



Kempsey Bypass

Fauna Mitigation Monitoring Results 2016-2017

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Cover photograph: Brushtail Possum (left) and a Northern Brown Bandicoot (right) captured via remote camera using the underpass at Bingis Lane, summer 2016-17.

Executive summary

Context

This report summarises the results of monitoring fauna underpasses during the summer period of 2016 to early 2017 as required by the Kempsey Bypass Ecological Monitoring Program (EMP) (Lewis 2012). This is the final round of ecological monitoring for the Kempsey Bypass.

Aims

The aim of the ecological monitoring as outlined in the EMP is to “determine the effectiveness of flora and fauna mitigation measures”.

Methods

Three fauna underpass structures were surveyed in accordance with the monitoring method and design specified in the EMP. This included camera, hair-tube and incidental observations of fauna tracks and scats at the underpasses, road kill monitoring and monitoring of fauna exclusion fences at the underpass structures.

Key results

- A range of species were detected by the remote cameras across the three monitoring locations. As per the 2016 findings, species frequently recorded included the Common Brushtail Possum (*Trichosurus vulpecula*), Rats (likely *Rattus fuscipes* and *Rattus rattus*) and Swamp Wallaby (*Wallabia bicolor*).
- The following animals were detected by hair tube and/or opportunistic searches: Rats, Common Brushtail Possums and Red-necked Wallabies (*Macropus rufogriseus*).
- Boat Harbour Creek underpass recorded species from four of the six nominated fauna groups targeted for monitoring including reptiles, small ground-dwelling mammals, possums and macropods. Bingis Lane underpass recorded species from three of the six fauna groups including macropods, possums and small ground-dwelling mammals and Pola Creek underpass recorded species from three of the six fauna groups including macropods, small ground-dwelling mammals and reptiles.
- Key target species, the Koala (*Phascolarctos cinereus*) and Brush-tailed Phascogale (*Phascogale tapoatafa*) were not recorded using the structures during the current monitoring period.
- No animals were found during the road kill checks.
- The fauna fence was generally in good condition at all three sites, but some maintenance is required to trim vegetation from the fence, repair Brush-tailed Phascogale panels and to address lifting of fence in certain areas, particularly gutters.

Conclusions

Use of the fauna underpasses by species within four of the six targeted groups for monitoring indicates, for the most part, that performance measures relating to fauna use of the underpasses for the summer 2016 monitoring period were met. Neither of the two key indicator species, the Brush-tailed Phascogale or Koala were recorded using the underpass structures during the current monitoring period. Brush-tailed Phascogales have previously been recorded using underpass structures constructed as part of the Frederickton to Eungai Pacific Highway Upgrade, to the north of the Kempsey Bypass (Niche 2017). Further information on the presence of these species within the vicinity of the underpasses would be required to understand possible reasons for these species not using/being detected using the underpasses.

Performance measures in relation to the fauna fence structure and road kill were met with no breaches or road kill observed, although some maintenance is required to preserve the fence’s functionality.

Review of underpass monitoring data at each of the three sites over the entire monitoring period indicated that performance measures relating to the detection of: *nominated indicator species from the six fauna groups, key targeted species and species with low dispersal ability* was partly met. Specifically, performance measures were met in relation to reptiles, small ground-dwelling mammals, possums and macropods being recorded using the underpasses. Key target species the Koala and Brush-tailed Phascogale were not recorded at/using the underpasses. However, lack of records alone is not sufficient to indicate failure of the mitigation measure for this species group. Further investigations would be required to understand presence of these species at/around the underpasses.

