm)	Fence breaches (if applicable)	Frogs detected
Slz5	25	40	40	15	20	No	2	3	20	1	Yes
Slz3-4	30	15	40	25	15	No	1	0	60	n/a	Yes
Slz2-3	65	10	20	15	40	No	1	0	200	n/a	Yes
Slz1-2	70	15	35	20	35	No	1	0	50	n/a	Yes
Slz1	75	20	25	10	45	No	2	1	60	n/a	Yes
Slz6	0	10	100	5	5	No	1	0	100	1	Yes
Slz7	15	25	30	10	10	No	1	0	80	n/a	Yes
Slz8	70	35	10	30	30	Yes	2	0	20	n/a	Yes
Slz9	25	15	15	15	30	Yes	1	0	50	n/a	Yes
Slz10	15	40	20	15	35	Yes	1	0	40	n/a	Yes

Table 16: Summary of captures: Smiths Creek impact site

	Spring 2016	Summer 2017	Autumn 2017
Number of frogs recorded	3	21	5
Number of adult males	0	11	1
Number of adult females	1	4	1
Number of sub-adults	1	3	1
Number of juveniles	0	0	1
Number of recaptures	0	3	0
Number of frogs with Chytrid/ swabbed	0/2	0/19	0/4

Habitat: Microhabitat within these zones included flood debris as overhang shelter, grass and leaf litter.

Water Levels: Mean depth 92.5 cm west, 51.0 cm east.

Pipers Creek Impact

Table 17: Summary of field works and prevailing abiotic variables: Pipers Creek impacts site

Date	Time		Air Temp. °C	Water Temp. °C	Humidity %	Stream Depth (cm)	Wind (0-3, 0=no wind)	Cloud Cover %	Rain (mm)
27/10/2016	Start	8:00:00 PM	24.8	21	60		1	33	0
27/10/2017	Finish	9:30:00 PM	20.4	20	75		2	60	1
19/01/2017	Start	1:16:00 AM	23	23.1	81.8	100	0	100	1
19/01/2017	Finish	3:06:00 AM	23	23.1	78.3	50	0	100	1
28/04/2017	Start	5:40:00 PM	18.9	17.9	65	80	0	0	0
28/04/2017	Finish	6:58:00 PM	18.1	17.9	65	80	0	0	0

Table 18: Habitat details recorded: Pipers Creek impacts site

Zone	OS %	Shrub %	Ground cover %	leaf litter %	Bare Earth %	Cattle	Pools	Riffles	Depth of deepest Pool (cm)	Fence breaches (if applicable)	Frogs detected
PIz5	35	50	15	10	35	No	1	0	200	0	
Piz4	45	10	5	15	70	No	1	0	100	n/a	Yes
Piz3	75	10	10	10	80	No	1	0	100	n/a	Yes
Piz2	15	45	10	20	50	No	1	0	150	n/a	Yes
Piz1	5	50	15	15	30	No	2	0	30	n/a	Yes
PIz6	15	35	30	20	60	No	1	0	50	2	
PIz7	20	40	50	5	20	Yes	1	0	200	few	
PIz8	50	30	20	15	60	Yes	1	0	100	n/a	Yes
PIz9	85	10	25	10	60	Yes	3	2	70	n/a	Yes
PIz10	50	30	20	10	50	Yes	3	2	30	n/a	

Table 19: Summary of captures: Pipers Creek impacts site

	Spring 2016	Summer 2017	Autumn 2017
Number of frogs recorded	7	5	0
Number of adult males	1	2	0
Number of adult females	2	1	0
Number of sub-adults	1	0	0
Number of juveniles	2	0	0
Number of recaptures	1	1	0
Number of frogs with Chytrid/ swabbed	0/6	1/4	0

Habitat: Microhabitat use included above and partially buried within leaf litter, and on bare ground.

Water Levels: Mean depth 95.0 cm west, 108.3 cm east. Over 200 cm in the deepest pool.

Maria River Impact

Table 20: Summary of field works and prevailing abiotic variables: Maria River impact site

Date	Time		Air Temp. °C	Water Temp. °C	Humidity %	Stream Depth (cm)	Wind (0-3, 0=no wind)	Cloud Cover %	Rain (mm)
31/10/2016	Start	7:45:00 PM	22.3	20.3	62	50	0	100	0
30/10/2016	Finish	10:30:00 PM	19.7	20.3	74	100	0	100	0
18/01/2017	Start	8:30:00 PM	30.5	27.8	68.6	50	2	50	0
18/01/2017	Finish	11:00:00 PM	26.6	27.8	77	50	2	50	0
27/04/2017	Start	5:38:00 PM	18.7	18.9	53	70	0	100	0
27/04/2017	Finish	7:02:00 PM	17.2	17.1	53	90	1	50	0

Table 21: Habitat details: Maria River impact site

Zone	OS %	Shrub %	Ground cover %	leaf litter %	Bare Earth %	Cattle	Pools	Riffles	Depth of deepest Pool (cm)	Fence breaches (if applicable)	Frogs detected
MIz6-7	20	10	15	40	30	No	1	0	100	1	Yes
MIz7-8	35	25	15	25	30	No	3	2	60	n/a	Yes
MIz8-9	65	5	10	25	30	No	3	2	50	n/a	Yes
MIz9-10	15	45	20	10	20	No	2	0	60	n/a	
MIz10	5	55	25	5	10	No	1	0	50	n/a	
MIz6	15	10	30	20	25	No	2	1	30	1	Yes
MIz5	15	10	10	20	50	No	1	0	80	n/a	Yes
MIz5-4	20	50	10	15	20	No	1	0	60	n/a	Yes
MIz4	15	80	<5	<5	<5	No	1	0	25	n/a	Yes
MIz4-3	20	80	5	<5	<5	No	1	0	40	n/a	Yes

Table 22: Summary of captures: Maria River impact site

	Spring 2016	Summer 2017	Autumn 2017
Number of frogs recorded	13	13	1
Number of adult males	5	5	0
Number of adult females	5	6	1
Number of sub-adults	1	0	0
Number of juveniles	0	0	0
Number of recaptures	5	3	0
Number of frogs with Chytrid/ swabbed	0/12	0/11	0/1

Habitat: Microhabitat within these zones included flood debris as overhang shelter, grass and leaf litter. Lantana is very abundant along both side of the river banks and is the dominant vegetation from MIz1 to MIz5.

Water Levels: Mean depth 51.3 cm west, 58.3 cm east.

Cooperabung Creek Reference

Table 23: Summary of field works and prevailing abiotic variables: Cooperabung Creek reference site

Date	Time		Air Temp. °C	Water Temp. °C	Humidity %	Stream Depth (cm)	Wind (0-3, 0=no wind)	Cloud Cover %	Rain (mm)
26/10/2016	Start	12:10:00 AM	15.1	18.5	83.5	10	2	100	0
26/10/2016	Finish	1:45:00 AM	14	18.5	79	40	0	0	0
17/01/2017	Start	2:45:00 AM	23.4	23.7	87	30	0	0	0
17/01/2017	Finish	4:15:00 AM	24	23.7	88.2	30	0	0	0
26/04/2017	Start	9:28:00 PM	16.2	18.2	53	30	0	0	0
26/04/2017	Finish	10:47:00 PM	13	18.2	53	40	0	0	0

Table 24: Habitat details: Cooperabung Creek reference site

Zone	OS %	Shrub %	Ground cover %	leaf litter %	Bare Earth %	Cattle	Pools	Riffles	Depth of deepest Pool (cm)	Fence breaches (if applicable)	Frogs detected
CRz1	15	55	35	65	0	No	2	1	20	n/a	Yes
CRz2	35	45	35	65	0	No	3	2	25	n/a	Yes
CRz3	45	25	75	25	0	Yes	1	1	30	n/a	Yes
CRz4	15	60	80	20	0	Yes	2	2	35	n/a	Yes
CRz5	35	50	5	70	25	Yes	2	2	30	n/a	Yes
CRz6	20	60	3	90	7	No	2	2	40	n/a	Yes
CRz7	5	45	40	60	0	No	2	3	35	n/a	Yes
CRz8	40	10	90	5	5	Yes	1	1	25	n/a	Yes
CRz9	65	10	10	85	15	Yes	2	1	25	n/a	Yes
CRz10	60	10	15	80	5	Yes	2	1	30	n/a	Yes

Table 25: Summary of captures: Cooperabung Creek reference site

	Spring 2016	Summer 2017	Autumn 2017
Number of frogs recorded	3	7	3
Number of adult males	0	5	1
Number of adult females	3	1	1
Number of sub-adults	0	0	1
Number of juveniles	0	0	0
Number of recaptures	1	4	1
Number of frogs with Chytrid/ swabbed	1/2	0/6	0/3

Habitat: Microhabitat found being used included above and partially buried within leaf litter (some of which included Lomandra shelters) and on rock.

Water Levels: Range from 25.0 to 100 cm.

Pipers Creek Reference

Table 26: Summary of field works and prevailing abiotic variables: Pipers Creek reference site

Date	Time		Air Temp. °C	Water Temp. °C	Humidity %	Stream Depth (cm)	Wind (0-3, 0=no wind)	Cloud Cover %	Rain (mm)
26/10/2016	Start	7:39:00 PM	19.9	21	72.7	30	0	100	0
26/10/2016	Finish	11:34:00 PM	16.1	21	89.6	30	0	0	0
17/01/2016	Start	9:00:00 PM	27	26	78.5	20	0	0	0
17/01/2016	Finish	12:30:00 AM	24	26	86.4	20	0	0	0
26/04/2017	Start	6:20:00 PM	19.2	17.7	53	20	0	20	0
26/04/2017	Finish	8:32:00 PM	16.8	17.7	53	60	0	0	0

Table 27: Habitat details: Pipers Creek reference site

Zone	OS %	Shrub %	Ground cover %	Leaf litter %	Bare Earth %	Cattle	Pools	Riffles	Depth of deepest Pool (cm)	Fence breaches (if applicable)	Frogs detected
PRz5	70	40	50	50	0	No	3	2	40	n/a	Yes
PRz4	30	50	15	50	35	No	2	1	40	n/a	Yes
PRz3	60	20	35	40	25	No	1	1	75	n/a	Yes
PRz2	50	35	60	5	45	No	3	2	25	n/a	Yes
PRz1	55	40	40	5	55	No	1	2	40	n/a	Yes
PRz6	65	50	35	30	45	No	1	1	30	n/a	Yes
PRz7	40	40	20	75	5	No	1	1	100	n/a	Yes
PRz8	35	40	25	70	5	No	1	0	100	n/a	Yes
PRz9	60	30	70	20	10	No	1	0	70	n/a	Yes
PRz10	85	25	25	35	40	No	1	1	50	n/a	Yes

Table 28: Summary of captures: Pipers Creek reference site

	Spring 2016	Summer 2017	Autumn 2017
Number of frogs recorded	17	30	2
Number of adult males	6	18	1
Number of adult females	5	6	0
Number of sub-adults	0	1	1
Number of juveniles	2	1	0
Number of recaptures	5	11	0
Number of frogs with Chytrid/ swabbed	3/12	1/25	0/1

Habitat: Microhabitat within these zones included above, partially buried and completely buried within leaf litter, sheltering under Lomandra, and within holes in the bank.

Water Levels: Range from 25.0 cm to 100 cm.

Annex 2 - Giant Barred Frog individual frog data

Sx = sex; L = length (mm); W = weight (g); DW = distance to water (m); S = swabbed for Chytrid fungus; Z = Zone; I = impact; U = unknown; M = male; F = female; J = juvenile

Location		Season	Sx	Age	Reproductive Status	L	W	DW	Pit_Tag_Co	Capture/Recapture	S	Z	Microhabitat	Activity
I	Cooperabung Creek	Spring	M	Adult						Not captured	N	Clz3		calling
I	Cooperabung Creek	Spring	M	Adult	Dark nuptial pads	59.5	42.0	4.0	000791E92F	Captured	Y	Clz5	Leaf litter under shrub	sitting
I	Cooperabung Creek	Spring	M	Adult	Dark nuptial pads	68.2	55.0	7.0	0007A3B45A	Captured	Y	Clz4	Under log	sitting
I	Cooperabung Creek	Spring	M	SA	Immature	582.0	45.0	9.0	000763515D	Capture	Y	Clz7	On litter	sitting
I	Cooperabung Creek	Spring	U	SA	Immature	50.0	34	10.0	00077E7E55	Capture	Y	Clz4	On litter	sitting
I	Cooperabung Creek	Spring	F	Adult	Moderate nuptial pads	87.0	90	13	0007833272	Capture	Y	Clz4	On litter	sitting
I	Cooperabung Creek	Spring	M	Adult	Moderate nuptial pads	69.0	62.0	4.5	00079205FF	Recapture	Y	Clz9	On litter	sitting
I	Cooperabung Creek	Spring	M	Adult	Light nuptial pads	65.0	55.0	16.0	00076346EC	Capture	Y	Clz4	On litter	sitting
I	Cooperabung Creek	Summer	F	Adult	Gravid	95.0	156.0	10.0	991001000620D127	Recapture	Y	Clz6	In Litter	Sitting
I	Cooperabung Creek	Summer	F	Adult	Gravid	100.0	160.0	15.0	0007D2632D	Capture	Y	Clz4	On litter	Sitting
I	Cooperabung Creek	Summer	F	Adult	Not Gravid	80.0	79	25.0	0007A3B78C	Capture	Y	Clz7	At base of tree on litter	Sitting
I	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	75.0	73.0	15.0	00079205FF	Recapture	Y	Clz2	On litter	Sitting
I	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	71.2	63	12	0007A3C3CE	Capture	Y	Clz1	At base of tree on litter	Sitting
I	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	72.5	73.0	6.0	0007A0DF410	Capture	Y	Clz7	On litter	Sitting
I	Cooperabung Creek	Summer	F	J	Not Gravid	79.5	65	10.0	000791E973	Recapture	Y	Clz6	in Litter	Sitting
I	Cooperabung Creek	Summer	M	J	Dark Nuptial Pads	77.0	71.0	10.0	0007359AS0	Recapture	Y	Clz7	At base of tree on litter	Sitting
I	Cooperabung Creek	Summer	U	SA		66.9	45.0	20.0	0007A0FD23	Capture	Y	CIz7	On litter	Sitting
I	Cooperabung Creek	Autumn		SA		52.7	12.0	4.5	0007635IE5	Capture	Y	CIz9	On litter	Sitting
I	Cooperabung Creek	Autumn	F	Adult	Moderately Gravid	95.0	130.0	5.0	00077E808F	Capture	Y	CIz4	On litter	Sitting
I	Maria River	Spring	F	Adult	Gravid	94.4	153.0	5.0	0007A2F3C5	Capture	Y	MIz8	On litter	Sitting
I	Maria River	Spring	F	Adult	Gravid	95.0	124.0	6.0	00079FD11C	Capture	Y	MIz7	On litter	Sitting

Location		Season	Sx	Age	Reproductive Status	L	W	DW	Pit_Tag_Co	Capture/Recapture	S	Z	Microhabitat	Activity
I	Maria River	Spring	M	Adult	Light nuptial pads	72.9	62.0	5.0	00077E7F26	Recapture	Y	MIz7	On litter	Sitting
I	Maria River	Spring	M	Adult	Light nuptial pads	75.7	69.0	7.0	00079FFA24	Capture	Y	MIz6	On litter	Sitting
I	Maria River	Spring		SA				4.0		Not captured	N	MIz5	On litter	Sitting
I	Maria River	Spring	F	Adult	Gravid	95.9	130	6.0	000791E958	Recapture	Y	MIz8	On litter	Sitting
I	Maria River	Spring	F	Adult	Gravid	104.9	160.0	6.0	0007634B30	Recapture	Y	MIz9	On litter	Sitting
I	Maria River	Spring	F	Adult	Gravid	96.2	115.0	13.0	0007634B30	Capture	Y	MIz17	On litter	Sitting
I	Maria River	Spring	M	Adult	Light nuptial pads	85.4	91.0	9.0	00077E7EBD	Recapture	Y	MIz8	On litter	Sitting
I	Maria River	Spring	M	Adult	Light nuptial pads	60.9	35.0	5.0	0007634AC3	Recapture	Y	MIz5	On litter	Sitting
I	Maria River	Spring	M	Adult	Light nuptial pads	77.8	60	2.0	00077E6BEA	Capture	Y	MIz7	On litter	Sitting
I	Maria River	Spring	U	SA		66.3	35.0	4.0	0007634BCE	Capture	Y	MIz7	On litter	Sitting
I	Maria River	Spring			Dark nuptial pads	70.2	80.0	13.0	0007635742	Capture	Y	MIz7	On litter	Sitting
I	Maria River	Summer	F	Adult	Gravid	102.0	176.0	1.0	00077E6C90	Recapture	Y	MIz7	On log	Sitting
I	Maria River	Summer	F	Adult	Gravid	93.8	140.0	0.5	00079EA489	Recapture	Y	MIz5	On bank	Sitting
I	Maria River	Summer	F	Adult	Gravid	112.2	165.0	2.0	0007634B30	Recapture	Y	MIz3	Under Litter	Sitting
I	Maria River	Summer	F	Adult	Gravid	97.3	135.0	0.0	0007D2A06E	Capture	Y	MIz7	On log	Sitting
I	Maria River	Summer	F	Adult	Gravid	102.5	135.0	1.0	0007A1021C	Capture	Y	MIz5	On litter	Sitting
I	Maria River	Summer	F	Adult	Gravid	96.2	167	4	0007A2E4F9	Capture	Y	MIz3	Under Litter	Sitting
I	Maria River	Summer	M	Adult	Moderate Nuptial Pads	70.0	42.0	7.0	00079206EB	Capture	Y	MIz7	On litter	Sitting
I	Maria River	Summer	M	Adult	Dark Nuptial Pads	89.3	75.0	3.0	0007D1ACFA	Capture	Y	MIz5	On litter	Jumpng
I	Maria River	Summer	M	Adult	Dark Nuptial Pads	71.0	70.0	5.0	0007A3A292	Capture	Y	MIz2	On litter	Sitting
I	Maria River	Summer	M	Adult	Dark Nuptial Pads	67.0	56	5	0007D1E5BB	Capture	Y	MIz3	On bank	Sitting
I	Maria River	Summer	M	Adult	Dark Nuptial Pads	68.7	61.0	10.0	0007A113B6	Capture	Y	MIz4	On litter	Sitting
I	Maria River	Summer						3.0		Not captured	N	MIz1	Under Litter	Sitting
I	Maria River	Summer						3.0		Not captured	N	MIz3	On bank	Sitting
I	Maria River	Autumn	F	Adult	Moderately Gravid	98.6	133	10	0007634952	Capture	Y	MIz9	Leaf litter	Sitting

Location		Season	Sx	Age	Reproductive Status	L	W	DW	Pit_Tag_Co	Capture/Recapture	S	Z	Microhabitat	Activity
I	Pipers Creek	Spring	U	J	n/a	46.5	16	2	000763533F	Capture	Y	PIz9	On grass	Sitting
I	Pipers Creek	Spring	U	J	n/a	39.0	16.0	4.0	000763533F	Capture	Y	PIz9	On grass	Sitting
I	Pipers Creek	Spring	U	SA	n/a	49.9	19.0	0.7	0007A3B4AD	Capture	Y	PIz8		
I	Pipers Creek	Spring	F	Adult	Gravid	94.5	253.0	6.0	0007633338	Capture	Y	PIz2	On litter	
I	Pipers Creek	Spring	F	Adult	Gravid	99.5	165	12	00077E7DA3	Recapture	Y	PIz8		
I	Pipers Creek	Spring	M					10.0		Not captured	N	PIz1	On Ground	
I	Pipers Creek	Spring	U	SA		53.6	26.0	5.0	00076356BC	Capture	Y	PIz2	On litter	Calling
I	Pipers Creek	Summer	F	Adult	Gravid	98.8	65.0	8.0	0007A0F015	Capture	Y	PIz3	Under Litter	Sitting
I	Pipers Creek	Summer	M	Adult	Light Nuptial Pads	60.7	93.0	12.0	0007A3B4AD	Recapture	Y	PIz3	On litter	Sitting
I	Pipers Creek	Summer	M	Adult	Light Nuptial Pads	66.9	31.0	10.0	000792057C	Capture	Y	PIz3	On litter	Sitting
I	Pipers Creek	Summer		Adult		62.5	34.0	8.0	0007A0EC64	Not Captured	Y	PIz9	In Litter	Sitting
I	Pipers Creek	Summer						12.0		Not Captured	N	PIz4	In Litter	Sitting
I	Smiths Creek	Spring	F	Adult	Light nuptial pads	76.8	83.0	2.0	0007A3C879	Capture	Y	SIz2	On Litter	Sitting
I	Smiths Creek	Spring		Adult						Not captured	N			
I	Smiths Creek	Spring	U	SA		50.4	20.0	4.0	000791EA05	Capture	Y	SIz4	Wood debris	Sitting
I	Smiths Creek	Summer	F?	Adult	Not Gravid	62.6	33.0	3.0	00077A0E9CC	Capture	Y	SIz1	On litter	Sitting
I	Smiths Creek	Summer	F	Adult	Gravid	105.6	145.0	8.0	0007921840	Capture	Y	SIz7	On litter	Sitting
I	Smiths Creek	Summer	F	Adult	Gravid	90.0	150.0	5.0	00077E7EE0	Capture	Y	SIz7	On litter	Sitting
I	Smiths Creek	Summer	F	Adult	Gravid	81.4	95.0	10.0	0007D1D046	Capture	Y	SIz6	On litter	Sitting
I	Smiths Creek	Summer	M	Adult	Light Nuptial Pads	68.9	55.0	10.0	0007A3A906	Recapture	Y	SIz4	On litter	Sitting
I	Smiths Creek	Summer	M	Adult	Dark Nuptial Pads	64.1	61.0	6.0	0007D26801	Recapture	Y	SIz5	In litter	Sitting
I	Smiths Creek	Summer	M	Adult	Moderate Nuptial Pads	62.0	39	8	0007D1CB91	Not Captured	N	SIz5	On litter	Sitting
I	Smiths Creek	Summer	M	Adult	Moderate Nuptial Pads	64.1	41	1.0	0007A0E076	Not Captured	N	SIz8	In litter	Sitting
I	Smiths Creek	Summer	M	Adult	Dark Nuptial Pads	67.2	53.0	3.0	0007A11983	Capture	Y	SIz6	On litter	Sitting
I	Smiths Creek	Summer	M	Adult	Light Nuptial Pads	62.5	37.0	3.0	0007D1E29B	Capture	Y	SIz10	On litter	Sitting

Location		Season	Sx	Age	Reproductive Status	L	W	DW	Pit_Tag_Co	Capture/Recapture	S	Z	Microhabitat	Activity
I	Smiths Creek	Summer	M	Adult	Dark Nuptial Pads	72.4	52.0	3.0	0007A3BD29	Capture	Y	SIz9	In grass	Sitting
I	Smiths Creek	Summer	M	Adult	Light Nuptial Pads	61.1	32.0	10.0	000791EA05	Capture	Y	SIz10	On litter	Sitting
I	Smiths Creek	Summer	M	Adult	Dark Nuptial Pads	84.5	76.0	5.0	000763463C	Capture	Y	SIz8	On litter	Sitting
I	Smiths Creek	Summer	M	Adult	Dark Nuptial Pads	78.1	63.0	7.0	00077E6B54	Capture	Y		In litter	Sitting
I	Smiths Creek	Summer						10.0		Recapture	Y		On bank	Sitting
I	Smiths Creek	Summer						5.0		Capture	Y	SIz7	On litter	Sitting
I	Smiths Creek	Summer						6.0		Capture	Y	SIz5	In litter	Sitting
I	Smiths Creek	Summer		SA		61.2	32.0	4.0	00079EA483	Capture	Y	SIz10	On litter	Sitting
I	Smiths Creek	Summer		SA		54.4	30.0	6.0	0007A0F7D7	Capture	Y	SIz6	On litter	Sitting
I	Smiths Creek	Summer		SA		52.3	24.0	12.0	0007A0EF07	Capture	Y		On litter	Sitting
I	Smiths Creek	Summer	M	Adult	Moderate Nuptial Pads	72.9	64.0	3.0	0007A0F8D0	Capture	Y	SIz6	In litter	Sitting
I	Smiths Creek	Autumn		J				1.5		Not captured	N	SIz5	In privet	Sitting
I	Smiths Creek	Autumn	M	Adult	Moderate Nuptial Pads	72.1	61	3.0	0007634E98	Capture	Y	SIz8	On litter	Sitting
I	Smiths Creek	Autumn		SA		68.7	61.0	5.0	0007634EE6	Capture	Y	SIz9	On litter	Sitting
I	Smiths Creek	Autumn	U					8.0		Not Captured	Y	SIz12	Under log	Sitting
I	Smiths Creek	Autumn	F	Adult				2.0		Not Captured	Y	SIz12	On litter	Sitting
Ref	Cooperabung Creek	Spring	F	Adult	Gravid	90.0	110.0	0.5	00079204EA	Recapture	Y	CRz3	Open ground	Sitting
Ref	Cooperabung Creek	Spring	F	Adult	Gravid	93.0	128.0	5.0	0007634827	Capture	Y	CRz1	Open ground	Sitting
Ref	Cooperabung Creek	Spring	F	Adult	Gravid	95.1	110.0	5.0	000763550A	Capture	Y	CRz2	Under leaf litter	Half buried
Ref	Cooperabung Creek	Summer	F	Adult	Gravid	109.5	179.0	3.0	00077E7FEB	Recapture	Y	CRz3	Under Lomandra	Sitting
Ref	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	77.8	64.0	1.0	00077E6AA0	Recapture	Y	CRz3	Under Lomandra	Sitting
Ref	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	75.5	75.0	2.0	00077E6AB1	Recapture	Y	CRz3	On litter	Sitting
Ref	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	79.4	75.0	2.0	00077E6CE7	Recapture	Y	CRz3	On litter	Sitting
Ref	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	67.9	57.0	1.0	1375334	Capture	Y	CRz10	On rock	Sitting

Location		Season	Sx	Age	Reproductive Status	L	W	DW	Pit_Tag_Co	Capture/Recapture	S	Z	Microhabitat	Activity
Ref	Cooperabung Creek	Summer	M	Adult	Dark Nuptial Pads	74.2	55.0	3.0	1374657	Capture	Y	CRz10	Base of tree	Sitting
Ref	Cooperabung Creek	Summer									N	CRz3		Calling
Ref	Cooperabung Creek	Autumn	M	Adult	Light Nuptial Pads	77.6	61	4.0	0007633E38	Capture	Y	CRz5	On Litter	Sitting
Ref	Cooperabung Creek	Autumn		SA		57.3	20.0	1.5	0077E8102	Capture	Y	CRz4	In Litter	Sitting
Ref	Cooperabung Creek	Autumn	F	Adult	Moderately Gravid	98.0	158	2.0	000763550A	Recapture	Y	CRz3	In Litter	Sitting
Ref	Pipers Creek	Spring	F	Adult	Gravid	91.0	128.0	10.0	0007633434	Recapture	Y	PRz2	Open ground	Sitting
Ref	Pipers Creek	Spring	F	Adult	Gravid	95.4	101.0	2.0	000792078E	Capture	Y	PRz1	In litter	Sitting
Ref	Pipers Creek	Spring	F	Adult	Gravid	98.8	111.0	5.0	000791EC0F	Capture	Y	PRz5	Under Lomandra	Sitting
Ref	Pipers Creek	Spring	F			77.5	86.0	7.0	00076350FA	Capture	Y	PRz6	Open ground	Sitting
Ref	Pipers Creek	Spring	F?			88.9	109.0	2.0	00077E80D9	Recapture	Y	PRz2	Under Litter	Buried
Ref	Pipers Creek	Spring	J		Juvenile	53.3	22	3	000791EC0D	Recapture	Y	PRz2	On ground	Sitting
Ref	Pipers Creek	Spring	J		Juvenile	54.5	19.0	0.5			Y	PRz6	On ground	Buried
Ref	Pipers Creek	Spring	M			75.5	57.0	2.0	000791EBA3	Recapture	Y	PRz4	Under Lomandra	Sitting
Ref	Pipers Creek	Spring	M			75.0	67	2.0	000791EC27	Recapture	Y	PRz3	Open ground	Sitting
Ref	Pipers Creek	Spring	M							Not captured	N			
Ref	Pipers Creek	Spring	M	Adult	Dark nuptial pads	73.8	56.0	3.0	000634742	Capture	Y	PRz7	On path	Jumpng
Ref	Pipers Creek	Spring	M			79.8	73.0	3.0	000791EB5B	Capture	Y	PRz1	Under Palm	Sitting
Ref	Pipers Creek	Spring	M		Dark nuptial pads	73.3	62.0	1.5	000791E994	Capture	Y	PRz4	Under Lomandra	Sitting
Ref	Pipers Creek	Spring	F?							Not captured	N			
Ref	Pipers Creek	Spring	U							Not captured	N			
Ref	Pipers Creek	Spring	U					4.0		Not captured	N			
Ref	Pipers Creek	Spring	U							Not captured	N			
Ref	Pipers Creek	Summer	F	Adult	Gravid	105.6	150.0	10.0	00079217BF	Recapture	Y	PRz5	On litter	Sitting
Ref	Pipers Creek	Summer	F	Adult	Moderate Gravid	90.6	133.0	4.0	000763S0FA	Recapture	Y	PRz2	On litter	Sitting
Ref	Pipers Creek	Summer	F	Adult	Gravid	94.0	165.0	15.0	00077E8009	Recapture	Y	PRz1	On litter	Sitting

Location		Season	Sx	Age	Reproductive Status	L	W	DW	Pit_Tag_Co	Capture/Recapture	S	Z	Microhabitat	Activity
Ref	Pipers Creek	Summer	F	Adult	Moderately Gravid	89.9	120.0	1.0	00077E8057	Recapture	Y	PRz8	On litter under log	Sitting
Ref	Pipers Creek	Summer	F	Adult	Gravid	95.5	126.0	7.0	00070276F1	Recapture	Y	PRz8	On litter	Sitting
Ref	Pipers Creek	Summer	F	Adult	Moderately Gravid	88.4	120.0	10.0	1372278	Capture	Y	PRz5	On litter	Sitting
Ref	Pipers Creek	Summer	F	Adult	Gravid	91.6	135.0	5.0	1373862	Capture	Y	PRz1	On litter	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	73.4	65.0	10.0	000791EAAF	Recapture	Y	PRz4	On litter	Sitting
Ref	Pipers Creek	Summer	M	Adult	Moderate Nuptial Pads	79.4	70.0	4.0	000791EBA3	Recapture	Y	PRz2	On litter	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	72.5	65.0	3.0	00079206C4	Recapture	N	PRz2	On litter	Sitting
Ref	Pipers Creek	Summer	M	Adult	Moderate Nuptial Pads	85.8	73.0	2.0	000791E994	Recapture	Y	PRz7	On log	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	70.5	66.0	1.0	0007020600	Recapture	Y	PRz8	On litter	Sitting
Ref	Pipers Creek	Summer	M	Adult						Not Captured	N	PRz7		Calling
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	79.4	66.0	2.0	1372640	Capture	Y	PRz5	On log	Sitting
Ref	Pipers Creek	Summer	M	Adult	Light Nuptial Pads	69.3	52.0	10.0	1376148	Capture	Y	PRz5	On ground	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	70.0	60.0	1.0	1372856	Capture	Y	PRz5	On litter	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	73.6	57.0	1.0	137325?	Capture	Y	PRz5	Under Lomandra	Sitting
Ref	Pipers Creek	Summer	M	Adult	Moderate Nuptial Pads	73.7	60.0	0.0	1373270	Capture	Y	PRz4	On rock	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	73.3	48.0	3.0	1376288	Capture	Y	PRz3	Under Lomandra	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	72.7	60.0	5.0	1328439	Capture	Y	PRz3	On Litter, under log	sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	76.5	80.0	2.0	1374700	Capture	Y	PRz2	On rock, in creek	sitting
Ref	Pipers Creek	Summer	M	Adult	Moderate Nuptial Pads	72.7	58.0	1.0	1375092	Capture	Y	PRZ1	On rock	Sitting
Ref	Pipers Creek	Summer	M	Adult	Light Nuptial Pads	70.6	47.0	2.0	1373280	Capture	Y	PRz1	On log	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	69.8	62.0	12.0	1372746	Capture	Y	PRz7	On litter	Sitting
Ref	Pipers Creek	Summer	M	Adult	Dark Nuptial Pads	71.8	51.0	0.5	1372623	Capture	Y	PRz9	On rock	Sitting
Ref	Pipers Creek	Summer	F	J	Moderately Gravid	87.7	110	8.0	00077E6D03	Recapture	N	PRz7	Base of tree	Sitting
Ref	Pipers Creek	Summer	U					10.0		Not Captured	Y	PRz2	On litter	Sitting
Ref	Pipers Creek	Summer	U					7.0		Not Captured	N	PRz8	On litter	Sitting

Location		Season	Sx	Age	Reproductive Status	L	W	DW	Pit_Tag_Co	Capture/Recapture	S	Z	Microhabitat	Activity
Ref	Pipers Creek	Summer	U					7.0		Not Captured	N	PRz8	On litter	Sitting
Ref	Pipers Creek	Summer	M	SA		57.6	25.0	1.0	1373646	Capture	Y	PRz8	On litter	Sitting
Ref	Pipers Creek	Autumn	M	Adult						Not Captured	Y	PRz2	Under litter	Sitting
Ref	Pipers Creek	Autumn	U	SA		55.2	20.0	15.0	000791EC91	Capture	Y	PRz1	On litter	Sitting

Annex 3 - Water Quality data (extracted from RMS 2017a and RMS 2017b)

Table 29: Triggered water quality parameters: Cooperabung Creek

(where values in black = < 20th % Values in red = > 80th % Shaded cells = outside/above ANZECC trigger)

Parameter	ANZECC trigger value	Median DS (US 20th % - 80th % trigger)											
		Aug 16	Sept 16	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Jun 17	Jul 17
Temperature ˚C	NA	13.0 (14.4-21.8)				22.2 (14.3-21.2)	23.3 (14.3-21.2)	26.2 (14.4-21.5)	22.2 (14.4-21.1)				12.4 (15.0-20.8)
Electrical Conductivity uS/cm	125 – 2200		216 (143-204)	321 (143-208)	287 (167-227)	471 (177-231)	604 (177-231)	588 (178-230)	481 (167-248)	258 (165-248)		178 (180-248)	
Dissolved oxygen %	85 – 110	91 (45-89)		41 (43-89)			87 (38-84)	103 (38-84)					
pH	6.5 – 8				7.0 (7.1-7.6)	6.9 (7.3-7.7)	6.8 (7.3-7.7)	7.1 (7.2-7.6)	6.4 (7.0-7.6)	6.7 (6.8-7.5)			
Turbidity (NTU)	6 – 50		7 (12-32)	5 (10-32)		7 (9-23)							
Total suspended solids mg/L	-												
Aluminium mg/L	0.055	0.35 (0.03-0.32)					0.01 (0.03-0.26)	0.01 (0.03-0.26)				0.43 (0.03-0.24)	
Arsenic mg/L	0.024												
Cadmium mg/L	0.0002												
Chromium mg/L	0.001												
Copper mg/L	0.0014												
Iron mg/L	ID	0.33 (0.38-0.78)		0.27 (0.43-0.78)		0.10 (0.48-0.85)	0.12 (0.48-0.85	0.14 (0.48-0.85)		0.33 (0.4-0.85)			0.35 (0.37-0.78)
Lead mg/L	0.0034												
Manganese mg/L	1.9			0.208 (0.022-0.107)	0.294 (0.022-0.107)		0.271 (0.022-0.136)	0.599 (0.022-0.136)				0.022 (0.024-0.136)	
Mercury mg/L	0.0006												
Nickel mg/L	0.011					0.002 (0.001-0.001)			0.002 (0.001-0.001)				
Silver mg/L													
Zinc mg/L	0.008					0.023 (0.005-0.007)	0.021 (0.005-0.007)	0.018 (0.005-0.007)	0.023 (0.005-0.008)				
Total nitrogen mg/L	0.5										0.1 (0.2-0.5)		
Total phosphorus mg/L	0.05												

Table 30: Triggered water quality parameters: Smiths Creek

(where values in black = < 20th % Values in red = > 80th % Shaded cells = outside/above ANZECC trigger)

Parameter	ANZECC trigger value	Median DS (US 20th % - 80th % trigger)											
		Aug 16	Sept 16	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Jun 17	Jul 17
Temperature ˚C	NA	12.6 (14.5-21.3)				24.8 (14.0-20.1)	21.5 (14.0-21.0)					14.4 (16.4-23.9)	11.3 (15.1-23.9)
Electrical Conductivity us/cm	125 – 2200			285 (168-242)	255 (168-244)	675 (174-255)	718 (174-265)	971 (174-351)	629 (183-365)	192 (205-365)		169 (190-365)	
Dissolved oxygen %	85 – 110											87 (17-81)	95 (17-84)
pH	6.5 – 8					6.7 (6.8-7.3)							
Turbidity (NTU)	6 – 50			8 (10-23)	53 (10-32)				70 (13-43)				10 (12-26)
Total suspnd solids mg/L	-				8 (5-5)	13 (5-6)		9 (5-8)					
Aluminium mg/L	0.055	0.69 (0.05-0.47)				0.03 (0.05-0.16)	0.02 (0.04-0.13)	0.01 (0.02-0.12)		0.20 (0.02-0.13)		0.43 (0.05-0.27)	
Arsenic mg/L	0.024												
Cadmium mg/L	0.0002												
Chromium mg/L	0.001												
Copper mg/L	0.0014						0.003 (0.001-0.001)						
Iron mg/L	ID	0.43 (0.45-0.80)	0.32 (0.42-0.77)			0.26 (0.40-0.85)			0.16 (0.37-1.43)				
Lead mg/L	0.0034												
Manganese mg/L	1.9	0.010 (0.011-0.147)				0.661 (0.011-0.205)	0.481 (0.011-0.212)	0.985 (0.011-0.266)				0.009 (0.011-0.217)	
Mercury mg/L	0.0006												
Nickel mg/L	0.011						0.002 (0.001-0.001)	0.003 (0.001-0.001)	0.002 (0.001-0.001)				
Silver mg/L													
Zinc mg/L	0.008				0.011 (0.005-0.008)						0.016 (0.005-0.008)		
Total nitrogen mg/L	0.5					1.0 (0.2-0.4)			0.8 (0.2-0.7)				

Parameter	ANZECC trigger value	Median DS (US 20th % - 80th % trigger)											
Total phosphorus mg/L	0.05		0.01 (0.02-0.06)	0.01 (0.02-0.05)				0.01 (0.02-0.08)					

Table 31: Triggered water quality parameters: Pipers Creek

(where values in black = < 20th % Values in red = > 80th % Shaded cells = outside/above ANZECC trigger)

Parameter	ANZECC trigger value	Median DS (US 20th % - 80th % trigger)											
		Aug 16	Sept 16	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Jun 17	Jul 17
Temperature ˚C	NA	12.4 (14.2-22.3)				27.2 (14.2-21.7)	22.8 (14.2-22.0)	27.0 (14.2-24.0)			16.6 (16.8-24.1)	13.9 (16.8-24.1)	11.2 (14.9-24.1)
Electrical Conductivity uS/cm	125 – 2200									64 (268-495)		264 (273-495)	
Dissolved oxygen %	85 – 110	87 (26-81)					12 (37-81)					81 (33-73)	83 (33-76)
pH	6.5 – 8										6.9 (7.0-7.2)		
Turbidity (NTU)	6 – 50		15 (16-47)	10 (16-47)						2 (14-46)	11 (12-51)		11 (12-47)
Total suspended solids mg/L	-												
Aluminium mg/L	0.055	0.56 (0.04-0.27)					0.01 (0.02-0.18)						
Arsenic mg/L	0.024												
Cadmium mg/L	0.0002												
Chromium mg/L	0.001												
Copper mg/L	0.0014												
Iron mg/L	ID										0.82 (0.34-0.69)		0.68 (0.36-0.64)
Lead mg/L	0.0034												
Manganese mg/L	1.9	0.014 (0.018-0.266)					0.535 (0.023-0.294)	0.372 (0.023-0.294)					
Mercury mg/L	0.0006												

Parameter	ANZECC trigger value	Median DS (US 20th % - 80th % trigger)											
Nickel mg/L	0.011												
Silver mg/L													
Zinc mg/L	0.008						0.018 (0.005-0.008)	0.009 (0.005-0.008)					
Total nitrogen mg/L	0.5			0.2 (0.3-0.6)					1.1 (0.3-0.6)				
Total phosphorus mg/L	0.05		0.01 (0.02-0.03)	0.01 (0.02-0.03)			0.04 (0.01-0.03)		0.04 (0.01-0.03)				

Table 32: Triggered water quality parameters: Maria River

(where values in black = < 20th % Values in red = > 80th % Shaded cells = outside/above ANZECC trigger)

Parameter	ANZECC trigger value	Median DS (US 20th % - 80th % trigger)											
		Aug 16	Sept 16	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Jun 17	Jul 17
Temperature ˚C	NA	12.9 (14.2-22.2)				24.7 (13.9-21.5)	21.9 (13.9-21.4)	24.9 (13.9-23.1)				14.1 (16.2-24.2)	11.1 (15.2-24.2)
Elctrical Cndctvty uS/cm	125 – 2200		283 (177-236)	303 (186-285)	298 (196-285)	317 (196-285)	391 (187-285)	485 (187-246)	305 (192-286)				283 (192-255)
Dissolved oxygen %	85 – 110	55 (16-48)	56 (16-50)					64 (17-43)	60 (17-51)				50 (15-43)
pH	6.5 – 8		6.1 (6.3-7.0)						6.2 (6.4-7.0)	6.0 (6.4-7.0)	6.3 (6.5-7.0)	6.1 (6.4-7.0)	
Turbidity (NTU)	6 – 50		9 (22-65)	8 (13-58)					80 (11-34)				0 (12-42)
Total suspnd solids mg/L	-	5 (6-14)	5 (6-14)			13 (5-11)	11 (5-9)	16 (5-9)	41 (5-9)				
Aluminium mg/L	0.055	0.61 (0.04-0.57)				0.02 (0.03-0.42)		0.01 (0.02-0.33)				0.58 (0.03-0.53)	
Arsenic mg/L	0.024				0.002 (0.001-0.001)	0.002 (0.001-0.001)	0.005 (0.001-0.002)						
Cadmium mg/L	0.0002												
Chromium mg/L	0.001												
Copper mg/L	0.0014					0.240 (0.001-0.001)			0.002 (0.001-0.001)				
Iron mg/L	ID					1.57	3.84	1.71	0.35		1.34		

Parameter	ANZECC trigger value	Median DS (US 20th % - 80th % trigger)											
						(0.46-1.06)	(0.46-1.18)	(0.46-1.29)	(0.38-1.29)		(0.55-1.29)		
Lead mg/L	0.0034												
Manganese mg/L	1.9	0.031 (0.055-0.206)			0.282 (0.055-0.206)	0.301 (0.074-0.221)	0.451 (0.074-0.231)	0.439 (0.074-0.279)				0.034 (0.055-0.253)	
Mercury mg/L	0.0006												
Nickel mg/L	0.011								0.002 (0.001-0.001)	0.002 (0.001-0.001)	0.003 (0.001-0.001)		
Silver mg/L													
Zinc mg/L	0.008						0.011 (0.005-0.007)		0.014 (0.005-0.007)		0.009 (0.005-0.008)		
Total nitrogen mg/L	0.5		1.0 (0.5-0.8)	0.4 (0.5-0.7)		1.0 (0.4-0.6)	0.9 (0.4-0.7)	1.2 (0.5-0.8)				0.5 (0.6-0.9)	0.4 (0.6-0.9)
Total phosphorus mg/L	0.05					0.06 (0.01-0.05)	0.06 (0.01-0.05)		0.07 (0.01-0.05)			0.01 (0.03-0.05)	0.01 (0.02-0.05)

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Road Kill Monitoring 2016/2017

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Road and Maritime Services

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Cover photograph: Fauna fence spring 2017 (Photo: J. Danvers)

Executive summary

Context

This report details the findings of the road kill surveys undertaken from July 27 2016 to July 28 2017, as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway upgrade project (the Project).

Aims

The road kill survey is designed to monitor the effectiveness of fauna mitigation measures on the OH2K Pacific Highway Upgrade (the Project).

Methods

Surveys were conducted weekly for the period July 27 2016 to July 28 2017. Surveys involved a vehicle being driven along the entire length of the existing highway in the Project area and identifying dead wildlife (road kill) seen on the roads and within three metres of the road edge. Geographic coordinates and species, where possible, were recorded. Where a threatened species was identified, additional information was recorded.

Key results

A total of 134 road kill animals were recorded over 53 weeks of monitoring, in comparison to 100 records for 12 weeks of baseline surveys. The 2016/2017 monitoring period recorded a lower average weekly road kill than baseline surveys for all seasons when considering the entire monitoring period, and when considering only the same four week period of construction surveys as the baseline surveys. One threatened species, the Koala, was recorded on two occasions (one beyond the northern boundary of the OH2K project) as road kill during the current monitoring period. Fauna fencing, underpasses and culverts are in the vicinity of the Koala road kill locations, as well as additional retrofitted boundary fencing to direct fauna towards the underpass.

Conclusions

Current trends indicate an overall reduction in road kill incidence during construction activities. The surveys for 2016/2017 show a reduced road kill rate compared to the baseline surveys in spring, summer and autumn, as such the performance indicator relating to reduced road kill incidence has been met. Other performance indicators relating to mitigation measures (rope bridges, fauna fencing and underpasses) are not yet relevant as structures are still under construction.

Management implications

There are no current recommendations based on the outcomes of the 2016/2017 monitoring period. Continued monitoring of road kill upon completion of mitigation measures will provide further information as to the effectiveness of these measures.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Environment (DoE) for matters of national environmental significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1995 (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (RMS 2016) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

1.1.1 Monitoring Framework

Road kill monitoring is to be performed in accordance with the EMP. The monitoring framework provided within the EMP and the reporting status is shown in Table 1.

Table 1: Road kill monitoring

Project Phase	Monitoring event: report	Timing of survey	Location
Baseline	*spring 2013, summer 2014, autumn 2014:* Niche 2015	Weekly during October (spring), January (summer) and April (autumn) prior to commencement of construction (12 weeks)	Entire length of existing highway in Project area
During clearing operations	*November 2014- July 2015*: Niche 2015	Daily	Portion of existing highway adjacent to clearing operations
One month following clearing operations			
For the duration of construction	*8 August 2015 – 22 July 2016*: Niche 2016 *27 July 2016 – 28 July 2017*: current report	Weekly	Entire length of existing highway in Project area
Within one month of opening of the Project		Weekly for 12 weeks. If this period does not coincide with the season (i.e. October (spring), January (summer) and April (autumn) in which baseline surveys were undertaken, also undertake weekly surveys during the first survey period (April, October or January) to occur after the opening of the Project (to allow for comparison to baseline results).	Entire length of completed Project
Upon completion of the Project (operation phase)		Weekly during October (spring), January (summer) and April (autumn (12 weeks) in Year 4, 5, 6 and 8, or until mitigation measures can be demonstrated to have been effective as defined in the EPBC approval.	Entire length of completed Project

1.1.2 Baseline Data

Baseline surveys were undertaken prior to the commencement of construction over 12 weeks in spring 2013, summer 2014 and autumn 2014. Monitoring took place weekly for four weeks in each of the seasons as required by the EMP. Baseline surveys recorded 100 animals as road kill during the three monitoring events, representing 33 species and an average weekly road kill for spring, summer and autumn of 9.5, 12.0 and 3.3 respectively.

1.1.3 Purpose of this report

This report complies with the monitoring requirements described within the EMP and details the findings obtained from the construction phase of monitoring from July 27 2016 – July 28 2017. The aim of this report is to summarise the methods and results of the 2016/2017 road kill monitoring and determine if performance measures have been met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance indicators for road kill monitoring:

- *"Lower rates of road kill in proximity (i.e. areas of the main carriageways within areas adjacent to installed fauna fencing, and within 100m of rope bridges and fauna underpasses) to fauna fencing, rope bridges and fauna underpasses than in sections of the upgrade not near wildlife crossing structures or fauna fences in Years 1 – 6 & 8 monitoring events.*
- *Reduced incidence of road kill from baseline conditions during monitoring events in Years 1 – 6 & 8 and when all monitoring events are considered at Year 8.*
- *Fauna exclusion fencing is installed at a minimum in the locations identified in Schedule 3 of the EPBC approval at Year 4."*

1.3 Monitoring Timing

The 2016/2017 monitoring period involved weekly monitoring of the entire length of the existing highway.

1.4 Reporting

Annual reporting of monitoring results are required to include:

- Detailed description of monitoring methodology employed.
- Results of the monitoring period.
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations.
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the Director General of the Department of Planning and Environment and the Environment Protection Authority.

1.5 Limitations

Due to safety concerns associated with slowing down or stopping on the highway, and prescribed data collection methods, data collection was limited to the following:

- Some road kill fauna were identified to the "vertebrate group" level only.
- Some road kill fauna could not be identified as a result of extensive collision damage. These records were classified as 'unknown'.
- It was not always possible to remove road kill fauna from the road side, potentially resulting in double counts.
- Small-sized road kill fauna have the potential to be partially or wholly removed by scavenger animals, resulting in impossible identification from the vehicle. As a result, it is possible that small fauna such as frogs, snakes, small mammals and birds have been under counted.
- Road kill surveys undertaken during and after clearing operations concerned only those sections of the highway adjacent to the areas being cleared. As such, these surveys cannot be compared with baseline and construction surveys where the entire length of the highway was surveyed.

2. Survey Methods

The survey method described within the EMP was employed for all surveys and is provided below.

"Baseline road kill surveys will involve a vehicle being driven along the entire length of the existing highway in the Project area and identifying dead wildlife (road kill) seen on the roads and within three metres of the road edge. Both driver and passenger will search the left-hand side of the road and its verge for road kill. When a road kill is observed from the vehicle, a closer inspection of the carcass will be undertaken where access is possible and where safely limitations permit. If safe access is not possible, due to local traffic conditions, binoculars will be used to try to identify carcasses. Road kill fauna will be identified to species level where possible, with reference to field guides. Those too seriously damaged to be accurately identified will be recorded as "unknown". Upon identification of the road kill, the animal should be removed if safe to do so, so as to avoid double counting during subsequent surveys".

For each road kill observed, the following attributes were recorded:

- Geographic coordinates of the road kill location.
- Species of road kill where possible.

The EMP also notes that: "*If the animal is identified as a TSC Act or EPBC Act threatened species, the following information will also be recorded:*

- *Sex and age class (juvenile or adult) where possible and safety limitations permit.*
- *Presence of pouch young (for marsupials) where possible and safety limitations permit.*

In addition, for TSC Act or EPBC Act threatened species, local habitat attributes will be recorded at a point five metres from the road verge at the road kill location, including:

- *Structure and floristics of vegetation, including dominant species of each vegetation stratum, height and per cent cover*
- *Presence and type of hydrological and surface drainage features*
- *Presence and type of rocky features*
- *Abundance and type of tree and log hollows*
- *Presence, type and abundance of foraging resources*
- *Presence and type of microhabitats."*

3. Results

The results summarise the 2016/2017 weekly monitoring undertaken from July 27 2016 to July 28 2017, a total of 53 monitoring events. Figure 1 shows the seasonal distribution of all road kill for the baseline and 2016/2017 monitoring period. The data was collected by Road and Maritime Services and is summarised below. The raw data is provided in Annex 1.

3.1 2016/2017 weekly monitoring

Fauna results

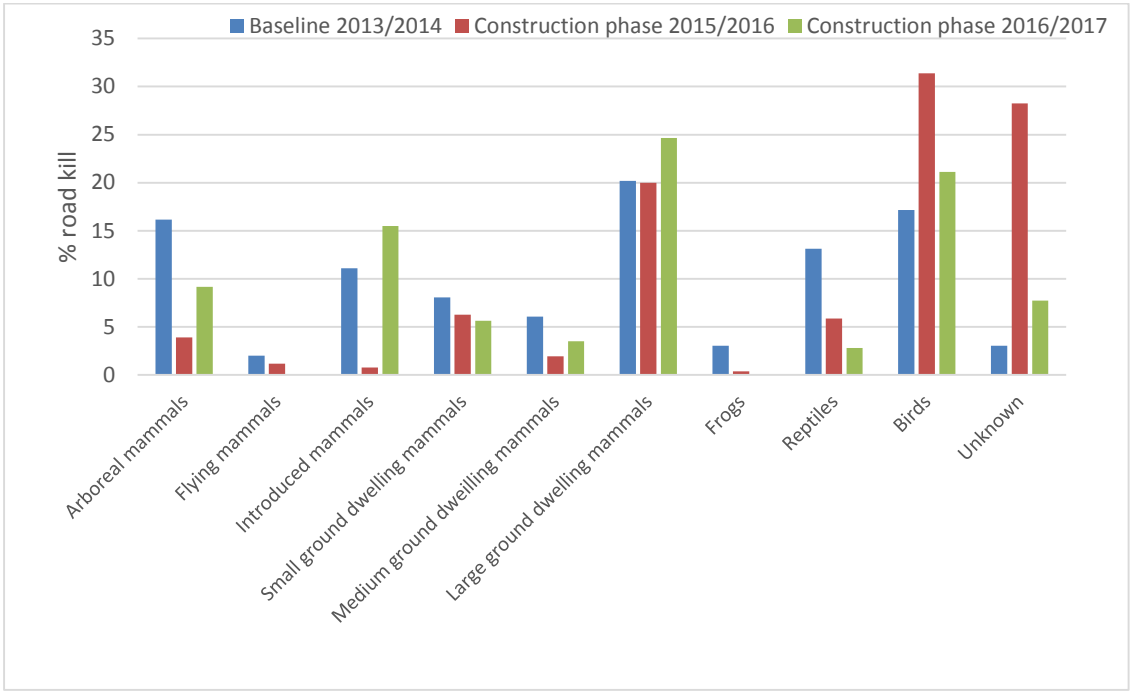
There were a total of 134 road kill records during the 2016/2017 monitoring period: 23% occurred in winter (late winter 2016, n = 14, and early winter 2017, n = 17), 32% in spring (n = 43), 25% in summer (n = 34) and 19% in autumn (n = 26).

The baseline report (Lewis 2014) defined fauna categories for analysis as follows:

- Arboreal mammals
- Flying mammals (i.e. bats)
- Introduced mammals
- Small ground dwelling mammals
- Medium ground dwelling mammals
- Large ground dwelling mammals
- Frogs
- Reptiles
- Birds

As stated in Section 1.5 Limitations, an 'unknown' category was included to account for those species that could not be identified. The percentage of road kill records for each category are presented in Graph 1. Large ground dwelling mammals (Kangaroo and Wallaby) (26% of road kill, n = 35), birds (22.4% of road kill, n = 34), and introduced mammals (15.5%, n = 22) were the most commonly recorded fauna groups.

Graph 1: Comparison of road kill fauna categories for each monitoring period



Threatened fauna

Two dead Koalas were recorded in spring 2016. These were located at the northern end of the Project area within 3 km of each other (Figure 2), with ID32 occurring beyond the northern boundary of the OH2K project. As per the EMP, additional details regarding the sex, age class and pouch young were recorded (Table 2). The sex of the individuals was unknown but they were considered to be adolescent animals. A number of habitat attributes were also recorded, these are provided in Table 3. Locations of both animals were adjacent to wet sclerophyll forest.

- ID32 – approximately 350 m north of the Stumpy Creek bridge underpass and beyond the northern boundary of the OH2K project. Approximately 100 m of boundary fence was retrofitted at this location (after the road kill event) to assist in directing fauna to the Ku2K Stumpy Creek bridge underpass. The existing fauna fence for the Ku2K section finishes at Stumpy Creek, however fauna fencing continues for approximately 400 m, erected in association with the Kempsey Bypass construction. The additional 100 m of retrofitted boundary fence continues north from this point.
- ID37 – approximately 100 m north of a 3 m x 3 m combined box culvert. There is also a 3 m x 3 m combined culvert approximately 600 m to the north of this location and a dedicated 3m x 3m culvert approximately 1100 m to the south. There is fauna fencing throughout this area (on the new alignment).

