

Third (Final) Annual Report for Post Construction Year 3, 4 and 6 Ecological Monitoring Devils Pulpit Pacific Highway Upgrade



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Prepared for: NSW Transport for NSW
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<i>UPR</i>	<i>Description</i>	<i>Date Issued</i>	<i>Issued By</i>
2885-1049	First issue	20/05/2021	David Andrighetto
2885-1068	Second issue	27/10/2021	David Andrighetto

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Executive Summary

Transport for NSW (Transport, formerly Roads and Maritime Services) upgraded a 7.3 kilometre section of the Pacific Highway at Devils Pulpit, between Grafton and Ballina on the NSW north coast. Conditions of Approval for the Project included the development and implementation of an Ecological Monitoring Program (EMP). GeoLINK has been engaged to implement the post construction terrestrial species monitoring program for the Project. The broad objective is to monitor the effectiveness of the following mitigation measures: fauna crossing structures, vegetated medians and vegetated connectivity corridor.

This report presents the results of the final year of post construction monitoring undertaken from January 2020 to February 2021 (referred to as Year 6). Permanent underpass camera and rope bridge camera results from January 2019 until August 2020 that were not reported in the Year 4 monitoring report (GeoLINK 2019) are also included. Woolgoolga to Ballina Pacific Highway upgrade (W2B) works and the 2019/ 2020 drought and bushfire impacted site conditions since the previous Year 4 monitoring.

The monitoring completed for the reporting period included:


- Targeted threatened species monitoring for the Rufous Bettong, Wallum Froglet, Green-thighed Frog, Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale, Koala and Spotted-tailed Quoll. The Greater Glider and Long-nosed Potoroo are also included as target threatened species as per recommendations made after Year 3 monitoring in the First Annual Report (GeoLINK 2018).
- Fauna underpass monitoring (motion detection cameras and scat/ track searches at ten structures).
- Rope bridge monitoring with motion detection cameras (one rope bridge).
- Vegetated median monitoring (spotlighting/call playback and nest box monitoring at two medians)
- Restoration of vegetated connectivity corridor (vegetation) monitoring.
- Roadkill monitoring.

All target species were recorded during the Year 6 reporting period except for the Rufous Bettong and Spotted-tailed Quoll.

Assessment of the monitoring results against the performance measures of mitigation measures being monitored found:

Fauna Underpasses: No complete crossings of target threatened species has been detected during the three years of post construction monitoring, although crossings by a number of native non-threatened species have been recorded. Varying levels of fauna activity between structures and limited results at a number of structures (including no complete crossings at underpass structure C3) indicate varying suitability or quality of each in providing fauna connectivity. Damage from the 2017 floods and 2019 bushfire has affected fauna underpass usage. Transport have upgraded one of the underpass structures (C6) during W2B works and are investigating repair works for the other structures. Other factors that have influenced the underpass monitoring results and/or lack of records of target threatened species relate to ecological factors (e.g. target species abundance and distribution), Project design features (e.g. culvert length, presence or absence of fauna furniture) and the 2019/ 2020 drought and bushfire.

With repair of the fauna underpass structures, the potential for fauna crossings would be expected to increase, particularly now that upgraded/ additional fauna fencing is in place (due to the W2B works).



Rope Bridge: Three target threatened species (Squirrel Glider, Brush-tailed Phascogale and Yellow-bellied Glider) and four other native species (Sugar Glider, Feathertail Glider, Common Ringtail Possum and Yellow-footed Antechinus) have been recorded on the rope bridge. Visitation by Feathertail Glider and Squirrel Gliders has been occasional to irregular, and rare for the other species. Directional movements have been recorded by six of these species, although likely complete crossings have only been recorded for the Feathertail Glider and Squirrel Glider. The vegetated medians provide better crossing opportunities for the target threatened gliders at Devils Pulpit compared to the rope bridge.

Vegetated Medians: Clearing phase surveys and post construction monitoring have indicated Yellow-bellied Glider and Greater Glider movements at the southern median, and Squirrel Glider movements across the northbound lane at both medians. The frequency of Squirrel Glider movement across the northbound lane during radio tracking was higher than the frequency of rope bridge crossings. Both vegetated medians provide opportunities for two way crossing for these threatened species across both lanes of the highway. The Greater Glider roadkill detected during Year 6 demonstrates that traffic collision remains a risk for crossing fauna.

Vegetation Connectivity Corridor: Recruitment and growth of native species has been recorded across the corridor, however exotic groundcovers (including weeds) are present and reducing native species recruitment in the southern half of the corridor. The 2019 bushfire impacted (reduced) native species diversity and cover in some areas, and increased weed cover mainly in the ground stratum. Compared to the former managed pastoral land, the corridor is regenerating and has vegetation characteristic of Subtropical Coastal Floodplain Forest, although exotic grass cover is hindering regeneration in the central to southern portion of the corridor.

Two recommendations were provided based on assessment of the EMP performance indicators and contingency measures:

- Underpasses: Maintain/ rectify underpass structures to be consistent with the EMP design intent.
- Vegetation Connectivity Corridor: Undertake bush regeneration and tree plantings works in localised areas with dense exotic groundcovers to assist the regeneration process where the density of understorey/ canopy tree recruits is low.

Fauna fencing at the site was updated as part of the W2B project between Years 4 and 6 of the post construction monitoring and no further fauna fencing contingency measures are triggered. Several other recommendations are provided for Transport consideration on future projects and relate to monitoring program design or connectivity structure design.

The findings of this project contribute to the expanding knowledge and dataset associated with road impacts and wildlife mitigation developed from research and other monitoring programs in Australia. It can be used to inform future road projects, road retrofit projects with a conservation objective, and as a reference for other projects with an interest in the threatened species that were monitored.



1. Introduction

1.1 Background

1.1.1 Introduction

Transport for NSW (Transport, formerly Roads and Maritime Services) upgraded a 7.3 kilometre section of the Pacific Highway at Devils Pulpit, between Grafton and Ballina on the NSW north coast (the Project – refer to **Illustration 1.1**). The Project involved widening the Pacific Highway from the existing single lane to a four-lane dual lane, with a wide median to allow for future upgrade to six lanes (Hyder 2012). Construction was completed in March 2014.

The Project was approved by the NSW Minister of Planning on 1 February 2011, subject to a number of conditions. Condition B6 stated:

‘Prior to the commencement of construction, the Proponent shall develop and implement an Ecological Monitoring Program to monitor the effectiveness of the mitigation measure identified in condition B4 for threatened species directly impacted by the project...’.

The *Devils Pulpit Upgrade Ecological Monitoring Program* (EMP) was developed by Hyder Consulting Pty Ltd (Hyder 2012) on behalf of Transport to address this condition. The broad objective of the EMP is to monitor the effectiveness of the mitigation measures identified in the Biodiversity Offset Strategy for threatened species directly impacted by the Project.

Project approval from the Commonwealth Minister for the Department of Sustainability, Environment, Water, Populations and Communities (now Department of Agriculture, Water and Environment; DoAWE) was received on 14 February 2011, also subject to a number of conditions. The *Spotted-tailed Quoll Management Plan* (SKM 2012) was prepared to address conditions 5(a)-(h) of the Commonwealth Conditions of Approval. This included the implementation of a program to monitor the effectiveness of the fauna crossings constructed for the Project for Spotted-tailed Quoll using surveillance cameras (which correlated to the EMP fauna underpass monitoring) and population monitoring. Post construction Spotted-tailed Quoll population monitoring was completed in 2015 as part of a separate monitoring program (Sandpiper 2016a).

GeoLINK has been engaged by Transport to implement the post construction terrestrial species monitoring program for the Project in accordance with the EMP (Hyder 2012), *Spotted-tailed Quoll Management Plan* (SKM 2012) and the *Pre-construction Threatened Fauna Monitoring Results* (GeoLINK 2012a). Specifically, the monitoring covers the following sections of the EMP:

- Section 6: Monitoring Target Terrestrial Species
- Section 7: Monitoring Crossing Structures (excluding *Section 7.4 Fauna Fencing*)
- Section 8: Monitoring Changes to Habitat Use
- Section 9: Other Monitoring Activities (excluding *Section 9.1 Weed Monitoring*).

The mitigation measures monitored for effectiveness under this program and their objective as stated in the EMP are provided in **Table 1.1** and shown in **Illustration 1.2**, and include:

- fauna crossing and structures
- vegetated medians
- vegetated connectivity corridor (Hyder 2012).



The effectiveness of these mitigation measures would be assessed by:

- monitoring threatened species adjacent to the Project footprint
- identifying changes to habitat usage and assess whether changes can be attributed to the Project (Hyder 2012).

Eight target terrestrial species were identified in the EMP including:

- Rufous Bettong (*Aepyprymnus rufescens*)
- Wallum Froglet (*Crinia tinnula*)
- Spotted-tailed Quoll (*Dasyurus maculatus*)
- Green-thighed Frog (*Litoria brevipalmata*)
- Yellow-bellied Glider (*Petaurus australis*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Brush-tailed Phascogale (*Phascogale tapoatafa*)
- Koala (*Phascolarctos cinereus*) (Hyder 2012).

All of these species are listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). The Spotted-tailed Quoll and Koala are dually listed as threatened species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Post construction monitoring in Year 3 (2017/ 2018 – GeoLINK 2018) identified the Long-nosed Potoroo (*Potorous tridactylus*) and Greater Glider (*Petauroides volans*) as additional threatened species at the site to monitor as part of the Project. Both species are listed under the EPBC Act, while the Long-nosed Potoroo is also listed under the BC Act.


The Oxleyan Pygmy Perch (*Nannoperca oxleyana*) comprises the target aquatic species of the EMP. Post construction monitoring requirements of the EMP for this species have been completed and are documented in the *Devils Pulpit Pacific Highway Upgrade Post-Construction Monitoring of Oxleyan Pygmy Perch and Surface Water* (GeoLINK 2015).

Post construction monitoring is required in Year 3 (2017/ 2018), Year 4 (2018/ 2019) and Year 6 (2020/ 2021) following completion of construction. This report presents the results of Year 6 (2020/ 2021) post construction monitoring completed from January 2020 to February 2021 (referred to as Year 6). Permanent underpass camera and rope bridge camera results from January 2019 until August 2020 that were not reported in the Year 4 monitoring report (GeoLINK 2019) are also discussed. Refer to GeoLINK (2018) for the study area description and a summary of the baseline (pre-construction) monitoring results.

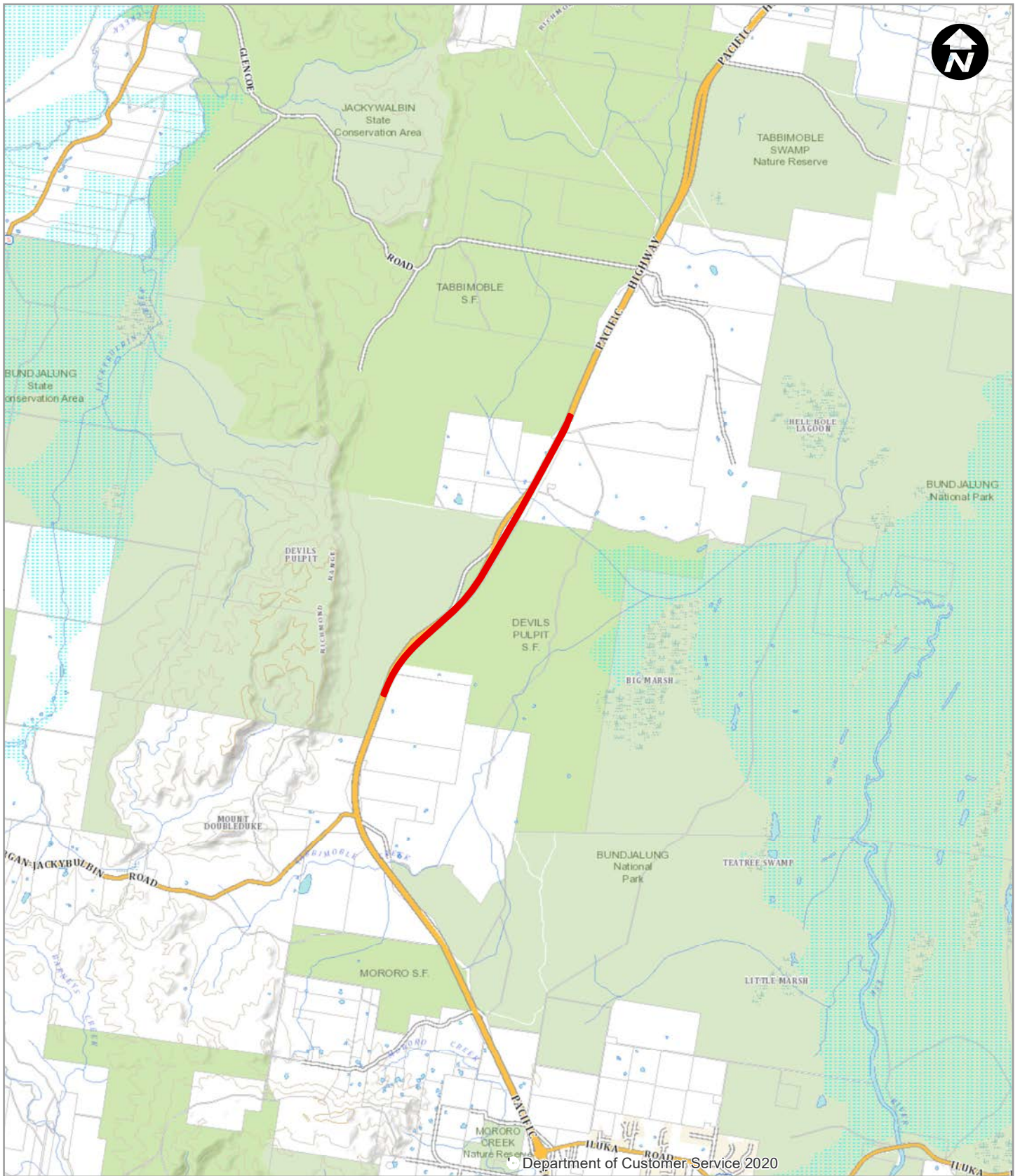
The Year 6 post construction monitoring is the final year for the EMP and this report includes an analysis of the monitoring results between years (including pre and post construction where possible), as well as an assessment of the Project against the EMP performance measures.

Table 1.1 Relevant Mitigation Measures Being Monitored

Mitigation Measure	Objective	Target Species	Features Being Monitoring
Fauna underpasses	<ul style="list-style-type: none"> ■ Maintain fauna movements and habitat connectivity for terrestrial and aquatic species. ■ Reduce roadkill. 	<ul style="list-style-type: none"> ■ Frogs ■ Reptiles ■ Terrestrial mammals 	<p>Six Culverts:</p> <ul style="list-style-type: none"> ■ C3, C6, C7, C8, C9, C10. <p>Four Bridges:</p> <ul style="list-style-type: none"> ■ Southbound bridge over Tabbimoble Floodway No. 2 (SBT2). ■ Northbound bridge over Tabbimoble Floodway No. 2 (NBT2). ■ Southbound bridge over Tabbimoble Floodway No. 3 (SBT3). ■ Northbound bridge over Tabbimoble Floodway No. 3 (NBT3).
Rope bridges	<ul style="list-style-type: none"> ■ Maintain fauna movements and habitat connectivity for arboreal mammals. ■ Reduce roadkill. 	<ul style="list-style-type: none"> ■ Sugar Glider (<i>Petaurus breviceps</i>) ■ Greater Glider ■ Common Brushtail Possum (<i>Trichosurus vulpecular</i>) ■ Common Ringtail Possum (<i>Pseudocheirus peregrines</i>) ■ Squirrel Glider ■ Yellow-bellied Glider 	<ul style="list-style-type: none"> ■ 1 x rope bridge extending over both lanes linking Devils Pulpit State Forest and Bundjalung National Park (chainage 68.500).
Vegetated medians	<ul style="list-style-type: none"> ■ Maintain fauna movements and habitat connectivity for arboreal mammals. ■ Reduce gap crossing distance for gliding mammals. ■ Reduce roadkill. 	<ul style="list-style-type: none"> ■ Sugar Glider ■ Greater Glider ■ Squirrel Glider ■ Yellow-bellied Glider 	<ul style="list-style-type: none"> ■ 2 x vegetated medians at chainage 66.300-67.800 and 69.300-70.700. ■ Gliders will be able to use vegetated median to move between Devils Pulpit State Forest and Bundjalung National Park due to short glide distances. ■ Supports Dry Sclerophyll Forest and Floodplain Forest vegetation communities.




Mitigation Measure	Objective	Target Species	Features Being Monitoring
Vegetated connectivity corridor	<ul style="list-style-type: none"> The vegetated connectivity corridor will improve connectivity in the vicinity of Tabbimoble Floodways 2 and 3, facilitating the movement of cover-dependent and less mobile fauna species. 	<ul style="list-style-type: none"> Frogs Reptiles Terrestrial mammals Arboreal mammals Cover-dependent birds 	<ul style="list-style-type: none"> 1 x corridor at chainage 70.200 - 71.900 (east of the highway alignment). Vegetated connectivity corridor will be at least 60m wide will involve rehabilitation of Subtropical Coastal Floodplain Forest.



Department of Customer Service 2020

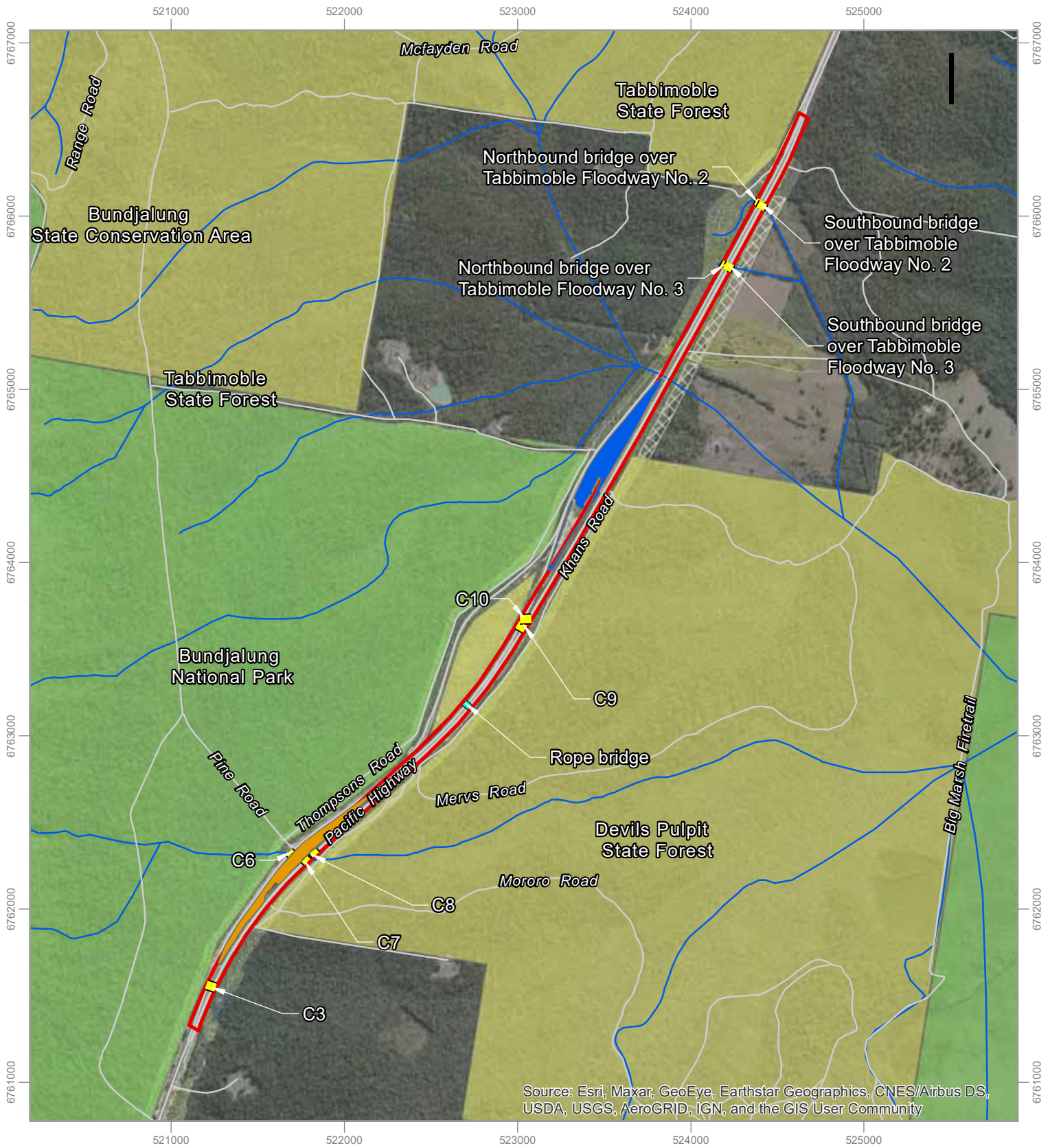
GDA 1994 MGA Zone 56

LEGEND

 The project



Site Locality - Illustration 1.1



LEGEND

- | | | |
|---------------------------------------|---------------------------------|--------------------------|
| Devil's Pulpit concept clearing limit | Northern median | Combined fauna underpass |
| State Forest | Southern median | Rope bridge |
| National Park reserve | Vegetated connectivity corridor | Watercourse |



Mitigation Measures Being Monitored - Illustration 1.2

1.1.2 Changes to Site Conditions

Since commencement of the post construction monitoring, site conditions have changed due to Woolgoolga to Ballina Pacific Highway upgrade (W2B) construction between November 2017-October 2021; and a bushfire in November 2019. W2B construction included:

- clearing along the northbound lane at both medians to facilitate construction works
- clearing along fence lines (both lanes)
- pavement and drainage works along the northbound lane, including minor realigning of the northbound lane at the southern median (Impact Site 2)
- installing/ upgrading fauna fencing along both lanes
- installation of 'Koala/ fauna grids' where access roads intersect the northbound lane
- replacement of the pipe culvert south of the C6 fauna underpass (Impact Site 2)
- upgrades to the C6 fauna underpass, including an extension, raising the dry bench height approximately 0.3 m inside the culvert; modifying the fauna furniture and creating an approximately 1m wide dry passage at the inlet and outlet
- various temporary lane closures and diversions. The Devils Pulpit subject section of the Pacific Highway reopened to two lanes of traffic in both directions in August 2020, with localised works continuing until approximately October 2021.

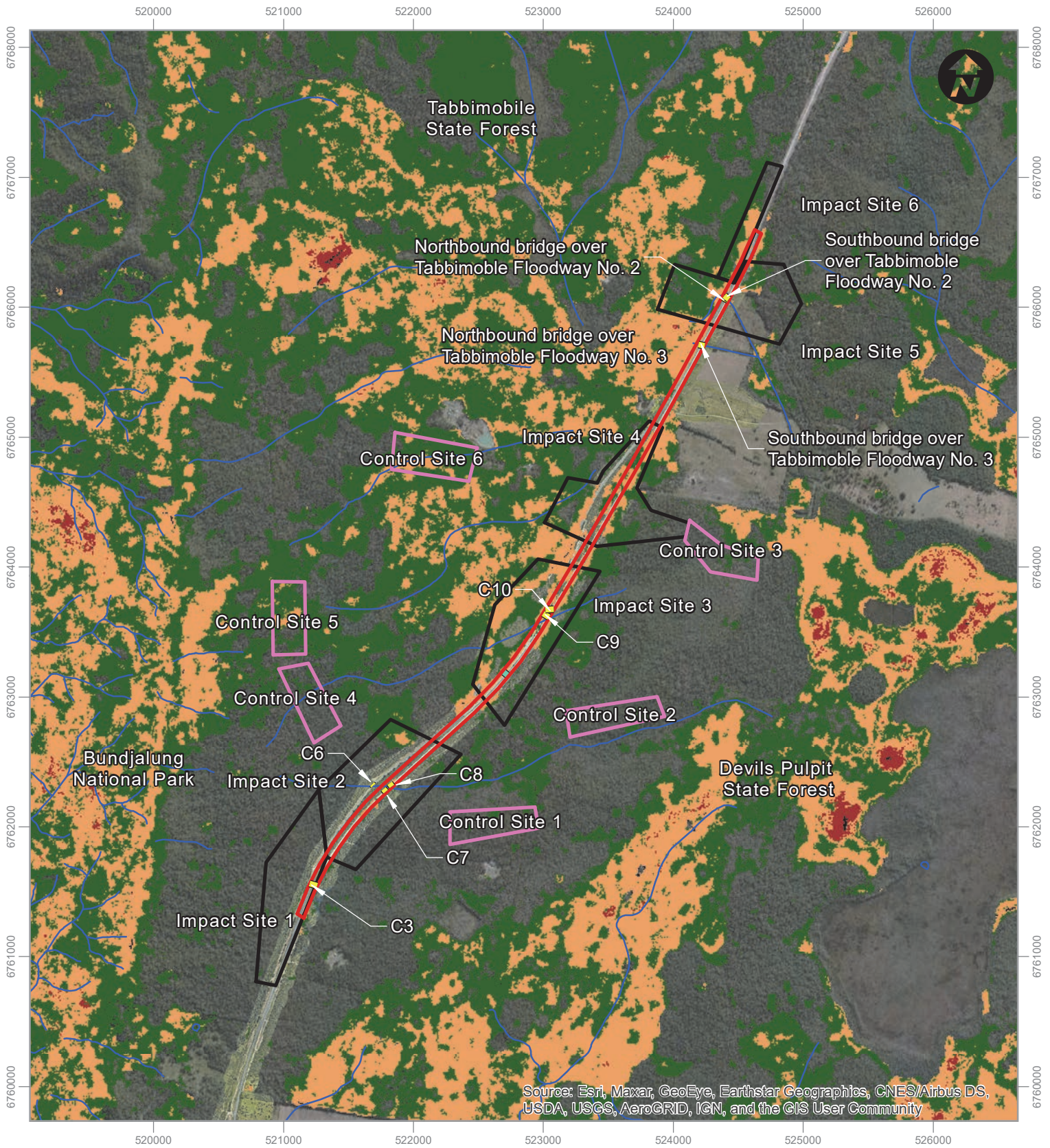
The entire study area was burnt during a bushfire in November 2019, excluding a localised area at the southern end of the southern median. The bushfire occurred during a period regional drought. Fire intensity ranged from low to moderate understorey burns to high intensity canopy burns, particularly on the western side of the highway. The bushfire moved across the study area in a north-west to south-east direction.

Department of Planning, Industry and Environment (DPIE) Fire Extent and Severity Mapping (FESM) for the study area is shown in **Illustration 1.3**. There are discrepancies with this mapping to what was observed on site (e.g. large portions of the study area are shown as unburnt), however is useful as a relative scale of fire intensity.

After the fires, vegetation and trees in proximity to the highway was assessment and additional hazardous tree were removed. Damage to infrastructure and resources from the fire included loss of 21 Devils Pulpit monitoring nest boxes and damage to fauna furniture at the Tabbimoble Floodway No. 2 and No.3 bridges.

These events have resulted in the following habitat changes along the Devils Pulpit section of the Pacific Highway:

- localised vegetation and habitat removal
- removal of 45 hollow-bearing trees from clearing and hazardous tree removal activities and
- increased vegetation fragmentation associated with the highway corridor.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

GDA 1994 MGA Zone 56

LEGEND

- | | | |
|---------------------------------------|--------------------------|----------------------------------------------|
| Devil's Pulpit concept clearing limit | Rope bridge | Unburnt |
| Control site | Combined fauna underpass | Reserved class for future development |
| Impact site | Watercourse | Low - burnt understory with unburnt canopy |
| | | Medium - partial canopy scorch |
| | | High- full canopy scorch/partial consumption |
| | | Extreme - full canopy consumption |
| | | No data |



DPIE Fire Extent and Severity Mapping - Illustration 1.3



Third (Final) Annual Report for Post Construction Year 3, 4 and 6 Ecological Monitoring
 Devils Pulpit Pacific Highway Upgrade
 2885-1052

Information shown is for illustrative purposes only
 Drawn by: AB Checked by: RE Reviewed by: DSA
 Source of base data: ERSI World Imagery
 Date: 12/04/2021



2. Methodology

2.1 Monitoring Target Terrestrial Species

2.1.1 Monitoring Sites

Six monitoring 'Impact' sites and six monitoring 'Control' sites were monitored as part of the target terrestrial species monitoring component of the Project. The impact sites (numbered 1-6) were originally paired (east and west of the new upgraded highway alignment), with Impact Sites 2 and 4 encompassing the vegetated medians. The following modifications were made as part of post construction monitoring due to access constraints or insufficient habitat remaining in the road reserve:

- Impact Site 1 (east) was relocated to the western side of the highway due to insufficient habitat remaining within road reserve and access limitations on adjacent land to the east
- Impact Site 6 (east) was removed. The survey effort at other impact sites was increased to offset the reduced effort at Impact Site 6.

Six monitoring 'Control' sites were established as part of the post construction monitoring (GeoLINK 2018) and located a minimum of 0.5 km from the Pacific Highway (refer to **Illustration 2.2**), with:

- three control sites (Control Site 1-3) located in Devils Pulpit State Forest to the east of the Project
- three control sites (Control Site 4-6) located in Bundjalung National Park to the west of the Project.

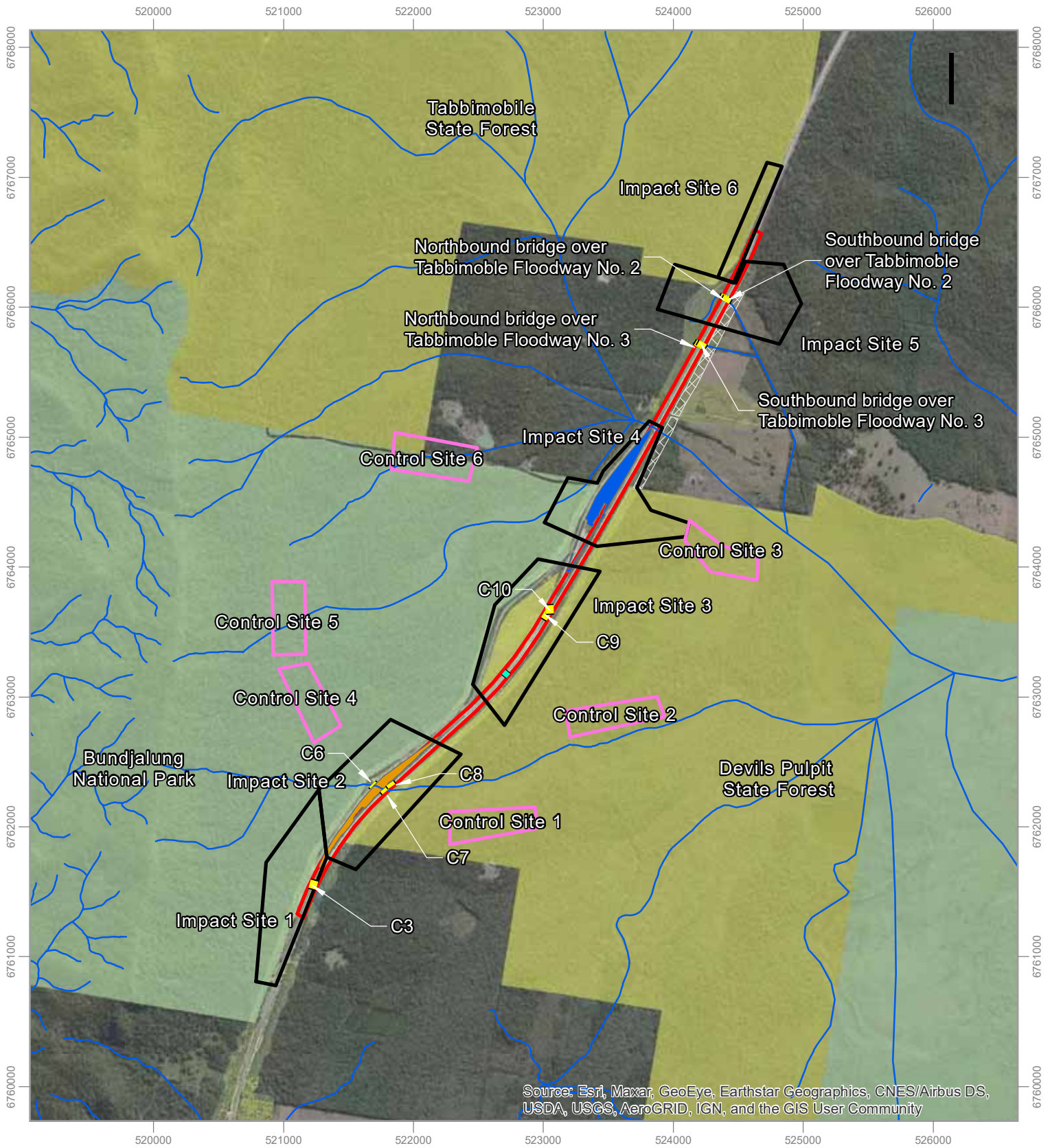
Table 2.1 details the habitat and target species for each site.