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1. Introduction

1.1 Context

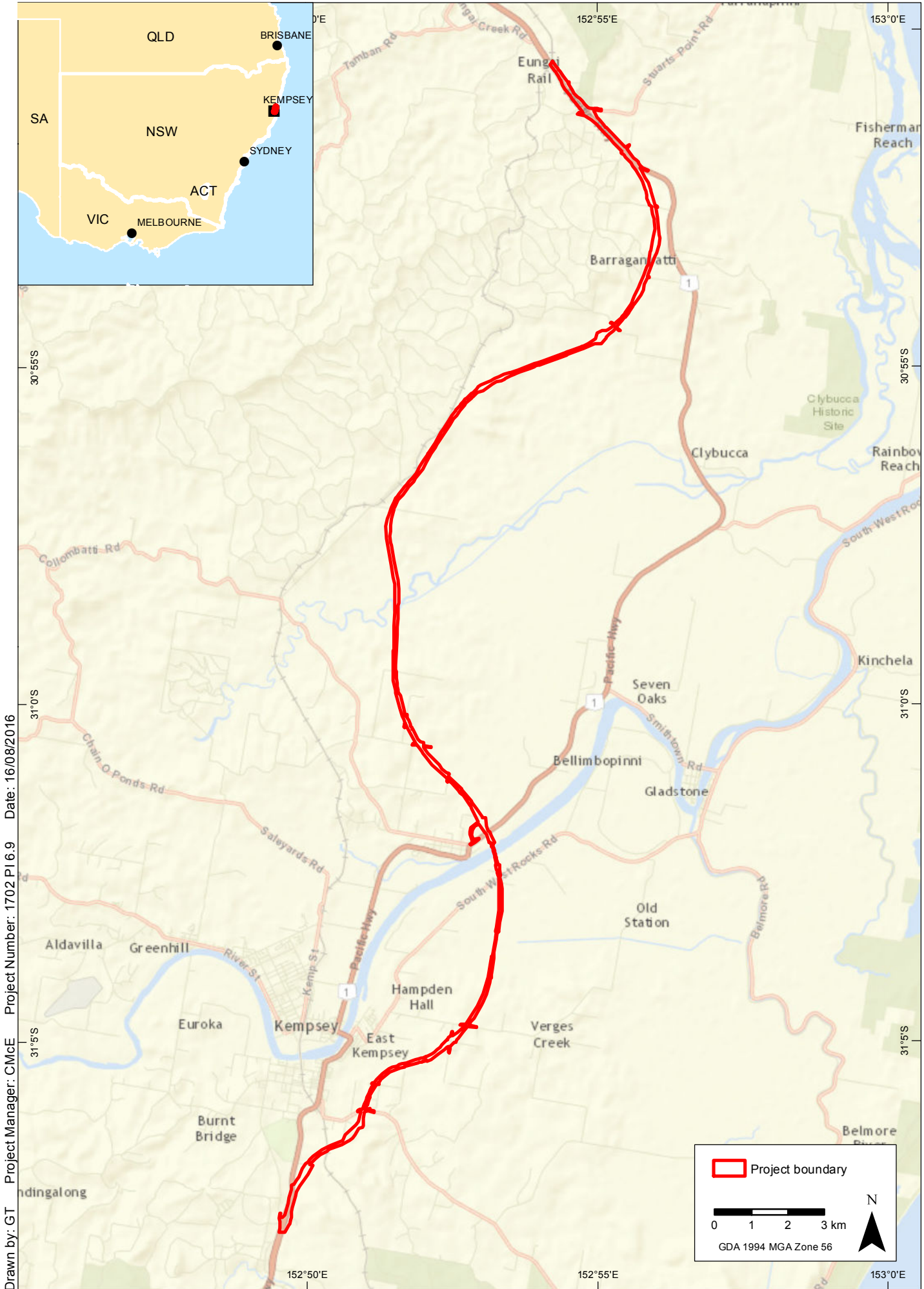
This report summarises the findings of ecological monitoring conducted during the summer period 2016-2017 undertaken in accordance with the Kempsey Bypass Ecological Monitoring Program (EMP) (Lewis 2012) (hereafter referred to as the 'EMP'). Monitoring undertaken during this period included fauna underpass monitoring for summer 2016-2017 only and represents the final round of underpass monitoring to be completed. Monitoring of the aerial crossing structures was completed and finalised in 2015-2016, as per the EMP. This report details the timing, methods and results of the underpass monitoring surveys, and discusses these in relation to performance benchmark criteria.

1.2 Background

In accordance with the Minister's Condition of Approval 2.10 (d) and the approved EMP, Niche Environment and Heritage Pty Ltd (Niche) were engaged by Roads and Maritime Services to undertake monitoring of fauna crossing structures and associated fauna fencing on the Kempsey Bypass. The project consisted of upgrading the Pacific Highway between South Kempsey and Frederickton, along a distance of approximately 14.5 kilometres (Figure 1). The aim of the EMP is to *"determine the effectiveness of flora and fauna mitigation measures"* as per the Statement of Commitment F22.

1.3 Objectives

The EMP details the schedule of ecological monitoring requirements for the life of the Project. This report provides the findings of the final fauna underpass and associated fauna fence monitoring activities undertaken during the Operational phase of summer 2016-2017, as identified in Table 1.



Drawn by: GT Project Manager: CMcE Project Number: 1702 PI 6.9 Date: 16/08/2016

Regional location – Kempsey Bypass monitoring
Pacific Highway Upgrade - Kempsey Bypass

FIGURE 1

Table 1: Summary of updated monitoring events based on consultation with EPA

Mitigation Measure	Construction (2010-2013)															Transition Year					Operational (2014-2016)														
	Year 1(2010)					Year 2 (2011)					Year 2 (2012)					Year 4 (2013)					Year 5 (2014)					Year 6 (2015)					Year 7 (2016)				
	Su	A	W	S	Su	Su	A	W	S	Su	Su	A	W	S	Su	Su	A	W	S	Su	Su	A	W	S	Su	Su	A	W	S	Su	Su	A	W	S	Su
Pre-Clearing Works																																			
Clearing Works																																			
Green-thighed Frog Breeding Ponds																																			
Next Boxes																																			
Aerial Crossing Structures (rope bridge and glider poles)																																			
Fauna Underpasses and Associated Fencing																																			
Glossy Black Cockatoo Monitoring																																			
Brush-tailed Phascogale Monitoring																																			