Table 2: Threatened species road kill

ID	Season	Date	Species detected	Sex	Age	Pouch young	Location	Easting	Northing
32*	Spring	5 October 2016	Koala	Unknown	Adolescent	n/a	North of Gate 20	483413	6555959
37	Spring	12 October 2016	Koala	Unknown	Adolescent	n/a	North of Gate 17	482815	6553852

n/a – not applicable; * = recorded beyond the northern limit of the OH2K project

Table 3: Local habitat attributes for threatened species road kill

ID	Structure and floristics					Hydrological features	Rocky features	Logs	Hollow-bearing trees	Foraging resources
	Broad habitat type	Overstorey	Mid stratum	Shrub layer	Ground cover					
32*	Wet sclerophyll forest	Absent	Absent	Acacia	Exotic grasses and some native grasses	none	none	none	none	Suitable foraging forest habitat approx. 1km to the south
37	Wet sclerophyll forest	Eucalypt and Casuarina	Casuarina	Acacia and Lantana		Gully with semi-permanent standing water within 100m	none	none	none	Suitable Koala habitat

* = recorded beyond the northern limit of the OH2K project

3.2 Road kill and mitigation measures

The majority of the traffic remains on the existing Pacific Highway, and fauna mitigation measures associated with the new carriageway are still under construction. The full benefit of these structures will not be realised until the new carriageway is operational and these structures are completed. As such, an assessment of road kill with regards to mitigation measures has not been undertaken for the 2016/2017 monitoring period.

3.3 2016/2017 road kill incidence comparison with previous construction surveys

Road kill incidence

Figure 1 shows the seasonal distribution of all road kill for the baseline and 2016/2017 monitoring period. These construction monitoring results cannot yet consider the relationship between mitigation measures (still under construction) and road kill distribution. Distribution of road kill will be considered in relation to mitigation measures once they are operational. The difference in survey effort between baseline and construction monitoring (12 weeks *vs.* 53 weeks) also makes visual comparison difficult. Instead, to examine changes in road kill rates, the average weekly road kill was calculated. The average weekly road kill for the baseline surveys and the 2015/2016 and 2016/2017 monitoring periods for all survey events is presented in Table 4.

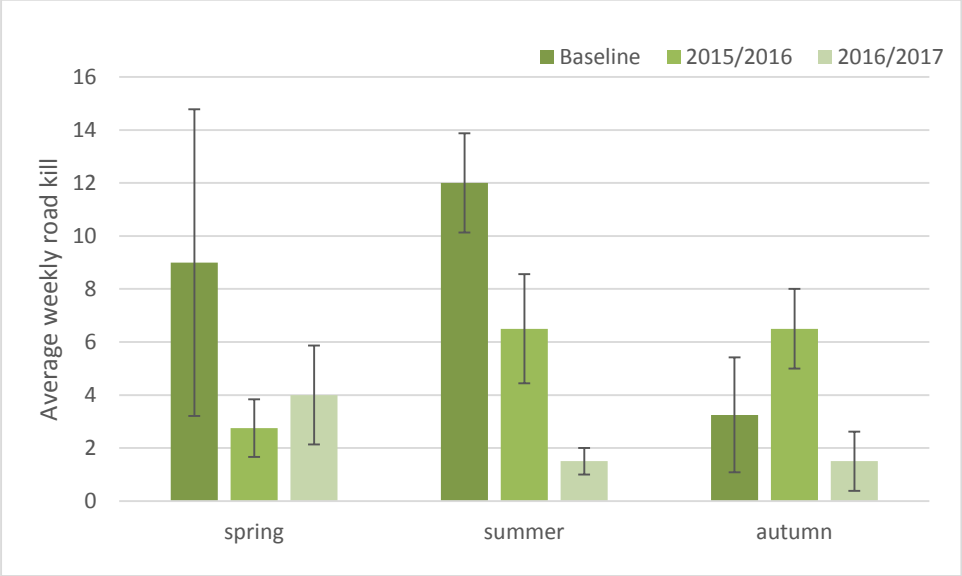
In order to directly compare the results of the baseline surveys with that of the later monitoring periods, the average weekly road kill for the four survey weeks undertaken in each season of the baseline surveys (spring (October), summer (January), autumn (May)), was compared to the same four weeks of each subsequent monitoring event. No road kill surveys were undertaken in winter during the baseline monitoring. Graph 2 shows the average weekly road kill over same four week period in baseline and construction monitoring periods.

The 2016/2017 monitoring period recorded a lower average weekly road kill than baseline surveys for all seasons when considering the entire monitoring period, and also when considering only the four week spring, summer and autumn periods. The 2016/2017 monitoring period also recorded a lower average weekly road kill in winter than the 2015/2016 monitoring period.

Table 4: Comparison of baseline and construction monitoring

Monitoring period		Spring (n)	Summer (n)	Autumn (n)	Winter (n)
Baseline	**2013/2014**	9.5 (4)	12.0 (4)	3.3 (4)	No surveys
Construction phase	**2015/2016 (all surveys)**	4.2 (13)	5.8 (13)	6.7 (13)	4.1 (12)
	2015/2016 (4 weeks)	2.75 (4)	6.5 (4)	6.5 (4)	No surveys
	2016/2017 (all surveys)	3.3 (13)	2.6 (13)	2.0 (13)	2.2 (14)
	2016/2017 (4 weeks)	4.0 (4)	1.5 (4)	1.5 (4)	n/a

Graph 2: Average (±SD, n = 4) weekly road kill per season, for baseline and construction monitoring



3.3.1 Fauna categories

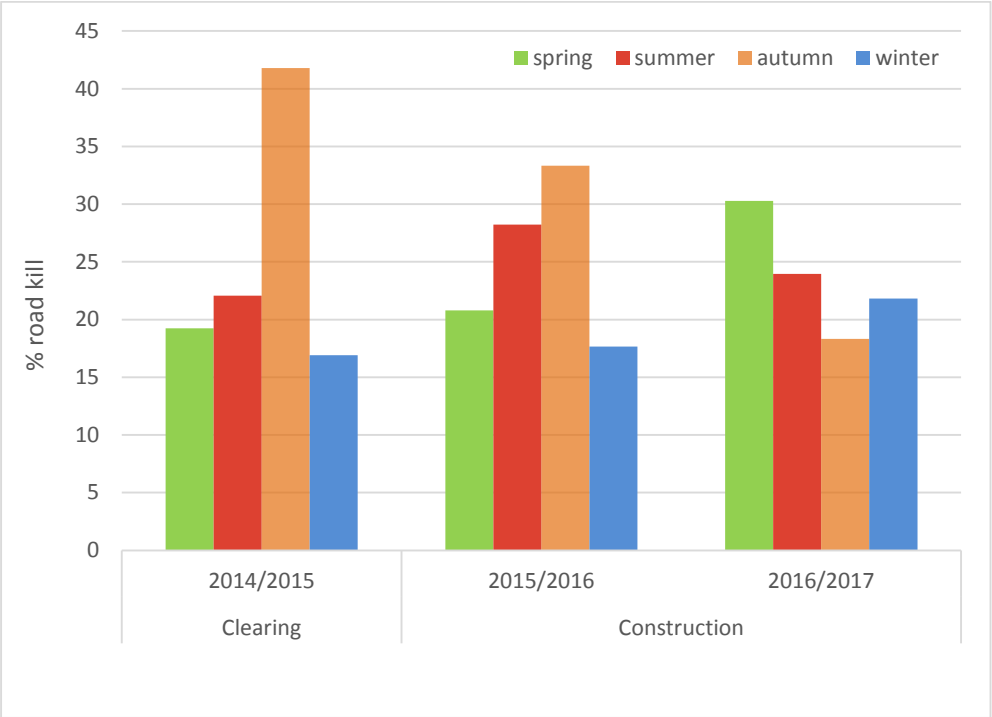
The percentage of road kill represented by each fauna category has been used to identify changes in road kill patterns. These categories and the percentage of road kill records are presented in Graph 1.

Terrestrial mammals and birds have been consistently the most commonly represented category during all monitoring periods. It is noted that small-sized road kill fauna have the potential to be partially or wholly removed by scavenger animals and not observed from the vehicle due to their size. Therefore there may be an under representation of smaller fauna, however this should be consistent across all surveys.

3.3.2 Seasonal differences

Seasonal differences in road kill rates were analysed using data obtained during the clearing (2014/2015) and also construction phases (2015/2016 and 2016/2017) as these monitoring periods include data from all four seasons. Baseline data was excluded from the comparison as winter surveys were not undertaken. Graph 3 shows the seasonal trend in road kill for each of the monitoring periods. A similar trend was observed between the 2014/2015 and the 2015/2016 monitoring periods with autumn recording the highest percentage of road kill. This trend was not observed in the 2016/2017 monitoring period where the highest number of road kill was recorded in spring. Further monitoring is required to establish any seasonal trends in road kill.

Graph 3: Percentage of road kill records per season



4. Discussion

A summary of the 2016/2017 survey results in relation to the performance measures is provided in Table 5.

Table 5: Performance measures

Performance Measures	Discussion
Lower rates of road kill in proximity (i.e. areas of the main carriageways within areas adjacent to installed fauna fencing, and within 100m of rope bridges and fauna underpasses) to fauna fencing, rope bridges and fauna underpasses than in sections of the upgrade not near wildlife crossing structures or fauna fences in Year 1 – 6 & 8 monitoring events.	**This performance measure was not assessed for the 2016/2017 monitoring period.** The majority of the traffic remains on the existing Pacific Highway, and fauna mitigation measures associated with the new carriageway are still under construction. As such, an assessment of road kill with regards to mitigation measures has not been undertaken.
Reduced incidence of road kill from baseline conditions during monitoring events in Years 1 – 6 & 8 and when all monitoring events are considered at Year 8.	**This performance measure was met for the 2016/2017 construction phase.** Overall there has been a decline in the recorded road kill between baseline and the subsequent two construction monitoring events. One threatened species (two individual Koalas, one beyond the northern boundary of the OH2K project) was recorded during the 2016/2017 monitoring period, while two threatened species (one Koala and two Grey-headed Flying-fox) were recorded as road kill during the baseline surveys (see Figure 2 for locations). Boundary fencing was retrofitted at the northern end of the Project to direct fauna to the Stumpy Creek bridge underpass. Culverts exist in the vicinity of both road kill locations.
Fauna exclusion fencing is installed at a minimum in the locations identified in Schedule 3 of the EPBC approval at Year 4.	**Not applicable until Year 4 (2018).**

5. Recommendations

5.1 Contingency measures

The EMP lists potential problems and contingency measures for various components of the monitoring program, however specific contingency measures for road kill have not been provided within the EMP. Road kill results will however be considered in relation to future underpass and fauna fence monitoring, as per the EMP.

5.2 Recommendations

Current trends indicate an overall reduction in road kill incidence during construction activities, as such there are no current recommendations based on the outcomes of the 2016/2017 monitoring period. These results represent construction monitoring and therefore cannot yet consider the relationship between mitigation measures (still under construction) and road kill rates or patterns. Continued monitoring of road kill upon completion of mitigation measures will provide further information as to the effectiveness of these measures.

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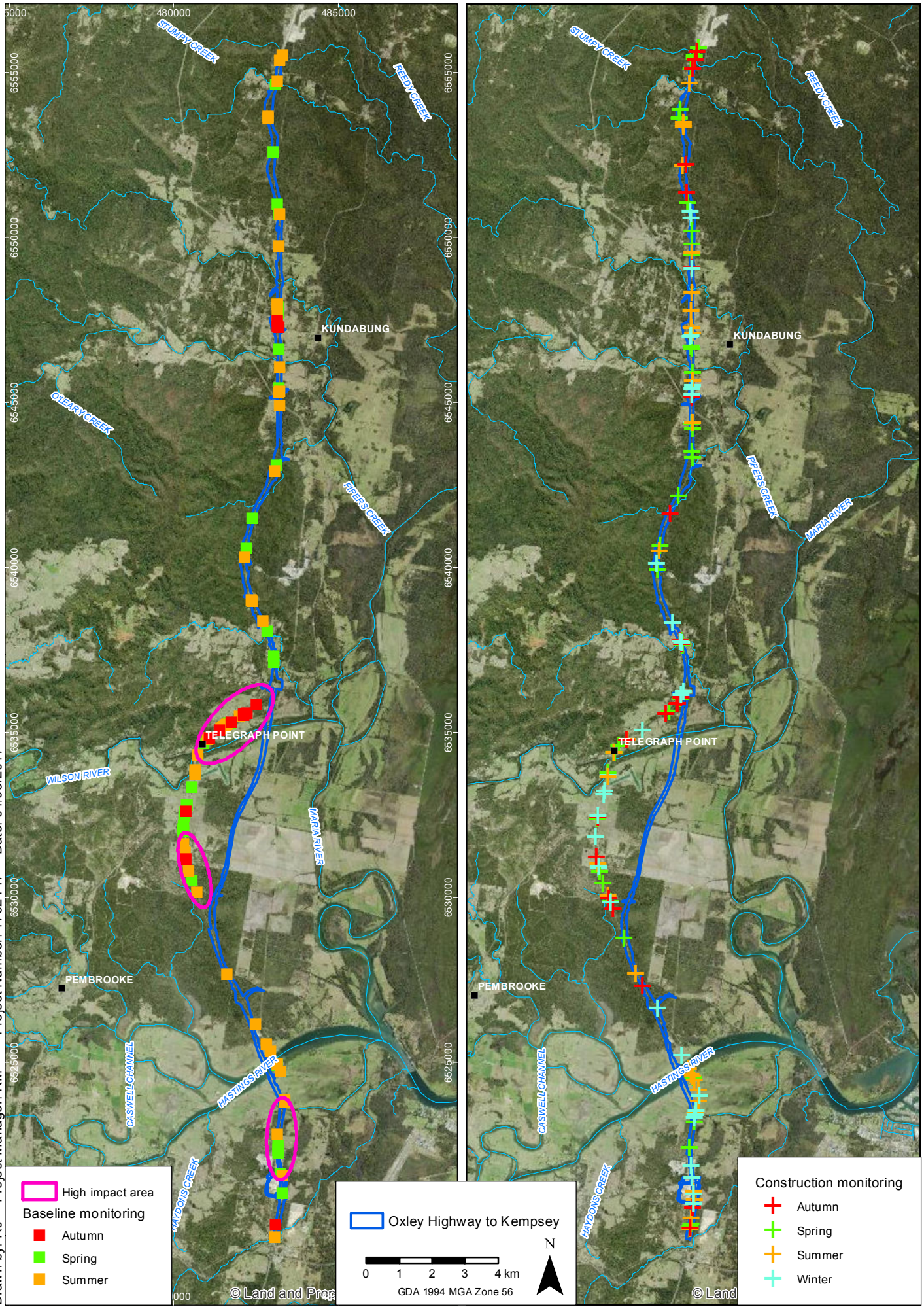

Seasonal distribution of road kill along the OH2K project (baseline monitoring vs. construction phase 2016-2017)

Pacific Highway Upgrade – Oxley Highway to Kempsey

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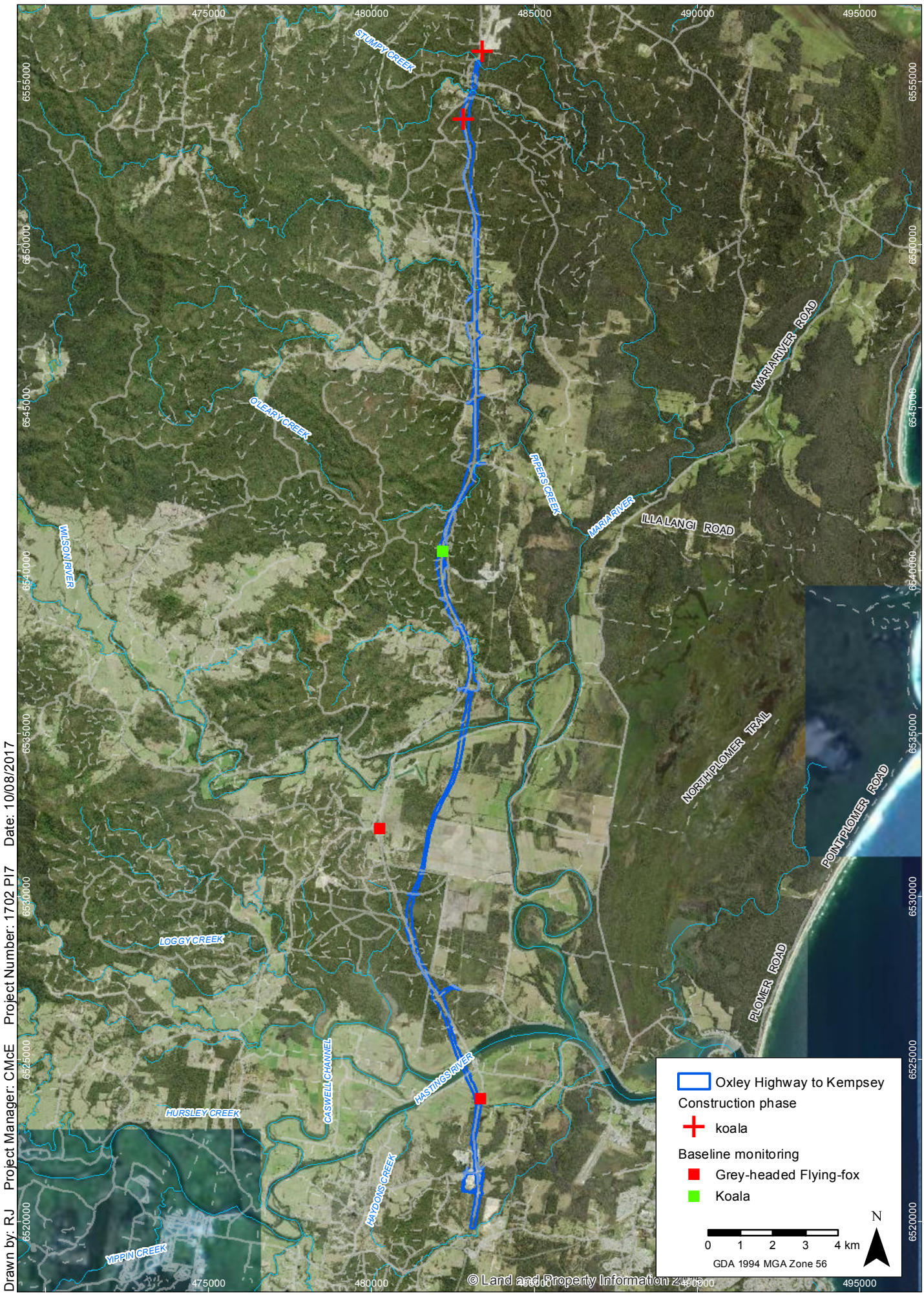
FIGURE 1

Imagery: (c) LPI 2014-10-06



Drawn by: RJ Project Manager: CMcE Project Number: 1702 PI7 Date: 10/08/2017

Threatened species road kill distribution along the OH2K project (baseline monitoring v. construction phase 2015-2016)

Pacific Highway Upgrade - Oxley Highway

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FIGURE 2

Imagery: (c) LPI 2014-10-06

Annex 1. Road Kill Data

Data presented as provided by Roads and Maritime Services. Table 6 provides location and fauna details. Table 7 presents additional habitat details where recorded. Note that additional data, including habitat and individual details, were not recorded for all road kill as the update to the EMP during the 2016/2017 season no longer required these details for all records, only for threatened species. An "ID" column has been added to the original data to link records between tables.

Table 6. Road kill locations and animal details

ID	Week number	Date	Start time	Finish time	Location description	Easting	Northing	Species	Assigned vertebrate group	Sex	Age	Pouch young
1	Week 51	27/07/2016	8:30am	9:50am	northbound, south of Cooperabung Creek	31°17'34.8"	152°49'12.8"	kookaburra	bird	unknown	adult	na
2					northbound, adjacent Cassegrain buildings	31°26'10.1"	152°49'22.9"	bird	bird	unknown	unknown	unknown
3					northbound, south of Fernbank Creek	31°25'20.0"	152°49'27.1"	kangaroo	mammal	unknown	unknown	unknown
4					northbound, north of McInerney's driveway	31°24'21.6"	152°49'11.7"	cat	mammal	unknown	adult	na
5	Week 52	02/08/2016	7:30	8:30	northbound, 2.3km south of Wilson River bridge	480273.61	6532036.5	unidentifiable	mammal	unknown	unknown	unknown
6					northbound, 0.9km south of Wilson River bridge	480567.27	6533420.63	unidentifiable	bird	unknown	unknown	unknown
7					southbound, 0.55km south Smiths Creek	483211.43	6545723.03	unidentifiable	bird	unknown	unknown	unknown
8	Week 53	11-Aug	7:30	8:30	southbound, 50m north of Cairncross State Forest	480375.262	6531089.268	echidna	mammal	unknown	unknown	unknown
9					within 60km/hr. section of Hastings River interchange	481972.026	6586925.854	unidentifiable	mammal	unknown	unknown	unknown
10					northbound, 600m south of Wilson River Bridge	480645.463	6533910.471	unidentifiable	bird	unknown	unknown	na
11	Week 54	19/08/2016	7:30	8:30	South of Kundabung interchange	483161.118	6546912.466	eastern grey kangaroo	mammal	unknown	unknown	unknown
12					Northern end of Ravenswood Road	483182.311	6550789.294	fox	mammal	unknown	adult	unknown
13	Week 55	26/08/2016	7:30	8:30	South of Wharf Rd Kundabung	483207.103	6544534.324	Yellow Tail Black Cockatoo	bird	unknown	adult	na
14						483207.103	6544585.759	Unknown	bird	unknown	adult	na

ID	Week number	Date	Start time	Finish time	Location description	Easting	Northing	Species	Assigned ver-tebrate group	Sex	Age	Pouch young
15	Week 56	01/09/2016	7:30	8:30	Northern end of Ravenswood Road	483189.853	6550007.144	Unknown	bird	unknown	adult	na
16	Week 57	07/09/2016	7:30	8:30		482797.01	6542362.23	eastern grey kangaroo	mammal	unknown	unknown	unknown
17						483208.07	6544544.486	eastern grey kangaroo	mammal	unknown	unknown	unknown
18	Week 58	15/09/2016	7:30	8:30		483130.027	6522614.902	unidentifiable	mammal	unknown	unknown	unknown
19						480331.435	6532588.126	unidentifiable	mammal	unknown	unknown	unknown
20						483164.97	6555314.874	Possum	mammal	unknown	unknown	unknown
21	Week 59	23/09/2016	7:30	8:30		483211.43	6544432.57	eastern grey kangaroo	mammal	unknown	unknown	unknown
22	Week 60	30/09/2016	15:30	16:30		483213.984	6543530.971	echidna	mammal	unknown	unknown	unknown
23						483165.267	6546907.521	eastern grey kangaroo	mammal	unknown	unknown	unknown
24						483201.81	6550424.03	kookaburra	bird	unknown	unknown	unknown
25						483072.429	6551245.034	goanna	reptile	unknown	unknown	unknown
26						482873.197	6537984.62	unidentifiable	bird	unknown	unknown	unknown
27						483242.512	6524730.821	unidentifiable	bird	unknown	unknown	unknown
28	Week 61	05/10/2016	7:30	8:30	South of Hastings River	483262.356	6523395.422	Possum	mammal			
29					Cooperabung Creek Bridge	482873.197	6537984.62	unidentifiable	bird			
30					South of Hastings River	483242.512	6524730.821	unidentifiable	bird			
31					South Wilsons River bridge	480648.186	6533986.621	grey goshawk	bird			
32					**north gate 20**	**483412.664**	**6555958.966**	**koala**	**mammal**	**unknown**	**adolescent**	**na**
33	week 62	12/10/2016	7:30	8:30	South of Hastings River	483246.835	6524726.877	small mammal	mammal			
34					North of OH2K interchange	481147.217	6528947.073	eastern grey kangaroo	mammal			
35					North wilmarra rd	482839.099	6536207.188	fox	mammal			
36					South Cooperabung creek	482909.213	6537883.327	small mammal	mammal			
37					**North gate 17**	**482815.923**	**6553852.401**	**koala**	**mammal**	**unknown**	**adolescent**	**na**

ID	Week number	Date	Start time	Finish time	Location description	Easting	Northing	Species	Assigned ver-tebrate group	Sex	Age	Pouch young
38					southern end of OH2K	483170.893	6520286.046	eastern grey kangaroo	mammal			
39	week 63	20/10/2016	7:30	8:30	North Wilson River bridge	480843.634	6534580.821	swamp wallaby	mammal			
40					Northern end of Cairncross SF	480405.13	6530997.481	feral dog	mammal			
41					Mobbs Dr	483207.902	6543711.444	Tawny Frog Mouth	bird			
42					Near old gate 8	483191.895	6546843.479	Unknown	bird			
43	Week 64	28/10/2016	7:30	8:30	South Smiths Creek Bridge	483212.03	6546110.998	Magpie	bird			
44	Week 65	04/11/2016	7:30	8:30	North Gate 17 K2K	482815.648	6553819.477	Possum	mammal			
45					southern end of OH2K	483154.027	6520204.737	rabbit	mammal			
46					ch 31700	483200.649	6549673.999	wood duck	bird			
47					North Tele Point Bridge	480989.521	6534790.628	rabbit	mammal			
48					North Tele Point Bridge	480848.233	6534581.871	red bellied black snake	reptile			
49					North Yarrabee Quarry	482143.707	6540128.3	swamp wallaby	mammal			
50	Week 66	11/11/2016	7:30	8:30	Nth end of overtaking lanes	480728.3	6530064.4	swamp wallaby	mammal			
51					South of Cooperabung Creek	482920.539	6537843.844	eastern grey kangaroo	mammal			
52					Between Yarrabee and Barries Creek	482228.784	6540851.964	echidna	mammal			
53	Week 67	18/11/2016	7:30	8:30	Nth Stumpy Creek	483285.887	6555711.157	kangaroo	mammal			
54					Nth gate 17 (K2K)	482838.212	6554097.301	Possum	mammal			
55					Cairncross SF	480498.219	6530641.607	echidna	mammal			
56	Week 68	25/11/2016	7:30	8:30	end of 2nd overtaking lane	482520.295	6535836.004	unidentifiable	bird			
57					Nth Stumpy Creek	483262.556	6555635.607	swamp wallaby	mammal			
58	Week 69	02/12/2016	7:30	8:30	Nth side of Sancrox Bridge	483257.55	6521286.05	goanna	reptile			
59					Sth of Hastings River Bridge	483278.42	6524658.93	white ibis	bird			
60					Telegraph Point turnoff	481231.92	6535003.65	swamp wallaby	mammal			

ID	Week number	Date	Start time	Finish time	Location description	Easting	Northing	Species	Assigned ver-tebrate group	Sex	Age	Pouch young
61					Scrubby Creek Rd turnoff	483126.03	6554871.56	swamp wallaby	mammal			
62		09/12/2016	7:30	8:30	Nth Bloodwood Rest Area	482913.01	6552398.24	wild dog	mammal			
63					South of Hastings River Bridge	483221.54	6524759.47	white ibis	bird			
64		16/12/2016	7:30	8:30	South Smiths Creek	483214.307	6545872.518	unknown	mammal			
65					South Smiths Creek	483214.307	6545872.518	unknown	mammal			
66					Kundabung SB off ramp	483235.04	6547326.66	kookaburra	bird			
67		21/12/2016	7:30	8:30	Entry into Carlye Rd	483205.387	6549750.825	swamp wallaby	mammal			
68					Under Sancrox bridge	483255.724	6520910.654	rabbit	mammal			
69					south Sancrox bridge	483176.348	6520477.398	dog	mammal			
70		29/12/2016	10:00	11:00	Nth Sancrox bridge	483275.307	6521022.81	magpie	bird			
71					South Hastings River Drive	483400.596	6524362.811	dog	mammal			
72					Kundabung Interchange	483189.613	6547455.735	magpie (x2)	bird			
73					near basin B30.00	483169.637	6547983.58	swamp wallaby	mammal			
74					near C35.80	482941.169	6553610.158	eastern grey kangaroo	mammal			
75					gate 5	483221.01	6544601.889	Unknown	unknown			
76	Week 70	06/01/2017	7:30	8:30	None noted							
77	Week 71	13/01/2017	7:30	8:30	Frog culvert OH2K	481492.842	6527884.527	black snake	reptile			
78					North Tele Point Bridge	480841.124	6534584.822	bandicoot	mammal			
79					Kundabung Interchange	483182.118	6547492.017	wood duck	bird			
80					South Pipers Creek	483198.429	6548546.092	swamp wallaby	mammal			
81	Week 72	20/01/2017	7:30	8:30	Near Cairncross waste facility turnoff	480668.682	6530236.138	eastern grey kangaroo	mammal			
82	Week 73	25/01/2017	7:30	8:30	Cairncross SF	480340.879	6531220.225	fox	mammal			
83					Hastings River Bridge	483092.86	6525005.238	Unknown	mammal			
84	Week 74	01/02/2017	7:30	8:30	Southern end of OH2K	483138.478	6520131.55	Unknown	bird			
85					South of Hastings River	483389.304	6524020.104	eastern grey kangaroo	mammal			

ID	Week number	Date	Start time	Finish time	Location description	Easting	Northing	Species	Assigned ver-tebrate group	Sex	Age	Pouch young
86	Week 75	08/02/2017	7:30	8:30	South of Hastings River	483176.203	6524840.535	Possum	mammal			
87	Week 76	16/02/2017	7:30	8:30	ch35700 - near rope crossing	482941.156	6553593.508	wallaby	mammal			
88	week 77	24/02/2017	7:30	8:30	South Wilsons River bridge	480648.476	6533863.22	Possum	mammal			
89					Between Yarrabee and Barries Creek	482204.361	6540711.726	dog	mammal			
90					Fernbank Creek Bridge	483305.394	6523640.883	cat	mammal			
91					ch35800	482931.132	6553688.264	magpie	bird			
92	Week 78	02/03/2017	7:30	8:30	PCAR - south	483202.892	6549296.211	eastern grey kangaroo	mammal			
93	Week 79	10/03/2017	7:30	8:30	None noted							
94	Week 80	16/03/2017	7:30	8:30	Cairncross waste facility turnoff	480686.345	6530163.75	fox	mammal			
95					South Cooperabung creek	482859.729	6536256.258	wallaby	mammal			
96					North Wilson River bridge	481205.498	6534974.745	Possum	mammal			
97					south Stumpy Creek	483295.369	6555597.886	bandicoot	mammal			
98	Week 81	21/03/2017	7:30	8:30	Cairncross SF	480804.68	6529835.468	eastern grey kangaroo	mammal			
99					South Cooperabung creek	482415.184	6535749.993	eastern grey kangaroo	mammal			
100	Week 82	31/03/2017	7:30	8:30	None noted							
101	Week 83	07/04/2017	7:30	8:30	Cooperabung Creek Bridge	482853.759	6537995.358	fox	mammal			
102					Southern end of OH2K	483140.673	6520165.96	unknown small mammal	mammal			
103	Week 84	13/04/2017	7:30	8:30	North Stumpy Creek	483346.256	6555839.009	wallaby	mammal			
104					South end of southern NB overtaking lanes	480307.351	6531413.5	eastern grey kangaroo	mammal			
105					South Barries Creek	482543.676	6541833.099	cat	mammal			
106					Northern Wauchope turnoff	480342.868	6532635.679	wallaby	mammal			
107					cut 18 K2K	483039.273	6551592.261	kookaburra	bird			
108	week 85	21/04/2017	7:30	8:30	2nd overtaking lanes NB	482753.888	6536084.287	eastern grey kangaroo	mammal			

ID	Week number	Date	Start time	Finish time	Location description	Easting	Northing	Species	Assigned ver-tebrate group	Sex	Age	Pouch young
109					Upper Smiths Creek Rd	483207.187	6545354.485	eastern grey kangaroo	mammal			
110	Week 86	28/04/2017	7:30	8:30	None noted							
111	Week 87	04/05/2017	7:30	8:30	South Sancrox bridge	483225.16	6520777.048	Possum	mammal			
112					south Cooperabung Creek	482883.053	6537890.994	antechinus	mammal			
113					fill 20	483031.802	6552420.987	swamp wallaby	mammal			
114	Week 88	12/05/2017	7:30	8:30	South stumpy creek	483214.959	6555312.267	Possum	mammal			
115					Blackmans Point turnoff	481694.581	6527507.982	cat	mammal			
116	Week 89	19/05/2017	7:30	8:30	south Cooperabung Creek	482743.947	6536071.953	Possum	mammal			
117	Week 90	26/05/2017	7:30	8:30	None noted							
118	Week 91	01/06/2017	7:30	8:30	South sports club	480531.946	6533320.964	cat	mammal			
119					under Kundabung bridge	483172.365	6547236.038	Unknown	mammal			
120					Sancrox bridge	483247.715	6520895.643	cat	mammal			
121	week 92	07/06/2017	7:30	8:30	Sancrox on ramp	483193.106	6521678.155	cat	mammal			
122					OH2K interchange	482152.23	6526852.357	swamp wallaby	mammal			
123	week 93	16/06/2017	7:30	8:30	Cairncross SF	480724.891	6530057.129	Possum	mammal			
124					South Hastings river	483265.602	6523519.527	Unknown	bird			
125	week 94	23/06/2017	7:30	8:30	None noted							
126	week 95	30/06/2017	7:30	8:30	None noted							
127	week 96	07/07/2017	7:30	8:30	Wharf Rd	483208.768	6545425.588	rabbit	mammal			
128	week 97	13/07/2017	7:30	8:30	Fernbank Creek Bridge	483319.855	6523722.023	Unknown	mammal			
129					Nth Fernbank Creek	483416.758	6524178.364	fox	mammal			
130	week 98	21/07/2017	7:30	8:30	South Cooperabung creek	482863.058	6536341.855	Possum	mammal			
131					Yarabee Rd	482119.288	6540336.234	eastern grey kangaroo	mammal			
132					PCAR - south	483192.732	6549259.933	Possum	mammal			
133	week 99	28/07/2017	7:30	8:30	Kundabung Interchange	483150.182	6547226.271	magpie	bird			

ID	Week number	Date	Start time	Finish time	Location description	Easting	Northing	Species	Assigned vertebrate group	Sex	Age	Pouch young
134					Cooperabung Creek Bridge	482845.637	6537967.018	Unknown	mammal			

Table 7: Road kill habitat details

ID	Broad habitat type	Overstorey	Mid stratum	Shrub layer	Groundcover	Hydrological features	Rock	Log	Hollow-bearing Trees	Foraging resources associated with fauna	Likely attractant	Comments
1	cleared	cleared	cleared	cleared	cleared	Cooperabung Ck	none	none	none	food/water source	unknown	
2	cleared	cleared	cleared	cleared	cleared	none	none	none	none	no	unknown	
3	cleared	cleared	cleared	cleared	cleared	Fernbank Ck within 50m	none	none	none	no	unknown	
4	cleared	absent	absent	absent	pasture grass	none	none	none	none	no	unknown	not directly adjacent works
5	cleared	absent	absent	absent	pasture / residential area	none	none	none	none	none	unknown	possible a cat
6	cleared	absent	absent	a	pasture / residential area	none	none	none	none	none	unknown	
7	wet sclerophyll forest	red gum	casuarina	grass	grass	Smiths Creek 550m away	none	none	none	eucalypts and grass	unknown	
8	dry sclerophyll forest	Blackbutt	cleared	grass	grass	adjacent farm dams	none	none	none	adjacent to state forest	unknown	
9	wet sclerophyll forest											
10	cleared											
11	wet sclerophyll forest	casuarina, eucalypts	casuarina	grass	grass	north of Smiths Creek	none	none	scattered	grasses	unknown	
12	wet sclerophyll forest		casuarina	grass	grass	scattered drainage lines and swampy areas	none	none	scattered	adjacent to state forest	unknown	
13	wet sclerophyll forest	casuarina, eucalypts	casuarina	grass	grass	scattered drainage lines and swampy areas	none	none	scattered	adjacent bushland	unknown	
14	wet sclerophyll forest	casuarina, eucalypts	casuarina	grass	grass	scattered drainage lines and swampy areas	none	none	scattered	adjacent bushland	unknown	

ID	Broad habitat type	Overstorey	Mid stratum	Shrub layer	Groundcover	Hydrological features	Rock	Log	Hollow-bearing Trees	Foraging resources associated with fauna	Likely attractant	Comments
15	wet sclerophyll forest	casuarina, eucalypts	casuarina	grass	grass	scattered drainage lines	none	none	scattered	adjacent bushland and farm pasture	unknown	
16	wet sclerophyll forest											
17	dry sclerophyll forest											
18	wet sclerophyll forest											
19	cleared											
20	wet sclerophyll forest											
21	dry sclerophyll forest											
22	wet sclerophyll forest											
23	wet sclerophyll forest											
24	wet sclerophyll forest											
25	dry sclerophyll forest											
26	wet sclerophyll forest											
27	wet sclerophyll forest											
28	wet sclerophyll forest											
29	wet sclerophyll forest											
30	wet sclerophyll forest											
31	wet sclerophyll forest											
32	**wet sclerophyll forest**	**absent**	**absent**	**acacia**	**exotic grass, some native grass**	**none**	**none**	**none**	**none**	**suitable foraging forest approx. 1km to the south**	**forest approx. 1km to the south**	
33	wet sclerophyll forest											
34	wet sclerophyll forest											
35	dry sclerophyll forest											
36	wet sclerophyll forest											

ID	Broad habitat type	Overstorey	Mid stratum	Shrub layer	Groundcover	Hydrological features	Rock	Log	Hollow-bearing Trees	Foraging resources associated with fauna	Likely attractant	Comments
37	**wet sclerophyll forest**	**Eucalypt and casuarina**	**casuarina**	**acacia and lantana**		**gully line with semi-permanent standing water within 100m**	**none**	**none**	**none**	**suitable koala habitat**	**surrounding suitable koala habitat**	
38	wet sclerophyll forest											
39	wet sclerophyll forest											
40	dry sclerophyll forest											
41	wet sclerophyll forest											
42	cleared											
43	wet sclerophyll forest											
44	wet sclerophyll forest											
45	wet sclerophyll forest											
46	Dry sclerophyll forest and cleared areas.											
47	wet sclerophyll forest											
48	wet sclerophyll forest											
49	wet sclerophyll forest											

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Koala Monitoring 2016

Year 2 Surveys – Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Roads and Maritime Services

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Cover photograph: Koala from unrelated project on Liverpool Plains (Photo: Matthew Stanton)

Executive Summary

Context

This report documents findings from the spring-summer 2016 monitoring period for the Koala, as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway upgrade project (the Project).

Aims

The aim of the Koala monitoring program is to determine whether the Project is having an impact on Koala populations and habitat of the Koala within the study area.

Methods

Each monitoring location was surveyed in accordance with the monitoring method and design specified in the Oxley Highway to Kempsey Pacific Highway Upgrade Ecological Monitoring Program (EMP, RMS 2016). Surveys were undertaken in November and December 2016.

Key results

A total of 82 plots across 27 sites were surveyed in spring-summer 2016. Koalas were found to be present within 10 of the 27 sites surveyed (37%) and the mean activity level (measured as the number of scats within plots) across the sites was 0.7% (SD = 1.1%). The distribution and activity level of Koalas recorded during the current survey is lower than for the previous two rounds of survey (baseline and 2015) and results indicate a decline in the presence and activity of Koalas across the Project area and in surrounding areas within control sites.

Koalas were recorded more frequently at impact sites (42%) than at control sites (33%), which is consistent with results observed in the previous two monitoring events. There was no significant difference between Koala presence at control and impact sites which is also consistent with the 2015 result.

Surveyed trees included 32 tree species, of which Koala scats were recorded at seven (22%). The tree species Koala scats were most commonly recorded beneath were Tallowwood (*Eucalyptus microcorys*) and Small-fruited Grey Gum (*E. propinqua*), which together comprised 30% of all surveyed tree species. Tree species use was not dissimilar to that recorded in the baseline or 2015 monitoring events.

Conclusions

Koala presence and activity levels appear to have decreased between the baseline, 2015 and 2016 monitoring events, but for both control and impact sites. In each of the surveys undertaken to date, impact sites recorded higher percentages of Koala presence than control sites. For this reason any decrease in Koala presence/activity cannot currently be directly or solely attributed to disturbance due to the Project.

It is also likely that Koala distribution/abundance would have been affected by the wildfire that occurred across the northern parts of the Project prior to the surveys in spring 2016. Continued monitoring data will assist in determining if the results reflect broader trends in population dynamics.

SAT plots provide data in compliance with the requirement of measuring Koala distribution, habitat use and activity levels, but do not provide any data on density, as it is not possible to determine the number of Koalas from scat records. Supplementing the SAT surveys with a direct survey technique such as spotlighting surveys would provide more robust data on Koala density against which the performance measure relating to this variable may be effectively assessed.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Environment (DoE) for matters of national environmental significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1995 (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (RMS 2016) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project. The Koala was identified as requiring mitigation and monitoring during the Project's construction and post construction periods.

1.1.1 Legal Status

The Koala (*Phascolarctos cinereus*) is listed as vulnerable under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and EPBC Act. Monitoring of the species is required under the Project's approval.

1.1.2 Monitoring Framework

The design, methods and performance indicators that define the Koala monitoring program are specified in the EMP. The monitoring program specifies that monitoring of all sites will continue in Year 1, 2 and 3 (construction phase) once substantial construction has commenced. Following the completion of the project, monitoring will continue in Year 4, 5, 6 and 8 (operation phase) or until the mitigation measures can be demonstrated to have been effective for the Koala.

To date, these monitoring events have been reported as follows:

- *Spring-summer 2015*: Niche 2016.
- *Spring- summer 2016*: current report.

This report therefore represents the second of three necessary construction monitoring reports for the Koala. The final construction surveys will be undertaken in spring-summer 2017 and be the subject of the final report for construction monitoring for the Koala. Operational monitoring is projected to commence in spring-summer 2018.

1.1.3 Baseline Data

In accordance with the EMP, baseline surveys for the Koala were undertaken to provide baseline data that could be used to identify changes in habitat use before and after construction of the Project, and to determine whether changes can be reasonably attributed to the Project. Baseline monitoring was conducted by Lewis Ecological prior to the commencement of construction (Lewis 2014). Remote cameras were also opportunistically deployed (targeting other threatened species) in August 2013, while spotlighting and Spot Assessment Technique (SAT) plot surveys were undertaken in spring 2013. The purpose of this baseline data is to enable before and after comparisons/analysis so that changes to the Koala population may be able to be detected.

1.1.4 Purpose of this Report

This report details the findings obtained from the 2016 monitoring period, following on from the baseline surveys and 2015 surveys. This it represents the second monitoring report for the construction phase of the Project.

The aim of this report is to summarise the methods and results of the spring-summer 2016 monitoring, and to compare the results with the baseline surveys to determine whether performance measures are being met and comment on whether additional measures should be considered.

1.2 Performance measures

The approved EMP specifies the following performance measures for the Koala (RMS 2016):

- *Monitoring is undertaken during baseline surveys from Year 1 – Year 6 & 8, or until mitigation measures are demonstrated to be effective*
- *Monitoring during Year 1 – Year 6 & 8 is undertaken at the Impact and Control sites where monitoring was undertaken during baseline surveys, subject to ongoing landowner agreement. Where landowner agreement cannot be obtained and the process in Section 3.1.2 of the EMP has been followed, this performance indicator will also be considered to have been met.*
- *Mitigation measures are demonstrated to be effective as defined in the EPBC approval when all monitoring events are considered at Year 8*
- *Fauna fence is installed at a minimum in areas identified in Schedule 3 of the EPBC approval at Year 4*
- *No changes to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 6 & 8, and then when all monitoring events are considered at Year 8.*

1.3 Monitoring timing

Monitoring is to occur once a year during spring-summer.

1.4 Reporting

Annual reporting of monitoring results will outline:

- A detailed description of the monitoring methodology employed.
- Results of the monitoring surveys.
- Discussion of the results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required, and any other recommendations.
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the Director General of the NSW Department of Planning and Environment and the NSW Environment Protection Authority (EPA).

2. Survey Methodology

2.1 Monitoring design

Surveys were undertaken in November and December 2016. In accordance with the baseline monitoring surveys, eight broad areas within a 20 km radius of the Project were surveyed and three types of monitoring sites were established within each:

- Treatment A: Sites with mitigation (i.e. sufficiently large culverts to allow Koalas to pass under the Highway and floppy top fencing).
- Treatment B: Sites where mitigation has not been proposed or only partial mitigation is proposed.
- Treatment C: Control or reference sites located in areas at least three kilometres, and often 5-10 km from the Project.

These eight broad areas include South Sancrox, North Sancrox, Cairncross State Forest (South), Cairncross State Forest (North), Cooperabung Hill, Mingaletta Road to Smiths Creek, Kundabung Road to North of Pipers Creek and Maria River State Forest.

Seventy two baseline SAT plots were established by Lewis (2014). Of these 72 sites, 24 were mitigation, three part mitigation, 21 no mitigation and 24 control sites. To ensure a balanced monitoring design between impact sites (mitigated and not mitigated) and control sites, an additional 24 control plots were established during the first monitoring event in 2015 (Niche 2016). In accordance with the baseline monitoring design these additional 24 control sites were established at least three kilometres from the project and they were grouped in clusters of three plots, one cluster for each of the eight broad areas.

In 2015, eight of the baseline plots had to be relocated to nearby locations because they had been established in the construction site itself or because they were located on private property and access was not possible. Three of the baseline monitoring plots that could not be accessed could not be relocated because there weren't any suitable sites nearby. These three plots were all part of the same cluster (impact, no mitigation) located in the North Sancrox area.

Details of all 96 monitoring sites are presented in Table 1 and the location of the 93 accessible monitoring sites are shown in **Figure 1.**

Table 1: Monitoring sites

Monitoring Area	Treatment	Treatment sub category	Data Source	Site Name	Easting	Northing
South Sancrox	Impact	No Mitigation	Baseline	1 Sancrox East - Cassegrains	483348	6521736
	Impact	No Mitigation	Baseline	2 Sancrox East - Cassegrains	483455	6521789
	Impact	No Mitigation	Baseline	3 Sancrox East - Cassegrains	483412	6521882
	Impact	Mitigation	Baseline_Niche relocation	1 Sancrox South	483299	6520671
	Impact	Mitigation	Baseline_Niche relocation	2 Sancrox South	483254	6520383
	Impact	Mitigation	Baseline_Niche	3 Sancrox South	483196	6520217

Monitoring Area	Treatment	Treatment sub category	Data Source	Site Name	Easting	Northing
			relocation			
	Control	Control	Baseline	1 Cowarra State Forest	480608	6519056
	Control	Control	Baseline	2 Cowarra State Forest	480658	6519496
	Control	Control	Baseline	3 Cowarra State Forest	481305	6519136
	Control	New Control	Niche	COWARRA NC1	479706	6518522
	Control	New Control	Niche	COWARRA NC2	479788	6517922
	Control	New Control	Niche	SAT COWARRA NC3	479795	6518227
North Sancrox	Impact*	No Mitigation	Baseline	1 Sancrox North - Expressway Spares	483042	6521731
	Impact*	No Mitigation	Baseline	2 Sancrox North - Expressway Spares	482869	6521683
	Impact*	No Mitigation	Baseline	3 Sancrox North - Expressway Spares	482999	6521818
	Impact	Mitigation	Baseline	1 Fernbank Creek	483101	6523362
	Impact	Mitigation	Baseline	2 Fernbank Creek	483032	6523223
	Impact	Mitigation	Baseline	3 Fernbank Creek	483056	6523123
	Control	Control	Baseline	1 Lake Innes	488124	6518469
	Control	Control	Baseline	2 Lake Innes	488047	6518398
	Control	Control	Baseline	3 Lake Innes	488228	6518390
	Control	New Control	Niche	COWARRA NC3 -SAT COW4	479674	6516436
	Control	New Control	Niche	SAT COW5	479704	6516174
	Control	New Control	Niche	SAT COW6	479667	6515913
Cairncross State Forest (South)	Impact	No Mitigation	Baseline	1 Cairncross State Forest (South)	482428	6526536
	Impact	No Mitigation	Baseline	2 Cairncross State Forest (South)	482385	6526644
	Impact	No Mitigation	Baseline	3 Cairncross State Forest (South)	482393	6526416
	Impact	No Mitigation	Baseline	16 Cairncross State Forest (south)	481655	6527256
	Impact	No Mitigation	Baseline	17 Cairncross State Forest (south)	481590	6527316
	Impact	No Mitigation	Baseline	18 Cairncross State Forest (south)	481637	6527175
	Impact	Mitigation	Baseline	4 Cairncross State Forest (South)	482249	6525930

Monitoring Area	Treatment	Treatment sub category	Data Source	Site Name	Easting	Northing
	Impact	Mitigation	Baseline	5 Cairncross State Forest (South)	482125	6526077
	Impact	Mitigation	Baseline	6 Cairncross State Forest (South)	482488	6526226
	Control	Control	Baseline	1 Limeburners Creek ""The Hatch""	487011	6529909
	Control	Control	Baseline	2 Limeburners Creek ""The Hatch""	487014	6529455
	Control	Control	Baseline	3 Limeburners Creek ""The Hatch""	487035	6528694
	Control	New Control	Niche	SAT PEVI1	476817	6528422
	Control	New Control	Niche	SAT PEVI2	476730	6528225
	Control	New Control	Niche	Cairncross NC1	475996	6528211
Cairncross State Forest (north)	Impact	No Mitigation	Baseline_Niche relocation	7 Cairncross State Forest (North)	481346	6530835
	Impact	No Mitigation	Baseline	8 Cairncross State Forest (North)	481695	6530786
	Impact	No Mitigation	Baseline	9 Cairncross State Forest (North)	481184	6530864
	Impact	Mitigation	Baseline	10 Cairncross State Forest (north)	481238	6530264
	Impact	Mitigation	Baseline	11 Cairncross State Forest (north)	481173	6530319
	Impact	Mitigation	Baseline	12Cairncross State Forest (north)	481438	6530335
	Control	Control	Baseline	13 Cairncross State Forest (Pembrooke)	473751	6528881
	Control	Control	Baseline	14 Cairncross State Forest (Pembrooke)	473464	6528969
	Control	Control	Baseline	15 Cairncross State Forest (Pembrooke)	473424	6529115
	Control	New Control	Niche	SAT RR1	475284	6532709
	Control	New Control	Niche	SAT RR2	475113	6532603
	Control	New Control	Niche	SAT RR3	474816	6532732
Cooperabung Hill	Impact	No Mitigation	Baseline	1 Cooperabung	482793	6537012
	Impact	No Mitigation	Baseline	2 Cooperabung	482755	6537093
	Impact	No Mitigation	Baseline	3 Cooperabung	482876	6537115

Monitoring Area	Treatment	Treatment sub category	Data Source	Site Name	Easting	Northing
	Impact	Mitigation	Baseline_Niche relocation	4 Cooperabung	482481	6539327
	Impact	Mitigation	Baseline_Niche relocation	5 Cooperabung	482364	6539761
	Impact	Mitigation	Baseline	6 Cooperabung	482364	6538610
	Control	Control	Baseline	1 Cooperabung Hill (Gum Scrub)	475489	6541854
	Control	Control	Baseline	2 Cooperabung Hill (Gum Scrub)	475570	6541903
	Control	Control	Baseline	3 Cooperabung Hill (Gum Scrub)	475838	6541962
	Control	New Control	Niche	SAT FL1	473693	6542127
	Control	New Control	Niche	SAT ST1	473346	6543256
	Control	New Control	Niche	SAT ST2	473682	6542890
Mingaletta to Smiths Creek	Impact	Mitigation	Baseline	1 Mingaletta-Smiths Creek	483304	6543632
	Impact	Mitigation	Baseline	2 Mingaletta-Smiths Creek	483444	6543585
	Impact	Mitigation	Baseline	3 Mingaletta-Smiths Creek	483100	6543670
	Control	Control	Baseline	1 Ballengara State Forest (Gregs Road)	477750	6543274
	Control	Control	Baseline	2 Ballengara State Forest (Gregs Road)	477644	6543623
	Control	Control	Baseline	3 Ballengara State Forest (Gregs Road)	477551	6543709
	Control	New Control	Niche	SAT BR1	477010	6544693
	Control	New Control	Niche	SAT BR2	476890	6544832
	Control	New Control	Niche	SAT BR3	476777	6544973
Kundabung Road to North of Pipers Creek	Impact	No Mitigation	Baseline	1 Kundabung	483095	6549036
	Impact	No Mitigation	Baseline	2 Kundabung	482873	6549112
	Impact	No Mitigation	Baseline	3 Kundabung	483285	6549374
	Impact	Mitigation	Baseline	4 Kundabung	483369	6550655
	Impact	Mitigation	Baseline	5 Kundabung	483331	6550938
	Impact	Mitigation	Baseline	6 Kundabung	483083	6550608
	Control	Control	Baseline	1 Kumbatine National	476044	6549609

Monitoring Area	Treatment	Treatment sub category	Data Source	Site Name	Easting	Northing
				Park		
	Control	Control	Baseline	2 Kumbatine National Park	476165	6549738
	Control	Control	Baseline	3 Kumbatine National Park	475889	6549468
	Control	New Control	Niche	SAT MAC1	476538	6552784
	Control	New Control	Niche	SAT MAC2	476558	6552361
	Control	New Control	Niche	SAT MAC3	476481	6552612
Maria River State Forest	Impact	Part Mitigation	Baseline_Niche relocation	1 Maria River	483074	6554460
	Impact	Part Mitigation	Baseline	2 Maria River	482836	6554330
	Impact	Part Mitigation	Baseline_Niche relocation	3 Maria River	482993	6554024
	Impact	Mitigation	Baseline	4 Maria River	482886	6552623
	Impact	Mitigation	Baseline	5 Maria River	482754	6552462
	Impact	Mitigation	Baseline	6 Maria River	483135	6552449
	Control	Control	Baseline	1 Maria River National Park	486965	6554366
	Control	Control	Baseline	2 Maria River National Park	486971	6554479
	Control	Control	Baseline	3 Maria River National Park	487004	6554203
	Control	New Control	Niche	SAT CO1	486292	6552230
	Control	New Control	Niche	SAT CO3	486811	6552227
	Control	New Control	Niche	SAT MAR 1	486811	6552454

* could not be surveyed due to private landowner access restrictions.

2.2 Methods

2.2.1 Koala Spot Assessment Technique

Surveys were undertaken following the SAT methodology (Phillips and Callaghan 2011) in accordance with the EMP monitoring procedure for Koala population monitoring. The SAT method involves a radial assessment of Koala activity within the immediate area surrounding a tree that is known to have been utilised by the species or is considered to be of importance to the species. The following describes the application of this technique:

1. Locate and mark a tree that is:
    a) A tree of any species beneath which one or more Koala faecal pellets have been observed; and/or
    b) A tree in which a Koala has been observed; and/or

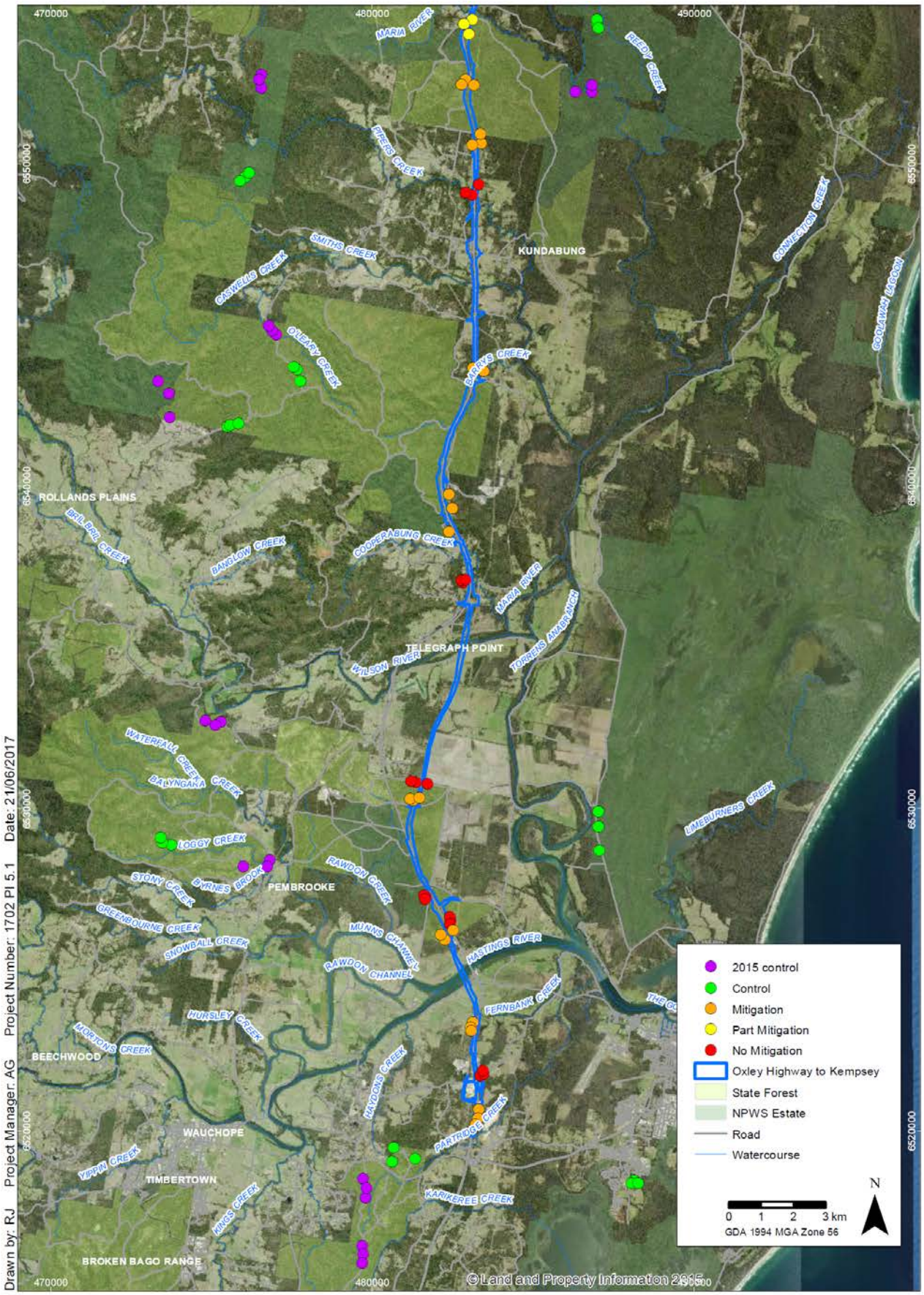
c) Any other tree known or considered to be important for Koalas or of interest for other assessment purposes.