Table 2.1 Target Terrestrial Species Monitoring Sites and Target Species

Site	Location (central chainage for impact sites)	Target Species	Design Mitigation Measure (impact sites only)	Vegetation Form and Class (Hyder 2011)
Impact Site 1	CH 66.270	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Koala ■ Rufous Bettong ■ Long-nosed Potoroo 	<ul style="list-style-type: none"> ■ Combined fauna underpass (C3). ■ Fauna fencing. 	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Spotted Gum Dry Sclerophyll Forest. ■ Grassy Woodlands: <ul style="list-style-type: none"> - Eastern Red Gum Floodplain Forest. - Forest Red Gum Floodplain Forest.
Impact Site 2	CH 67.170	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Green-thighed Frog ■ Koala ■ Rufous Bettong ■ Squirrel Glider ■ Yellow-bellied Glider ■ Long-nosed Potoroo ■ Greater Glider 	<ul style="list-style-type: none"> ■ Combined fauna underpass (C6, C7 and C8). ■ Vegetated median. ■ Fauna fencing. 	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Blackbutt Dry Sclerophyll Forest. - Spotted Gum Dry Sclerophyll Forest. ■ Grassy Woodlands: <ul style="list-style-type: none"> - Forest Red Gum Floodplain Forest.
Impact Site 3	CH 69.000	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Green-thighed Frog ■ Koala ■ Squirrel Glider ■ Yellow-bellied Glider ■ Long-nosed Potoroo 	<ul style="list-style-type: none"> ■ Combined fauna underpass (C9 and C10). ■ Fauna fencing. ■ Rope bridge. 	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Scribbly Gum Dry Sclerophyll Forest. - Blackbutt Dry Sclerophyll Forest. ■ Grassy Woodlands: <ul style="list-style-type: none"> - Eastern Red Gum Floodplain Forest.
Impact Site 4	CH 70.100	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Rufous Bettong ■ Squirrel Glider ■ Yellow-bellied Glider ■ Long-nosed Potoroo ■ Greater Glider 	<ul style="list-style-type: none"> ■ Vegetated median 	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Scribbly Gum Dry Sclerophyll Forest. - Blackbutt Dry Sclerophyll Forest. ■ Grassy Woodlands: <ul style="list-style-type: none"> - Forest Red Gum Floodplain Forest.
Impact Site 5	CH 71.845 (Tabbimoble 2)	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Green-thighed Frog ■ Koala ■ Rufous Bettong ■ Wallum Froglet 	<ul style="list-style-type: none"> ■ Restoration of vegetation connectivity corridor. ■ Combined fauna underpass Tabbimoble Floodway No 2 and 3 	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Scribbly Gum Dry Sclerophyll Forest. - Blackbutt Dry Sclerophyll Forest. ■ Grassy Woodlands: <ul style="list-style-type: none"> - Eastern Red Gum Floodplain Forest.

Site	Location (central chainage for impact sites)	Target Species	Design Mitigation Measure (impact sites only)	Vegetation Form and Class (Hyder 2011)
		<ul style="list-style-type: none"> ■ Long-nosed Potoroo 	<ul style="list-style-type: none"> ■ bridges). ■ Fauna fencing. 	<ul style="list-style-type: none"> ■ Forested Wetland: <ul style="list-style-type: none"> - Paperbark Swamp Forest on coastal lowlands of the North Coast (note: this community is outside the Hyder 2011 study area footprint).
Impact Site 6	CH 72.300	<ul style="list-style-type: none"> ■ Squirrel Glider ■ Yellow-bellied Glider ■ Greater Glider 	<ul style="list-style-type: none"> ■ No mitigation measures. 	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Scribbly Gum Dry Sclerophyll Forest. - Blackbutt Dry Sclerophyll Forest. ■ Grassy Woodlands: <ul style="list-style-type: none"> - Eastern Red Gum Floodplain Forest.
Control Site 1	Devils Pulpit State Forest	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Rufous Bettong ■ Squirrel Glider ■ Yellow-bellied Glider 	-	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Spotted Gum Dry Sclerophyll Forest. - Blackbutt Dry Sclerophyll Forest.
Control Site 2	Devils Pulpit State Forest	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Koala ■ Rufous Bettong ■ Squirrel Glider ■ Yellow-bellied Glider 	-	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Blackbutt Dry Sclerophyll Forest. - Scribbly Gum Dry Sclerophyll Forest.
Control Site 3	Devils Pulpit State Forest	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Green-thighed Frog ■ Koala ■ Rufous Bettong ■ Wallum Froglet 	-	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Blackbutt Dry Sclerophyll Forest. ■ Grassy Woodlands: <ul style="list-style-type: none"> - Eastern Red Gum Floodplain Forest.
Control Site 4	Bundjalung National Park	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Green-thighed Frog ■ Koala ■ Rufous Bettong ■ Squirrel Glider ■ Yellow-bellied Glider 	-	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Spotted Gum Dry Sclerophyll Forest ■ Grassy Woodlands: <ul style="list-style-type: none"> - Forest Red Gum Floodplain Forest.
Control Site 5	Bundjalung National Park	<ul style="list-style-type: none"> ■ Brush-tailed Phascogale ■ Green-thighed Frog 	-	<ul style="list-style-type: none"> ■ Dry Open Sclerophyll Forest (shrubby sub formation): <ul style="list-style-type: none"> - Spotted Gum Dry Sclerophyll Forest

Site	Location (central chainage for impact sites)	Target Species	Design Mitigation Measure (impact sites only)	Vegetation Form and Class (Hyder 2011)
		<ul style="list-style-type: none"> ■ Rufous Bettong ■ Squirrel Glider ■ Yellow-bellied Glider 		<ul style="list-style-type: none"> ■ Grassy Woodlands: <ul style="list-style-type: none"> - Forest Red Gum Floodplain Forest.
Control Site 6	Bundjalung National Park	<ul style="list-style-type: none"> ■ Koala 	-	<ul style="list-style-type: none"> ■ Grassy Woodlands: <ul style="list-style-type: none"> - Eastern Red Gum Floodplain Forest. ■ Forested Wetland: <ul style="list-style-type: none"> - Paperbark Swamp Forest on coastal lowlands of the North Coast (note: this community is outside the Hyder 2011 study area footprint).



LEGEND

- | | | |
|---------------------------------------|---------------------------------|--------------------------|
| Devil's Pulpit concept clearing limit | State forest | Rope bridge |
| Control site | National park reserve | Combined fauna underpass |
| Impact site | Northern median | Watercourse |
| | Southern median | |
| | Vegetated connectivity corridor | |



Monitoring Site Locations - Illustration 2.1

2.1.2 Methodology

This section provides the 'Target Terrestrial Species' monitoring methodology used during post construction monitoring. Survey techniques are generally in accordance with the EMP (Hyder 2012) and GeoLINK (2012a), with the following modifications:

- Camera traps targeting the Rufous Bettong and Brush-tailed Phascogale were used in substitution of hair tubes. The survey methodology was revised so that data collected was comparable to the data collected as part of the *Woolgoolga to Ballina Pacific Highway Upgrade Rufous Bettong & Brush-tailed Phascogale Preconstruction Baseline Monitoring Survey* (Lewis 2014).
- Nest box monitoring was undertaken in substitution of arboreal Elliott B trapping.
- Mammal spotlighting transects use one person per spotlighting transect rather than two people.

These modifications were developed in consultation with Transport and NSW Environment Protection Authority (EPA) and approved by the NSW Department of Planning and Environment (DoPE) on 22 June 2017.

Additionally, Koala Spot Assessment Technique (SAT) monitoring was terminated from the monitoring program and was not undertaken as part of the Year 4 or 6 monitoring. Year 3 post construction monitoring found that '*Due to the recorded low density and activity levels of Koalas in the study area and EMP design, the EMP will not be able to identify changes in Koala relative abundance nor determine if any changes are attributed to the Devils Pulpit Pacific Highway upgrade*' (GeoLINK 2018). Cessation of Koala SAT monitoring was endorsed by the NSW Environmental Protection Agency (EPA – Peter Higgs – Senior Threatened Species Officer; email correspondence dated 12 July 2018).

All other survey techniques adopted during Year 6 monitoring were consistent with the methods used during the Year 3 and 4 monitoring (GeoLINK 2018, 2019a).

2.1.3 Rufous Bettong


Rufous Bettong monitoring included camera traps at five impact and five control sites and spotlighting at six impact and six control sites in winter, spring and summer of 2020/ 2021.

2.1.3.1 Camera Traps

Camera traps were established at each site in two lines of three (six cameras in a grid) spaced 100 m apart, with a trap density of one camera per hectare. The cameras were primarily Titley Scientific Trail Camera 0.35 sec Fast Trigger 12MP No-Glow Infra-red LED (Trail Cameras). Up to three Bushnell NatureView Cam HD Max cameras and three X-Trail 3CW HD cameras were used when the Trail Cameras were being maintained. The cameras were set in a horizontal orientation following the methodology in *Taylor et al.* (2014). This included:

- Removing vegetation and leaf litter at the site. Existing clearings were selected to minimise vegetation disturbance.
- Use of a bait station (110 mm x 35 mm PVC pipe pegged to the ground). Bait stations were positioned 1.2-1.5 m* from the camera for Trail Cameras and 2 m for the other cameras.
- Positioning the camera approximately 0.4 m above the ground on a tree, with the camera angled down at the bait station.

**Bait stations were moved closer to the cameras (from 2 m in Year 3 monitoring) for the Trail Cameras as this was found to produce better quality images for identification with the wide-angle camera lens.*



Cameras were set for 14 continuous trap nights each season (winter, spring and summer), with the following recording parameters for the Trail Cameras:

- Camera mode: Photo.
- Resolution: 12MP.
- Night mode: Balanced.
- Multi-shot: three with 20 second delay.
- Sensitivity: High.
- Timer mode set from 5.00 pm to 7.00 am (14 hours) each day, with the time adjusted for changes in daylight saving.

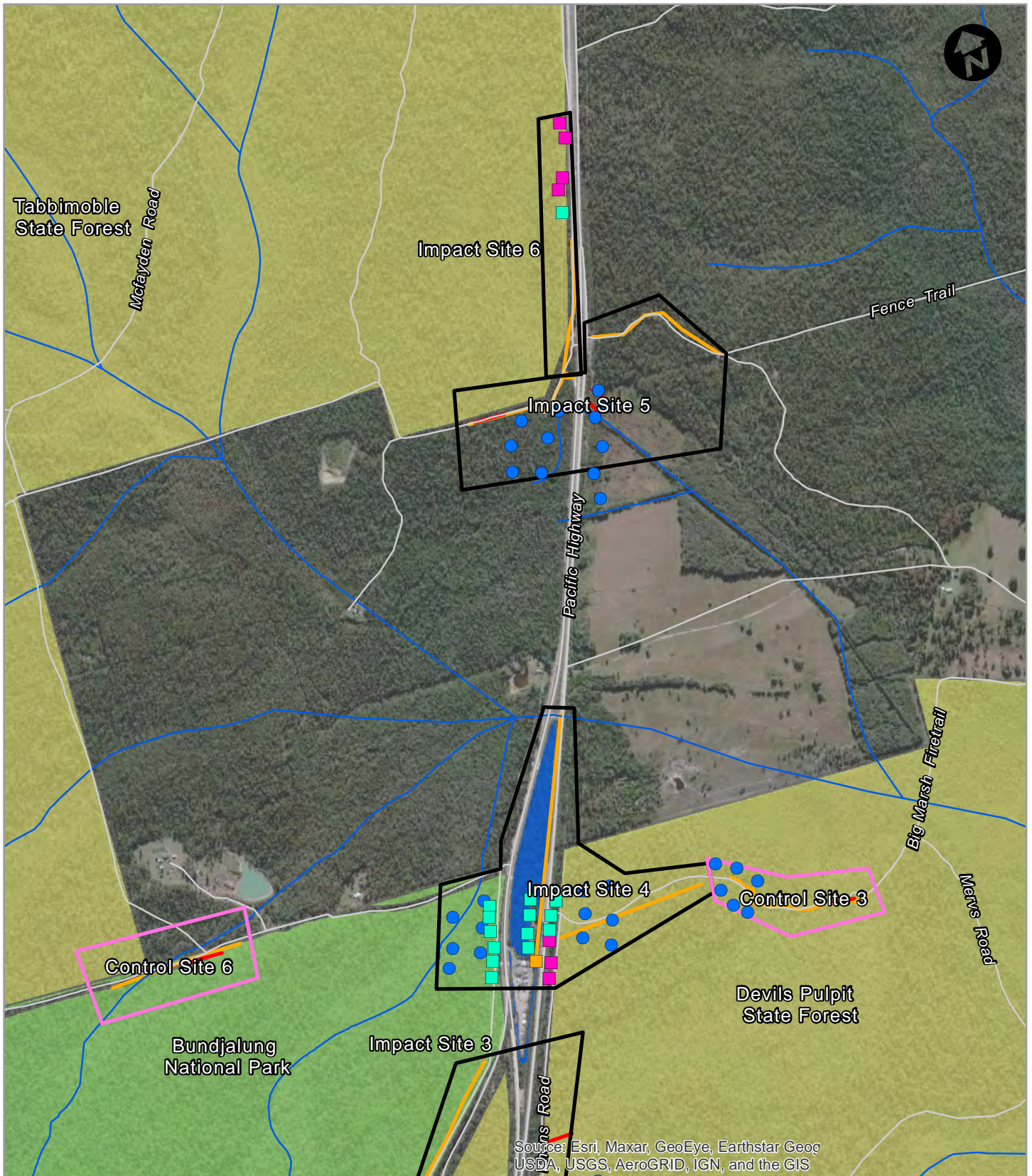
Equivalent settings were used with the other camera types.

Bait stations were baited with a peanut butter, honey, oats, vanilla essence and sesame oil mix. Camera trap locations are provided in **Appendix A** and shown in **Illustration 2.2**. All camera trap locations were the same as those used during Year 3 monitoring, except at Impact Site 5 (east) which was relocated after the Year 4 winter surveys to Transport land to avoid conflicts with activities on the private land. A summary of the installation and retrieval dates, and survey effort is provided in **Appendix A**.

All images were downloaded onto a computer and reviewed by a senior ecologist. All mammals detected were recorded, with the following data collected: identification accuracy (possible, probable, definite) and number of individuals (>1 only if >1 in the photo/ s or defined features were observed). Where traps were collected after 14 nights, records of target species only recorded from night 15 onwards were recorded as opportunistic records and not included in the analysis.

'Activity levels' of target species at each site were calculated as a function of the number of cameras that detected the relevant target species for each season. It is used as a surrogate for relative density. The mean and standard errors were derived from the percentage activity values for the three survey periods (seasons) to provide an overall activity level for each site for Year 6 monitoring. This methodology allows for comparison with data collected for the W2B project (e.g. Lewis 2014).

Additionally, Year 3 and 4 results have been re-analysed to allow for comparison of activity levels between years.



Source: Esri, Maxar, GeoEye, Earthstar Geoc, USDA, USGS, AeroGRID, IGN, and the GIS

GDA 1994 MGA Zone 56

LEGEND

- Control site
- Impact site
- State Forest
- National Park reserve

Northern median

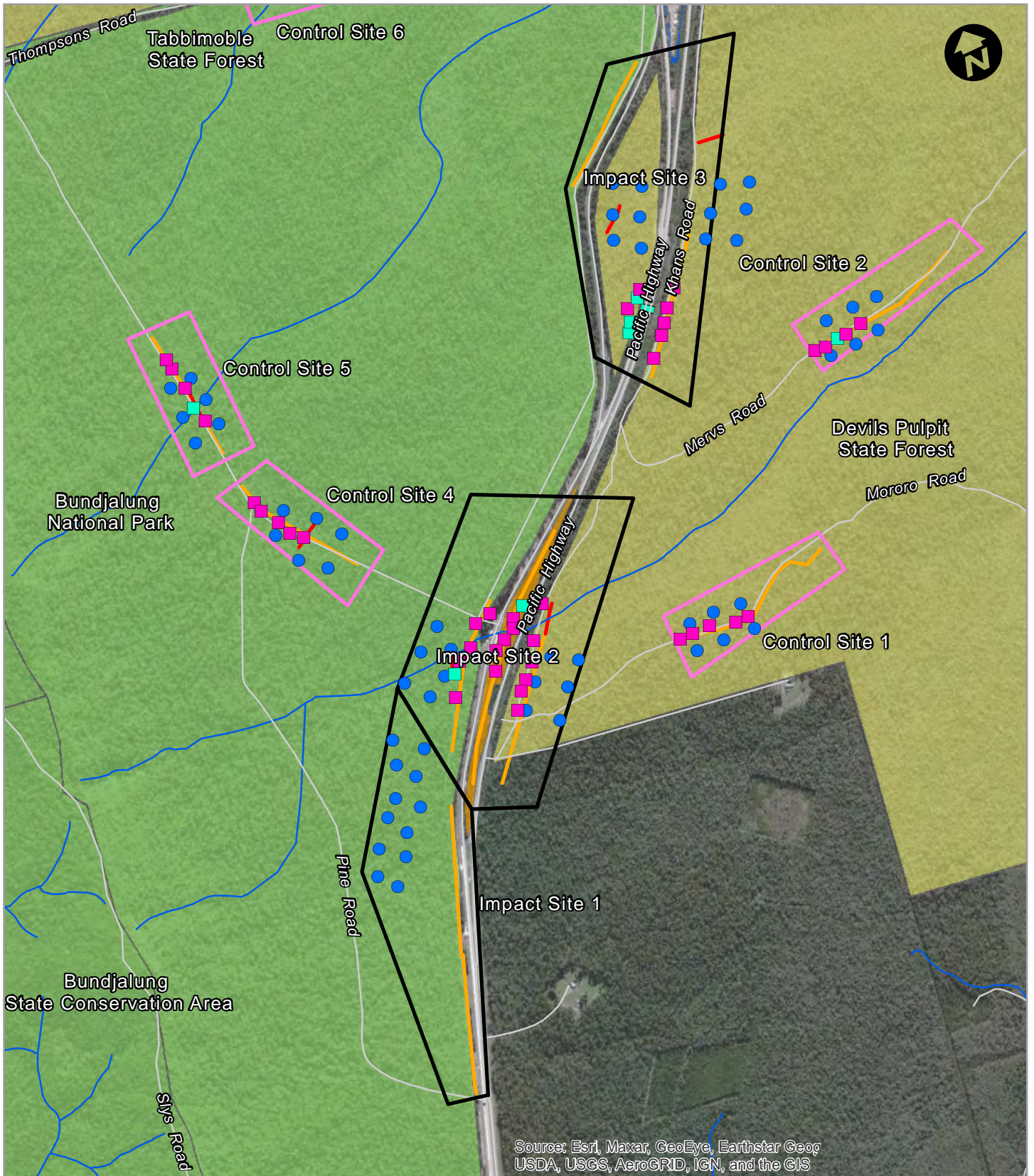
- Frog survey
- Mammal spotlighting survey
- Watercourse
- Rufous Bettong/ Brush-tailed Phascogale camera trap

Nest Box

- Nest box (burnt)
- Nest box (not burnt)
- Nest box (not burnt; not accessible in spring/summer)



**Target Terrestrial Species Monitoring Locations
Illustration 2.2 - Sheet 1 of 2**



Source: Esri, Maxar, GeoEye, Earthstar Geog
 USDA, USGS, AeroGRID, IGN, and the GIS

GDA 1994 MGA Zone 56

LEGEND

- | | | | |
|-----------------------|-----------------------------------------------------|----------------------------|----------------------|
| Control site | Northern median | Frog survey | Nest Box |
| Impact site | Southern median | Mammal spotlighting survey | Nest box (burnt) |
| State Forest | Rope bridge | Watercourse | Nest box (not burnt) |
| National Park reserve | Rufous Bettong/ Brush-tailed Phascogale camera trap | | |



**Target Terrestrial Species Monitoring Locations
 Illustration 2.2 - Sheet 2 of 2**

2.1.3.2 Spotlighting

While five impact sites (1, 2, 3, 4 and 5) and five control sites (1, 2, 3, 4 and 5) were nominated as target sites for the Rufous Bettong, spotlighting was undertaken at all six impact and six control sites, targeting all target mammal species. Spotlighting was undertaken along 500 m transects with one observer spotlighting at a rate of 1 km/ hour. This included ten impact site transects and six control site transects. Two additional 1 km transects were undertaken at the vegetated medians at Impact Sites 2 and 4 and were spotlighted at the same rate. Refer to **Illustration 2.2** for spotlighting survey locations.

Spotlighting surveys were undertaken over three non-consecutive nights per season (winter, spring and summer).

Threatened nocturnal avifauna and reptiles were also recorded when encountered.

Table 2.2 **Table 2.2** summarises spotlighting survey sites and effort. Survey dates and weather conditions are provided in **Appendix A**.

All mammals (excluding flying-foxes) detected (observed and/ or call identified) were recorded, with the following data collected: species; number of individuals; sex; age; presence and number of dependant young; behaviour.

Threatened nocturnal avifauna and reptiles were also recorded when encountered.

Table 2.2 Spotlighting Survey Effort During Year 6 Monitoring

Site	No. Spotlighting Surveys			
	Winter	Spring	Summer	Total
Impact Site 1 (east)	3	3	3	9
Impact Site 1 (west)	3	3	3	9
Impact Site 2 (east)	3	3	3	9
Impact Site 2 (median)	3	3	3	9
Impact Site 2 (west)	3	3	3	9
Impact Site 3 (east)	3	3	3	9
Impact Site 3 (west)	3	3	3	9
Impact Site 4 (east)	3	3	3	9
Impact Site 4 (median)	3	3	3	9
Impact Site 5 (east)	3	3	3	9
Impact Site 5 (west)	3	3	3	9
Impact Site 6 (west)	3	3	3	9
Control site 1	3	3	3	9
Control site 2	3	3	3	9
Control site 3	3	3	3	9
Control site 4	3	3	3	9
Control site 5	3	3	3	9
Control site 6	3	3	3	9
Total Impact Sites	36	36	36	108

Site	No. Spotlighting Surveys			
	Winter	Spring	Summer	Total
Total Control Sites	18	18	18	54
Total All Sites	54	54	54	162

2.1.4 Spotted-tailed Quoll

The Spotted-tailed Quoll monitoring component covered under this monitoring program is detailed in the *Spotted-tailed Quoll Management Plan* (SKM 2012) and relates to monitoring fauna underpass structures. The survey methodology is discussed in **Section 2.2.1**, noting that the monitoring is being undertaken in post construction years 3, 4 and 6 as per the EMP, rather than years 1, 3 and 5 as stated in some sections of SKM (2012).

2.1.5 Green-thighed Frog and Wallum Froglet

Threatened frog monitoring was undertaken targeting the Green-thighed Frog and Wallum Froglet. Target sites are shown in **Illustration 2.2**. Three impact sites (2, 3 and 5) and three control sites (3, 4 and 5) were surveyed targeting the Green-thighed Frog. One impact site (5) and one control site (3) was also surveyed targeting the Wallum Froglet.

The surveys included:

- **Spotlighting:** 100 m spotlighting transects with two observers 20 m apart, on two non-consecutive nights per season (spring and summer). Spotlighting was undertaken at a rate of 200 m/ hour.
- **Call Playback:** Green-thighed Frog and/ or Wallum Froglet call playback was undertaken near the centre of each spotlighting transect or within appropriate habitat. The methodology included five minutes listening, two minutes call playback, five minutes listening, two minutes call playback, then five minutes listening.

The EMP required two threatened frog surveys following suitable separate rainfall events in both spring and summer (four surveys in total). Due to insufficient rain in Year 6 spring, four survey events were undertaken in Year 6 summer; and summer surveys 1 and 2 were undertaken on consecutive days which formed part of the same rainfall event to ensure sufficient surveys were undertaken. Specific survey dates are provided in **Table 2.3**.

The survey rainfall event criteria outlined in EMP (Hyder 2012) were met for each survey (i.e. when between 30-50 mm of rain was recorded within a 24 hour period, or when soil saturation levels are high and 20-30 mm of rain was recorded within a 24 hour period). Most frog survey events were also in line with the triggers recommended in GeoLINK (2018) (i.e. 'a rainfall event which exceeded 50 mm within a 24 hour period with a preference given to rainfall events which exceeded 75 mm in 24 hours or an accumulated total of 150 mm over a 72 hour period'). Weather conditions during the surveys are provided in **Appendix A**.

Table 2.3 Threatened Frog Monitoring Survey Dates During Year 6 Monitoring

<i>Survey Event</i>	<i>Date</i>
Year 6 Summer Survey 1	14/12/2020
Year 6 Summer Survey 2	15/12/2020
Year 6 Summer Survey 3	7/01/2021
Year 6 Summer Survey 4	18/02/2021

2.1.6 Yellow-bellied Glider

Targeted Yellow-bellied Glider surveys were undertaken at four impact sites (2, 3, 4 and 6) and four control sites (1, 2, 4 and 5) in winter, spring and summer for three non-consecutive nights per season. Spotlighting was also undertaken at Impact Sites 1 and 5, and Control Sites 3 and 6. The surveys included:

- **Spotlighting:** As for **Section 2.1.3.2**. Spotlighting was undertaken along ten 500 m impact site transects; two 1 km impact site transects and six 500 m control site transects with one observer spotlighting at a rate of 1km/ hour.
- **Call-playback:** Yellow-bellied Glider call-playback was undertaken at one point along the seven impact sites (2 east, 2 median, 2 west, 3 east, 3 west, 4 east, 4 median and 6 west) and four control site (1, 2, 4 and 5) spotlighting transects that targeted the Yellow-bellied Glider. The methodology comprised five minutes listening, five minutes Yellow-bellied Glider call playback, two minutes listening, five minutes playback, two minutes listening. A Faunatech modified Toa megaphone (or equivalent) was used to broadcast recorded Yellow-bellied Glider call recordings.

Yellow-bellied Glider survey dates are provided in **Appendix A**.

2.1.7 Squirrel Glider

Target Squirrel Glider surveys were undertaken at four impact sites (2, 3, 4 and 6) and four control sites (1, 2, 4 and 5). Spotlighting was also undertaken at Impact Sites 1 and 5, and Control Sites 3 and 6. The surveys included:

- **Spotlighting:** As for **Section 2.1.3.2**. Spotlighting was undertaken along ten 500 m impact site transects; two 1 km impact site transects and six 500 m control site transects with one observer spotlighting at a rate of 1 km/ hr. Spotlighting surveys were conducted for three non-consecutive nights each season (winter, spring and summer).
- **Nest Box Monitoring:** Forty-nine (31 impact and 18 control) unburnt Squirrel Glider nest boxes (Hollow-Log Home – rear entry timber design) of the 70 installed in winter 2017 were surveyed in Year 6 winter, spring and summer. One nest box (Impact 4 (median)) was not inspected in spring and summer as access to the median was removed as part of W2B completion works. Nest box locations are shown in **Illustration 2.2** and detailed in **Appendix B**. **Table 2.4** details the nest box configuration at relevant sites. The nest boxes were checked by a tree climber under ecologist supervision. When fauna were present, either:
 - the nest box entrance was blocked and the nest box was lowered for direct ecologist inspection and species identification. The nest boxes were subsequently re-instated
 - a camera with a remote screen was used by the arborist and inspected by the ecologist.

Table 2.4 Nest Box Configuration

Site	No. of Nest Boxes	
	Year 3 & Year 4	Year 6 (unburnt)
Impact Site 2 (west)	6	5
Impact Site 2 (median)	6	5
Impact Site 2 (east)	6	6
Impact Site 3 (west)	5	2
Impact Site 3 (east)	6	6
Impact Site 4 (west)	6	0
Impact Site 4 (median)	5	1
Impact Site 4 (east)	5	2
Impact Site 6 (west)	5	4
Control site 1	5	5
Control site 2	5	4
Control site 4	5	5
Control site 5	5	4
Total Impact Sites	50	31
Total Control Sites	20	18
Total All Sites	70	49

2.1.8 Brush-tailed Phascogale

Brush-tailed Phascogale monitoring was undertaken in winter, spring and summer, and included:

- Camera Traps: Refer to **Section 2.1.3.1**.
- Spotlighting: Refer to **Section 2.1.3.2**.
- Nest Box Monitoring: Refer to **Section 2.1.7**.

2.1.9 Koala

Koala monitoring surveys included:

- **Spotlighting:** Refer to **Section 2.1.3.2**.
- **Call-playback:** Koala call-playback was undertaken at one point along the eight impact sites (1 east, 1 west, 2 east, 2 west, 3 east, 3 west, 5 east, 5 west) and four control sites (2, 3, 4, 6) spotlighting transects that targeted the Koala for three non-consecutive nights in winter, spring and summer. The methodology comprised five minutes listening, five minutes Koala call playback, two minutes listening, five minutes playback, two minutes listening. A Faunatech modified Toa megaphone (or equivalent) was used to broadcast the Koala call recording. Survey dates are provided in **Appendix A**.

2.2 Monitoring Crossing Structures

2.2.1 Fauna Underpasses

2.2.1.1 Monitoring Sites

The EMP and *Spotted-tailed Quoll Management Plan* (SKM 2012) identified 10 combined fauna underpass structures that require monitoring. These structures are shown in **Illustration 1.2** and are described in GeoLINK (2018).


2.2.1.2 Methodology

Underpass monitoring undertaken as part of Year 6 monitoring included:

- **Underpass camera traps:** Motion-detecting cameras were installed at each of the ten combined fauna underpass structures. The camera configurations and installation/ retrieval dates are provided in **Table 2.5**. The cameras are operating for the full year and checked each season (roughly two to three monthly), including replacing sd cards and batteries. This reporting period covers monitoring undertaken in Year 4 between 18/02/2019 and 20/08/2019 (outside of the Year 4 reporting period) and all of Year 6.
- **Substitution camera traps:** Two camera traps (substituting sand-plots) were established 0.4 m above the ground at the ends of each fauna underpass culvert or in locations complementing underpass cameras at the bridges for a minimum of four weeks each season (winter, spring and summer); excluding at C3. As there is limited potential for the two substitution cameras previously designated to this structure to enhance camera coverage/ fauna detectability above the underpass camera detection rate, these substitution cameras were installed on the northern wingwall at both ends of the pipe culverts located south of the C6 fauna underpass (referred to as C6 pipes). Installation and retrieval dates are detailed in **Table 2.6**.
- **Fauna furniture camera traps:** Camera traps (substituting hair-tubes) were installed at the six underpass structures with timber rail fauna furniture (11 cameras in total). Two cameras were installed at five of the underpasses, located at each end of the fauna furniture within the underpass and facing towards the centre of the structure. Only one camera trap was installed on the fauna furniture at NBT2 (eastern end, facing west) as the western portion of the fauna furniture was destroyed in the 2019 bushfire. The camera traps were set for a minimum of four weeks per season. Installation and retrieval dates are provided in **Table 2.6**.
- **Scat and track searches:** Scat and track searches were undertaken at each of the ten fauna underpass structures twice per season (0.5 hours per structure per event) in winter, spring and summer. Triggs (2004) was used for fauna identification. Survey dates are provided with the results in **Appendix C**.