A W S Su = Autumn, Winter, Spring and Summer.
 Green shading denotes survey period undertaken
 Orange shading denotes survey to be undertaken as part of this brief
 1. Not enough rain received to trigger the need for monitoring

2. Fauna Underpass and Associated Fauna Fencing Monitoring Program

This section details the findings obtained from the final period of the fauna underpass and associated fauna fencing monitoring program. The methods, results and comparison with previous results are discussed below, in addition to recommendations for the implementation of contingency measures based on a comparison of results against performance measures.

2.1 Monitoring Timing

The EMP states the following monitoring timing for the fauna underpass and associated fauna fencing structures:

“It is proposed that monitoring of the fauna underpasses and associated fauna fencing be undertaken in order to provide long term insights into the mitigation effectiveness once revegetation and landscaping efforts have developed sufficient cover. Monitoring would commence when the upgrade becomes operational and be undertaken for 4 weeks during late autumn and 4 weeks in early summer for years 1, 2/3 and 4 after which the need for further monitoring would be reviewed in consultation with EPA (Table 6). Summer has been selected as one sampling time period given the ecothermic habits of most herpetofauna (frogs and reptiles) whilst late autumn has been selected as the second sampling period given this time reflects the breeding season for the Brush-tailed Phascogale, when males are most active and likely to utilise the fauna underpass structures. Additional monitoring may be required in the event the monitoring data suggests a fauna underpass is ineffective and modification/treatments are required”.

Surveys investigating the fauna underpasses and associated fauna fencing occurred in summer 2016-2017, as scheduled in the EMP (Table 1).

2.2 Performance Measures

Indicators of success for the fauna underpass and associated fencing monitoring includes:

- Use of the fauna underpass by the nominated indicator species
- Use of the fauna underpass by key target species
- Use of the fauna underpass by fauna with low dispersal abilities
- Low rate of fauna road strike and
- No breaches in the fauna fence.

Six fauna groups and two key target species have been nominated in the EMP on which to determine the effectiveness of each underpass structure. The six groups include:

- Frogs
- Reptiles
- Mammals including four sub groups:
 - Small ground-dwelling (Antechinus, Rodents, Bandicoots)
 - Echidna (*Tachyglossus aculeatus*)
 - Possums
 - Macropods (Swamp Wallaby, Red-necked Wallaby, Eastern Grey Kangaroo).

The two key target species include the Brush-tailed Phascogale and Koala.

The degree of success of each structure will be determined by the complete passage of one or more individuals from each of the six groups provided they have been previously recorded in that area” (Table 2).

Table 2: Nominated Fauna Classes in EMP (Lewis 2012)

Table 3-2. Summary of fauna classes previously recorded at or near (<1 km) underpass locations.
√ denotes presence.

Monitoring Species/Group	Boat Harbour Creek	Bingis Lane	Pola Creek	Comment
Frogs	√	√	√	
Reptiles	√	√	√	
Mammals				
Small Ground Dwelling		√		
Echidna	√			Likely to occur at Bingis Lane and Pola Creek
Possums	√	√	√	
Macropods	√	√	√	
Key Target Species				
Brush-tailed Phascogale		√		
Koala	√	√	√	Recorded adjacent to these locations and the area is mapped as secondary habitat with primary habitat < 1 km away (see KKPoM).

2.3 Methods

The methods used for monitoring the fauna underpasses and associated fauna fencing were based on the EMP as described below.

“Monitoring is proposed for each of the three dedicated fauna underpasses using the following techniques:

- A single automated camera installed in the middle of each fauna underpass with the objective to record the direction of small, medium and large fauna. Left operating over a continuous 30 day period;
- Hair tubes (10) in residual habitat bordering the culvert and left operating for 14 nights. Hair tubes will be attached to fauna furniture installed in each underpass at various heights and baited with either a meat or vegetable bait. The objective of this is to sample for a range of ground dwelling, scansorial and arboreal fauna;
- Scat and track surveys focusing on a visual search of the underpass and immediate surrounds each time the sand pads are inspected;
- Survey of the fauna fencing for 250 m either side of the underpass to identify and report any breaches; and
- Survey of the carriageway for road struck fauna within 500 m of the fauna underpass.”

Three underpasses were monitored, including one combined 9 m X 5 m reinforced concrete arch culvert at Boat Harbour Creek – Site 1, one dedicated 3 m X 3 m reinforced box culvert underpass at Bingis Lane – Site 2 and a bridge underpass at Pola Creek – Site 3. The location of each underpass is shown on Figure 2.