2. Identify and mark the 29 nearest trees to the tree marked initially.
3. Undertake a search for Koala faecal pellets beneath each of the 30 marked trees. Visually inspect the ground surface beneath trees to a distance of one metre from the trunk. If no pellets are observed, rake the leaf litter within the prescribed search area. Two person minute per tree should be dedicated to the search for faecal pellets. The search should be ended once a single pellet is found or the search time has expired (whichever happens first). Faecal pellets should not be removed from the site unless verification is necessary.
4. The activity level of a site is calculated as the percentage of surveyed trees within the site (of 30 trees) that have a Koala faecal pellet recorded within its search area. The result is used to assess whether the site supports “Low”, “Medium (normal)” or “High” Koala activity.
5. The presence (or absence) of scats was recorded, along with a number of other attributes including the species of the tree under which the scat was located.

2.2.2 Analysis

The SAT results are presented separately by plot and by cluster, but most of the histograms and data analysis were present by cluster only. Plots within the same cluster are not independent from each other and therefore cannot be used for most statistical analyses. Presence-absence of Koalas was determined using data from clusters.

Statistical analysis was undertaken to assess changes in Koala tree use. Based on the methods used to collect the data and the location of the plots it was determined that a Chi-square test was the most suitable statistical test to use. This test compares proportions of plots with and without Koala scats and so is amenable to data that detects presence or absence. It also does not require equal numbers of impact and control sites to be sampled as numbers of plots expected to be “used” and “unused” can be worked out based on proportions of the number of plots actually sampled.



Koala SAT plot locations 2016

Oxley Highway to Kempsey - PI 5.1 Koala report

FIGURE 1

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Imagery: (c) LPI NSW 2012-2014

3. Results and Discussion

3.1 SAT plots

The full data set collected during the monitoring survey is presented in Annex 1. It was noted that on a number of occasions the marked tree did not correspond with the baseline and 2015 monitoring SCT (selection criteria tree) species. As such, for clarity of results and to facilitate future monitoring, the DBH (diameter at breast height) is provided for the marked tree, and this tree will be considered as the SCT for the current and future monitoring events.

Results of the SAT plot surveys are shown in Table 2. Of the 93 accessible SAT plots, a total of 82 SAT plots were surveyed across the eight monitoring areas (Figure 1). Eleven plots could not be surveyed or accessed for safety reasons as these sites were completely burnt during recent wildfires. These included six impact plots from Maria River State Forest, three control plots from Maria River National Park and two impact plots along Kundabung Road to the North of Pipers Creek.

A total of 2,460 trees were assessed across the 82 plots (30 at each plot). Of the 82 surveyed plots, Koala scats were recorded from 15% (12 of 82) of the individual plots. When grouped according to site, Koala scats were recorded at 37% of sites across the survey area (10 of 27) (Graph 1). The mean SAT activity level, measured as the proportion of trees within each site with scats present, was 0.7% across the 27 sites (SD = 1.1) and ranged from 0 to 4.4%. This was lower than the mean activity recorded across the sites in 2015 (2.0% ± SD3.5) and for the baseline surveys (4.9% ± SD6.8). This is considered low use in the east coast, low density area according to Phillips and Callaghan (2011); with normal use being classified as 3.3%-12.6%.

Graph 2 shows Koala activity at each of the eight monitoring areas. While the SAT plot activity was generally low, it was highest at the following locations:

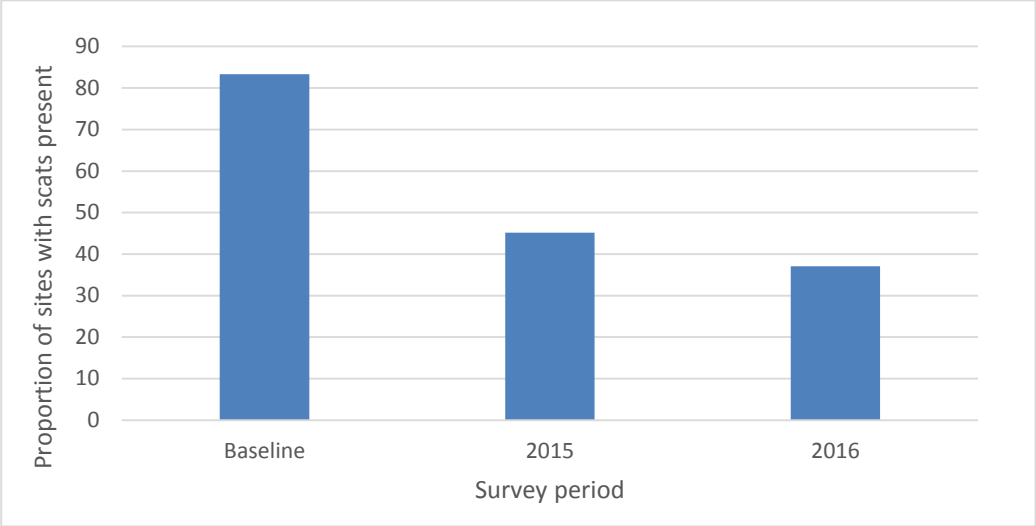
- North Sancrox (2.2%): scats were present at all three clusters in the North Sancrox area including Fernbank Creek, Lake Innes and Cowarra State Forest, with scats being recorded at all three plots at the Fernbank Creek impact site cluster.
- Maria River State Forest (2.2%): scats were recorded at two of the three control plots within Maria River National Park.

One Koala was recorded within one of the SAT plots (Maria River NP3) in Maria River National Park. This site had recently been burnt as part of a NSW National Parks and Wildlife Service back-burning operation in an effort to combat a local wildfire. There was no understorey or ground-cover vegetation present within this site – it had all been burnt, but the canopy was still intact. The Koala, which appeared to be healthy, was found resting in a Tallowwood Tree (*Eucalyptus microcorys*).

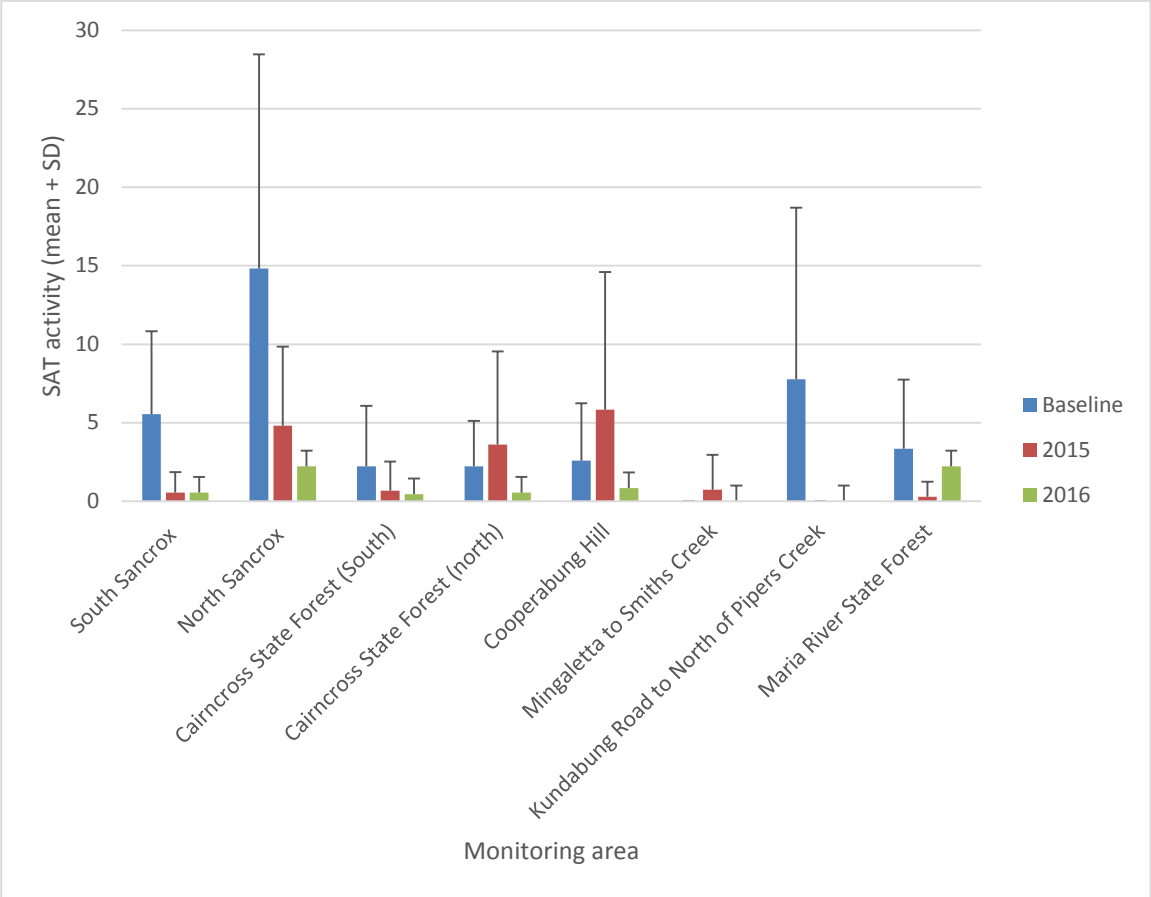
Comparison of the data with previous years (Graph 1 and Graph 2) demonstrates a clear difference in the presence of Koalas, with 83% of sites recording Koala activity in the Baseline surveys and only 37% during the current survey period (Graph 1). Similarly, activity levels across the eight monitoring areas were generally, but not always, greater in the baseline surveys and also usually greater in the 2015 surveys, but with less of a clear difference (Graph 2).

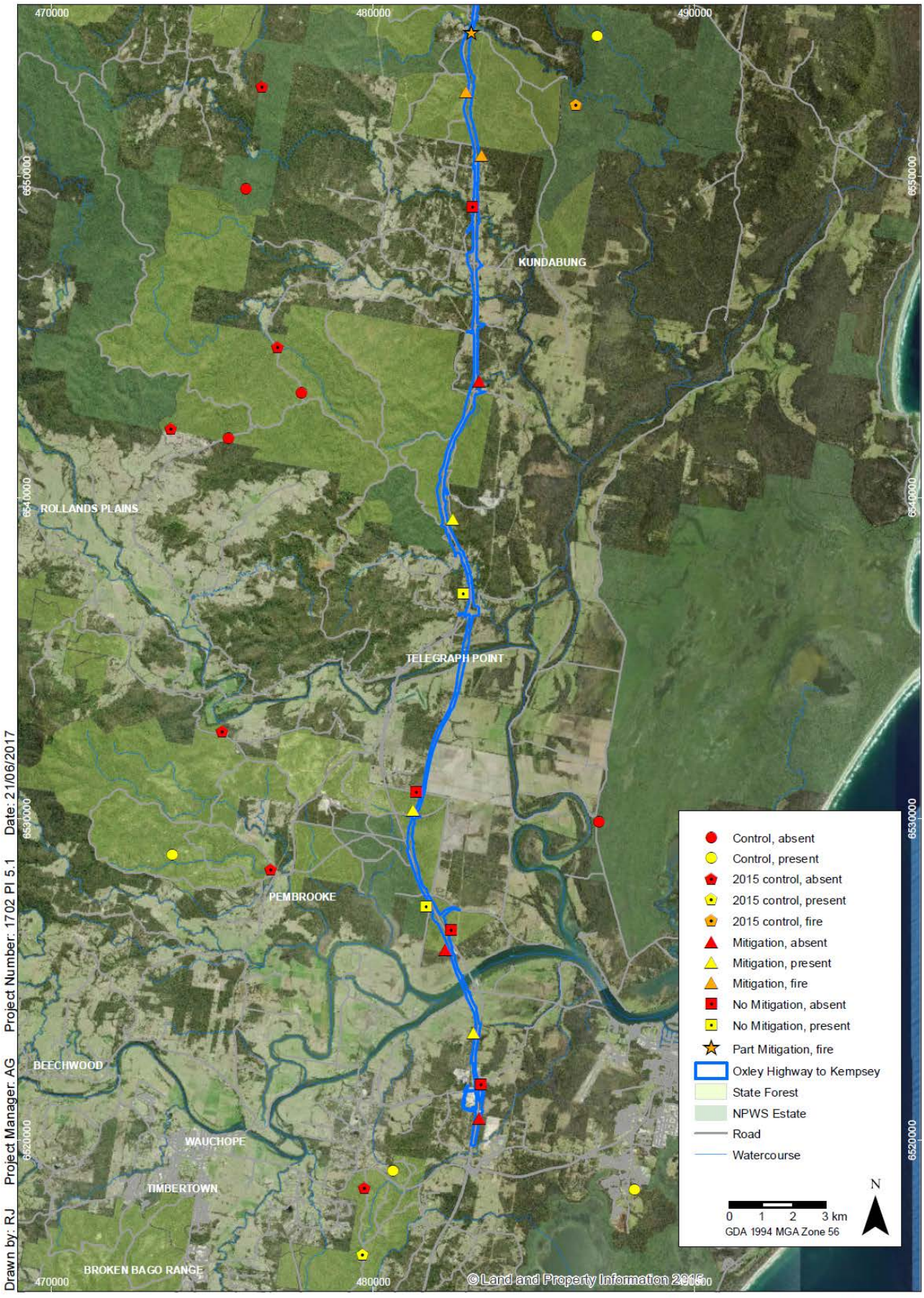
Koala presence was mainly recorded in the southern and central portions of the Project area (**Figure 2**), however, four of the sites in the north of the alignment were completely burnt and so could not be accessed. It is likely that Koala distribution/abundance would have been affected by the wildfire across the northern parts of the Project area (Figure 2 and Table 2).

Graph 1: Proportion of sites with scats present for each monitoring event to date



Graph 2: Observed Koala activity across the eight monitoring areas





Koala SAT plot results 2016

Oxley Highway to Kempsey - PI 5.1 Koala report

FIGURE 2

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Imagery: (c) LPI 2012-2014

Table 2: Koala SAT plots results 2016

Monitoring Area	Cluster no.	Treatment	Data Source	Site ID	Activity (%) Baseline	Activity (%) 2015	Activity (%) 2016	Scat presence (per cluster) Baseline	Scat presence (per cluster) 2015	Scat presence (per cluster) 2016
South Sancrox	1	No Mitigation	Baseline	SANCROX E1	10.0	3.3	0.0	present	present	absent
			Baseline	SANCROX E2	0.0	0.0	0.0			
			Baseline	SANCROX E3	0.0	0.0	0.0			
	2	Mitigation	Baseline_Niche relocation	SANCROX S1	13.3	0.0	0.0	present	absent	absent
			Baseline_Niche relocation	SANCROX S2	3.3	0.0	0.0			
			Baseline_Niche relocation	SANCROX S3	10.0	0.0	0.0			
	3	Control	Baseline	COWARRA SF1	0.0	0.0	0.0	present	absent	present
			Baseline	COWARRA SF2	3.3	0.0	0.0			
			Baseline	COWARRA SF3	10.0	0.0	6.7			
	4	New Control	Niche	SAT COWARRA NC1	-	0.0	0.0	not monitored	present	absent
			Niche	SAT COWARRA NC2	-	3.3	0.0			
			Niche	SAT COWARRA NC3	-	0.0	0.0			
North Sancrox	5	No Mitigation	Baseline	SANCROX N1	3.3	no access	no access	present	no access	no access
			Baseline	SANCROX N2	0.0	no access	no access			
			Baseline	SANCROX N3	0.0	no access	no access			
	6	Mitigation	Baseline	FERNBANK CK1	33.3	0.0	3.3	present	present	present
			Baseline	FERNBANK CK2	30.0	0.0	6.7			
			Baseline	FERNBANK CK3	23.3	6.7	3.3			
	7	Control	Baseline	LAKE INNES1	26.7	13.3	0.0	present	present	present
			Baseline	LAKE INNES2	13.3	6.7	3.3			
			Baseline	LAKE INNES3	3.3	6.7	0.0			

Monitoring Area	Cluster no.	Treatment	Data Source	Site ID	Activity (%) Baseline	Activity (%) 2015	Activity (%) 2016	Scat presence (per cluster) Baseline	Scat presence (per cluster) 2015	Scat presence (per cluster) 2016
South Sancrox	1	No Mitigation	Baseline	SANCROX E1	10.0	3.3	0.0	Present	present	absent
			Baseline	SANCROX E2	0.0	0.0	0.0			
			Baseline	SANCROX E3	0.0	0.0	0.0			
	2	Mitigation	Baseline_Niche relocation	SANCROX S1	13.3	0.0	0.0	present	absent	absent
			Baseline_Niche relocation	SANCROX S2	3.3	0.0	0.0			
			Baseline_Niche relocation	SANCROX S3	10.0	0.0	0.0			
	3	Control	Baseline	COWARRA SF1	0.0	0.0	0.0	present	absent	present
			Baseline	COWARRA SF2	3.3	0.0	0.0			
			Baseline	COWARRA SF3	10.0	0.0	6.7			
	4	New Control	Niche	SAT COWARRA NC1	-	0.0	0.0	not monitored	present	absent
			Niche	SAT COWARRA NC2	-	3.3	0.0			
			Niche	SAT COWARRA NC3	-	0.0	0.0			
North Sancrox	5	No Mitigation	Baseline	SANCROX N1	3.3	no access	no access	Present	no access	no access
			Baseline	SANCROX N2	0.0	no access	no access			
			Baseline	SANCROX N3	0.0	no access	no access			
	6	Mitigation	Baseline	FERNBANK CK1	33.3	0.0	3.3	Present	present	present
			Baseline	FERNBANK CK2	30.0	0.0	6.7			
			Baseline	FERNBANK CK3	23.3	6.7	3.3			
	7	Control	Baseline	LAKE INNES1	26.7	13.3	0.0	present	present	present

Monitoring Area	Cluster no.	Treatment	Data Source	Site ID	Activity (%) Baseline	Activity (%) 2015	Activity (%) 2016	Scat presence (per cluster) Baseline	Scat presence (per cluster) 2015	Scat presence (per cluster) 2016
			Baseline	LAKE INNES2	13.3	6.7	3.3			
			Baseline	LAKE INNES3	3.3	6.7	0.0			
	8	New Control	Niche	SAT COW4	-	10.0	0.0	not monitored	present	present
			Niche	SAT COW5	-	0.0	0.0			
			Niche	SAT COW6	-	0.0	3.3			
Cairncross State Forest (South)	9	No Mitigation	Baseline	CAIRNCROSS SF1	0.0	0.0	0.0	present	present	absent
			Baseline	CAIRNCROSS SF2	3.3	6.7	0.0			
			Baseline	CAIRNCROSS SF3	0.0	3.3	0.0			
	10	No Mitigation	Baseline	CAIRNCROSS SF16	0.0	0.0	3.3	Present	absent	present
			Baseline	CAIRNCROSS SF17	0.0	0.0	3.3			
			Baseline	CAIRNCROSS SF18	13.3	0.0	0.0			
	11	Mitigation	Baseline	CAIRNCROSS SF4	3.3	0.0	0.0	Present	absent	absent
			Baseline	CAIRNCROSS SF5	3.3	0.0	0.0			
			Baseline	CAIRNCROSS SF6	0.0	0.0	0.0			
	12	Control	Baseline	LIMEBURNERS CK1	0.0	0.0	0.0	present	absent	absent
			Baseline	LIMEBURNERS CK2	3.3	0.0	0.0			
			Baseline	LIMEBURNERS CK3	0.0	0.0	0.0			
	13	New Control	Niche	SAT PEVI1	-	0.0	0.0	not monitored	absent	absent
			Niche	SAT PEVI2	-	0.0	0.0			

Monitoring Area	Cluster no.	Treatment	Data Source	Site ID	Activity (%) Baseline	Activity (%) 2015	Activity (%) 2016	Scat presence (per cluster) Baseline	Scat presence (per cluster) 2015	Scat presence (per cluster) 2016
			Niche	SAT PEVI3	-	0.0	0.0			
Cairncross State Forest (north)	14	No Mitigation	Baseline_Niche relocation	CAIRNCROSS SF7	0.0	3.3	0.0	absent	present	absent
			Baseline	CAIRNCROSS SF8	0.0	20.0	0.0			
			Baseline	CAIRNCROSS SF9	0.0	10.0	0.0			
	15	Mitigation	Baseline	CAIRNCROSS SF10	3.3	0.0	0.0	present	present	present
			Baseline	CAIRNCROSS SF11	3.3	0.0	3.3			
			Baseline	CAIRNCROSS SF12	6.7	3.3	0.0			
	16	Control	Baseline	CAIRNCROSS SF13	6.7	3.3	3.3	present	present	present
			Baseline	CAIRNCROSS SF14	0.0	0.0	0.0			
			Baseline	CAIRNCROSS SF15	0.0	3.3	0.0			
	17	New Control	Niche	SAT RR1	-	0.0	0.0	not monitored	absent	absent
			Niche	SAT RR2	-	0.0	0.0			
			Niche	SAT RR3	-	0.0	0.0			
Cooperabung Hill	18	No Mitigation	Baseline	COOPERABUNG1	3.3	3.3	0.0	present	present	present
			Baseline	COOPERABUNG2	0.0	23.3	3.3			
			Baseline	COOPERABUNG3	10.0	0.0	0.0			
	19	Mitigation	Baseline_Niche relocation	COOPERABUNG4	0.0	3.3	6.7	present	present	present
			Baseline_Niche relocation	COOPERABUNG5	3.3	3.3	0.0			
			Baseline	COOPERABUNG6	0.0	0.0	0.0			

Monitoring Area	Cluster no.	Treatment	Data Source	Site ID	Activity (%) Baseline	Activity (%) 2015	Activity (%) 2016	Scat presence (per cluster) Baseline	Scat presence (per cluster) 2015	Scat presence (per cluster) 2016
	20	Control	Baseline	COOP HILL1	6.7	0.0	0.0	present	absent	absent
			Baseline	COOP HILL2	0.0	0.0	0.0			
			Baseline	COOP HILL3	0.0	0.0	0.0			
	21	New Control	Niche	SAT FL1	-	16.7	0.0	not monitored	present	absent
			Niche	SAT ST1	-	0.0	0.0			
			Niche	SAT ST2	-	20.0	0.0			
Mingaletta to Smiths Creek	22	Mitigation	Baseline	MIN-SMITHS CK1	0.0	0.0	0.0	absent	absent	absent
			Baseline	MIN-SMITHS CK2	0.0	0.0	0.0			
			Baseline	MIN-SMITHS CK3	0.0	0.0	0.0			
	23	Control	Baseline	BALLENGARA SF1	0.0	0.0	0.0	absent	absent	absent
			Baseline	BALLENGARA SF2	0.0	0.0	0.0			
			Baseline	BALLENGARA SF3	0.0	0.0	0.0			
	24	New Control	Niche	SAT BR1	-	6.7	0.0	not monitored	present	absent
			Niche	SAT BR2	-	0.0	0.0			
			Niche	SAT BR3	-	0.0	0.0			
Kundabung Road to North of Pipers Creek	25	No Mitigation	Baseline	KUNDABUNG 1	0.0	0.0	0.0	present	absent	absent
			Baseline	KUNDABUNG 2	10.0	0.0	0.0			

Monitoring Area	Cluster no.	Treatment	Data Source	Site ID	Activity (%) Baseline	Activity (%) 2015	Activity (%) 2016	Scat presence (per cluster) Baseline	Scat presence (per cluster) 2015	Scat presence (per cluster) 2016
			Baseline	KUNDABUNG 3	0.0	0.0	0.0			
	26	Mitigation	Baseline	KUNDABUNG 4	33.3	0.0	fire	present	absent	no access - fire
			Baseline	KUNDABUNG 5	13.3	0.0	fire			no access - fire
			Baseline	KUNDABUNG 6	10.0	0.0	0.0			absent
	27	Control	Baseline	KUMBATINE NP1	3.3	0.0	0.0	present	absent	absent
			Baseline	KUMBATINE NP2	0.0	0.0	0.0			
			Baseline	KUMBATINE NP3	0.0	0.0	0.0			
	28	New Control	Niche	SAT MAC1	-	0.0	0.0	not monitored	absent	absent
			Niche	SAT MAC2	-	0.0	0.0			
			Niche	SAT MAC3	-	0.0	0.0			
Maria River State Forest	29	Part Mitigation	Baseline_Niche relocation	MARIA RIVER 1	0.0	0.0	fire	present	absent	no access - fire
			Baseline	MARIA RIVER 2	3.3	0.0	fire			
			Baseline_Niche relocation	MARIA RIVER 3	6.7	0.0	fire			
	30	Mitigation	Baseline	MARIA RIVER 4	0.0	0.0	fire	absent	present	no access - fire
			Baseline	MARIA RIVER 5	0.0	0.0	fire			
			Baseline	MARIA RIVER 6	0.0	3.3	fire			
	31	Control	Baseline	MARIA NP1	0.0	0.0	0.0	present	absent	present
			Baseline	MARIA NP2	10.0	0.0	3.3			
			Baseline	MARIA NP3	10.0	0.0	3.3			
	32	New	Niche	SAT CO1	-	0.0	fire	not	absent	no access –

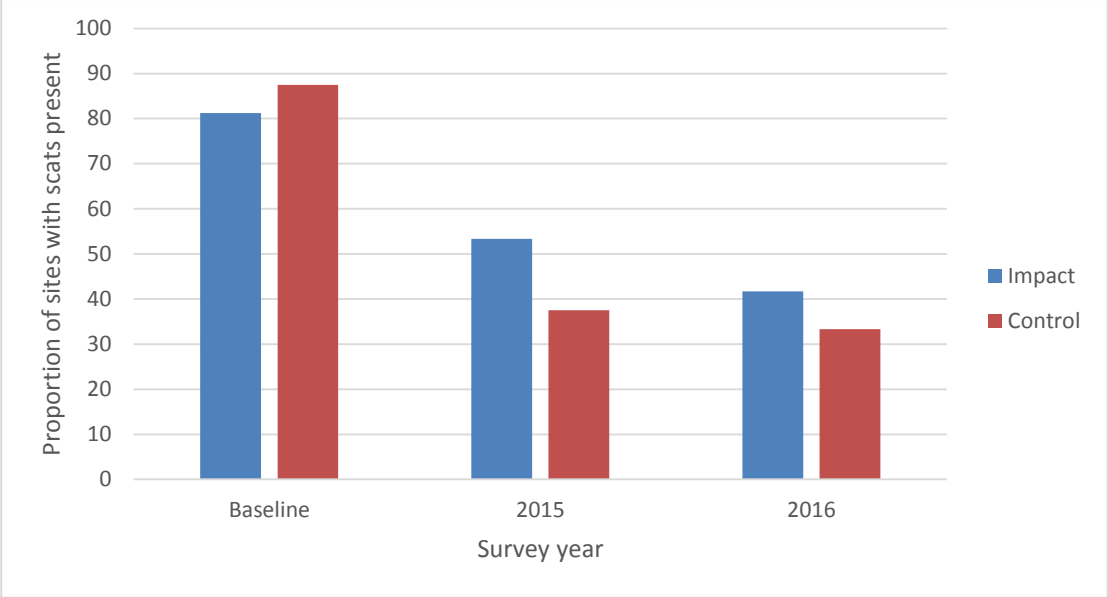
Monitoring Area	Cluster no.	Treatment	Data Source	Site ID	Activity (%) Baseline	Activity (%) 2015	Activity (%) 2016	Scat presence (per cluster) Baseline	Scat presence (per cluster) 2015	Scat presence (per cluster) 2016
		Control						monitored		fire
			Niche	SAT CO3	-	0.0	fire			
			Niche	SAT MAR 1	-	0.0	fire			

3.2 Impact v control sites analysis

At a treatment level, the number of Koala scats recorded at impact sites was greater than at the control sites (42% cf 33%) (Graph 3). This result is similar to that of last year (53% of impact sites cf 38% of control sites) although, as noted previously, with lower numbers of Koala scats in 2016 compared to 2015 and also the baseline surveys.

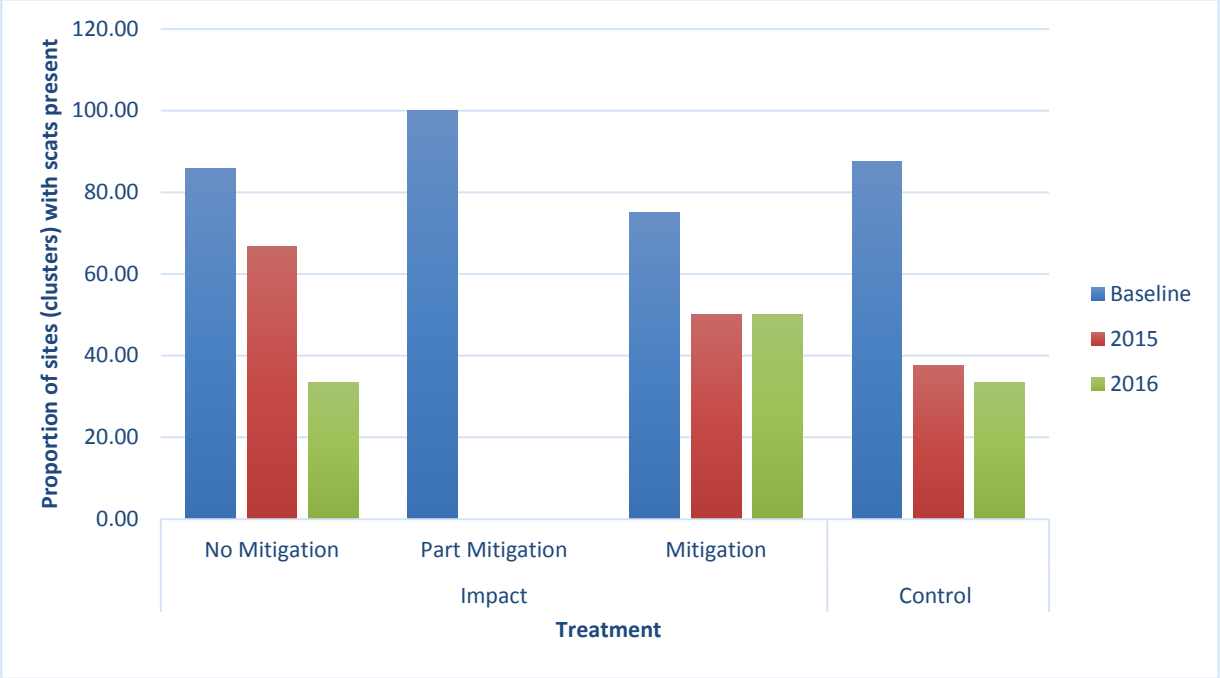
If we compare the Koala presence/absence results between control and impact clusters there is no significant difference in Koala presence at impact and control sites between the baseline and 2016 surveys, or 2015 and 2016 surveys ($X^2 = 0.241$, df = 3, $p < 0.05$ and $X^2 = 0.767$, df = 3, $p < 0.05$).

Graph 3: Koala presence per treatment class



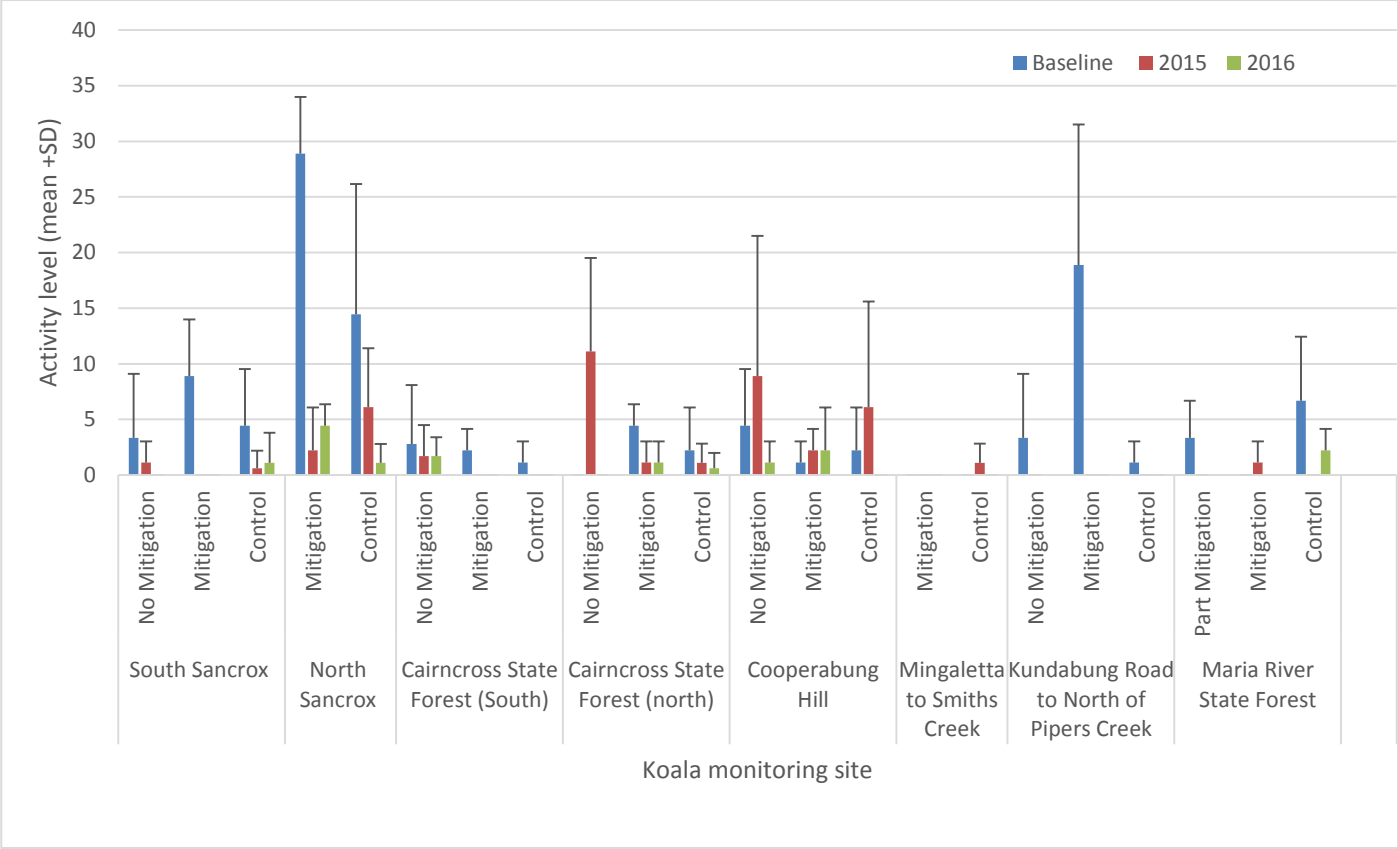
Review of Koala presence within the different impact/control categories does not reveal any clear trends regarding Koala presence or absence from these sites according to the treatment group or year (Graph 4). For example the proportion of scats found within the control sites in 2015 and2016 decreased markedly from the baseline, but there was little difference in the survey results at the control sites between 2015 and 2016. At the impact sites, 50% of the sites with mitigation had Koala scats in 2015 and 2016, while at the unmitigated sites, there was a reduction in the number of Koala scats from 2015 to 2016. No Koala scats were recorded in the part-mitigation site in 2015 and the site could not be surveyed due to fire in 2016. Two of the mitigation sites and one of the control sites also could not be surveyed due to fire.

Graph 4: Koala presence at the different treatment sites



Koala activity at each of the sites is shown in Graph 5. Koala activity was generally lower in 2016 than either of the two previous surveys, and as mentioned previously, there were a greater number of sites with no Koala activity recorded. Further monitoring data would be required to determine if the results reflect broader trends in population dynamics.

Graph 5. Koala activity at each site (mean ± SD)



3.2.1 Tree species use

A total of 2,460 trees were surveyed within the 82 plots. Koala scats were recorded at 15 (0.61%) of the trees surveyed. Surveyed trees included 32 tree species of which Koala scats were recorded at seven (22%) (Table 3). The tree species Koala scats were most commonly recorded beneath were Tallowwood (*Eucalyptus microcorys*) and Small-fruited Grey Gum (*E. propinqua*), which together comprised 30% of all surveyed tree species.

Proportionally, Koala scats were found most frequently beneath Prickly-leaved Tea Tree (*Melaleuca styphelioides*) and Swamp Mahogany (*E. robusta*), 5.6% and 2.7% respectively. However, these two tree species were relatively uncommon at the SAT sites (these species representing only 2.2% of the surveyed trees).

Other tree species used included Coastal Blackbutt (*Eucalyptus pilularis*), Pink Bloodwood (*Corymbia intermedia*) and Forest Oak (*Allocasuarina torulosa*), with a percentage of use ranging from 0.49% to 1.9% (Table 3).

These results are not dissimilar to those of 2015 with Koalas recorded using a similar suite of species.

Table 3: Summary of tree species used by Koala during the SAT surveys

Common name	Species name	Total trees assessed	No. trees with Koala scats	Proportional use (% scats per tree species)
Prickly-leaved Tea Tree	*Melaleuca styphelioides*	18	1	5.6
Swamp Mahogany	*Eucalyptus robusta*	37	1	2.7
Small-fruited Grey Gum	*Eucalyptus propinqua*	209	4	1.9
Coastal Blackbutt	*Eucalyptus pilularis*	165	2	1.2
Pink Bloodwood	*Corymbia intermedia*	222	2	0.90
Tallowwood	*Eucalyptus microcorys*	531	4	0.75
Forest Oak	*Allocasuarina torulosa*	205	1	0.49
Grey Ironbark	*Eucalyptus siderophloia*	94	0	0
Turpentine	*Syncarpia glomulifera*	118	0	0
White Stringy bark	*Eucalyptus globoidea*	97	0	0
White Mahogany	*Eucalyptus acmenoides*	39	0	0
Broad-leaved Paperbark	*Melaleuca quinquenervia*	29	0	0
Thin-leaved Stringybark	*Eucalyptus eugenioides*	77	0	0
Flooded Gum	*Eucalyptus grandis*	51	0	0
Forest Red Gum	*Eucalyptus tereticornis*	21	0	0
Thick-leaved Mahogany	*Eucalyptus carnea*	40	0	0
Red Mahogany	*Eucalyptus resinifera*	74	0	0
Red Bloodwood	*Corymbia gummifera*	99	0	0
Brush Box	*Lophostemon confertus*	60	0	0
Black She0ak	*Allocasuarina littoralis*	31	0	0
Cheese Tree	*Glochidian ferdinandi*	6	0	0

Common name	Species name	Total trees assessed	No. trees with Koala scats	Proportional use (% scats per tree species)
Cabbage Gum	*Eucalyptus amplifolia*	6	0	0
Narrow-leaved Paperbark	*Melaleuca linariifolia*	70	0	0
Blue Gum	*Eucalyptus saligna*	35	0	0
Red Ironbark	*Eucalyptus fibrosa*	3	0	0
Scribbly Gum	*Eucalyptus haemostoma*	43	0	0
	Melaleuca sieberii	8	0	0
Green Wattle	*Acacia irrorata*	5	0	0
Swamp Paperbark	*Melaleuca ericifolia*	1	0	0
	Corymbia spp.	4	0	0
Spotted Gum	*Corymbia maculata*	43	0	0
Grey Ironbark	*Eucalyptus paniculata*	8	0	0
	Melaleuca sp.	2	0	0
Scribbly Gum	*Eucalyptus signata*	7	0	0
Unidentified sp.		2	0	0

3.2.2 Weather conditions

The weather conditions during the field surveys (from Kundabung weather station) are provided in Table 4.

Table 4: Weather conditions during spring-summer 2016

Time	Rainfall (mm)	Temp (°C) (max)	Temp (°C) (min)	Wind speed (km/h)
01/11/2016	13.4	24.44	12.89	1.07
02/11/2016	0.2	25.1	10.72	1.05
14/11/2016	0	26	12.96	1.27
15/11/2016	0	24.35	11.28	1.48
16/11/2016	0	26.92	9.24	1.24
17/11/2016	0	26.2	13.11	1.38
20/11/2016	0	29.41	16.24	1.42
21/11/2016	0	31.77	13.03	1.59
29/11/2016	7	33.7	13.48	1.43
01/12/2016	1	28.94	14.03	1.6
02/12/2016	0	35.62	17.34	1.16
05/12/2016	25	35.47	20.28	1.86
06/12/2016	1.2	32.8	21.04	1.16
07/12/2016	2.2	23.89	19.77	1.14
08/12/2016	1.4	29.02	19.29	1.89

4. Summary and Conclusion

4.1 Summary

Results of SAT baseline surveys showed that Koalas were recorded across most of the study area, apart from the Mingaletta-Smiths Creek area. During the 2015 monitoring, Koala distribution was slightly patchier, in particular in the northern portion of the Project, where Koalas were only recorded from one site. During the current monitoring period Koala presence was mainly recorded in the southern and central portions of the Project area (Figure 2), however, four of the sites (13%) in the north of the alignment were completely burnt and so could not be accessed. It is likely that Koala distribution/abundance would have been affected by the wildfire across the northern parts of the Project area which occurred just prior to the spring 2016 surveys.

Comparison of the current results with 2015 and baseline surveys indicates a downward trend in Koala presence and activity across the Project area and surrounding area within control sites. Koalas were recorded at 83%, 45% and 37% of sites during the baseline, 2015 and 2016 surveys respectively; and SAT activity levels across the eight monitoring areas decreased from 4.8% (SD = 4.7%, baseline) to 2.1% (SD = 3.0%, 2015) to 0.9% (SD = 0.9%, 2016). Koala activity has decreased since the baseline. However, while the establishment of additional control sites has resulted in a more balanced design (which may allow for statistical analysis), the lack of results means that statistical analysis is not possible.

In all three surveys undertaken to date, Koalas were more frequently recorded in impact clusters than in control clusters. Between 2015 and the current survey there was no significant difference in the number of Koalas recorded at the control and impact sites, indicating there is no evidence to indicate that the Project may be affecting the local Koala population.

The results of the 2016 (year 2) monitoring, also observed during the 2015 monitoring, show that the average activity levels align with the category of low use on the east coast (low density area), based on the categories defined by Phillips and Callaghan (2011). This is a reduction down from the moderate (normal) category observed during baseline surveys.

The tree species used by Koalas during the baseline and 2015 monitoring were similar to those recorded in the current survey.

Koala activity was generally lower in 2016 than either of the two previous surveys, and as mentioned previously, there were a greater number of sites with no Koala activity recorded. Further monitoring data would be required to determine if the results reflect temporal trends in population dynamics.

4.2 Performance measures

Table 5 provides details on how the results obtained to date compare against the performance measures from the EMP, and any recommendations arising from these results.

At this stage there is insufficient data to attribute the observed reduction in Koala presence/activity to Project-related activities as this trend was observed for both impact and control sites. It is also likely that Koala distribution/abundance would have been affected by the wildfire that occurred across the northern parts of the Project area prior to the surveys in spring 2016. Further monitoring data will provide further opportunities to determine trends in the Koala population that will assist in assessment of the results against the performance criteria which states “no change” to Koala “densities, distribution, habitat use and movement patterns compared to baseline data”.

Table 5. Performance measures

Performance measure	Response
Monitoring is undertaken during baseline surveys from Year 1 – Year 6 & 8, or until mitigation measures are demonstrated to be effective.	**This performance measure for Year 2 has been met**. SAT plot monitoring in 2016 has been undertaken as per the 2015 and baseline surveys.
Monitoring during Year 1 – Year 6 & 8 is undertaken at the Impact and Control sites where monitoring was undertaken during baseline surveys, subject to ongoing landowner agreement. Where landowner agreement cannot be obtained and the process in Section 3.1.2 of the EMP has been followed, this performance indicator will also be considered to have been met	**This performance measure for Year 2 has been met**. Year 2 monitoring was undertaken at the same sites as surveyed in 2015 – with the exception of a number of the sites which could not be accessed due to wildfire. In 2015, eight of the baseline plots had to be relocated to nearby locations because they had been established in the construction site itself or because they were located on private property and access was not possible. Three of the baseline monitoring plots that could not be accessed could not be relocated because there weren't any suitable sites nearby. These three plots were all part of the same cluster (impact, no mitigation) located in the North Sancrox area. Details of all 96 monitoring plots are presented in Table 1 and the location of the 93 accessible monitoring plots are shown in Figure 1.
Mitigation measures are demonstrated to be effective as defined in the EPBC approval when all monitoring events are considered at Year 8.	Not applicable for Year 2.
Fauna fence is installed at a minimum in areas identified in Schedule 3 of the EPBC approval at Year 4.	Not applicable for Year 2.
No changes to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 6 & 8, and then when all monitoring events are considered at Year 8.	**This performance measure has not been met.** The 2016 monitoring results indicate a reduction in the presence and activity of Koalas across the Project area from the baseline and 2015 surveys. However this result is consistent across both the impact and control sites with no significant difference in the proportion of sites with Koalas between the impact and control sites. As such, any observed decrease in Koala presence/activity should not be directly attributed to disturbance due to the Project. It is also likely that Koala distribution/abundance would have been affected by the wildfire that occurred across the northern parts of the Project are prior to the surveys in spring 2016. Further monitoring data will assist in determining if the results reflect broader trends in population dynamics. SAT plots provide data in compliance with the requirement of measuring Koala distribution, habitat use and activity levels, but do not provide any data on density, as it is not possible to determine the number of Koalas from scat records. Supplementing the SAT surveys with a direct survey technique such as spotlighting surveys would provide more robust data on Koala density against which the performance measure relating to this variable may be assessed.

References

Lewis, B.D (2014). Pacific Highway Upgrade: Oxley Highway to Kempsey Pre-construction Spring and Summer Baseline Monitoring. Report prepared for RPS-RMS by Lewis Ecological Surveys.

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Phillips, S. and Callaghan, J. (2011). The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas Phascolarctos cinereus. Australian Zoologist 35 (3), 774-780.

RMS (2016). Oxley Highway to Kempsey Pacific Highway Upgrade Ecological Monitoring Program. Roads and Maritime Update to report prepared by SMEC Hyder Joint Venture, August 2016.

Annex 1. Koala SAT results – 2016 monitoring

On a number of occasions the marked tree did not correspond with the baseline and 2015 monitoring SCT (selection criteria tree) species. As such, for clarity of results and to facilitate future monitoring, the DBH is provided for the marked tree, and this tree will be considered as the "New SCT" for the current and future monitoring events. DBH = diameter at breast height, Radial = radial distance of search area from New SCT.

Area N	Monitoring area	Treatment	Treatment sub-category	Site_ID	Easting	Northing	Activity	Previous SCT	New SCT	DBH (cm)	Radial (m)	Notes
1	South Sancrox	Impact	No Mitigation	SANCROX E1	483348	6521736	0.0	Tallowwood	Tallowwood	46	30	
1	South Sancrox	Impact	No Mitigation	SANCROX E2	483455	6521789	0.0	Tallowwood	Thin-leaved Stringybark	31	25	
1	South Sancrox	Impact	No Mitigation	SANCROX E3	483412	6521882	0.0	Tallowwood	Tallowwood	44.9	30	
1	South Sancrox	Impact	Mitigation	SANCROX S1	483299	6520671	0.0	Tallowwood	Blackbutt	54.5	50	
1	South Sancrox	Impact	Mitigation	SANCROX S2	483254	6520383	0.0	Tallowwood	Thin-leaved Stringybark	54	30	
1	South Sancrox	Impact	Mitigation	SANCROX S3	483196	6520217	0.0	Tallowwood	Tallowwood	46.9	30	
1	South Sancrox	Control	Control	COWARRA SF1	480608	6519056	0.0	Tallowwood	Small-fruited Grey Gum	60.5	20	
1	South Sancrox	Control	Control	COWARRA SF2	480658	6519496	0.0	Tallowwood	Blackbutt	101	20	
1	South Sancrox	Control	Control	COWARRA SF3	481305	6519136	6.7	Tallowwood	Small-fruited Grey Gum	34	15	
1	South Sancrox	Control	New Control	SAT COWARRA NC1	479706	6518522	0.0	Tallowwood	Blackbutt	71	30	
1	South Sancrox	Control	New Control	SAT COWARRA NC2	479788	6517922	0.0	Tallowwood	Tallowwood	47	25	
1	South Sancrox	Control	New Control	SAT COWARRA NC3	479795	6518227	0.0	Tallowwood	Blackbutt	57	20	
2	North Sancrox	Impact	No Mitigation	SANCROX N1	483042	6521731		Swamp Mahogany				No access
2	North Sancrox	Impact	No Mitigation	SANCROX N2	482869	6521683		Tallowwood				No access
2	North Sancrox	Impact	No Mitigation	SANCROX N3	482999	6521818		Tallowwood				No access
2	North Sancrox	Impact	Mitigation	FERNBANK CK1	483101	6523362	3.3	Tallowwood	Tallowwood	61.8	40	
2	North Sancrox	Impact	Mitigation	FERNBANK CK2	483032	6523223	6.7	Tallowwood	Tallowwood	39.7	40	
2	North Sancrox	Impact	Mitigation	FERNBANK CK3	483056	6523123	3.3	Tallowwood	Tallowwood	45	30	
2	North Sancrox	Control	Control	LAKE INNES1	488124	6518469	0.0	Tallowwood	Tallowwood	45	30	
2	North Sancrox	Control	Control	LAKE INNES2	488047	6518398	3.3	Swamp Mahogany	Swamp Mahogany	103	30	
2	North Sancrox	Control	Control	LAKE INNES3	488228	6518390	0.0	Swamp Mahogany	Thin-leaved Paperbark	28	30	
2	North Sancrox	Control	New Control	SAT COW4	479674	6516436	0.0	Tallowwood	Blackbutt	68.5	30	

Area N	Monitoring area	Treatment	Treatment sub-category	Site_ID	Easting	Northing	Activity	Previous SCT	New SCT	DBH (cm)	Radial (m)	Notes
2	North Sancrox	Control	New Control	SAT COW5	479704	6516174	0.0	Tallowwood	Tallowwood	34.5	15	
2	North Sancrox	Control	New Control	SAT COW6	479667	6515913	3.3	Tallowwood	Tallowwood	54	25	
3	Cairncross State Forest (South)	Impact	No Mitigation	CAIRNCROSS SF1	482428	6526536	0.0	Tallowwood	Tallowwood	35.4	20	
3	Cairncross State Forest (South)	Impact	No Mitigation	CAIRNCROSS SF2	482385	6526644	0.0	Tallowwood	Tallowwood	56.1	30	
3	Cairncross State Forest (South)	Impact	No Mitigation	CAIRNCROSS SF3	482393	6526416	0.0	Tallowwood	Tallowwood	29.8	30	
3	Cairncross State Forest (south)	Impact	No Mitigation	CAIRNCROSS SF16	481655	6527256	3.3	Tallowwood	Tallowwood	38.5	30	
3	Cairncross State Forest (south)	Impact	No Mitigation	CAIRNCROSS SF17	481590	6527316	3.3	Tallowwood	Tallowwood	45.5	30	
3	Cairncross State Forest (south)	Impact	No Mitigation	CAIRNCROSS SF18	481637	6527175	0.0	Tallowwood	Tallowwood	51.5	35	
3	Cairncross State Forest (South)	Impact	Mitigation	CAIRNCROSS SF4	482249	6525930	0.0	Tallowwood	Tallowwood	57.4	30	
3	Cairncross State Forest (South)	Impact	Mitigation	CAIRNCROSS SF5	482125	6526077	0.0	Tallowwood	Tallowwood	64.2	20	
3	Cairncross State Forest (South)	Impact	Mitigation	CAIRNCROSS SF6	482488	6526226	0.0	Tallowwood	Blackbutt*	71.6	20	
3	Cairncross State Forest (South)	Control	Control	LIMEBURNERS CK1	487011	6529909	0.0	Scribbly Gum	Scribbly Gum	94	60	Not tagged
3	Cairncross State Forest (South)	Control	Control	LIMEBURNERS CK2	487014	6529455	0.0	Scribbly Gum	Scribbly Gum	81	60	Not tagged
3	Cairncross State Forest (South)	Control	Control	LIMEBURNERS CK3	487035	6528694	0.0	Scribbly Gum	Scribbly Gum	75	45	Not tagged
3	Cairncross State Forest (South)	Control	New Control	SAT PEVI1	476817	6528422	0.0	Tallowwood	Sydney Blue Gum	58		
3	Cairncross State Forest (South)	Control	New Control	SAT PEVI2	476730	6528225	0.0	Tallowwood	Sydney Blue Gum	40	30	
3	Cairncross State Forest (South)	Control	New Control	SAT PEVI3	475996	6528211	0.0		Sydney Blue Gum	55	30	
4	Cairncross State Forest (north)	Impact	No Mitigation	CAIRNCROSS SF7	481346	6530835	0.0	Blackbutt	Blackbutt	64.5	30	
4	Cairncross State Forest (north)	Impact	No Mitigation	CAIRNCROSS SF8	481695	6530786	0.0	Forest Red Gum	Pink Bloodwood	28.3	30	
4	Cairncross State Forest (north)	Impact	No Mitigation	CAIRNCROSS SF9	481184	6530864	0.0	Tallowwood	Tallowwood	42.2	40	
4	Cairncross State Forest (north)	Impact	Mitigation	CAIRNCROSS SF10	481238	6530264	0.0	Swamp Mahogany	Swamp Mahogany	37.8	30	
4	Cairncross State Forest (north)	Impact	Mitigation	CAIRNCROSS SF11	481173	6530319	3.3	Tallowwood	Tallowwood	64.2	40	
4	Cairncross State Forest (north)	Impact	Mitigation	CAIRNCROSS SF12	481438	6530335	0.0	Tallowwood	Tallowwood	72		
4	Cairncross State Forest (north)	Control	Control	CAIRNCROSS SF13	473751	6528881	3.3	Tallowwood	Small-fruited Grey Gum	44	40	
4	Cairncross State Forest (north)	Control	Control	CAIRNCROSS SF14	473464	6528969	0.0	Tallowwood	Sydney Blue Gum	86	30	
4	Cairncross State Forest (north)	Control	Control	CAIRNCROSS SF15	473424	6529115	0.0	Tallowwood	Sydney Blue Gum	80		
4	Cairncross State Forest (north)	Control	New Control	SAT RR1	475284	6532709	0.0	Tallowwood	Tallowwood	78	30	

Area N	Monitoring area	Treatment	Treatment sub-category	Site_ID	Easting	Northing	Activity	Previous SCT	New SCT	DBH (cm)	Radial (m)	Notes
4	Cairncross State Forest (north)	Control	New Control	SAT RR2	475113	6532603	0.0	Tallowwood	Small-fruited Grey Gum	54		
4	Cairncross State Forest (north)	Control	New Control	SAT RR3	474816	6532732	0.0	Tallowwood	Tallowwood	61	20	
5	Cooperabung Hill	Impact	No Mitigation	COOPERABUNG1	482793	6537012	0.0	Tallowwood	Tallowwood	68	60	
5	Cooperabung Hill	Impact	No Mitigation	COOPERABUNG2	482755	6537093	3.3	Tallowwood	Small-fruited Grey Gum	26.8	50	
5	Cooperabung Hill	Impact	No Mitigation	COOPERABUNG3	482876	6537115	0.0	Tallowwood	Tallowwood	49.7	35	
5	Cooperabung Hill	Impact	Mitigation	COOPERABUNG4	482481	6539327	6.7	Tallowwood	Tallowwood	34	30	
5	Cooperabung Hill	Impact	Mitigation	COOPERABUNG5	482364	6539761	0.0	Forest Red Gum	Tallowwood	25.7	30	
5	Cooperabung Hill	Impact	Mitigation	COOPERABUNG6	482364	6538610	0.0	Tallowwood	Tallowwood	73	40	
5	Cooperabung Hill	Control	Control	COOP HILL1	475489	6541854	0.0	Tallowwood	Tallowwood	41.8	30	
5	Cooperabung Hill	Control	Control	COOP HILL2	475570	6541903	0.0	Tallowwood	Tallowwood	31.5	25	
5	Cooperabung Hill	Control	Control	COOP HILL3	475838	6541962	0.0	Tallowwood	Tallowwood	28.7	30	
5	Cooperabung Hill	Control	New Control	SAT FL1	473693	6542127	0.0		Tallowwood	45.4	25	
5	Cooperabung Hill	Control	New Control	SAT ST1	473346	6543256	0.0		Tallowwood	64.5	15	
5	Cooperabung Hill	Control	New Control	SAT ST2	473682	6542890	0.0		Tallowwood	31.5	20	
6	Mingaletta to Smiths Creek	Impact	Mitigation	MIN-SMITHS CK1	483304	6543632	0.0	Tallowwood	Blackbutt	42	20	
6	Mingaletta to Smiths Creek	Impact	Mitigation	MIN-SMITHS CK2	483444	6543585	0.0	Tallowwood	Tallowwood	58	40	
6	Mingaletta to Smiths Creek	Impact	Mitigation	MIN-SMITHS CK3	483100	6543670	0.0	Tallowwood	Small-fruited Grey Gum	37.6		
6	Mingaletta to Smiths Creek	Control	Control	BALLENGARA SF1	477750	6543274	0.0	Tallowwood	Tallowwood	37	30	
6	Mingaletta to Smiths Creek	Control	Control	BALLENGARA SF2	477644	6543623	0.0	Small-fruited Grey Gum	Small-fruited Grey Gum	23.5	30	
6	Mingaletta to Smiths Creek	Control	Control	BALLENGARA SF3	477551	6543709	0.0	Tallowwood	Tallowwood	42.5	25	
6	Mingaletta to Smiths Creek	Control	New Control	SAT BR1	477010	6544693	0.0	Tallowwood	Sydney Blue Gum	42.5	20	
6	Mingaletta to Smiths Creek	Control	New Control	SAT BR2	476890	6544832	0.0	Tallowwood	Sydney Blue Gum	49	25	
6	Mingaletta to Smiths Creek	Control	New Control	SAT BR3	476777	6544973	0.0	Tallowwood	Flooded Gum	60.5	20	
7	Kundabung Road to North of Pipers Creek	Impact	No Mitigation	KUNDABUNG 1	483095	6549036	0.0	Tallowwood	Tallowwood	65.5	60	
7	Kundabung Road to North of Pipers Creek	Impact	No Mitigation	KUNDABUNG 2	482873	6549112	0.0	Tallowwood	Tallowwood	73.5	30	
7	Kundabung Road to North of Pipers Creek	Impact	No Mitigation	KUNDABUNG 3	483285	6549374	0.0	Tallowwood	Tallowwood	65	40	
7	Kundabung Road to North of Pipers Creek	Impact	Mitigation	KUNDABUNG 4	483369	6550655	fire	Tallowwood				Burnt

Area N	Monitoring area	Treatment	Treatment sub-category	Site_ID	Easting	Northing	Activity	Previous SCT	New SCT	DBH (cm)	Radial (m)	Notes
7	Kundabung Road to North of Pipers Creek	Impact	Mitigation	KUNDABUNG 5	483331	6550938	fire	Tallowwood				Burnt
7	Kundabung Road to North of Pipers Creek	Impact	Mitigation	KUNDABUNG 6	483083	6550608	0.0	Forest Red Gum	Grey Ironbark	55	40	
7	Kundabung Road to North of Pipers Creek	Control	Control	KUMBATINE NP1	476044	6549609	0.0	Tallowwood	Tallowwood	35.5	20	
7	Kundabung Road to North of Pipers Creek	Control	Control	KUMBATINE NP2	476165	6549738	0.0	Tallowwood	Tallowwood	37.5	15	
7	Kundabung Road to North of Pipers Creek	Control	Control	KUMBATINE NP3	475889	6549468	0.0	Tallowwood	Tallowwood	56.5	20	
7	Kundabung Road to North of Pipers Creek	Control	New Control	SAT MAC1	476538	6552784	0.0		Red Mahogany	83.6	15	
7	Kundabung Road to North of Pipers Creek	Control	New Control	SAT MAC2	476558	6552361	0.0		Spotted Gum	51.5	20	
7	Kundabung Road to North of Pipers Creek	Control	New Control	SAT MAC3	476481	6552612	0.0	Spotted Gum	Spotted Gum	58	15	
8	Maria River State Forest	Impact	Part Mitigation	MARIA RIVER 1	483074	6554460	fire	Tallowwood				Burnt
8	Maria River State Forest	Impact	Part Mitigation	MARIA RIVER 2	482836	6554330	fire	Tallowwood				Burnt
8	Maria River State Forest	Impact	Part Mitigation	MARIA RIVER 3	482993	6554024	fire	Tallowwood				Burnt
8	Maria River State Forest	Impact	Mitigation	MARIA RIVER 4	482886	6552623	fire	Tallowwood				Burnt
8	Maria River State Forest	Impact	Mitigation	MARIA RIVER 5	482754	6552462	fire	Tallowwood				Burnt
8	Maria River State Forest	Impact	Mitigation	MARIA RIVER 6	483135	6552449	fire	Tallowwood				Burnt
8	Maria River State Forest	Control	Control	MARIA NP1	486965	6554366	0.0	Tallowwood	Pink Bloodwood	28	40	
8	Maria River State Forest	Control	Control	MARIA NP2	486971	6554479	3.3	Tallowwood	Tallowwood	61.5	40	
8	Maria River State Forest	Control	Control	MARIA NP3	487004	6554203	3.3	Tallowwood	Tallowwood	36	30	Koala present-tallowwood
8	Maria River State Forest	Control	New Control	SAT CO1	486292	6552230	fire					Burnt
8	Maria River State Forest	Control	New Control	SAT CO3	486811	6552227	fire	Blackbutt				Burnt
8	Maria River State Forest	Control	New Control	SAT MAR 1	486811	6552454	fire					Burnt

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Pacific Highway Upgrade: Oxley Highway to Kundabung

Clearing Report

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Final Report – Version 5

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Cover Photo: Female koala (*Phascolarctos cinereus*) shortly after being release in Rawdon Creek Nature Reserve.