The underpass camera traps comprised Reconyx HC500 HyperFire cameras, housed in security casings. At culverts, they were installed on the wall in the centre of each culvert cell between 0.4 to 1 m high (depending on inundation risk); while locations at bridges varied to maximise field of view. The cameras were set with the following recording parameters, consistent with those used for the Glenugie Pacific Highway Upgrade monitoring (Sandpiper 2017):

- Motion Sensor: On.
- Sensitivity: High.
- Time Lapse: Off.
- Pictures/ Trigger: 10

- 
- Picture interval: Rapidfire.
 - Image resolution: 1080p.
 - Quiet Period: No delay.

The substitution camera traps and fauna furniture camera traps comprised Titley Scientific Trail Camera 0.35 sec Fast Trigger 12MP No-Glow Infra-red LED. The cameras were set with the following recording parameters:

- Camera mode: Photo.
- Resolution: 12MP.
- Night mode: Balanced.
- Multi-shot: 5 with 0 second delay.
- Sensitivity: High (except during Year 6 Summer at some Tabbimoble Floodway cameras that were being falsely triggered by vehicle movements. The sensitivity at these cameras were reduced to low).
- Timer: off.

All images were downloaded onto a computer and reviewed by an ecologist. Data recorded included species, date, time, location, direction of movement (east, west, N/ A, returned), and outcome. 'Complete crossings' were defined as follows:

- Bridges:
 - image sequence shows a complete crossing
 - directional movement indicative of a complete crossing
 - image sequence shows a complete crossing when comparing cameras, fauna species and recording times at other cameras on the subject bridge or the adjacent opposite lane bridge.
- Underpasses:
 - image sequence shows a complete crossing when comparing cameras at each end of the structure, or
 - image sequence from camera in the centre (middle) of a culvert shows movement in one direction and the fauna does not return.

Unique complete crossings were identified by comparing the species, times and dates of recordings on the different cameras at each structure (and adjacent bridge in the case of the Tabbimoble Floodway bridges).

Table 2.5 Underpass Camera Trap Configuration and Effort During Year 6 Reporting Period

Underpass	Underpass Camera Trap	Year 4						Year 6										Total Days Active (Y4&6)		
		Start	1 st Check		End		Total Active Days	Start	1 st Check		2 nd Check		3 rd Check		5 th Check		End		Total Days Active	
			Date	Days Active	Date	Days Active			Date	Days Active	Date	Days Active	Date	Days Active	Date	Days Active	Date			Days Active
C3 (3 cell RBC)	2 x cameras (attached to northern wingwall at inlet and outlet).	18/02/19*	29/04/19	71 (eastern camera only)	20/08/19	113 (eastern camera only)	184 (eastern camera only)	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
C6 (1 cell RCBC)	1 x camera (in centre of culvert)	18/02/19*	29/04/19	0	20/08/19	0	0	24/01/20	20/04/20	88	10/07/20	81	^Temporary removal 18/09/20. Reinstalled 8/10/20.	63	04/12/20	63	15/02/21	73	368	368
C7 (2 cell RCBC):	2 x camera (in centre of each culvert cell)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
C8 (2 cell RCBC):	2 x camera (in centre of each culvert cell)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
C9 (2 cell RCBC):	2 x camera (in centre of each culvert cell)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
C10 (2 cell RCBC):	2 x camera (in centre of each culvert cell)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
NBT3	2 x camera (1 at northern bank; 1 at southern bank)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
NBT2	2 x camera (1 at northern bank; 1 at southern bank)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
SBT3	3 x camera (1 at northern bank; 1 at southern bank central span; 1 at southern abutment span)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573
SBT2	2 x camera (1 at northern bank; 1 at southern bank)	18/02/19	29/04/19	71	20/08/19	113	184	24/01/20	20/04/20	88	10/07/20	81	2/10/20	84	04/12/20	63	15/02/21	73	389	573

*C3 west and C6 underpass camera traps were not operational during the subject Year 4 period due to W2B construction works.
 ^ C6 underpass camera trap was temporarily removed between 18/09/2020 and 8/10/2020 due to W2B construction works.

Table 2.6 Underpass Substitution and Fauna Furniture Camera Trap Installation and Retrieval Dates, and Effort during Year 6 Monitoring

Id.	No. Substitution Cameras	No. Fauna Furniture Cameras	Winter			Spring			Summer			Total Active Days	
			Date Installed	Date Retrieved	Active Days	Date Installed	Date Retrieved	Active Days	Date Installed	Date Retrieved	Active Days	Substitution Camera	Fauna Furniture Camera
C3 (3 cell RCBC)	0	0	-	-	-	-	-	-	-	-	-	-	-
C6 (1 cell RCBC)*	2	2	3/08/2020	31/08/2020	29 (58)	1/09/2020	18/09/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	121 (242)
						8/10/2020	22/10/2020						
C6 (pipes)	2	0	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)^	121 (242)^	N/A
C7 (2 cell RCBC):	2	0	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	N/A
C8 (2 cell RCBC):	2	2	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	92 (184)
C9 (2 cell RCBC):	2	0	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	N/A
C10 (2 cell RCBC):	2	0	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	N/A
NBT3	2	2	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	121 (242)
NBT2	2	1*	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	121 (242)
SBT3	2	2	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	121 (242)
SBT2	2	2	3/08/2020	31/08/2020	29 (58)	1/09/2020	2/10/2020	32 (64)	22/12/2020	20/01/2020	30 (60)	121 (242)	121 (242)

Effective trap nights are provided in brackets behind 'Active Days'.

* Year 6 spring surveys were staggered due to W2B construction works.

^ denotes camera with potential battery failure reducing trap nights of one of the cameras by 14 days in summer.

2.2.2 Rope Bridge

2.2.2.1 Description

The Devils Pulpit rope bridge is located at approximate chainage 68.500 over both the north and southbound lanes at a cutting (refer to **Illustration 1.2**). Original design features of the rope bridge are described in GeoLINK (2018), while modifications (release point and 30mm diameter silver rope) is described in GeoLINK (2019).

2.2.2.2 Methodology

Monitoring of the rope bridge is required continuously in post construction monitoring years 3, 4 and 6. This reporting period covers monitoring undertaken in Year 4 between 15/01/2019 and 16/08/2019 and all of Year 6 (31/01/2020 to 1/02/2021). Two Reconyx cameras were installed on the rope bridge at each pole (one camera at each end). The cameras were positioned on the main rope bridge approximately 2 m from the poles, facing towards the respective pole. They are checked each season (every three months) and SD cards and batteries are replaced during each inspection. Camera setup, inspection and removal dates during the reporting period are provided in **Table 2.7**. A malfunction of the camera on the western pole resulted in 91 days of no data between 28/05/2020 and 27/08/2020.

Reconyx SC950 cameras were used during the Year 4 monitoring period and on the western pole during Year 6. A HC600 Hyperfire camera was used on the eastern pole during Year 6. This camera has the same specifications as the SC950, except it is not time programmable so the camera was always on.

Recording parameters set include:

- Motion Sensor: On.
- Sensitivity: High.
- Time Lapse: Off.
- Pictures/ Trigger: 10
- Picture interval: Rapidfire (up to two per second).
- Image resolution: 3.1MP.
- Quiet Period: 6.00 am to 6.00 pm (SC950 cameras only in Year 4 and January to August of Year 6. The quiet period was turned off on the SC950 camera [western pole] between August 2020 and February 2021).
- Night mode: Balanced.

All images were downloaded onto a computer and reviewed by a senior ecologist. Data recorded included species, date, time, location (eastern rope bridge pole or western rope bridge pole) and direction of movement (east, west, N/ A, returned). Complete crossings were noted where an individual was recorded at both ends of the structure, moving in one direction and the time and sequence of images corresponding to indicate the individual crossed the entire structure. Where cameras were always on, only images captured between 6.00 pm and 6.00 am were analysed as part of the main analysis. Other images captured outside this period were inspected and noted as opportunistic records.

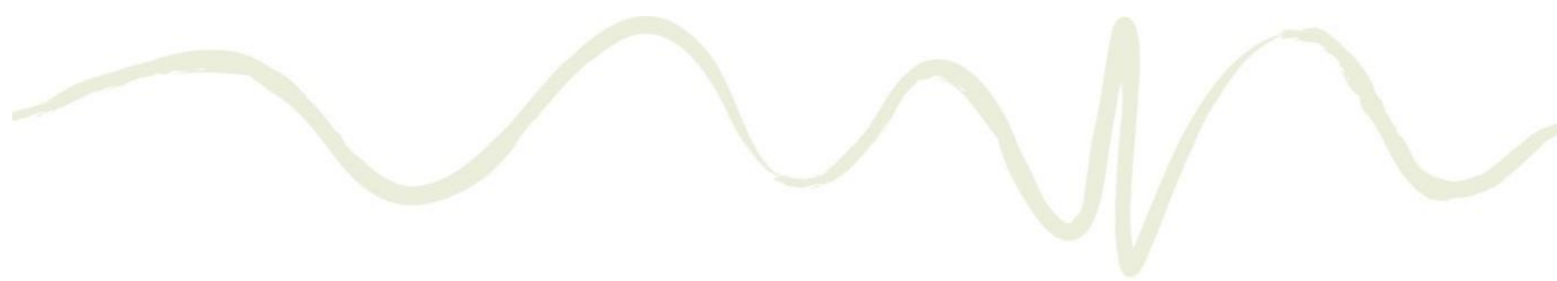


Table 2.7 Rope Bridge Camera Inspection Dates and Effort for Year 6 Reporting Period

Underpass Camera Trap	Year 4						Year 6											Total Days Active (Y4&6)	
	Start	1 st Check		End		Total Active Days	Start	1 st Check		2 nd Check		3 rd Check		5 th Check		End			Total Days Active
		Date	Days Active	Date	Days Active			Date	Days Active	Date	Days Active	Date	Days Active	Date	Days Active	Date	Days Active		
Rope Bridge Pole East	15/01/19	10/05/19	116	16/08/19	98	214	31/01/20	28/05/20	119	19/08/20	83	27/08/20	8	22/10/20	56	1/02/21	101	367	581
Rope Bridge Pole West	15/01/19	10/05/19	116	16/08/19	98	214	31/01/20	28/05/20	119	19/08/20	0*	27/08/20	0*	22/10/20	56	1/02/21	101	276	490

* denote period of camera malfunction.

2.2.3 Vegetated Median

2.2.3.1 Description

The Project encompasses two vegetated medians that are surveyed as part of the EMP. Locations of the medians are shown in **Illustration 1.2**. The southern median corresponds with Impact Site 2 and the northern median corresponds with Impact Site 4. A description of each median is provided in GeoLINK (2018).

2.2.3.2 Methodology

Vegetated median monitoring activities undertaken during the Year 6 monitoring included:

- **Spotlighting:** As for **Section 2.1.3.2**. Spotlighting was undertaken along one one-kilometre transect at each median with one observer spotlighting at a rate of one kilometre/ hour. Spotlighting surveys were conducted for three non-consecutive nights each season (winter, spring and summer). **Table 2.2** lists spotlighting survey sites and effort. Survey dates and weather conditions are provided in **Appendix A**.
- **Nest Box Monitoring:** As for **Section 2.1.7**. Squirrel Glider nest boxes were monitored once per season in winter, spring and summer. The five nest boxes located at Impact Site 2 (median) and one nest box located at Impact Site 4 (median) that remained post the 2019 bushfire were inspected as part of the Year 6 monitoring. The nest box at Impact Site 4 (median) was not inspected in spring and summer as access to the median was removed as part of W2B works. Nest box locations are shown in **Illustration 2.2** and detailed in **Appendix B**.

2.2.4 Restoration of Vegetated Connectivity Corridor

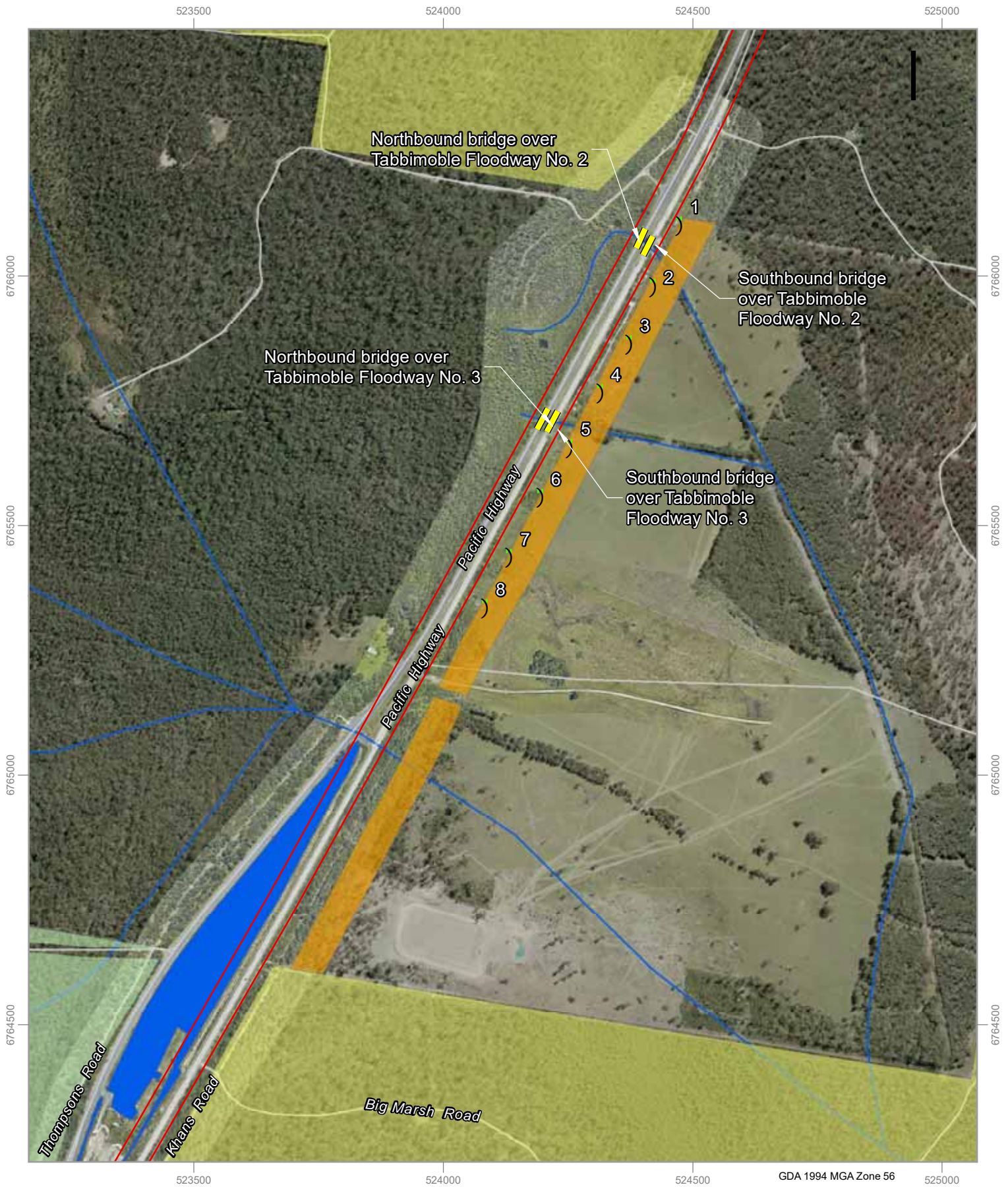
The 'vegetation connectivity corridor' is located between chainage 70.200-71.900 on the eastern side of the highway. It has a width of approximately 60 m (refer to **Illustration 1.2**).

Vegetation monitoring at the connectivity corridor during the reporting period comprised the Year 6 spring post construction monitoring event undertaken on 29/10/2020. The monitoring included:

- **Vegetation quadrats:** The eight 20x20 m quadrats established in winter Year 3 within the corridor were monitored (refer to **Illustration 2.3** and **Appendix D**). Within each quadrat, the following attributes were recorded:
 - diversity of species (i.e. species inventory of all native and exotic species, including noxious weeds)
 - per cent cover of native and exotic species (modified Braun-Blanquet scale; refer to **Table 2.8**)
 - height of plants in each stratum
 - general condition of the quadrat
 - whether any second generation or subsequent generations have been naturally recruited
 - any evidence of disturbance (e.g. fire, litter, disease, herbivory).
- **Photo point monitoring:** A photo was undertaken of the quadrat during each monitoring event, from the north-east corner facing the south-east corner.

Table 2.8 Modified Braun-Blanquet Cover Classes

<i>Class</i>	<i>Percentage Cover</i>
1	<5 % sparse
2	<5 % common
3	5-25 %
4	26-50 %
5	51-75 %
6	76-100 %



LEGEND

- Devil's Pulpit concept clearing limit
- State forest
- Northern median
- Vegetated connectivity corridor
- Combined fauna underpass
- Watercourse
- Vegetation monitoring location



Vegetation Connectivity Corridor Monitoring Sites - Illustration 2.3

2.3 Other Monitoring Activities

2.3.1 Roadkill Monitoring

Roadkill monitoring was undertaken once per week for four weeks per season (winter, spring and summer), totalling 12 events. It involved a vehicle being driven for the length of the upgrade (approximately 15.5 km of road encompassing both highway lanes and the Bundjalung rest area) mapping and identifying roadkill. The following data was recorded at each roadkill: species, GPS location, lane and presence/ absence of fauna fence. Roadkill monitoring dates are provided in **Appendix E**. Opportunistic roadkill detected when undertaking other activities were also recorded.

2.4 Survey Limitations

The EMP provides a list of typical survey limitations. The following specific limitations were also noted during Year 6 monitoring:

- Call playback and call identification: Highway traffic noise was considered a key limitation for call playback broadcast, and response detection and identification at impact sites. The range to which call playback was effective and the ability to hear and identify fauna calls was reduced.
- Spotlighting:
 - The effectiveness of spotlighting was affected (reduced) by highway vehicle lighting in some sections of Impact Site 1 (east), Impact Site 1 (west), Impact Site 2 (median) and Impact Site 6 (west).
 - Spotlighting transects have been established along cleared tracks/ easements at all sites except Impact Site 2 (median) and Impact Site 4 (median). The ability to observe in the canopy is reduced along some sections of these transects.
 - The effectiveness of spotlighting was impacted by the post fire regrowth structure in areas with dense epicormic growth on canopy trees.
- Nest box monitoring: refer to **Section 1.1.2**.
- Fauna underpass monitoring:
 - impacted where fauna furniture was damaged by the fires (refer to **Section 1.1.2**)
 - W2B construction works were undertaken along the northbound land and affected monitoring at underpass C3 and C6 (refer to **Section 2.2.1**).
- Camera traps: There are limitations with camera trap detectability which has been well documented in scientific literature (e.g. Meek 2015).



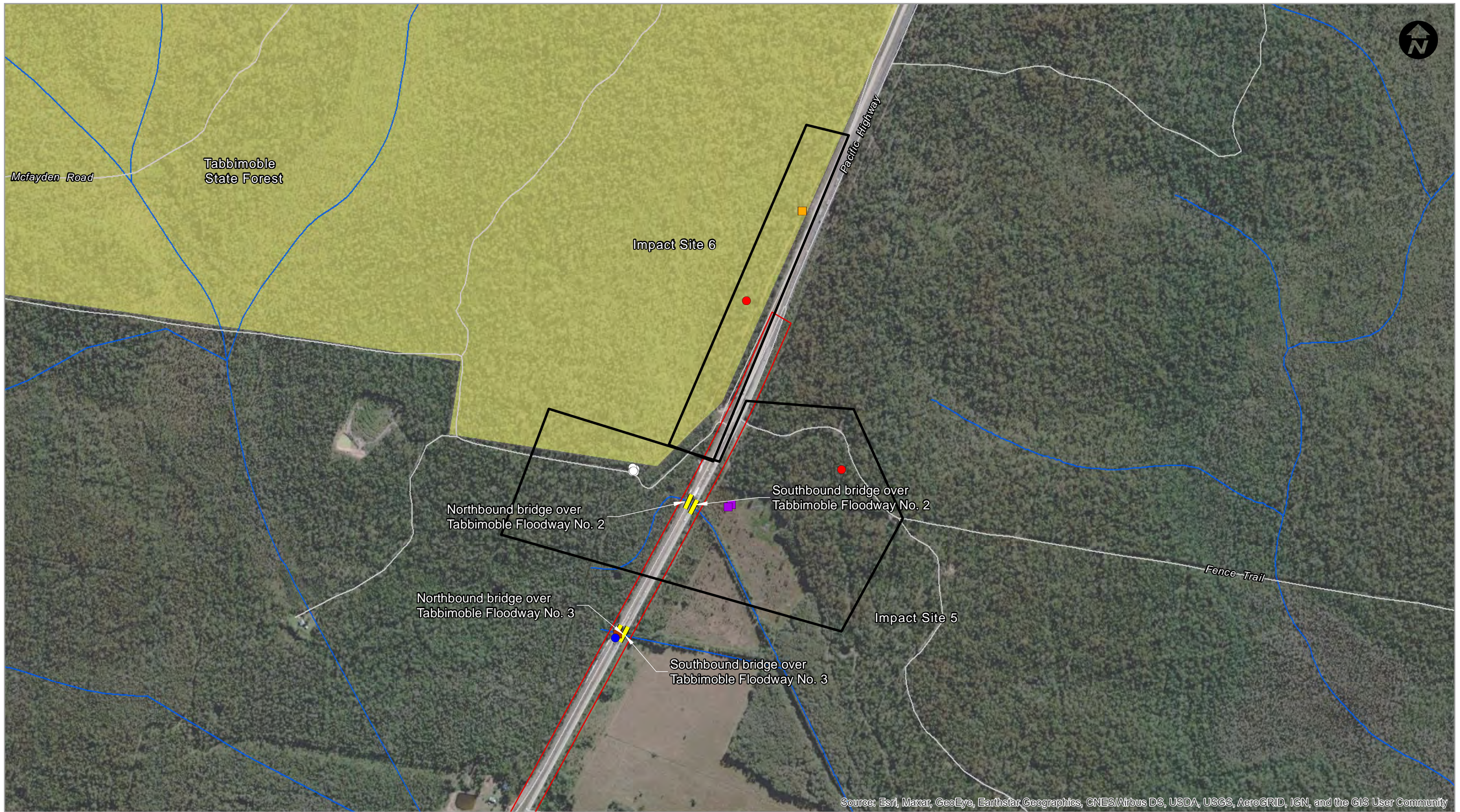
3. Results

3.1 Results

Monitoring results are provided below per survey method and target mitigation measure. Raw monitoring results are provided in **Appendix B** to **Appendix H** as follows:

- Appendix B: Nest Box Monitoring Locations and Results
- Appendix C: Fauna Underpass Monitoring Results
- Appendix D: Restoration of Vegetation Connectivity Corridor Results
- Appendix E: Roadkill Monitoring Results
- Appendix F: Rufous Bettong/ Brush-tailed Phascogale Camera Trap Results
- Appendix G: Spotlighting and Call Playback Results
- Appendix H: Threatened Frog Survey Results

Locations of recorded threatened species are shown in **Illustration 3.1**.



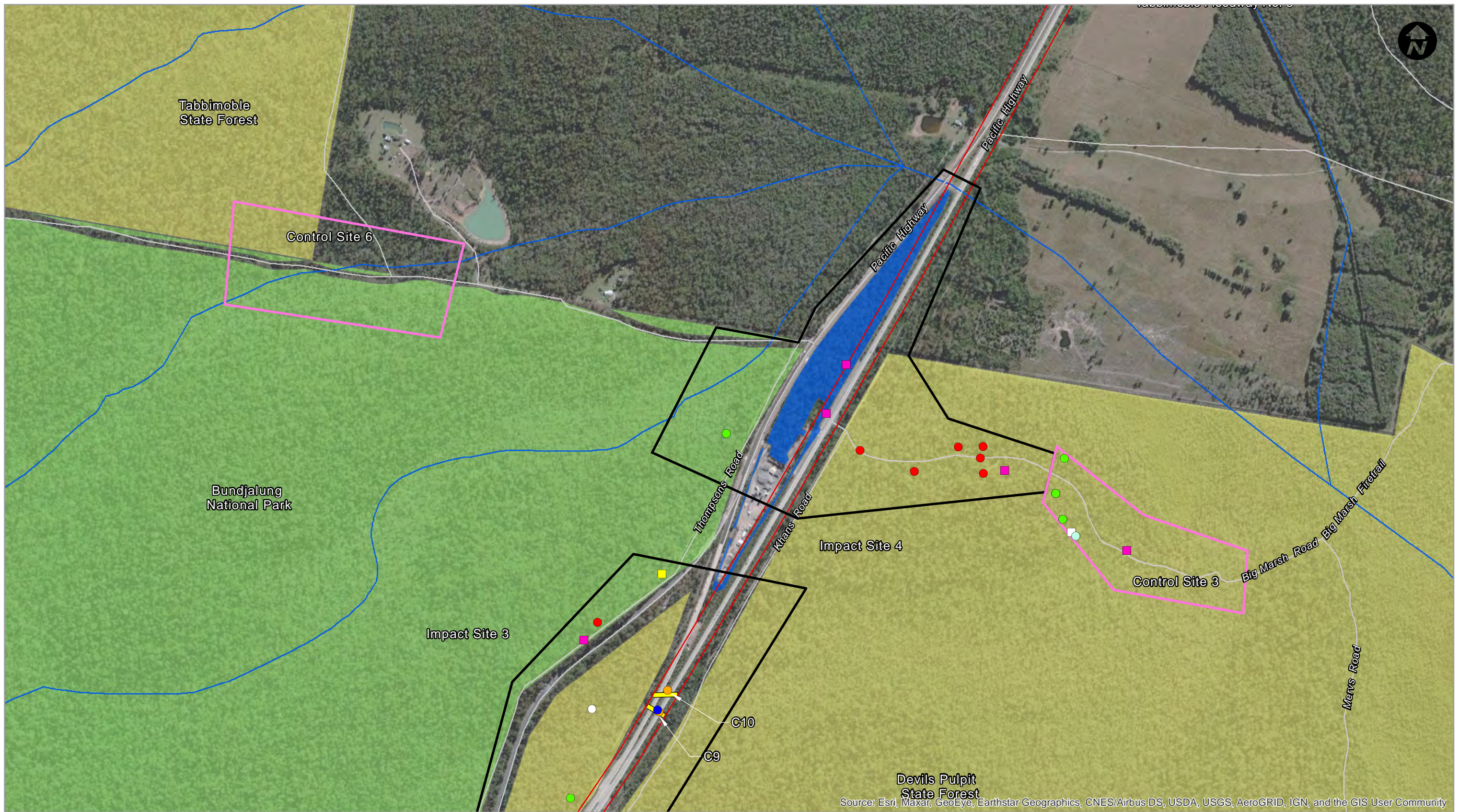
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND

- | | | | |
|---------------------------------------|--------------------------|---------------------------|-------------------------|
| Devil's Pulpit concept clearing limit | State Forest | Threatened Species | Southern Myotis |
| Impact site | Combined fauna underpass | Eastern Bent-winged Bat | Squirrel Glider |
| Watercourse | | Greater Glider | Squirrel Glider (Pr/Po) |
| | | Green-thighed Frog | Wallum Froglet |

0 200 Metres





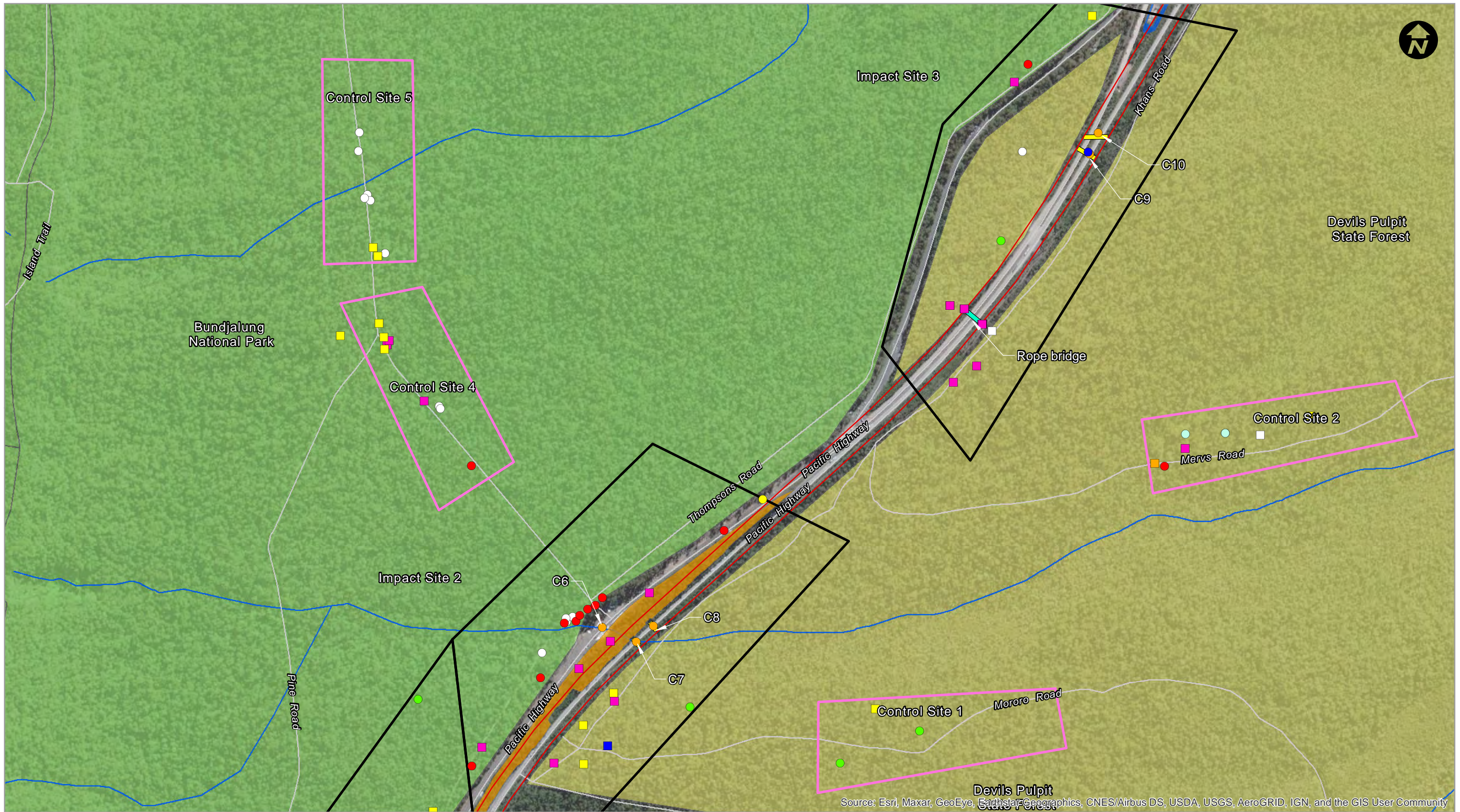
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND

- | | | | |
|---------------------------------------|--------------------------|---------------------------|------------------------|
| Devil's Pulpit concept clearing limit | State Forest | Threatened Species | Little Bent-winged Bat |
| Control site | National Park reserve | Brush-tailed Phascogale | Long-nosed Potoroo |
| Impact site | Combined fauna underpass | Eastern Bent-winged Bat | Masked Owl |
| Northern median | Watercourse | Greater Glider | Squirrel Glider |
| | | Green-thighed Frog | Yellow-bellied Glider |



**Recorded Threatened Species
Illustration 3.1 - Sheet 2 of 4**



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND

- | | | | |
|---------------------------------------|--------------------------|---------------------------|-------------------------|
| Devil's Pulpit concept clearing limit | State Forest | Threatened Species | Long-nosed Potoroo |
| Control site | National Park reserve | Brush-tailed Phascogale | Masked Owl |
| Impact site | Combined fauna underpass | Eastern Bent-winged Bat | Powerful Owl |
| Northern median | Rope bridge | Greater Glider | Squirrel Glider |
| Southern median | Watercourse | Green-thighed Frog | Squirrel Glider (Pr/Po) |
| | | Koala | Yellow-bellied Glider |
| | | Little Bent-winged Bat | |



Recorded Threatened Species
Illustration 3.1 - Sheet 3 of 4



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND

- | | | | |
|---------------------------------------|--------------------------|---------------------------|------------------------|
| Devil's Pulpit concept clearing limit | State Forest | Threatened Species | Little Bent-winged Bat |
| Control site | National Park reserve | Brush-tailed Phascogale | Powerful Owl |
| Impact site | Combined fauna underpass | Greater Glider | Squirrel Glider |
| Southern median | Watercourse | Green-thighed Frog | Yellow-bellied Glider |

0 200 Metres



3.2 Rufous Bettong/ Brush-tailed Phascogale Camera Trap Results

Rufous Bettong/ Brush-tailed Phascogale (RB/ BTP) camera trap results for Year 3, Year 4 and Year 6 monitoring are provided in **Appendix F**. Year 6 results are discussed in this section and comparison between years is provided in **Section 3.2.1** below.