Photos of each underpass are provided in Plates 1 to 3 below.



Plate 1: Boat Harbour Creek Underpass



Plate 2: Bingis Lane Underpass



Plate 3: Pola Creek Underpass

2.3.1 Remote camera

Infrared remote cameras (Scoutguard SV 560) were placed within each underpass in order to capture fauna passing through. On the 28th November 2016, two cameras were installed at both Boat Harbour Creek and Bingis Lane, and three cameras installed at Pola Creek. The cameras were set to take a photo burst when triggered, of three photos every five seconds, at all times of the day over a 30 day period.

2.3.2 Hair tube and opportunistic searches

To supplement the remote cameras, particularly to enable detection of smaller species such as Brown Antechinus (*Antechinus stuartii*) and Bush Rats (*Rattus* sp.) 10 hair tubes were also placed within each underpass for 17 consecutive nights in summer (28th November to 15th December 2016). Each hair tube was baited with a mixture of oats, honey and peanut butter. The hair tubes were placed at even spacing throughout the underpass and where possible were mounted above the ground on the underpass fauna furniture. Hair samples were analysed by Barbara Triggs (of 'Dead Finish') and identified to species level where possible.

Opportunistic searches for scats and tracks occurred within each underpass while placing and collecting the survey equipment.

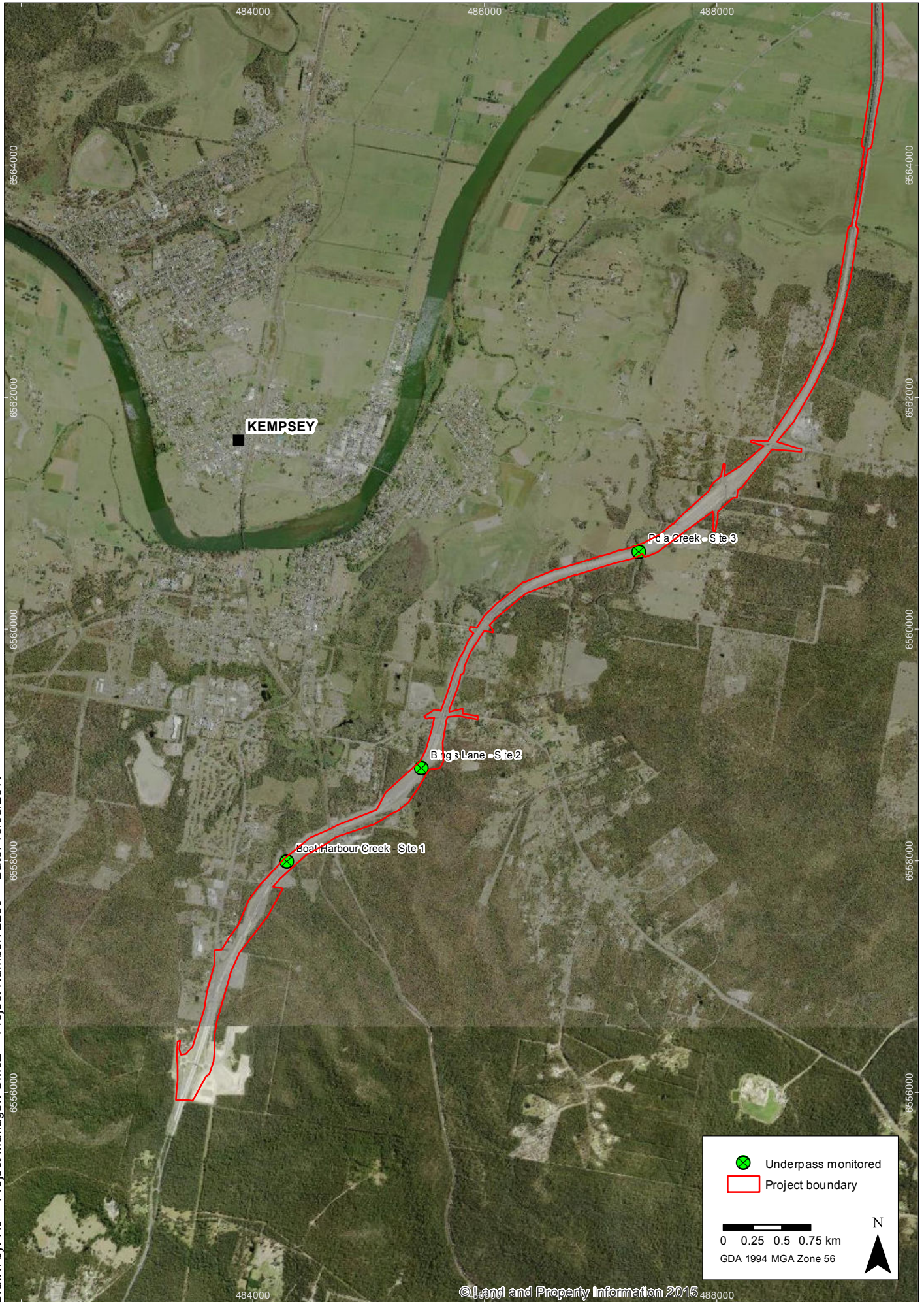
2.3.3 Road kills

Inspection of the carriageway within 500 m of the fauna underpasses to search for road kill was undertaken in summer on the 20 December 2016.