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1. Introduction

Sandpiper Ecological Surveys was contracted by Lend Lease Engineering to provide ecological services during construction of the Oxley Highway to Kundabung (OH2K) section of the Pacific Highway Upgrade. The following report discusses the procedures and results of ecological tasks undertaken during the clearing phase of the project. Clearing for the OH2K project commenced on 3 November 2014 and substantive clearing was completed by 25 August 2015. A small section in the north of the project corridor will be cleared in 2016. The results of that clearing will be detailed in a supplementary report with any additional clearing for ancillary work. This report has been prepared in accordance with the specifications of the Oxley Highway to Kempsey Ecological Monitoring Program (EMP) (RMS 2016). Section 7 of the EMP specifies, "A report on the clearing procedures will be prepared upon the completion of clearing operations and will include:

1. Details of methods used during pre-clearing surveys and clearing operations.
2. Fauna species displaced by clearing, species captured, species released and any wildlife mortalities resulting either directly or indirectly from the clearing operations.
3. Location of fauna within clearing footprint (recorded with GPS) and release locations.
4. Hollow-bearing tree register, and comparison of this data to nest box plan (assess the adequacy of nest boxes installed and how they are mitigating the loss of tree hollows).
5. Discussion of the effectiveness of those methods employed.
6. Recommendations for future pre-clearing and/or clearing procedures."

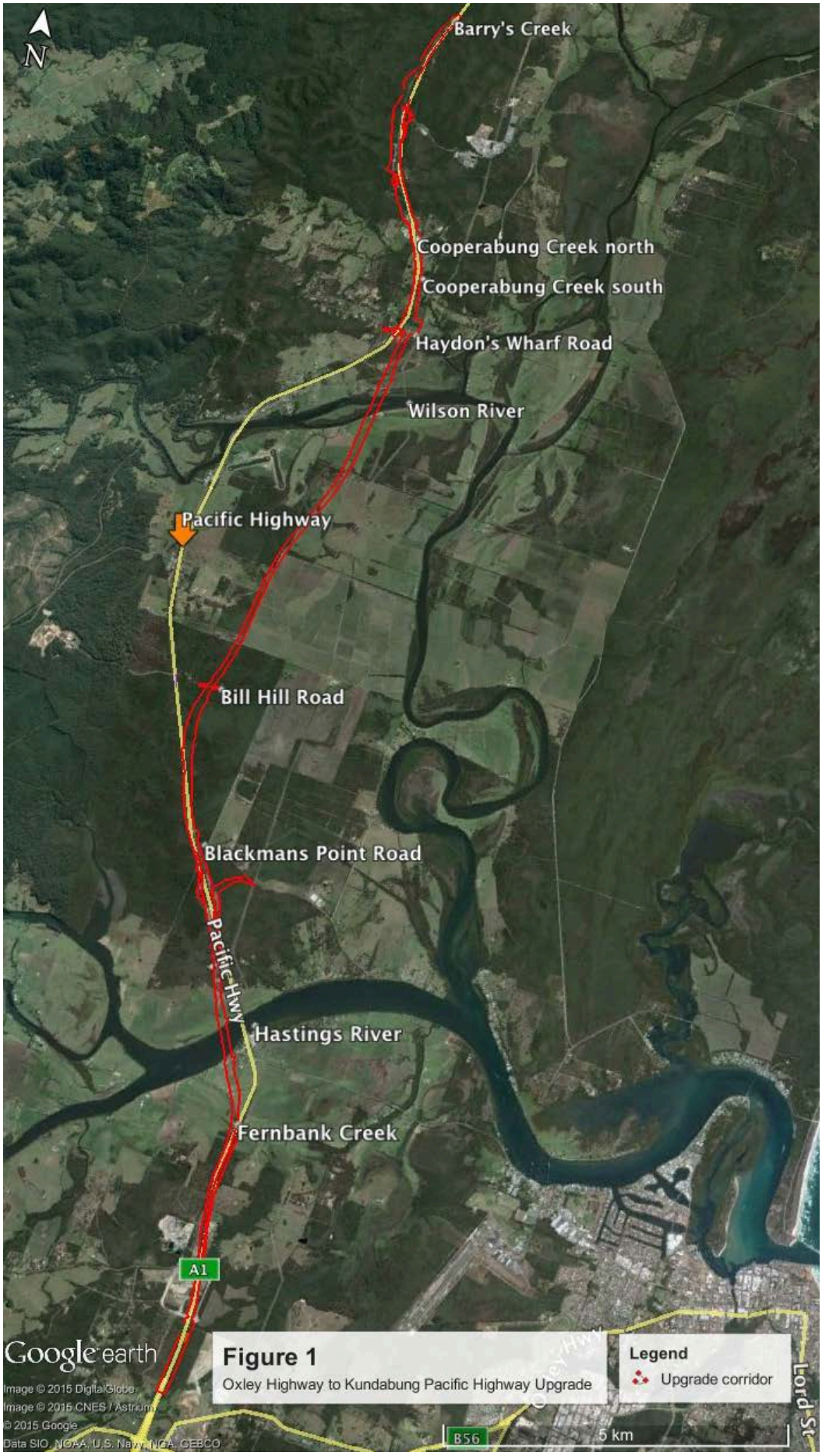
The above points form the scope of this report.

1.1 Background

The EMP (RMS 2016) summarises the pre-clearing and clearing procedures required and includes details on the type of data to collect for target species and activities (Section 4.1 of EMP). Further specification on survey requirements is provided in the various threatened species management strategies, namely giant barred frog (Mixophyes iteratus), green-thighed frog (Litoria brevipalmata) and microbats (see Lewis 2013a, b, c). There are some discrepancies between management strategies and the EMP although, in the event of inconsistencies, the EMP will take precedence (refer Section 1.2 of EMP). For example, the green-thighed frog management strategy specifies (section 3.3, pg 16) "The project ecologist will conduct frog surveys consisting of active searches set at 15 minutes per hectare of suitable microhabitats immediately prior (<2hrs) to commencing clearing operations… The requirement for nocturnal surveys is to be made at the discretion of the project ecologist performing the pre-clearing surveys." In contrast, the EMP states (Table 9, pg 30) "Targeted searches for green-thighed frog (Litoria brevipalmata) and giant barred frog (Mixophyes iteratus) will be undertaken where known or potential habitat for the species occurs within the clearing limits. Surveys to last 1 person hour per hectare of habitat to be disturbed/removed and involve the use of call broadcast, spotlighting and active searches of litter, debris and logs."

1.2 Study area

The OH2K Pacific Highway Upgrade extends from the Pacific Highway/Oxley Highway intersection in the south to immediately north of Barry's Creek in the north, a distance of approximately 24km (Figure 1). The study area abuts the southern end of the Kundabung to Kempsey (K2K) Pacific Highway Upgrade. The OH2K alignment follows the existing Pacific Highway for much of its length with deviations across the Hastings and Wilson river floodplains.


N
Barry's Creek
Cooperabung Creek north
Cooperabung Creek south
Haydon's Wharf Road
Wilson River
Pacific Highway
Bill Hill Road
Blackmans Point Road
Pacific Hwy
Hastings River
Fernbank Creek
A1
B56
Oxley Hwy
Lord St
5 km
Google earth
Image © 2015 DigitalGlobe
Image © 2015 CNES / Astrium
© 2015 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Figure 1
Oxley Highway to Kundabung Pacific Highway Upgrade
Legend
Upgrade corridor

2. Methods

2.1 Terrestrial fauna

2.1.1 Vegetation and pre-construction surveys

Retaining vegetation within the project corridor was dependent on detailed design of the upgrade. Where necessary, ecologists provided advice to the design team on Endangered Ecological Communities (EEC) and other sensitive habitats that should be protected. Vegetation mapping provided by RMS was used as a baseline for the distribution of EEC. Verification of EEC, project and retained vegetation boundaries was conducted from 18-22 August 2014. Verification involved a targeted foot-based traverse of the alignment to verify vegetation community boundaries. Previously unmapped areas of EEC were also inspected. These areas were typically cleared land where regrowth had occurred since RMS purchased the land. During clearing, vegetation to be retained within the project boundary was delineated by orange bunting or helicopter tape. All staff involved in clearing operations were tool-boxed on the marking system used. Targeted surveys and habitat assessment for giant-barred frog (Mixophyes iteratus), koala (Phascolarctos cinereus), spotted-tailed quoll (Dasyurus maculatus), grey-headed flying-fox (Pteropus poliocephalus), threatened flora and noxious weeds were conducted at the same time as EEC verification. RMS conducted pre-construction surveys for threatened fauna prior to construction.

2.1.2 Habitat resource surveys

Prior to commencement of clearing in a specific area the alignment was traversed to mark fauna habitat resources, including hollow-bearing trees (HBT), nest trees, trees with hollow arboreal termitaria, dreys, large hollow logs, bush rock and glider sap trees. The HBT survey included remarking of trees identified by Lewis (2013, NBPoM) and marking additional trees. HBT's were marked with red and white danger tape and four large "H" were painted on the trunk at head height (Plate 1). The tree number was written on the flagging tape and, in some cases, sprayed on the trunk. Data collected on each tree included: tree number, species, location (GDA 94), diameter at breast height (DBH), proportion of crown remaining, and hollow size (small 10-50mm, medium 51-150mm, large 151-300mm and very large >300mm), type (e.g. branch, trunk, spout, fissure, decorticating bark), and evidence of use (i.e. chew marks or wear around entrance, white-wash, pellets, scats, or scratches). Habitat resource surveys began one week prior to the commencement of clearing and were undertaken progressively during the clearing phase. Not all previously marked HBT's were remarked if no evidence of fauna habitat was recorded.

Trees in flower were not marked during the clearing phase. The EMP suggests that such trees should be treated the same as habitat trees and be retained during stage one clearing. However, such an approach is contrary to standard practice and would reduce the likelihood that arboreal fauna would move away from the clearing area thereby reducing the effectiveness of two-stage clearing. Large flowering trees may actually attract fauna into the clearing area, which is contrary to the intent of the two-stage process.

Plate 1: HBT's marking protocol – red and white danger tape and painted orange "H".

2.1.3 Frog surveys

Frogs were targeted during all nocturnal spotlight surveys (refer section 2.1.4), and diurnal pre-clear surveys (refer section 2.1.5), as part of targeted surveys in areas of potential habitat and targeted surveys in areas of mapped threatened frog habitat. Two species of threatened frog have been recorded in the OH2K alignment, giant barred frog and green-thighed frog (Lewis 2013b & c). Giant barred frog habitat was mapped at two sites on Cooperabung Creek and green-thighed frog habitat was identified north of Blackmans Point Road (chainage 9000 to 9350) and south of Barry's Creek (chainage 23900). The frog hygiene protocol included in the Fauna and Flora Management plan was applied during all frog surveys. Lewis (2013b) identified potential giant barred frog habitat on Barry's Creek, several hundred meters downstream of the alignment, but no potential or known habitat was mapped within the section of creek traversed by the upgrade.

Giant barred frog

Surveys for giant barred frog were conducted on two non-consecutive nights within 5 days of clearing, and during the day, immediately prior to clearing. Nocturnal surveys were conducted by 2-3 personnel and involved a foot-based meandering traverse of potential habitat with hand held (200 lumen) spotlights. Survey effort was focused on the riparian zone and vegetation within 50m of the creek channel as this represents primary habitat. The total area of potential giant barred frog habitat within 50m of the creek was 0.42ha. During each nocturnal survey calls of giant barred frog were periodically broadcast through a 5watt megaphone for a period of five minutes. Each broadcast was followed by a brief (1-2 minute) listening period before active searching recommenced. Calls were broadcast at approximate 15-minute intervals. During some surveys observers imitated giant barred frog calls throughout the sample period. Call imitation is an effective means of detecting giant barred frogs. In all cases greater survey effort was expended to maximise frog capture and relocation. The sporadic nature of clearing at Cooperabung Creek meant that giant barred frog habitat was sampled on multiple occasions.

Diurnal surveys involved active searching of leaf litter, splitting and rolling logs, and searching beneath and around *Lomandra longifolia* clumps. These surveys occurred prior to each scheduled clearing event and an ecologist was present to supervise all clearing. An ecologist supervised all clearing in giant barred frog habitat, and during clearing, periodically inspect the clearing front and clumps of vegetation removed (Plate 2). The procedure for clearing inspections was discussed with operators at the start of work. In areas of dense ground cover, particularly featuring *Lantana camara*, operators were asked to remove small patches of ground cover to enable systematic inspection of area to be cleared as clearing progressed.

Captured frogs were housed individually in clip-seal plastic bags or plastic aquaria, with a small amount of leaf litter and water. Data collected on each captured frog included: sex, snout-vent length and breeding condition. Adult frogs (>40mm in length) were taken to Ben Lewis to be pit-tagged. Individuals were housed temporarily before being released outside but within 150m of the project boundary. All frogs were released on the same section of creek on which they were captured. The intent was to keep individuals for one night only, however, the recapture of a male frog within the LoC four nights after it was initially released resulted in two individuals being housed for 2 to 3 nights until clearing was completed. The decision to house frogs for longer was based on concern about potential movement into the clearing zone and subsequent mortality. Prior to the construction of a temporary crossing over Cooperabung Creek the affected pool was dip-netted for tadpoles. Dip netting was conducted in three sessions for a combined period of 75 person minutes. All dewatering activities were performed in accordance with Environmental Work Method Statement 17.

Plate 2: Stripping of vegetation in degraded giant barred frog habitat north of Cooperabung Creek on 24 November 2014.

Green-thighed frog

Targeted surveys for green-thighed frogs occurred during, and immediately after, major rainfall events. Otherwise this species was targeted during general spotlight and preclear surveys. Activity of green-thighed frogs is closely associated with rainfall and rain events of 50-75mm over a period of 1-3 days is required to stimulate breeding activity, although frogs may remain active after such events. Three major rainfall events occurred during the summer/autumn breeding season, 20 to 28 January 2015 (400mm), 18 to 24 February (124mm) and 21 to 23 March (95mm) (Bureau of Meteorology 2015).

Green-thighed frog habitat at Blackmans Point Road (chainage 9000 and 9350) was cleared prior to the January rain event and potential habitat north of Bill Hill Road was cleared between the January and February events. Both nocturnal and diurnal targeted surveys for green-thighed frogs were undertaken in the Blackmans Point and Bill Hill Road areas during the January 2015 rain event. As part of the pre clear requirements, in known green thighed frog habitat, active searches involved the use of a rake and wrecking bar to search vegetation and debris. Active searches were carried out for a minimum of 15 minutes per hectare of habitat as per (Lewis 2013b). As habitat was cleared outside of suitable survey conditions the two non-consecutive nights survey five days prior to clearing specified in the EMP was not strictly applied. Importantly, Lewis (2013b) did not specify this requirement. Targeted nocturnal surveys during favorable conditions were undertaken by 2-3 staff and involved a meandering traverse of the upgrade corridor and adjacent habitat using 200 lumen spotlights. Green-thighed frog calls were broadcast through a 5-watt megaphone for periods of 2-5 minutes, with a brief (1-2 minute) listening period after each broadcast. An iPhone was used to broadcast calls on one night due to equipment failure. Frogs recorded were captured, sexed and housed temporarily in clip-seal plastic bags with a small amount of water. Captured frogs were released within suitable habitat outside the limit of clearing. Green-thighed frogs were also targeted during nightly spotlight surveys (refer Section 2.1.4). These surveys involved repeated sampling of the same habitat and act as surrogate non-consecutive night surveys prior to clearing.

2.1.4 Spotlighting and nocturnal preclear surveys

Nocturnal surveys included spotlighting for arboreal mammals, including koalas, and frogs. Call broadcast and stag watching were regarded as additional measures to be used as required. Call broadcast is an effective means of detecting arboreal fauna, however, fauna can be drawn to the playback site, which, in this case, was considered counter-productive. Stag watching can, in some cases, be an effective means of determining if a tree is occupied by fauna. Experience on the Sapphire to Woolgoolga and Nambucca Heads to Urunga Pacific Highway Upgrades indicated that stag watching was time consuming and of less value than targeted spotlight surveys.

Spotlight surveys targeted the clearing front (i.e. area to be cleared the next day) the night before clearing was to occur. The area spotlighted was based on daily advice from Lend Lease site engineers who provided an annotated map of the alignment with clearing areas marked. Spotlighting was undertaken from Sunday through to Thursday each week. The spotlight surveys targeted all fauna, with specific emphasis on arboreal mammals (particularly koala, squirrel glider and yellow-bellied glider), and threatened frogs (particularly green-thighed frog). Spotlighting involved a slow meandering foot-traverse of the clearing front by two staff using hand-held spotlights and binoculars. Observed fauna were identified to species level.

Most of the alignment was spotlighted on multiple occasions due to the three-stage clearing process (i.e. stage 1 - drains & basins, stage 2 – mainline, stage 3 – habitat trees) and the standard approach of spotlighting a greater area than was cleared the following day was implemented. Frogs were recorded during all spotlight surveys, although greater effort was focused on frogs in priority habitats such as, wetlands, dams, creeks and potential green-thighed frog habitat.

Data collected during spotlight surveys included: personnel, area sampled (chainage or location description), start and end time, date, weather conditions (rain, cloud cover, wind speed, air temperature, relative humidity), habitat type, species, number of individuals and behaviour (foraging, calling, roosting, transit). The location of threatened species was recorded using a hand held GPS (datum GDA 94). Species observed and heard calling were recorded. When possible fauna were captured and released immediately in a predetermined location outside the limit of clearing and adjacent to the point of capture (in accordance with the Flora and Fauna Management Plan).

2.1.5 Diurnal pre-clearing surveys

Diurnal pre-clearing surveys were conducted immediately prior to clearing a section of the alignment and the section inspected was the same as that spotlighted the previous evening. Spotlighting was generally not conducted in areas cleared of trees due to the absence of arboreal fauna habitat. Surveys typically commenced prior to the start of clearing each morning but some sections of habitat were inspected at other times, as required by the clearing schedule. In many cases habitat was inspected several times as the area inspected always exceeding that cleared within a day.

Pre-clearing inspections involved a meandering foot-based traverse of the clearing footprint by one or (sometimes) two observers. During the traverse all accessible fauna habitats were inspected. This included use of a wrecking bar to roll and split logs and visual searching of the shrub and canopy layers for koalas, bird nests, possum dreys and unmarked HBT. A rake was used to search leaf litter in potential green-thighed frog habitat. Captured fauna were released immediately into adjoining habitat or, if adjacent habitat was unsuitable, housed temporarily in cotton or plastic bags (frogs only).

2.1.6 Trapping

Large (B-type) Elliott traps were used in areas with high potential for small ground mammals, such as the riparian zone of Cooperabung Creek. Traps were baited with peanut butter, honey and oats and were set in the late afternoon and checked at first light. Captured fauna were processed and released into surrounding habitat at least 100m from the Limit of Clearing (LoC) boundary. Two trap lines were set during the clearing phase. On 21 January 2015, a total of 10 Elliot traps (small mammal traps) were set at approximate even intervals in moist closed forest north of Bill Hill Rd, chainage 11000, for a period of one night. On 17 February 2015 a trap line was set south of Cooperabung Creek. A total of ten Elliot traps were set at random throughout habitat for a period of one night.

A koala trap was used as required. The koala trap was based on Phillips (2011) and included a corflute pen positioned around the occupied tree with a large cage trap fitted into a hole in the fence (Plate 3). A protocol was developed to deal with koalas recorded in the clearing area (Appendix A). The adopted protocol differs slightly to the method proposed in the EMP. The main difference was that a pen trap was installed immediately upon identifying a koala during spotlighting rather than leaving the individual to move, potentially to another tree in the clearing limit. This approach was preferred due to concern about relocating the koala the following day. There is a high likelihood that a koala identified at night would move prior to the morning pre-clear survey and relocating that individual in tall forest with a dense shrub layer during daylight would be difficult. Due to concern about an increased risk of mortality if an identified individual was left to move elsewhere within the clearing limit it was decided to control the situation and minimise the risk of mortality. The method proposed in the EMP relies on relocating a koala during the morning preclear and installing a 50m buffer around the occupied tree. A pen trap would then be installed if the koala does not vacate the area. The EMP does not specify the time between the initial observation and installation of the pen trap.

Plate 3: Koala trap installed around a tallowwood occupied by a female koala on 19 January 2015.

2.1.7 Microchiropteran bats

Structures identified in the Microbat Management Strategy (Lewis 2013dc) were inspected in September 2014. The methods used to inspect culverts and exclude roosting microbats are summarised in a letter report submitted to Lend Lease Engineering in November 2014 (Appendix B). Periodic inspection of exclusion devices in accessible culverts, such as at Barry's Creek, was undertaken throughout the clearing phase. Pipe culverts along the Cooperabung Range were inspected daily whilst clearing was occurring nearby. Several of these culverts were occupied intermittently by between 1 and 3 eastern horseshoe bat (Rhinolophus megaphyllus). Exclusion of horseshoe bats was ineffective due to their habit of hanging on imperfections in the concrete pipe. As a consequence, an inspect and observe method was adopted whereby pipes were inspected for roosting or dead bats during morning preclear surveys. No sites required seasonal limitation of clearing and grubbing as per the Microbat Management Strategy (Lewis 2013c).

2.1.8 Habitat tree inspections

Habitat trees were left in-situ for a minimum of 48 hours (2 nights) after surrounding vegetation had been cleared. In some instances the retention period was longer due to weather, equipment breakdown or clearing logistics. In some cases trees containing dreys and nests were removed immediately or after one night. Retention of these trees for longer periods either has no benefit as animals cannot leave (i.e. nests) or increases the risk of injury (i.e. dreys). Common ringtail possums (*Pseudocheirus peregrinus*) will often leave dreys during the first stage of clearing, moving into vegetation to be cleared where they are at risk of injury. In addition, dreys are often situated in the shrub-layer and can be difficult for operators to see and clear around. Removing dreys at the start of clearing, particularly early in the morning, reduces the risk of injuring fauna.

The majority of HBTs were felled carefully using a harvester, although a small number of trees, mainly in creek lines, close to the existing highway, on the boundary, or within narrow service corridors were felled by chainsaw. Immediately prior to felling each HBT was inspected visually and the preferred fall direction discussed with the machine operator.

During the initial inspection the location of major hollows was noted to enable quicker detection once the tree was felled. HBT's were felled in a careful manner with specific attention given to the direction of fall in relation to visible hollows, topography and ground debris. Where possible, trees were felled on the side without hollows, upslope, away from windrows and uneven ground.

The clearing method varied between contractors depending on operator skill and equipment capability. In most cases small and medium sized trees were cut near the base and placed on the ground, or the tree was pushed with the root bole intact and lowered to the ground. Large trees were felled with the root bole intact.

Once felled, two ecologists carefully inspected each HBT. All trunk and branch hollows and broken hollow limbs were inspected using a hand-held LED torch and/or a bore scope. Trees were rolled over to expose buried hollows, and branches were cut off to enable closer inspection or set aside for further trimming with a hand-held chainsaw. Inspection time varied depending on tree size and hollow number and ranged from 5-20 minutes. Information collected on each HBT included:

- Date and personnel;
- Tree number and species;
- Number, type (branch, trunk, spout, fissures) and size (small 2-5cm; medium 5-15cm, large 15-30cm; very large >30cm) of hollows;
- Species and number of individuals present;
- Evidence of previous use; and
- If fauna were detected the fate of captured individuals.

Evidence of previous use by fauna was based on the presence of:

- Leaf nest;
- Feathers, scats, fur, eggs or egg shell;
- Wear or chew marks at the hollow entrance.

The shape and size of nesting material, the size of the entrance hole, type of tree and animal signs (i.e. fur, feathers, scats) were used to determine which species might have used the hollow.

Fauna were either left in hollows (by temporarily sealing openings or captured and placed in cotton bags or a cat cage). Frogs were housed individually in plastic clip-seal bags with a small amount of water and leaf litter. Hollows containing fauna were plugged with a cotton bag and placed between the LoC and project boundary (Plate 4). Fauna were only left in-situ if they were uninjured, if the tree could be left undisturbed and if there was minimal activity nearby. Hollows were unplugged at dusk and re-inspected the following morning. In cases

where there was no adjoining forest to place hollows in or animal/s were suspected of being injured a hand-held chainsaw was used to trim retained sections of tree to enable extraction of fauna. Captured fauna and occupied hollows were placed into the adjoining forest, or the closest area of suitable forest (i.e. appropriate area and habitat type for the subject species) within 100m of the LoC boundary. All gliders were transferred to nest boxes, which were installed temporarily in habitat to the point of capture (Plate 5). Nest boxes were inspected the following day and removed if there was no sign of continued use. Reptiles were placed on trees with decorticating bark and hollows or in piles of logs where there was good refuge habitat. Insectivorous bats were released at dusk near their point of capture and frogs were released on drainage lines or at dams. The maximum distance between point of capture and point of release was 150m and most individuals were released immediately adjacent to their point of capture.

Plate 4: Section of tree with a hollow occupied by two sugar gliders being moved outside the LoC. The hollow (centre of log) is plugged with a cotton bag.

Plate 5: Sugar gliders settled into nest boxes after being after being removed from habitat trees.

2.2 Aquatic fauna

2.2.1 Locations

To the authors knowledge fish translocations occurred at all locations along the OH2K upgrade where existing water bodies had to be dewatered completely to facilitate construction activities such as creek diversions, culvert and bridge construction and infilling of farm dams. There were nine such locations; they are listed in Table 1 along with the dates of fish translocation.

Table 1: Locations of the capture and release points for fish translocation along the OH2K upgrade.

Date	Waterway	Chainage	Capture Location (GDA94)	Release Location (GDA94)
10/12/2015	Compound Dam	6950	56J482412, UTM6525860	56J483064, UTM6525648
11/12/2015	Compound Dam	6950	56J482412, UTM6525860	56J483064, UTM6525648
6/02/2015	Gate L26 Dam	20150	56J482572, UTM6538386	56J482273, UTM6538707
6/03/2015	Haydon's Wharf Rd Unnamed Creek	18250	56J483079, UTM6536595	56J482961, UTM65366174
6/03/2015	Haydon's Wharf Rd Southern Dam	17900	56J483037, UTM6536225	56J482961, UTM65366174
9/03/2015	Haydon's Wharf Rd Unnamed Creek	18250	56J483079, UTM6536595	56J482961, UTM65366174
18/03/2015	Wakeboard Dam	18200	56J483111, UTM6536501	56J482961, UTM65366174
22/04/2015	Salvinia Dam	17100	56J482830, UTM6535478	56J482799, UTM6535450
29/04/2015	Haydon's Wharf Rd Northern Dam	18100	56J4831217, UTM6536400	56J482961, UTM65366174
7/07/2015	4400 Dam	4400	56J483233, UTM6523454	56J483296, UTM6523678

2.2.2 Capture

Fish and other aquatic fauna were captured using a mixture of backpack electrofishing, seine net deployment and/or dip netting. The specific methods employed at each site are listed in Table 2.

Table 2: Capture methods employed at each of the fish translocation locations.

Date	Waterway	Chainage	Methods	Comments
10/12/2015	Compound Dam	6950	Seine Net	Large quantities of sediment disturbed during seine net deployment.
11/12/2015	Compound Dam	6950	Seine Net	
6/02/2015	Gate L26 Dam	20150	Dip Net	Captures occurred as water level receded and then subsequently as water was released from the dam into a constructed channel
6/03/2015	Haydon's Wharf Rd Unnamed Creek	18250	Electrofisher (125V, 40Hz) and Dipnet	Numerous deep holes requiring continued pumping to facilitate capture.
6/03/2015	Haydon's Wharf Rd Southern Dam	17900	Seine Net	Very smooth, even benthic surface.
9/03/2015	Haydon's Wharf Rd Unnamed Creek	18250	Electrofisher (125V, 40Hz) and Dipnet	Numerous deep holes requiring continued pumping to facilitate capture.
18/03/2015	Wakeboard Dam	18200	Dipnet and Seine Net	Seine net deployed with difficulty in the upstream sections, then changed to the dipnet for the remainder.
22/04/2015	Salvinia Dam	17100	Electrofisher (250 V, 30 – 50 Hz) and Dipnet	Capture and release points both full of Salvinia (Salvinia molesta),
29/04/2015	Haydon's Wharf Rd Northern Dam	18100	Dipnet and Seine Net	
7/07/2015	4400 Dam	4400	Electrofisher (350 V, 30 – 50 Hz) and Dipnet	Lots of debris, high TSS and algal concentrations, seine net deployment not possible.

Fish capture was generally delayed until the dewatering had progressed to the point where fish capture was judged to be most effective without causing undue distress to aquatic fauna. This approach allows an increased efficiency of fish capture while minimising the amount of dirty water created; fish capture activities tend to significantly increase the suspended sediment concentrations in the water as benthic material is disturbed by almost all of the fishing methods employed. An aquatic ecologist was usually present once dewatering had progressed to the point where the maximum water depth was approximately 1 m and supervised pumping from that point on. When fish capture commenced every effort was made to complete them in the minimum time to avoid long periods where aquatic fauna were exposed to low water levels, which increase their susceptibility to temperature fluctuations, increased suspended sediment concentrations, decreased dissolved oxygen concentrations, reduced habitat availability, increased fauna densities and resulting increases in predator/prey interactions.

2.2.3 Backpack Electrofishing

The backpack electrofisher was employed as the chief method of capture where debris in the water column and the benthic surface excluded the use of other nets. In general the settings were adjusted to utilise the lowest possible voltage to effectively stun fish and the most appropriate frequency to effectively stun the

majority of fish present in any particular waterway. This tends to mean lower voltages in smaller volumes of water or higher salinities and lower frequencies when targeting larger bodied fish such as eels. The voltage settings of the backpack electrofisher utilised were between 150 V and 350 V and the frequency setting were adjusted between 30 and 50 Hz. During backpack electrofishing the fish are stunned by the electrofishing operator and collected by a second member of the ecology team using a dipnet (5 mm woven mesh). The backpack electrofisher cannot be used in circumstances where the maximum water depth exceeds 1m due to safety concerns. Captured fish were held temporarily in a half filled 20 L bucket and transferred intermittently into 50 L nelly bins, filled with water from the immediate site and aerated with battery powered pumps.

2.2.4 Seine Netting

The seine net was utilised in broad areas of shallow water where the water column and benthic surface where relatively free of debris, and the benthic surface was firm and smooth. Seine netting is an effective way of collecting large numbers of fish quickly but can lead to larger numbers of fish perishing as a result of capture. The seine net used was 10 m long, 2 m deep and constructed of 5 mm woven mesh. In general it was deployed repeatedly until the ratio of capture to effort became very low or zero. In waterbodies with high numbers of visible mosquito fish (*Gambusia holbrooki*) an effort was made to deploy the seine net through the top 10 - 20 cm of the water column to capture the majority of the mosquito fish prior to disturbing the benthic material and further targeting native fish. This was done to minimise the amount of time spent sorting Mosquitofish from native fish, a process which can be time consuming and cause undue stress to all captured organisms as they need to be held in captivity for longer periods. The aims of this approach were achieved with varying levels of success, usually depending upon the depth of water at the time of fish capture, the numbers of firetail gudgeons (*Hypseleotris galii*) present and/or the terrain surrounding the waterbody in question. After each deployment of the seine net the captured fish were transferred into 50 L nelly bins, filled with water from the immediate site and aerated with battery powered pumps.

2.2.5 Dip Netting

The dip net was utilised in situations where very little water remained after pumping, where it was not safe to employ the backpack electrofisher and not possible to use the seine net, where water was running through a channel carrying aquatic fauna and/or during backpack electrofishing. The dipnets used were constructed of 5 mm woven mesh with and opening approximately 60 cm x 50 cm. Captured fish were held temporarily in a half filled 20 L bucket and transferred intermittently into 50 L nelly bins, filled with water from the immediate site and aerated with battery powered pumps.

2.2.6 Holding, Transport and Release

Captured aquatic fauna were held in 50 L nelly bins, filled with water from the immediate site and aerated with battery powered pumps. The nelly bins were stocked at a density of less than 5% (kg fish/L water). Fish were separated by size to avoid predation of smaller fish by larger fish. Holding times were generally less than 1 hour. Fish were transported by hand or light vehicle from the place of capture to the release point at regular intervals to avoid overcrowding of holding tanks and long holding periods.

Release points that best resembled the capture point in terms of water quality and habitat were chosen within the immediate catchment area. Where water quality did not closely resemble the measurements collected at the release point in terms of temperature, pH and conductivity water from the release point was gradually mixed in to the holding tanks to avoid shock. Non-native fish were separated out and euthanased in an ice slurry during the process of releasing native fish. At the release point all native fauna were identified, counted and observed as they swam away. Perished native fish and euthanased non-native fish were buried on-site.

2.3 Stage 2 nest box assessment

The NBPoM specifies (Section 7.1, page 23) that "The contractor will install 60% of the nominated nest boxes prior to or during the clearing works with the objective of providing temporal refuge habitat for those hollow dependent fauna displaced during clearing operations. The remaining 40% of nest boxes will be installed by the contractor once a final tally of functional tree hollows has been compiled and reviewed as a result of the data collected during the clearing supervision. Occupancy rates of tree hollows during the clearing supervision will also facilitate the final number and types of nest boxes being installed."

The NBPoM specifies (section 4, page 12) that "The final (i.e. second stage) will be an appraisal once the clearing works have been completed and a final tally of the actual numbers of hollow bearing trees and tree hollows has been tallied based on the detailed design (numerical data substituted back into the formulas provided below). At this point in time the nest box plan will be updated to reflect the final number of nest boxes required and re submitted to the EPA for approval."

The formula referred to above is:

Density of HBT/ha * Mean number of functional hollows/HBT * correction factor (20% or 1.2).

To obtain the necessary data for input into the nest box equation the number of Hollow Bearing Trees (HBT)/hectare (ha) and the number of functional hollows/HBT for each nest box zone was calculated. Data were combined for nest box zones that occurred on opposite sides of the alignment such as zones A and B, C and D and O and P. It was necessary to combine adjacent zones as the recording of HBT data did not distinguish between east and west sides of the alignment. Data were sourced for each nest box zone from clearing records and Lend Lease Engineering calculated the area cleared/zone. A 200m buffer was added to each zone to account for any inaccuracies in recording the location of HBT during clearing. This means that the calculated HBT/ha overestimates the actual number of HBT in each zone and the calculation of nest boxes required is therefore conservative. Other data relevant to the assessment were also calculated, including: total number of habitat trees inspected, number of HBT, area cleared (ha), number of functional hollows, other types of hollows and the number of hollows with evidence of use.

3. Results

3.1 Threatened Fauna

Twelve threatened species were recorded during the clearing phase (Table 3). All 12 species are listed on the NSW *Threatened Species Conservation (TSC) Act 1995* and three are also listed on the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* (Table 1). Koala (or evidence of) was recorded on five occasions during clearing. Three records were of road-killed individuals, two near Yarrabee Road and one near Sancrox Road. One individual was recorded in the clearing zone north of Bill Hill Road and scats were recorded beneath a Swamp Mahogany south of Bill Hill Road (refer 3.2.1).

Grey-headed flying-fox were recorded throughout the alignment with consistent records during the clearing phase. No grey-headed flying-foxes were recorded roosting in the alignment. A camp of black flying-fox (Pteropus alecto) was recorded on Dalhunty Island west of the upgrade corridor on 8 December 2014. The camp was surveyed on several occasions between 8 December 2014 and 15 January 2015 to determine if grey-headed flying-foxes were present. The peak count was 238 black flying-fox on 15 January 2015. No grey-headed flying-fox were recorded at the camp.

Glossy black cockatoo were recorded at three sites, Sancrox Road, Cooperabung Creek and Barry's Creek. A (probable) little eagle was observed roosting within the alignment south of the Blackmans Point interchange on 25 November 2015 and individuals were recorded flying over the highway between Blackmans Point Road and Bill Hill Road in December 2014 and January 2015. An arborist removed the little eagle nest at chainage 10875 on 24 July 2014 (Appendix C). Masked owls were recorded on five occasions. Owls were heard calling north of Mahogany Road (6/1/15) and north of Bill Hill Road (9 & 11/3/15) and two road-killed individuals were recorded on the existing highway south of the Wilson River bridge on 4 and 11 May 2015. A flock of 10 varied sitella was recorded foraging in mixed eucalypt forest west of Yarrabee Road on 14 January 2015.

Table 3: Threatened species recorded during and immediately after the clearing phase. V = vulnerable, E = endangered.

Species Name	Common Name	Status		No. Ind; No. Sites; Comments
		NSW	C'Wealth	
Litoria brevipalmata	Green-thighed Frog	V		2 ind; Males calling at East Rd 150m north of Blackmans Point Rd.
Mixophyes iteratus	Giant Barred Frog	E	E	8 ind; 2 on alignment Cooperabung Ck, 6 east of alignment Cooperabung Ck.
Hieraaetus morphnoides	Little Eagle	V		1 ind; Roosting in *E. pilularis* south of Wharf Rd; recorded in November and December 2014 flying over highway in Blackmans Point Road area.
Pandion cristatus	Eastern Osprey	V		2 individuals recorded foraging in Dalhunty Channel (Wilson River) west of alignment.
Tyto novaehollandiae	Masked Owl	V		4 ind; Two road killed 100m and 200m south of Wilson River; one calling near Mahogany Road and one calling north Bill Hill Road.
Calyptorhynchus lathami	Glossy-black Cockatoo	V		8 ind; 2 feeding in Allocasuarina sp. Sancrox Rd; 5 flying over Cooperabung Ck; 1 flying over Barry's Ck.
Daphoenositta chrysoptera	Varied Sitella	V		~10 individuals in feeding flock north of Cooperabung Range.
Phascolarctos cinereus	Koala	V	V	5 ind; 2 road kill sites; 1 scat recorded under swamp mahogany sth Bill Hill Road, 1 Bill Hill Rd spotlighting.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Recorded throughout the alignment during entire clearing phase.
Maundia triglochinoides	Maundia	V		>100 ind; 1 site with newly emergent plants approx. 0.05ha (ch 3750); Abundant at Fernbank Creek.
Petaurus norfolcensis	Squirrel Glider	V		Recorded during spotlight surveys foraging north of Haydon's Wharf Rd. Ch 17550.
Dasyurus maculatus	Spotted-tailed Quoll	V		Roadkill individual recorded on date 5.7.15, Cooperbung Creek.

3.1.1 Threatened frog surveys

Threatened frog surveys were conducted at five locations within the OH2K alignment (Tables 4 and 5). Giant barred frogs were targeted at two sites on Cooperabung Creek and green-thighed frogs at three sites, north of Blackmans Point Road, north of Bill Hill Road and Barry's Creek.

Giant barred frogs were recorded at both sites on Cooperabung Creek (Plate 6). Up to six male frogs were recorded over a 50m section of creek at Cooperabung Creek south (chainage 18950 E 483087; N 6537284) and two individuals, one male and one female, were recorded at Cooperabung Creek north (chainage 19660 E 0482781; N 6537974). The project boundary fence and location of temporary frog fence at Cooperabung Creek

south was moved outside the riparian zone to avoid impacts on giant barred frog habitat and all individuals recorded at that site were outside the (adjusted) project boundary fence and therefore were not captured or processed. Two giant barred frogs were captured within the LoC at Cooperabung Creek north, one adult male and one adult female. Both individuals had been previously PIT (Passive Integrated Transponder) tagged. The adult male was initially captured on 11 February 2015, released on 12 February 2015 and recaptured within the LoC on 15 February 2015. A (probable) adult female was observed outside the temporary frog fence on 13 February 15 and left insitu. An adult female was captured within the LoC on 16 February 2015. The adult male and female captured on 15 and 16 February 2015 were held in separate aquaria for two and three nights respectively until substantive clearing of riparian habitat had been completed. Both individuals were released alive and in good health on 18 February 2015. No giant barred frog tadpoles were captured during targeted dip-netting at Cooperabung Creek north.

Plate 6: Male giant barred frog (Mixophyes iteratus) recorded outside the alignment at Cooperabung Creek.

Table 4: Timing and results of giant barred frog surveys conducted during the clearing phase of the OH2K upgrade. M = male; F = female; J = juvenile.

Site	Survey Date	Duration (minutes)	Personnel	No. Individuals & (Sex)	Comment
Cooperabung Creek sth (Ch 18900)	5/2/15	NR	2	3 (M)	Outside boundary – not captured
	7/2/15	45	2	3 (M)	Outside boundary – not captured
	9/2/15	80	1	6 (M)	Outside boundary – not captured
	5/3/15	50	2	3 (2M; 1J)	Outside boundary – not captured
Cooperabung Creek nth (Ch 19660)	19/11/14	50	2	0	Temporary fence on north side
	20/11/14	28	3	0	
	23/11/14	30	2	0	North of creek
	8/12/14	40	3	0	
	14/12/14	25	3	0	
	15/12/14	60	2	0	
	16/12/14	20	2	0	North of creek
	29/1/15	60	2	0	
	11/2/15	70	3	1 (M)	SV- 74mm; 55gr; adult; released 100m upstream boundary
	13/2/15	60	2	1 (F)	Outside frog fence - not captured
	15/2/15	60	3	1 (M)	Recapture; same frog as 11/2/15; held for three nights until site cleared; released 150m upstream of boundary.
	16/2/15	65	3	1 (F)	SV – 95mm; 120gr; held for two nights until site cleared; released 150m upstream of boundary
	17/2/15	30	2	0	
	26/2/15	60	2	0	
	27/2/15	45	2	0	
	4/3/15	30	2	0	
	9/3/15	24	2	0	
	10/3/15	15	2	0	

Clearing, at Cooperabung Creek north, in late February and early March 2015 was limited to minor excavation and rock placement for a drill rig and installation of temporary exclusion fence on the eastern side of the existing highway.

Twenty-two targeted surveys for giant barred frogs were conducted at the two sample sites between 19 November 2014 and 10 March 2015, including 18 at Cooperabung Creek north. Clearing was undertaken in stages, mid-November and December 2014, mid and late February 2015 and late March 2015. Despite Barrys Creek being described as unsuitable for giant barred frogs (Section 2.2.2, OH2K Giant Barred Frog Strategy, Lewis 2013), targeted surveys were carried out on two occasions and during nocturnal pre-clear surveys.

Green-thighed frogs were recorded at one site following the January 2015 rainfall event. Targeted (nocturnal) green thighed frog surveys were conducted on three non-consecutive nights at Blackmans Point Road and Bill Hill Road in mid-late January 2015 (Table 5). On 22 January 2015 two male frogs were recorded at an ephemeral pond outside the project boundary near East Road (approx. chainage 9000), north of Blackmans Point Road (E: 481840 N: 6527853) (Plate 7). Other frog species present in the area were *Litoria dentata, Limnodynastes peronii, Litoria gracilenta* and *Crinia signifera*.

Plate 7: Adult male green-thighed frog (Litoria brevipalmata) recorded near east Road, north of Blackmans Point Road on 22 January 2015.

Table 5: Timing and results of green-thighed frog surveys conducted during the clearing phase of the OH2K upgrade.

Site	Survey Date	Duration (minutes)	Personnel	No. Individuals & (Sex)	Comment
Blackmans Point Rd/East Rd area	22/1/15	75	2	2 (M)	Survey occurred during heavy rain.
	27/1/15	60	2	0	Survey followed a week of consistent rain
	28/1/15	60	2	0	Survey followed a week of consistent rain
Bill Hill Road area	19/1/15	Nr	2	0	Survey occurred during heavy rain.
	21/1/15	135	2	0	Survey occurred during heavy rain.
	27/1/15	90	2	0	Survey followed a week of consistent rain
	9/3/15	25	1	0	
Barry's Creek	9/12/14	20	1	0	
	29/1/15	60	2	0	Survey followed a week of consistent rain

3.2 Spotlighting

A total of 186 spotlight surveys were conducted between 2nd November 2014 and 21 August 2015 (Table D1, Appendix D). During spotlight surveys 309 records of 51 species were made, including 18 species of frog, five reptiles, 19 mammals and seven birds (Table 6). One introduced species; black rat (Rattus rattus) was recorded. Threatened species recorded during spotlight surveys included; Koala, Grey-headed Flying-Fox, Masked Owl, Giant-barred Frog, Green-thighed Frog and Little Eagle. During spotlighting, 29 vertebrates from 17 species were captured and relocated from the clearing front. Of these, 19 individuals were frogs removed from dams, sedge swamps and drainage lines (Table 6).

Table 6: Species of vertebrate captured during pre-clearing and spotlighting surveys for the Oxley Highway to Kundabung Pacific Highway upgrade. ^{V} = Listed as vulnerable by the NSW *Threatened species Conservation Act 1995*. Note: does not include deceased or euthanized; ** introduced species.

Species Name	Common Name	Preclearing & Trapping (No. relocated)	Spotlighting (No. relocated)	Giant Barred Frog Surveys	Targeted Frog Surveys	Incidental
Adelotus brevis	Tusked Frog		x(1)			
Crinia spp.			x			
Limnodynastes peronii	Stripped Marsh Frog		x(4)	x(1)		
Litoria brevipalmata	Green-thighed Frog^{V}		x			
Litoria caerulea	Common green tree frog		x			
Litoria dentata	Bleating Tree Frog		x(1)			
Litoria dentata tadpoles		x(170)				
Litoria fallax	Easter Dwarf Tree Frog	x(1)	x(5)			
Litoria gracilenta	Dainty Green Tree Frog		x		x(1)	
Litoria latopalmata	Broad-palmed Frog		x			
Litoria nasuta	Striped Rocket Frog		x(2)	x(1)		
Litoria peronii	Peron's Tree Frog		x(2)			
Litoria revelata	Whirring Tree Frog					x(1)
Litoria tyleri	Tyler's Tree Frog		x(2)			
Mixophyes iteratus	Giant Barred Frog ^{V}		x	x(8)		
Pseudophryne coriacea	Red-backed Toadlet		x(1)			
Pseudophryne spp.		x(1)	x			
Uperoleia fusca	Dusky Toadlet		x			
Uperoleia laevigata	Smooth Toadlet		x			
Uperoleia spp.			x(1)			
Hemiaspis signata	Black bellied Swamp Snake	x(2)		x(1)		x(1)
Lampropholis delicata	Garden Skink	x(8)		x(5)		x(1)
Amphibolurus muricatus	Jacky Lizard		x(1)			
Cacophis krefftii	Southern Dwarf Crowned	x(2)	x(1)			
Dendrelaphis punctulata	Common Tree Snake					
Egernia mcpheei	Eastern Crevice Skink	x(1)				
Fossorial Skink spp.		x(3)				
Hemisphaeriodon gerrardii	Pink Tongue Lizard		x(1)			
Lampropholis amicula	Friendly Sun Skink			x(1)		
Ramphotyphlops nigrescens	Blackish Blind Snake	x(5)				x(15)
Rhinoplocephalus nigrescens	Eastern Small-eyed Snake	x(3)	x(1)			
Saiphos equalis	Yellow-bellied Three-toed skink	x(1)				
Saproscincus oriarus	Heath Shadeskink			x(1)		

Tiliqua scincoides	Blue Tongue Lizard						x(2)
Vermicella annulata	Bandy Bandy		x(1)				
Demansia psammophis	Yellow Faced Whip Snake	x(1)					
Acrobates spp.	Feathertail glider		x				
Antechinus spp.		x(3)	x				
Antechinus stuartii	Brown Antechinus	x	x				
Macropus giganteus	Eastern Grey Kangaroo		x				
Macropus rufogriseus	Red-necked Wallaby		x				
Macropod spp.			x				
Micro-bat spp.			x				
Perameles nasuta	Long-nosed Bandicoot		x				
Petaurus breviceps	Sugar Glider		x				x(1)
Petaurus spp.			x				
Phascolarctos cinereus	Koala[V]		x(1)				
Pseudocheirus peregrinus	Common Ringtail Possum		x				x(1)
Pteropus poliocephalus	Grey-headed Flying Fox		x				
Pteropus spp.	Flying Fox		x				
Rattus fuscipes	Bush Rat	x(4)					
Rodentia spp.	Rodent		x				
Tachyglossus aculeatus	Echidna	x(1)	x(1)				x(1)
Trichosurus caninus	Short-eared Brushtail Possum		x				
Trichosurus vulpecula	Common Brushtail Possum		x				
Wallabia bicolor	Swamp Wallaby		x				
Aegotheles cristatus	Owlet-nightjar		x				
Cacomantis variolosus	Brush Cuckoo		x				
Dacelo novaeguiineae	Kookaburra						x(1)
Eurostopodus mystacalis	White-throated Nightjar						
Hieraaetus morphnoides	Little Eagle (po)[V]		x				
Philemon corniculatus	Noisy Friarbird		x				
Podargus strigoides	Tawny Frogmouth		x				x(1)
Tyto alba	Barn Owl		x				
Tyto novaehollandiae	Masked Owl[V]		x				
	Freshwater Crayfish spp.		x(3)				
Rattus rattus	Black Rat **	x	x				

3.2.1 Koala Capture and Relocation

One Koala was detected during nightly spotlight surveys on 19 January 2015. The individual was located in a large tallowwood at chainage 11850 (E: 481423 N: 6530439), approximately 300m north of Bill Hill Rd in Cairncross State Forest. The OH2K Koala Protocol was implemented and the individual was trapped at approximately 4.30am the following morning.