A total of 26 species/ species groups were recorded, an average of 9.5 species (SD: 2.17) per site for each survey event. The average diversity was similar during winter, spring and summer (9.4 [SD: 1.76], 10.1 [SD: 1.92] and 9.7 [SD: 1.16] species/ species groups respectively). The average diversity was also similar when comparing impact and control sites (9.8 [SD: 1.53] and 9.6 [SD: 1.88] species/ species groups, respectively).

The species that were recorded at the most sites were the House Mouse (*Mus musculus*), Swamp Wallaby (*Wallabia bicolor*) (both species at all sites), Black Rat (*Rattus rattus*), Bush Rat (*Rattus fuscipes*), Eastern Grey Kangaroo (*Macropus giganteus*), Northern Brown Bandicoot (*Isodon macrourus*), Short-beaked Echidna (*Tachyglossus aculeatus*) and Yellow-footed Antechinus (*Antechinus flavipes*) (each species at 14 sites). The mean number of sites that each species was recorded at was 8.3 (SD: 5.16), with impact sites (5.4, SD: 3.55) higher than control sites (2.9, SD: 1.84).

Two target threatened species were recorded via the RB/ BTP camera traps:

- Brush-tailed Phascogale: six grid sites (four impact sites and two control sites).
- Long-nosed Potoroo: at two grid sites (two control sites).

No Rufous Bettongs or other threatened fauna species were recorded.

Images of recorded threatened species are shown from **Plate 3.1** to **Plate 3.3**. Images of a possible native mouse (*Pseudomys sp.*) were recorded at Impact Site 3 (west), Impact Site 5 (west) and Control Site 5. In each case the animal was unable to be identified to species level from the images and the records are considered a tentative 'possible' identification. The *Pseudomys* genus includes a number of threatened species.

Activity levels of the Brush-tailed Phascogale and Long-nosed Potoroo for each site are provided in **Table 3.1**. Average activity levels were lower at impact sites than at control sites for both species. There were an additional two opportunistic records of the Brush-tailed Phascogale at Control Site 3 and one opportunistic record of the Long-nosed Potoroo at Control Site 2 from images captured outside of the 14 day monitoring period. These records were not included in the activity level analysis.

Table 3.1 Activity Levels for the Brush-tailed Phascogale and Long-nosed Potoroo for Year 6 Monitoring

Site	Brush-tailed Phascogale		Long-nosed Potoroo	
	Activity Level	SE	Activity Level	SE
Impact Site 1 (west)	6 %	6	0 %	0
Impact Site 1 (east)	0 %	0	0 %	0
Impact Site 2 (west)	0 %	0	0 %	0
Impact Site 2 (east)	6 %	6	0 %	0
Impact Site 3 (west)	6 %	6	0 %	0
Impact Site 3 (east)	0 %	0	0 %	0
Impact Site 4 (west)	6 %	6	0 %	0
Impact Site 4 (east)	0 %	0	0 %	0
Impact Site 5 (west)	0 %	0	0 %	0
Impact Site 5 (east)	0 %	0	0 %	0
Average Impact Sites	2 %	1	0 %	0
Control Site 1	12 %	8	0 %	0
Control Site 2	0 %	0	12 %	8
Control Site 3	12 %	8	12 %	8
Control Site 4	0 %	0	0 %	0
Control Site 5	0 %	0	0 %	0
Average Control Sites	5 %	2	5 %	2
All Sites	3 %	1	2 %	1

3.2.1 Year 3, 4 and 6 Comparison

Species diversity during Year 3, Year 4 and Year 6 monitoring was comparable (mean number of species/ site: 9.0 [SD: 2.60], 10.5 [SD: 2.66], 9.5 [SD: 2.17] respectively).

Generally, the species that were recorded at the most sites also remained consistent throughout Year 3, Year 4 and Year 6 monitoring. An exception is an increase in the number of sites with House Mouse records during Year 6 monitoring (all 15 sites) compared with five sites in Year 3 (33 % of sites; all impact sites) and eight sites in Year 4 (53 % of sites; six impacts sites and two control sites) (refer to **Plate 3.4**). Also of note were records of Wild Pig (*Sus scrofa*) at three sites (two impact and one control site) during Year 6 monitoring (refer to **Plate 3.5**). Wild Pigs had not previously been recorded during Year 3 or Year 4 monitoring.

A comparison of the activity level of target species at impact and control sites for Year 3, Year 4 and Year 6 monitoring is provided in **Figure 3.1**. The following trends can be observed:

- Brush-tailed Phascogale:

- activity levels generally decreased at both impact and control sites between each monitoring period. An exception was an increase in activity levels at control sites between Year 4 and Year 6
- activity levels were generally higher at impact sites compared with control sites, except during Year 6.

- Long-nosed Potoroo:

- activity levels decreased at both impact and control sites between each monitoring period
- activity levels were lower at impact sites compared with control sites during Year 3 and Year 6 and equal in Year 4.

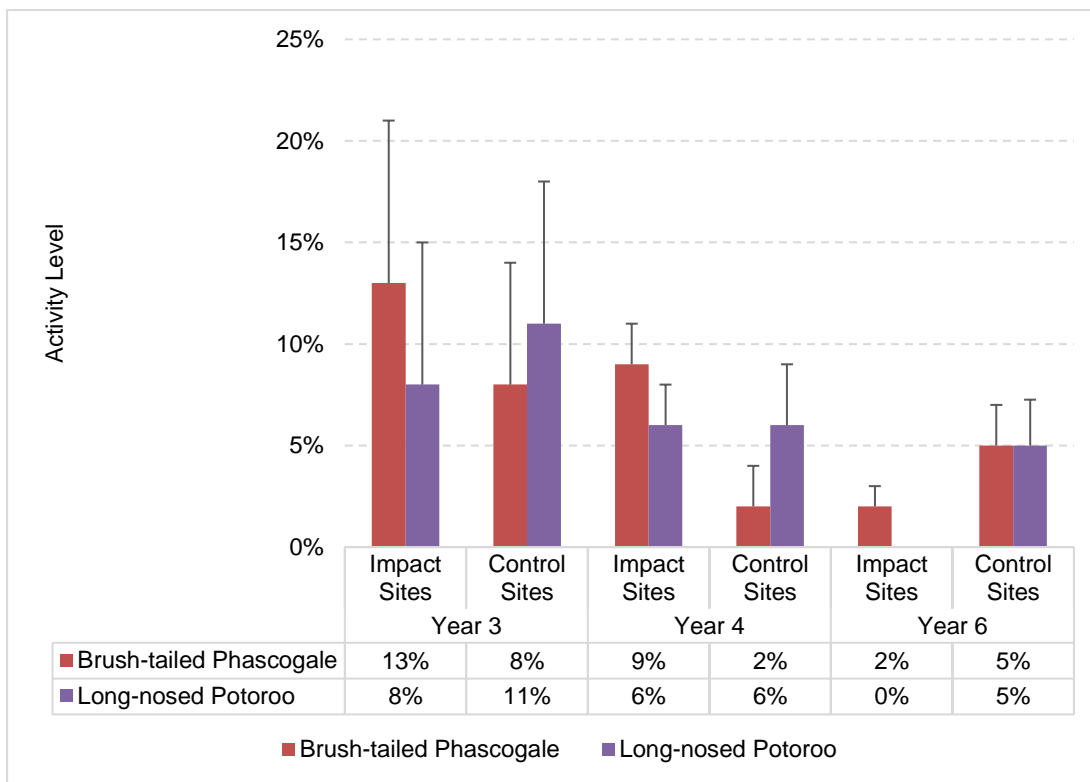


Figure 3.1 Average Activity Levels of Brush-tailed Phascogale and Long-nosed Potoroo at Impact and Control Sites During Year 3, Year 4 and Year 6.



Plate 3.1 Brush-tailed Phascogale image from Control 3 during Year 6 summer monitoring.



Plate 3.2 Long-nosed Potoroo image from Control 2 during Year 6 summer monitoring.



Plate 3.3 Two Long-nosed Potoroos in image from Control 2 during Year 6 spring monitoring.



Plate 3.4 Three House Mice at Impact Site 3 (west) during Year 6 summer monitoring.



Plate 3.5 Wild Pig image from Control 5 during Year 6 spring monitoring.


3.3 Spotlighting and Call Playback Results

Spotlighting and call playback results are provided in **Appendix G** and summarised in **Table 3.2**. A total of 99 records of 13 species/ species groups were obtained. The average number of records (abundance) per species was 6.6 (SD: 6.70). The Greater Glider (20 records; 7 sites), Squirrel Glider (17 records; 11 sites), Sugar Glider (16 records; 10 sites) and Yellow-bellied Glider (14 records; 7 sites) were the most commonly recorded species and were recorded at the highest number of sites (mean number of sites per species: 4.2, SD 3.47). The highest percentage of records were obtained in spring (43 %), followed by summer (33 %) and winter (23 %).

The average number of species recorded at each site (species diversity) was 3.5 (SD: 1.69), which was slightly lower at impact sites (mean: 3.3, SD: 1.42) compared to control sites (mean: 4.0, SD: 2.19). The highest species diversity was recorded at Control site 2 (eight species). The lowest species diversity was recorded at Impact Site 1 (west) where there were no records, and Impact Site 5 (west), Impact Site 6 (west), and Control Site 5, which each had two species recorded.

Three target threatened species were recorded during spotlighting/ call playback surveys:

- Squirrel Glider: 17 records from 11 transect sites (eight impact sites and three control sites). This species was recorded on both sides of the highway and within both vegetated medians.
- Yellow-bellied Glider: 14 records from seven transect sites (three impact sites and four control sites). This species was recorded on both sides of the highway, but not within the medians.
- Greater Glider: 20 records from seven transect sites (five impact sites and two control sites). This species was recorded on both sides of the highway, but not within the medians.



Target threatened species not recorded included the Koala, Rufous Bettong, Long-nosed Potoroo and Brush-tailed Phascogale. Other non-target threatened species recorded were the Masked Owl (*Tyto novaehollandiae*) and Powerful Owl (*Ninox strenua*). Both of these species are listed under the BC Act.

The number of records for each target threatened species at each site is displayed in **Figure 3.2**. Three *Petaurus spp.* (*P. breviceps* or *P. norfolcensis*) records that could not be identified to species level have not been included with this data.

3.3.1 Year 3, 4 and 6 Comparison

A comparison of activity levels of threatened species during Year 3, Year 4 and Year 6 monitoring is provided in **Figure 3.3**. The average activity level for the Yellow-bellied Glider was lower at impact sites compared to control sites during Year 6. In contrast, the average activity levels for the Greater Glider and Squirrel Glider were higher at impact sites compared to control sites. These trends were similar in both Year 3 and Year 4 monitoring for the Yellow-bellied Glider and Greater Glider, and the opposite for the Squirrel Glider in Year 6 compared to Years 3 and 4 (i.e. Squirrel Glider records were higher at control sites compared to impact sites during Years 3 and 4). Average activity levels were lower for the recorded target species at both impact and control sites in Year 6 compared to Years 3 and 4, with the exception of the Squirrel Glider at impacts sites where increased activities levels were recorded.

Table 3.2 Summary of Recorded Target Species Spotlighting/ Call Playback Results for Year 6 Monitoring

<i>Site</i>	<i>Greater Glider</i>	<i>Squirrel Glider</i>	<i>Yellow-bellied Glider</i>	<i>Other Arboreal Mammals</i>	<i>Other Terrestrial Mammals</i>	<i>Total</i>
Impact Site 1 (west)	0	0	0	0	0	0
Impact Site 1 (east)	0	4	2	1	0	7
Impact Site 2 (west)	8	1	0	4	0	13
Impact Site 2 (median)	0	2	0	3	0	5
Impact Site 2 (east)	0	1	3	0	1	5
Impact Site 3 (west)	1	1	1	1	1	5
Impact Site 3 (east)	0	1	0	1	0	2
Impact Site 4 (median)	0	3	0	4	1	8
Impact Site 4 (east)	6	1	0	2	2	11
Impact Site 5 (west)	0	0	0	1	3	4
Impact Site 5 (east)	1	0	0	3	0	4
Impact Site 6 (west)	1	0	0	1	0	2
Impact Total	17	14	6	21	8	66
Activity Level*	1.21	1.00	0.43	1.50	0.57	-
ST Dev	2.68	1.27	1.00	1.42	0.98	-
ST Error	0.72	0.34	0.27	0.38	0.26	-
Control Site 1	0	0	1	1	1	3
Control Site 2	1	1	1	3	2	8
Control Site 3	0	1	0	1	0	2
Control Site 4	2	1	5	2	0	10
Control Site 5	0	0	1	2	0	3
Control Site 6	0	0	0	3	0	3
Control Total	3	3	8	12	3	29
Activity Level*	0.50	0.50	1.33	2.00	0.50	-
ST Dev	0.84	0.55	1.86	0.89	0.84	-
ST Error	0.34	0.22	0.76	0.37	0.34	-
Total All Sites	20	17	14	33	11	95

* Activity level refer to the no. of records/ 500 m spotlight transect

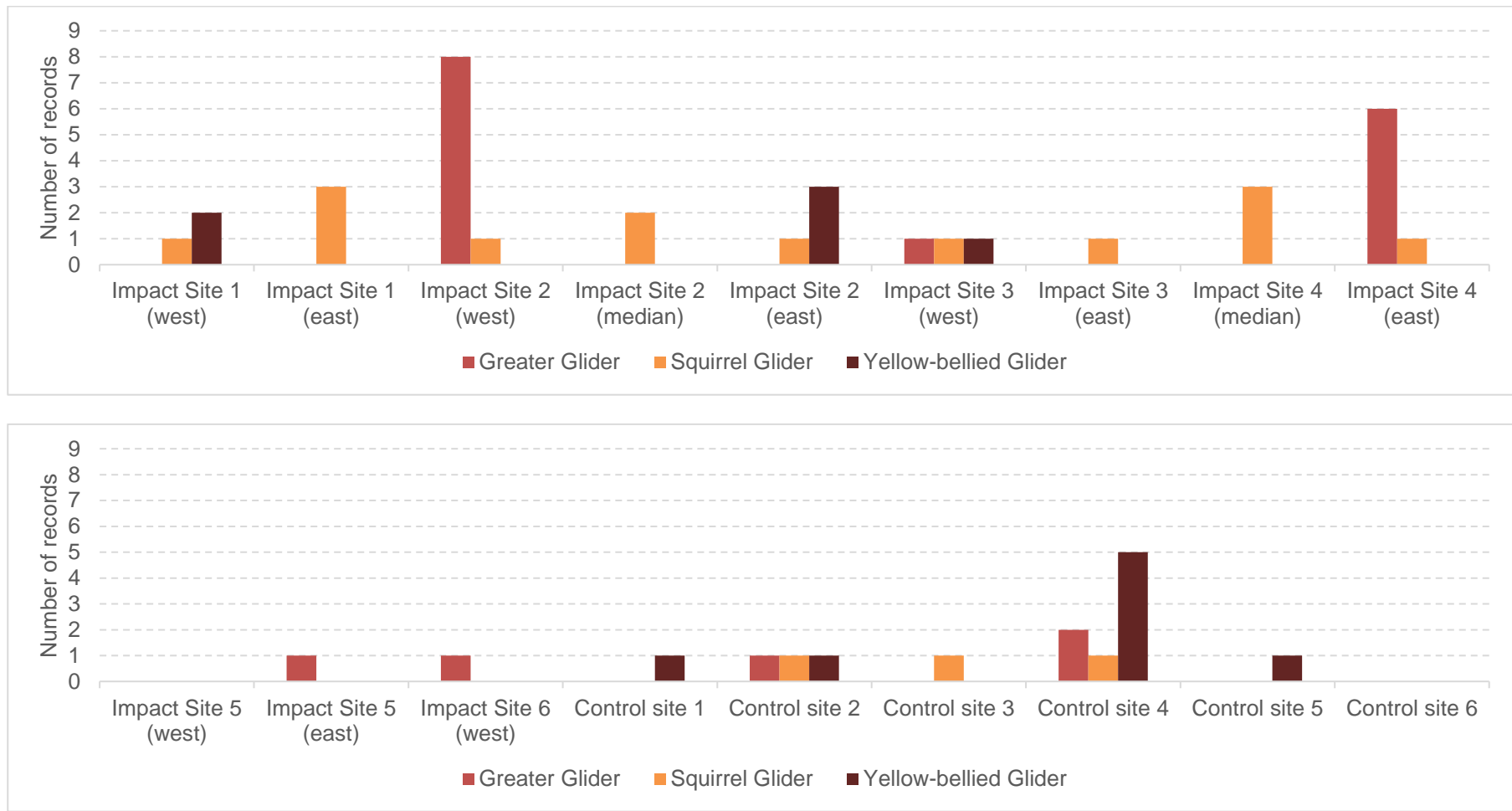


Figure 3.2 Number of Target Species Recorded via Spotlighting/ Call Playback during Year 6 Monitoring

Note: Spotlighting transects are 1 km long at Impact Site 2 (median) and Impact Site 4 (median); and 500 m long at all other sites.

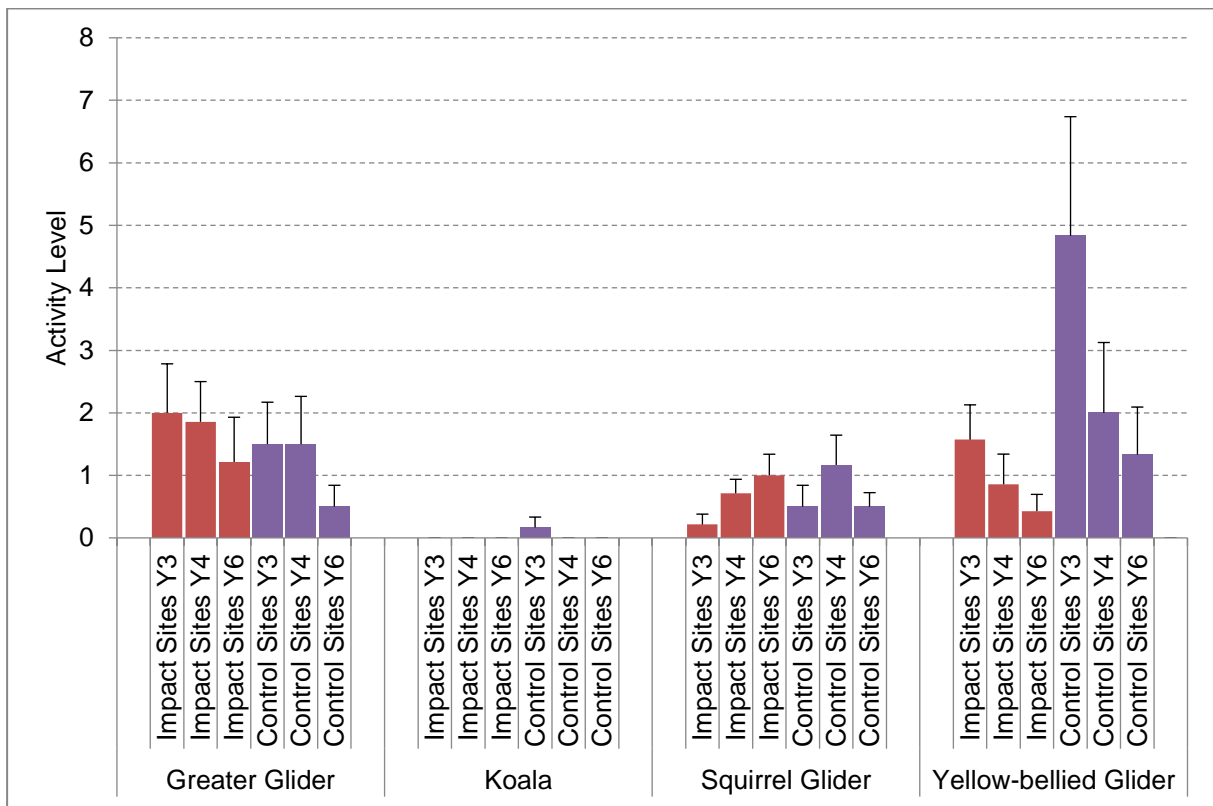


Figure 3.3 Mean Activity Levels of Target Species Recorded via Spotlighting/ Call Playback Survey during Year 3, Year 4 and 6 Monitoring

3.4 Threatened Frog Survey Results

Year 6 frog survey results are shown in **Appendix H**. Twenty-three frog species were recorded in total, averaging 13.3 species per site (range: 10-16; SD: 2.00). The highest diversity (number) of species was recorded at Control site 5 (16), Impact Site 3 (west) (15) and Impact Site 5 (west) (12).

The average number of species at each transect site per monitoring event was 8.6 (SD: 2.27). The most commonly recorded species (i.e. species recorded at the most number of transect sites) were the Striped Marsh Frog (*Limnodynastes peronii*), Green Tree Frog (*Litoria caerulea*), Striped Rocket Frog (*Litoria nasuta*), Tyler's Tree Frog (*Litoria taylori*) and Cane Toad (*Rhinella marina*), each of which were recorded at all nine sites.

The Green-thighed Frog was recorded at five sites, including both impact and control sites, all located on the western side of the highway (Impact Sites 2, 3 and 5 (west), Control Sites 4 and 5). It was recorded during all four survey events. The Wallum Froglet was recorded at one site (Impact Site 5 (east)) during summer surveys 3 and 4.

The number of individuals and location of threatened frog species recorded during each survey event is provided in **Figure 3.4**. Green-thighed Frog numbers ranged from 0-10 (mean: 1.6; SD: 2.66). Wallum Froglet numbers also ranged from 0-10 (mean: 0.4; SD: 1.84).

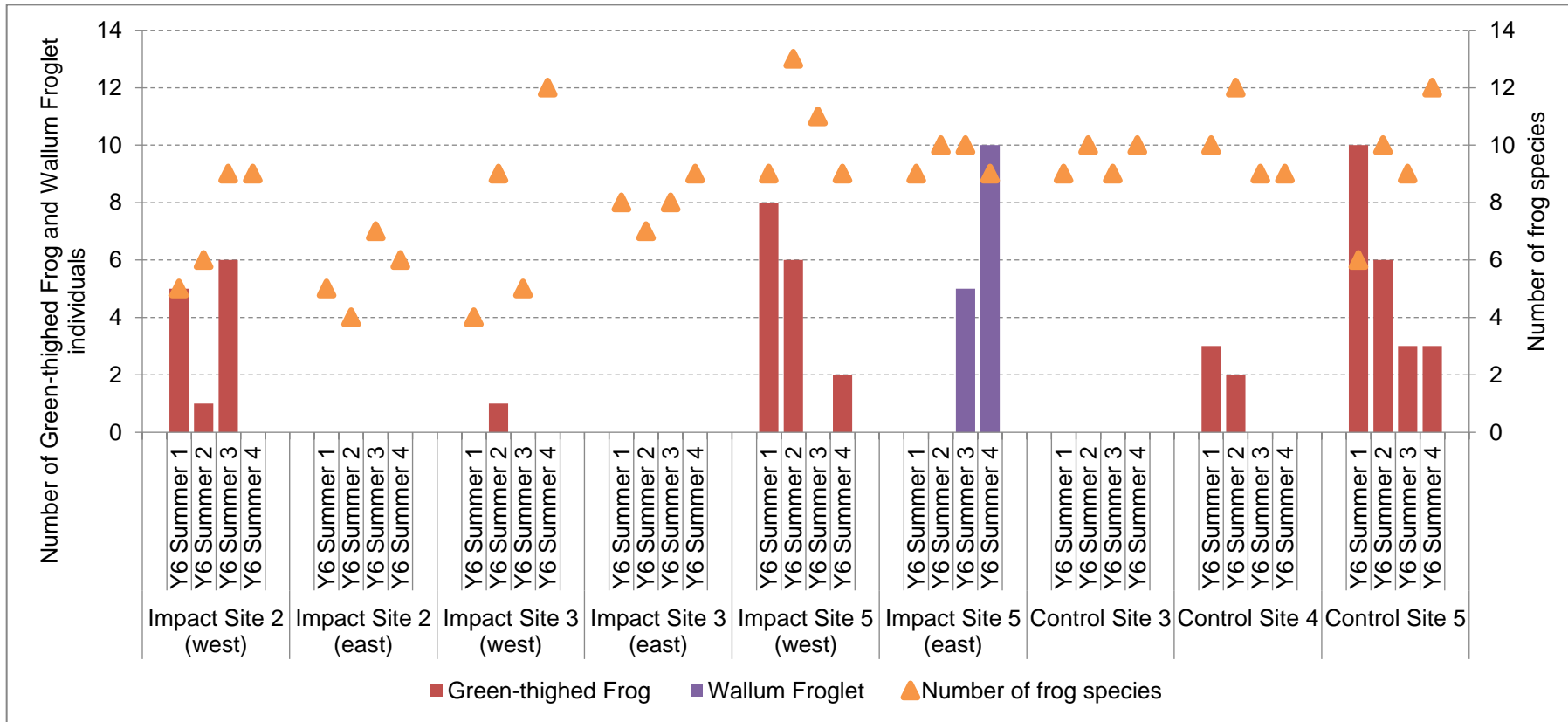


Figure 3.4 Threatened Frog Survey Results During Year 6 Monitoring

3.4.1 Year 3, 4 and 6 Comparison

Figure 3.5 shows a comparison between the number of target threatened frog species individuals and the number of frog species recorded at impact and control sites in Year 3, Year 4 and Year 6 monitoring. Higher species diversity (number of species) was recorded at both impact and control sites in Year 6 compared to Years 3 and 4. Higher numbers of threatened frogs were recorded at impact sites in Year 6 compared to Years 3 and 4; while numbers were variable at control sites between years.

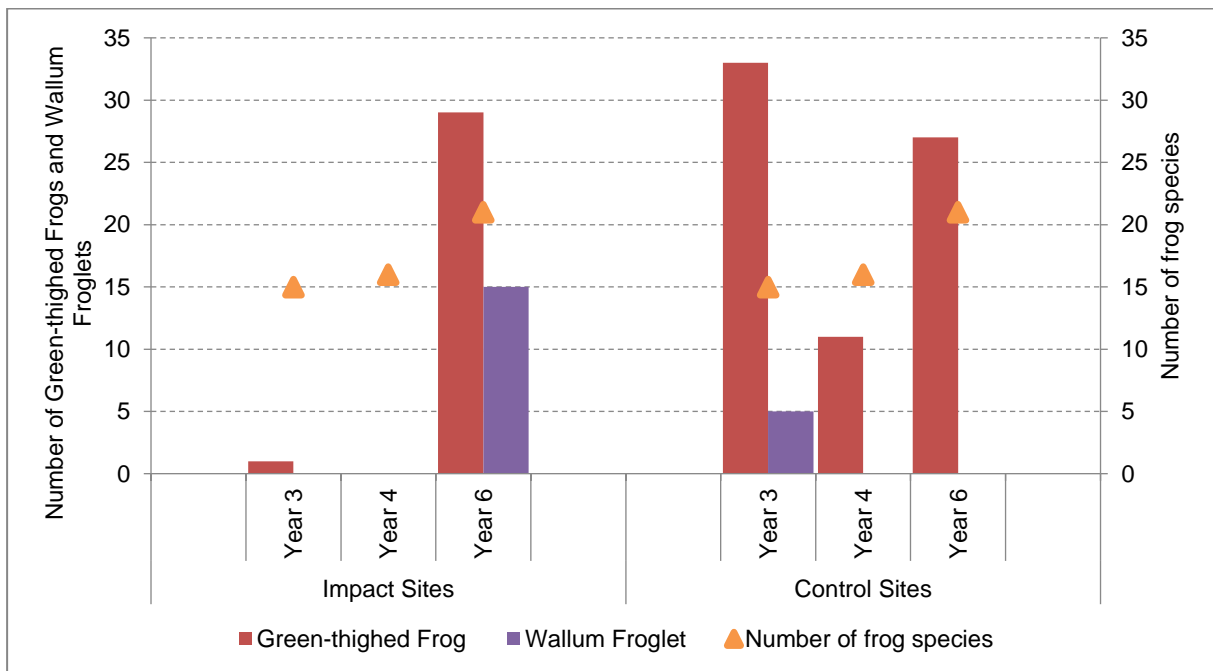


Figure 3.5 Threatened Frog Survey Results During Year 3, Year 4 and Year 6 Monitoring

Figure 3.6 shows a comparison between the number of sites where threatened frog species were recorded in Year 3, Year 4 and Year 6 monitoring. Green-thighed Frogs were recorded at more impact sites in Year 6 compared to Years 3 and 4, and the same number of control sites each year. Wallum Froglets were not frequently recorded and detected only at one impact site in Year 6 and one control site in Year 3.