2.3.4 Fauna fencing

'Floppy top' fauna fencing was monitored for at least 250 m either side of each underpass on both side of the road for all three sites. Any breaches that may have occurred were recorded.

Drawn by: RJ Project Manager: CMcE Project Number: 2250 Date: 10/08/2017



Fauna underpass monitoring locations
Pacific Highway Upgrade - Kempsey Bypass

FIGURE 2

2.4 Results

2.4.1 Remote cameras

A range of species were detected by the remote cameras across the three monitoring locations (Table 3). A total of 15 species were recorded from several different fauna groups including small and large native mammals, reptiles and birds as well as a number of introduced pest species (Red Fox, Dog, Domestic Cat and Rabbit). Native species that were frequently recorded utilising the underpasses, included the Common Brushtail Possum (*Trichosurus vulpecula*), Lace Monitor (*Varanus varius*) and Swamp Wallaby (*Wallabia bicolor*). Less frequent users included the Red-necked Wallaby (*Macropus rufogriseus*), Northern Brown Bandicoot (*Isodon macrourus*) and possible Antechinus which were only recorded on two separate occasions at one of the three sites. Plates 4 to 7 show photographs of species captured on the remote infrared cameras. Boat Harbour Creek recorded species from four of the six nominated fauna groups including reptiles, small ground dwelling mammals, Possums and Macropods. See Table 2 for a list of the nominated fauna classes as in the EMP. Bingis Lane and Pola Creek underpasses each recorded three of the six nominated fauna groups: Bingis Lane recorded Macropods, Possums and small ground-dwelling mammals and Pola Creek recorded Macropods, small ground-dwelling mammals and reptiles.

Key target species, the Koala and Brush-tailed Phascogale were not recorded using the structures during the current monitoring period.

Table 3: Species recorded via remote camera at each underpass site, summer 2016

Species	Boat Harbour Creek	Bingis Lane	Pola Creek
Swamp Wallaby (<i>Wallabia bicolor</i>)		✓	✓
Red-necked Wallaby (<i>Macropus rufogriseus</i>)	✓		
Common Brushtail Possum (<i>Trichosurus vulpecula</i>)	✓	✓	
Northern Brown Bandicoot (<i>Isodon macrourus</i>)		✓	
Small Mammal (possible Antechinus sp.)	✓		
Rattus sp.			✓
Small bird (unknown species)	✓		
Corvus sp.	✓	✓	
Lace Monitor (<i>Varanus varius</i>)	✓		✓
Water Dragon (<i>Intellagama lesueurii</i>)	✓		✓
Dog			✓
Red Fox (<i>Vulpes vulpes</i>)	✓	✓	✓
Goat (<i>Capra hircus</i>)		✓	
Hare/Rabbit			✓
Domestic Cat (<i>Felis catus</i>)		✓	✓



Plate 4: Red-necked Wallaby recorded in Boat Harbour Creek underpass, summer 2016-2017



Plate 5: Lace Monitor recorded at Boat Harbour Creek, summer 2016-2017



Plate 6: Northern Brown Bandicoot recorded in Bingis Lane underpass, summer 2016-2017



Plate 7: Red fox recorded at Pola Creek, summer 2016-2017

2.4.2 Hair tube and opportunistic searches

There were minimal results obtained using hair tubes at Boat Harbour Creek. Only two species were detected; Common Brushtail Possum and a rodent but with only one fine hair it could not be identified to species level. A Red-necked Wallaby was also observed inside the fauna fence at the site.

Hair tubes at Bingis Lane detected only one species; the Common Brushtail Possum which was detected in six of the 10 hair tubes. At Pola Creek, there was evidence of Rats (*Rattus* sp.) with two confirmed records of *Rattus rattus*.

2.4.3 Road kills

No road kill was observed at any of the underpass sites during the road kill survey.

2.4.4 Fauna fencing

The results of the fauna fence inspection for all three underpasses are detailed in Table 4.