After an initial inspection, by the project ecology team, it was noted the right eye had partial clouding. This was sufficient to warrant transferring the animal to the Port Macquarie Koala Hospital for further assessment. The animal was a 7-8 year old female carrying no joeys but with evidence of previous breeding. After consultation with vets at the hospital the clouding of the right eye was deemed to be corneal scarring from a previous injury. Other than the aforementioned injury, vets thought the animal was of healthy weight and condition.

The koala was held for an extra week due to a small injury sustained whilst in care. Following discussions within the project team and senior management at the Koala Hospital and reconnaissance for a suitable release site it was agreed that Rawdon Creek Nature Reserve, on the western side of the existing highway, was the most suitable release site. This was deemed to be within the animals home range and safer from the impacts of logging, ongoing clearing and vehicle movement than forest adjoining the upgrade. The release occurred at approximately 11am on 3 February 2015. The animal was released onto a Tallowwood tree, which is a primary feed tree species and the same species occupied when the individual was captured (Plate 8). The GPS coordinates for the release site were: E: 480226 N: 6529946.

Plate 8: Female koala being released onto a tallowwood (Eucalyptus microcorys) after treatment at the Port Macquarie Koala hospital.

3.3 Pre-clearing surveys and trapping

A total of 376 pre-clearing surveys were undertaken between 3 November 2014 and 7 September 2015 (Table D2, Appendix D). Pre-clearing surveys prior to the commencement of spotlighting were for minor clearing work. Sixteen species were recorded during the surveys, including three frog, nine reptile and four mammal species (Table 4). Seventeen species and 206 individuals, including 170 *Litoria dentata* tadpoles, were captured and relocated. A further 180 Litoria peroni and 405 striped marsh frog tadopoles were relocated during aquatic fauna surveys. Trapping results included: one bush rat (Rattus fuscipes) captured north of Bill Hill Road; and two bush rats, two black rats (Rattus rattus) and one brown antechinus (Antechinus stuartii) at Cooperabung Creek. The bush rats and brown antechinus' were relocated outside clearing area and two Black Rats were euthanised in accordance with Sandpiper's DPI AC&E licence.

3.2 Habitat tree removal

3.2.1 Habitat resource survey

A total of 468 Hollow-bearing Trees (HBT) were marked during the habitat resource surveys. This included trees marked during the initial survey (Lewis 2013d) and additional trees marked during the habitat resource survey and pre-clear surveys.

3.2.2 Hollow characteristics and species recorded

During clearing of the OH2K alignment, 443 habitat trees were inspected, of which 310 (70%) contained 738 hollows (Table 7). Small branch hollows were most abundant (243) followed by medium branch (229), medium trunk (60), small trunk (56), large trunk (46), large branch (45), large spout (25), medium spout (22), very large spout (4) very large trunk (4), very large branch (3), and small spout (1) (Table 5). Inspected trees also contained 11 nests (6 stick nests, 5 cup nests), 64 termitaria (with hollows) and 19 dreys. Fifteen (15) trees had native beehives and five (5) had European beehives. A further six trees contained fissures and one (1) had decorticating bark. A total of 62 trees were occupied by vertebrate fauna and a further 91 trees displayed evidence of use. Of the 310 trees with hollows 153 (49.3%) were occupied or showed evidence of use by vertebrate fauna. The higher quality hollows removed from HBTs were placed into low conservation value retained vegetation to act as habitat for small ground dwelling and scansorial fauna.

A total of 125 individuals and 28 species were captured during HBT removal (Table 7, Plates 9-20). Species richness was comprised of seven mammal (25% of total species), 10 reptile (36%), four bird (14%) and seven frog (25%) species. The most commonly captured fauna were tree skinks (43 individuals, 3 species), tree frogs (19 individuals, 7 species), sacred kingfisher (13 individuals + 12 eggs), sugar gliders (13 individuals), feathertail glider (13 individuals), brown antechinus (7 individuals) as well as four tree snakes of two species (coastal carpet python and common green tree snake), and four large possums of two species (common brushtail possum and common ringtail possum). None hollow dependent species recorded during HBT inspections were small-eyed snake (Cryptophis nigrescens; 1 ind), blackish blind snake (Ramphotyphlops nigrescens; 5 ind) and *Lampropholis* spp. (1 ind). *R. nigrescens* was often recorded in the root-ball of trees, particularly stags.

The largest number of individuals was removed from stags (34 individuals), followed by tallowwood (24 individuals + 11 eggs), coastal blackbutt (29), small-fruited grey gum (14) and red mahogany (9). The tree species with the highest proportion of active hollows was small-fruited grey gum (57%), followed by white stringybark (47%), pink bloodwood (45%), coastal blackbutt (40%) and stag (35%). *Acacia longifolia, Melaleuca styphelioides,* and *Callistemon spp.* had an activity rating of 100%. This is attributed to the confirmed presence of dreys prior to tree felling.

Table 7: Results of Hollow Bearing Tree inspections conducted during the clearing phase of the Oxley to Kundabung Pacific Highway upgrade. *A hollow was considered viable if it was >1cm in diameter and 10cm deep; S = small; M = medium; L = large; VL = very large; Term = termitaria; Fis = fissure; E = epiphyte, CN = cup nest; SN = stick nest; PN = passerine nest; NB = native bee hive; EB = European bee hive; D = drey; De = decorticating bark; Basal = basal.

Tree Type	No. Inspected	No. trees with hollows (%)	Hollow Type								Spout	Other	No. Active HBT	No. HBT with evidence	No. Individuals & Species
			Branch				Trunk								
			S	M	L	VL	S	M	L	VL					
Blackbutt	72	55(76)	52	53	8		3	3	10		1m, 2l	D1, NB3, Fis2, EB2, Term1, SN1	19	10	lace monitor (2), *Eulamprus spp.* (5), sugar glider (9), tawny frogmouth (2), sacred kingfisher nestlings (4)*Litoria peronii* (4), green tree snake (1), small-eyed snake
Pink Bloodwood	11	7(64)	10	6	4				1			Term2, D1,	3	2	*Eulamprus tenuis* (1), microbat sp. (1),
Red Bloodwood	8	5(62)	5	1				3				NB1, Term1		1	
Bloodwood spp.	12	10(83)	10	14	8		1	2				PN1, Term2	2	3	Unid. Bird chicks(2)
White stringybark	32	27(84)	19	17	3		1	5	1		1vl, 4l, 1m	Term4, D2, EB 1, NB1, Basal 1, Fis 2	6	9	Feathertail glider (1), sugar glider (3), *Eulamprus tenuis* (1*), Litoria dentata*, pink tongue lizard (1)
Tallowwood	55	37 (67)	30	38	5	2	3	2	5		3m, 1l	Term 34, CN 1, NB 2	4	13	Sacred kingfisher chick (5), feathertail glider (2), sacred kingfisher eggs (4), *Litoria peronii* (1), sacred kingfisher nestlings (4), lace monitor eggs (7), sugar glider (1), *Litoria tyleri* (1), *Litoria dentata* (1), *Eulamprus tenuis* (3), common brushtail possum (1), blackish blind snake (1)
Melaleuca nodosa	6	5(83)	4	1			2	3					2		*Litoria fallax* (1), *Litoria dentata* (1)
Melaleuca quinquenervia	9	6(67)	2	1			5	4	2			D1,		1	
Melaleuca styphelioides	1											D1		1	

Melaleuca spp.	7	4(57)	2				1					SN1, D1, Term2	2	*Litoria peronii* (1)
Stag	117	92(79)	48	65	11	1	31	17	11	3	1vl, 18l, 17m, 1s	Fis2, NB1, Basal2, Term4, NB5, EB1, E1	10	31	*Eulamprus spp*.(9), antechinus spp. (7) - pinkies (5), blackish blind snake (2), *Lampropholis sp*. (1), feathertail glider spp. (5), brushtail possum (1), green tree snake (2), *Litoria tyleri* (1), *Egernia mcpheei* (1), microbat sp. (1), carpet python (1), *Litoria caerulea* (1), pink tongue lizard (2)
Eucalyptus spp.	5	2(40)	1	2				2	3			Term4	2		Bird eggs poss. king fisher sp. (4), *Eulamprus tenuis* (2)
White mahogany	6	5(83)	13	1	1			4	3			CN1	1		Noisy friarbird
Norfolk Island Pine	1											CN2	1		Figbird eggs (3)
Camphor laurel	1											D1			
Euc. stringybark spp.	15	7	10	2			1	4				D2, Term6, CN1, NB1	2	2	Feathertail glider spp. (2), noisy friarbird
Swamp she-oak	9	6(67)	3	2				1	3			De1	1		*Litoria gracilenta* (1)
Black she-oak	5											D4, CN1			Common ringtail possum (1), noisy friarbird (1)
Euc. Ironbark	2	2(100)	2									Term1	1	1	*Litoria spp*. (1)
Small fruited grey gum	7	5(71)	3	2				2	2		1vl	NB1	1	3	*Litoria peronii* (1), feathertail glider (2), *Eulamprus tenuis* (11)
Acacia spp.	1											D1			
Red Mahogany	32	16(50)	16	9	2		5	6	4	1		Term2	4	5	*Eulampris spp*. (4), blackish blind snake (1), feathertail glider den (1), *Litoria caerulea* (2), *Litoria gracilenta* (1)
Forest red gum	6	5(83)	1	6	2		2				1vl	EB1, Term1	1	2	
Flooded gum	5	3(60)	2	4	1							SN2		1	
Spotted Gum	3	1(33)	1												

Swamp mahogany	2	2(100)	5	2								EB1	1	1	*Eulamprus tenuis* (3)
Turpentine	4	3(75)	3	1								D1		1	
Brush box	1											D1		1	
Callistemon spp.	1											D1		1	
Acacia longifolia	1											D1	1		Common ringtail possum (1)
Water gum	2	2(100)	1	2			1	2							
Lophostemon sp.	1	1(100)							1						
Forest oak	1											SN1			
Tallowwood with nest boxes	2	2(100)													
Totals	443	310	243	229	45	3	56	60	46	4	53	64 term,19 Drey,15 NB,5 SN,5 EB,6 CN,3 Basal,6 Fis, 1 E.	62	91	

Plate 9: Feathertail glider captured from HBT.

Plate 10: Common ringtail possum relocated from drey in forest oak.

Plate 11: Juvenile (puggle) short-beaked echidna.

Plate 12: Juvenile sugar glider.

Plate 13: *Egernia mcpheii* relocated during preclear survey.

Plate 14: Bandy bandy relocated during spotlight surveys.

Plate 15: Pink tongue lizard relocated during spotlight surveys.

Plate 16: Southern dwarf crown snake relocated during spotlight surveys.

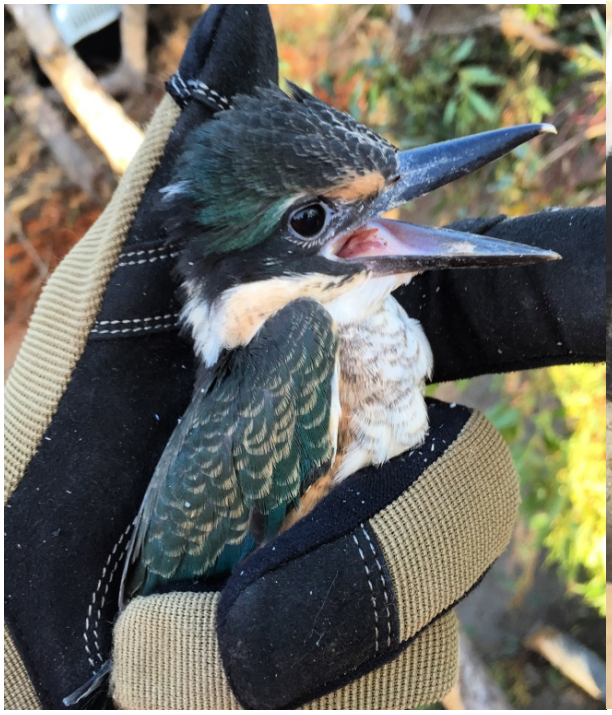


Plate 17: Sacred kingfisher fledgling.

Plate 18: Juvenile tawny frogmouth.

Plate 19: Brown Gerygone nest in clearing zone (chicks fledged).

Plate 20: Australian Figbird nest and eggs. Nest retained & chicks fledged.

3.2.2 Mortality

Twenty (20) individuals comprising 7 species died from 10 separate incidents during mainline clearing (Table 8, Appendix D). Eleven eggs of two species (sacred kingfisher and Australian figbird) were also euthanised. Five individuals, comprised of four species (list species), died during habitat tree removal and seven individuals, comprised of four species (list species) were found dead during general clearing. All deaths attributed to general clearing were of reptiles and frogs.

The number of individuals killed during HBT removal (5 individuals) was 4% of fauna relocated from HBT and made up 25% of total mortalities. The number of individuals found dead in either the previous days clearing area or on light vehicle access tracks (7 individuals) was 5.6% of fauna captured and 35% of total mortalities. The number of individuals euthanised (8) made up 6.4% of total fauna captured and 40% of the total mortalities. The total number of individuals killed or euthanised during the clearing phase (20 individuals out of 359 total) represents 5.5% of the fauna captured and relocated during all activities.

Table 8: Fauna mortality during the clearing phase of the OH2K Pacific Highway Upgrade.

Species & No.	Chainage	Location description	Injuries	Cause of death
Litoria nasuta x1	Ch 9600	On vehicle track	Crushed	Run over by light vehicle on access track
Figbird Eggs x3	Ch 5500	Cracked during tree removal	Cracked open	Euthanised
Sacred kingfisher eggs x 4	7200 W	Termitaria in HBT	N/A	Destroyed during HBT removal
Sacred kingfisher eggs x 4	7850 E	Termitaria in HBT	N/A	Destroyed during HBT removal
Brown Antechinus x 1	Ch 10000	Stump clearing, crushed by dozer	Crushed	Bulldozer
Brown Antechinus x 5	8500 E	South Blackmans Point Rd	Nil but very young	Separation from mother, died in care. HBT removal
Sacred Kingfisher Chicks x 2	8000 W	South Wharf Rd	Crushed	HBT removal. Crushed, Euthanised
Sacred Kingfisher Chicks x 3	8000 W	South Wharf Rd	Nil, very young	Taken into care, euthanised
Blind Snake x 1	24500	Barrie's Creek	Crushed	Crushed during stage 1 clearing
Green Tree Snake x 1(prob)	202000	North Cooperabung Dr	Crushed	Crushed during stage 1 clearing
Sugar Glider x 1	19000	North Haydon's Wharf, HBT removal	Crushed/paralysed	Euthanised by Vet
Lit. caerulea x 1	6000	Glen Ewan Rd	Crushed	Crushed by light vehicle on access track
Blackish Blind Snake x 1	18300	Wyndell Close	Crushed	HBT removal crushed
Blackish Blind Snake (3)	24500	Barry's Creek	Crushed/severed	Severed by excavator

3.3 Aquatic fauna

A total of 17589 (this number includes some block counting and estimates where counting individual fish was thought to be counter-productive) fish and other aquatic fauna were captured and successfully released during fish translocation efforts. A total of 8431 mosquitofish (*Gambusia holbrooki*) were captured and euthanased (also includes some block counting). The total number of individual taxa captured, translocated (TR), dead in transit (DT) or euthanased (EE) are displayed in Table 9. The most common fish encountered were firetail gudgeons (*Hypseleotris galii*) and mosquitofish. A relatively large proportion of firetail gudgeons (approximately 30%) perished during fish translocations. Lower numbers of striped gudgeons (12%) and empire gudgeons (7%) also perished. Other species captured included; long-finned eel (88 individuals; Plate 21), short-finned eel (75 individuals; Plate 21), silver perch (14 individuals; Plate 22), goldfish (2 individuals; Plate 22), and eastern long-necked turtle (2 individuals; Plate 23).

Table 9: Combined numbers of fish captured, translocated (TR), dead in transit (DT) and euthanased (EE) for all fish translocation activities along the OH2K upgrade.

Common Name	Species Name	Fish Captured	TR	DT	EE
Invasive Fish					
Goldfish	*Carassius auratus*	2	0	0	2
Mosquitofish	*Gambusia holbrooki*	8431	0	0	8431
Silver Perch	*Bidyanus bidyanus*	14	0	0	14
Amphibian					
Peron's Tree Frog (tadpole)	*Litoria peronii*	180	180	0	0
Striped Marsh Frog (tadpole)	*Limnodynastes peronii*	405	375	30	0
Crayfish					
Yabby	*Cherax species*	12	12	0	0
Fish					
Empire Gudgeon	*Hypseleotris compressa*	5119	4759	360	0
Firetail Gudgeon	*Hypseleotris galii*	13479	9501	3978	0
Long-finned Eel	*Anguilla reinhardtii*	88	85	3	0
Short-finned Eel	*Anguilla australis*	75	75	0	0
Striped Gudgeon	*Gobiomorphus australis*	2922	2564	358	0
Shrimp					
Glass Shrimp	*Paratya australiensis*	36	36	0	0
Turtle					
Eastern Snake-necked Turtle	*Chelodina longicollis*	2	2	0	0
Grand Total		30765	17589	4729	8447

Plate 21: Shortfin Eel (*Anguilla australis*) (left side) and Longfin Eel (*Anguilla reinhardtii*) (right side) were captured during aquatic fauna surveys.

Plate 22: Silver perch (Bidyanus bidyanus) (left side) and goldfish (Carassius auratus) (right side).

Plate 23: Eastern Snake-necked Turtle (*Chelodina longicollis*)

3.4 Stage 2 nest box assessment

The stage 2 calculation of nest box numbers, using data gathered during the clearing phase, is presented in Table 10. The results are substantially different to those presented in the NBPoM, with a total of 114 boxes calculated in stage 2 compared with 469 during stage 1 (Table 11). Based on stage 2 calculation only 24.3% of the initial estimate of boxes are required.

Large discrepancies were recorded in zones A/B, C/D, L, N, O/P and R. After stage 2 calculations zone A/B had an actual nest box requirement of 10, 11.3% of the original stage 1 calculation. Zone C/D requires 15 nest boxes, 20.8% of the initial calculation. Zones L and N require 1 (7.1% of initial calculation) and 4 (16.6% of initial calculation) nest boxes respectively. Zone O/P had the largest discrepancy where only 6.6% of the initial 30 nest boxes from stage 1 calculations were required. Zones F and K are the only zones where the initial calculation was under-representative of the actual abundance of hollows. Stage 2 calculations require the installation of 1 box in zone F and 3 in zone K.

Table 10: Habitat tree and hollow data gathered from each nest box zone during the clearing phase of the Oxley to Kundabung project. SoC = side of carriageway; T = termitaria; Dr = drey; DB decorticating bark; F = fissures, Ba = basal.

NB Zone	Zone chainage	SoC	No. Habitat Trees Inspected/Zone	No. HBT with Hollows (incl term):Drey	Area cleared (ha)	HBT/ha	No. functional hollows	Hollows/ tree	Other	Used hollows/ha	Used hollows (incl term):Drey
A & B	900 - 1700	Both	37	25:8	7.95	3.14	66	2.64	8xDr, 1xT, 1xBa, 2xF	0.62	5:2
C & D	3500 - 4250	Both	43	12:0	7.16	1.67	88	7.33	4xT	0.41	3:0
E	7000 - 8000	West	32	29:0	13.13	2.20	57	2	7xT, 1xF	0.68	9:0
F	8050 - 8650	East	54	38:4	12.78	2.97	79	2.1	4xDr, 11xT	1.09	14:1
G	9000 - 9600	East	22	13:3	4.16	3.12	30	2.31	3xDr, 2xT, 1xBa	0.24	1:0
H	10000 - 10800	Both	29	21:0	7.07	2.97	66	3.14	7xT, 2xF	0.56	4:0
I	10800 -11450	Both	37	24:1	4.77	5.03	62	2.58	1xDr, 1xT	3.14	15:0
J	11650 - 12350	Both	38	28:1	4.41	6.34	53	1.89	1xDr, 3xT	2.72	12:0
K	12550 - 13150	West	12	12:1	3.61	3.32	25	2.08	1xDr, 2xT	0.54	3:0
L	13600 - 14200	West	5	3:0	5.53	0.54	5	1.67	1xDB	0.18	1:0
M	17400 - 17950	West	9	7:0	4.99	1.40	21	3	7xT	0.20	1:0
N	18000 - 18550	Both	16	13:1	13.69	0.94	50	3.85	1xDr, 4xT	0.51	7:0
O & P	20550 - 21550	West	10	8:0	9.85	0.81	17	2.13	1xDB	0.20	2:0
Q	22000 - 22700	West	10	9:0	9.62	0.93	21	2.33	2xT	0.31	3:0
R	23000 - 24000	West	21	15:0	8.39	1.78	31	2.07	1xT	0.35	3:0

Table 11: Stage 2 nest box calculation for the OH2K Pacific Highway Upgrade.

NB Zone	Number of NB	Equation	Number of NB - Stage 2	Number of NB installed - Stage 1	No. of extra NB required - Stage 2
A & B	88	3.14*2.64*1.2	10	40	0
C & D	72	1.67*7.33*1.2	15	39	0
E	14	2.20*2*1.2	5	9	0
F	10	2.97*2.1*1.2	7	6	1
G	24	3.12*2.31*1.2	9	15	0
H	19	2.97*3.14*1.2	11	12	0
I	60	5.03*2.58*1.2	16	36	0
J	41	6.34*1.89*1.2	14	25	0
K	8	3.32*2.08*1.2	8	5	3
L	14	0.54*1.67*1.2	1	8	0
M	11	1.40*3*1.2	5	7	0
N	24	0.94*3.85*1.2	4	12	0
O&P	30	0.81*2.13*1.2	2	16	0
Q	9	0.93*2.33*1.2	3	6	0
R	45	1.78*2.07*1.2	4	27	0
Total	469		114	263	4

4. Discussion

4.1 Coverage of scope items

The scope of this report included:

1. Details of methods used during pre-clearing surveys and clearing operations.
2. Fauna species displaced by clearing, species captured, species released and any wildlife mortalities resulting either directly or indirectly from the clearing operations.
3. Location of fauna within clearing footprint (recorded with GPS) and release locations.
4. Hollow-bearing tree register, and comparison of this data to nest box plan (assess the adequacy of nest boxes installed and how they are mitigating the loss of tree hollows).
5. Discussion of the effectiveness of those methods employed.
6. Recommendations for future pre-clearing and/or clearing procedures."

Scope items are addressed in the following sections:

- Section 2 covers methods used during preclear surveys and clearing operations. That section also covers methods employed during spotlight surveys, targeted threatened species surveys and pre-construction requirements.
- Section 3 outlines the results of ecological work carried out during the clearing phase. This includes records of any threatened fauna, fauna relocated or displaced, and any mortalities during the clearing phase. The location of fauna captured and released is presented as chainages in relevant tables in Appendix D. As all fauna were released adjacent to their point of capture the chainage listed for HBT or pre-clear surveys also relate to release locations. AMG coordinates are presented for threatened fauna. The hollow bearing tree register is presented in Appendix D and data summarised in Section 3. A comparison of HBT data collected during clearing and that presented in the NBPoM is presented in section 3 and discussed in section 4.
- Section 4 of the report discusses the results and interprets the effectiveness or otherwise of methods implemented to minimise impacts on wildlife throughout the clearing phase. Recommendations for future projects are also presented in this section. The hollow bearing tree register is presented in the appendix (Appendix D, Table D3).

4.2 Success of clearing phase fauna mitigation

4.2.1 Clearing method

The clearing method was successful in reducing impacts on local fauna. The low mortality rate (i.e. <4% from HBT removal) and the number of individuals relocated from HBT (125 individuals), pre-clear surveys (205 individuals) and spotlight surveys (29 individuals) supports this notion. The implementation of a staged clearing process whereby HBTs were retained for at least two nights after surrounding vegetation was removed may be a key factor to the successful minimisation of mortalities of local fauna. The two stage clearing process whereby HBT are retained for at least two nights enables fauna to escape the clearing area. Whilst engaged in spotlighting activities on the Nambucca to Urunga Highway Upgrade sugar gliders were observed, on two occasions, inhabiting retained HBTs on the night following stage one clearing but were not present in the tree once felled after 48 hours (N. Priest pers obs). The two-night retention time for potential HBT provides a reasonable balance between animal welfare and clearing progress.

The utilisation of harvesters and bulldozers in the felling of HBTs had varied success. Whilst the inclusion of harvesters in clearing operations has obvious benefits for careful removal of small and medium sized trees the ability to lower trees is influenced by machine and operator capability. Standard 30 - 40 tonne harvesters cannot lower large trees. We noted a substantial difference in equipment and operator capability between clearing contractors. When harvesters were not available, or trees were too large to be handled, and after consultation with RMS and Lend Lease staff, bulldozers were employed to fell HBTs. In some cases both a bulldozer and harvester were used. In some instances larger trees that a harvester would not have been able to lower gently were felled better with the bulldozer provided the operator managed to slow the fall of the tree by placing the blade of the machine on the root ball as it was levered out of the ground. Using a bulldozer to remove HBT's is preferable to the cutting and pushing method preferred at times by harvester operators for large trees.

One notable benefit of harvesters is a reduction in use of hand-held chainsaws to remove vegetation from drainage lines and the ability to easily cut and sections of tree containing fauna. Falling trees with hand-held saws increases the risk of mortality, as the impact tends to be greater than if a tree is pushed with the root ball attached. Harvesters are also able to cut and carry sections of tree with occupied hollows, which reduces stress (& risk of mortality) associated with extracting animals out of hollows. Cutting and relocating vacant hollows to nearby adjacent habitat also creates refuge for small ground dwelling mammals and reptiles. With the assistance of a harvester this was done with ease and precision reducing any impacts on the receiving environment.

The results show that the first stage of clearing (i.e. all non-HBT) is insufficient to force all animals away from the clearing zone. This is not surprising given the influence of competition for resources and the importance of viable hollows for hollow dependent fauna (Gibbons & Lindenmayer 2002). Competition for space in adjoining vegetation that already contains occupied home ranges will influence the ability of fauna to relocate. Generally, total canopy separation between HBT's is regarded as essential to encourage movement and reduce clearing impacts on hollow dependent fauna. An appropriately designed scientific study is required to resolve the issue of one verse two nights retention time. Such a study should be conducted in similar habitats using the same clearing methods and with sufficient replication.

4.2.2 Impacts on fauna

During this stage of the clearing phase, 113.6 ha of native vegetation was removed including 310 HBT containing 738 functional hollows. At OH2K the proportion of HBT with evidence of use by fauna (49.3%) was substantially lower than that reported for the Nambucca to Urunga (74%), Glenugie (65%) and Sapphire to Woolgoolga (57%) Pacific Highway Upgrades (Sandpiper Ecological 2015 & 2010; Benchmark Environmental management 2013). It was similar to the Coopernook to Herons Creek (44%) and Hunter Expressway (KK2B) (48%) project and greater than the Karuah to Bulahdelah (31%) upgrade (see Benchmark Environmental Management 2007; Sandpiper Ecological Surveys 2009, 2012). The proportion of occupied HBT recorded at OH2K (14%) was substantially lower than Nambucca to Urunga (35%), Sapphire to Woolgoolga (35%), Glenugie (38%), Hunter Expressway KK2B (22%) and Karuah to Bulahdelah (20%) (Sandpiper 2015, 2010,2012; BEM 2007, 2013).

Differences in rates of occupancy and evidence of use between projects is due, in part, to different habitat type and quality, survey effort and clearing method. Importantly the results from OH2K are similar to the nearby Coopernook to Herons Creek project. Much of the OH2K alignment was situated within State Forest that has been logged repeatedly for almost 100 years. It takes over 100 years for most Eucalypt species to start forming viable hollows (OEH, 1999) and successive logging rotations can remove most of the available hollows within a forest.

Fauna recorded in HBTs was biased toward the Reptilian Class, with 36% of animals captured being reptiles. In comparison to mammals and Amphibians (frogs) with 25% each. Birds (Aves) made up the remaining 14%. Small animals, such as feathertail glider and many lizards, snakes and frogs, can remain in large isolated trees for several days and in some cases weeks, as they are still able to forage within the tree canopy (D. Rohweder pers obs). The degree of isolation of HBT following the initial clearing phase contributes to the likelihood of occupancy by small mammals and reptiles after two nights. Animals, including petaurid gliders, are more likely to continue using trees situated within gliding distance of the forest edge than those that are fully isolated, particularly if these trees support (or occur near) blossom. Some species, such as the common brushtail possum seem to be more tolerant of disturbance than others and may stay within retained HBTs. Site fidelity may depend on the availability of alternate hollow resources.

Squirrel, yellow-bellied and greater gliders are rarely detected during HBT inspections. It is unclear why this is the case but may be due to a greater sensitivity to disturbance. Although squirrel gliders have been removed from hollows at K2B, S2W at HEX they were uncommon in HBT's but at HEX were the most common petaurid glider in nest boxes (SES 2012 & 2013). The 28 species recorded during HBT inspections at OH2K is slightly lower than S2W (30 species) and Coopernook to Herons Creek (37 species) projects.

The mortality rate during clearing at OH2K (4%) was comparable to several other studies, including NH2U (3.3%), HEX (4%), Karuah to Bulahdelah (4%), Glenugie (4%), Sapphire to Woolgoolga (3%) and Coopernook to Herons Creek (3%) (BEM 2007, 2013; SES 2009, 2010, 2012, 2015). The similarity in mortality rates between OH2K and other similar clearing programs is interesting because, of the studies cited, OH2K and NH2U are the only projects in which harvesters were consistently used to fell HBT's. The result for Coopernook to Herons Creek is biased by the exclusion of mortality whilst animals were in care. Nonetheless, the finding indicates that harvesters do not substantially reduce mortality.

4.2.3 Adequacy of survey methods

Survey methods applied during this project included, pre-clear inspections (active search), spotlight surveys, targeted frog surveys, trapping (small mammal & koala), and inspection of HBT. These methods resulted in the capture and relocation of 359 individuals from 28 species. Survey effort was substantial with a total of 443 habitat trees inspected, 376 pre-clear surveys and 186 spotlight surveys completed. The difference in spotlight and preclear surveys can be explained through workload expectations. All areas that were deemed viable habitat for arboreal mammals and threatened frogs was spotlighted the night before clearing operations commenced. The reason for the discrepancy between the number of spotlight and preclear surveys can be explained by the following:

1. Spotlight surveys typically covered a large area of habitat.
2. Preclears were conducted progressively during the day and two preclears were sometimes conducted in an area covered by a single spotlight survey.
3. Grassland, cleared land with scattered shrubs, young regrowth or weed infestations were not spotlighted (as these were deemed unlikely to support arboreal mammals or any threatened frog species) but were precleared.
4. Unless covered as part of mainline spotlight surveys fence lines were not spotlighted separately due to the limited extent of vegetation removal and ability to conduct thorough pre-clear inspections.

Six ecological staff were involved in the project and 3-4 personnel were onsite most days between mid-October 2014 and mid-June 2015.

Twelve threatened species (11 animal, 1 plant) were recorded during the clearing phase (Table 6). Of these species, two (giant barred frog and koala) were considered in direct threat of clearing operations and

therefore captured and relocated. A road-killed spotted-tailed quoll was recorded on the existing highway at Cooperabung Creek 5 July 2015 (pers comm B. Lewis). On 3 December 2014, a squirrel glider was recorded foraging in vegetation north of Haydon's Wharf Road during spotlight surveys. No squirrel gliders were captured during clearing in that area.

The result of fauna rescue during clearing is positive and has satisfied the intent of the various conditions of approval that relate to minimising the impact of clearing on fauna, and the Ecological Monitoring Program. All but three of the species relocated are common and abundant in northern New South Wales and the conservation benefit associated with the rescue and relocation of common species is questionable. Capture and relocation of fauna from cleared areas as a conservation measure is flawed as it ignores the effect of competition, home range use, social interactions and distribution of key habitat resources on the distribution of fauna (Krebs 1994). The premise that removing (occupied) habitat and relocating resident fauna to adjacent habitat where they will continue to survive ignores the ecological factors that influence species distribution. Many translocation programs have been successful but these involve detailed planning and typically, the movement of fauna into habitat that no longer supports the species being translocated.

Relocating threatened species may be beneficial, although, positive outcomes are not guaranteed for the reasons listed above. Whilst there have been numerous successful translocations of threatened species from one area to another (see Serena 1994) there is less information on the results of small-scale movement. Research on the behaviour of relocated fauna is required before it is regarded as a positive conservation measure. One record to mention here is the observed return of a relocated giant barred frog at Cooperabung Creek. The male frog was captured within the alignment during targeted surveys on 11 February 2015, it was processed (measured, weighed and PIT tag number recorded) and then released 100m upstream from the capture site on 12 February 2015. This animal was subsequently recaptured within the clearing limit three days later on 15 February 2015. Recapture was confirmed by comparing the PIT tag number. Temporary giant barred frog fence was in place, suggesting the animal swam downstream to access the construction site. Whilst such behaviour seems atypical the male frog was captured at the same section of creek bank on both occasions, suggesting that this was a favoured calling location.

The clearing phase of the OH2K project extended from spring 2014 to mid-winter 2015. This period includes the primary stages of breeding for several species of bird and the primary breeding season for frogs (Hoskin *et al* 2015). The high incidence of certain bird species, such as sacred kingfisher, can be explained by season. Sacred kingfishers are a common species that predominately nest in arboreal termite mounds (termitaria) and tree hollows from September to January. They can often have two clutches in this time (Morcombe 2014). Eight of the eleven eggs that were euthanised were sacred kingfisher and five sacred kingfisher chicks were killed in the process of clearing or were euthanised, this accounted for 25% of the total mortality rate for the clearing phase. The high occurrence of sacred kingfisher nesting activity was most pronounced in late 2014. Some mitigating actions to reduce mortality of the species were discussed on site and implemented accordingly. These actions included retaining active nest trees for as long as possible or until nestlings had fledged. This was successfully adopted on three occasions. The occurrences where nest trees were felled after two nights were in areas of critical works.

Three rainfall events occurred during the summer/autumn frog breeding season. These events occurred 20 to 28 January 2015 (400mm), 18 to 24 February (124mm) and 21 to 23 March (95mm) (Bureau of Meteorology 2015). Dry conditions persisted prior to 20 January 2015. Weather had a strong influence on threatened frog species detections. Green-thighed frogs were recorded outside the project boundary during the January rainfall event, which occurred after the area of known habitat north of Blackmans Point Road was cleared. Green-thighed frog activity is closely linked to rainfall. Although frogs can be detected for some time after rain events have triggered breeding the species is rarely detected during dry conditions prior to rainfall. The below average rainfall experienced in spring 2014 and early summer 2014/15 meant that targeted surveys were

unnecessary. Nonetheless, green-thighed frogs were targeted during all spotlight and pre-clear surveys in areas of identified habitat.

A total of 19 giant barred frog observations were recorded, three of which were within the project boundary and one immediately outside temporary frog fencing on the western boundary at Cooperabung Creek north. All of these records occurred after at least one of the significant rainfall events. This is consistent with findings and previous research suggesting significant rainfall events trigger frog activity.

The survey methods applied during the clearing phase of the OH2K project follow standard procedures applied during several other highway upgrades. Some methods proposed in the EMP were considered impractical or inappropriate given the weather conditions and were therefore not applied. Examples include:

1. Arboreal mammal surveys did not include stag watching or call playback. Stag watching is a time consuming method and results are often inconclusive. The method was used on the S2W and NH2U projects where it was found to be less effective than spotlight surveys. Call broadcast is useful in detecting yellow-bellied glider and koala, however, the method relies on prompting a territorial response and may draw fauna into the clearing area from a substantial distance away. Once again spotlight was deemed to be the preferred method as it would not draw fauna into the clearing area from adjacent habitat.

2. Flowering trees were not marked as Habitat Trees. Whilst blossom is a critical food resource for fauna, including arboreal mammals, the retention of such trees would only encourage fauna to remain within the clearing area and compromise the two stage clearing process.

4.2.4 Habitat tree retention and clearing times/recommendations for future preclearing and/or clearing procedures.

Retention times for HBT's and other habitat trees warrant further assessment. Habitat tree is a broad term that includes all trees with fauna habitat, whilst HBT includes trees with hollows only. Trees containing dreys and bird nests, that is, habitat trees, can be removed immediately, or one night after initial clearing. Possum dreys should be removed immediately to reduce the likelihood of possums exiting the drey during the initial clearing phase when they are subject to an increased risk of mortality. Retaining bird nests may only serve a positive conservation outcome if the nest tree can be retained long enough for chicks to hatch and fledge, as occurred with sacred kingfisher nests during this project.

Further consideration of the HBT removal process is warranted as harvesters are often unable to gently fell large HBT's. In some cases a bulldozer can fell large HBT's more gently or a bulldozer and harvester can be used together. Greater flexibility must be included in clearing methods to acknowledge that harvesters have limitations and bulldozers have a role to play in HBT removal. Operator experience and machine capability have a strong influence on HBT removal. Small harvesters or machines with a high centre of gravity are not capable of gently lowering even small to medium sized trees and stricter controls are required to exclude some equipment.

The timing (season) of clearing has a substantial influence on outcomes, particularly mortality. Clearing during the breeding season for native birds (i.e. October – January) can cause considerable mortality of chicks and eggs, as occurred during this project. In contrast, clearing during autumn and winter reduces the likelihood of impacts on breeding individuals and also provides time for animals of all classes to adjust breeding territories before the onset of the new breeding season. Removal of habitat within the territory of a breeding pair of animals during the breeding season is likely to affect breeding success even if individuals are not directly impacted. Numerous active bird nests were removed during this project, although few nestlings were affected.

4.2.5 Aquatic fauna

The fish translocation effort along the OH2K upgrade was relatively successful. Large numbers of aquatic fauna were captured and translocated successfully using a variety of methods. The authors are confident that the vast majority of aquatic fauna present in the waterways that were dewatered were captured and translocated prior to dewatering.

There were significant losses of firetail gudgeons (30% of this species captured) and, to a lesser extent, empire gudgeons and striped gudgeons. The majority of these losses occurred at two of the waterways; the Compound Dam and the Wakeboard Dam. There are a number of factors that contributed to these losses, including:

- The sensitivity of firetail gudgeons to capture and handling;
- High temperatures at the time of capture, and the subsequent effects on fish metabolism and dissolved oxygen concentrations in the water;
- High suspended sediment and algal concentrations in the water at the time of capture, possibly stressing fish prior to capture;
- Large numbers of fish captured leading to increased processing times; and
- Use of the seine net, leading to disturbance of bottom sediments;

There are also a number of mitigating strategies that were applied at other sites to avoid these losses, including;

- Reduced use of the seine net where other methods could be successfully employed;
- Attempts to drag the seine net through the surface 10 - 20 cm for the first few shots to capture the majority of mosquitofish and firetail gudgeons prior to disturbing the bottom sediments;
- Gradual deployment of the seine net through increasing areas of the water present to reduce the number of fish captured per shot and reduce processing times; and
- Returning fish to the water for later capture when numbers captured were thought to be too large.

4.3 Stage 2 nest box assessment

The large difference between the stage one and two nest box calculations is consistent with the NH2U project where the number of required boxes was reduced from 303 (stage one) to 164 (stage two). At OH2K the number was reduced from 469 (stage one) to 114 (stage two). There are several likely reasons for the large discrepancy between the stage one and two calculations, including:

1. Overestimate of hollow number and occurrence from ground inspections – It is difficult to accurately count the number of hollows from the ground. Gibbons and Lindenmayer (2002) list issues that may cause both over and underestimates of hollow number, such as obstruction by foliage, inclusion of blind hollows and tree type. During clearing inspections at OH2K no hollows were recorded in 30% of the trees identified as containing hollows from the initial ground-based assessment. Although this rate is high it is not unusual for some HBT identified from ground observations to not contain hollows. Comparison of hollows in a random sample of trees identified from ground observations by Lewis (2013) with the results of clearing surveys found that the number of hollows recorded from the ground was higher for each tree and the total number of hollows recorded from ground observations (145 hollows) was more than 3 times greater than the number recorded during clearing (44 hollows; Table 9). During preclearing HBT markup a number of original HBTs did not appear to exhibit any hollows and therefore were not classified as HBT. It

seems that a very conservative approach was adopted to counting hollows during the initial HBT survey, which resulted in an overestimate of nest boxes required.

2. Inclusion of a 20% error factor - The inclusion of a 20% error factor, in the nest box equation, assumes that ground counts are underestimates only, yet this is not the case. Whilst foliage may obscure hollows causing an underestimate the inclusion of 'blind' hollows will cause an overestimate. These confounding factors may cancel each other out and the application of an error factor results in an overestimate.
3. Application of minimum specification for hollow to be considered viable – Sandpiper Ecological does not record hollows <10mm diameter or less than 100mm deep as these are not considered viable.
4. Destruction of hollows during felling – Tree hollows often break apart following impact with the ground. Care is taken to piece hollows back together and obtain an accurate count, however, undercounting of hollows is likely when trees hit the ground with great impact (i.e. operator unable to slow the descent). On the OH2K project many HBT's were felled in a controlled and gradual manner and as a consequence many hollows remained intact, which enabled accurate counts. The error associated with counts of hollows in felled trees is predicted to be approximately 10%.
5. Rationalisation of hollow numbers – Inspection of hollows after felling involves some (minor) rationalisation of hollows. For example, a forked branch with short hollows entering the same chamber may be counted as a single hollow. Hollow counts from the ground usually only count evident hollow entrances.
6. Initial HBT surveys consider the entire project corridor and therefore include some HBT that are not cleared once the clearing limits are refined. This would have some effect on numbers of hollows registered during clearing.

Table 12: Twenty-five randomly chosen HBTs showing original survey hollow counts and Sandpipers on-ground hollow count.

HBT number	Tree Species	NBPoM hollow count	Sandpiper on-ground count
H01	Corymbia intermedia	3	0
H05	Corymbia intermedia	7	2
H108	Melaleuca spp.	5	1
H121	Corymbia intermedia	3	1
H125	Stag	13	9
H130	Mahogany spp.	5	1
H139	Eucalyptus pilularis	6	0
H144	Eucalyptus pilularis	3	2
H155	Stag	7	3
H167	Eucalyptus pilularis	7	2
H189	Eucalyptus pilularis	2	1
H204	Mahogany spp.	5	3
H211	Eucalyptus pilularis	3	1
H216	Eucalyptus pilularis	2	0
H222	Eucalyptus resinifera	5	0
H235	Eucalyptus robusta	3	2
H244	Stag	7	4
H256	Eucalyptus resinifera	4	1
H268	Stag	5	0
H283	Eucalyptus robusta	4	1
H299	Eucalyptus tereticornis	14	2
H305	Eucalyptus tereticornis	6	4
H318	Eucalyptus resinifera	11	1

H325	Eucalyptus microcorys	7	3
H345	Eucalyptus resinifera	8	0
Total		145	44

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Appendix A – Koala Protocol

Oxley Highway to Kundabung (OH2K) Pacific Hwy Upgrade

Protocol for Managing Koalas during Clearing and Construction Operations – *Draft (v1)*

The koala *(Phascolarctos cinereus*) is listed as threatened (vulnerable) under NSW (*Threatened Species Conservation Act* 1995) and Commonwealth (*Environmental Protection and Biodiversity Conservation Act* 1999) legislation. The following protocol has been prepared to minimise impacts on koalas during the clearing and construction phase of the Oxley Highway to Kundabung (OH2K) Pacific Highway Upgrade and to satisfy standard pre-clearing procedures. The protocol provides procedural guidelines to be followed if koalas are encountered during clearing and construction activities, including their capture and relocation if required.

During Clearing Operations:

1. Surveys for koalas during clearing and grubbing operations:
    - In areas containing potential koala habitat, foot-based, observational surveys for koalas ('Koala Surveys') will be conducted the night before (using spotlights) and in the morning immediately prior to clearing. *'Potential koala habitat'* is defined as areas where scats have been collected, where koalas have been sighted, which satisfy the definition of "habitat critical to the survival of koalas" (as per DotE 2013) or delineated in project approvals.
    - Koala Surveys will cover the area scheduled for clearing that day ('Day Clearing Zone') and habitat immediately adjacent.
    - Koala Surveys may extend beyond the Day Clearing Zone to establish the presence or otherwise of koalas ahead of the clearing front.
    - Clearing contractors and site staff will be asked to provide any sightings of koalas to the Environment Team.

2. Koala identified in tree within Day Clearing Zone in area of contiguous habitat:
    a. Immediately enforce a 50m-radius Exclusion Zone (refer Point 6) around occupied tree.
    b. Install koala pen trap, unless:
        i. Sighting occurs on a Friday when individuals would be left to move unassisted.
        ii. Female with joey on back would not be trapped and left to move unassisted.
    c. Capture koala and assess health status.
    d. Sick and/or injured koalas transported to Port Macquarie koala hospital.
    e. Healthy and un-injured koalas relocated (refer Point 5).
    f. Koalas would only be removed from site if they require treatment or hospitalisation.
    g. In some instances it may take several days to capture a koala, and capture time may be influenced by stress. Pen traps would be installed for 72 hours before alternate methods are applied. Standard alternate procedure would involve the use of flags to encourage koalas to descend the tree where they are hand captured. A tree climber may be required in some instances.

3. Koala identified in tree within Day Clearing Zone in isolated remnant (no suitable release habitat within 200m of site):

a. Clearing of remnant would cease and koala allowed to move unassisted – no trapping would occur.
b. Periodic daytime observation and spotlighting would occur to track koala movement within remnant.
c. If koala is sighted within an area of high risk (e.g. remnant beside highway), rescue options would be discussed with Port Macquarie Koala Hospital.

4. Koala identified in tree up to 50m outside the LoC and adjacent Day Clearing Zone:
   a. Immediately enforce a 50m-radius Exclusion Zone (refer Point 6) around occupied tree.
   b. Assess the site and Project Ecologist to determine an appropriate course of action. Options include:
      i. Retain Exclusion Zone and avoid clearing the buffer until koala has relocated;
      ii. Implement trapping protocol (Point 2);
      iii. Continue clearing whilst spotter observes koala.

5. Retention and relocation:
   a. Captured individuals shall be relocated to suitable habitat within their predicted home range, and:
      i. Behind the clearing front;
      ii. Outside LoC;
      iii. In close proximity to point of capture;
      iv. Away from high risk areas (i.e. roads); and
      v. Within habitat identified as suitable by the Project Ecologist.
   b. Captured individuals will be released at time of capture or later as determined by the Project Ecologist.

6. Exclusion (Buffer) Zone restrictions:
   a. No clearing or grubbing operations within Exclusion Zone apart from the following exceptions:
   b. Hand felling of small shrubs around occupied tree (i.e. shrubs with interlocking canopy or within 2m of trunk) is permissible to improve effectiveness of pen trap.
   c. Plant and equipment may be 'walked' through Exclusion Zone under supervision of Project Ecologist. Machinery must be walked as far from the occupied tree as possible and pathway clearing would be limited to vegetation <150mm diameter.
   d. Clearing outside the buffer must be done in such a manner to ensure that felled timber does not enter the buffer zone.

7. Incidental observations of koalas during clearing operations:
   - All site personnel to be instructed (weekly tool box, staff notifications) to report koala sightings to the Project Ecologist or Environment Manager and to immediately enforce a 50m Exclusion Zone around sighted individual(s).
   - Environmental staff and plant and machinery operators conducting clearing operations shall be tool boxed on key aspects of the Protocol for Managing Koalas During Clearing and Construction Operations, particularly Exclusion Zone restrictions and areas of known or predicted high koala activity.
   - All contractors and staff must be aware of koala presence when moving around the site at dawn or dusk (periods of increased koala activity) particularly during the winter months when site work overlaps these periods.

During Construction Operations:

1. Koala sighted in habitat near construction operations:
    a. Koala sighting to be reported immediately to Environment Manager or Project Ecologist.
    b. All site personnel and staff working within the area of the sighting to be made aware of koala presence and encouraged to be vigilant.
    c. Plant/vehicle speed shall be reduced within 200m of sighting.
2. Koala sighted within construction area:
    a. Koala sighting to be reported immediately to Environment Manager or Project Ecologist.
    b. Operations within 50m of koala must cease immediately until such time as the koala exits the construction area.
    c. Vehicle speed must be reduced to 40kph within 200m of koala.
    d. Signs must be erected on all vehicle movement paths identifying the presence of koala and specifying restrictions.

Data Management and Review:

1. Project Ecologist to maintain record of koala sightings, captures, relocations and transfers to koala hospital.
2. Protocol to be reviewed by Project Ecologist prior to 2015 koala breeding season (Jul-Dec).

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Appendix B – Culvert inspection and exclusion

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4 December 2014

Cc. Nathan Russell, Hari Corliss

Dear Grant,

RE: Microchiropteran bat roost exclusion from pipe and culvert structures for the Oxley Highway to Kundabung (OH2K) Pacific Highway upgrade.

1. Introduction

The Oxley Highway to Kempsey Microbat Management Strategy ((MMS) LES 2013) details a number of management strategies to mitigate impacts on microbats and identified roost sites. One of these strategies (Strategy C) is planned roost exclusion. According to the MMS, roost exclusion will be necessary at those structures requiring removal or substantial modification. At a minimum, this will apply to those structures identified in Table 5-2 (of the MMS).

The MMS states that the timing of roost exclusion will occur during autumn (mid April-May) and the start of spring (September). Importantly, these two periods fall outside the breeding season for the southern myotis (*Myotis macropus*) and over-wintering times for southern myotis, little bent-wing (*Miniopterus australis*) and eastern horseshoe bat (*Rhinolophus megaphyllus*). For the current reporting period, roost exclusion was conducted during September 2014.

2. Roost exclusion

As required by the MMS, roost boxes were installed in adjacent habitat >6 months prior to the planned roost exclusion (RPS 2013). The process for roost exclusion was then followed in accordance with the MMS. Beginning from 16 September 2014, pre-exclusion surveys were conducted on all structures identified in Table 5-2 within the Oxley Highway to Kundabung (OH2K) section (refer Table 1) to assess roost activity. For roosts determined as inactive, all potential roost points (i.e. expansion joins, grab holes, pipe joins, drainage holes) were filled with variably sized styrofoam rod and steel mesh was used for high-flow drain holes (Plate 1). For roosts containing microbats, the species and number of individuals present was identified to determine the importance of the roost. No roosts were assessed to be of high conservation value (refer to MMS).

Plate 1. Vacant drain holes (L) and expansion joins (M) were filled with styrofoam rod and steel mesh was used at high-flow drain holes (R).

Biodiversity Survey

Project Management

Impact Assessment

Ecological Monitoring

Specialist Surveys

To exclude microbats from occupied roosts the following steps were followed:

1. During the day all unoccupied roost points were filled except for two minor (sub-optimal) roost points (e.g. hold points);
2. Occupied roost points were re-inspected ~90 minutes after dark and if vacant were filled;
3. Minor (sub-optimal) roost points were re-inspected the following day and if vacant were filled. If minor roost point was occupied then step 2 was repeated until all roost points were decommissioned.

Details of roost exclusion and inspection history are provided in Table 1. Microbats were observed in 9 of the 13 culverts inspected. Little bentwing bats were recorded in three culverts and eastern horseshoe bats in six culverts. The twin galvanised pipe culverts at 22200 are suspected of being used as a flyway. Results indicate that horseshoe bats do not always roost in the same culverts and the number and presence of bats at several culverts changed during the September surveys. This means that repeat surveys will be required to confirm bats are absent.

Table 1. Details of roost exclusion conducted on structures identified in Table 5-2 of the MMS within the OH2K upgrade section. EH = eastern horseshoe bat; LB = little bent-wing bat.

Culvert (chainage)	Cells	Conserv Rating	Inspection History	Exclusion	Management
510067 (1000)	750 RCP	low	17/9: nil, Anabat: EH calls @ E end, not roosting - excluded; 19/9 & 23/9 & 25/9: no bats in pipe or on curtains.	EXCLUDED (18/9/14 - curtain over entrance & exit)	No inspection required
599011 (18250)	1300x4 RCP	high	16/9: LB x5; 18/9: LB x14 in hold pts – partially excluded >dark; 19/9: bats in 1 hold pt - left; 22/9: no bats in hold pt – excluded, 10 bats hanging from scuff in ceiling; 23/9: LB x3 hanging from scuff in ceiling.	EXCLUDED (22/9/14, Styrofoam rod in roost pts)	Inspect prior to decommission
599012 (18720)	1800 RCP	mod	18/9: LB x1 – partially excluded >dark; 19/9: no bats - excluded; 23/9: nil.	EXCLUDED (19/9/14, Styrofoam rod in roost pts)	Inspect prior to decommission
599016 (20250)	1800 RCP	low	17/9: nil - excluded; 23/9: LB? x1 on side wall.	EXCLUDED (17/9/14, Styrofoam rod in roost pts)	Inspect prior to decommission
599017 (20500)	750 RCP	low	17/9 & 18/9: nil, Anabat; EH calls b/t 1800-1900, prob flying through not roosting; 19/9: EH x3 on ceiling. Likely only small no's of EH but likely used as flyway so not appropriate to curtain due to risk of entanglement.	NOT EXCLUDED.	Inspect prior to decommission
599019 (21290)	900 RCP	low	16/9: EH x3 on ceiling; 23/9: EH x1 on ceiling; 23/9: nil - partially excluded; 24/9: nil – excluded.	EXCLUDED (24/9/14, Styrofoam rod in roost pts)	Inspect prior to decommission
599020 (21500)	1200 RCP	low	16/9: EH x3 on ceiling; 18/9: scats below most hold pts - partially excluded; 23/9: nil >dark – excluded; 24/9: EH x1 on ceiling.	EXCLUDED (23/9/14, Styrofoam rod in roost pts)	Inspect prior to decommission
599021 (21790)	900 RCP	low	16/9: nil – excluded; 23/9: EH x1 on ceiling.	EXCLUDED (16/9/14, Styrofoam rod in joins)	Inspect prior to decommission
599021DS (21790)	900 RCP	low	16/9: nil – excluded; 23/9: nil	EXCLUDED (16/9/14, Styrofoam rod in roost pts)	Inspect prior to decommission
599022 (22200)	3000x2 Galv Pipe	low	16/9: nil; 23/9: nil. Likely a major flyway; no cracks/joins; ltd roost potential; not appropriate to curtain due to risk of bat entanglement.	NOT EXCLUDED.	Inspect prior to decommission

599023 (22350)	750 RCP	low	16/9: nil, Anabat; 18/9: EH x3 on ceiling; 19/9: EH x3 on ceiling; 23/9: EH x1 on ceiling. Likely only small no's of EH but probably used as flyway so not appropriate to curtain.	NOT EXCLUDED.	Inspect prior to decommission
599026 (23140)	900 RCP	low	16/9: EH x1 on ceiling; 17/9: nil - excluded; 23/9: EH x1 on ceiling.	EXCLUDED (17/9/14, styrofoam rod in roost pts)	Inspect prior to decommission
599028 (23990)	3000x5 RCC	mod	22/9: LB x5 in drain holes – partial exclusion; 23/9: LB x1 in drain hole & LB x2 in corner of ceiling; 24/9: nil - excluded; 25/9: nil.	EXCLUDED (24/9/14, steel mesh over drain holes)	Inspect prior to decommission

The roosting habit of eastern horseshoe bat, that is, there preference for hanging from an imperfection (i.e. chip or lump) in culvert, means they are difficult to exclude. Consequently ongoing inspection of culverts and exclusion immediately prior to work on structures is required to minimise impacts on this species. The removal of adjoining vegetation may be sufficient to deter use of culverts by horsehoe bats (and other species) and observation during clearing and earthworks will be important to guide the need for exclusion.

3. Roost management during clearing

In accordance with Strategy B (MMS), the project ecologist will perform pre-clearing surveys of all structures described in Table 1 with the exception of culverts at chainages 1000, 22200 and 21790. Surveys will involve visual inspection from structure entry/exit and will be performed daily during clearing operations within 100m of the structure. Inspections will occur as part of daily pre-clear surveys.

4. Roost management during construction

Two measures will be adopted during construction - monthly inspection during the first six-months of construction activity (i.e. earthworks, construction of new culvert etc) occurring within 100m of structure and inspection and exclusion immediately prior to decommissioning (i.e. removal of structure or work immediately abutting structure). Excluded and non-excluded structures will require different management approaches prior to decommission. Information gathered during the clearing and earthworks phases should be used to guide the application of measures specified in sections 4.1 and 4.2. For example, if, following clearing, bats are not detected using a culvert during successive inspections the frequency or need for ongoing inspection and exclusion shall be reviewed.