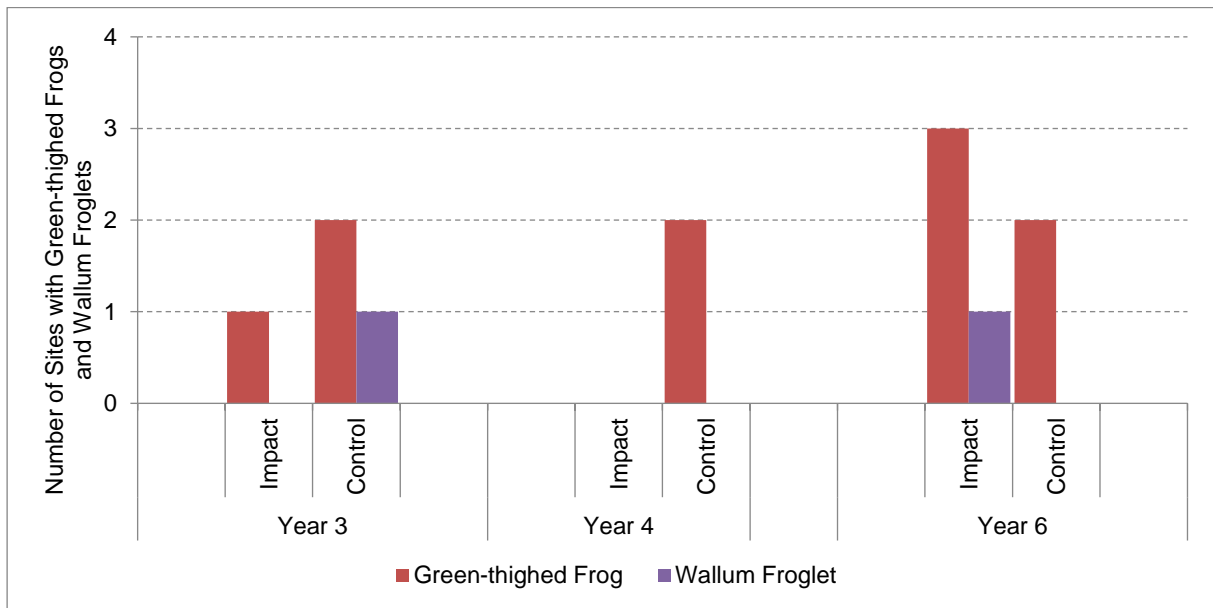


Figure 3.6 Number of Sites With Threatened Frogs During Year 3, Year 4 and Year 6 Monitoring

3.5 Nest Box Monitoring Results

The nest box monitoring results are provided in **Appendix B**. The Squirrel Glider was the only target species recorded occupying nest boxes, with a total of 19 individuals (including subadults; excluding dependant pouched young) recorded occupying eight nest boxes (16 %). A summary of sites with nest boxes occupied by Squirrel Glider is provided in **Table 3.3**. Other vertebrate fauna recorded occupying the nest boxes included reptiles (a Lace Monitor and a gecko [likely Robust Velvet Gecko *Oedura robusta*] which dispersed during the inspection) and a frog (*Litoria sp.* which also dispersed during the inspection).

A further 34 nest boxes (69 %) were not occupied, however showed evidence of glider (*Petaurus sp.*) activity through leaf nesting material deposits. No Brush-tailed Phascogales or evidence of nest box usage by this species was recorded. No active European Bee (*Apis mellifera*) hives were present.

During Year 6 monitoring six gliders dispersed before identification to the species level could be made and were recorded as being either Squirrel Gliders or Sugar Gliders. For analysis purposes, these gliders have been categorised as Squirrel Gliders based on the previous nest box monitoring results.

Table 3.3 Summary of Squirrel Glider Nest Box Site Occupancy for Year 3, Year 4 and Year 6 Monitoring

Site	Nest Boxes Occupied During Year 3	Nest Boxes Occupied During Year 4	Nest Boxes Occupied During Year 6
Impact Site 2 (west)	-	Y	-
Impact Site 2 (median)	-	Y	Y
Impact Site 2 (east)	Y	Y	Y
Impact Site 3 (west)	Y	-	Y
Impact Site 3 (east)	Y	Y	Y
Impact Site 4 (west)	Y	-	-
Impact Site 4 (median)	-	Y	-
Impact Site 4 (east)	-	Y	-
Impact Site 6 (west)	Y	Y	Y
Control Site 1	-	Y	-
Control site 2	-	-	Y
Control Site 4	-	Y	Y
Control Site 5	-	Y	-

Figure 3.7 shows the number of Squirrel Glider individuals recorded over time at the site while **Figure 3.8** shows nest box occupancy rates. The nest box monitoring observed a peak in Squirrel Glider numbers in Year 4 winter (22). Five to eight Squirrel Gliders were recorded during the five subsequent monitoring events, despite a 30-31 % reduction in nest box numbers monitored during the three Year 6 monitoring events (refer to **Section 2.1.7**). The proportion of gliders at impact and control sites has fluctuated. The number of nest boxes showing evidence of glider occupancy has increased overtime.

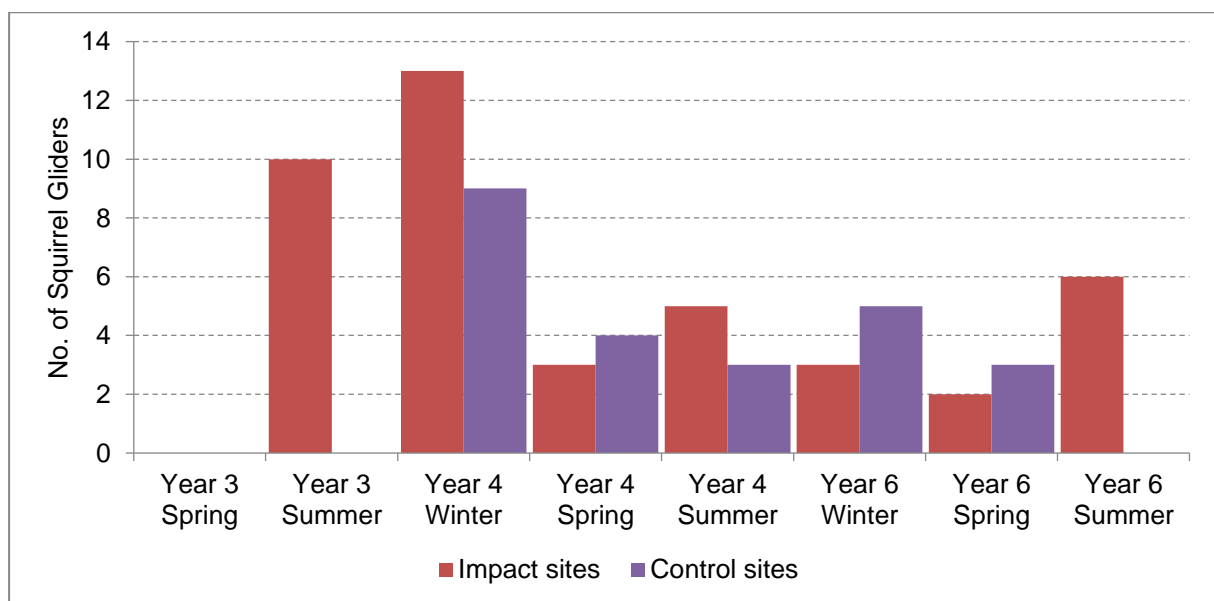


Figure 3.7 Squirrel Glider Results During Year 3, Year 4 and Year 6 Monitoring



Figure 3.8 Nest Box Occupancy Rates During Year 3, Year 4 and Year 6 Monitoring

Evidence of glider use = nest boxes occupied by gliders or containing leaf litter.

* For Year 6 the calculation for percent occupation excludes nest boxes that had been burnt or could not be accessed.

3.6 Fauna Underpass Monitoring Results

3.6.1 Underpass Cameras

Fauna underpass camera monitoring results are summarised in **Appendix C**. Camera monitoring (including underpass cameras, substitution cameras and fauna furniture cameras) recorded a total of 1820 records of 31 fauna species/ species groups (excluding birds). On average native species contributed to the majority of records (73 %). The most recorded species were the Black Rat (352), Eastern Water Dragon (*Intellagama lesueurii* - 257), Swamp Wallaby (257) and Lace Monitor (*Varanus varius* – 201). Several species (e.g. Eastern Water Dragon, Black Rat, Cane Toads, Antechinus sp., and Water Rat *Hydromys chrysogaster*) regularly displayed habitation behaviour within or adjacent to the structures (such as foraging, basking, etc) rather than dispersing through the underpasses. A sample of images from are provided in **Plate 3.6** to **Plate 3.13**.

The majority of records were obtained from SBT3 (421), C6 (298), C7 (265) and NBT3 (228). Fauna underpasses with the least number of records included C3 (30), C9 (54), C10 (58) and NBT2 (89).

A total of 992 unique complete crossings of 26 species/ species groups were recorded. Most unique complete crossings recorded were of Black Rats (199, mostly at C6), Swamp Wallabies (189, mostly at SBT3), Eastern Grey Kangaroos (148 mostly from SBT3) and Lace Monitors (139 – mostly at C7). SBT3, C7, NBT3 and C6 recorded the most unique complete crossings, numbering 287, 166 139 and 131 respectively. Although the number of unique complete crossings at C6 was high, most were made by Black Rats. The proportion of unique complete crossings made by native species at C6 was relatively low (26 %). No unique complete crossings were recorded at C3, while low numbers of unique complete crossings were recorded at C10 (21), C9 (30), NBT2 (49) and SBT2 (68). The overall weekly rate of unique complete crossings for all species was 12.12.

No records of any threatened species were obtained during underpass camera monitoring.

Comparison of fauna records and complete crossings between similar structures shows the following trends:

- Substantially higher numbers of records and unique complete crossings were recorded at the Tabbimoble Floodway No.3 bridges (NBT3 and SBT3) compared to the Tabbimoble Floodway No.2 bridges. The main difference between the bridges at these waterways are:
 - Tabbimoble Floodway No.3 bridges are longer (3 and 4 spans) and include areas with flat ground on both sides of the waterway and groundcover vegetation.
 - Tabbimoble Floodway No.2 bridges are shorter (2 spans), have limited vegetation, and SBT2 has irregular rock scour protection that would require negotiating for fauna to cross.

All bridges are a similar width (10 m to 12.04 m).

- Substantially higher numbers of unique complete crossings were recorded at C7 compared to C8 (166 to 96), despite both culverts being a similar length (19.67 m and 22.13 m respectively) and located along the same drainage line; and C8 supporting fauna furniture (thereby would be expected to have recorded more small mammal crossings [Goldingay et al 2019]). The main difference between these structures is the damaged scour protection at the outlet of C8 which creating pooled water at the eastern end of the culvert (GeoLINK 2018).
- Substantially higher numbers of records and unique complete crossings were recorded at short culverts below one lane (C6, C7 and C8; ~16 - 22 m) compared to longer culverts below two lanes (C3, C9 and C10; ~49 - 59 m). C3, C9 and C10 have semi-permanent pooled water at the outlet (eastern end) which is likely to also be impacting fauna use of these structures. Comparisons between C8 and C9/ C10 however demonstrate the length trend as they all have semi-permanent pooled water at the outlet, and were monitored for the same duration and with the same camera configuration.
- Macropods and bandicoots were generally recorded at higher numbers at the bridge structures compared to culverts; except for the Swamp Wallaby at C7.



Plate 3.6 Eastern Grey Kangaroos grazing while moving west (northern bank) at SBT3. A complete crossing was recorded.



Plate 3.7 Lace Monitor moving east-west at fauna underpass C7. A complete crossing was recorded.



Plate 3.8 Feral cat moving east-west at fauna underpass C7.
A complete crossing was recorded



Plate 3.9 Short-beaked Echidna moving east-west at fauna underpass C7.
A complete crossing was recorded.



Plate 3.10 Brown Goshawk using fauna furniture at SBT3.
This was a regular observation, mainly at underpasses with fauna furniture.



Plate 3.11 Swamp Wallaby moving west-east at fauna underpass C9.
A complete crossing was not recorded on this occasion.



Plate 3.12 Eastern Grey Kangaroo crossing west-east at SBT3 (southern span)

A complete crossing was recorded. Note that the animal is crossing in an area with no rock. Macropods were frequently observed to avoid the irregular rock when crossing.



Plate 3.13 Common Brushtail Possum crossing west-east at fauna underpass C7.

A complete crossing was not recorded on this occasion.

3.6.2 Scat and Track Searches

Underpass scat and track search results are provided in **Appendix C**. A total of twenty-three species/ species groups (excluding avifauna) were identified through direct observation or detection of scats and/ or tracks, including:

- Thirteen mammals: Eastern Bent-winged Bat (*Miniopterus orianae oceanensis*), Little Bent-winged Bats (*Miniopterus australis*), Antechinus sp., Cat (*Felis catus*), Common Brushtail Possum, Eastern Grey Kangaroo, European Fox (*Vulpes vulpes*), *Rattus* sp., Ringtail Possum (*Pseudocheirus peregrinus*), Short-beaked Echidna, Southern Myotis (*Myotis macropus*), Swamp Wallaby and Water Rat.
- Three amphibians: Cane Toad, Green Tree Frog and Striped Marsh Frog.
- Seven reptiles: Lace Monitor, Eastern Water Dragon, Sun-skink (*Lampropholis delicata*), Eastern Crevice Skink (*Egernia mcphreei*), *Egernia* sp., *Elapid* sp. and Martin's Bar-sided Skink (*Eulamprus martini*).

Most of the underpass usage observed/ detected by amphibians, reptiles and small terrestrial mammals (i.e. Antechinus sp., *Rattus* sp. and Water Rats) was associated with habitation of the structure. Results indicative of complete crossing fauna crossings were of:

- Cat at C7.
- Eastern Grey Kangaroos at NBT3.
- Lace Monitor at C7, C8, C9 and C10.
- *Macropod* sp. at SBT3.
- *Rattus* sp. at C6 (pipe culverts south of fauna underpass).
- Short-beaked Echidna at C10.
- Swamp Wallaby at C7, C8, C9, SBT3 and NBT3.
- Water Dragon at C6 (observed crossing).

No scats or tracks of target threatened species were detected at the underpass structures.

Fauna underpass structures C3, C7, C8, C9 and C10 were observed to support small to large roosting colonies of Little Bent-winged Bats during winter (range of individuals per structure: 2 to approx. 1800), with C3, C9 and C10 also used by small to medium sized colonies in early spring (range of individuals per structure: 3 to approx. 55). Individual Eastern Bent-winged Bats were observed roosting in C9 and NBT3 in winter. An individual Southern Myotis was observed roosting in NBT3 in winter. These three microbat species are listed as threatened species under the BC Act.

3.7 Rope Bridge Results

Rope bridge cameras recorded a total of 103 records of six species (refer to **Table 3.4**). The Feathertail Glider (*Acrobates pygmaeus* – 42 records) was the most commonly recorded species followed by the Squirrel Glider (39 records) and Sugar Glider (10 records) (plus seven *Petaurus sp.* records of either of these species that could not be identified to species levels). Other species recorded included the Brush-tailed Phascogale (2 records) and the Common Ringtail Possum (3 records). A sample of photos from the reporting period are provided in **Plates 3.14 to 3.17**.

The Feathertail Glider, Squirrel Glider and Sugar Glider were recorded on both the eastern and western sides of the rope bridge. The Brush-tailed Phascogale was recorded on the eastern side of the rope bridge only, while the Common Ringtail Possum was recorded at the western end of the rope bridge only. Overall, the total number of records was slightly higher at the western side (53) than the eastern site (50), despite the camera at the western pole malfunctioning for 16 per cent of the recording days. No images of fauna slipping on metal element were captured during Year 6.

No Yellow-bellied Glider or Greater Glider activity on the rope bridge was recorded in Year 6.

Table 3.4 Species Recorded by Rope Bridge Camera Traps During the Year 6 Reporting Period

Species	Eastern Pole		Western Pole		TOTAL Visits
	No. of Visits	Visits/ Week	No. of Visits	Visits/ Week	
Brush-tailed Phascogale	2	0.02	0	0.00	2
Common Ringtail Possum	0	0.00	3	0.04	3
Feathertail Glider	13	0.16	29	0.42	42
Glider sp.*	3	0.04	4	0.06	7
Squirrel Glider	25	0.30	14	0.20	39
Sugar Glider	7	0.08	3	0.04	10
TOTAL	50	0.60	53	0.76	103

Directional movement of the Feathertail Glider, Squirrel Glider and Sugar Glider occurred on both the eastern and western sides of the rope bridge (refer to **Table 3.5**). There were 12 occasions when gliders were recorded on both sides of the rope bridge on the same night (6 Feathertail Gliders, 5 Squirrel Gliders, 1 *Petaurus sp.*). These are potentially indicative of rope bridge crossings, with:

- Feathertail: five east-west and one west-east movements
- Glider sp.: one west-east movement
- Squirrel Glider: three east-west movements and two west-east movements.

However, directional movements were not consistent at each end of the rope bridge. It is also plausible that gliders were present at each end of the rope bridge on the same night and did not cross.

During the time of the western pole camera malfunction, only one potential crossing could have occurred during this period. There were only three visits to the eastern pole during this period, including two returns (Brush-tailed Phascogale and Squirrel Glider) and one directional record (Squirrel Glider moving east-west).

Squirrel Gliders were recorded moving east, west and making return movements on both sides of the rope bridge. Directional movement of Squirrel Gliders was recorded most often in a western direction (19 records).

Brush-tailed Phascogales were recorded twice on the eastern side of the rope bridge moving in a western direction. A return movement was observed on one of the occasions.

Some records (27 %) did not involve directional movement. This was partly attributed to Feathertail Glider habitation activity (i.e. foraging) at the rope bridge poles. Other instances were associated with animal's non-directional sequences or a low quality or number of images.

Table 3.5 Direction of Movement of Species on Rope Bridge During the Year 6 Reporting Period

Species	Eastern Pole				Western Pole				TOTAL
	East	West	Return	N/A	East	West	Return	N/A	
Brush-tailed Phascogale	-	1	1	-	-	-	-	-	2
Common Ringtail Possum	-	-	-	-	2	-	-	1	3
Feathertail Glider	5	4	-	4	7	12	-	10	42
Glider sp.*	-	3	-	-	-	-	-	4	7
Squirrel Glider	3	13	5	4	5	7	1	1	39
Sugar Glider	-	5	-	2	1		-	2	10
Grand Total	8	26	6	10	15	19	1	18	103



Plate 3.14 Squirrel Glider at the western rope bridge pole.



Plate 3.15 Brush-tailed Phascogale at the eastern rope bridge pole.



Plate 3.16 Sugar Glider at the eastern rope bridge pole.



Plate 3.17 Ringtail Possum at the western rope bridge pole.

3.7.1 Year 3, 4 and 6 Comparison

A comparison of the visitation rate (number of visits per week) of target species at the eastern and western glider pole for Year 3, Year 4 and Year 6 monitoring is provided in **Figure 3.11**. The following trends can be observed:

- overall visitation rates (combined species) increased during Year 3 and Year 4, however decline during Year 6
- overall visitation rates were higher at the western pole compared with the eastern pole in Years 3 and 4, however during Year 6 visitation at the western pole decreased to lower levels than at the eastern pole
- during Year 3 and Year 4 Feathertail Gliders had the highest visitation rates, followed by Squirrel Gliders. During Year 6 Feathertail Glider visitation dropped significantly, which was the main contributor to the decrease in overall visitation in Year 6. In contrast, Squirrel Glider visitation remained relatively constant.

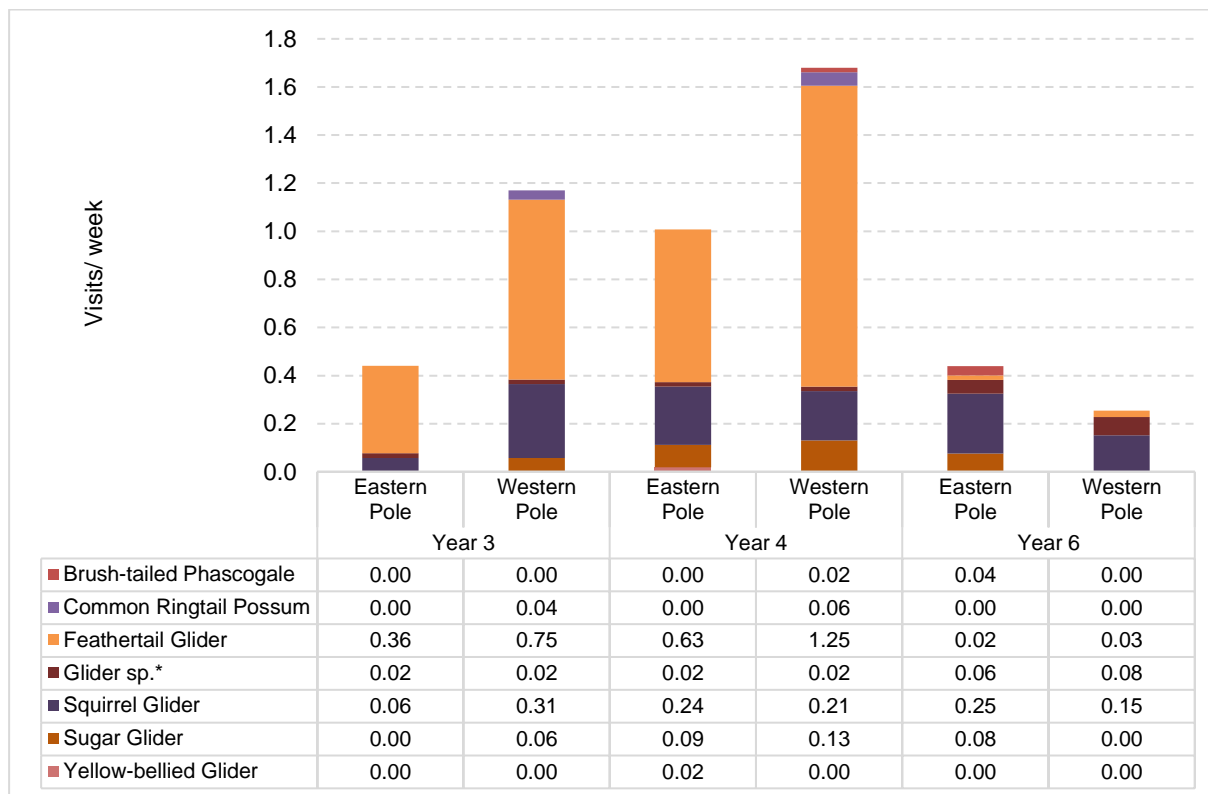


Figure 3.9 Visitation rates (visits/ week) of target species at each rope bridge pole during Year 3, Year 4 and Year 6 monitoring

Note: This data relates to monitoring years rather than reporting periods.

Table 3.6 shows the number of potential crossing recorded each year during the post construction monitoring. Recorded potential crossings were highest in Year 4 and mainly associated with Feathertail Glider activity.

Table 3.6 Potential complete crossings during Year 3, Year 4 and Year 6 monitoring

Species	Year 3	Year 4	Year 6
Feathertail Glider	5	21	0
Glider sp*	0	0	1
Squirrel Glider	0	4	1

3.8 Vegetated Median Results

The results for spotlighting and call playback surveys, and nest box monitoring at the vegetated medians is included in **Sections 3.3** and **0** respectively.

3.9 Restoration of Vegetated Connectivity Corridor Results

Vegetation quadrats and photo point results are provided in **Appendix D** and summarised in **Table 3.7**. Vegetation structure at each site was divided into three categories:

- Trees (T1) = 3 m tall
- Shrubs (T2) = woody species <3 m tall
- Groundcovers (G) = non-woody species (e.g. herbs, grasses, sedges and rushes)

3.9.1 Year 6 Spring

A total of four tree species (all native) were recorded in the tree layer, with Swamp Box and Broad-leaved Paperbark being the dominant species at most sites. Upper tree height ranged between seven and 10 metres at each quadrat. Total cover scores at each site varied from 2 to 7 for native trees.

Thirteen 'shrub' species were recorded, including both native and weed species. Commonly recorded species included Swamp Box saplings, Forest Red Gum saplings, and Paperbarks (*Melaleuca linariifolia*, *M. nodosa*, *M. quinquenervia* and *M. sieberi*, *M. thymifolia*). The only weed species recorded was Groundsel Bush, which was uncommon. Total shrub cover scores at each site ranged from 2 to 4 for native species and 0 to 1 for weed species.

Fifty-five species were recorded in the groundcover layer, including 36 native and 19 exotic species. Dominant species included Pennywort (*Centella asiatica*), Blady Grass (*Imperata cylindrica*), Bluegrass (*Ischaemum australe*), Milkwort (*Polygala paniculata**) and Pigeon Grass (*Setaria sphacelata**). Total cover scores of groundcovers at each site ranged from 2 to 6 for native species and 2 to 6 for exotic species.

Condition varied from good at three quadrats (Q1, Q2, Q3), moderate at one site (Q4) and poor at four sites (Q5, Q6, Q7 and Q8). Disturbance from fire was recorded at all sites.

3.9.2 Year 3, 4 and 6 Comparison

A comparison of cover, number of native species and mean height cover for the tree, shrub and ground layer at each quadrat recorded in Year 3, Year 4 and Year 6 spring is provided in **Figure 3.10**, **Figure 3.11** and **Figure 3.12** respectively. Results varied both spatially (between quadrats) and temporally (between monitoring events). The following overall trends can be observed:

- a reduction in the number of native species in the tree and shrub layer at most sites
- an increase in tree height in the tree layer at all sites
- generally, at each quadrat the native cover scores remained stable and where variations occurred, they were minor
- for native species cover there was an increase in the tree layer at Q3 and Q4; a decrease in the tree layer at Q7; a decrease in the shrub layer at Q7, and a decrease in the ground layer at Q4, Q7 and Q8
- for exotic species cover there was an increase in the shrub layer at Q2 and Q4, a decrease in the ground layer at Q1, and an increase in the ground layer at Q4, Q7 and Q8.

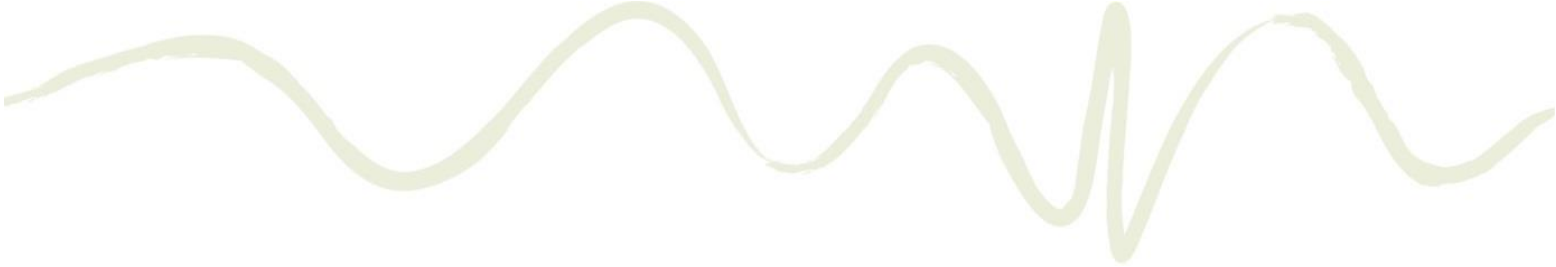
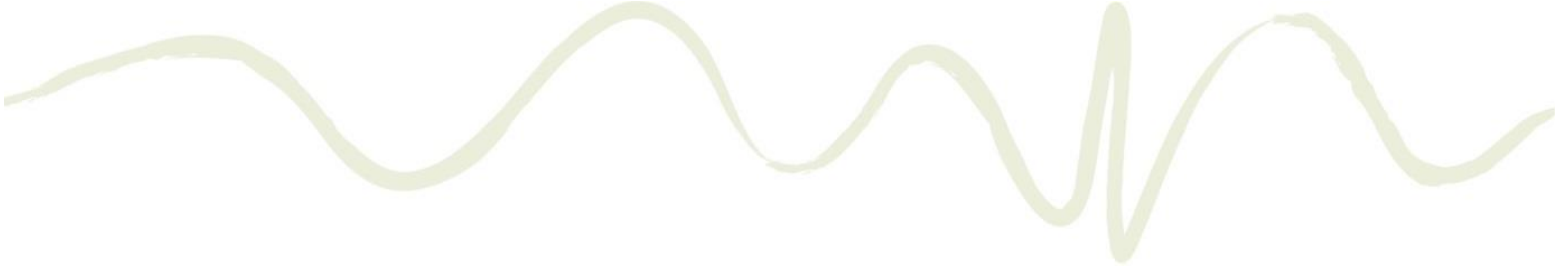


Table 3.7 Summary of Year 6 Spring Vegetation Quadrat Data

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Trees (T1) > 3 m								
Number of native species	2	3	2	4	2	3	2	2
Number of exotic species	0	0	0	0	0	0	0	0
Mean height (m)	7	8	10	8	7	8	7	8
Cover of native species*	6	3	5	4	2	3	2	3
Cover of exotic species*	0	0	0	0	0	0	0	0
Shrubs (T2) < 3 m								
Number of native species	5	7	7	4	4	4	6	3
Number of exotic species	0	1	0	1	0	0	0	0
Mean height (m)	1	2	3	3	3	3	3	3
Cover of native species*	3	3	4	3	2	3	2	2
Cover of exotic species*	0	1	0	1	0	0	0	0
Groundcovers (G)								
Number of native species	21	23	23	6	3	5	6	11
Number of exotic species	8	12	7	5	4	7	4	6
Mean height (m)	0.5	1	0.5	0.5	1.2	1.2	1.2	1.2
Cover of native species*	6	5	5	4	2	3	3	3
Cover of exotic species*	2	3	3	6	6	6	6	6
Condition	Good recovery from fire	Good recovery from fire	Good recovery from fire	Moderate	Poor	Poor	Poor	Poor



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Evidence of recruitment	Low	Low	Good (herbs)	Very low (Due to groundcover)	Very low	Low	Low	Low
Evidence of disturbance (e.g. fire, litter, disease, herbivory)	Y – fire	Y - fire	Y - fire	Y - fire	Y - fire	Y - fire	Y - fire	Y - fire

* modified Braun-Blanquet score

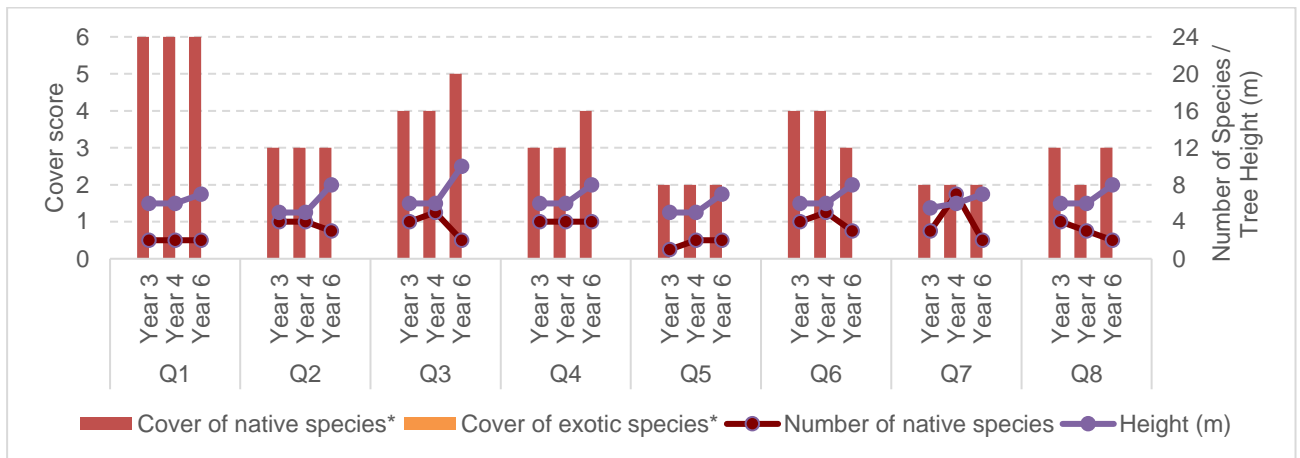


Figure 3.10 Cover of native and exotic species, number of native species and mean height of tree (T1) layer – Year 3, Year 4 and Year 6 monitoring

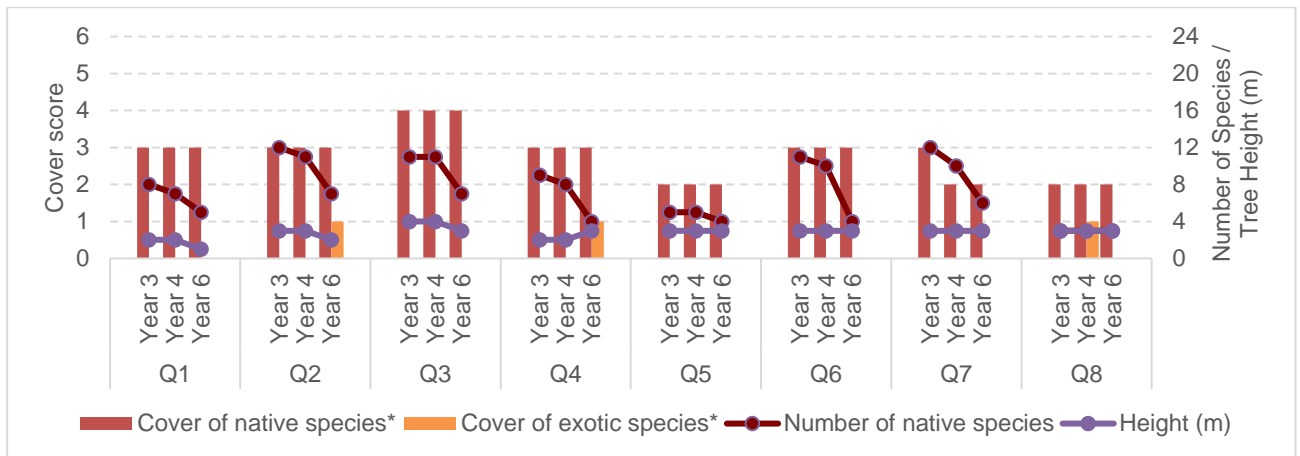


Figure 3.11 Cover of native and exotic species, number of native species and mean height of shrub (T2) layer – Year 3, Year 4 and Year 6 monitoring

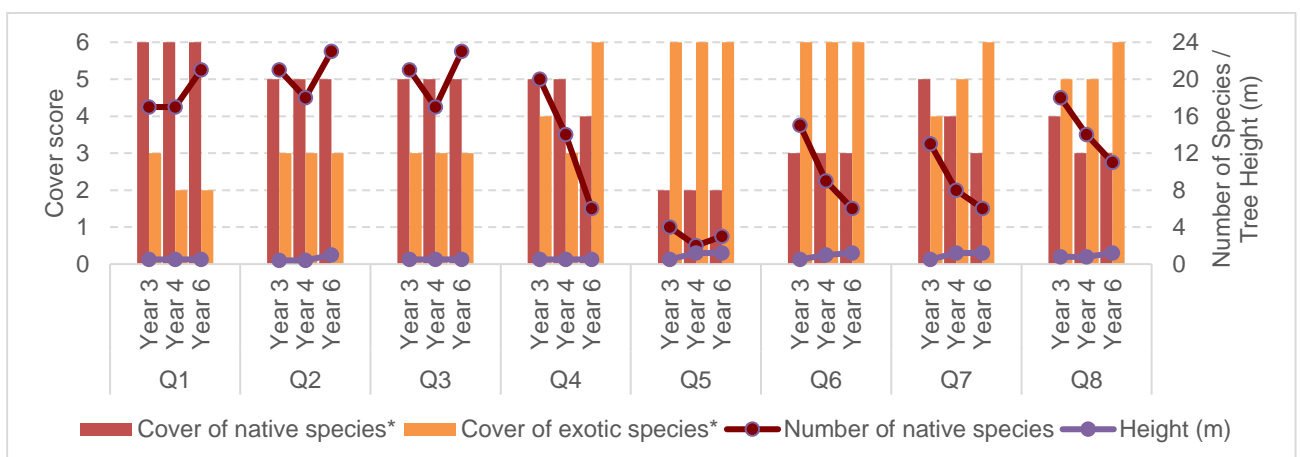


Figure 3.12 Cover of native and exotic species, number of native species and mean height of groundcover (G) layer – Year 3, Year 4 and Year 6 monitoring

*Braun-Blanquet score

3.10 Roadkill Monitoring Results

3.10.1 Year 6

Roadkill monitoring results are provided in **Appendix E** and summarised in **Table 3.8**. A total of 23 roadkills were recorded during surveys or opportunistically, comprising 14 species/ species groups. The most commonly recorded roadkills were birds (9 records), followed by Little Red Flying-foxes (*Pteropus scapulatus*), reptiles (Carpet Python *Morelia spilota*, Lace Monitor) and terrestrial mammals (Northern Brown Bandicoot, Red-necked Wallaby *Macropus rufogriseus*, Short-beaked Echidna), 3 records each. Roadkill numbers were highest in summer (15) and relatively equal in winter (5) and spring (3).