Table 4: Fauna fence inspection results at each site, summer 2016

Date	Breach/maintenance /fence ended	Site	Bearing	Metres from underpass	Comments
01/12/2016	Fence maintenance	Boat Harbour Creek	W		Fence panel detached and trees on fence
01/12/2016	Fence maintenance	Boat Harbour Creek	SW	80	Panel fallen off and grass growing over fence. Entire fence needs trees and shrubs trimmed.
01/12/2016	Fence lifting in gutter	Bingis Lane	SE	15	
01/12/2016	BTP* Fence netting finishes	Bingis Lane	SE	200	
01/12/2016	Fence maintenance	Bingis Lane	SE	215	Vegetation growing too close, animals able to climb.
01/12/2016	Fence lifting slightly	Bingis Lane	NE	115	
01/12/2016	Fence finishes	Bingis Lane	NE	130	
01/12/2016	End Fence	Pola Creek	NE	80	
01/12/2016	Fence ending	Pola Creek	SW	100	
01/12/2016	Fence lifting in gutter	Pola Creek	SE	25	

*BTP stands for Brush-tailed Phascogale

The fauna fence inspection determined that maintenance is required to repair some parts of the Brush-tailed Phascogale component of the fence (panel) at Boat Harbour creek. At Bingis Lane and Pola Creek the

fence may require maintenance to address the lifting at the base of the fence in some parts, particularly in gutters. Vegetation growing on and over the fence at Boat Harbour Creek and Bingis Lane requires trimming to ensure animals cannot climb up the vegetation and over the fence.

2.4.5 Comparison with previous results – fauna use of underpasses

Table 5 provides a summary of the fauna underpass monitoring results at all three sites over the three-year monitoring period. It includes results of six survey events – autumn and summer 2014, autumn and summer 2015 and autumn and summer 2016.

Results are as follows:

- Frogs have not been recorded at any sites except for Pola Creek (2016). This could be attributed to the fact that the survey methods used (hair tubes, remote cameras and limited opportunistic surveys), are not generally very effective at detecting small and often cryptic reptile and amphibian species.
- Reptiles have been recorded using the structures at each site with reptiles being recorded in two of the three years at Boat Harbour Creek and Pola Creek and during 2014 at Bingis Lane.
- Small ground dwelling mammals were recorded at Bingis Lane and Boat Harbour Creek in 2014 and 2016 but were absent in 2015 surveys. This included the Northern Brown Bandicoot recorded in summer 2016/17 at the Bingis Lane site which hadn't been detected since summer 2014/15.
- Possums (Common Brush-tailed Possum) were commonly detected utilising these structures having been recorded in at least two of three year monitoring events at all sites.
- Macropods (Swamp Wallabies and Red-necked Wallabies) were also commonly recorded at the underpasses being recorded at each site every year.
- Key target species, the Koala and Brush-tailed Phascogale were not recorded using the structures during the current monitoring period or any previous monitoring period.

Table 5: Nominated fauna groups recorded/observed at the underpasses

Monitoring Species/Group	Boat Harbour Creek			Bingis Lane			Pola Creek		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Frogs	-	-	-	-	-	-	-	-	✓
Reptiles	-	✓	✓	✓	-	-	✓	-	✓
Mammals									
Small Ground Dwelling	✓	-	✓	✓	-	✓	✓	-	✓ -
Echidna	-	-	-	-	-	-	-	-	-
Possums	-	✓	✓	✓	✓	✓	✓	-	✓
Macropods	✓	✓	✓	✓	✓	✓	✓	✓	✓
Key Target Species -Brush-tailed Phascogale, Koala	-	-	-	-	-	-	-	-	-

Species previously recorded but not detected during the summer 2016 monitoring event include:

- Eastern Grey Kangaroo (*Macropus giganteus*) - recorded in summer at Boat Harbour Creek and autumn at Bingis Lane in 2015 (Niche 2015).
- Common Ringtail Possum (*Pseudocheirus peregrinus*) - recorded on remote cameras at Pola Creek in autumn 2014 and summer 2014/15 (ERM 2014b, 2014c).

3. Discussion

3.1 Summer 2016/2017 monitoring event - compliance with performance measures

The performance measures and the results of this monitoring period are detailed in Table 6, including suggested actions in response to these results, if required. It should be noted that this was the final monitoring event for the Kempsey Bypass.

All underpass sites recorded use by a number of the nominated indicator species/groups, however there were some groups missing from each of the underpass sites (Table 6). This has resulted in the performance measures for the summer 2016 monitoring period being met for the most part in relation to the fauna underpasses. With respect to the fauna fence structure and road kill monitoring, the performance measures have been fully met.