According to MMS roost exclusion should occur:

- Outside of the breeding season for southern myotis and any other species detected breeding (during the pre-clearing survey) by the Project Ecologist in the structure; and
- Outside over wintering times for the little bent-wing bat, eastern horseshoe bat and southern myotis.

To date no species have been recorded breeding within the structures, although several structures could be used during the overwinter period (June-August). Exclusion work discussed below would need to occur before or after that period. The roost at 18250 is classified as a High Conservation Value roost and therefore seasonal limitation of construction work will apply unless a noise and vibration plan is prepared. In this case the site is used as an overwinter roost by little bentwing bats and restrictions would apply from mid-June to mid-August.

4.1 Excluded structures

Excluded structures occur at chainages 1000, 18250, 18720, 20250, 21290 x 2, 21500, 21790, 23140 and 23990. Post-exclusion inspections of the 10 structures excluded revealed four with eastern horseshoe bats and one with little bentwing bats hanging from imperfections in the ceiling and one structure with a little bentwing bat attached to the wall (Plate 2; Table 1). Because all expansion joins, grab holes, pipe joins, drainage holes within these structures were filled during the exclusion process, it is reasonable to assume that bats roosting within these structures will be visible during inspections conducted from the structure entry/exit. As such,

decommission of already excluded structures, with the exception of chainage 1000, should proceed in accordance with the following steps:

1. 48-72 hours prior to decommission (i.e. removal of structure or work on/adjoining structure) inspect interior of structure from entry/exit area during daylight. Inspections should involve careful observation of ceiling and wall surfaces with spotlight/binoculars to determine the presence/absence of roosting bats.
2. If bats are absent, install a curtain across the entry/exit leaving a 100mm gap at the base.
3. If bats are present, re-inspect structure ~90 minutes after dark and later in the evening if necessary. If bats are absent, install a curtain across the entry/exit leaving a 100mm gap at the base (Plate 3).
4. If bats are still present after two evening inspections, repeat step 1-3 the following day.
5. Internal and external sides of entry/exit curtains should be inspected for bats each morning prior to decommission.
6. Curtains will only be installed after written confirmation from Lend Lease Engineering that the procedure will not have a detrimental effect on drainage.

The entry/exit to structure RCP 510067 at chainage 1000 was curtained during the September 2014 exclusion process (Plate 3) and further inspection of that site is not required.

Plate 2. Eastern horsehoe bats (L) were observed hanging from the edge of expansion joins (chainage 22350) and little bent-wing bats (R) were observed hanging from imperfections in the concrete ceiling (chainage 18250) several days after roost cavities were filled.

Plate 3. RCP 511067 (chainage 1000) was excluded with a nylon curtain after determining microbats were not roosting within the structure. The curtain features a 100mm gap at the base.

4.2 Non-excluded structures

Non-excluded structures occur at chainages 20500, 22200 and 22350 (Table 1). These structures will require a similar approach to that recommended for excluded structures. For the 750mm RCP structures (i.e. chainage 20500 and chainage 22350), Anabat detectors will be used to assist in determining the presence/absence of microbats that may be roosting within cavities in the structure. Exclusion of these structures should proceed as follows:

1. At dusk, 48-72 hours prior to decommission, Anabat detectors will be positioned at structure entry/exit and a visual inspection (using spotlight and binoculars) of the structure interior will be conducted from entry/exit area. Anabat detectors should remain in place for at least 60 minutes during which time the entry/exit is visually monitored for bats exiting the structure.
2. If by ~90 minutes after dark visual inspection and Anabat detectors demonstrate that no bats are present, install a curtain across the entry/exit leaving a 100mm gap at the base.
3. If bats are present, re-inspect structure later in evening and if absent, install a curtain across the entry/exit leaving a 100mm gap at the base.
4. If bats are still present after two inspections, repeat step 1-3 the following day.
5. Internal and external sides of entry/exit curtains should be inspected for bats each morning prior to decommission.
6. Curtains will only be installed after written confirmation from Lend Lease Engineering that the procedure will not have a detrimental effect on drainage.

Alternate measures such as positioning floodlights in selected culverts after bats have departed should be considered as an alternative to curtaining.

For the twin 3000mm galvanized pipes (chainage 22200 – Plate 4), initial inspections revealed no viable egress roost points and limited roost points on the wall/ceiling surface. However, the pipes are probably used as a microbat flyway and would present an entanglement hazard if curtained. We recommend that this structure, which can be effectively inspected visually, be monitored during clearing (as per item 3) and inspected 48-72 hours prior to decommission, including each morning up to decommission.

Plate 3. C599022 (chainage 22200) features 2x 3000mm galvanised pipes. The structure is likely a major microbat flyway and would present an entanglement hazard if curtained.

5. Cassegrain Winery access road

The RCP (3 x 1300mm) structure on the side road leading to Cassegrain Winery (chainage 2600) was inspected on 17 September 2014. The structure features numerous gaps and cracks 25-100mm wide and >300mm deep. No microbats were evident during the inspection although the structure features numerous deep cavities that could not be visually inspected. The site is regarded as potential microbat roosting habitat. Exclusion of this structure, if required, would need to be done in accordance with the MMS.

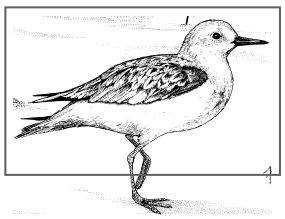
Please contact me on 0429 460 338 if you have any questions regarding the information provided.

Yours faithfully,

Dr Brendan Taylor

Senior Ecologist

Appendix C – Little Eagle nest removal



Sandpiper Ecological Surveys

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Ecological Monitoring

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30 July 2014

Cc Grant Fletcher

Dear Nathan,

RE: Removal of Little Eagle nest.

Between 22 and 24 July 2014 Mr Tom Welch (Sandpiper ecologist) inspected the little eagle nest located near chainage 10875. The aim of the inspection was to determine if the nest could be removed prior to the onset of breeding, as recommended by the "*Assessment of Impact: Little Eagle (Hieraaetus morphnoides) in the Pacific Highway Upgrade – Oxley Highway to Kempsey Project area*" report (SMEC/Hyder 2013). Inspections were undertaken at the following times:

- 22 July 2014 – 1115-1215hrs and 1530 – 1630hrs;
- 23 July 2014 – 0630-0745hrs and 1630-1740hrs; and
- ➢ 24 July 2014 – 0615-0730hrs and 1230-1300hrs.

The nest was observed from a point 45m northwest that had an unobstructed view of the nest and surrounding sky. On 22 July the proposed construction footprint 500m north and south of the nest was searched for additional stick nests.

During the morning inspection on 23 July a bird was briefly observed occupying the nest before flying away with a second bird, which was roosting nearby. These birds were observed whilst approaching the observation point and positive identification was impossible due to low light and an obstructed view. No further bird activity was recorded during the other observation periods and no additional stick nests were recorded.

The nest was removed at 1pm on 24 July by an arborist. The nest was then inspected on the ground for any evidence of recent activity. No eggs or chicks were present, although the nest was in good condition. The nest consisted of a deep bowl of sticks lined with bark and synthetic material and measuring approximately 600mm in diameter and 300mm deep.

The observation of a possible little eagle and the good condition of the nest suggests that birds may have been preparing to use it during the 2014 breeding season. Whilst removing the nest reduces the likelihood that little eagles will nest in that location in 2014 it is possible that the pair will nest nearby. Work was undertaken in accordance the SMEC/Hyder (2014) assessment.

If you have any questions regarding the above information please contact me on 0401 195 480.

Yours Faithfully

Dr David Rohweder
Managing Director/Senior Ecologist

Appendix D – Field data

Table D1: Spotlight surveys conducted for the Oxley Highway to Kundabung Pacific Highway Upgrade. Ind = individuals; Beh = Behaviour; NR = Not recorded. C = calling; F = flying; T = transit; F = foraging. Chainage locations are provided for all fauna captures in addition to GPS location of threatened fauna.

Date	Observers	General Location	Location (chainage)	Start Time	End Time	Weather (cloud, wind, rain, temp, rh)	Visibility	Species	No. Ind	Behaviour	Comments & GPS location (Thr spp)
3/11/14	DR, NP	Compound south to Hastings river (private)	7000-7700	1945	2115	100%, rl, ls, t20.5, 80%	M	Litoria fallax	>5	C	
2/11/14	NP, JE		6900-6700	1930	2030	30%, rl, nil, 19.5, 65%	M	Litoria fallax	>5	C	
								Brush Cuckoo	1	C	
								Flying Fox spp.	5	T/C	
5/11/14	TW, JE	Cairncross SF	7600 - 8250	1930	2100	100%, rl, mod, 19.2, 92%	DK	Pseudophryne coriacea	1	C	
6/11/14	NP/TW		7600-8300	1940	2100	60%, nil, nil, 19.3, 81%	BR	Pseudophryne coriacea	1	C	
								Fan-tailed Cuckoo	1	C	
								Microbat spp.	1	T	
								Flying Fox spp.	1	T	
9/11/14	NP/TW		7600-8300	1950	21:10	20%, msb, nil, 25.3, 63%	DT	Sugar Glider	1	F	
								Macropod spp.	>1	F/T	
								Microbat spp.	2	F/T	
								Limnodynastes peronii	1	F	
10/11/14	NP/JE		7600-8300	2020	2130	80%, rl, ls, 24.7, 74.6%	DT	Nil			
11/11/14	NP/TW		8288-8900 E of existing HWY	2000	2105	100%, rl, ls, 19.7, 76%	DK	Nil			
12/11/14	NP/TW		7700-8700	2009	2116	80%, nil, nil, 20.4, 75%	DK	Nil			
13/11/14	NP/TW		7700-8700	2005	2105	75%, msb, nil, 23, 83%	DT	Jacky Lizard	1	R	Relocated outside LoC
16/11/14	NP/JE		7686-8103	2005	2050	20%, nil, nil, 25.3, 71%	DT	Feathertail Glider spp.	1	F	In road reserve.
19/11/14	NP/BT		9200-9500	2005	2043	20%, nil, nil, 23.4, 77%	DT	Litoria gracilenta	1	C	
								Microbat spp.	1	T/F	
19/11/14	NP/BT	Tea Tree area	13350-14050	2100	2200	30%, nil, nil, 21.7, 76.5%	DT	Owlet Nightjar	1	C	
								Red-necked Wallaby	1	T	
								Pseudophryne coriacea	2	C	
								Litoria fallax	1	C	
								Limnodynastes peronii	2	T	Relocated outside LoC
								Litoria gracilenta	1	C	
19/11/14	NP/BT	Cooperabung	19700-20200	2210	2300	10%, nil, nil, 19.5, 76%	DK	Grey-headed flying fox	>5	C	
								Litoria fallax	>10	C	
								Litoria peroni	>5	C	
20/11/14	BT/JE/TW	Cooperabung Ck sth	19650-19700	2037	2105	0%;mSb; nil; 21.2; 78.2%	DK	Adelotus brevis	>5	C	
20/11/14	BT/JE/TW	Cooperabung	19700-20200	2107	2120	0%;mSb; nil; 21.2; 78.2%	DK	Nil			
20/11/14	BT/JE/TW	Haydons wharf rd	18050-18200	2128	2140	0%;mSb; nil; 21.2; 78.2%	DK	Nil			
20/11/14	BT/JE	Tea tree farm	13350-14050	2218	2245	0%;mSb; nil; 24.2, 78.6%	DK	Grey-headed flying fox	1	F	
								Litoria dentata	1	C	
								Litoria fallax	1	C	
20/11/	BT/JE	Black mans pt	9400-9650	2300	2331	0%;mSb; nil; 20.2,	DK	Grey-headed flying	1	F	

14						77.9%		fox			
23/11/14	NP/TW	Compound sth	6000-6900	2007	2042	100%, mlb, nil, 27.8, 60.2%	DK	Litoria nasuta	1	T	
								Eastern grey kangaroo	2	F	
23/11/14	NP/TW	Mahogany rd	9400-9800	2055	2130	100%,mlb, 29.6, 50.5%	DK	Nil			
24/11/14	NP/TW	Compound north	6900-7600	2012	2100	100%, rl, nil, 27.5, 67%	DK	Nil			
24/11/14	NP/TW	Mahogany Rd	9850-10400	21:10	2200	100%, rl, nil, 26.5, 67%	DK	Owlet-nightjar	1	C	
								Feather tail glider	1	T	
								Macrapod spp.	1	T	
26/11/14	NP/TW	Nth compound	7200-8200	2007	2054	100%, nil, nil, 22.6, 82%	DK	Feathertail glider	1	F	
								Tawny frogmouth	1	T/F	Flew directly into tree trunk. Was ok
	NP/TW	Mahogany rd	9150-9950	2104	2135	100%, nil, nil, 23.2, 77.6%	DK	Swamp wallaby	1	T/F	
27/11/14	NP/TW	Nth compound	7600-8200	2010	2100	80%, nil, msb, 20.9, 80%	DK	Small Eyed Snake	1	T/F	
30/11/14	BT/TW	Haydons wharf sth	17400-17800	2025	2143	0%, mSb, nil, 21.3, 71%	Mod	Litoria nasuta , Litoria fallax, Pseudophryne coriacea, Litoria tyleri, Litoria peronii;	>30	C	
								Grey-headed flying fox	6	F	
30/11/14	NP/JE	Wharf rd	7200-8200	2010	2055	10%, MLB! nil, 24.3, 74%	Mod	Nil			
1/12/14	NP/JE	Mahog rd north	10000-10500	2015	2050	90%, msb, lr, 22.1, 81.8%	Dk	Microbat spp.	1	F/T	
1/12/14	NP/JE	Wharf rd	8300-8600	2100	2135	90%, rl, lr, 20.2,88.4%	DK	Flying fox spp.	1	T	
								Litoria nasuta	1	T	Relocated
3/12/14	NP/BT	Haydons wharf nth	18000-18660	2026	2135	90%;MLB;nil;23.3; 82.6%	Mod	Squirrel Glider	1	F	
								Grey-headed flying fox	>5	F/T	
								Litoria Fallax	>10	C	
								Limnodynastes peroni	3	C	
3/12/14	NP/BT	Wyndell Close		21:40	2155	90%, mc, nil, 23.3, 84%	Mod	Limnodynastes peroni	5	C	
								Grey-headed flying fox	3	T/C	
4/12/14	NP/JE	Wharf rd north	18300-18805	20:39	2136	90%, MLB, nil, 21.3, 86.3%	Mod	Grey-headed flying fox	>10	C/F/T	
								Limnodynastes peronii	<5	C	
								Litoria fallax	>5	C	
								Crinia spp.	1	C	
								Pseudophryne spp.	1	C	
7/12/14	NP/JE	Mahogany Rd	10000-10450	21:00	21:30	70%, msb, nil, 22.6, 91%	Mod	Nil			
7/12/14	NP/JE	Wharf Rd north		2000	2045	75%, msb, nil, 23, 88%	Mod	Grey-headed flying fox	>5	C	
								Litoria fallax	<5	C	
8/12/14	NP/TW	Barrie's Ck		2115	2200	100%, msb, HS, 23.1, 87%	Dk	Short Eared Brushtail Possum	1	F	
								Pseudophryne coriacea	>30	C	1 individual relocated
15/12/14	NP/GM	Cooperabung Ck	19600	2030	2130	50%, rl, nil, 20.9, 70%	DK	Pseudophryne coriacea	1	C	
								Echidna	1	F	Relocated upstream
								Flying fox spp.	5	C	
16/12/14	NP/GM	Cooperabung	19600-20200	2020	2140	100%, msb, ls, 22.5, 88%	DK	Flying fox spp.	5	C/F	
								Litoria dentata	>10	C	1 individual relocated
								Litoria fallax	>20	C	

								Limnodynastes peronii	>10	C	
								Pseudophryne coriacea	>10	C	
								Litoria tyleri	<5	C	
								Litoria peronii	<5	C	
17/12/14	NP/GM	North Haydons wharf		2030	2130	95%, rl, ls, 20.2, 88%	DK	Litoria fallax	13	C (1 pair observed mating)	13 Relocated
17/12/14	NP/GM	South Haydons wharf		2130	2200	100%, rl, ls, 19.8, 90%	DK	Litoria fallax	3	P	3 Relocated
5/1/14	NP/GM	Blackmans point rd	8900-9200	2025	2103	10%, nil! nil, 24.2, 74%	BR	Litoria dentata	1	C	
								Owlet Nightjar	1	C	
								Bandy Bandy	1	F	Relocated
5/1/15	NP/GM	Mahogany Rd	99500-10500	2112	2155	10%, nil, nil, 22.8, 82%	BR	Owlet Nightjar	1	C	
6/1/15	NP/GM	Range rd	20700-21000	2035	2141	0%, nil, nil, 28.3, 69.7%	BR	Litoria peronii	5	C	1 relocated
								Flying Fox spp	>50	T	
								Adelotus brevis	1	-	Relocated
								Litoria tyleri	>10	C	2 relocated
								Pseudophryne coriacea	>5	C	
								Limnodynastes peronii	<5	C	
6/1/15	NP/GM	Mahog rd	10500-11100	2200	2310	0%, nil, nil, 26.9, 76.4%	BR	Litoria dentata	1	C	
								Limnodynastes peronii	1	T	Relocated
								Owlet Nightjar	1	C	
								Possible Masked Owl	1	C	
								Macrapod spp	2	T	
6/1/15	NP/GM	Blackmans south	8650-8900	2335	0000	0%, nil, nil, 25.3, 78.1%	BR	Nil			
7/1/15	NP/JE	Mahog north	10500-11100	2040	2115	10%, nil, nil, 26, 63.8%	DT	Owlet Nightjar	1	C	
								Macrapod spp.	3	T/F	Probable Swamp Wallaby
								Microbat spp.	1	T/F	
7/1/15	BT/GM		21000-21500	2035	2115	10%, nil, nil, 26, 63.8%	DT	Nil			
8/1/15	NP/JE	Bill Hill South	11100-11400	2040	2140	0%, msb, nil, 24, 84%	DT	Feathertail Glider spp.	1	F/T	
								Tawny Frogmouth	2	T/C	
								Owlet Nightjar	1	C	
8/1/15	NP/JE	Median NB	10500-10900	2150	2240	0%, msb, nil, 26.7, 70%	DT	Owlet Nightjar	1	C	
8/1/15	BT/GM		21000-21500	2035	2110	0%, msb, nil, 24, 84%	DT	Nil			
8/1/15	BT/GM		8900	2130	2140	0%, msb, nil, 26.7, 70%	DT	Nil			
11/1/15	NP/JE	Range rd	20600-21500	2035	2050	100%, nil, mod, 24.9, 92%	DK	Nil			
11/1/15	NP/JE	Bill Hill South	10700-11450	2105	2205	100%, nil, mod, 22.8, 89.2%	DK	Green Tree Snake	1	T	Climbing stag HBT Hs48
								Microbat spp.	4	T/F	
								Crinia signifera	5	C	
13/1/15	NP/TW	North coop	21500-21800	2050		80%, mlb, nil, 25, 81%	DT	Pseudophryne coriacea	>100	C	
								Adelotus brevis	1	C	
								Microbat spp.			
18/1/15	NP/JE	North Bill Hill	11500-12350	2133	1109	30%, nil, nil, 25.5, 75%	DK	Owlet Nightjar	3	C	

								Feathertail Glider spp.	2	F/T	
								Small Eyed Snake	1	T	Relocated
								Limnodynastes peroni	2	T	1 relocated
								Macrapod spp.	2	T	
								Microbat spp.	3	T/F	
18/1/15	NP/JE	North cut 19	21700-22000	2033	2115	20%, nil, nil, 26.1, 74.4%	DT	Pseudophryne coriacea	1	C	
								Litoria tyleri	1	C	
19/1/15	NP/TW	Haydons wharf South	17200-17500	2049	2115	90%, lr, mlb, 23.8, 77.4%	DK	Litoria peronii	1	C	
								Pseudophryne spp.	1	C	
								Litoria fallax	3	C	
								Litoria nasuta	>5	C	
								Litoria dentata	3	C	
19/1/15	NP/TW	Bill Hill rd North	11500-12350	2130		90%, lr, mlb, 25.6, 75.3%	DK	Owlet Nightjar	3	C	
								Common Brushtail Possum	2	F/T	1 individual sitting in Turpentine
								Koala	1	F	Sitting in large Tallowwood at ch11850; E: 481423 N:6530439
								Swamp Wallaby	1	T/F	
								Litoria dentata	>3	C	
								Litoria tyleri	2	C/T	1 relocated
								Limnodynastes peronii	1	T	Relocated
21/1/15	NP/JE	Bill Hill North, East Rd	11500-12350	2030	2245	90%, lr, rl, 23.9, 95%	DK	Limnodynastes peronii	>100	C/T	3 relocated
								Litoria peronii	<5	C	
								Litoria gracilenta	>100	C/M	
								Litoria dentata	>10	C	Heavy rain in preceding nights (190mm)
								Crinia signifera	>50	C/M	
								Adelotus brevis	>10	C	
								Litoria nasuta	>10	C	
								Pseudophryne coriacea	>10	C	
								Litoria fallax	>5	C	
								Freshwater Crayfish	>10	F	3 relocated
22/1/15	NP/JE	East Rd frogging		2000	2115	100%, hr, rl, 22.8, 94%	DK	Litoria brevipalmata	2	C	Initially heard calling in response to playback. Responded every time call played. Photos, video and GPS coordinates recorded; E: 481840 N: 6527853
								Litoria dentata	>10	C	
								Crinia signifera	>50	C	
								Litoria gracilenta	>100	C/T	
								Limnodynastes peronii	>30	C	
								Pseudophryne coriacea	2	C	
								Litoria nasuta	<10	C	
								Litoria fallax	<10	C	
								Freshwater Crayfish	3	F	

								Tawny Frogmouth	1	C	
27/1/15	NP/GM	Bill Hill Rd	11500-12350	2030	2200	100%, rl, lr, 20.5, 90%	DK	Crinia signifera	>50	C	
								Litoria dentata	>40	C	
								Limnodynastes peronii	>30	C	
								Litoria fallax	<10	C	
								Pseudophryne coriacea	<5	C	
								Owlet Nightjar	1	C	
27/1/15	NP/GM	East Rd Frogging		2200	2300	100%, rl, lr, 19.6, 90.5%	DK	Crinia signifera	>20	C	
								Limnodynastes peronii	>10	C	
								Litoria dentata	<15	C	
								Uperoleia laevigata	<5	C	
28/1/15	NP/GM	Frogging South of Blackmans pt rd		2030	2130	80%, msb, nil, 21.4, 79.5	DT	Litoria tyleri	>20	C	
								Litoria fallax	<10	C	
								Limnodynastes peronii	>10	T/C	
								Crinia signifera	>10	C	
								Psued. coriacea	>10	C	
								Uperoleia laevigata	<5	C	
29/1/15	NP/GM	Frogging Cooperabung		2030	2130	5%, msb, nil, 20.3, 73.9%	DT	Litoria tyleri	<10	C	
								Litoria dentata	<10	C	
								Uperoleia fusca	>10	C	
								Limnodynastes peronii	<5	C	
								Litoria fallax	<10	C	
29/1/15	NP/GM	Frogging Barrie's Creek		2135	2235	5%, rl, nil, 20, 84.9%	DT	Pseudophryne coriacea	>200	C	
								Litoria fallax	1	C	
								Pink Tongue Lizard	1	T	
1/2/15	NP/JE	Cooperabung range	21600-22000	2020	2105	90%, rl, mod, 23.2, 82.8%	DT	Pseudophryne coriacea	>50	C	
1/2/15	NP/JE	Cooperabung drive corner		2110	2130	90%, rl, ls, 22.9, 90%	DT	Feathertail Glider spp.	1	F	
								Tawny Frogmouth	2	P	Juveniles.
1/2/15	NP/JE	Haydons Wharf Rd South	17600-18050	2130	2220	90%, rl, mod, 22.1, 99.5%	DK	Limnodynastes peronii	<5	C	
								Litoria fallax	<5	C	
								Litoria nasuta	<5	C	
								Litoria tyleri	>5	C	
								Litoria dentata	>10	C	
								Litoria peronii	>5	C	
								Uperoleia spp.	1	C	
1/2/15	NP/JE	Bill Hill North	11500-12350	2230	2315	60%, rl, nil, 22.6, 100%	DT	Feathertail Glider spp.	1	F	
								Litoria dentata	>10	C	
								Litoria gracilenta	<5	C	
2/2/15	NP/JE	Haydons Wharf Rd South	17600-18050	2035	2140	40%, nil, nil, 24.7, 75.2%	DT	Common Ringtail Possum	1	F	
								Litoria nasuta	<5	C	
								Litoria peronii	>5	C	
								Limnodynastes peronii	>10	C	
								Litoria tyleri	>10	C	

								Uperoleia spp.	2	C	
								Litoria fallax	<5	C	
								Litoria dentata	<5	C	
3/2/15	NP/TW	Haydons wharf	17600-18050	2030	2120	0%, nil, nil, 20.8, 78%	BR	Litoria nasuta	<5	C	
								Litoria peronii	<5	C	
								Limnodynastes peronii	<10	C	
								Litoria tyleri	<10	c	
								Uperoleia spp.	<10	C	
								Litoria fallax	<10	C	
								Pseudophryne coriacea	<15	C	
3/2/15	NP/TW	Bill Hill North	11500-12350	2125	2230	0%, nil, nil, 19.9, 74%	BR	Owlet Nightjar	1	C	
								Crinia signifera	>20	C	
								Limnodynastes peronii	<10	C	
								Litoria fallax	<5	C	
								Litoria nasuta	<5	C	
4/2/15	TW/JE	Haydons wharf rd sth	17200 - 17700	2032	2105	20%, nil, nil, 21.4, 68%	BR	Litoria nasuta	>5	C	
								Litoria peronii	<5	C	
								Limnodynastes peronii	<5	C	
								Litoria tyleri	<5	C	
								Litoria fallax	>5	C	
								Pseudophryne coriacea	>5	C	
								Grey-headed flying fox	1	F	
4/2/15	TW/JE	Haydons wharf rd nth	18200 - 18551	2115	2153	10%, nil, nil, 20.8, 69%	BR	Litoria fallax	>10	C	
5/2/15	NP/TW	North Sancrox	3400-3575	2040	2120	50%, rl, nil, 23.6, 67%	BR	Pseudophryne coriacea	<20	C	
5/2/15	NP/TW	North Haydons wharf	18200 - 18551	2130		75%, rl, nil, 22.3, 70%	BR	Rodent spp.	1	F	
								Litoria revelata	<10	C	
								Litoria fallax	<10	C	
								M. ITERATUS	3	C	
								Limnodynastes Peronii	<20	C	
								Uperoleia spp.	3	C	
7/2/15	NP/JE	North Haydons Wharf/Coop Ck frogging	18200 - 18551	2015	2200	20%, nil, nil, 23.3, 78.6%	BR	Mixophyes iteratus	4	C	At least 3 calling. All within 3m from stream.
8/2/15	NP/JE	South Fernbank	3600-4100	2020	2130	0%, nil, nil, 27.5, 71.8%	DK	Pseudophryne coriacea	>20	C	
8/2/15	NP/JE	North Haydons - Coop close	18200-19500	2145	2245	0%, nil, nil, 24.2, 80.7%	DK	GH FF	1	F	
								Tawny Frogmouth	1	F	
								Litoria dentata	1	C	
9/2/15	NP/JE	Cooperabung range	21900-22100	2050	2125	75%, rl, lr, 22.8, 96.7%	DK	Pseudophryne coriacea	>20	C	
10/2/15	NP/JE	Cooperabung range	21900-22400	2045	2130	60%, nil, nil, 22.9, 82.4%	DK	Pseudophryne coriacea	>50	C	
								Feathertail Glider spp.	1	F	
								GH FF	3	F	
10/2/15	NP/JE	Fernbank South	4100-4470	2210	2245	80%, nil, lr, 22.8, 78.6%	DK	Pseudophryne coriacea	>30	C	
								Uperoleia spp.	2	C	
								Litoria fallax	<5	C	
11/2/15	NP/JE/DR	Coop Ck literatus survey		2030	2140	20%, nil, nil, 24, 79.1%	DK	Mixophyes iteratus	1	C	Animal captured for pit tagging and

											relocation
11/2/15	NP/DR	Coop range	21900-22500	2210	2330	10%, nil, nil, 22.2, 79.5%	DK	Feathertail Glider spp.	1	T	
								Pink tongue lizard	1	F	Relocated
								Pseudophryne coriacea	>50	C	
15/2/15	NP/JE/TW	Coop Ck iteratus survey		2025	2125	80%, nil, nil, 24.4, 73.9%	DT	Mixophyes iteratus	1	C	Animal captured for pit tagging and relocation
15/2/15	NP/TW	Haydons Wharf to Coop Close		2135	2210	80%, nil, nil, 23.2, 82%	DK	small mammal spp. (Rodent? Ante?)	2	F/T	
15/2/15	NP/TW	Sancrox North	2800-3600	2230	2320	20%, rl, nil, 22.9, 98.2%	DT	Sugar Glider	1	F	
								Tawny Frogmouth	1	F	
16/2/15	NP/JE/TW	Coop Ck iteratus survey		2020	2125	10%, nil, nil, 24.5, 76%	DT	Mixophyes iteratus	1	F	Animal captured for pit tagging and relocation (large individual, prob. female.
	NP	Elliot trap line set									
16/2/15	NP/TW	Sancrox Rd North W	2800-3500	2145	2215	10%, nil, nil, 25.6, 76%	DT	GH FF	1	C	
17/2/15	NP/JE	Coop Ck iteratus survey		2030	2100	Nil, nil, nil, 25, 71.3%	DT	Antechinus spp.	1	F	Climbing tree. Noticed animal didn't want to climb higher than bark on F.Gum, just circled tree, hiding under decort. Bark.
17/2/15	NP/JE	Compound E Bdy		2120	2130	30%, nil, nil, 24.5, 75%	DT	Nil			
18/2/15	NP/JE	Coop Range	21900-22700	2125	2200	80%, nil, lr, 23.9, 84.4%	DK	Pseudo. coriacea	>10	C	
26/2/15	NP/GM	Coop Ck and Compound		0500	0600	60%, nil, nil,	DK	Uperoleia spp.	1	C	
								Litoria fallax	1	C	
27/2/15	NP/GM	Coop Ck		0500	0545	50%, nil, nil, 20, 92%	DK	Nil			
5/3/15	NP/BT	Coop Ck, sth fence line		0510	0600	0%, nil, nil, 23.7, 81%	DT	M iteratus 40m+ upstream	5	2c	1x juv(55mm); 2 males C
6/3/15	NP/JE	New Blackmans point rd		0445	0550	10%, nil, nil, 20.8, 76.2%	BR	Feathertail Glider spp	1	F	
2/3/15	NP/TW	Yarrabee Rd		0500	0555	85%, rl, ls, 23, 85.7	DK	Brown Antechinus	1	F	
2/3/15	NP/TW	Coop Range						Pseudophryne coriacea	>5	C	
3/3/15	NP/TW	Coop Range	22450-22620	0500	0545	0%, nil, nil, 18.4, 85.9%	DK	Microbat spp.	1	F	
3/3/15	NP/TW	Yarrabee Rd		0545	0600	0%, nil, nil, 18.2, 78%	DT	Nil			
4/3/15	NP/TW	Yarrabee rd East		0540	0600	0%, nil, nil, 21.9, 80%	DT	Nil			
4/3/15	NP/TW	Coop Creek fence line East		0500	0530	0%, nil, nil, 22.3, 79.7%	DT	Nil			
5/3/15	TW/JE	Coop range nth	22585-22900	532	610	0%, nil, nil, 22.3, 79.7%	DT	Nil			
5/3/15	TW/JE	Yarrabee nth	22000-22200	500	520	0%, nil, nil, 20.4, 82.1%	DT	Nil			
6/3/15	TW/BT	Coop range nth	22585-22900	525	600	0%, nil, nil, 23.1, 80%	DT	Nil			
6/3/15	TW/BT	Nth/sth Yarrabee rd E		500	515	0%, nil, nil, 21.7, 82.6%	DT	Nil			
9/3/15	TW/JE	Coop Ck ITERATUS survey		500	524	0%, nil, nil, 19.4, 76.6%	DT	Nil			
9/3/15	TW/JE	Yarrabee rd nth	Yarrabee nth	532	554	0%, nil, nil, 20.1, 79.7%	DT	Nil			
10/3/15	TW/JE	Cooperabung Ck		500	515	0%, nil, nil, 19.7, 94.2%	DT	Nil			
10/3/15	TW/JE	Nth Cooperabung range	22500-22900	530	550	0%, nil, nil, 22.3, 79.7%	DT	Nil			
11/3/15	TW/JE	Nth Cooperabung	22850-22200	515	615	90%, nil,nil, 22.4, 88.7%	DT	Nil			

		range									
12/3/15	TW/JE	Nth Cooperabung	21700-22100	518	605	0%, nil, nil, 19.4, 94.2%	BR	Pseudophryne coriacea	1	C	
								Tawny frogmouth	2	R	
13/3/15	TW/JE	Nth Cooperabung		517	523	100%, msb, heavy, 22.1, 92.8	DK	Nil			Rained out, had to leave site
16/3/15	TW/JE	Nth Cooperabung	21500-22400	516	613	0%, msb, nil, 18, 82%	DK	Pseudophryne Coriacea	5	C	
16/3/15	BT	Bill hill rd	13100-14200	502	615	0%, msb, nil, 18, 82%	DK	Nil			
17/3/15	BT	Bill hill rd	13100-14850	455	608	0%, mSb, nil, 14.8, 88%	DK	ONj	1	C	
18/3/15	BT/JE	Nth Cooperabung	22100-22400	505	527	50%;mSb;nil;	DK				
18/3/15	BT/JE	Nth Cooperabung	22850-22900	530	545	50%;mSb;nil;	DK				
19/3/15	BT	Bill hill rd	11600-11700	459	554	0%, nil, nil, 22.2;81%	DK				
19/3/15	BT	Bill hill rd	11900-12250	459	554	0%, nil, nil, 22.2;81%	DK	ONj	1	C	
30/3/15	NP/TW	North Cooperabung range	22900-23300	0530	0630	60%, nil, nil, 19, 82%	DK	Southern Dwarf Crown Snake	1	T	Relocated
8/4/15	NP	South	1100-1600	0440		0%, msb, nil, 15.5, 58.8%	DT	Sugar Glider	1	T	Juvenile
								Macropod spp.	2	T	
								Crinia signifera	>10	C	
								Pseudophryne coriacea	>5	C	
8/4/15	TW/GM	Sth Barries Ck	22900-23350	437	530	0%, nil, nil, 12.1, 82%	DT	Nil			
8/4/15	TW/GM	Sth Barries Ck	22900-23350	1840	1950	0%, nil, nil, 19.1, 70%	DT	Nil			
8/4/15	TW/GM	Sth Sancrox	750-1050	2020	2045	0%, nil, nil, 17.2, 71%,	DT	Ln bandicoot	1	F	
9/4/15	TW/GM	Sth Sancrox	750-1050	1850	1920	0%, msb, nil, 19.1,72.5%	DT	Nil			
	TW/GM	Sth Barries	22900-23300	1956	2030	0%, msb, nil, 18.2, 76%	DT	Crinia signifera	2	C	
13/4/15	NP/TW	Sth Barries Ck	22900-23400	1845	1925	10%, rl, nil, 20.7, 75.3%	DT	Litoria peronii	1	F	Relocated to stream
14/4/15	NP/TW	Sth Barries Ck	22900-23400	1905	1925	20%, nil, nil, 21.4, 75%	DK	Nil			
14/4/15	NP/TW	Blackmans South	7900-8650	1950	2040	20%, nil, nil, 22.5. 73.2%	DK	Nil			
15/4/15	NP/TW	South Barries	23200-23400	1905	1936	0%, nil, nil, 22.2, 82%	DK	Nil			
16/4/15	NP/TW	South Barries East	23350-23750	1855	2000	20%, nil, nil, 23.8, 82%	DK	Nil			
20/4/15	NP/JE	South Barries East	22900-23750	1850	1930	100%, nil, mlb, 19.7, 85%	DK	Nil			
21/4/15	NP/JE	South Barries Creek East	22500-23000	1850	1945	20%, nil, msgb, 17.6, 77%	DK	Nil			
7/5/15	NP/JE	South of Cooperabung close West	18300-18800	1840	1930	0%, nil, rl, 13.1, 97%	DK	Long Nose bandicoot	1	C	
								Crinia signifera	>10	C	
14/5/15	NP/JE	South East sancrox	700-1000	1830	1920	10%, nil, msb, 17.8, 59.3%	DK	Nil			
3/11/14	DR, NP		7000-7700	1945	2115	NR	M	Nil			
4/11/14	DR, JE		7300-8000	1945	2130	cc 60%, rl, nil, 23.3, 61.8	Bright	White-throated nightjar	1	C	
								Brush cuckoo	1	C	
17/11/14	DR, TW		7700-7800	2004	2024	Cc80%, rl, nil, 22.2, 64.4	Dark	Nil			
17/11/14	DR,TW		8900-9300	2035	2120	Cc80%, rl, nil, 22.2, 64.4	Dark	Nil			Green-thighed frog survey along track
17/11/14	DR, TW		21000-21500	2145	2235	Cc90%, nil, nil, 23.6, 62.7	Dark	GHFF	1	F	
18/11/14	DR, NP		9150-9650	2040	2125	100%, nil! light, 22.3, 86.5	Dark	Nil			
18/11/14	DR, NP		13600-14050	2150	2230	100%, nil! nil, 23.4, 76.2	Dark	Lim peronii, Lit nasuta, Uperoleia spp	2,1,1	T	All relocated outside alignment

18/11/14	DR, NP		21300-21500	2300	2135	100%, nil! nil, 22, 80%	Dark	GHFF	1	F	
18/11/14	DR, NP		20700-21000	2340	2400	100%, nil! nil, 22, 80%	Dark	GHFF	2	F	
23/11/14	DR, GM		Nth side coop Ck	2020	2050	95%; MLB, nil, 32.3; 33.4%	Dark	GHFF, Tawny Frog	1, 1	F	GBF survey nth side coop ck.; very poor conditions
23/11/14	DR, GM		19050-19350	2105	2135	95%, MLB, nil, 31.3, 38.3%	Dark	Noisy friar bird	1	R	
24/11/14	DR, GM		19050-19600	2020	2140	100%, nil! nil, 27.4, 63.2	Dark	GHFF	3	F	GBF survey sth side coop Ck, moderate cond - stormy; playback & active search (20min x 2 person)
								Limnodynastes peronii	1	T	
25/11/14	DR, GM		17850-18050	2025	2110	100%, rl, prev24hr, 23.1, 74.5	Dark	GHFF, L. fallax, L. peronii, L. caerulea.	5	F	
								L. fallax	5	C	
								L. peronii	1	C	
								L. caerulea	2	C	
25/11/14	DR, GM		10000-10600	2130	2230	100%, rl, <24hr, 22.8, 78.9	Dark	Nil			
25/11/14	TW, JE		7200-7650	2023	2130	100%, rl, <24hr, 27.7, 86%	Dark	GHFF, Eastern Grey kangaroo, Little Eagle (pr)	1, 1, 1	C, T, R	482293E, 6526355N
25/11/14	TW, JE		9150-9650	2140	2220	100%, nil, <24hr, 26.2, 82%	Dark	Nil			
26/11/14	DR, GM		17300-17800	2020	2220	100%, nil, v light, 22.7, 79.4	Dark	GHFF, Litoria nasuta	10, 1	F	
27/11/14	DR, GM		17300-17800	2020	2145	70%; rl, prev 24hr, 23.4, 65.4	Dark	GHFF, tawny frogmouth, L. fallax, L. tyleri, Ps. coriacea	6, 2, 5, 1, 10	F, R, C	Fallax & tyleri relocated into adj dam.
8/12/14	DR, TW, NP		19700	2030	2110	80%, nil, prev 24hr, 26.7, 71	Detail seen	Litoria gracilenta, L. latopalmata	2, 10+	C, C	GBF survey, 5m call broadcast at 3 sites; 3 person search of riparian zone; Ck dry
9/12/14	DR, TW, JE		23850-24100	2000	2030	80%, nil, prev24hr, nr, nr	Detail seen	Ps. coriacea, grey-headed flying-fox	50+	C	
10/12/14	DR, JE		20050-20700	2000	2125	100%, nil, nil, 24, 75	Detail seen	Petaurus spp., Feathertail glider, Ps. coriacea, L. fallax, Ad. brevis, Limnodynastes peroni	1,1,20,10, 5,5	F, C	Gliders at 20700; near HBT's
14/12/14	DR, GM, NP		Coop Ck	2020	2045	20%, rl! nil, 24.7, 83	Detail seen	Tawny frog; red-backed toadlet; tusked frog	1,2,1	C	
14/12/14	DR, GM, NP		20250-20700	2100	2130	20%, nil! nil, 23, 89	Detail seen	Red-backed Toadlet, tusked frog, antechinus spp	5, 5, 1	C, C, F	
12/1/15	DR, TW		10500-bill Hill	2040	2140	10%, rl! prev 24hr, 27, 73	Detail seen	Owlet nightjar, brown antechinus, Crinia signifera, L. dentata	1, 1, 1	C, T, c	
12/1/15	DR, TW		9025-9075& 9325-9275	2200	2254	5%, rl, prev24hr, 24.3, 76	Detail seen	Lim. peroni, Litoria dentata, Litoria tyleri, Ps. coriacea	5, 1, 1	C, C, C	
14/1/15	DR, NP		21500-22000	2045	2125	50; rl; nil; 29.3; 74	Detail seen	Feathertail spp; Ps coriacea; est small-eyed	1,1,1	F, F, T	Small-eyed & Toadlet relocated
14/1/15	DR, NP		11500-11600	2205	2230	nil; rl; nil; 27.7; 79	Detail seen	Lim peronii; owlet nightjar	2, 1	T, C	
15/1/15	DR, JE		11500-11600	2040	2100	100; nil; nil; 27.4; 73.9	Dark	Owlet nightjar, Litoria gracilenta	1, 1	C, C	
15/1/15	DR, JE		21500-22000	2125	2200	10; rl; nil; 27.9; 77.7	Dark	Ps. coriacea; L. tyleri; L. peronii	Several	C, C, C	Tyleri & peronii both in basin
9/2/15	DR		Coop Ck sth	2015	2135	40; rl; LS	Dark	M. iteratus; Lim. peroni; Litoria revelata; U. fusca, Lit tyleri; Litoria latopalmata	6 (os), 1, 3, 2, 1, 2	C	6 M. iteratus over 59m of creek bank - outside LoC
10/2/15	DR		18200-19200	2000	2100	15; rl; nil; 23	Dark	M. iteratus; tawny frogmouth; Litoria dentata; Litoria latopalmata	2; 1; 3; 3	C	2 iteratus on east side of Ck, outside LoC

13/2/15	DR, JE		Cooperabung Ck	2045	2145	15; nil; shower; 22	Dark	M. Iteratus; Limnodynastes peroni	1; 1	F	1 female tetanus just outside frog fence
13/2/15	DR, JE		21900-22400	2200		75; nil; shower; 22	Dark				
9/3/15	DR		11650-11700	0500	0530	0; nil; nil; 18; 77.2	DS	Barn owl; owlet nightjar	1, 2	C	
9/3/15	DR		Blackmans Pt Rd	0535	0615	0; nil; nil; 18; 77.2	DS	Nil			
10/3/15	DR		11700-12200	0500	0600	10; nil; nil; 21; 87	DS	Tawny frogmouth; owlet n'jar; ft cuckoo	1, 2, 2	C	
11/3/15	DR		11900-12350	0500	0600	90; nil; nil; 23; 85.6	DS	Owlet n'jar; barn owl	1, 1	C	
12/3/15	DR		11900-13150	0500	0615	0; nil; nil; 20; 81.	DS	Tawny F'mouth	1	C	
13/3/15	DR		11900-13100	0500	0615	100; rl; light; 21; 86	D	Nil			
26/3/15	DR, NP		900-1400	0530	0630	100; rl; nil; 21.7; 85	D	Nil			
27/3/15	DR, NP		1100-1600	0545	0630	Nil; rl; nil; 19.1; 62	D				
19/5/15	NP/JE	South East sancrox	800-1600	1800	1900	50%, nil, msb, 18.4, 85.6%	DK	Feather tail Glider	1	T	
								Microbat spp	2	F	Bat boxes in location
								Crinia signifera	<10	C	
								CRTP	1	F	
20/5/15	NP/GM	South East sancrox	800-1600	1815	1920	30%, nil, rl, 19.9, 85%	DK	Petaurid spp (SuG or SqL)	1	T	
								CRTP	1	F	
								Crinia signifera	<10	C	
NR	TW/JE	South East sancrox	750-1700	1810	1920	80%, nil, nil, 18.7, 95%	DS	Black rat	1	T	
								Tawny frog mouth	1	R	
NR	TW/JE	South East sancrox	750-1700	2028	2120	0%, nil, nil, 16.3, 83.7%	DS	Nil			
NR	TW/JE	South East sancrox	750-1700	1805	1900	0%, nil, nil, 18.8, 93.6%	DS	Nil			
20/07/15	GM/JE	Sancrox	1850-2450	1900	2030	50%, light, 16.2, 84.1%	nr	Eastern grey kangaroo, flying-fox spp.	1, 1	F	
21/07/15	GM/JE	Sancrox	1850-2450	1800	1900	5%, nil, 15.2, 87.3%	DS	nil			
22/07/15	GM/JE	Sancrox	1850-2450	1800	1900	100%, nil, 14.1, 93.6%	Dark	nil			
23/07/15	GM/JE	Sancrox	1850-2450	1800	1845	nr, nr, 17.9, 87.9%	nr	flying-fox spp	2	f	
18/08/15	GM	South SB Fernbank Creek	3600 - 4500	530	600	0%, nil, nil, 11, 81	Good	nil			
20/08/15	GM	RMS depot to Sancrox bridge SB	1800 - 2300	530	600	40%, light, nil, 11, 88	Good	nil			
21/08/15	GM	RMS depot to Sancrox bridge SB	1800 - 2300	530	600	0%, nil, nil, 11.8, 89	Good	nil			

Table D2: Pre-clearing surveys conducted for the Oxley Highway to Kundabung Pacific Highway Upgrade.

Date	Observer	Chainage Sampled	Purpose of clearing	Start Time	Finish Time	Species Captured (1 row for each individual)	Fate	Release Location
3/11/14	NP	6900-6700	Stage 1	0630	0800	1x Hemiaspis signata; 1x Lamp. delicata. 1x HBT marked up; active N.Friarbird? nest present.	Relocated outside LoC	W. Of BDY @ ch6800
4/11/14	DR	6800-7000	Stage 1	0720	0730	Nil		
4/11/14	DR	7000-7800	Stage 1	0600	0715	2x HBT marked (termitaria)		
5/11/14	DR/JE	7000-7700	Stage 1	0600	0730	3x HBT marked up		
6/11/14	TW/JE	7600-8250	Stage 1	0600	0720	Nil		
7/11/14	NP/TW	7000-7700	Stage 1	0550	0730	1x Lampropholis delicata relocated; 1x HBT marked up.	Relocated outside LoC	W. Of BDY @ ch7300
7/11/14	NP	19700	Stage 1	1000	1130	Nil		
10/11/14	NP/JE	7000-7700	Stage 1	0600	0710	2x HBT marked up (active S.Kingfisher in termitaria)		
11/11/14	NP/DR	7000-7700	Stage 1	0600	0700	Nil		
12/11/14	TW/NP	8288-8900	Stage 1	0600	0655	1x HBT marked		
12/11/14	TW	8200-8250	Stage 1	0710	0720	Nil		
13/11/14	NP/TW	7700-8700	Stage 1	0600	0710	1x Drey removed		
14/11/14	NP/TW	7700-8500	Stage 1	0600	0710	1x Hemiaspis signata; 2x Lampropholis delicata relocated	Relocated outside LoC	E of BDY @ ch8200
17/11/14	NP/JE	7686-8103	Stage 1	0600	0715	1x HBT log for relocation; 1x small mammal nest		
17/11/14	NP/JE	nr	Bund	0730	0800	Nil		
17/11/14	NP	19675	Frog fence	1200	1300	Nil		
18/11/14	NP/JE	8900-9500	Stage 1	0620	0730	1x Blind Snake; 1x HBT log	Relocated outside LoC	E of BDY @ ch 9100
18/11/14	NP/JE	7400	Stage 1	0600	0615	Nil		
19/11/14	NP/BT	8900-9500	Stage 1	0600	0710	1x Blind Snake; 3x HBTs marked up	Relocated outside LoC	E of BDY @ ch 9300
19/11/14	TW	21250-21500	Stage 1	0600	0650	1x log marked for relocation		
20/11/14	TW	21450-21500	Stage 1	0600	0620	Nil		
20/11/14	BT	20775-20700	Stage 1	0600	0630	Nil		
20/11/14	TW/BT	20180-19700	Stage 1	0635	0715	Nil		
21/11/14	TW	20700-20750	Stage 1	0600	0615	Nil		
21/11/14	TW	20100-19700	Stage 1	0625	705	Nil		
21/11/14	TW	18050-18200	Stage 1	0715	0730	Nil		
20/11/14	NP/JE	9200-9600	Stage 1	0600	0635	Nil		
20/11/14	NP/JE	13300-14300	Stage 1	0640	0800	1x HBT marked up		
21/11/14	NP/JE	13300-14300	Stage 1	0600	0645	1x HBT marked up		
21/11/14	NP/JE	9400-9600	Stage 1	0650	0745	Crows seen using stick nest; 1 deceased Litoria nasuta on track (squashed)		
24/11/14	NP/TW	9400-9800	Stage 1	0600	0700	Nil		
25/11/14	NP/TW	9800-10350	Stage 1	0600	0700	Nil		
26/11/14	NP/GM	9150-10600	Stage 1	0600	0900	2x HBT logs marked; 4x HBT marked		
26/11/14	TW	7200-8200	Stage 2	0600	0700	3x HBT marked		
27/11/14	NP/GM	9150-9950	Stage 2	0600	0730	1x drey removed; 1x HBT marked up; 1x Egernia major in log just outside LoC		
27/11/14	TW	7200-8200	Stage 2	0600	0650	Nil		
28/11/14	TW/GM	7800-8200	Stage 2	0600	0710	Nil		
28/11/14	NP	9150-9950	Stage 2	0610	0710	Nil		
4/11/14	DR	7000-7800	Stage 1	0600	0715	2x HBT marked (termitaria)		
4/11/14	DR	6800-7000	Stage 1	0720	0730	N/A		
18/11/14	DR/TW	21000-21350	Stage 1	0600	0655	1x fossorial skink		
24/11/14	DR	19050-19350	Stage 2	0600	0630	1x drey		
24/11/14	DR	21500	10x50m	0640	0700	2x horseshoe bats in pipe culvert; outside clearing zone - monitor.		
24/11/14	DR	19700	Basin in GBF	0800	0930	Strip basin; 1x Hemiaspis signata; 1x Saproscincus oriarus; 1x Lampropholis delicata; 1x Lampropholis amicula	Relocated into adjacent riparian habitat	
25/11/14	DR/GM	19050-19550	Stage 2	0600	0700	Nil		
26/11/14	DR	19350-19600	Stage 2	0600	0630	Nil; discussed clearing in GBF habitat		

26/11/14	TW	7200-7650	Stage 2	0600	0645	Nil		
27/11/14	DR	17400-17900	Stage 1	0600	0830	1x eastern small-eyed snake; 1x old antechinus den; 2x HBT marked	Relocated outside alignment	
27/11/14	DR	18300-18500	Services	0715	0745	1x passerine nest with dead chick		
27/11/14	DR	17400-17900	Stage 1	0600	0700	1x HBT marked		
1/12/14	NP	91500-9950	Stage 2	0600	0700	Nil		
1/12/14	TW/BT	17400-17900	Stage 1	0600	0700	3x HBT & drey marked up		
1/12/14	TW/BT	7500-7800	Stage 1	0720	0735	Nil		
2/12/14	NP	9159-10500	Stage 2	0600	0740	1x HBT marked up		
2/12/14	TW/BT	17250-17900	Stage 1	0600	0650	Nil		
2/12/14	TW/BT	18300-18870	Boundary fence	0730	0800	Nil		
3/12/14	TW	17250-17900	Stage 1	0600	0650	1x HBT with termitaria marked for retention		
3/12/14	TW	Wyndell Close	Access	1500	1510	Nil		
3/12/14	NP	9400-10450	Stage 2	0600	0710	1 x HBT marked up		
4/12/14	NP	9400-10000	Roadside	0600	0635	1x small cup nest removed		
4/12/14	TW/BT	18000-18660	Stage 1	0600	0650	3x HBT marked up		
4/12/14	TW/BT	Wyndell Close	Stage 1	0710	0730	Nil		
4/12/14	TW/BT	C599011(bat culvert)	Stage 1	0750	0755	Nil bats		
4/12/14	TW/BT	C599012(bat culvert)	Stage 1	0800	0805	Nil bats		
4/12/14	TW/BT	C599019(bat culvert)	Stage 1	0815	0820	Nil bats		
5/12/14	NP	7900-9000	Stage 2	0600	0715	1 x HBT marked up; active Sacred Kingfisher nest		
5/12/14	TW/BT	18000-18660	Stage 1	0600	0650	Nil		
5/12/14	TW/BT	Wyndell Close	Stage 1	0710	0725	Nil		
5/12/14	TW/BT	C599011(bat culvert)	Stage 1	0620	0623	Nil bats		
5/12/14	TW/BT	C599012(bat culvert)	Stage 1	0640	0645	Nil bats		
8/12/14	NP	10000-10450	Stage 2	0600	0700	Nil		
9/12/14	TW	18000-18700	Stage 1	0600	0700	Marked 28 FF trees.		
9/12/14	TW	Wyndell close	Stage 1	0715	0735	1x nest tree change to outside LoC		
12/12/14	NP/JE	Cooperabung Dr - Range rd.	Stage 2	0610	0700	1x Drey marked up		
24/11/14	JE	6119 - Hasting river	Stage 2	0525	0800	2 x HBT marked up		
25/11/14	JE	6800 - 7600	Stage 2	0520	0835	5x HBT marked up; 1 x Demansia psammophis relocated	Adjacent habitat	
3/12/14	JE	6561 - 8594	Stage 2	0525	1115	Nil		
4/12/14	JE	6561-8594	Stage 2	0545	0620	Nil		
8/12/14	DR	18050-18700	Stage 2	0600	0700	1 x HBT marked		
8/12/14	TW	17900-18250	Stage 1	0600	0630	Nil		
8/12/14	DR	Dalhunty Is, south bank	General observation	1200	1239	Flying fox camp, mostly black, 201 individuals		
9/12/14	DR	23730-24110	Stage 1	0730	1100	GTF search (20 mins); 14 FF (4 ironbark, 8 tallowwood); 4 nest boxes, several HBTs		
10/12/14	DR	23730-24110	Stage 1	0600	0645	Discussed HBT for removal; 2 hazardous trees, 1 nest tree removed after 24hrs		
10/1/14	DR	Wyndell Close	Stage 1	0720	0800	Discussed removal of trees on fence line; no significant habitat		
10/12/13	DR	Nth Cooperabung Drive	Stage 2	1200	1300	3 new HBT's,		
10/12/14	DR	Dalhunty Is, south bank	General observation	1330	1345	Flying fox camp, 201 individuals, all black FF		
11/12/14	DR/NP	20050-20700	Stage 2	0600	0710	1 x drey, numerous FF trees		