Two threatened species roadkills were confirmed, an opportunistic record of a Greater Glider during winter (26/08/2020) and a Koala during summer (1/12/2020). Both were recorded from the northbound lane at Impact Site 2 where fauna fencing was present, however is not a barrier to the Greater Glider and not of a design specific to Koalas.

Terrestrial mammals are the main fauna group that the fauna fencing at Devils Pulpit provides a barrier for. Of the three terrestrial mammal roadkills recorded, two were located along a section of road with fauna fencing (Northern Brown Bandicoot and Short-beaked Echidna) and the other was located within the Bundjalung rest area in a location without fauna fencing (Red-necked Wallaby). It is unclear how the roadkill terrestrial mammals within the fauna fencing area accessed the roadway.

Table 3.8 Summary of Year 6 Roadkill Monitoring Results

Species	Winter	Spring	Summer	Total	In Area with Fauna Fencing	In Area without Fauna Fencing
Amphibians	-	-	3	3	3	-
Arboreal mammals *	1 (1)	-	1	2	2	-
Birds *	3 (1)	-	6	9	9	-
Little Red Flying-foxes *	-	1 (1)	2	3	2	1
Reptiles	-	1	2	3	3	-
Terrestrial mammals	1	1	1	3	2	1
All species	5	3	15	23	21	2

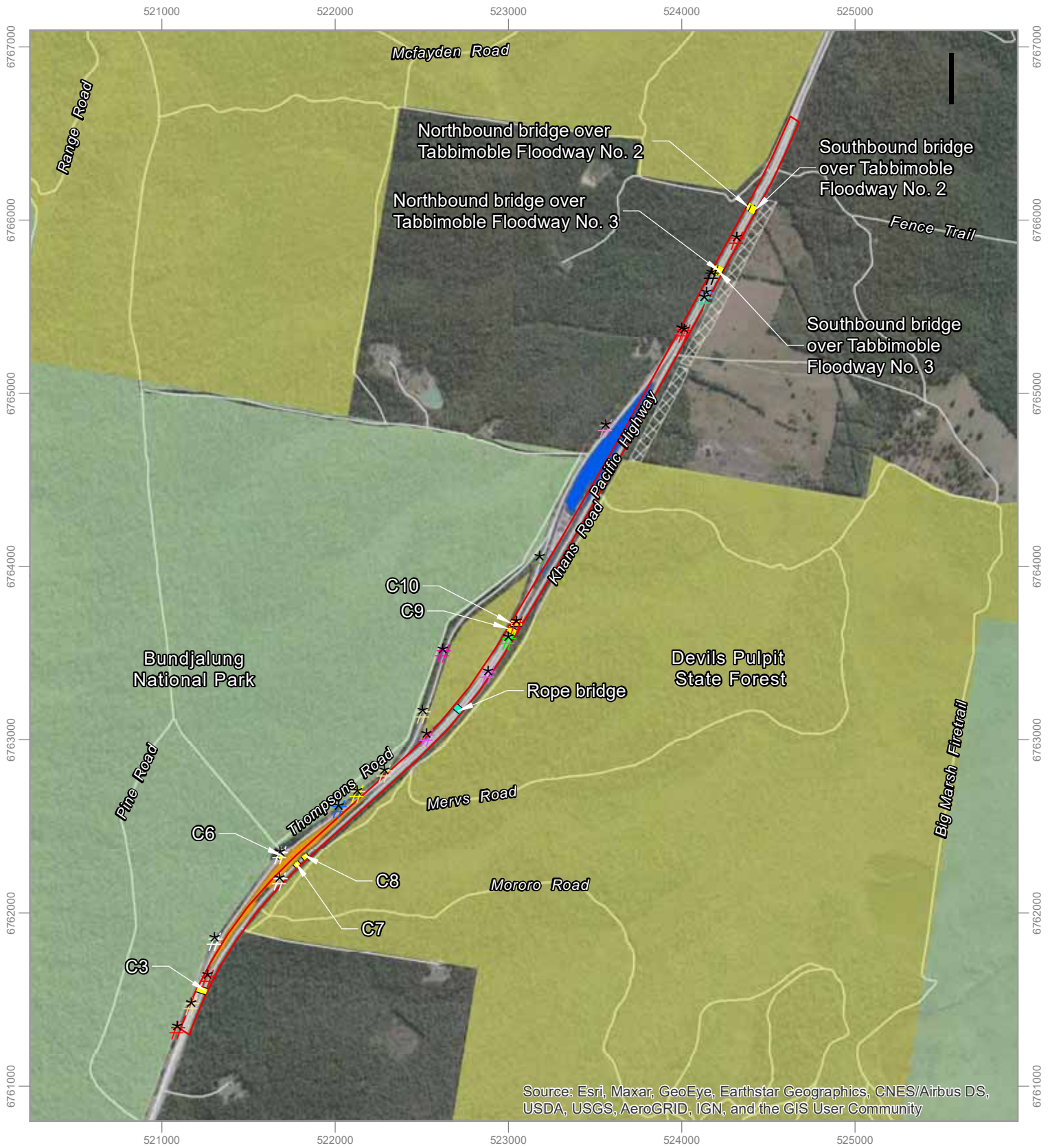
* Numbers in brackets are the portion of the records that were opportunistic; recorded outside of spring, winter, or summer survey dates.

3.10.2 Year 3, 4 and 6 Comparison

Due to the limited roadkill survey effort and low numbers of roadkills recorded during the post construction monitoring, it is not possible to describe trends in roadkill records at the site over time or the effectiveness of the fauna fencing. This is despite the fauna fencing being substantially upgraded between Year 4 and Year 6. This is demonstrated in **Table 3.9** which provides a summary of terrestrial mammal records each year of post construction monitoring and the presence of fauna fencing at each roadkill site.

Table 3.9 Terrestrial Mammal Roadkill Results During Year 3, Year 4 and Year 6 monitoring

<i>Fauna Fencing</i>	<i>Year 3</i>	<i>Year 4</i>	<i>Year 6</i>
Present	0	0	2
Absent	4	10	1
Total	4	10	3



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

GDA 1994 MGA Zone 56

LEGEND

- Devil's Pulpit concept clearing limit
- State forest
- National park reserve
- Northern median
- Southern median
- Vegetated connectivity corridor
- Combined fauna underpass
- Rope bridge

- Roadkill**
- * Cane Toad
 - * Carpet Python
 - # Crow
 - * Dove
 - * Greater Glider
 - * Koala
 - * Kookaburra

- * Lace Monitor
- * Little Red Flying-fox
- * Magpie
- * Northern Bandicoot
- * Red-necked Wallaby
- * Short-beaked Echidna
- * Unidentifiable Bird



Road Kill Monitoring Results - Illustration 3.2



Third (Final) Annual Report for Post Construction Year 3, 4 and 6 Ecological Monitoring
 Devils Pulpit Pacific Highway Upgrade
 2885-1058

Information shown is for illustrative purposes only
 Drawn by: AB Checked by: RE Reviewed by: DSA
 Source of base data: ERSI World Imagery
 Date: 22/04/2021

4. Discussion

4.1 Target Threatened Species

The following target threatened species were recorded during the Year 6 monitoring reporting period:

- Green-thighed Frog
- Wallum Froglet
- Yellow-bellied Glider
- Squirrel Glider
- Brush-tailed Phascogale
- Koala
- Long-nosed Potoroo
- Greater Glider.

The Rufous Bettong and Spotted-tailed Quoll were target species not recorded which is discussed further in **Sections 4.1.1** and **4.1.10** respectively.

Two non-target threatened species were opportunistically recorded during Year 6 monitoring: Masked Owl and Powerful Owl (BC Act listed). Both species were assessed in the Project EA (Hyder 2011).


Tentative possible native mouse (*Pseudomys sp.*) records were observed again this year during RB/ BTP camera trap image analysis. The *Pseudomys* genus includes several threatened species. It is plausible that some of the tentative records would be of animals from the *Rattus* or *Melomys* genus, especially where records are irregular and not consecutive between years. Possible (*Pseudomys sp.*) have been recorded each year at Impact Site 3 (west). Target Elliott A trapping at this site would be required for the species identification to be confirmed.

4.1.1 Rufous Bettong

The Rufous Bettong was not recorded during Year 6 monitoring, nor during Year 4 monitoring. Images of the possible RB/ BTP records from Year 3 were subsequently reviewed against the larger image dataset gathered for the Project and it was confirmed that they were not of Rufous Bettong (one was a probable juvenile Red-necked Pademelon and the other a probable Long-nosed Potoroo). With this amendment, no Rufous Bettongs have been recorded during the post construction monitoring.

Project EA surveys (Hyder 2011) did not record the Rufous Bettong and the species was only an unconfirmed record during baseline monitoring (GeoLINK 2012a). The results collectively indicate that a resident Rufous Bettong population does not occur in the study area.

The potential suitability of the fauna underpass structures at Devils Pulpit for the Rufous Bettong is unclear. Sandpiper (2017) recorded numerous Rufous Bettong crossings at a comparable sized fauna underpass structure at Glenugie, although with natural material on the floor. AMBS (2001, cited in Bond and Jones 2013) reported bettongs (species not defined) using structures at least 52 m in length. In relation to other medium sized mammals known to occur within the study area, Northern Brown and Long-nosed Bandicoots were recorded using the underpass structures (both culvert and bridge structures), whereas Long-nosed Potoroos and Red-necked Pademelons were not (noting that the abundance of bandicoots in the study area is significantly higher than potoroos and pademelons; refer to **Section 3.2**). The limited fauna fencing along the highway during Years 3 to 4 may have



contributed to this result, although fauna fencing suitable as a barrier/ funnel for terrestrial mammals was functional along large portions of the site in Year 6.

4.1.2 Wallum Froglet

There is insufficient data to discuss changes in Wallum Froglet habitat use with relevance to the Project. It has been recorded at a very low frequency (25 % of surveys) and limited distribution (two sites: Impact Site 5 (east) in Year 6 and Control Site 3 in Year 3) during post construction monitoring. All records are located on the eastern side of the highway, despite similar habitat occurring on both sides of the highway. The Wallum Froglet was not recorded during the baseline (pre-construction) monitoring (GeoLINK 2012) or during surveys associated with the EIS.

There are numerous occurrences of Wallum Froglet populations in habitat adjacent to roads. The record of this species adjacent to the highway during Year 6 post construction indicates the habitat suitability of the study area has not been compromised by the Project. The EMP has not been designed to assess connectivity impacts on the Wallum Froglet or the effectiveness of the frog fencing or fauna underpass structures for this species.

The Year 6 Wallum Froglet records were located within a vegetated connectivity corridor. The regeneration of this area from former grazing land as part of the Project offset is beneficial for this species.

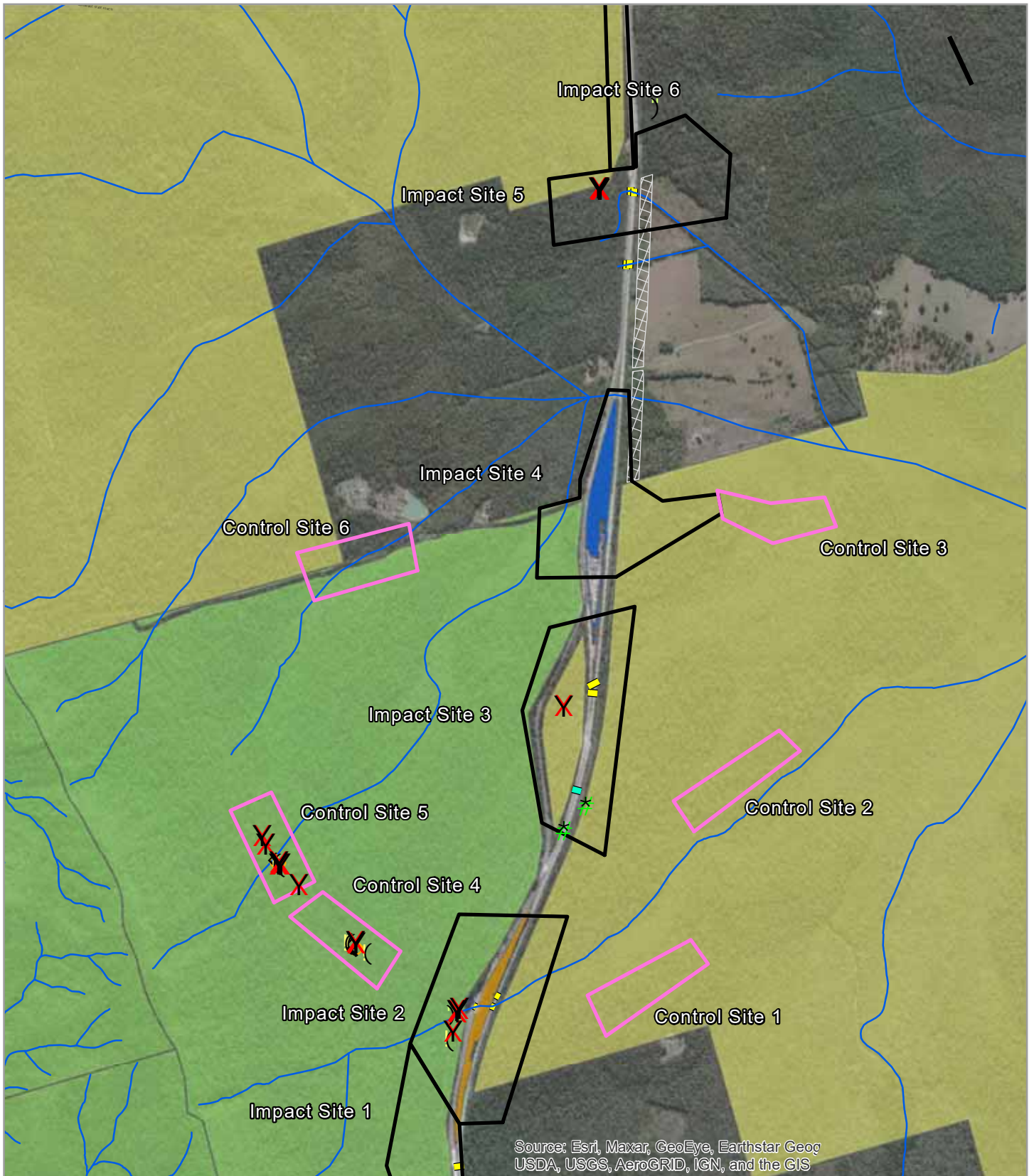
4.1.3 Green-thighed Frog

There is insufficient data to discuss changes in Green-thighed Frog habitat use and whether it is attributed to the highway upgrade. This is due to limited pre-construction records and no post-construction records on the eastern side of the highway; and made complex by the species' cryptic nature (Lemckert et al., 2006).

The post construction monitoring has frequently recorded Green-thighed Frog activity at three monitoring sites (33 % of sites, recorded from at least one of these sites during 67 % of surveys), with the known distribution increasing in Year 6 to two additional sites, all located on the western side of the highway (refer to **Illustration 4.1**). Although not demonstrated through the EMP, it is likely that a Green-thighed Frog subpopulation located on the eastern side of the highway would persist post construction based on:

- the presence of suitable habitat
- the diversity of other frog species recorded pre and post construction.

The EMP has not been designed to assess connectivity impacts on the Green-thighed Frog or the effectiveness of the frog fencing or fauna underpass structures for this species.



GDA 1994 MGA Zone 56

LEGEND

- Control site
- Impact site
- State Forest
- National Park reserve
- Northern median
- Southern median
- Vegetated connectivity corridor
- Rope bridge
- Combined fauna underpass
- Watercourse

Green-thighed Frog

- # 2012 - Construction
-) 2012 - Pre-construction
- (Year 3
-) Year 4
- X Year 6



Green-thighed Frog Study Area Distribution Mapping - Illustration 4.1

4.1.4 Yellow-bellied Glider

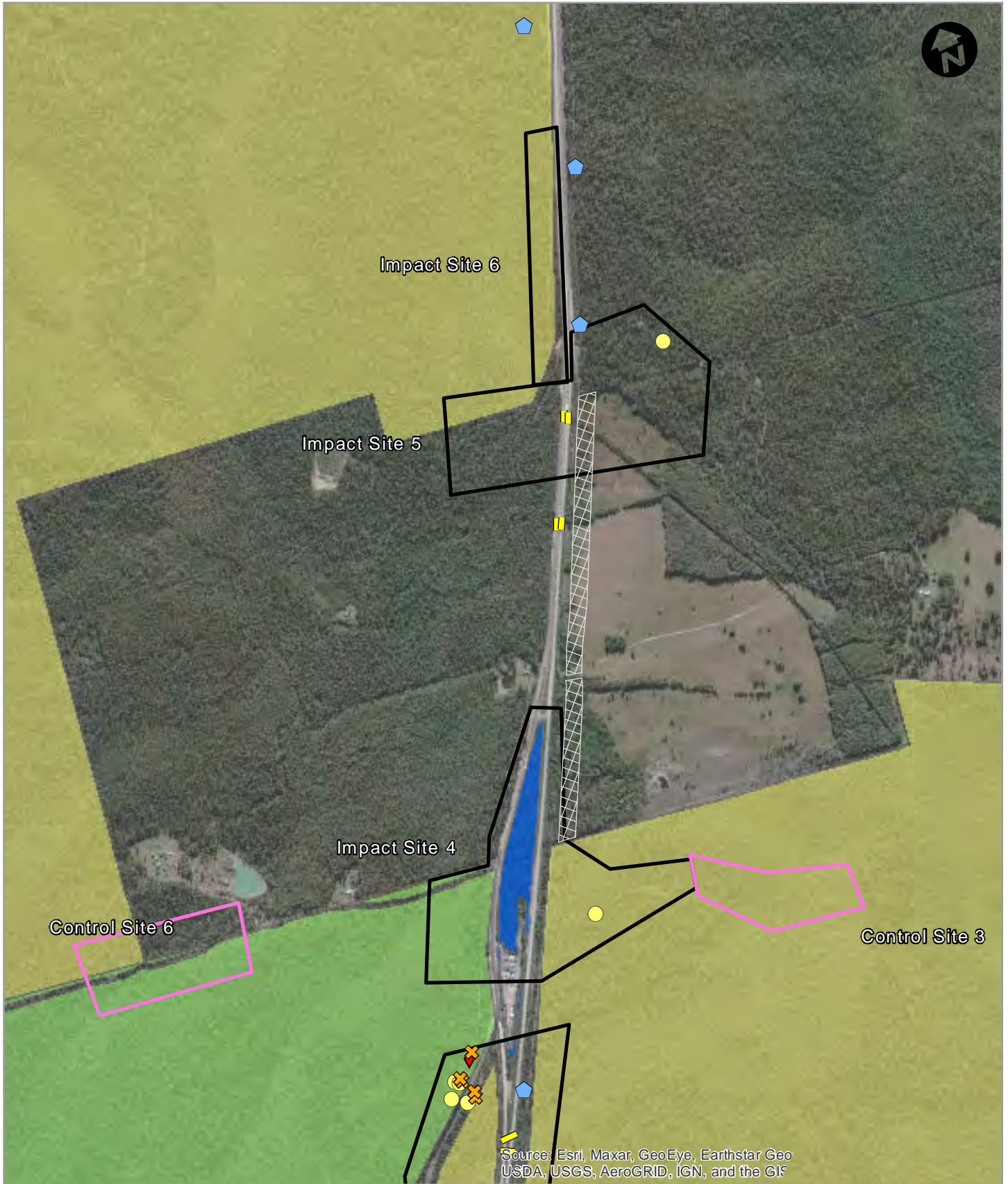
There is insufficient baseline/ pre-construction data to determine if there has been a change in Yellow-bellied Glider habitat use as a result of the Project. Post construction monitoring has however recorded the Yellow-bellied Glider at the same locations where the species was recorded pre/ during construction (Hyder 2011; GeoLINK 2012a; GeoLINK 2012b) as well as additional sites (refer to **Illustration 4.2**), demonstrating continued occupation of the study area post construction.

Yellow-bellied Glider activity levels and the number of occupied sites reduced at both impact and control sites in Year 6 compared to the Years 3 and 4 post construction monitoring. Similar trends have been observed over the same period during Yellow-bellied Glider monitoring on other regional highway monitoring projects (i.e. W2B Pacific Highway upgrade and Warrell Creek to Nambucca Heads Pacific Highway upgrade; Sandpiper 2020a). The 2019/ 2020 drought and 2019 bushfire are likely to have impacted the local Yellow-bellied Glider population through population declines or shifts in distribution, which have been recorded during other studies (Goldingay and Kavanagh 1991; Lunney 1987 in NPWS 2003).

No Yellow-bellied Glider rope bridge visits were recorded during the Year 6 monitoring and records in proximity of the rope bridge were limited to a single record on the western side of the highway during this period. During the five years of rope bridge camera monitoring undertaken at Devils Pulpit (GeoLINK 2018, 2019; Sandpiper 2016b), only a single Yellow-bellied Glider rope bridge visit has been recorded (Year 4; eastern side). While a complete crossing was not confirmed, this record was significant as it is the first known record of the species on a rope bridge. The Yellow-bellied Glider has previously been recorded on glider poles (Goldingay *et al.* 2018; Taylor and Rohweder 2020) with one study observing repeated pole use and detecting highway crossings on three occasions (Taylor and Rohweder 2020).

The Yellow-bellied Glider has not been recorded within either vegetated median during the post construction monitoring, although has been recorded on both sides of the southern median each year. Records in proximity to the northern median have been limited to a single record east of the highway during Year 3 and suggesting this area is not within a family groups' core territory. Calculations from a 2019 (post W2B clearing; before post bushfire hazardous tree removal) glide crossing assessment indicated that Yellow-bellied Glider should be able to cross the highway at both medians in both directions, although an above average glide performance would be required to cross east-west over the southbound lane at the northern median (GeoLINK 2019). The Taylor and Rohweder (2020) highway Yellow-bellied Glider pole crossing records suggest that traffic may not inhibit glider movement across the highway at the medians.

Although not demonstrated, it is likely that the Yellow-bellied Glider can move across the highway at Devils Pulpit via the vegetated medians and that these provide better potential crossing opportunities for this species than the rope bridge. The Yellow-bellied Glider has recently been recorded in a vegetated median along the Pacific Highway at Wells Crossing (Simon Wilson, Transport for NSW pers. comms. 3/08/2021), supporting this suggestion. Future projects should consider different approaches to record Yellow-bellied Glider highway crossings such as radio/GPS tracking or baited camera traps within medians.

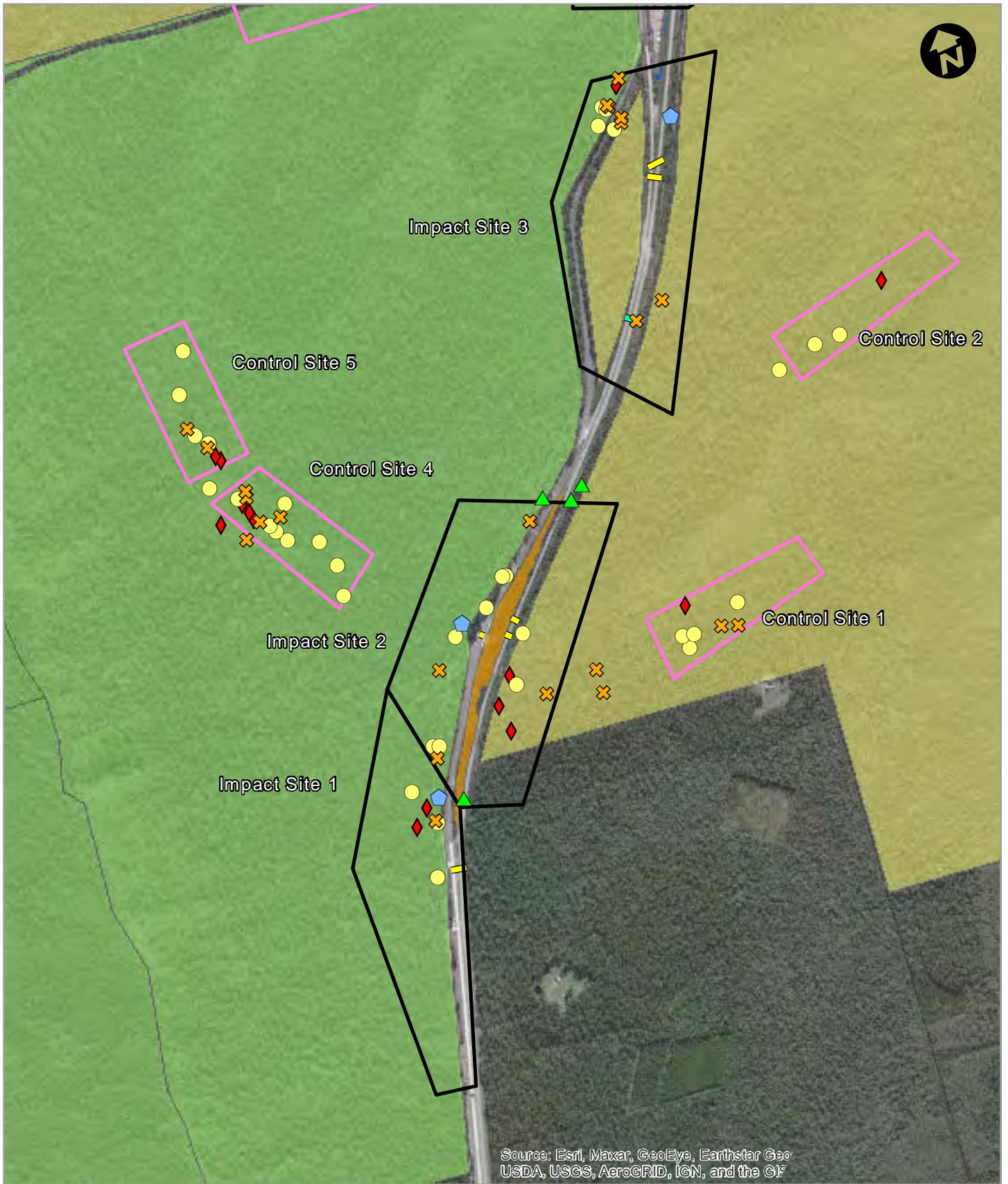


LEGEND

- | | | | |
|-----------------------|---------------------------------|------------------------------|--------|
| Control site | Northern median | Yellow-bellied Glider | Year 4 |
| Impact site | Vegetated connectivity corridor | 2011 - Hyder EIS | Year 6 |
| State Forest | Combined fauna underpass | Year 3 | |
| National Park reserve | | | |

0 400 Metres

**Yellow-bellied Glider Study Area Distribution Mapping
Illustration 4.2 - Sheet 1 of 2**



LEGEND

- | | | | |
|-----------------------|--------------------------|-----------------------|--------|
| Control site | Northern median | Yellow-bellied Glider | Year 3 |
| Impact site | Southern median | 2011 - Hyder EIS | Year 4 |
| State Forest | Rope bridge | 2012 - Construction | Year 6 |
| National Park reserve | Combined fauna underpass | | |



Yellow-bellied Glider Study Area Distribution Mapping
Illustration 4.2 - Sheet 2 of 2

4.1.5 Squirrel Glider

The Squirrel Glider was recorded by spotlighting, rope bridge monitoring and nest box monitoring during the Year 6 reporting period at:

- Eleven (61 %) of the spotlighting transect sites. Activity levels were higher at impact sites in Year 6 compared to Years 3 and 4; and lower at control sites in Year 6 compared to Year 4, although the same as Year 3 activity levels at control sites.
- Seven (approximately 61 %) of the remaining nest box transects.
- Both sides of the rope bridge with directional movement recorded at both ends; five potential complete crossings were recorded.