Table 6: Underpass monitoring performance measures, summer 2016-2017 results and actions required

Success indicators	Potential problems	Results against performance measure	Contingency measures/ Required actions
Use of fauna underpass by the nominated indicator species (Table 2.) <ul style="list-style-type: none"> • Frogs • Reptiles • Mammals <ul style="list-style-type: none"> ▪ Small-ground dwelling (<i>Bingis Lane only</i>) ▪ Echidna (<i>Boat Harbour Creek only</i>) ▪ Possums ▪ Macropods 	a) Low usage rates of native fauna.	<p>The diversity of native fauna recorded was similar to previous autumn 2016 monitoring event. Frogs were not detected at any site.</p> <p>Reptiles were recorded at Pola Creek and Boat Harbour Creek, but not at Bingis Lane.</p> <p>Small ground dwelling mammals were detected at all sites.</p> <p>Possums were detected at Boat Harbour Creek and Bingis Lane but not Pola Creek. This may be due to the surrounding habitat and lack of fauna furniture or refuge from predators, due to the underpass being a bridge structure.</p> <p>The Echidna was not recorded at any site. As per Table 2 the echidna has only been recently recorded at Boat Harbour Creek so is not listed as an indicator species for the other sites. The lack of detection may be due to a range of factors: they are shy of using these structures; they may use them, but not during the designated monitoring period and thus aren't being recorded; they are not present in the surrounding habitat.</p> <p>Macropods were recorded at all three sites.</p>	<p>Due to their small size and cryptic nature, frogs are less likely to be recorded using the prescribed survey methodology. Targeted aural and nocturnal spotlighting surveys would be required to specifically survey for these species at the underpasses. However, frogs were detected at Pola Creek during the autumn 2016 monitoring event so no action required.</p> <p>Reptiles, small ground-dwelling mammals and possums were recorded using two of the three underpasses, therefore no action required.</p> <p>Further investigations would be required to understand lack of echidna records at/around the underpasses. Lack of records alone is not sufficient alone to indicate failure of the mitigation measure for this species group.</p> <p>No action required in relation to underpass use by macropods.</p>

Success indicators	Potential problems	Results against performance measure	Contingency measures/ Required actions
Use by fauna with low dispersal abilities. (This includes four fauna groups: frogs, reptiles, small ground dwelling mammals and echidna).	a) Low usage rates of native fauna.	Reptiles and small ground-dwelling mammals were recorded at two of the three underpasses and frogs at one.	Possible reasons/actions relating to lack of frogs and echidnas are discussed above. No action required.
Use of the fauna underpass by key target species (Brush-tailed Phascogale (<i>Bingis Lane only</i>) and Koala)	b) One or more of the key target species not using the underpass structure.	There were no records of the Koala or Brush-tailed Phascogale using any of the three underpasses in summer 2016.	Brush-tailed Phascogales were recorded in close proximity (less than 1 km) to Bingis Lane in 2013 and 2014 (OEH 2017). Database searches revealed that Koalas were recorded within a 3 km radius of Boat Harbour Creek and Bingis Lane in 2014 (OEH 2017). There are no recent (within last five years) Koala records in the vicinity (3 km radius) of Pola Creek (OEH 2017), therefore it is considered unlikely that this species would be recorded using it. Further investigations would be required to understand lack of Brush-tailed Phascogale and Koala records at the underpasses. Lack of records within the underpasses alone is not sufficient to indicate failure of the mitigation measure for this species group.
	c) High visitation/usage rates by exotic predators.	Foxes and Cats were consistently present at all three sites.	Provided the fauna furniture remains intact it should allow native fauna refuge from predation. No action required. Potential to investigate pest control for exotic predators including the Fox, Dog and Cat.
Low rate of fauna road strike	d) Unacceptable rates of road strike in the vicinity of the underpasses (<250 m).	No road kill observed.	No action required.
No breaches in the fauna fence	e) Road strike of species which the fence is designed to exclude.	No road kill observed.	No fauna fence breaches were identified at any of the three sites, but maintenance is required to trim vegetation and keep it off the fence, repair the panel on the Brush-tailed Phascogale fencing and to address lifting of the main fence

			Required actions
			in a number of places, particularly, gutters.

3.2 Fauna Underpass Monitoring Program 2014-2016 – compliance with performance measures

Given this was the final monitoring event for the Kempsey Bypass underpasses the overall success of each structure was reviewed based on the performance measures and the results over the entire monitoring program undertaken over the last three years. These are detailed in Table 7, including suggested actions in response to these results, if required.

It has been determined that the performance measures relating to the fauna fence and road strike were met indicating success of these mitigation measures, therefore no further action is required in relation to these. Performance measures relating to the detection of the nominated indicator species from the six fauna groups, key targeted species and species with low dispersal ability was partly met (Table 7). Specifically, reptiles, small ground-dwelling mammals, possums and macropods were recorded using the underpasses at each of the three sites indicating successful mitigation of each of the structures for these fauna groups. Frogs were not detected within the underpasses, but were found in habitat adjacent to one of the structures (Pola Creek). Lack of frog records is most likely due to limitations of survey methodology to detect these species. The Echidna was not recorded at Boat Harbour Creek (or the other sites also). Database searches revealed a long-term absence (over 10 years) of records of Echidnas from the vicinity of the Boat Harbour Creek. Further investigations would be required to understand lack of Echidna records at/around the underpasses.