8/12/14	DR	18050-18700	Stage 1 & 2	0600	0700	1 x HBT		
15/12/14	NP/GM	20000-20700	Stage 2	0600	0700	Nil		
16/12/14	NP/GM	19600-20700	Stage 2/creek clearing	0600	0800	1 x HBT marked up, 1HBT destroyed		
17/12/14	NP/GM	19600-20700	Stage 2/ creek clearing	0600	0800	1 dead Snake found		
6/1/15	NP	8900-9200	Stage 2	0610	0640	Nil		
6/1/15	BT/GM	9500-10500	Stage 2	0610	0640	Stick nest@10500 (corvid?)		
7/1/15	NP	8650-9200	Stage 2	0600	0645	2 x HBT marked up		
7/1/15	NP/JE	10500-11000	Stage 2	0600	0825	1x Blue tongue lizard escaped capture		
7/1/15	BT/GM	20600-21100	Stage 2	0610	0650	Nil		
8/1/15	NP/JE	10000-11100	Stage 2	0600	0700	1x Echidna relocated		
8/1/15	BT/GM	20900-21500	Stage 2	0610	0655	Nil		
9/1/15	NP/JE	10000-11400	Stage 2	0610	0810	6x HBTs marked up; 3 logs marked up		
9/1/15	NP/JE	8910	Roundabout	0815	0840	1x HBT marked up		
9/1/15	BT/GM	20600-21100	Stage 2	0610	0640	Nil		
12/1/15	NP/TW	11200-11400	Stage 2	0600	0715	1 x HBT marked up		
13/1/15	NP/TW	11200-11400	Stage 2	0600	0720	1 x Lampropholis delicata relocated		
14/1/15	NP	11200-11400	Stage 2	0600	0700	1 x HBT marked up		
14/1/15	NP	7400-8900	Service corridor	0700	0800	Nil		
15/1/15	NP	11400-11600	Stage 2	0600	0700	3 x HBT marked up		
15/1/15	NP	7400-8900	Service corridor	0700	0800	1 x HBT stump marked up.		
14/1/14	TW	18600-18900	Fence line	0630	0700	Nil		
15/1/14	TW	18000-17600	Fence line	0630	0700	Nil		
16/1/15	NP	11400-11600	Stage 2	0600	0700	1 x HBT log marked up		
16/1/15	NP	7400-8900	Service corridor	0700	0800	1 x Lampropholis delicata relocated		
16/1/15	TW	18050-17225	Fence line	0630	0700	1x nest marked		
19/1/15	NP/TW	11600-12350	Stage 1	0600	0745	3 x HBT marked up		
19/1/15	NP/TW	Wilson River South	Grass slashing	0800	0900	Nil		
19/1/15	BT	21500-21950	Stage 1	0600	0655	Nil		
19/1/15	BT	7600-8870	Service corridor	0805	0840	Nil		
20/1/15	NP	7600-8870	Service corridor	0700	0735	Nil		
22/1/15	NP/JE	7600-8870	Service corridor	0700	0710	Nil		
28/1/15	NP/GM	Trapping line		0600	0640	1 x Bush Rat	relocated into adjacent habitat	
3/2/15	NP	7600-8870	Service corridor	0730	0815	Nil		
3/2/15	NP	11500-12350	Stage 1	0600	0720	1 x HBT marked up		
4/2/15	TW/JE	17200-17700	Stage 2	0600	0640	Nil		
4/2/15	NP	11500-12350	Stage 1	0600	0700	Nil		
5/2/15	TW	17200-17700	Stage 2	0610	0640	Nil		
5/2/15	TW	21600-22100	Stage 1	0655	0730	Nil		
5/2/15	NP	11500-12350	Stage 1	0600	0700	Nil		
5/2/15	NP/TW	Haydons wharf rd-18540	Stage 2	0900	1000	1x Saiphos equalis relocated; 1x Drey marked up; 3x HBT marked up		
6/2/15	NP	Sancrox	Stage 1	0700	0800	3 x HBT marked up		
9/2/15	NP	Haydons wharf rd-18540	Stage 2	0600	0730	Nil		

9/2/15	NP	Cooperabung Range	Stage 1	0740	0815	FF trees marked up		
10/2/15	NP	Fernbank South	Stage 1	0600	0720	Nil		
11/2/15	NP	Fernbank South	Stage 1	0630	0740	3 x HBT marked up		
12/2/15	NP	Fernbank South	Stage 1	0615	0715	Nil		
13/2/15	NP	Fernbank South	Stage 1	0615	0700	1 x Wedge-tail Eagle observed hunting		
16/2/15	TW/JE	Fernbank South	Stage 1	0615	0710	Nil		
16/2/15	NP	18000-19300	Stage 2	0615	0700	Nil		
16/2/15	NP	22300-22445	Stage 1	0715	0815	1 x HBT; 1 x HBT log; Fauna furniture trees marked		
17/2/15	NP	18800-19300	Stage 2	0615	0700	Nil		
17/2/15	NP	22300-22445	Stage 1	0700	0800	Brown Gerygone Nest marked up		
17/2/15	JE/TW	19600	Creek clearing	0900	1000	1 x HBT marked up		
18/2/15	NP	Haydons wharf south fence line	Fence line	0630	0700	Nil		
18/2/15	TW	4000-4500	Fence line	0630	0650	Nil		
18/2/15	TW	Nth bank Hastings river	Stage 2	0700	0710	Nil		
18/2/15	TW	6800-6850	Stage 2	0715	0725	Nil		
18/2/15	TW	7577-7336	Fence line	0730	0745	Nil		
18/2/15	NP	22300-22445	Stage 1	0730	0800	Nil		
19/2/15	TW	7577-7336	Fence line	0630	0640	Nil		
19/2/15	TW	7000	Stage 2	0645	0645	Nil		
19/2/15	NP	22300-22445	Stage 1	0630	0715	Nil		
25/2/15	NP/GM	Cooperabung Creek	Stage 2	0630	0715	Nil		
26/2/15	NP/GM	Cooperabung Creek	Stage 2	0630	0715	Nil		
27/2/15	NP/GM	Cooperabung Creek	Stage 2	0620	0700	1 x small HBT relocated by hand over LoC		
27/2/15	NP/GM	Crushing yard, Cooperabung Compound	Stage 2	0710	0800	4 x Tawny Frogmouths just outside LoC, mentioned to operators		
2/3/15	NP/TW	22100-22400	Stage 1	0630	0710	Culvert clear of Bats, Gerygone chicks fledged.		
2/3/15	NP/TW	South Wilson River	Stage 2	0730	0800	Nil		
3/3/15	NP	22600-22700	Stage 1	0700	07300	Nil		
3/3/15	TW	South Wilsons river	Stage 2	0730	0800	1x HBT taken down		
3/3/15	TW/NP	Nth Yarrabee rd. E	Side road	0630	0710	2x Microbats (probable horseshoe) in culvert N of Yarrabee		
4/3/15	NP/TW	Nth Yarrabee rd.	Side road	0630	0715	Nil		
4/3/15	NP	22600-22700	Stage 1	0730	0815	Nil		
5/3/15	BT/NP	Nth Yarrabee rd. E	Side road	0610	0700	Nil		
5/3/15	TW/JE	22585-22900	Stage 1	0630	0700	Nil		
5/3/15	TW/JE	Yarrabee nth	Side road	0710	730	Nil		
6/3/15	TW/BT	22585-22900	Stage 1	0630	0700	Nil		
6/3/15	TW/BT	Nth/south Yarrabee rd. E	Side road	0715	0745	Nil		
6/3/15	TW	Wyndell close	Side road	0815	0825	Nil		
9/3/15	TW/JE	Yarrabee nth	Side road	0715	0730	Nil		

9/3/15	TW/JE	22600-22900	Stage 1	0630	0700	Nil		
10/3/15	TW	22400-22900	Stage 1	0630	0700	Nil		
10/3/15	TW	18800-19400	Stage 2	0720	0755	Nil		
11/3/15	TW/JE	22800-22900	Stage 1	0630	0640	Nil		
11/3/15	TW/JE	Yarrabee south	Stage 1	0700	0720	Nil		
11/3/15	TW/JE	Tinkers south	Fence line	0740	0805	Nil		
11/3/15	TW/JE	21800-22150	Stage 2	0820	0900	1x HBT marked; 3x logs marked		
12/3/15	TW/JE	22400-21650	Stage 2	0630	0720	Nil		
12/3/15	TW/JE	Yarrabee rd. South	Side road	0735	0750	Nil		
12/3/15	TW/JE	Cut 19B	Stage 2	0800	0805	Nil		
13/3/15	TW	22100-21660	Stage 2	0715	0755	FF marked up		
13/3/15	TW/JE	South Yarrabee rd.	Side road	0635	0655	Nil		
13/3/15	TW	20700 cut 19A	Fauna fence	0810	0820	Nil		
16/3/15	TW/JE	21500-22400	Stage 2	0640	0750	Nil		
16/3/15	TW/JE	Cut 19a West 20700	Fauna fence	0800	0805	Nil		
16/3/15	BT	13100-14200	Stage 2	0640	0725	Nil		
16/3/15	BT	Wharf rd.- Blackmans pt. rd.	Stage 2	0740	0755	Nil		
17/3/15	BT	13100-14900	Stage 2	0640	0756	Mark up Stick nest (inactive?) @14850		
18/3/15	BT/JE	22100-22400	Stage 2	0630	0650	Nil		
18/3/15	BT/JE	22850-22900	Stage 2	0652	0659	Nil		
19/3/15	BT	11600-11700	Stage 2	0920	0930	Nil		
19/3/15	BT	11900-12250	Stage 2	0830	0920	3x HBT marked up		
19/3/15	BT	13850-15550	Stage 2	0640	0725	Nil		
24/3/15	JE	22180	Culvert	nr	nr	Nil		
24/3/15	JE	Wyndell close	Stage 2	nr	nr	Nil		
24/3/15	JE	Wilmaria rd.	Stage 2	nr	nr	Nil		
25/3/15	JE	Wyndell close	Stage 2	nr	nr	Nil		
25/3/15	JE	Wilmaria rd.	Stage 2	nr	nr	Nil		
26/3/15	JE	22180	Culvert	nr	nr	Nil		
26/3/15	JE	Wilmaria rd.	Stage 2	nr	nr	Nil		
26/3/15	JE	Wyndell close	Stage 2	nr	nr	Nil		
26/03/15	DR, NP	0900-1400	Stage 2	0615	0700	Nil		
27/3/15	JE	22180	Culvert	nr	nr	Nil		
27/3/15	JE	Wilmaria rd.	Stage 2	nr	nr	Nil		
27/03/15	DR, NP	1100-1600	Stage 2	0615	0700	Nil		
30/3/15	NP	Blackmans point rd.	Interchange	0645	0715	Egernia mcpheei located but escaped capture		
6/3/15	NP	Blackmans point blackbutt	Stage 2	nr	nr	Nil		
6/3/15	NP/JE	Median 1100	Stage 1	nr	nr	2 x HBT marked up		
6/3/15	NP	Dalhunty Island	Large tree clearing	nr	nr	Fox observed.		
30/3/15	NP/JE	Fernbank Creek	Haul rd.	nr	nr	2x Antechinus spp. fled hollow log into grass		
8/4/15	NP	1100-1600	Stage 2	0620	0720	3 x HBT marked up; 2 x dreys marked up		
8/4/15	NP	Fernbank Ck	Stage 2	0830	0900	Nil		
9/4/15	NP	750-1600	Stage 2	0600	0700	Nil		
8/4/15	TW/GM	22900-22300	Stage 2	0605	0710	Nil		
8/4/15	TW/GM	Nth Haydons wharf rd.	Stage 2/Side road	0815	0815	1x nest checked		

9/4/15	TW/GM	22000-23350	Stage 2	0610	0720	1x horseshoe bat in 700mm culvert adj to cleared area. Was not in culvert prior to clearing		
9/4/15	TW	18000-18300	Stage 2/side road	0820	0840	Nil		
9/4/15	TW	Railway-Wilsons	Stage 2	0855	0925	Nil		
9/4/15	TW	Barries Ck heritage bridge	Stage 2	0945	1000	Nil		
10/4/15	TW/GM	22900-23300	Stage 2	0610	0700	Nil		
10/4/15	TW/GM	18000-18300	Side road	0730	0800	Nil		
10/4/15	TW/GM	18700	Stage 2	0810	0815	Nil		
10/4/15	NP	750-1100	Stage 2	0600	0700	1x drey removed		
10/4/15	NP	Fernbank Ck	Stage 2	0700	0730	Nil		
14/4/15	NP/TW	22900-23400	Stage 2	0600	0700	FF trees marked up		
15/4/15	NP	7900-8650	Stage 2	0600	0700	Nil		
13/4/15	TW	22900-23350	Stage 2	0610	0700	Nil		
15/4/51	TW	22900-23400	Stage 2	0610	0650	Nil		
16/4/15	NP	7900-8650	Stage 2	0600	0715	2 x FF trees marked up		
16/4/15	TW	23000-23400	Stage 2	0600	0625	Nil		
16/4/15	TW	23550-23750	Stage 2	0640	0740	FF marked up, HBTs remarked. Core Koala habitat		
16/4/15	TW	Barries Ck bridge	Stage 2	0750	0800	Nil		
16/4/15	TW/NP	23550-23750	Stage 2	0800	0830	Core Koala habitat		
17/4/15	NP	7900-8650	Stage 2	0600	0715	Nil		
17/4/15	TW	23255-23750	Stage 2	0610	0710	FF marked, HBTs remarked		
20/4/15	NP/JE	22900-23500 E	Stage 2	0610	0720	1x HBT marked up; Glossy Black Cockatoo flew overhead		
20/4/15	NP/JE	7900-8650	Stage 2	0730	0815	Nil		
21/4/15	NP	7900-8650	Stage 2	0600	0700	Nil		
21/4/15	JE	22900-23750	Stage 2	0600	0630	Nil		
21/4/15	JE	22890-23390	Stage 2	0630	0700	Nil		
21/4/15	JE	Hayden's wharf area	Extension	0730	0800	Nil		
22/4/15	NP/JE	22700-23500	Stage 2	0600	0700	Nil		
22/4/15	NP/JE	Cooperabung close fence line East	Fence line	0710	0730	Nil		
23/4/15	NP	Cooperabung close - Cooperabung creek East	Positrack	0700	0730	Nil; 3x Wood ducks stuck behind concrete barrier on highway.		
23/4/15	NP	Yarrabee rd. culvert extension	Culvert access	0740	0815	Nil		
23/4/15	NP	South railway	Stage 2	0830	0900	Nil		
23/4/15	NP/JE	Fernbank creek	Stage 2	1100	1115	Nil		
23/4/15	NP/JE	Barries creek batter	Stage 2	1200	1300	Nil		
24/4/15	NP	Blackmans bus stop	Stage 2	0600	0700	Nil		
28/4/15	NP	Barries Ck batter and wings at Cooperabung hill climb	Small trees	0700	0740	Nil		
28/4/15	TW	7450-8750	Stage 2	0615	0645	FF marked up		
28/4/15	TW	Blackmans bus stop	Stage 2	0645	0705	FF marked up		

28/4/15	TW	Hayden's wharf rd.	12 trees	730	0750	Nil		
28/4/15	TW/NP	South railway	Stage 2	815	0850	Coral trees marked for disposal		
29/4/15	NP	South Railway, Wilson north bank	Stage 2	0700	0745	Nil		
29/4/15	NP	Cooperabung hill climb barriers	Two offshoots	0800	0810			
29/4/15	NP	Culvert South East Yarrabee	Culvert access	0820	0840	Nil. Nil bats in culvert		
29/4/15	TW	7450-7750	Remaining trees	0630	0700	Nil		
29/4/15	TW	Blackmans bus stop	Remaining trees	0700	0710	Nil		
30/4/15	TW	7450-7550	Remaining trees	0620	0645	Nil		
30/4/15	NP	18800	Access track	0700	0715	Nil		
30/4/15	NP/TW	Fence line Wyndell close	Fence line	0730	0830	Nil		
4/5/15	JE	Dalhunty Island	Stage 2	0800	0900	Nil		
6/5/15	NP	7450-7550	Remaining trees	0600	0645	Nil		
6/5/15	NP	9200-9300	Stage 1	0650	0730	Nil, mentioned to Hari - sediment in GTF habitat		
6/5/15	GM	18700-18800	Crossing	0700	0720	Empty bird nest taken out		
6/5/15	GM	Wyndell Close	Fence line	0730	0745	Nil		
7/5/15	NP	9200-9300	Basin	0600	0630	Nil		
7/5/15	NP	7350-7650	Drain	0640	0700	1 x HBT marked up; 3 logs marked for relocation		
8/5/15	JE	19750-20250	Slashing	0730	0815	Nil		
8/5/15	JE	Cut 19A	Widening	1300	1330	Nil		
8/5/15	JE	750-100	Median	0900	1000	Nil		
8/5/15	JE	18300-18700	Stage 2	0630	0800	Nil		
11/5/15	NP	10400-11300	Drain	0600	0645	Nil		
11/5/15	NP	18440-18800	Stage 2	0700	0800	1 x HBT marked up; FF marked up		
11/5/15	NP	19750-20250	Slashing	0810	0830	Nil		
12/5/15	NP	4450-4800	Stage 2	0700	0800	Nil		
12/5/15	JE	19750-20250	Stage 2	0700	0800	Nil		
12/5/15	JE	18100-18300	Stage 2	0810	0900	Nil		
13/5/15	NP	4450-4800	Stage 2	0600	0630	Nil		
13/5/15	NP	18440-18800	Stage 2	0640	0715	2 x FF trees marked up; no bats in culvert		
13/5/15	NP	19750-20250	Slashing	0725	0800	Nil		
14/5/15	NP	8500-8900	Stage 2	0830	0900	Nil		
14/5/15	NP	19750-20250	Remaining trees	0730	0815	1 X FF tree marked		
14/5/15	NP	18440-18800	Fence line	0700	0730	1 x Small Eyed Snake relocated		
15/5/15	NP	18440-18800	Fence line	0700	0730	Nil		
15/5/15	JE	19750-20250	Remaining trees	0720	0745	Nil		
15/5/15	NP/JE	700-1000 E	Stockpile	0800	0930	10 x FF trees marked		
18/5/15	NP	700-1000	Stockpile and fence	0620	0715	Nil bats in boxes		
19/5/15	JE	18100-18700	Fence line	0700	0730	Nil		
11/12/14	DR/NP	20050-20700	Stage 2	0600	0710	1 x drey; numerous FF trees		

15/12/14	DR	South compound	Fence line	0700	0730	Nil		
15/12/14	DR/NP/GM	Dalhunty Island South bank	General observation	1200	1220	Flying-fox camp, 189 individuals, all black, dependent juv present		
16/12/14	DR	6600	Stockpile	0630	0700	Nil		
12/1/15	DR	21000	Stage 2	0600		Clearing cancelled		
13/1/15	DR	20800-21200	Stage 2	0600	0700	Nil		
14/1/15	DR	21500-22000	Stage1	0600	0800	1x Egernia mcpheei; 1x Calyptotis spp; 1x small cup nest (poss YFH); 10x varied sitella	Skinks released immediately over boundary & cup nest inspected	
15/1/15	DR	21500-21900	Stage 1	0600	0730	Nil - searched for sitella		
15/1/15	DR	Dalhunty Is South bank	General observation	0900	0920	238 black flying-fox; 2 x osprey		
16/1/15	DR/TW	21600-22000	Stage 1	0600	0720	Nil		
10/2/15	DR	18200-18600	Stage2	0600	0700	Nil - good stack of fauna furniture (mostly ironbark) sheared.		
11/2/15	DR	18200-18900	Stage 2	0600	0700	Nil - marked some extra fauna furniture		
12/2/15	DR	18200-18300	Stage2	0700	0730	Nil		
9/3/15	DR	Blackmans Pt. Rd	Stage 2	0800	0930	1 x drey; 1 x HBT		
9/3/15	DR	11650-11700	Stage 2	0725	0750	Nil; raked litter & searched for GTF		
10/3/15	DR	11650-12250	Stage 1	0600	0715	Nil		
11/3/15	DR	11900-13100	Stage 1 & fence line	0615	0715	Nil		
10/3/15	DR/TW/JE	Cooperabung Ck	Crossing	0930	1530	75 person minutes dip netting		
12/3/15	DR	12150-13150	Stage 2	0615	0715	Nil		
12/3/15	DR	10600-11400	Nth bound west edge	0730	0800	Nil		
12/3/15	DR	~10800	South bound median	0810	0830	1x hazardous tree, which will damage a tree outside the median. No significant habitat value.		
26/3/15	DR/NP	900-1400	Stage 2	0645	0730	15x fauna furniture trees marked		
27/3/15	DR/NP	1100-1600						
20/5/15	NP/GM	700-1800	Fence line and mainline	0630	0800	2 x HBTs marked u; 2 x Hlogs marked up		
25/05/15	TW/JE	750-1700	Stage 2	0630	0730	Bat boxes in area inspected		
26/05/15	TW	18600-18700	Fence line	0700	0800	2 fauna furniture trees marked		
27/05/15	TW	18600-18700	Fence line	0700	0730	nil		
28/05/15	TW	750-1700	Stage 2	0640	0710	Bat boxes in area inspected		
26/05/15	JE	750-1700	Stage 2	0615	0800	Bat boxes in area inspected		
27/05/15	JE	750-1700	Stage 2	0615	0710	Bat boxes in area inspected		
3/06/15	JE	Southern side of Hastings River	Install rock platform	0700	0730	Nil		
4/06/15	JE	16860	Crush mangroves and infill	0800	0830	Nil		
4/06/15	JE	16650	Crush mangroves and infill	0845	0900	Nil		
5/06/15	JE	16650	Crush mangroves and infill	08454	0900	Nil		
10/06/15	JE	16860	Crush mangroves and infill			Nil		

10/06/15		10500 to 10782	Clear west side Nth bound carriageway			Nil		
11/06/15	JE	13600 to 14300	clear fence line	0800	0845	Nil		
12/06/15	JE	11700 to 11800	Stock pile	0630	0730	Nil		
12/06/15	JE	16700	Dalhunty island	0730	0745	Nil		
15/06/15	DO	20070-20700	Fenceline	0830	0930	Nil		
16/06/15	TW	20080-20700	fenceline	0650	0715	Nil		
16/06/15	TW	9750-10000	stockpile	0730	0750	Nil		
16/06/15	TW	4500-4900	full width	0830	0900	Water Dragon in tree - tree to be retained		
17/06/15	TW	4500-4900	full width	0730	0800	Nil		
19/06/15	DR	16700	Dalhunty island	0730	0800	Agreed to retain 1 small stag near LoC & 1 mature swamp oak		
22/06/15	DO	20070-20700	Fenceline	0800	0830	Nil		
22/06/15	DO	20150-20500	Extension of LoC	0900	0930	Nil		
22/06/15	DO	16450-16550	Mainline clearing	1000	1030	1 cockspur coral tree within LoC		
23/06/15	BL	20070-20700	Fence line	0900	1000	Nil		
23/06/15	BL	15500	Mainline	800	830	1 HBT (BLP with 1sb)		
24/06/15	JE	20080 to 20800	Fence line, additional clearing along drainage line	700		Nil		
	JE	Cut 17/16	Clearing of batter Nth and South bound	840		Nil		
	JE	4700 to 4900	Filling in swampy habitat at Fernbank Ck			Nil		
25/06/15	JE	20080 to 20800	Fence line and additional clearing along drainage line			Nil		
		4500 to 4800	Fill in habitat at Fernbank Ck			Nil		
21/07/15	GM/JE	1850-2450	South Sancrox Rd	645	745	Nil		
21/07/15	GM	18000	Powerline easement Wyndell Close	745	800	Nil		
22/07/15	GM/JE	1850-2450	Stage 2	645	745	Nil		
23/07/15	GM	1850-2450	Stage 2	700	800	Nil		
24/07/15	GM	1850-2450	Stage 2	630	730	Nil		
25/07/15	JE	1850 to 2450	Stage 2	730	815	Nil		

27/07/15	JE	1620 to 2300	Stage 2	630	800	marked up Casuarina with active drey (see HBT removal)		
28/07/15	JE	1900 to 2450	Stage 2	645	720	Nil		
29/07/15	JE	2350 to 2800	Stage 2	645	740	Nil		
29/07/15	JE	750 to 1700	East side water main	1030	1145	Nil		
30/07/15	JE	750 to 1700	East side water main	645	715	Nil		
31/07/15	JE	750 to 1700	East side water main					
3/08/15	JE	750 to 1700	East side water main					
3/08/15	JE	2350 to 2800	Stage 2					
4/08/15	JE	2350 to 2800	Stage 2	900	930	Nil		
5/08/15	BDL	2800-3600	Stage 2	545	630	Nil		
6/08/15	BDL	2800-3850	Stage 2	530	715	Nil		
7/08/15	BDL	2800-4100	Stage 2	530	730	Grey headed Flying fox; 3 x Rusa Deer		
8/08/15	BDL	2150-2450	Stage 2	730	800	Nil		
10/08/15	BDL	2150-4100	Stage 2	515	730	Nil		
11/08/15	BDL	2150-4100	Stage 2	515	745	1 x Sugar Glider; 1 x Deceased Long-nosed Bandicoot		
12/08/15	BDL	1900-4300	Stage 2	515	800	1 x Common Ringtail Possum		
13/08/15	BDL	1000-4300	Stage 2	515	945	1 x Barn Owl; 1 x Common Ringtail Possum		
14/08/15	BDL	3600-4300	Stage 2	515	715	1 x Common Ringtail Possum		
18/08/15	GM	4000 - 4650	Stage 2	630	800	Nil; Fairy Martins nesting in box culvert		
18/08/15	GM	Mooney St (Sports club) to 200m north along highway	Grass slashing	900	915	Nil		
18/08/15	GM	21030 - 20240	Stage 2	930	1100	Active burrow found (ch20590) and excavated, nothing found		
19/08/15	GM	2300 - 2500	Stage 2	600	630	Nil		
20/08/15	GM	1800 - 2300	Stage 2	615	715	Nil		
21/08/15	GM	1800 - 2300	Stage 2	615	715	Nil		
24/08/15	JE	1800 to 2500	Cancelled due to rain	645	710			
25/08/15	JE	1800 to 2500	East side	640	715	nil		
26/08/15	JE	Lend Lease Compound				nil		
7/09/15	JE	Corner Bill Hill and Pacific Hwy	East side	700	730	nil		

Table D3: Habitat tree data collected during clearing for the Oxley Highway to Kundabung Pacific Highway Upgrade. NR = not recorded

HBT #	Date	Observers	Location	Tree species	Hollows	Fauna signs	Fauna present	Comment
H123	5/11/14	NP	South compound ch6500	E. pilularis	1sb	Nil	Nil	
H122	5/11/14	NP	South compound ch6500	E. pilularis	2sb, 1mb	Old leaf material in sb. Some wear	Nil	Possible Petaurid
H121	5/11/14	NP	South compound ch6500	Corymbia intermedia	1sb	Some leaf material, very wet	Nil	
HS5	5/11/14	NP	South compound ch6500	E. globoidea	1m term Large chamber (30x30cm, old)	Wear in chamber	Nil	
HAdd	5/11/14	NP	South compound ch6500	E. microcorys	3s term	Foraging holes	Nil	S. Kingfishers observed scouting termitaria
HAdd	5/11/14	NP	South compound ch6500	Melaleuca spp.	S stick nest	N/A	Nil	Possible White-headed pigeon
H125	6/11/14	TW/JE	7100	Stag	1lt, 1mt, 3st, 2sb, 2mb	Fresh leaf nest, large nest constructed of small clumps of fresh euc leaves.	Nil	Possible BT Phascogale
H157	6/11/14	TW/JE	7100	Eucalyptus spp.	1s term		Nil	
HAdd	6/11/14	TW/JE	7100	Eucalyptus spp.	1s term 300mm deep hole	4 small white eggs (25mm)	Nil	Possible Kingfisher spp. eggs
H131	6/11/14		Ch7900 W of existing hwy	E. pilularis	1mb	Nil	Nil	
H13#	6/11/14		Ch7900 W of existing hwy	E. pilularis	Nil	Nil	Nil	
HAdd	10/11/14	NP/JE	7600 - 7900	E. acmenoides	Nil	Noisy Friarbird Nest	Adult bird flying about, alarmed	Very fresh nest, about to lay?
H148	10/11/14	NP/JE	7600 - 7900	E. pilularis	2sb	Nil	Nil	
H146	10/11/14	NP/JE	7600 - 7900	E. pilularis	Nil	Nil	Nil	
HAdd	10/11/14	NP/JE	7600 - 7900	E. acmenoides	1sb	Nil	Nil	
HAdd	10/11/14	NP/JE	7600 - 7900	Corymbia gummifera	Nil	Nil	Nil	
HS24	10/11/14	NP/JE	Ch 8500 W of existing hwy	E. pilularis	1lt, 1sb	Drey material, wear.	Lace Monitor	LM escaped capture into windrow
HAdd	10/11/14	NP/JE	Ch 8500 W of existing hwy	Eucalyptus spp.	1sb, 1s term	Nil	Nil	
H139	10/11/14	NP/JE	Ch 8500 W of existing hwy	E. pilularis	Nil	Nil	Nil	
HAdd	10/11/14	NP/JE	Ch 8500 W of existing hwy	E. acmenoides	Nil	Nil	Nil	
HS14	12/11/14	TW/NP	7600 - 7900	E. globoidea	1vl sp	Nil	Nil	
HAdd	12/11/14	TW/NP	7600 - 7900	E. microcorys	1sb, 1s term	Wear in sb	Nil	
HAdd	12/11/14	TW/NP	7600 - 7900	E. microcorys	1m term	Fresh leaf nest in term chamber	Nil	Possible Petaurid/FTG
H149	12/11/14	TW/NP	7600 - 7900	E. pilularis	1lt	Nil	Nil	
HAdd	12/11/14	TW/NP	7600 - 7900	E. pilularis	1sb, 1mb, 1lt	Nil	Nil	
H167	17/11/14	NP/JE	8200 - 8300	E. pilularis	1mb, 1sb	Nil	Nil	
H166	17/11/14	NP/JE	8200 - 8300	E. resinifera	Nil	Nil	Nil	

HAdd	17/11/14	NP/JE	8200 - 8300	E. pilularis	1sb	Nil	Nil	
H162	18/11/14	nr	Ch7500	Stag	1vlb, 1vl sp, 1lt, 3lb	Old leaf nest	2 x Eulamprus tenuis, 1 x Adult Brown Antechinus, 5 pinkies	Adult escaped into windrow, pinkies died in care, 1 x Eulamprus escaped
HAdd	19/11/14	nr	18600	Stag	Nil	Nil	Nil	
HAdd	24/11/14	TW/NP	Ch13900	Melaleuca quinquenervia	1sb, 1mt	Wear in m hollow	Nil	
HAdd	24/11/14	TW/NP	Ch13900	nr	Nil	Nil	Nil	
HAdd	24/11/14	TW/NP	Ch13900	nr	1mt	Nil	Nil	
HAdd	25/11/14	NP/GM	South Hastings river floodplain	Araucaria heterophylla	Nil	2 cup nests	3 x Figbird eggs	Well developed embryo, euthanased
HAdd	25/11/14	TW/NP	Ch13900	nr	1sb, 1st	Nil	1 x Lit. den tats	Relocated E of LoC
H?	26/11/14	nr	8900 Blackmans Pt Rd	Corymbia gummifera	2mt, 1sb	Nil	1 x native beehive	Relocated
HAdd	26/11/14	nr	8900 Blackmans Pt Rd	Camphor laurel	Nil	Drey	Nil	
HAdd	26/11/14	nr	Ch9300	Eucalyptus spp.(Mahogany)	Nil	Nil	Nil	Term. had poss. hollows
HAdd	26/11/14	nr	Ch9301	Eucalyptus spp.(Mahogany)	Nil	Drey	Nil	
HAdd	26/11/14	TW/NP	Ch13900	Casuarina glauca	Dec. bark	Nil	Nil	Felled onto windrow
HAdd	27/11/14	TW/NP		Allocasuarina littoralis	Nil	Drey	Nil	
H137	27/11/14	TW/NP	Ch7100, north of compound	E. pilularis	1sb	Leaf material	Nil	
HAdd	27/11/14	TW/NP	Ch7100, north of compound	E. microcorys	1sb	Leaf nest	Nil	Probable FTG
HAdd	27/11/14	TW/NP	Ch7100, north of compound	E. pilularis	2mb, 1sb	Nil	Nil	
HAdd	27/11/14	TW/NP	Ch7100, north of compound	Eucalyptus spp. (Ironbark)	1sb	Old leaf.	Nil	
HAdd	27/11/14	TW/NP	Ch7100, north of compound	E. propinqua	1mt	Wear, claw marks	1 x Lit. peronii	Hollow relocated
H127	1/12/14	TW/BT	Ch7500	Stag	1m sp	Nil	Nil	
H128	1/12/14	TW/BT	Ch7500	Stag	Nil	Nil	Nil	
H129	1/12/14	TW/BT	Ch7500	E. pilularis	1m sp	Nil	Nil	
H134	1/12/14	TW/BT	Ch7500	E. pilularis	5mb	Nil	1 Eulamprus spp.	Hollow cut and relocated
H132	1/12/14	TW/BT	Ch7500	Stag	1sb, 1m sp	Old leaf nest	Nil	
HAdd	1/12/14	TW/BT	Ch7500		1sb, 1st, 1m sp	Extensive leaf nest, Petaurid	Nil	
H130	1/12/14	TW/BT	Ch7500	Eucalyptus spp.(Mahogany)	1sb	Nil	Nil	
HAdd	1/12/14	TW/BT	Ch7500	E. microcorys	1m term	M chamber	5 x S.Kingfisher chicks	3 deceased, 2 euthanased
HAdd	1/12/14	TW/BT	Ch7500		1s term	Old chambers	Nil	
HAdd	2/12/14	NR	Blackmans point	Stag	1st	Nil	Nil	
H172	2/12/14	NR	Blackmans point	E. pilularis	1sb	Nil	Nil	
HAdd	2/12/14	NR	Blackmans point		2 x Stick nests	Nil	Nil	1 nest lost in windrow
HAdd	2/12/14	NR	Blackmans point	E. microcorys	1s term	Nil	Nil	
HAdd	2/12/14	NR	Blackmans point	E. pilularis	Nil	Nil	Nil	
HAdd	3/12/14	NP	Wharf Rd south	E. microcorys	1 term	Nil	1 x FTG	
HAdd	3/12/14	NP	Wharf Rd south	E. propinqua	1mt	Nil	Nil	
HAdd	3/12/14	NP	Wharf Rd south	E. microcorys	1l term, 1m term		4 s. kingfisher eggs	

HAdd	3/12/14	NP	Wharf Rd south	Stag	1m	Leaf nests	Antechinus	Relocated insitu
HAdd	3/12/14	NP	Wharf Rd south	Eucalyptus spp.(Mahogany)	1s term	Leaf nest	1 x FTG	
HAdd	3/12/14	NP	Wharf Rd south	Stag	1ms	Old leaf nest	Nil	Possible Antechinus nests
HAdd	3/12/14	NP	Wharf Rd south	Acacia spp.	1 Drey	Drey	Nil	
H143	4/12/14	NR	Wharf Rd	Stag	3st, 2mb	2 old leaf nests	1 x Blind Snake	
HAdd	4/12/14	NR	Wharf Rd	E. globoidea	Nil	Nil	Nil	
HAdd	4/12/14	NR	Wharf Rd	Eucalyptus spp.(Mahogany)	1l term	Nil	Nil	Possible Kookaburra
HAdd	4/12/14	NR	Wharf Rd	Eucalyptus spp.(Mahogany)	Nil	Cup nest	Nil	N. Friarbird
HAdd	4/12/14	NR	Wharf Rd	E. resinifera	3sb	Leaf nest	Nil	Probable FTG
HAdd	4/12/14	NR	Wharf Rd	E. microcorys	1sb	Nil	Nil	
HAdd	4/12/14	NR	Wharf Rd	E. microcorys	1mt	Very old leaf nest	Nil	
HAdd	4/12/14	NR	Wharf Rd	E. microcorys	Nil	Nil	Nil	
HAdd	4/12/14	NR	Wharf Rd	E. pilularis	1sb	Nil	Nil	
HAdd	4/12/14	NR	Wharf Rd	E. microcorys	Nil	Nil	Nil	
HAdd	4/12/14	NR	Wharf Rd	E. pilularis	1mt	Nil	Nil	Native beehive relocated
HAdd	4/12/14	NR	Wharf Rd	Stag	Nil	Nil	Nil	
H142	4/12/14	NR	Wharf Rd	E. pilularis	4mb, 2sb	Leaf nest	Sugar Glider x 7	4 juveniles
HS12	5/12/14	NR	8000 - 8500	E. microcorys	1s term	Nil	Nil	
H157	5/12/14	NR	8450	E. resinifera	1st	Nil	Nil	
HAdd	5/12/14	NR	8000 - 8500	Eucalyptus spp.	1l term	Nil	Nil	
HAdd	5/12/14	NR	8000 - 8500	Allocasuarina littoralis	Drey	Nil	CRTP x 1	Tree was not marked up
HAdd	5/12/14	NR	8000 - 8500	E. pilularis	Nil	Nil	Tawny Frogmouths x 2	Flew from tree
HAdd	5/12/14	NR	8000 - 8500	E. microcorys	4mb, 3sb	Nil	Nil	
H144	5/12/14	NR	8000	E. pilularis	2mb	Leaf nests	Sugar Glider x 2	
HAdd	5/12/14	NR	8000 - 8500	E. microcorys	1mb, 1sb	Nil	Litoria peronii x 1	
HAdd	5/12/14	NR	8000 - 8500	E. microcorys	1m term, 1s	Nil	Nil	
H140	5/12/14	NR	8100	E. pilularis	Trunk fissure	Nil	Euro bees	
H141	5/12/14	NR	8100	E. pilularis	1s term, 2sb	Nil	4 fresh S. Kingfisher eggs	Native beehive relocated
H302	8/12/14	NR	North Haydons Wharf	Stag	1l sp	Nil	Nil	
HAdd	8/12/14	NR	North Haydons Wharf	Stag	3mb, 2sb, 1l sp	Leaf nest	Nil	Possible Petaurid
H299	8/12/14	NR	North Haydons Wharf	E. tereticornis	2mb	Nil	Nil	Euro Bees
HAdd	10/12/14	DR	Barrie's Ck	Stag	Nil	Nil	Nil	
HAdd	10/12/14	DR	Barrie's Ck	Stag	1mb, 2sb	Leaf, Glider fur, Snake skin	Nil	
HAdd	10/12/14	DR	Barrie's Ck	E. grandis	Stick nest	Leaf material, artificial material, pillow stuffing	Nil	Possible crow
HS11	10/12/14	DR	Barrie's Ck	Stag	1m sp	Leaf nest	Nil	
HAdd	7/1/15	NR	Blackmans point	Allocasuarina littoralis	1 Nest	Noisy Friarbird	Nil	
HAdd	7/1/15	NR	Blackmans point	Stag	Nil	Nil	Nil	Felled accidently
HAdd	8/1/15	NP/JE	Mahogany north	E. microcorys	1sb, 2s term	S.Kingfisher nest	4x S. Kingfisher nestlings	Flew away once released (approx. 1 week from fledging)
H183	8/1/15	NP/GM	Mahogany north	E. pilularis	1lb, 5mb, 4sb	Some leaf material	2 x Eulamprus spp.	Hollow relocated east of LoC
HAdd	8/1/15	NP/GM	Mahogany north	E. microcorys	Nil holes in term	Nil	Nil	
H186	8/1/15	NP/GM	Mahogany north	E. pilularis	1mb,	Nil	Euro bees	Euro bees prevented thorough search

H204	8/1/15	NP/GM	Mahogany north	Eucalyptus spp.(Mahogany)	2sb, 1mb	Nil	Native bees	Hive relocated
HAdd	8/1/15	NP/GM	Mahogany north	E. microcorys	Nil	Nil	Nil	
H187	8/1/15	NP/GM	Mahogany north	Stag	1sb, 1mb, trunk fissure	Nil	Nil	
HAdd	8/1/15	NP/GM	Mahogany north	E. microcorys	2s term	Nil	Nil	
H?	8/1/15	NP/GM	Mahogany north	Eucalyptus spp.(Mahogany)	3mt	Wear	Nil	Trunk relocated
HAdd	8/1/15	NP/GM	Mahogany north	E. pilularis	1l sp	Nil	Nil	
H189	8/1/15	NP/GM	Mahogany north	E. pilularis	Fissure	Old blind snake skin	Native bees	
H?	8/1/15	NP/GM	Mahogany north	E. pilularis	1l sp	Nil	1 x Eulamprus spp.	Escaped capture
HAdd	8/1/15	NP/GM	Mahogany north	E. pilularis	Stick nest	Nil	Nil	Possible old crow nest
HAdd	8/1/15	NP/GM	Mahogany north	Eucalyptus spp.(Mahogany)	1s term	Nil	Nil	
HAdd	8/1/15	NP/GM	Mahogany north	E. microcorys	Nil	Nil	Nil	
HAdd	8/1/15	NP/GM	Mahogany north	Corymbia spp.(Bloodwood)	Passerine nest	Dead chicks	2 x dead chicks	Olive feathers present, OBO?
HAdd	8/1/15	NP/GM	Mahogany north	E. microcorys	Nil in term	Nil	Nil	
HAdd	7/1/15	BT	20700	Stag	1sb	Nil	Lampropholis sp	Escaped
HAdd	9/1/15	BT	21350	Stag	1s sp	Old euc leaf nest	Nil	Felled accidently
HAdd	9/1/15	BT	20900	E. propinqua	3sb 1mb	Euc Leaf nest(FTG?)	Nil	
HAdd	9/1/15	BT	20750	Stag	1sb,1st	Nil	Nil	
H314	9/1/15	BT	20700	E. acmenoides	2sb 1mb	Nil	1 x Eulamprus sp	Escaped
HAdd	9/1/15	BT	20690	Corymbia spp. (Spotted Gum)	1sB	Nil	Nil	
HAdd	9/1/15	BT	Blackmans point rd.	E. pilularis	2sb	Nil	Nil	
HAdd	9/1/15	NP/JE	Blackmans Point	E. microcorys	1sb	Nil	Nil	
HAdd	9/1/15	NP/JE	Blackmans Point	E. pilularis	Nil	Nil	Nil	
HAdd	9/1/15	NP/JE	Blackmans Point	E. microcorys	Nil	Cup Nest	Nil	
HAdd	9/1/15	NP/JE	Blackmans Point	E. globoidea	1mb	Nil	Nil	
HAdd	9/1/15	NP/JE	Blackmans Point	E. pilularis	1mb	Nil	1 x Litoria peronii	Relocated
HAdd	9/1/15	NP/JE	Blackmans Point	E. microcorys	1s term	Nil	Nil	
HAdd	9/1/15	NP/JE	Blackmans Point	Stag	3mb	Nil	Nil	
HAdd	13/1/15	NP/TW	Median SB	Stag	1m sp	Old Antechinus nest	Nil	
HAdd	13/1/15	NP/TW	Median SB	Stag	1m sp	Nil	Nil	
HAdd	13/1/15	NP/TW	Median SB	Stag	1l sp	Nil	Nil	
HAdd	13/1/15	NP/TW	Median SB	Melaleuca spp.	Nil	Nil	Nil	Orchids
HAdd	13/1/15	NP/TW	Median SB	Stag	1m sp	Very old leaf nest	Nil	
HS51	13/1/15	NP/TW	Median SB	E. resinifera	2mb, 1sb, 1lt	Wear in hollows	Nil	
H237	13/1/15	NP/TW	Median SB	Stag	2l sp	Nil	Native beehive	
H194	13/1/15	NP/TW	Median SB	Corymbia spp.(Bloodwood)	4lb, 5mb	Old leaf nest	Nil	
HAdd	13/1/15	NP/TW	Median SB	Corymbia spp.(Bloodwood)	4mb, 2sb	Nil	Nil	
HAdd	13/1/15	NP/TW	Median SB	Eucalyptus spp. (Mahogany)	2mb, 2sb, 1st	Wear	Euro beehive	
H196	13/1/15	NP/TW	Median SB	Corymbia spp.(Bloodwood)	4lb, 3mb, 2sb	Nil	Nil	
H309	13/1/15	NP/TW	Cooperabung Range	E. microcorys	1m sp	Nil	Nil	
H308	13/1/15	NP/TW	Cooperabung Range	Corymbia spp. (Spotted Gum)	Nil	Nil	Nil	
HAdd	13/1/15	NP/TW	Cooperabung Range	Stag	Nil, Dec bark	Nil	Nil	Most of Dec bark knocked off in stage 1 clearing
HAdd	13/1/15	NP/TW	Blackmans Point Rd	E. pilularis	1sb	Nil	Nil	

HAdd	13/1/15	NP/TW	Blackmans Point Rd	Stag	2mb, 1s basal	Old drey material, old Antechinus nest	Nil	Termitaria and best hollow knocked off during stage 1 clearing
HAdd	14/1/15	NP/TW	Median SB	E. resinifera	Nil	Nil		
HAdd	14/1/15	NP/TW	Median SB	E. resinifera	1mb	Nil	1 Eulamprus spp. Escaped capture	Prob Eul. tenuis
H235	14/1/15	NP/TW	Median SB	E. robusta	2mb	Nil	Eulamprus tenuis x 3, Euro bees	2 x Eul. tenuis relocated, tree left as is overnight due to bees.
H228	14/1/15	NP/TW	Median SB	E. resinifera	Nil	Nil		
HAdd	15/1/15	NP/TW	Median Bill Hill	Stag	1mb	Nil	Nil	
H208	15/1/15	NP/TW	Median Bill Hill	Stag	1mb, 3sb	3 leaf nests, feathers present in mb	2 x Feathertail Gliders	Feathers possible Owlet Nightjar.
H207	15/1/15	NP/TW	Median Bill Hill	Stag	Nil	Nil	Nil	
H206	15/1/15	NP/TW	Median Bill Hill	Stag	1mb	Nil	Nil	
H241	15/1/15	NP/TW	Median Bill Hill	Stag	3mb, 1lb, 2sb	Extensive leaf material, twigs with leaves in one nest, very worn	Nil	Possible Phascogale, Rat, Possum
H209	15/1/15	NP/TW	Median Bill Hill	Stag	1lb, 4mb, 2sb	Stripped bark/twigs/feather nest, bird flew from tree	Poss. ONJ flew from tree	
HS47	15/1/15	NP/TW	Median Bill Hill	Stag	1sb	Nil	Nil	
HS48	15/1/15	NP/TW	Median Bill Hill	Stag	Nil	Nil	Nil	
HAdd	15/1/15	NP/TW	Median Bill Hill	Stag stump	Nil	Nil	Nil	
H211	15/1/15	NP/TW	Median Bill Hill	E. pilularis	1mb	Nil	Nil	
H212	15/1/15	NP/TW	Median Bill Hill	Stag	1mt, 3sb	Nil	Nil	
H238	15/1/15	NP/TW	Median Bill Hill	Stag	Nil	Nil	Nil	
H551	15/1/15	NP/TW	Median Bill Hill	Stag	1lt, 2mb	Leaf nest, poss. Petaurid	1 x Brushtail Possum spp, 2 x Eulamprus tenuis, Native beehive	Possum escaped to bush E of LoC, 2 x Eul. tenuis relocated
HAdd	15/1/15	NP/TW	Median Bill Hill	Stag	1mb	Nil	Native beehive	
HAdd	15/1/15	NP/TW	Median Bill Hill	Stag	Nil	Nil	Nil	
H239	15/1/15	NP/TW	Median Bill Hill	E. pilularis	3mb, 1sb	Nil	1x Eulamprus tenuis	
HAdd	15/1/15	NP/TW	Median Bill Hill	E. pilularis	3sb	Nil	Nil	
H215	15/1/15	NP/TW	Median Bill Hill	Stag	1l sp	3 leaf nests, prob Antechinus	1 x Antechinus, escaped capture, 2 x Eulamprus tenuis, Native beehive	
H214	15/1/15	NP/TW	Median Bill Hill	Stag	1m sp, 1mb	Leaf/feathers	Nil	Possible Rat or ONJ
HAdd	15/1/15	NP/TW	Median Bill Hill	Stag	Nil	Nil	Nil	
H213	15/1/15	NP/TW	Median Bill Hill	Stag	1mb, 2sb, 1m sp	Leaf nest	3 x Feathertail Glider spp., 1 Green Tree Snake	
HAdd	15/1/15	NP/TW	Median Bill Hill	Eucalyptus spp.(Mahogany)	Nil	Drey material in fork	Nil	
H220	15/1/15	NP/TW	Median Bill Hill	Stag	Nil	Nil	Nil	
HAdd	15/1/15	NP/TW	Median Bill Hill	Stag	Nil	Nil	Native beehive	
H225	15/1/15	NP/TW	Median Bill Hill	Stag	1mb, 1lt	2 leaf nests, prob Antechinus	1 x Antechinus escaped capture	
H221	15/1/15	NP/TW	Median Bill Hill	E. pilularis	1lt, 2sb	Nil	Nil	
H222	15/1/15	NP/TW	Median Bill Hill	E. resinifera	Nil	Nil	1 x Eulamprus spp. escaped	
H216	15/1/15	NP/TW	Median Bill Hill	E. pilularis	Nil	Nil	Nil	
H217	15/1/15	NP/TW	Median Bill Hill	E. resinifera	3mb	Nil	Native beehive	
H218	15/1/15	NP/TW	Median Bill Hill	E. resinifera	Nil	Nil	Nil	

HAdd	15/1/15	NP/TW	Cut 19, Cooperabung Range	E. acmenoides	4sb	Nil	Nil	
HAdd	16/1/15	NP	Bill Hill rd.	Corymbia intermedia	1s term	Nil	Nil	
HAdd	2/2/15	TW/NP	11450 - 12200 Bill Hill North	E. pilularis	1lb	Nil	Nil	
HAdd	2/2/15	TW/NP	11450 - 12200 Bill Hill North	Eucalyptus spp. (Ironbark)	1sb, 1s term	Nil	1 x Litoria spp.	
HAdd	3/2/15	TW/NP	11450 - 12200 Bill Hill North	Stag	1st	Nil	Nil	
HAdd	4/2/15	TW/NP	23800 - 24000 Barrie's Creek	E. microcorys	1s term	Old bird scat	Nil	
H222	4/2/15	TW/NP	11450 - 12200 Bill Hill North	Stag	1m term	Nil	Nil	
HS152	4/2/15	TW/NP	11450 - 12200 Bill Hill North	Syncarpia glomulifera	1mb	Nil	Nil	
H250	4/2/15	TW/NP	11450 - 12200 Bill Hill North	Stag	1mt, 1mb	Nil	Nil	
HS153	4/2/15	TW/NP	11450 - 12200 Bill Hill North	Stag	1sb	Nil	Nil	
H245	4/2/15	TW/NP	11450 - 12200 Bill Hill North	Stag	1mb, 2sb	Nil	1 x Eulamprus tenuis(escaped), 1 x Litoria tyleri, 1 x Egernia mcpheei	
H244	4/2/15	TW/NP	11450 - 12200 Bill Hill North	Stag	2mb, 2mt	Nil	Nil	
HS141	4/2/15	TW/NP	11450 - 12200 Bill Hill North	E. globoidea	1m sp	Nil	Nil	
HAdd	5/2/15	TW/NP	11450 - 12200 Bill Hill North	Stag	1lb	Nil	Nil	
HAdd	5/2/15	NP/TW	Haydons wharf South	E. microcorys	1m term	7 Goanna eggs (old)	Nil	
H291	5/2/15	NP/TW	Haydons wharf South	Stag	10mb, 2vlt	Nil	Nil	
H29	5/2/15	NP/TW	Haydons wharf South	Stag	nr	nr	nr	European bees (aggressive)
HAdd	5/2/15	NP/TW	Haydons wharf South	E. microcorys	1sb	Nil	Nil	
HAdd	5/2/15	NP/TW	Haydons wharf South	E. microcorys	1s term	1 wire nest	Nil	Nest made almost entirely of wire
HAdd	5/2/15	NP/TW	Haydons wharf South	E. microcorys	4s term	Nil	Nil	
HAdd	6/2/15	NP	11450 - 12200 Bill Hill North	Stag	5mb, 3sb	Nil	Nil	
HAdd	6/2/15	NP	11450 - 12200 Bill Hill North	Stag	2sb	Nil	Nil	
H89	9/2/15	NP/JE	Ch3200-3600	Stag	1mt, 4sb	Nil	Nil	
HAdd	9/2/15	NP/JE	Ch3200-3600	Stag	1sb, 1st	Nil	Nil	
H88	9/2/15	NP/JE	Ch3200-3600	E. acmenoides	1lt, 1sb	Nil	Nil	
H108	9/2/15	NP/JE	Ch3200-3600	Melaleuca spp.	1sb	Nil	Nil	
HAdd	9/2/15	NP/JE	Ch3200-3600	E. pilularis	Nil	Nil	Nil	
HAdd	9/2/15	NP/JE	Ch3200-3600	Corymbia spp.(Bloodwood)	1st, 1sb	Nil	Nil	
HAdd	10/2/15	NP/DR	Fernbank Ck South	Stag	3 st, 1lbasal	Antechinus nest	At least 3 x Antechinus spp., 1 x Microbat spp.	Felled during initial clearing, no 48hr wait. MBat took flight before ID possible
H285	10/2/15	DR, JE	17500	Stag	1lsp	Nil	Nil	
HAdd	10/2/15	DR, JE	17700	Stag	Nil	Nil		
HAdd	10/2/15	DR, JE	18300	E. microcorys	1m term	Recent sacred kingfisher nest		
HAdd	10/2/15	DR, JE	18500	E. microcorys	1m term	Nil		
HAdd	10/2/15	DR, JE	18500	Lophostemon confertus	drey	Drey removed during clearing		

HAdd	10/2/15	DR, JE	18600	Callistemon spp.	drey	Drey - nil		
H93	11/2/15	NP/JE	Ch3200-3600	nr	1st, 3sb	Nil	Nil	
H92	11/2/15	NP/JE	Ch3200-3600	Corymbia spp.(Bloodwood)	1mb, 1sb	Nil	Nil	
H95	11/2/15	NP/JE	Ch3200-3600	Stag	1lt	Nil	Nil	
H96	11/2/15	NP/JE	Ch3200-3600	E. pilularis	1mb	Nil	Nil	
H94	11/2/15	NP/JE	Ch3200-3600	E. pilularis	1mb, 2sb	Nil	Nil	
HAdd	11/2/15	NP/JE	Ch3200-3600	Eucalyptus spp.(Mahogany)	1sb	Nil	Nil	
HAdd	11/2/15	NP/JE	Ch3200-3600	Eucalyptus spp.(Mahogany)	1mt, 1mb, 4sb	Nesting material in trunk hollow	Nil	
HAdd	11/2/15	NP/JE	Ch3200-3600	Eucalyptus spp.(Mahogany)	1st, 2sb	Nil	Nil	
H99	11/2/15	NP/JE	Ch3200-3600	E. pilularis	1sb	Nil	Nil	
HAdd	11/2/15	NP/JE	Ch3200-3600	Stag	1lt	Fresh nesting material, Antechinus?	Nil	
HAdd	11/2/15	DR, NP	17900	E. microcorys	1m term	Old kookaburra nest (probable)		
H300	12/2/15	DR	18250	Stag	1l sp	Nil	1x carpet python (juvenile)	
HAdd	12/2/15	NP/DR	Fernbank Ck South	Stag	1m sp, 1st	Possible RTP drey material	Nil	Mistakenly felled by operator during initial clearing
H322	12/2/15	NP/JE	23000, Cooperabung range	nr	Nil	Nil	Nil	
HAdd	12/2/15	NP/JE	23000, Cooperabung range	E. propinqua	Nil	Nil	Nil	
HAdd	12/2/15	NP/JE	23000, Cooperabung range	Eucalyptus spp.(Ironbark)	1mt	Nil	Nil	
HAdd	12/2/15	NP/JE	23000, Cooperabung range	Corymbia spp.(Bloodwood)	1sb	Nil	Nil	
HS165	12/2/15	NP/JE	23000, Cooperabung range	E. acmenoides	2lt, 4mt, 1lb, 5sb	Nil	Nil	
HAdd	13/2/15	NP/JE	Haydons Wharf North	E. microcorys	1m term	Kookaburra sized chamber?	Nil	
HAdd	13/2/15	NP/JE	Haydons Wharf North	E. microcorys	1sb, 1m term	Kookaburra hollow?	Sugar Glider	Euthanased by vet, broken back.
HAdd	13/2/15	NP/JE	Haydons Wharf North	E. propinqua	1mb	Nil	Feathertail Glider spp. X 2	
HAdd	13/2/15	NP/JE	Haydons Wharf North	E. propinqua	1lt	Claw marks up trunk to hollow. Hollow smoothed out	Nil	
H319	13/2/15	NP/JE	Haydons Wharf North	Eucalyptus spp.	3lt, 2mt, 2mb	Nil	Eulamprus tenuis	
HAdd	13/2/15	NP	Fernbank South	E. tereticornis	1st	Nil	Nil	Sugar Glider emerged from non marked HBT
HAdd	16/2/15	TW/JE	Fernbank Ck South	Melaleuca quinquenervia	Drey	Drey	Nil	
HAdd	16/2/15	TW/JE	Fernbank Ck South	Stag	Nil	Nil	Nil	
HAdd	16/2/15	TW/JE	Fernbank Ck South	Melaleuca quinquenervia	Nil	Nil	Nil	Dropped into dam
HAdd	16/2/15	TW/JE	Fernbank Ck South	E. resinifera	1vlt, 2lt, 4mt, 2st	Old leaf nest	Nil	One central chamber
HAdd	16/2/15	TW/JE	Fernbank Ck South	E. resinifera	1lt, 2mt, 1st, 1sb	Old leaf nest	Nil	One central chamber
H80	17/2/15	NP	Sancrox North	Stag	2mb	Nil	Nil	
HAdd	17/2/15	NP	Sancrox North	E. globoidea	1l sp, 1mb	Nil	Nil	
HAdd	17/2/15	NP	Sancrox North	E. resinifera	1mb	Nil	Nil	
H87	18/2/15	NP/TW	Sancrox North	E. resinifera	1lb, 1sb	Nil	Nil	
H85	18/2/15	NP/TW	Sancrox North	E. pilularis	2mb, 1lb	Nil	Nil	
H84	18/2/15	NP/TW	Sancrox North	Stag	1st, 1sb	Nil	Nil	
HAdd	18/2/15	NP/TW	Sancrox North	E. resinifera	Nil in term	Nil	Nil	