Similar observations of increased activity levels at impact sites have been recorded over a comparable period for the W2B project (Sandpiper 2020a).


There is insufficient baseline/ pre-construction data to determine if there has been a change in Squirrel Glider habitat use as a result of the Devil Pulpit project. However the Squirrel Glider has been recorded at all target impact sites (four sites) and control sites (four sites) during the post construction monitoring, which replicates the locations that Squirrel Gliders were recorded during preconstruction surveys (Hyder 2011 and GeoLINK 2012a) (refer to **Illustration 4.3**). These results indicate that resident Squirrel Glider groups continue to occupy both sides of the highway at these sites.

Visitation rates by Squirrel Gliders to the rope bridge have overall been relatively consistent during Years 3, 4 and 6 post construction monitoring (average 0.41 visits/week) and higher than the rates recorded during the initial trial monitoring (0.02 visits/week; Sandpiper 2016a). Similar temporal increases in visitation rates have been observed on other projects (e.g. Sandpiper 2020a; Soanes 2015). Sandpiper (2020a) suggested that this trend may be associated with a lag in resident gliders' discovery and familiarity with the crossing structure. The overall EMP visitation rate is also higher than visitation rates recorded during rope bridge monitoring at the Glenugie Pacific Highway upgrade site (mode: 0.21 visits per week; Sandpiper 2017).

Some recent studies have classified visitation and crossing rates differently (e.g. Golding *et al.*, 2018; Soanes *et al.*, 2015; Sandpiper 2020a). This report has presented the findings in a way that enable the results to be expressed differently to enable comparisons to these studies or future projects.

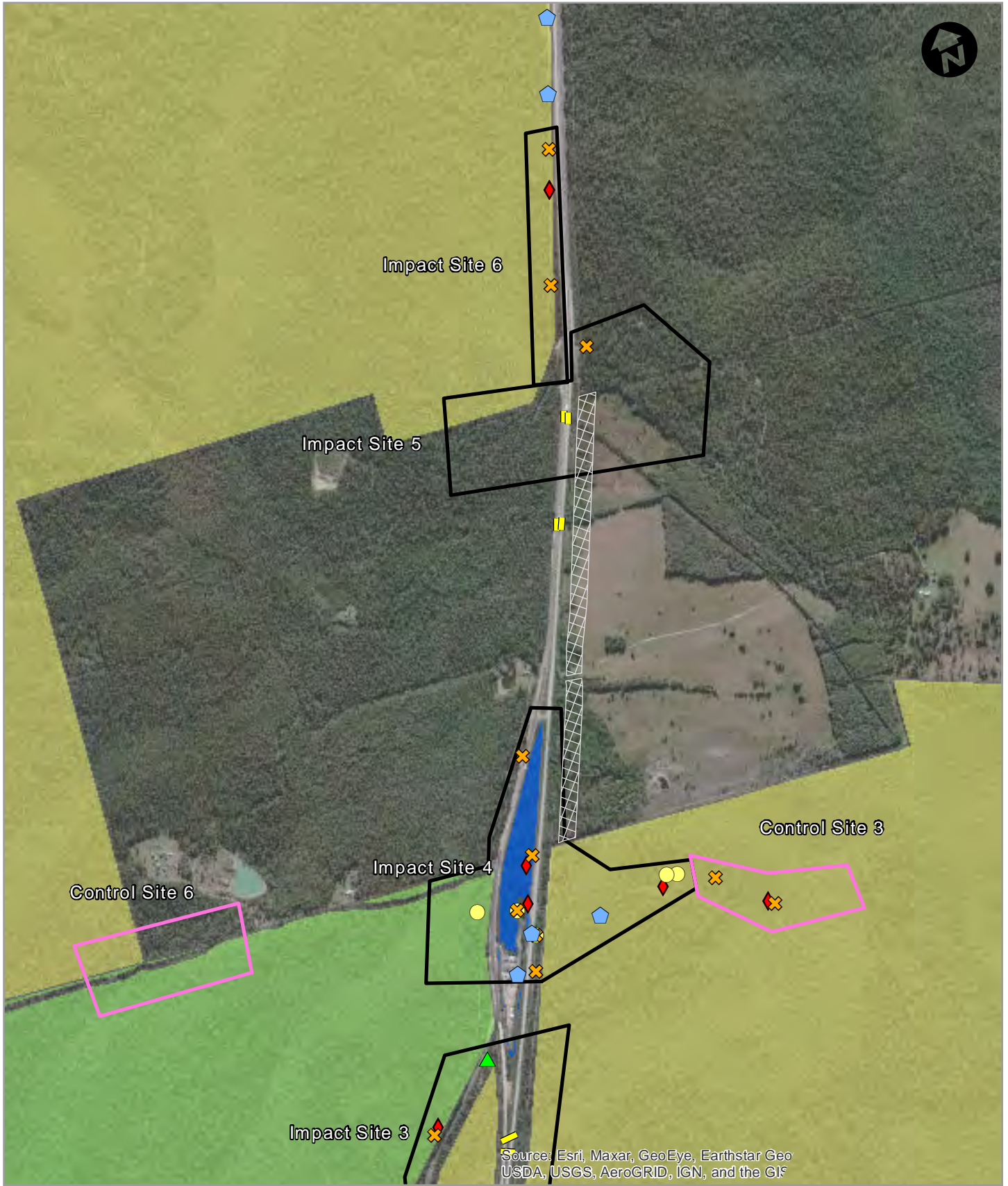
The Squirrel Glider has been recorded within and on both sides of the highway at the northern and southern median. The Squirrel Glider radio tracking in Year 5 (GeoLINK 2021) demonstrate that both male and female Squirrel Gliders were able to cross the northbound lane of the Pacific Highway at both medians at the Devils Pulpit site under no night traffic conditions. No crossings of the southbound lane were recorded, therefore the maintenance of Squirrel Glider movement across this newly constructed lane has not been demonstrated. It is expected that Squirrel Gliders could cross both the northbound and southbound lanes of the Pacific Highway at the vegetated medians when both lanes are open to traffic (GeoLINK 2021).

The Squirrel Glider radio tracking recorded frequency of glider movement across the northbound lane into the median was greater than Squirrel Glider visits to the rope bridge. This suggests that the vegetated medians provide greater opportunities for Squirrel Glider movement across the highway at Devils Pulpit. Part of the reason for this could be that there are many more crossing opportunities when numerous potential launch trees are available compared to a singular location when artificial crossing structures are used. However, given accumulating evidence of the use of arboreal crossing structures by the Squirrel Glider and other gliding species (e.g. Ball and Goldingay 2008; Soanes *et al.*



2015, 2018; Goldingay et al. 2018), the use of rope bridges and gliding poles is warranted where clearing gaps exceed gliding ability.

Numerous studies have looked at Squirrel Glider use of vegetated medians, rope bridges and poles to cross roads (e.g. Soanes et al. 2014; Soanes et al. 2015; Taylor and Goldingay 2013). The frequency of use of these crossing structures varies depending on specific site conditions and glider home range configurations. The objective of any glider crossing structure and target frequency of fauna movement should be considered when determining the appropriate glider connectivity structure for a particular site. Site topography, maintenance requirements and clearing impacts should also be considered.



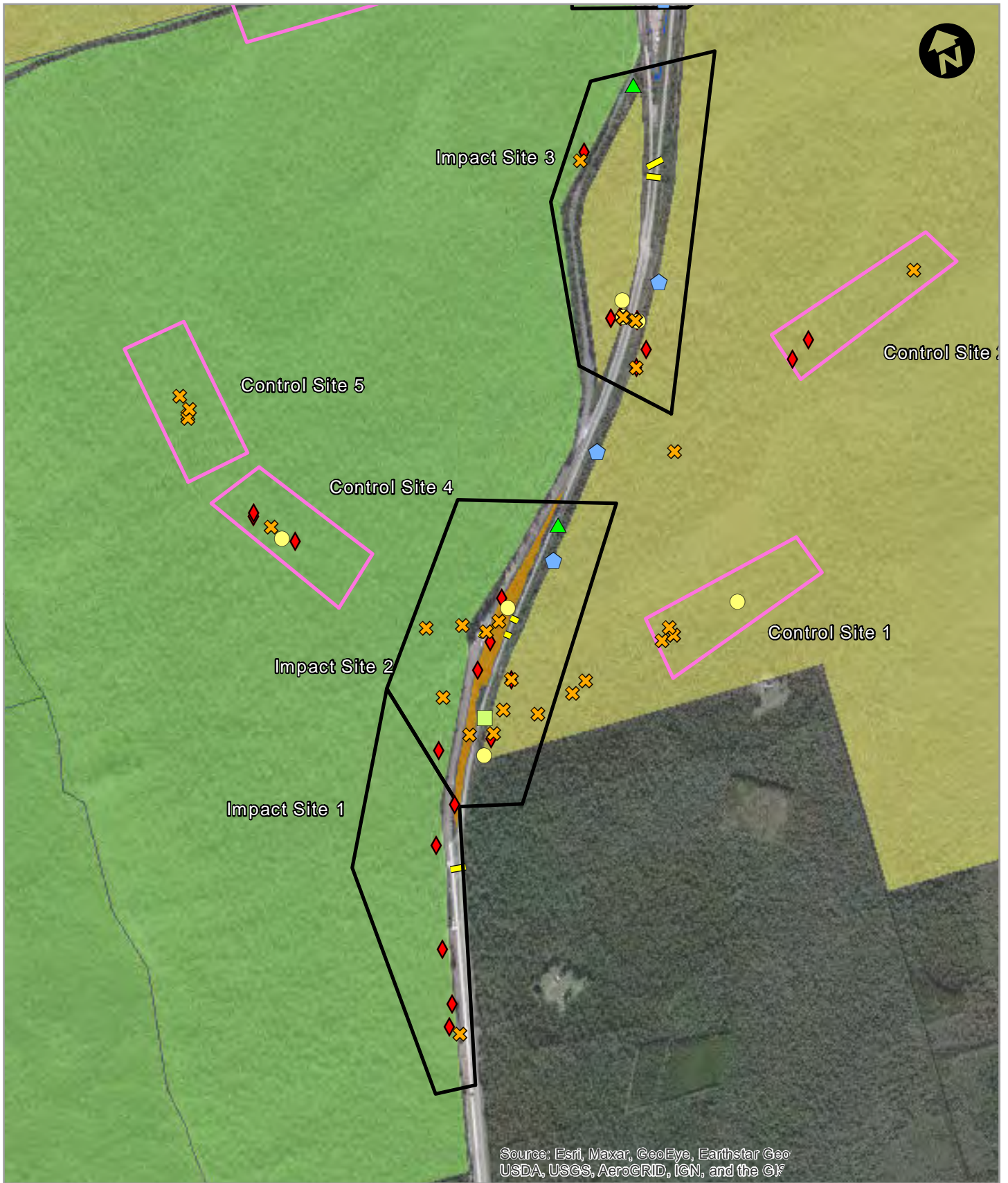
Source: Esri, Maxar, GeoEye, Earthstar Geo
 USDA, USGS, AeroGRID, IGN, and the GfK

LEGEND

- | | | | |
|-----------------------|---------------------------------|------------------------|--------|
| Control site | Northern median | Squirrel Glider | Year 3 |
| Impact site | Vegetated connectivity corridor | 2011 - Hyder EIS | Year 4 |
| State Forest | Combined fauna underpass | 2012 - Construction | Year 6 |
| National Park reserve | | | |



**Squirrel Glider Study Area Distribution Mapping
 Illustration 4.3 - Sheet 1 of 2**



Source: Esri, Maxar, GeoEye, Earthstar Geo
 USDA, USGS, AeroGRID, IGN, and the GfK

LEGEND

- | | | | |
|-----------------------|--------------------------|-------------------------|--------|
| Control site | Northern median | Squirrel Glider | Year 3 |
| Impact site | Southern median | 2011 - Hyder EIS | Year 4 |
| State Forest | Rope bridge | 2012 - Construction | Year 6 |
| National Park reserve | Combined fauna underpass | 2012 - Pre-construction | |



Squirrel Glider Study Area Distribution Mapping
 Illustration 4.3 - Sheet 2 of 2

4.1.6 Brush-tailed Phascogale

The Brush-tailed Phascogale was recorded by camera traps at six (40 %) of the RB/ BTP camera trap grid sites and on the eastern rope bridge camera on two occasions during Year 6. The number of sites where the Brush-tailed Phascogale was recorded in Year 6 is lower and has shifted in terms of distribution when compared to the Years 3 and 4 results (refer to **Illustration 4.4**). Overall activity levels have also decreased over the post construction monitoring period. Mansfield *et al.* 2017 found that '*phascogale abundance is highly spatially and temporally variable, most likely as a response to heterogeneity in habitat and foraging resources operating at a range of spatial scales*'. The 2019/ 2020 drought and bushfire are likely to be the primary factors contributing to the observed Brush-tailed Phascogale distribution and abundance changes during the post construction monitoring.

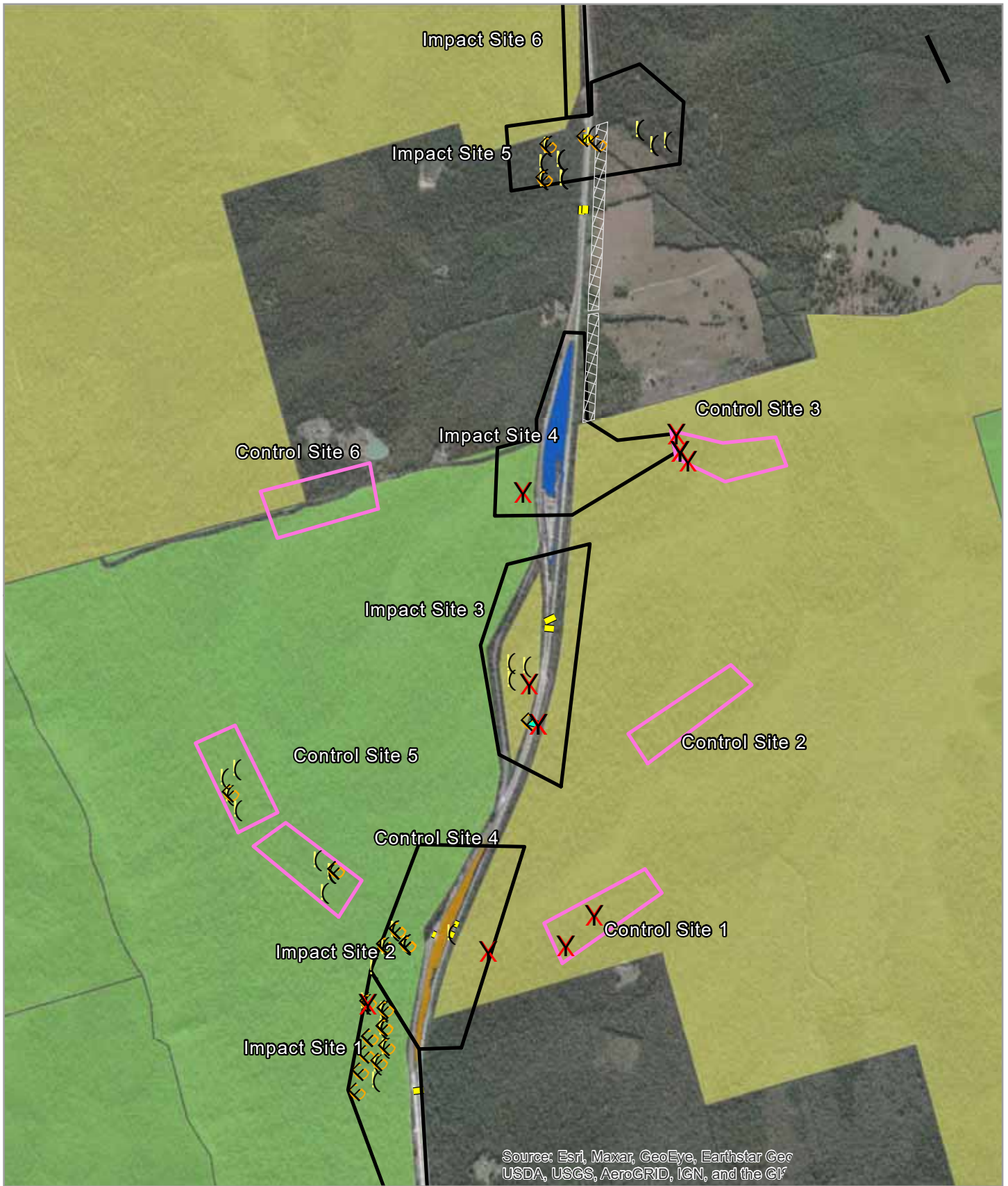
Pre/ during construction surveys (Hyder 2011; GeoLINK 2012a; GeoLINK 2012b) did not record any Brush-tailed Phascogales. Therefore, distribution and abundance comparisons cannot be made pre/ post construction, nor any statements regarding the impacts of the Devils Pulpit project.

Brush-tailed Phascogale visitation at the rope bridge has only been recorded on three occasions during the five years of rope bridge camera monitoring undertaken at Devils Pulpit (GeoLINK 2018, 2019; Sandpiper 2016a). No complete crossings have been recorded, with two of the three records being return visits and the other being a directional crossing movement with no camera record on the other side of the rope bridge. Similar observations have been recorded during previous studies (Soanes *et al.*, 2015; Sandpiper 2017), which also failed to record images of directional movement on both ends of the rope bridge to confirm a complete crossing.

No underpass crossings were recorded during the post construction monitoring, despite the species being recorded using similar structures on other highway upgrade projects (e.g. Sandpiper 2017; Niche 2020). In relation to the fauna underpass structures, the Year 6 Brush-tailed Phascogale records were located:

- Within 500 m on the western side of the highway at C9 and 10.
- Within 500 m on the eastern side of the highway at C6, C7 and C8.
- Not within 500 m of C3, SBT2, NBT2, SBT3, NBT3.

During Years 3 and 4, fauna fencing in the study area was limited and not of a design that would create a barrier/ funnel for the highly agile Brush-tailed Phascogale. Large sections of Brush-tailed Phascogale designed fauna fencing was in place during Year 6, however reduced activity levels (an indicator of relative abundance) was observed during this period. These factors along with camera trap limitations are overall likely to have reduce the ability of the EMP to record Brush-tailed Phascogale activity at the underpasses.



LEGEND

- Control site
- Impact site
- State Forest
- National Park reserve

- Northern median
- Southern median
- Vegetated connectivity corridor

- Rope bridge
- Combined fauna underpass

Brush-tailed Phascogale

- C Year 3
- G Year 4
- X Year 6



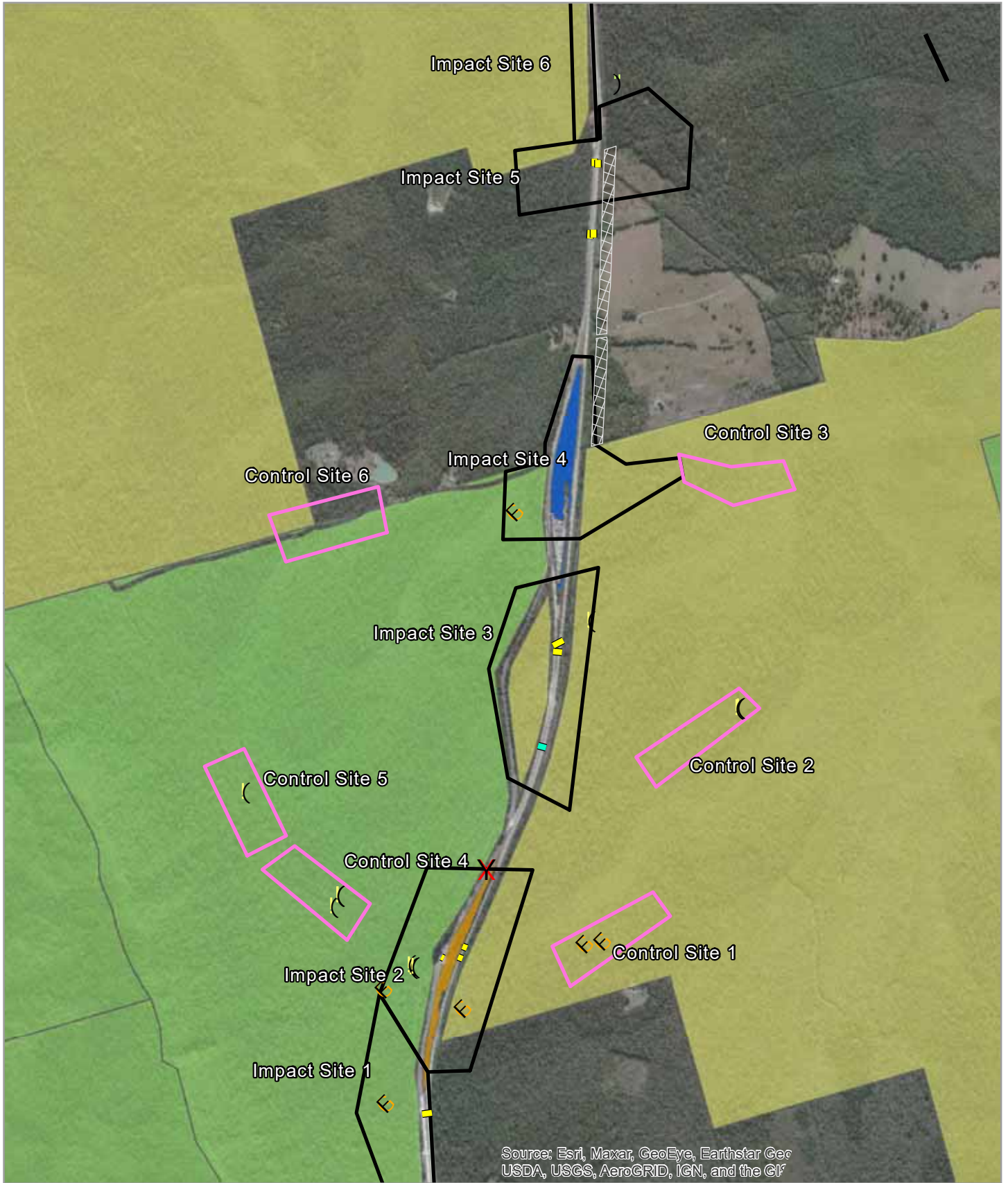
Brush-tailed Phascogale Study Area Distribution Mapping - Illustration 4.4

4.1.7 Koala

The only Koala record during Year 6 was a roadkill on the northbound lane at Impact Site 2 during summer. The record is located in the vicinity of the previous post construction records associated with Bundjalung National Park (refer to **Illustration 4.5**). Fauna fencing was present in this area, along with a fauna/ Koala grid at the Pine Road entrance, however, is not of a design specific to Koalas. It is unclear how the Koala entered the roadway, although potential options include climbing the fence and going around the end of the fence at the Bundjalung rest area. Transport/ Pacific Complete (W2B principal contractor) were notified of the roadkill and conducted a fauna fence inspection as a contingency response (in accordance with Section 10 of the EMP).

The post construction monitoring results are indicative of a low density Koala population in the study area. Koala surveys undertaken as part of W2B project in the general locality recorded similar findings (RMS 2016; GeoLINK unpublished). No Koala underpass or rope bridge crossings were recorded. This is not unexpected given the low density of records and limited fauna fencing (Years 3 and 4) or Koala fencing (Year 6) along the Project site to direct Koalas moving east or west across the study area to underpass structures.

There are insufficient records to determine pre/ post construction changes to Koala activity within the study area and attribute any changes to the Devils Pulpit project. The Koala roadkill demonstrates that the roadkill risk remains within the study area for the Koala and that fauna fencing should be holistic and specific to the target fauna.



LEGEND

- Control site
- Impact site
- State Forest
- National Park reserve

- Northern median
- Southern median
- Vegetated connectivity corridor

- Rope bridge
- Combined fauna underpass

Koala

-) 2012 - Pre-construction
- (Year 3
- ⚡ Year 4
- ✗ Year 6



Koala Study Area Distribution Mapping - Illustration 4.5

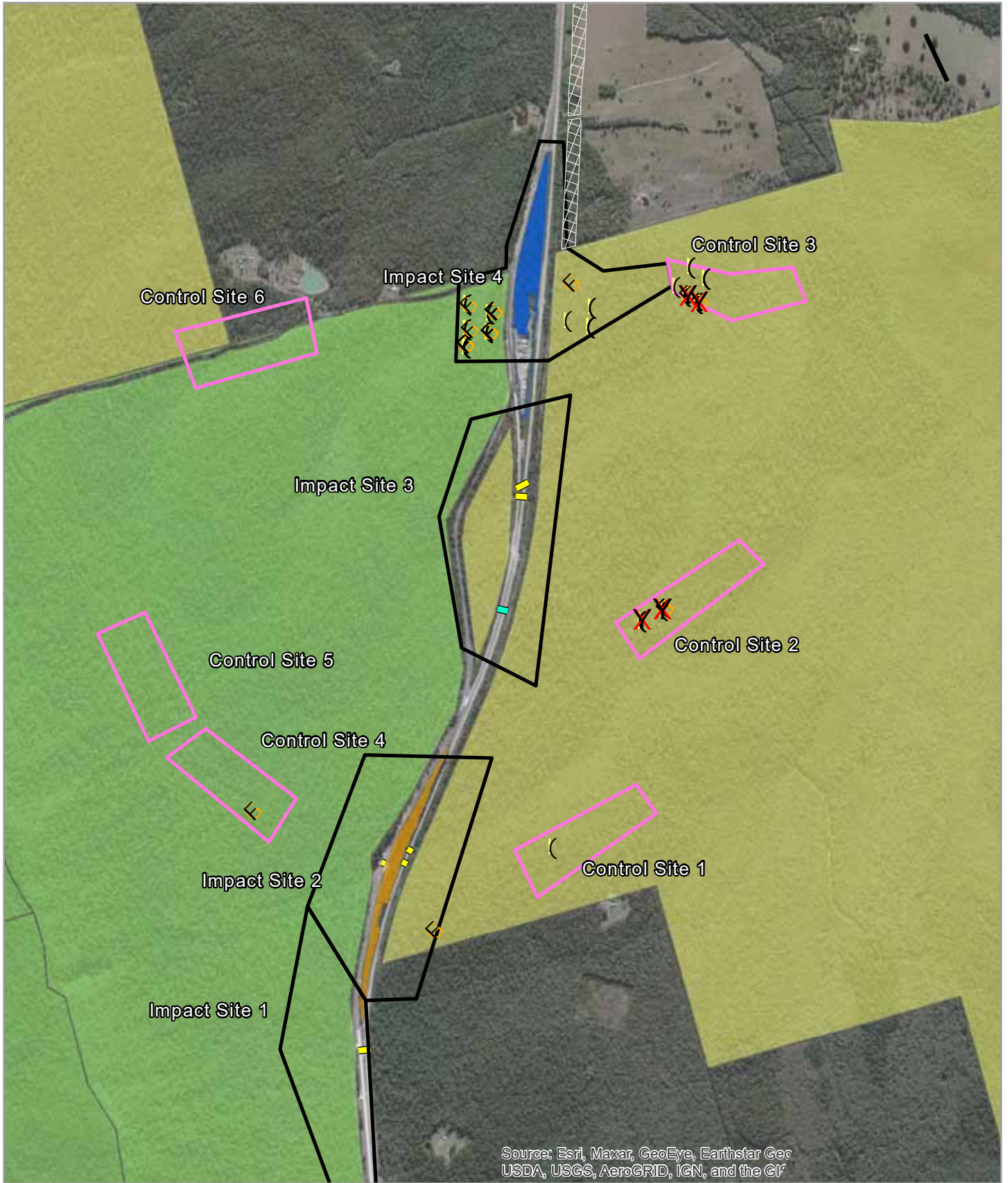
4.1.8 Long-nosed Potoroo

Pre/ during construction surveys (Hyder 2011; GeoLINK 2012a; GeoLINK 2012b) did not record any Long-nosed Potoroos. Therefore, distribution and abundance comparisons cannot be made pre/ post construction, nor any statements regarding the impacts of the Devils Pulpit project.

The Long-nosed Potoroo was recorded by camera traps at two (13%) of the RB/ BTP camera trap grid sites during Year 6, comprising two (40%) of the five control grid sites and none of the 10 impact sites. Overall activity levels and distribution reduced in Year 6 compared to Years 3 and 4 and there were no Long-nosed Potoroo records on the western side of the highway. This decline is attributed to the 2019 bushfire and similar declines have been observed during other studies post fire (Catling et al. 2001; cited in DEPI 2013).

No Long-nosed Potoroo activity was recorded at any of the underpass crossing structures during Year 6 or the entire EMP. In Year 6, this was not unexpected given the absence of Long-nosed Potoroos records in proximity to the underpass structures (all records were >500 m east of the highway). During Years 3 and 4, Long-nosed Potoroo activity primarily occurred in locations without fauna underpass structures and there was limited fauna fencing along the Project site at the time to direct Long-nosed Potoroos to the underpass structures (GeoLINK 2019).

The potential suitability of the fauna underpass structures at Devils Pulpit for the Long-nosed Potoroo is unclear. Lewis (2015) recorded one adult Long-nosed Potoroo using a comparable sized culvert (2.4 m width x 1.8 m high and 31 m long) as part of the Tungan Bypass project. The record was made after culvert modifications were made (i.e. mulch layer, increased shelter logs and the creation of a dirt bund to direct water flows away from the culvert inlet). AMBS (2002, cited in Bond and Jones, 2013) reported Long-nosed Potoroos using 3 m x 3 m underpass structures 40 to 52 m long as part of the Bulahdelah to Coolongolook highway upgrade monitoring. Long-nosed Potoroo underpass activity was also recorded as part of the Coopernook to Herons Creek highway upgrade monitoring (Sandpiper 2015; cited in Sandpiper 2020). In relation to other medium sized mammals known to occur within the study area, Northern Brown and Long-nosed Bandicoots were recorded using the underpass structures (both culvert and bridge structures), whereas Red-necked Pademelons were not, although this is not unexpected given that the abundance of the latter species was substantially lower than bandicoots in the study area (refer to Section 3.2). Overall, it is plausible that underpass structures at Devils Pulpit are suitable for Long-nosed Potoroo use, however this has not been demonstrated during the EMP.



LEGEND

- | | | | |
|-----------------------|---------------------------------|--------------------------|---------------------------|
| Control site | Northern median | Rope bridge | Long-nosed Potoroo |
| Impact site | Southern median | Combined fauna underpass | |
| State Forest | Vegetated connectivity corridor | Year 3 | |
| National Park reserve | | Year 4 | Year 6 |



Long-nosed Potoroo Study Area Distribution Mapping - Illustration 4.6

4.1.9 Greater Glider

There is insufficient data to discuss changes in Greater Glider habitat use and whether it is attributed to the highway upgrade due to the limited pre-construction records (GeoLINK 2012a; GeoLINK 2012b). However, the species has been recorded at all pre-construction record sites and at additional sites during the post construction monitoring (refer to **Illustration 4.7**), which demonstrates continued occupation.

Greater Glider activity levels and the number of occupied sites reduced at both impact and control sites in Year 6 compared to the Years 3 and 4 post construction monitoring (where similar results were recorded). This reduction can be attributed to the 2019 bushfire because the species is known to be sensitive to wildfire (Lunney, 1987, Andrews et al., 1994, Lindenmayer et al., 2011; cited in DoE undated).