With respect to the key target species, Koalas were not recorded at any of the underpasses and Brush-tailed Phascogales were not recorded at Bingis Lane (or the other sites). However, lack of records alone is not sufficient to indicate failure of the mitigation measure for these species groups. For example database searches revealed no recent (within the last five years) records of Koalas within the vicinity (three kilometres) of Pola Creek (OEH 2017). Further investigations would be required to understand lack of Koala and Brush-tailed Phascogale records at/around the underpasses.

Table 7: Underpass monitoring performance measures, 2014-2016 results and actions required

Success indicators	Potential problems	Results against performance measure	Contingency measures/ Required actions
Use of fauna underpass by the nominated indicator species (Table 2.) <ul style="list-style-type: none"> • Frogs • Reptiles • Mammals <ul style="list-style-type: none"> ▪ Small ground-dwelling (<i>Bingis Lane only</i>) 	a) Low usage rates of native fauna.	<ul style="list-style-type: none"> • Boat Harbour Creek has recorded all fauna groups except frogs and the echidna. • Bingis Lane has recorded all fauna groups except frogs and the echidna • Pola Creek has recorded all fauna groups except the echidna 	Performance measure met in relation to reptiles, small ground-dwelling mammals, possums and macropod usage. As discussed in Table 6, the lack of frog records is likely due to the survey methodology. Hair tubes, camera surveys and opportunistic sightings do not favour detection of frogs due to their small size and, cryptic

Success indicators	Potential problems	Results against performance measure	Contingency measures/ Required actions
<ul style="list-style-type: none"> ▪ Echidna (<i>Boat Harbour Creek only</i>) ▪ Possums ▪ Macropods 			<p>nature. Targeted aural and nocturnal spotlighting surveys would be required to specifically target these species.</p> <p>However, frogs have been previously detected in adjacent habitat at Pola Creek. Therefore, no action required.</p> <p>Database searches (OEH 2017) reveal the most recent recording of an Echidna within 3 km of Boat Harbour Creek was in 2005.</p> <p>Further investigations would be required to understand the lack of echidna records at/around the underpasses. Lack of records alone is not sufficient to indicate failure of the mitigation measure for this species group.</p>
<p>Use by fauna with low dispersal abilities. (This includes four fauna classes: frogs, reptiles, small ground dwelling mammals and echidna).</p>	<p>a) Low usage rates of native fauna.</p>	<p>Detection of these groups discussed above.</p>	<p>Performance measure met in relation to reptiles and small ground-dwelling mammals.</p> <p>See above for limitation of survey methodology to detect frogs and lack of recent records of Echidna from the broader area. Lack of records alone is not sufficient to indicate failure of the mitigation measure for this species group.</p>
<p>Use of the fauna underpass by key target species (Brush-tailed Phascogale (<i>Bingis Lane only</i>) and Koala)</p>	<p>b) One or more of the key target species not using the underpass structure.</p>	<p>There were no records of the Koala or Brush-tailed Phascogale using any of the three underpasses over three years. Brush-tailed Phascogale are only listed as an indicator species for the Bingis Lane site as specified in the EMP and Table 2.</p>	<p>As detailed in Table 6, database searches revealed that Koalas were recorded within a 3 km radius of Boat Harbour Creek and Bingis Lane in 2014 (OEH 2017). There are no recent (within last five years) Koala records in the vicinity (3 km radius) of Pola Creek (OEH 2017), therefore it is considered unlikely that this species would be recorded using it.</p> <p>Also detailed in Table 6, database searches revealed that Brush-tailed Phascogales were recorded in close proximity to Bingis Lane in 2013 and 2014 (OEH 2017). The Brush-tail Phascogale has also previously been recorded using underpasses north of the Kempsey bypass on the Frederickton to Eungai Pacific Highway Upgrade (Niche 2017). Further investigations would be required to understand lack of</p>

Success indicators	Potential problems	Results against performance measure	Contingency measures/ Required actions
			Brush-tailed Phascogale and Koala records at the underpasses. Lack of records within the underpasses alone is not sufficient to indicate failure of the mitigation measure for this species group.
Low rate of fauna road strike	c) Unacceptable rates of road strike in the vicinity of the underpasses (<250 m).	Two records of road kill were observed adjacent to underpasses in autumn 2016 No road kill was found in autumn or summer 2015 or summer 2016. This is considered to be a low rate of fauna road strike.	Performance measure met, no further action required.
No breaches in the fauna fence	d) Road strike of species which the fence is designed to exclude.	No road kill observed. The latest monitoring event found no breaches.	Performance measures met. No immediate action required. Ongoing fence maintenance is recommended to remove vegetation growing on the fence which may allow fauna to climb the fence and access the road corridor.

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