HAdd	18/2/15	NP/TW	Sancrox North	E. globoidea	2sb	Nil	1x Feathertail Glider (Narrow toed)	
H82	18/2/15	NP/TW	Sancrox North	S. glomulifera & stag hanger	2sb, 1mt	Wear on mt	Cryptoblephar us spp.	
HAdd	18/2/15	NP/TW	Sancrox North	Corymbia intermedia	Nil	Nil	Nil	
H83	18/2/15	NP/TW	Sancrox North	Corymbia spp.(Bloodwood)	1mt, 1mb, 1sb	Extensive leaf nest	Nil	Nest soaked due to recent rain
H118	25/2/15	NP/GM	Compound	E. pilularis	1sb	Old leaf nest	Nil	
HAdd	27/2/15		Cooperabung Ck	Stag	2st	Old leaf nest (prob Ante)	Nil	Relocated outside LoC
HAdd	27/2/15		Cooperabung Ck	Melaleuca spp.	Drey	Drey	Nil	
HAdd	2/3/15		Wilsons south	E. grandis	Stick nest	Nest	Nil	
	3/3/15	TW	Wilsons south floodplain	E. microcorys	1mb, 2sb	Old leaf nest (prob ante)	1 Litoria tyleri, 1 Litoria dentata	Relocated into tree E of LoC. Tree very isolated in paddock
H303	4/3/15	NP	Cooperabung Close South	E. grandis	1lb, 3mb, 1sb	Scratches, wear at hollow entrances	Nil	Prob bird sign as pretty isolated tree
HAdd	5/3/15	NP	New Yarrabee Rd	Stag	Nil	Nil	Nil	
H321		TW/JE	Fill 22	E. microcorys	1lt, 1mb, 3sb	Nil	Nil	
H318	9/3/15	TW/JE	Fill 22	E. resinifera	1mb	Nil	Blackish blind snake	
HAdd	9/3/15	TW/JE	Fill 22	Corymbia intermedia	1mb, 1m term	Nil	Nil	
HAdd	9/3/15	TW/JE	Fill 22	E. microcorys	1m term, 1sb	Nil	1xfeathertail glider, 1x Eulamprus tenuis	
H224	10/3/15	DR	11250	Stag	1mt	Nil	1x Eul. tenuis	Released on west side carriageway
HAdd	10/3/15	DR	11250	Syncarpia glomulifera	2s	Nil		
H336	10/3/15	TW/JE	Cut 23	Stag	1ls, 1ms, 1lt, 1st	Old leaf nest	Nil	
HAdd	10/3/15	TW/JE	Cut 23	Eucalyptus spp.(Ironbark)	1mb	Nil	Nil	
H325	10/3/15	TW/JE	Cut 23	E. microcorys	1lt, 1st, 1mt	Wear in hollows	Nil	Euro bees in st
H306	11/3/15	TW	South of Cooperabung Ck	E. tereticornis	1st	Nil	Nil	Nil
HAdd	13/3/15	JE	South bank Hastings River	Acacia longifolia	1 drey	1x drey	1x ringtail possum	Escaped capture
HAdd	13/3/15	DR/JE	12100-12600	E. resinifera	1sb	feathertail glider den		
HAdd	13/3/15	DR/JE	12100-12600	E. resinifera	nil	Nil		
H276	13/3/15	DR/JE	12250	E. resinifera	nil	Nil	green tree frog	
H262	13/3/15	DR/JE	12200	E. resinifera	3sb	Nil		
H256	13/3/15	DR/JE	12100-12300	E. resinifera	1mb	old owlet nightjar nest		
H267	13/3/15	DR/JE	12150	E. resinifera	nil		graceful tree frog	
HAdd	13/3/15	DR/JE	12100-12600	E. resinifera	Nil	Nil		
H268	13/3/15	DR/JE	12100	Stag	Nil		Green tree frog	
HAdd	13/3/15	DR/JE	12100-12600	Melaleuca styphelioides	Nil	1 x drey		
H26#	13/3/15	DR/JE	12100-12300	E. resinifera	1sb	Nil		
H257	13/3/15	DR/JE	12150	E. resinifera	1mb		Eulamprus tenuis	
H251	13/3/15	DR/JE	12200	E. resinifera	1lb, 1sb	Nil		
H252	13/3/15	DR/JE	12200	E. resinifera	Nil		green tree frog, E. tenuis	
HAdd	16/3/15	TW/JE	Cut 22	Eucalyptus spp.(Ironbark)	1m term	M chamber	Nil	
HAdd	16/3/15	TW/JE	Cut 22	Stag	1mt	Nil	Nil	
HAdd	16/3/15	TW/JE	Cut 22	Stag	1sb	Nil	Nil	
Hs163	16/3/15	TW/JE	Cut 22	Stag	1lsp, 1lb	Nil	Nil	
Hs162	16/3/15	TW/JE	Cut 22	Stag	1lsp	Nil	Nil	
HS159	18/3/15	BT/JE	21000	Stag	1l sp, 2mb	Nil	Pink-tongue skink; blackish Blind snake	released in adjacent habitat
HAdd	18/3/15	BT/JE	12400 - 13150	Melaleuca nodosa	1mt	Nil	Nil	

HAdd	18/3/15	BT/JE	12400 - 13150	Melaleuca nodosa	1st	Nil	Lit. fallax x1	released in adjacent habitat
HAdd	18/3/15	BT/JE	12400 - 13150	Melaleuca nodosa	1sb, 1mb	Nil	Lit. dentata x1	released in adjacent habitat
HAdd	18/3/15	BT/JE	12400 - 13150	Melaleuca nodosa	2mt, 1sb	Nil	Nil	
HAdd	18/3/15	BT/JE	12400 - 13150	Stag	1mt, 1sb, 1m sp	Nil	Nil	
HAdd	18/3/15	BT/JE	12400 - 13150	Stag	1st, 1mt, 1m term	Nil	Nil	
HAdd	18/3/15	BT/JE	12400 - 13150	Stag	1m sp	Nil	Nil	
H281	18/3/15	BT/JE	12400 - 13150	Eucalyptus robusta	1l sp	Drey material	Nil	Probable Common Ringtail poss
H282	18/3/15	BT/JE	12400 - 13150	Stag	1l sp	Nil	Nil	
H283	18/3/15	BT/JE	12400 - 13150	Eucalyptus robusta	1m term	Nil	Nil	
HAdd	18/3/15	BT/JE	12400 - 13150	Eucalyptus robusta	1st, 1mt, 1mb, 3sb	Worn hollow entrance	Lit fallax x2, Lit peronii x2	
HS169	19/3/15	JE/TW	Cooperabung	Tristaniopsis spp.	1sm, 1st	Nil	Nil	
H320	19/3/15	JE/TW	Cooperabung	Tristaniopsis spp.	2mb, 2mt	Nil	Nil	
HAdd	19/3/15	JE/TW	Cooperabung	E. microcorys	Nil	Nil	Nil	
HAdd	19/3/15	JE/TW	Cooperabung	Lophostemon	1lt	Nil	Nil	
HAdd	19/3/15	JE/TW	T Tree farm	Allocasuarina torulosa	Crows nest	Nil	Nil	
HAdd	19/3/15	JE/TW	T Tree farm	Melaleuca quinquenervia	1mt, 1sb	Nil	Nil	
HAdd	19/3/15	JE/TW	T Tree farm	Melaleuca quinquenervia	1lt, 1mt, 1st	Nil	Nil	
HAdd	19/3/15	JE/TW	T Tree farm	Melaleuca quinquenervia	1lt, 1mb	Nil	Nil	
HAdd	19/3/15	JE/TW	T Tree farm	Melaleuca quinquenervia	Nil	Nil	Nil	
HAdd	19/3/15	BT	12400 - 13150	Melaleuca quinquenervia	1st, 1mt	Nil	Nil	
HAdd	25/3/15	JE	Blackmans point road	Stag	Nil	Nil	Nil	
HAdd	25/3/15	JE	Blackmans point road	Stump stag	1vlt	Nil	Nil	
HAdd	25/3/15	JE	Blackmans point road	Stag	3lb, 2mb, 1lt	Nil	Nil	
HAdd	25/3/15	JE	Blackmans point road	Casuarina spp.	Drey	Nil	Nil	
HAdd	25/3/15	JE	Blackmans point road	E. globoidea	2mb, 2sb	Nil	Nil	
HAdd	25/3/15	JE	Blackmans point road	E. globoidea	2mb, 1sb	Nil	Nil	
HAdd	25/3/15	JE	11900 - 12200	Melaleuca nodosa	Nil	Nil	Nil	
HS149	25/3/15	JE	11900 - 12200	Melaleuca nodosa	1st, 2sb	Nil	Nil	
HS147	25/3/15	JE	11900 - 12200	Casuarina glauca	1mt	Nil	Nil	
HS148	25/3/15	JE	11900 - 12200	Casuarina glauca	1mb	Nil	Nil	
HS144	25/3/15	JE	11900 - 12200	Casuarina glauca	1lt, 1mb, 1sb	Nil	Nil	
HS146	25/3/15	JE	11900 - 12200	Casuarina glauca	Nil	Nil	Nil	
HS145	25/3/15	JE	11900 - 12200	Casuarina glauca	1lt	Nil	1 x Litoria gracilenta	Relocated
H269	25/3/15	JE	12100	Casuarina glauca	1lt, 1sb	Nil	Nil	
HAdd	25/3/15	JE	11900 - 12200	Casuarina glauca	1sb	Nil	Nil	
HAdd	25/3/15	JE	11900 - 12200	Casuarina glauca	Nil	Nil	Nil	
HAdd	30/3/15	NP	22000	Eucalyptus spp.(Ironbark)	Nil	Nil	Nil	
HAdd	30/3/15	NP	22000	Eucalyptus spp.(Ironbark)	1mb, 1lb	Nil	Native bees	
HAdd	30/3/15	NP	22000	E. microcorys	1sb	Old leaf nest	Nil	
H304	26/3/15	NP/DR	Wyndell close	E. microcorys	2vlb, 4lb, 13mb, 3sb, 3lt	Wear, 2x old leaf nest	1 x common Brushtail possum, 2 x Eulamprus tenuis, 1x blackish Blind snake, native beehive	Brushtail escaped capture, blind snake dead
HAdd	9/4/15	NP	South Sancrox	E. globoidea	1l sp	Fresh Drey material, wear.	Nil	Stripped bark
H04	9/4/15	NP	South Sancrox	Stag	1m sp	Old leaf nest	Nil	
H64	9/4/15	NP	South Sancrox	E. resinifera	Nil	Nil	Nil	
HAdd	9/4/15	NP	South Sancrox	E. globoidea	1l sp, 1mt	Wear on both entrances	Nil	Old Euro Beehive
HAdd	9/4/15	NP	South Sancrox	E. globoidea	1l sp, 1mt	Old Drey material, old leaf nest	Nil	

HAdd	9/4/15	NP	South Sancrox	E. globoidea	1mb	Old leaf nest	Nil	Hanger in tree
H60	9/4/15	NP/GM	South Sancrox	E. globoidea	2lb, 1mb	Fresh Leaf Nest	3 x Sugar Gliders (M, F, F(juv))	Native beehive
H58	9/4/15	NP/GM	South Sancrox	Stag	1vl sp, 1lb	Nil	Native bees	
H57	9/4/15	NP/GM	South Sancrox	Corymbia intermedia	1sb	Nil	Nil	
HAdd	9/4/15	NP/GM	South Sancrox	E. globoidea	Nil	Nil	Nil	Sugar glider observed climbing tree late morning
H59	9/4/15	NP/GM	South Sancrox	Corymbia intermedia	1lt, 2sb	Ringtail Drey material in t	Nil	
HAdd	9/4/15	NP/GM	South Sancrox	Allocasuarina littoralis	Drey	Old Drey	Nil	
H61	9/4/15	NP/GM	South Sancrox	E. globoidea	1basal	Nil	Nil	
HAdd	9/4/15	NP/GM	South Sancrox	Corymbia intermedia	2lb, 1sb	Nil	1 x Eulamprus tenuis	
H63	9/4/15	NP/GM	South Sancrox	Syncarpia glomulifera	1sb	Nil	Nil	
HAdd	9/4/15	NP/GM	South Sancrox	Syncarpia glomulifera	Drey	Old Drey	Nil	
H01	9/4/15	NP/GM	South Sancrox	Corymbia intermedia	Nil	Nil	Nil	
H03	9/4/15	NP/GM	South Sancrox	E. microcorys	Nil	Nil	Nil	
H05	9/4/15	NP/GM	South Sancrox	E. globoidea	2mb, 1sb	Nil	1 x Eulamprus tenuis	
HAdd	9/4/15	NP/GM	South Sancrox	Allocasuarina littoralis	Drey	Old Drey	Nil	
Hnestbox1	10/4/15	NP	Barries Creek	E. microcorys	2 boxes	Nil	Nil	
Hnestbox2	10/4/15	NP	Barries Creek	E. microcorys	2 boxes	Nil	Nil	
H352	10/4/15	NP	Barries Creek	E. grandis	1sb	Nil	Nil	
HAdd	10/4/15	NP	Barries Creek	Corymbia spp.(Bloodwood)	1sb	Nil	Nil	
H351	10/4/15	NP	Barries Creek	E. grandis	1mb	Nil	Nil	
H05	10/4/15	NP	South Sancrox	Corymbia intermedia	1mb, 1sb	Nil	1 x Microbat spp	Took flight before ID possible
Hs41	10/4/15	NP/TW	Haydons Wharf	E. microcorys	Nil	Nil	Nil	
H294	10/4/15	NP/TW	Haydons Wharf	E. tereticornis	1sb	Nil	Nil	
H333	14/4/15	NP	South Barries Creek	Stag	1mt, 1m sp	Leaf nest	1 x Pink Tongue Lizard	Nil
H414	15/4/15	NP/TW	South Barries Creek	E. propinqua	1lt, 1vl sp	Nil	Eulamprus tennis X11	Native beehive relocated
HAdd	20/4/15	NP/JE	South Barries East	Eucalyptus spp.(Ironbark)	1lt, 1mb	Extensive leaf nest	Nil	Possible Antechinus
HS158	20/4/15	NP/JE	South Barries East	E. resinifera	1st	Nil	Nil	
H349	20/4/15	NP/JE	South Barries East	Stag	1l sp	Nil	1 x Eulamprus tennis	Relocated
HAdd	20/4/15	NP/JE	South Barries East	E. resinifera	1m term	Nil	Nil	
HAdd	20/4/15	NP/JE	Fernbank creek	Melaleuca spp.	1l term, 1s term	Old bark nest	Nil	
H344	21/4/15	DR/JE	South Barries Creek	E. globoidea	1sb, 2mb	Nil	Nil	
H345	21/4/15	DR/JE	South Barries Creek	E. resinifera	Nil	Nil	Nil	
HAdd	21/4/15	DR/JE	South Barries Creek	Corymbia spp. (Spotted Gum)	Nil	Nil	Nil	
H342	21/4/15	DR/JE	South Barries Creek	Stag	1mb	Nil	Nil	
HSStump	23/4/15	NP	Blackmans interchange	Stag	2st	Old nesting den	Nil	
HAdd	23/4/15	NP/JE	Blackmans interchange	E. pilularis	Nil	Nil	Nil	
H153	23/4/15	NP/JE	Blackmans interchange	E. pilularis	Nil	Nil	Nil	
HsStump	23/4/15	NP/JE	Blackmans interchange	Stag	1st	Old leaf nest	Nil	
HAdd	23/4/15	NP/JE	Blackmans interchange	Eucalyptus spp.(Mahogany)	Nil in term	Nil	Nil	
H55#	23/4/15	NP/JE	Blackmans interchange	Stag	1mb, 1sb	Old drey material	Nil	
HAdd	23/4/15	NP/JE	Blackmans interchange	Stag	Nil	Nil	Nil	
HAdd	23/4/15	NP/JE	Blackmans interchange	Eucalyptus spp.(Mahogany)	1s term	Nil	Nil	
HAdd	23/4/15	NP/JE	Blackmans	E. pilularis	2sb	Nil	1 x Lit. peronii	Relocated

			interchange					
HAdd	23/4/15	NP/JE	Blackmans interchange	E. globoidea	Nil	Nil	Nil?	
HAdd	23/4/15	NP/JE	Blackmans interchange	E. microcorys	Nil	Nil	Nil	
HAdd	23/4/15	NP/JE	Blackmans interchange	E. pilularis	1lt, 1st, 3mb, 2sb	Nil	1 x Green Tree Snake	Relocated in situ
HSStump	24/4/15	NP	Blackmans interchange	Stag	3st	Old leaf nest, old den	Nil	
HAdd	24/4/15	JE	New Blackmans rd.	E. pilularis	3mb	Nil	Nil	
HAdd	24/4/15	JE	New Blackmans rd.	E. globoidea	1mt	Nil	1 x Lit. dentata	Relocated
HAdd	24/4/15	JE	New Blackmans rd.	Corymbia gummifera	Nil	Nil	Nil	
HAdd	24/4/15	JE	New Blackmans rd.	E. globoidea	1mb, 1sb	V. Old leaf material	Nil	
HAdd	29/4/15	TW	New Blackmans rd.	E. globoidea	1m term	M chamber	Nil	
H155	29/4/15	TW	South railway	Stag	2mb, 1sb	Nil	1 x gr tree snake	Relocated
HS20	7//5/15	NP/GM	North of compound	E. pilularis	2st	Possible antechinus markings	Nil	
HAdd	11/5/15	NP	Cooperabung culvert	E. tereticornis	1vl sp, 2lb, 1mb	Possible old leaf nest	Nil	
H305	13/5/15	NP	South Tinkers Driveway	E. tereticornis	3mb, 1m term	Old Lorikeet feathers in mb	Nil	
HAdd	13/5/15	NP	North Wyndell close	E. globoidea	Nil	Nil	Nil	
H19	nr	TW	17000	Stag	2mt	1 old leaf nest		
HAdd	nr	TW	17000	E. globoidea	1lt, 2mb, 1st	nil		
H20	2/06/15	JE	1500	E. globoidea	Large fissure in trunk	Old leaf material about 2m above ground	Nil	
HAdd	2/06/15	JE		E. pilularis	1sb	Nil	Nil	
HS132	2/06/15	JE		E. globoidea	2mt, 3sb	Nil	Nil	
HAdd	2/06/15	JE		E. globoidea	1lb, 1sb		Nil	
HAdd	2/06/15	JE		E. globoidea	1sb, t fissure		pink tongue	
H10	2/06/15	JE	1250	E. globoidea	3mb, 5sb		Nil	
HAdd	2/06/15	JE	11670	Stag	1l sp	very old leaf nest	Nil	
HAdd	20/07/15	JE	1600 - 1800	Corymbia spp. (Bloodwood)	1sb	Old nest in termitaria	Nil	
HAdd	20/07/15	JE	1600 - 1800	E. globoidea (senescing)	Nil	Nil	Nil	
HAdd	20/07/15	JE	1600 - 1800	Stag	1sb	Nil	Nil	
HAdd	20/07/15	JE	1600 - 1800	Corymbia spp. (Bloodwood)	1mt	Nil	Nil	
HAdd	20/07/15	JE	1600 - 1800	Melaleuca	Nil	small old nest	Nil	
HAdd	20/07/15	JE	1600 - 1800	E. pilularis	3lt, 2mt, 3lb, 1mb	old nests (2) in trunk and branch	Nil	
HAdd	20/07/15	JE	1600 - 1800	Casuarina spp.	Nil	Active Drey	Female ringtail and baby (furred)	Relocated in nest box, within 80 metres. Mother & baby gone next morning
HAdd	25/07/15	JE	1850 - 2450	Stag	1l sp, 1st, 1mt	2 nests, probably antechinus, good condition	Nil	
HAdd	25/07/15	JE	1850 - 2450	Corymbia spp. (Bloodwood)	Nil	Termitaria		
HAdd	25/07/15	JE	1850 - 2450	Stag	1st, t fissure	Nil		
HAdd	27/07/15	JE	1860	Stag	3st	old nest material	Nil	
	27/07/15	JE	1860	E. microcorys	1m sp	old nest material	Nil	
	27/07/15	JE	1750	Casuarina	Nil	Active new drey	Female ringtail and baby (furred)	Relocated in nest box, within 120 metres.
H44	28/07/15	JE	1900 - 2100	E. pilularis	Nil	Nil		
H46	28/07/15	JE	Ch1900 - 2100	E. pilularis	2sb	Nil		
H47	28/07/15	JE	Ch1900 - 2100	E. pilularis	1mb	Nil		
H48	28/07/15	JE	Ch1900 - 2100	E. microcorys	1mb	Nil		
H49	28/07/15	JE	Ch1900 - 2100	Corymbia gummifera	Nil	Nil		
H50	28/07/15	JE	Ch1900 - 2100	Corymbia gummifera	1mb, 1sb	Nil		

HAdd	28/07/15	JE	Ch1900 - 2100	E. microcorys	1m sp, 2st	Nil		
HAdd	28/07/15	JE	Ch1900 - 2100	E. microcorys	1mb, 1sb	Nil		
HAdd	28/07/15	JE	Ch1900 - 2100	E.globoidea	1 term	Nil		
HAdd	28/07/15	JE	Ch1900 - 2100	E. microcorys	1l sp, 1mb, 1sb	Nil		
HAdd	28/07/15	JE	Ch1900 - 2100	E. microcorys	3mb	old leaf nest material, bee hive	Trigonia	Relocated onto retained veg
HAdd	30/07/15	JE	Ch 750 to 1900	E. microcorys	1lb, 3mb, 1sb	Nil		
		JE						
HAdd	4/08/15	JE	Ch 2450 to 2800	E.globoidea	1sb			
H79	4/08/15	JE	Ch 2450 to 2800	E. pilularis	6mb, 4sb	Nil		
HAdd	4/08/15	JE	2450 - 2800	Stag (E.globoidea)	1lt, 1mb, 1sb	Old leaf nest material		
HAdd	4/08/15	JE	2450 - 2800	Corymbia gummifera	1 term	Nil		
HAdd	4/08/15	JE	2450 - 2800	Stag	2mt, 2sb	Nil		
HAdd	4/08/15	JE	2450 - 2800	Stag	Nil	Nil		
H65	4/08/15	JE	2450 - 2800	E. pilularis	Nil	Nil		
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	Corymbia intermedia	Nil	Nil	Nil	
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	Stag	1m sp	Old glider nest	Nil	
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	E. pilularis	1sb	Nil	Nil	
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	E. pilularis	Blind	Nil	Nil	
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	E. pilularis	2lb, 1sb	Nil	Small-eyed Snake around base of tree	Captured and relocated 100 m to north east
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	Stag	1m sp	Nil	Nil	
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	E. pilularis	Blind	Nil	Nil	
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	E. globoidea	2sb, 1 term	Nil	Nil	
HAdd	7/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	E. pilularis	1sb	Nil	Nil	
HAdd	11/08/15	BDL	Cassegrains to Fernbank Creek east of hwy	Melaleuca quinquenervia	3st	Nil	Nil	
HAdd	13/08/15	BDL	West of driver reviver at Sancrox	Blackbutt Stag	Nil	Nil	Nil	
HAdd	19/08/15	GM	1600	E. microcorys (senescent)	5mb, 3sb	termitaria	nil	
HAdd	19/08/15	GM	3350 - 4400	E. pilularis	1mb	Old leaf nest material	2 x Litoria peronii	Released in adjacent habitat
HAdd	19/08/15	GM	3350 - 4400	E. pilularis	Nil	Nil	Nil	
HAdd	19/08/15	GM	3350 - 4400	Stag	1lt (spout), 1mb	Nil	Nil	
HAdd	19/08/15	GM	3350 - 4400	Eucalyptus sp.	Nil	Nil	Nil	
HAdd	19/08/15	GM	3350 - 4400	E. robusta	5sb	Old leaf nest material	Nil	
H114	19/08/15	GM	3350 - 4400	Eucalyptus sp.	2sb	Nil	Nil	
HAdd	19/08/15	GM	3350 - 4400	Eucalyptus sp.	Nil	2 x termitaria	Nil	Trunk painted "BEES", none present
H111	19/08/15	GM	3350 - 4400	E. resinifera	4sb	Nil	Nil	

HAdd	19/08/15	GM	3350 - 4400	Melaleuca sp.	2st	Nil	1 x Litoria peronii	Relocated insitu
H112	19/08/15	GM	3350 - 4400	Eucalyptus sp.	3sb	Nil	Nil	
H 107	19/08/15	GM	3350 - 4400	E. pilularis	2mb	Leaf & bark in lace monitor hollow	Lace monitor	Escaped into windrow
H122a	19/08/15	GM	3350 - 4400	Allocasuarina spp.	1st	Nil	Nil	Large Elkhorn
H102	19/08/15	GM	3350 - 4400	E. microcorys	6sb	Nil	Nil	
H103	19/08/15	GM	3350 - 4400	Eucalyptus sp.	4sb	Fresh leaf nest	Nil	Possible feathertail glider nest, cut section relocated into adjacent habitat
H106	19/08/15	GM	3350 - 4400	Eucalyptus sp.	5sb	Nil	Nil	
HAdd	19/08/15	GM	3350 - 4400	Melaleuca sp.	1sb	Nil	Nil	
H122b	19/08/15	GM	3350 - 4400	Stag	1sb	Termitaria	Nil	Large Elkhorn
H42	19/08/15	GM	2350	Stag	1mb, 1st, 1sb	Nil	Nil	
H43	19/08/15	GM	2350	Stag	2mb, 1sb	Old leaf material in 2mb	Nil	
H56	20/08/15	GM	1300	Corymbia intermedia	2lb, 5mb, 4sb	1lb with old leaf	Nil	
HAdd	25/08/15	JE	Ch 1800 to 2500 East side	Corymbia gummifera	1mt	old nest material	Nil	
HAdd	25/08/15	JE	Ch 1800 to 2500 East side	E. pilularis	2sb		Nil	
H37	25/08/15	JE	Ch 1800 to 2500 East side	E. pilularis	Nil	Nil	Nil	
H38	25/08/15	JE	Ch 1800 to 2500 East side	E. pilularis	1sb	Nil	Nil	
HAdd	25/08/15	JE	Ch 1800 to 2500 East side	E. pilularis	2sb	Nil	Nil	
H35	25/08/15	JE	Ch 1800 to 2500 East side	Stag	Nil	Nil	Nil	
HS125	25/08/15	JE	Ch 1800 to 2500 East side	Corymbia gummifera	2sb	Nil	Nil	

Table D4: Register of terrestrial fauna captured during the clearing phase of the Oxley Highway to Kundabung Pacific Highway Upgrade.

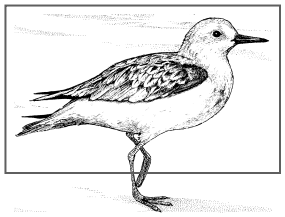
Capture situation/HBT no.	Fauna Retrieved					Immediate Fate	Final Fate (for individuals retained)	Release Site (Location)
	Species	Sex	Age	Breeding Status	Evidence of Injury			
Preclear	Black bellied Swamp Snake		Juv		Nil	Released immediately	Released alive	W of BDY @ch6800
Preclear	Lampropholis delicata				Nil	Held for ID	Released alive	W of BDY @ch6800
Preclear	Lampropholis delicata				Nil	Held for ID	Released alive	W. Of BDY @7300
HS24	Lace Monitor				Nil	Escaped capture into windrow	Observed alive and uninjured	Ch8200
FF mark-up	Egernia mcpheei				2 missing toes (old injury)	Held for ID	Released alive	W of BDY @ ch7350
Spotlight	Jacky Lizard				Nil	Held for ID	Released alive	E of BDY @ ch8100
Preclear	Black bellied Swamp Snake		Juv		Nil	Held for ID	Released alive	E of BDY @ ch8300
Preclear	Lampropholis delicata x 2				Nil	Held for ID	Released alive	E of BDY @ ch8200
Drillers	Black bellied Swamp Snake		Juv		Nil	Held for relocation	Released alive	W of BDY at Fernbank Ck
Preclear	Blackish Blind Snake				Nil	Held for ID	Released alive	E of BDY @ ch9100
Pre clear	Blackish Blind Snake				Nil	Held for ID	Released alive	E of BDY @ ch9400
HBT removal	3 x Figbird eggs				Cracked shell	Euthanased	Euthanased	N/A
Iteratus habitat	Limnodynastes peronii				Nil	Released immediately	Released alive	W of BDY at Cooperabung ck
HBT removal	Litoria peronii				Nil	Hollow cut and placed over LoC	Released alive	E of LoC @ch7200
GBF clearing	Black bellied Swamp Snake				Nil	Held for ID	Released alive	W of LoC @ Ch19700
GBF clearing	Saproscincus oriarus				Lost tip of tail	Held for ID	Released alive	W of LoC @ Ch19700
GBF clearing	Lampropholis delicata x 4				Nil	Held for ID	Released alive	W of LoC @ Ch19700
GBF clearing	Lampropholis amicula				Nil	Held for ID	Released alive	W of LoC @ Ch19700
Preclear	Small Eyed Snake				Nil	Relocated immediately	Released alive	Ch 17500
Preclear	Fossorial Skink spp.				Nil	Relocated immediately	Relocated immediately	Ch 21000
Spotlighting	Litoria peronii x 2				Nil	Held for ID	Released alive	In drainage E of LoC @ ch14000
Spotlighting	Litoria nasuta				Nil	Held for ID	Released alive	In drainage E of LoC @ ch14000
Spotlighting	Uperoleia spp.				Nil	Held for ID	Released alive	In drainage E of LoC @ ch14000
Spotlighting	Litoria fallax x 5				Nil	Held for ID	Released alive	Ch17500
Spotlighting	Litoria tyleri				Nil	Held for ID	Released alive	Ch17500
HBT134	Eulamprus spp.				Nil	Left in situ	Hollow place over LoC	E of LoC at ch7450
HAdd	S.Kingfisher chicks x 2		Pinkies		Nil	Held in calico bag	Euthanased	N/A
HAdd	S. Kingfisher chicks x 3		Pinkies		Yes, crush injuries	Deceased	Placed over LoC	W of LoC @ ch7450
Spotlight	Lit. nasuta				Nil	Held for ID in zip lock bag	Released alive	W of Loc @ ch8500
Stump clearing	Lampropholis delicata x 2				Nil	Relocated immediately	Released alive	W of LoC @ Ch10000
Stump clearing	Brown Antechinus x 2	M	Sub Adult		Nil	Held in aquarium	Released at dusk	E of LoC @ Ch10000
H162	Brown Antechinus pinkies x 5		Pinkies		Nil	Held in calico bag	Died in care	N/A
Stump Clearing	Brown Antechinus		Sub Adult		Yes, crushed	Deceased	Deceased	N/A
Spotlight	Pseudophryne coriacea		Adult		Nil	Held in zip lock bag	Released alive	W of existing highway, Barries Ck
HBT removal	S. Kingfisher eggs (1)				Old	Placed outside LoC	N/A	N/A
Frog fence	Lampropholis delicata				Nil	Held for ID	Released alive	W of LoC at Cooperabung Ck
H143	Blind Snake				Nil	Held for ID	Released alive	W of LoC at ch 8700
HAdd	Narrow Toed Feathertail Glider x 2	M, M	Adult		Nil	Held for ID, settling	Released at dusk	W of LoC @ ch17500

HAdd	Common Ringtail Possum	F	Adult		Nil	Held in calico bag and Nestbox	Released in Nestbox at dusk	W of LoC @ ch 8500
H142	Sugar Glider x 7	1M, 2F, 4unknown	Adult x 3, juv x 4	Breeding	Nil (orange fungus on ears)	Held together in calico bag and nestbox	5 Gliders released at dusk, 2juv stolen next day.	W of LoC @ch 8500
H144	Sugar Glider x 2	M, F	Adult		Nil (orange fungus on ears)	Held in calico bag and nestbox with Euc. leaves	Released in nestbox at dusk	W of LoC at ch 8500
HAdd	Antechinus (At least 1)		Adult		Nil	Left insitu	Log placed over LoC	W of LoC @ ch 17500
HAdd	Litoria peronii		Adult		Nil	Held in plastic zip lock bag	Released outside LoC	W of LoC @ ch 8500
HAdd	S.Kingfisher Eggs (4)				Nil	Euthanased	N/A	N/A
HAdd	S.Kingfisher Eggs (4)				Yes, crushed	Deceased	N/A	N/A
Preclear	Yellow Faced Whip Snake				Nil	Held for relocation	Released alive in hollow log	W of LoC @ ch7100
Spotlighting	Echidna	M	Adult		Nil	Held for relocation	Released alive in riparian veg	W of LoC @ ch19600
Spotlight	Lit. dentata				Nil	Held in plastic ziplock bag for ID	Released alive	W of LoC @ ch19700
Frogging	Lit. fallax x13				Nil	Held in plastic gloves	Released immediately	W of LoC @ ch???
Frogging	Lit. fallax x 3				Nil	Held in plastic gloves	Released immediately	W of LoC @ ch???
Workers find	Echidna	M	Juv		Leech sore/wobbly walk	Held in cotton bag in cat cage	Taken to vet, held in care for 24hrs	Cooperabung Nature Reserve
Spotlight	Bandy Bandy		Sub-adult		Nil	Held for relocation	Released outside LoC	E of LoC at Blackmans Point Rd
Spotlight	Lim. peronii				Nil	Held in plastic bag for ID	Released outside LoC	E of LoC @ 10700
Spotlight	Lit. peronii				Nil	Held in plastic bag for ID	Released outside LoC	W of LoC @ 20800
Spotlight	Adelotus brevis				Nil	Held in plastic bag for ID	Released outside LoC	W of LoC @ 20800
Spotlight	Lit. tyleri x 2				Nil	Held in plastic bag for ID	Released outside LoC	W of LoC @ 20800
Preclear	Echidna	F	Adult		Nil	Held for relocation	Released outside LoC	E of LoC @10700
HBT Add	S. Kingfisher nestlings x 4		Sub adult		Nil	Released alive	Flew to neighbouring trees	Outside LoC @ ch10000
H183	Eulamprus spp. x 2				Nil	Left insitu	Hollow relocated outside LoC	E of LoC @ ch10200
HBT Add	Eulamprus sp.				Nil	Left insitu	Relocated outside LOC	W of LOC @20700
Preclear	Lamp. delicata				Nil	Held for relocation	Released outside LoC	E of LoC @ Bill Hill Rd
Spotlight	Bandy Bandy				Nil	Held for relocation	Released outside LoC	E of LoC @ Blackmans Point Rd
Workers find	Blue tongue Lizard		Adult		Dazed, missing toes-old injury	Taken to vet	???	???
Preclear	Lamp. delicata				Nil	Held for ID	Released outside LoC	E of alignment @ 7700
H235	Eulamprus tenuis x 2				Nil	Held for ID	Released outside LoC	E of LoC @ ch11200
H208	Feathertail Glider spp. X 2				Nil	Left insitu	Log relocated outside LoC	E of LoC @ ch 11300
H551	Brushtail Possum spp.		Adult		Nil	Fled from tree	Escaped to bush outside LoC	E of LoC @ ch11200
H551	Eulamprus tenuis x 2				Nil	Held for ID	Released outside LoC	E of LoC @ ch11200
H239	Eulamprus tenuis				Nil	Held for ID	Released outside LoC	E of LoC @ ch11200
H215	Eulamprus tenuis x 2				Nil	Held for ID	Released outside LoC	E of LoC @ ch11200
H213	Narrow-toed Feathertail Glider	Female	Adult	Parous	Nil	Held in calico bag	Released outside LoC in Nestbox at dusk	W of LoC @ ch 11200
H213	Narrow-toed Feathertail Glider x 2	Female	Sub adult		Nil	Held in calico bag	Released outside LoC in Nestbox at dusk	W of LoC @ ch 11200

H213	Common Tree Snake (Green)				Nil	Left insitu	Log relocated outside LoC	W of LoC @ ch 11200
HAdd	Litoria peronii				Nil	Held for ID	Released outside LoC	E of LoC @ ch8900
Spotlighting	Lim. peronii				Nil	Held for relocation	Released outside LoC	W of LoC @ ch12200
Spotlighting	Small Eyed Snake				Nil	Relocated immediately	Released outside LoC	W of LoC @ ch11900
Preclear	Litoria dentata tadpoles x170		Tadpoles		Nil	Held for ID	Released outside LoC	W of LoC @ ch12200
Spotlighting	Limnodynastes peronii		Adult		Nil	Held for relocation	Released outside LoC	W of LoC @ ch12100
Spotlighting	Lit. tyleri		Adult		Nil	Held for relocation	Released outside LoC	W of LoC @ ch11800
Spotlighting	KOALA	Female	Adult	Evidence of breeding	Partial clouding in right eye	Held in trap	Taken to Koala hospital	Rawdon Creek Nature Reserve E: 480226, N:6529946
Trapping	Bush Rat		Adult		Nil	Held in trap for ID	Released outside LoC	W of LoC @ ch11890
Spotlighting	Lit. dentata				Nil	Relocated immediately	Released outside LoC	W of LoC @ ch 12000
Workers Find	Tawny Frogmouth		Juv		Nil	Held in cardboard box until evening	Released back in nest tree with family group	Northern compound, Cooperabung Dr
Spotlighting	Pink Tongue Lizard				Nil	Held for ID	Released outside LoC	W of LoC at Barrie's Creek
Preclear	Saiphos equalis				Nil	Held for ID	Released outside LoC	E of LoC @ ch18400
H245	Eulamprus tenuis				Nil	Escaped capture	Na	Na
H245	Lit. Tyleri				Minor toe laceration	Relocated immediately	Released outside of LoC	E of LoC @ 11800
H245	Egernia mcpheei				Nil	Relocated immediately	Released outside of LoC	E of LoC @ 11800
HAdd	Antechinus x 3				Nil	2 x Escaped capture, 1 x left insitu	Stag placed outside LoC	W of LoC @ ch4000
HAdd	Microbat spp.				Nil	Took flight before capture	N/A	N/A
Spotlighting	Pink Tongue Lizard				Nil	Held for photo	Released outside LoC	W of LoC @ ch22300
Frogging	Lit. gracilenta				Poss. chytrid fungus	Held in aquarium for 3 weeks	Released outside alignment (nil chytrid)	E of LoC on Bill Hill rd
HAdd	Feathertail Glider spp. X 2	F, M	Adult		Nil	Held until dusk	Released in Nestbox	E of Loc @
HAdd	Sugar Glider	M	Adult		Yes, paralysed	Taken to vet	Euthanased	N/A
Workers find	Sugar Glider	M	Sub Adult		Nil	Held for 2 nights until clearing complete	Released in Nestbox near find location	W of LoC @ ch 4000
Trapping	Bush Rat x 3		Adult		Nil	Released immediately	Released outside LoC	W of LoC @ ch19600 (Coop Ck)
Trapping	Antechinus spp.		Adult		Nil	Held in aquarium until clearing finished	Released outside LoC	W of LoC @ ch19600
Trapping	Black Rat x 2		Adult		Tail laceration	Released in clearing area		
HAdd	Narrow toed Feathertail Glider	F	Adult		Nil	Held in calico bag	Released in Nestbox	W of LoC @ ch3500
H82	Cryptoblepharus spp.				Nil	Held in plastic zip lock bag for ID	Released outside LoC	W of LoC @ ch 3400
H319	Eulamprus tenuis				Nil	Held in calico bag	Released outside LoC	W of LoC @ Coop Creek
Cooperabung Ck	MIXOPHYES ITERATUS X2	F, M	Adult		F gravid.	Held in plastic aquariums for tagging and measurements	Released upstream 200m	W. of LoC @ Coop Ck
HAdd	Litoria tylerii				Nil	Released immediately	Released into tree outside LoC	E of LoC
HAdd	Litoria dentata				Nil	Released immediately	Released into tree outside LoC	E of LoC
Workers find	Lit. revelata				Nil	Held for ID	Released near dam outside LoC	E of LoC at ch21000

On site	Blue tongue lizard				End of tail missing	Held and assessed injury	Released E of LoC	E of LoC Sth tinkers driveway
HAdd	Feathertail glider	M	Adult		Nil	Held in calico bag and put in nestbox	Released E of LoC	E of LoC 21800
HAdd	Eulamprus tenuis				Nil	Released immediately	Released E of LoC	E of LoC 21800
H318	Blackish blind snake				Nil	Released immediately	Released E of LoC	E of LoC at 21800
HS159	Blackish blind snake				No	Released immediately	Released W of LoC	W of LoC at 21000
HS159	Pink-tongue skink				No	Released immediately	Released W of LoC	W of LoC at 21000
HAdd	Lit. fallax x1				No	Released immediately	Released E of LoC	Released E of LoC ~14000
HAdd	Lit. dentata x1				No	Released immediately	Released E of LoC	Released E of LoC ~14000
HAdd	Lit fallax x2				No	Released immediately	Released E of LoC	Released E of LoC ~14000
HAdd	Lit peroni x2				No	Released immediately	Released E of LoC	Released E of LoC ~14000
Spotlighting	Southern Dwarf Crowned Snake		Juv		Nil	Held for ID	Released W of LoC	Released W of LoC @ ch 22100
H304	Common Brushtail Possum		Adult		Nil	Escaped capture	In neighbours shed @ Wyndell close	Wyndell close
H304	Eulamprus tenuis x 2				Nil	1 escaped, 1 relocated	Relocated South of LoC	Wyndell Close
H304	Blackish Blind Snake				Yes, deceased	Na	Na	Na
H60	Sugar Glider x 3	M, F, F	A, A, J		Juv F was dazed upon capture, held for observation, was ok.	Held in calico bag	Released in Nestbox	W of LoC @ ch1500
H?	Eulamprus tenuis				Tail missing (old injury)	Released immediately	Released outside LoC	W of LoC @ chainage 1100
H05	Eulamprus tenuis				Nil	Released immediately	Released outside LoC	W of LoC @ chainage 1100
Workers find	Common Ringtail Possum	M	A		Nil	Held for observation and until clearing finished	Released in nestbox in retained veg	Retained veg @ ch850
Workers find	Blackish Blind Snake x15		Juv		Nil	Relocated outside LoC	Released outside LoC	W of LoC @ 1550
H333	Pink Tongue Lizard		Juv		Nil	Held for ID	Released outside LoC	W of LoC @ ch22800
Spotlighting	Lit. peronii		Juv		Nil	Relocated	Released in nearby stream	Ch 22900
H349	Eulamprus tennis				Nil	Held for ID	Released in log	East of LoC at 23500
Found on ground	Lampropholis delicata				Nil	Held for ID	Released outside LOC	East of LoC @ 10000
HAdd	Lit. peronii				Nil	Held for relocation	Released outside LoC	East of LoC at ch9000
HAdd	Common Green Tree Snake		Juv		Nil	Left insitu	Plugged, branch cut and relocated	East of LoC @ ch 8000
HAdd	Lit. dentata				Nil	Held for relocation	Released outside LoC	North of LoC @ back and point rd
Old Barries creek bridge	3 x Blackish Blind Snakes				1 x tail section missing	Held for relocation	Released outside LoC	East of LoC @ Barries creek
Old Barries creek bridge	2 x Southern Dwarf Crowned Snake				Abrasions and slow moving	Held for relocation	Released outside LoC	East of LoC @ Barries Creek
Old Barries creek bridge	1 x Pseudophryne spp.				Nil	Held for relocation	Released outside LoC	East of LoC @ Barries creek.
HS145	Lit. gracilenta				Nil	Released immediately	Released outside LoC	T Tree Farm
H155	Green tree snake				Nil	Left insitu	Section relocated outside LOC	SE of LOC in bush
Fern bank creek	Litoria fallax				Nil	Released immediately	Released outside LoC	Fernbank creek
Workers find	Kookaburra				Wing broken	Taken to vet	Euthanased	N/A
Preclear	Small Eyed Snake				Nil	Held for ID	Released outside LoC	W of LoC @ ch 18200
H276	green tree frog				Nil	Held for relocation	Released outside LoC	west of 12500
H267	graceful tree frog				Nil	Held for relocation	Released outside LoC	west of 12500
H268	Green tree frog				Nil	Held for relocation	Released outside LoC	west of 12500

H257	Eulamprus tenuis				Nil	Held for relocation	Released outside LoC	west of 12500
H252	green tree frog, E. tenuis				Nil	Held for relocation	Released outside LoC	west of 12500
H300	Carpet python		juvenile		Nil	Held for relocation	Release outside LoC	Cooperabung Creek - Haydons Wharf Road
H224	Eulamprus tenuis				Nil	Held for relocation	Release outside LoC	Release on west side carriageway
Preclear	Eastern Small-eyed Snake	na	Adult	na	Nil	kept in calico bag for 1 hour	released into nest box area @ 3650	nest box zone at 3650
HAdd	Ringtail possum	F	Adult		Nil	Relocated in nest box	Released	E:0483144; N 65207319
HAdd	Joey Ringtail possum	Unknown	Furred	Nil	Nil	Relocated in nest box	Released	E:0483144; N 65207319
HAdd	Ringtail possum (same as above)	F	Adult		Nil	Relocated in nest box	Released	E:0483144; N 65207319
HAdd	Joey Ringtail possum (same as above)	Unknown	Furred	Nil	Nil	Relocated in nest box	Released	E:0483144; N 65207319



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Biodiversity Survey

Project Management

Impact Assessment

Ecological Monitoring

Specialist Surveys

Kieran Metcalfe
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OH2K Pacific Highway Upgrade
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8 August 2017

cc. Grant Fletcher

Dear Kieran,

RE: OH2K phase 2 clearing report – September 2015 to June 2017.

Introduction

Sandpiper Ecological Surveys was contracted by Lend Lease Engineering (LLE) to provide ecological services during construction of the Oxley Highway to Kundabung (OH2K) section of the Pacific Highway Upgrade. Part of the provision of ecological services includes reporting on clearing operations and associated ecological tasks. The following report provides results from ecological tasks undertaken during phase 2 clearing in the north of the project area for the period September 2015 and June 2017. It should be read as an addendum to the substantive report submitted at completion of Phase 1 clearing which occurred between 3 November 2014 and 25 August 2015 (Sandpiper 2015).

Methods

Clearing operations during phase 2 largely focused on a small amount of habitat clearing in the north of the project area, fence-line clearing and clearing associated with decommissioning bridges at Cooperabung Creek and Barrys Creek. Pre-clearing procedures followed those described in the Phase 1 report (Sandpiper 2015) and included:

- Diurnal pre-clear surveys – conducted immediately prior to clearing a section of the alignment. Involved a meandering foot traverse by one to two ecologists. During traverses, all accessible fauna habitats were inspected. This included use of a wrecking bar to roll and split logs and visual searching of the shrub and canopy layers for koalas, bird nests, possum dreys and unmarked hollow bearing trees (HBT). A rake was used to search leaf litter in potential green-thighed frog habitat. Captured fauna were released immediately into adjoining habitat or, if adjacent habitat was unsuitable, housed temporarily in cotton or plastic bags (frogs only), and later released into nearby suitable habitat.
- Habitat tree inspections - Habitat trees were left in-situ for a minimum of 48 hours (2 nights) after surrounding vegetation had been cleared. In some instances, trees containing dreys and nests were removed immediately if they were accessible from the ground and deemed vulnerable to damage/disturbance during the under-scrubbing. Once felled, all hollows were inspected using a hand-held LED torch and/or a bore scope. Captured fauna were released into surrounding habitat.

- Frog surveys - frogs were targeted during all nocturnal spotlight surveys and diurnal pre-clear surveys and threatened frog targeted surveys were conducted in areas of potential habitat or areas mapped as supporting either giant barred frog (*Mixophyes iteratus)* or green-thighed frog (*Litoria brevipalmata*). Stage 2 clearing areas affected by threatened frog habitat included Cooperabung Creek and south of Barry's Creek (chainage 23900) (giant barred frog) and north of Blackmans Point Road (chainage 9000 to 9350) (green-thighed frog). The frog hygiene protocol included in the Fauna and Flora Management plan was applied during all frog surveys. Frog survey protocols were as per those described in Stage 1 clearing report (Sandpiper 2015).

Results

No fauna deaths were reported during phase 2 clearing operations and no fauna were recovered during pre-clearing surveys conducted prior to general and fence-line clearing operations (Table 1). Targeted nocturnal surveys at Cooperabung Creek prior to bridge decommissioning resulted in capture of two giant barred frogs (Plate 1; Table 1 and 2). In both instances, individuals were relocated 120 - 190m upstream.

Plate 1. Giant barred frogs captured on 10 January 2017 (left) and 23 March 2017 (right) at Cooperbung creek during targeted nocturnal survey (L). Individuals were released 120m and 190m upstream, respectively.

Only one hollow bearing tree was removed during phase 2 clearing operations (Table 3). The tree featured a native beehive in a small trunk hollow. The hive was relocated in adjoining habitat. Road mortality surveys were conducted on two occasions during clearing operations adjacent Barrys Creek (Table 4). No road-killed fauna were observed on the road surface during these surveys.

Discussion

Phase 2 pre-clearing and clearing procedures during the reporting period may be regarded as successful due to the absence of fauna deaths and the detection and relocation of targeted threatened species. Few fauna were detected during phase 2 pre-clearing surveys which likely reflects the relatively small clearing footprint and mostly low quality habitat removed. The exception to this was Cooperabung Creek and Barrys Creek areas, where a small amount of riparian habitat was removed.

Targeted pre-clearing frog surveys at Cooperabung Creek resulted in capture of two threatened giant barred frogs. Such captures highlight the importance of the pre-clearing survey protocols for this target species. Repeat surveys

are a critical feature of this protocol especially during times of the year when the species may be difficult to detect.

Please contact me if you have any questions regarding the information provided.

Yours faithfully,

Dr Brendan Taylor
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Table 1: Results of the pre-clear inspections conducted during Stage 2 clearing operations August 2016 to June 2017. (GBF = giant barred frog; Hbt = hollow-bearing tree). Inspections were generally carried out in favourable weather conditions.

Date	Observer	Chainage/Area Sampled	Purpose	Start Time	Finish Time	Species Captured	Release Location
8/8/2016	JE	NR	Preclear for frog fence	0700	1200	Nil	
9/8/2016	JE	NR	Preclear for frog fence	0630	0900	Nil	
9/8/2016	NP & JE	Barrys Ck	GBF pre-clear survey - spotlight	1730	2000	Nil	
10/8/2016	NP & JE	Barrys Ck west	Spotlight survey for clearing	1730	2000	Nil	
11/8/2016	NP	Barrys creek West	1 x Hbt marked up	0600	0700	Nil	
11/8/2016	NP & JE	Barrys creek West	GBF pre-clear survey - spotlight	1715	2000	Nil	
12/8/2016	NP	Barrys creek West	pre-clear	0630	0900	Nil	
15/8/2016	JE	Barrys Ck west	pre-clear	545	800	Nil	
15/8/2016	NP & JE	Barrys Ck	Phase 2 microbat exclusion in Barrys Creek culvert	1730	1945	ni	
31/10/2016	ST	sw of rail line	fence line clearing	1035	1050	nil	
31/10/2016	ST	ne of rail line	fence line clearing	1015	1030	nil	
31/10/2016	ST	ne of Haydons Wharf Rd	fence line clearing	0950	1010	nil	
7/2/2017	JE & K	Cnr Cooperabung Drv and C Range Rd	Preclearing inspection	0620	0835	nil	
	JE & K	Hacks ferry Rd and exit from Wilson Rvr bridge	Preclearing inspection	0620	0835	nil	
15/3/2017	JE	Cooperabung Drv to Yarranbee Rd	Stage 2: Habitat mark up	0700	1045	nil	
16/3/2017	JE	top of Cooperabung Range to Yarranbee Rd	Stage 2: Koala search, 100m in from temp fence	0945	1245	nil	
20/3/2017	JE	20080 to 21500	Stage 2: Preclearing inspection with LL staff.	0630	1045	nil	
21/3/2017	JE	20080 to end of stage 2.	Spotlight, koala search.	0400	0715	nil	
21/3/2017	JE	20080 to 21100	Stage 2: Preclearing inspection	0730	1115	nil	
22/3/2017	JE	Yarrabee to end Stage 2	Stage 2: Spotlight, koala search	0430	0700	nil	
22/3/2017	JE	20080 and 22800	Pre-clearing inspection	0700	0915	nil	
22/3/2017	JE	20650 to 21100	Additional preclearing inspection	0945	1215	nil	
23/3/2017	JE	Cooperabung Ck	GBF pre-clear survey - spotlight	1900	2145	GBF x1; [E:482864 N:6537992]	released 120m upstream
29/3/2017	JE	Cooperabung Ck	Seal scuppers in bridge to exclude microbats	1600	1815	nil	
24/5/2017	JE, Sam (LL)	Cassegrain to Fernbank Ck	Preclearing inspection along fence line.	0845	1115	nil	

Table 2: Results of the pre-clear threatened frog spotlight surveys conducted during Stage 2 clearing operations August 2016 to June 2017 (GBF = giant barred frog; GtF = green-thighed frog).

Date	Observers	General Location	Location (chainage)	Start Time	End Time	Weather (cloud, wind, rain, temp, rh)	Visibility	Species	No. Individuals	Comments
10/8/16	NP/JE	Barrys Creek	23800-24500	1800	1930	0%, nil, nil, 20.3, 82%	Dark	Nil		
11/8/16	NP/JE	Barrys Creek	23800-24500	1800	1930	0%, nil, nil, 19.3, 87%	Dark	Nil		
15/8/16	NP/JE	Barrys Creek culvert	24300	1830	1930	bat exclusion in scupper	Dark	nil		
10/1/17	NP/JE	GBF survey, Cooperabung Crk		2030	2215	50%, msb,nil, 27.5, 75.6%	Dark	GBF	1F; [E: 482870, N: 6538014]	94mm. New. PIT tag number: 991001000620127. Released 190m upstream.
12/1/17	NP/JE	GBF survey, Cooperabung Crk		2020	2130	100%, nil, nil, 25.1, 83.2%	Dark	L. fallax	17	Relocated south of frog fence
19/1/17	NP/JE	GBF survey, Cooperabung Crk		2030	2110	100%, nil, very light drizzle, 22.7, 72%	Dark	L. fallax	4	Relocated south of Frog fence
13/3/17	NP	GTF survey, Blackmans Point Rd		1940	2045	100%, nil, nil, 23.1, 75%	Dark	Lit. peronii tads, Lim. peronii	30+, 2.	

Table 3: Results of hollow-bearing tree removal (Hbt) during Stage 2 clearing operations August 2016 to June 2017.

Hbt Number	Date	Observer	Location	Tree species	Hollows	Fauna signs	Fauna present	Comment
HSAdd	15/8/16	JE	23800- 24500	Tallow wood	Trunk: 1x small	nil	old native beehive	relocated over LoC

Table 4: Results of the road mortality surveys during Stage 2 clearing operations August 2016 to June 2017.

Date of Survey	Observers	Start location/ Area inspected	Carriageway (NB, SB)	Distance of kill from start	Species /group	Accuracy	Adj clearing <48hrs	Adj Clearing	Location (approx)
12/8/16	NP	23800-24500	Nil						
15/8/16	JE	23800-24500	Nil						

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October 2017