No Greater Glider activity has been recorded on the rope bridge during the five years of camera monitoring undertaken at Devils Pulpit (this EMP and Sandpiper 2016b). The species has been recorded on both sides of the highway in the general vicinity of the rope bridge (Impact Site 3), although only in very low numbers to the east (one record) and to the west post the 2019 bushfire (refer to **Illustration 4.7**).

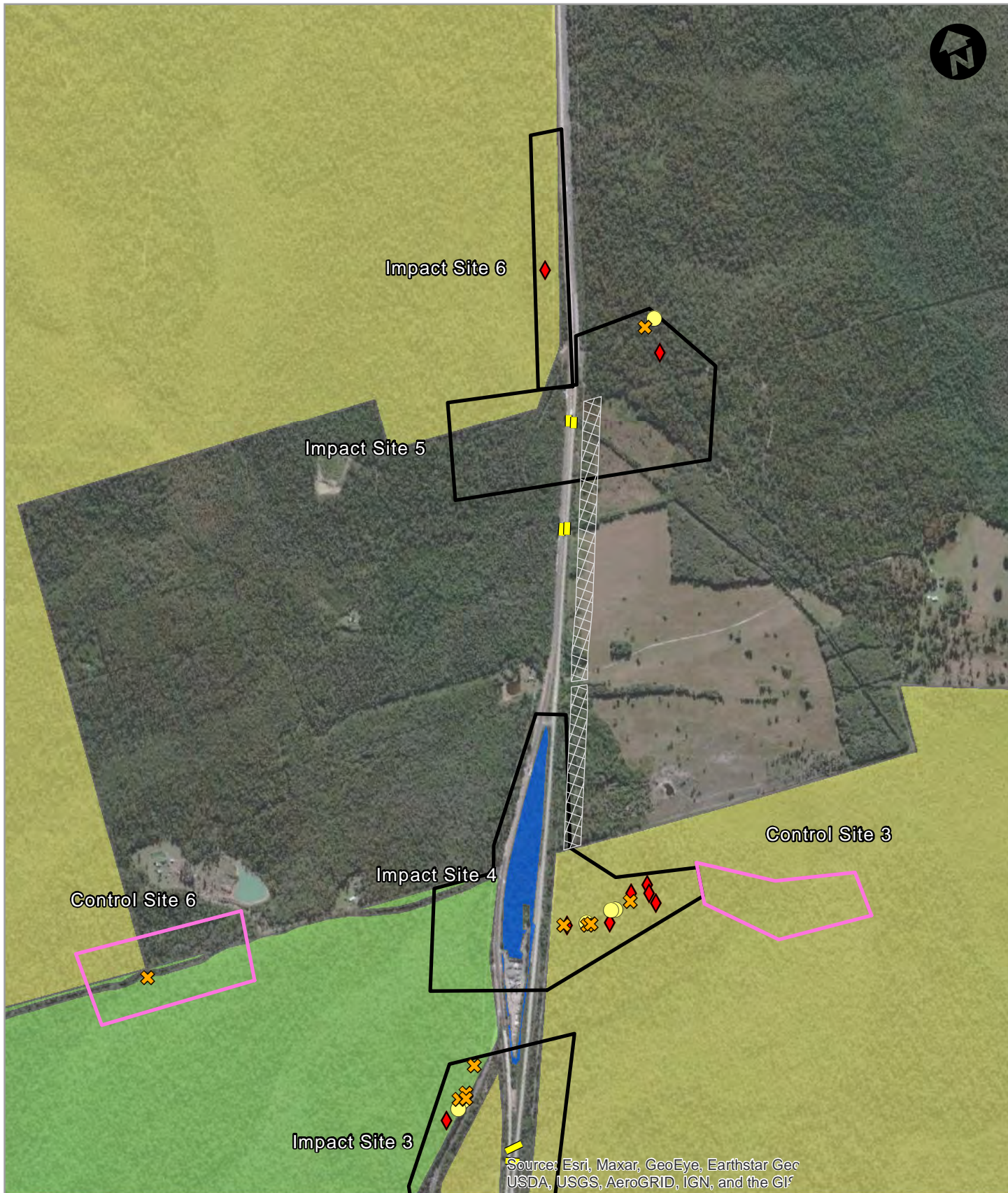
At the southern vegetated median, the Greater Glider was only recorded on the western side during Year 6. This contrasts to Years 3 and 4 where the Greater Glider was recorded within and on both sides of the highway at this site (Impact Site 2 (east, median and west)). Results indicative of Greater Glider movements across the highway between the southern median and adjacent habitat were recorded during Years 3 and 4, although it was not determined which lane, or if both were traversed. Movement across both lanes is plausible based on the highway clearing distance, the height of adjacent trees (GeoLINK 2019) and the species glide performance (Taylor and Goldingay 2009; WPSQ undated), despite the additional clearing undertaken as part of W2B between Years 4 and 6 which increased the clearing width.

A Greater Glider roadkill recorded on the northbound lane at the southern median during Year 6 demonstrates that:

- Gliders have a willingness to cross the highway at the median at a location with an approximately 44 m clearing distance.
- Gliders crossing the highway are susceptible to traffic collision.

The increased canopy gap at the northbound lane in the vicinity of the roadkill from the recent W2B works (from approximately 25 m to 44 m) is likely to have increased the roadkill risk for crossing gliders.

No Greater Gliders have been recorded within the northern median as part of the EMP spotlighting surveys, although an opportunistic record was made during Squirrel Glider radio tracking in Year 5. The Greater Glider was recorded east of the northern median each year during post construction monitoring. Although not confirmed, Greater Glider movement across the both lanes at the northern median is plausible based on the highway clearing distance, the height of adjacent trees (GeoLINK 2019) and the species glide performance (Taylor and Goldingay 2009; WPSQ undated).



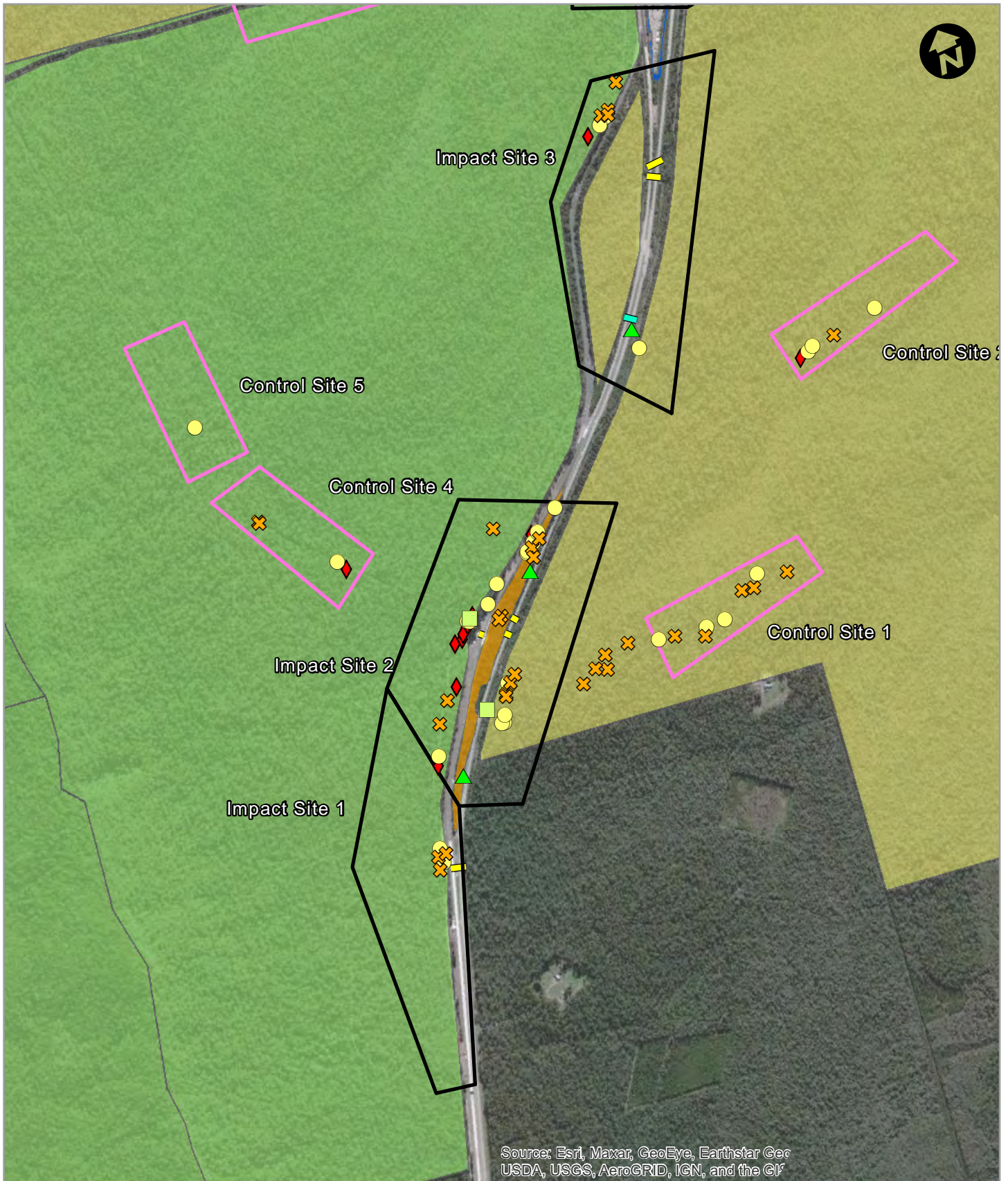
Source: Esri, Maxar, GeoEye, Earthstar Geo, USDA, USGS, AeroGRID, IGN, and the GIS

LEGEND

- | | | | |
|-----------------------|---------------------------------|-----------------------|--------|
| Control site | Northern median | Greater Glider | Year 4 |
| Impact site | Vegetated connectivity corridor | Year 3 | Year 6 |
| State Forest | Combined fauna underpass | | |
| National Park reserve | | | |



Greater Glider Study Area Distribution Mapping
Illustration 4.7 - Sheet 1 of 2



LEGEND

- | | | | |
|-----------------------|--------------------------|-------------------------|--------|
| Control site | Northern median | Greater Glider | Year 3 |
| Impact site | Southern median | 2012 - Construction | Year 4 |
| State Forest | Rope bridge | 2012 - Pre-construction | Year 6 |
| National Park reserve | Combined fauna underpass | | |



Greater Glider Study Area Distribution Mapping
Illustration 4.7 - Sheet 2 of 2

4.1.10 Spotted-tailed Quoll

The Spotted-tailed Quoll was not recorded during any post construction monitoring events undertaken as part of this monitoring program or during target surveys in 2014 and 2015 (Sandpiper 2016a). Sandpiper (2016a) found:

'Quolls are likely to move through forest in the vicinity of the upgrade and, at times, cross the Pacific Highway in vicinity of the upgrade, although use would primarily be limited to male quolls roaming in search of mates during the breeding season and dispersing juveniles. The roadkilled male quoll recorded in May 2013 is evidence that individuals occur in the area and the timing of that record supports the idea of occasional visitation during the breeding season.... the area does not support a resident population of quolls. Therefore, the probability of detecting quolls within the Devils Pulpit study area is low.'

The results of this monitoring program support these statements. The likelihood of the Spotted-tailed Quoll using the underpasses during Years 3 and 4 was low due to the limited fauna fencing. Most of the additional fauna fencing present during Year 6 was a design unlikely to create a barrier/ funnel for a highly agile species such as Spotted-tailed Quoll, although it would be expected to funnel ground dwelling prey (e.g. bandicoots) which may lead quolls to the underpass (e.g. when following tracks and scent trails).

No corrective actions of the Spotted-tailed Quoll Management Plan have been triggered to date.

4.1.11 Pest Fauna Observations

The EMP has observed an increase in some pest fauna within the study area. This includes:

- Cane Toads which have established and progressively increased in abundance throughout the study area. No Cane Toads were recorded in the study area during surveys undertaken for the EIS (Hyder 2011) or pre/ during construction activities (GeoLINK 2012a; 2012b). They have been recorded during each year of the post construction monitoring, originally only at impact sites adjacent to the highway (GeoLINK 2018), then at all sites in Year 6. The 2019 bushfire and subsequent rain appears to have been advantageous for the species, enabling Cane Toads to establish further into the forest away from the highway and access tracks.
- Wild pigs, particularly in Bundjalung National Park, where tracks and diggings are frequent. Their movement into the area occurred between Years 4 and 6, corresponding with the 2019/ 2020 drought, bushfire and subsequent rain.
- House Mouse across the study area (refer to **Section 3.2**).

Feral predators (feral cats, wild dogs/dingo and foxes) have also been observed throughout the post construction monitoring, including at underpass structures. Analysis of pest fauna abundance and interaction with threatened fauna (particularly in relation to crossing structures) has not been undertaken as part of this study, however this is worth investigating on future projects. Observations of European Hare (*Lepus europaeus*) have been occasional and in low numbers throughout the post construction monitoring.

4.2 Effectiveness of Mitigation Measures (Connectivity Structures)

Monitoring of crossing structures and roadkill monitoring is discussed in **Table 4.1** in relation to the performance measures specified in the EMP. Key findings are summarised below.

4.2.1 Fauna Underpass

No complete crossings of target threatened species have been detected, although crossings by a number of native non-threatened species have been recorded. Varying levels of fauna activity between structures and limited results at a number of structures (including no complete crossings at C3) indicate varying suitability or quality of each in providing fauna connectivity. As discussed in GeoLINK (2018, 2019), significant rainfall events in early 2017 resulted in damage at some structures, including:

- Scouring at the inlet and/ or outlet of five culvert structures (C3, C6, C8, C9 and C10; refer to **Plate 4.1** and **4.2**), causing pooling of water within or at the entrance to the subject culverts. C6 has since been upgraded (refer to **Section 1.1.2**), although pools of water remain across most of the entrances and dense aquatic vegetation (Bulrush, *Typha* sp.) occurs at the inlet.
- Damage to the fauna furniture.

The 2019 bushfire further damaged the fauna furniture at the Tabbimoble floodway bridges.

This damage has affected fauna underpass usage which is demonstrated during the Year 6 reporting period by the substantially greater number of unique fauna crossings at structures without pooled water at the entrance compared to structures with pooled water (refer to **Section 3.6.1**). Transport are currently investigating repair works for these structures.



Plate 4.1 Typical water height at the outlet of C3.



Plate 4.2 Scouring and pooled water at the outlet of C8.

The bridge underpass monitoring results suggest that fauna are more likely to use bridge underpasses with an obvious passage for fauna to traverse, compared to those with less defined or irregular (rocky) routes. For example, the absence of a clear passage at SBT2 (refer to **Plates 4.3** and **4.4**) is likely to have reduced the number of fauna records and complete crossings recorded for this structure and the adjoining NBT2. In contrast, the Tabbimoble Floodway No.3 bridges have defined passages (refer to **Plates 4.5** and **4.6**) and recorded higher numbers of fauna records and complete crossings.

Other key factors that have influenced the underpass monitoring results and lack of records of target threatened species include:

- absence of a resident population (e.g. Rufous Bettong and Spotted-tailed Quoll)
- low density populations (i.e. Koala)

- absence of crossing structures in proximity to target threatened species population (i.e. Long-nosed Potoroo)
- limited fauna fencing during Years 3 and 4 of the EMP
- fauna fence designs not being a barrier for target species (e.g. Koala)
- the 2019/ 2020 drought and bushfire impacting fauna abundance.

With repair of the fauna underpass structures, an increase in the potential for fauna crossings would be expected. Particularly because upgraded/ additional fauna fencing is now installed (due to the W2B works) and as fauna populations recover from the 2019 bushfire.

The EMP has not been designed to assess the effectiveness of the frog fencing or fauna underpass structures for target threatened frog species. This should be considered on future projects.



Plate 4.3 Northern bank at SBT2 with rock scour protection that crossing fauna need to navigate.



Plate 4.4 Southern bank at SBT2 with rock scour protection and no obvious path that crossing fauna need to navigate.




Plate 4.5 Northern bank at NBT3 showing obvious passage for crossing fauna (flat regular ground).



Plate 4.6 Southern bank at NBT3.
The vegetation has been trimmed in this photo to prevent obstruction of camera traps. The image shows that the passage for crossing fauna consists of regular flat ground.

4.2.2 Rope Bridge

Three target threatened species (Squirrel Glider, Brush-tailed Phascogale and Yellow-bellied Glider) and four other native species (Sugar Glider, Feathertail Glider, Common Ringtail Possum and Yellow-footed Antechinus) have been recorded on the rope bridge. Visitation by Feathertail Gliders and



Squirrel Gliders has been occasional to irregular, and rare for the other species. Directional movements have been recorded by six of these species, through likely complete crossings have only been recorded for the Feathertail Glider and Squirrel Glider. The vegetated medians appear to provide better crossing opportunities for the target threatened gliders at Devils Pulpit compared to the rope bridge.

4.2.3 Vegetated Medians

Clearing phase surveys and post construction monitoring have indicated Yellow-bellied Glider and Greater Glider movements at the southern median, and Squirrel Glider movements across the northbound lane at both medians. The frequency of Squirrel Glider movement across the northbound lane during radio tracking was higher than the frequency of rope bridge crossings. Both vegetated medians provide opportunities for two way crossing for these threatened species across both lanes of the highway. The Greater Glider roadkill demonstrates that traffic collision remains a risk for crossing fauna.

4.2.4 Vegetation Connectivity Corridor

Recruitment and growth of native species has been recorded across the corridor, however exotic groundcovers (including weeds) are present and reducing native species recruitment in the southern half of the corridor. The 2019 bushfire impacted (reduced) native species diversity and cover in some areas, and increased weed cover mainly in the ground stratum. Compared to the former managed pastoral land, the corridor is regenerating and has vegetation characteristic of Subtropical Coastal Floodplain Forest, although exotic grass cover is hindering regeneration in the central to southern portion of the corridor.

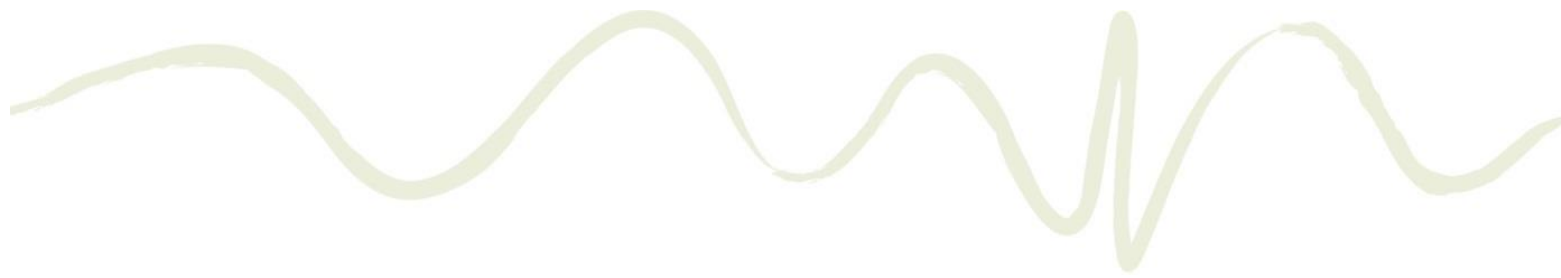
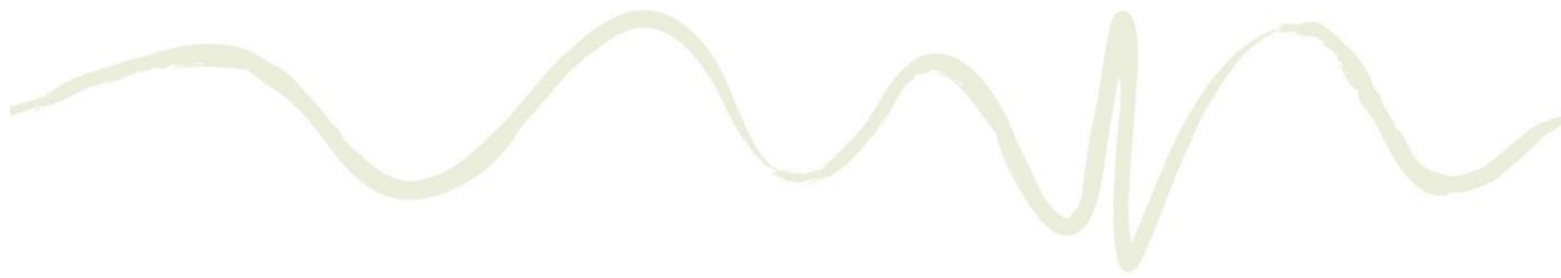


Table 4.1 EMP Performance Measures

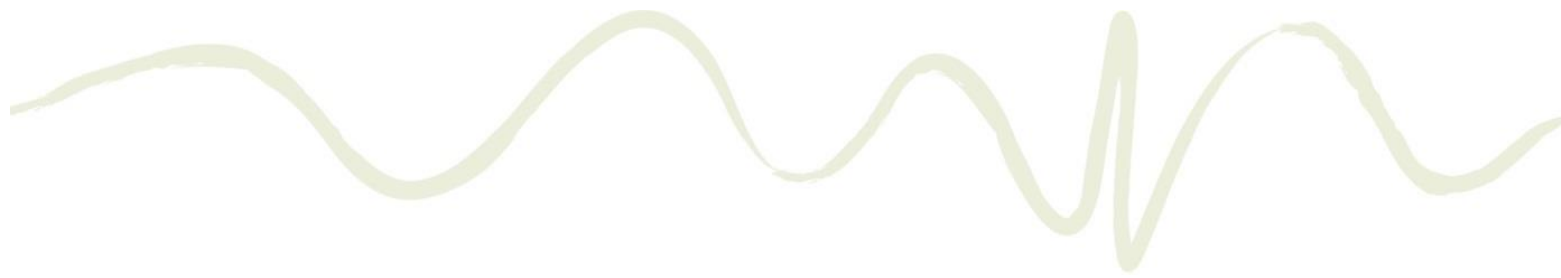
Mitigation	Performance Measure	Findings to Date
7.2 Fauna Underpasses	A completed passage from one side of the Project to the other by native fauna species previously recorded from the Project area. Completed passage/ s to be made by species from each native fauna group; reptile, frog, terrestrial mammal.	<p>The monitoring program targets listed threatened species, none of which have been recorded crossing any of the fauna underpass structures during the three years of post construction monitoring. Complete crossings have however been recorded for a range of non-threatened native species. The Year 6 reporting period recorded complete crossings by:</p> <ul style="list-style-type: none"> ■ small mammals terrestrial and scansorial mammals: <ul style="list-style-type: none"> - Antechinus at C6 and SBT3 (two crossings). - Bush Rat at NBT2 (one crossing) - Water Rat at C9 and C9 (two crossings) ■ medium terrestrial mammals: <ul style="list-style-type: none"> - Bandicoot sp. at SBT3 (15 crossings) - Long-nosed Bandicoot at C6 and C7 (four crossings) - Northern Brown Bandicoot at NBT3 and SBT3 (15 crossings) - Short-beaked Echidna at C7 and C8 (six crossings) ■ arboreal mammals: <ul style="list-style-type: none"> - Common Brushtail Possum at C7 (two crossings) - Common Ringtail Possum at C10 (one crossing) ■ macropods: <ul style="list-style-type: none"> - Eastern Grey Kangaroo at C9, NBT3, SBT3, NBT2 and SBT2 (148 crossings) - Macropod sp. at C7, C8, C9, NBT3 and SBT3 (44 crossings) - Red-necked Wallaby at NBT2, SBT3, NBT2 and SBT2 (75 crossings) - Swamp Wallaby at C7, C8, C9, C10, NBT3, SBT3, NBT3 and SBT2 (189 crossings) ■ reptiles: <ul style="list-style-type: none"> - Eastern Water Dragon at C6, C7, C8, C9, C10, NBT3, SBT3, NBT2 and SBT2 (82 crossings) - Lace Monitors at C6, C7, C8, C9, C10, NBT3, SBT3, NBT2 and SBT2 (139 crossings). - Land Mullet at C7 (two crossings) - a skink at NBT2 and SBT2 (two crossings) ■ amphibian: <ul style="list-style-type: none"> - Green Tree Frog at SBT2 (one crossing).



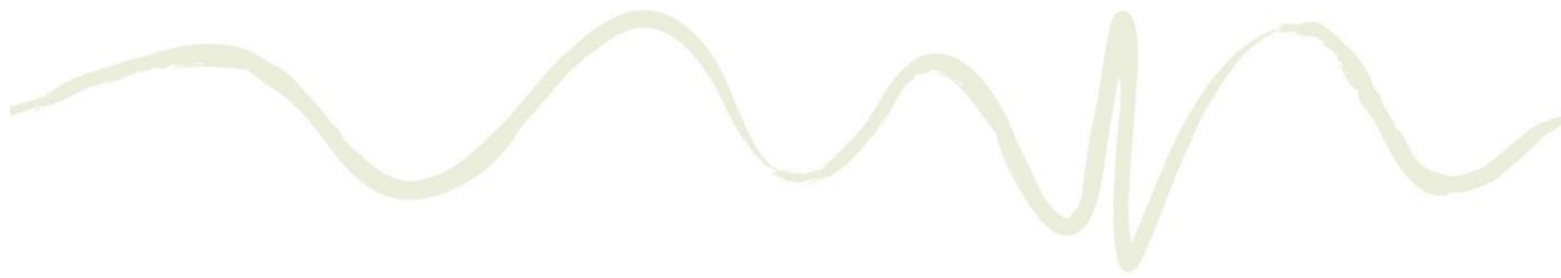
Mitigation	Performance Measure	Findings to Date
		<p>Several other reptiles and an amphibian were detected using the structures as habitat (refer to Section 3.6).</p> <p>This adds to the results from Years 3 and 4 (GeoLINK 2018; 2019). Results varied between structures and limited results at a number of structures (including no unique complete crossings at C3) indicate varying suitability or quality of each in providing fauna connectivity.</p> <p>Variations with EMP underpass design requirements and/ or construction/ condition issues (GeoLINK, unpublished) are likely to be affecting the functionality of the structures in providing fauna passage across the highway (refer to Section 4.2.1).</p>
	<p>If Spotted-tailed Quolls are detected via camera surveys, underpass monitoring or roadkill monitoring a completed passage/ s by spotted-tailed quoll.</p>	<p>No Spotted-tailed Quolls have been recorded to date.</p>
<p>7.3 Rope Bridge</p>	<p>No threatened species roadkill.</p>	<p>A Koala roadkill was recorded during Year 6 (refer to Section 4.1.7). This is a target threatened species for the fauna underpass management measure. The fauna fence in the vicinity of the roadkill comprised a 'Phascogale' fence design (1,200 mm high fence, with fine mesh [0 to 300 mm from the ground] and a 600 mm metal sheet [300 to 900 mm from the ground]) and not a specific Koala exclusion fence design. A Greater Glider roadkill was also recorded however this species is not relevant to the fauna underpasses.</p>
	<p>Complete crossing of the rope bridge by a diversity of native arboreal fauna species known to occur in the Project area, such as Brushtail Possum or Sugar Glider.</p>	<p>Rope bridge monitoring has recorded four non-threatened target species visiting the rope bridge (Feathertail Glider, Yellow-footed Antechinus, Ringtail Possum and Sugar Glider). Of these, complete crossings have only been recorded for the Feathertail Glider, although directional movements have been recorded for the other species. The Feathertail Glider was a frequent visitor to the rope bridge prior to the 2019 bushfire. Visitation by other non-threatened native species is rare.</p>
	<p>Complete crossing of the rope bridge by arboreal target species (Brush-tailed Phascogale, Squirrel Glider, Yellow-bellied Glider).</p>	<p>The Brush-tailed Phascogale, Squirrel Glider and Yellow-bellied Glider have all been recorded at the rope bridge. The Squirrel Glider has been recorded making directional movement in both directions, and likely complete crossings have been detected.</p>



Mitigation	Performance Measure	Findings to Date
		<p>Directional movement at the eastern end of the rope bridge was been recorded for the Yellow-bellied Glider and Brush-tailed Phascogale on one occasion each, although no complete crossings have been confirmed. Rope bridge visits by these species are rare. The Greater Glider has not been recorded on the rope bridge.</p>
	<p>Lower rates of roadkill in proximity to rope bridge than in sections of the upgrade away from crossing structures.</p>	<p>There is insufficient data to compare arboreal animal roadkill rates in relation to the rope bridge. Three arboreal mammal roadkills were recorded during the post construction monitoring, including two in Year 6 within 1km of the road bridge (Koala and Greater Glider). The factors associated with these roadkills (e.g. fauna fencing for the Koala) do not relate to the presence of the rope bridge.</p>
<p>7.5 Vegetated Median</p>	<p>Identification of arboreal fauna species within vegetated medians.</p>	<p>Arboreal fauna recorded at the vegetated medians during post construction monitoring include:</p> <ul style="list-style-type: none"> ■ Northern median: four species including the Squirrel Glider, Feathertail Glider, Sugar Glider and Greater Glider. ■ Southern median: six species including Squirrel Glider, Feathertail Glider, Greater Glider, Common Ringtail Possum, Small-eared Possum and Sugar Glider. The Yellow-bellied Glider has been recorded on both sides of the highway in the vicinity of the median, however not within the actual median during post construction monitoring. <p>Of these species, the medians are designed to facilitate connectivity for gliders across both lanes. The Squirrel Glider has been recorded crossing the northbound lane in both directions at both medians (GeoLINK 2021). Other results indicative of glider movements have been recorded at the southern median:</p> <ul style="list-style-type: none"> ■ Pre-clearing surveys recorded three Yellow-bellied Gliders crossing the southbound lane at the southern median where clearing had been completed (GeoLINK 2012b). While the highway was not open to traffic at this stage, this recording demonstrates the ability of the Yellow-bellied Glider to cross the southbound lane, as well as the northbound lanes which has a similar clearing width and adjacent trees of similar height. ■ Greater Gliders records in Years 3 and 4 were indicative of Greater Glider movements across the highway between the southern median and adjacent habitat (GeoLINK 2019; 2020), although it was not determined which lane, or if both were traversed. <p>Due to the size of the vegetated medians, they provide habitat for both gliding and non-gliding fauna in their own right; as well as provide refuge for fauna crossing the highway.</p>
	<p>Identification of other fauna species within vegetated medians.</p>	<p>See comments above.</p>



Mitigation	Performance Measure	Findings to Date
7.6 Restoration of Vegetated Connectivity Corridor	Increase in height of native plants over time.	This performance measure has been realised. During the Project construction phase the corridor primarily comprised former managed pastoral land, with saplings around 2-3m tall (David Andrighetto, pers. obs. 2012). All quadrats recorded recruitment and growth of native species to varying extents with the mean tree heights observed at 7-10 m during Year 6. Native plant height in the shrub layer has either been stable or reduced due to the 2019 bushfire; while the height of the ground stratum has been consistent.
	Increase of per cent cover in native plant species and a reduction of per cent cover of exotic species over time.	<p>There is no comprehensive pre-construction/ baseline data for comparison and the post construction monitoring has found native cover scores have remained stable or varied to a minor extent. Cover of exotic groundcover increased in some locations during post construction monitoring. Dense Pigeon Grass in the central to southern sections (quadrats 5 to 8) is likely to reduce recruitment rates of native species in this area.</p> <p>Notwithstanding, the transformation of the corridor from managed pastoral land to a corridor with regrowth vegetation including native species in three stratum suggests that this performance measure is being realised.</p>
	Weed cover (including noxious and invasive weed species) not to exceed 20 per cent. In the event that weed cover exceeds 20 per cent, a regular weeding program will be implemented.	Exotic species (including weeds and invasive grasses) exceed 20 % cover in the southern quadrats (particularly around quadrats 5 and 6), triggering the provision for 'a regular weeding program'. This is primarily triggered by dense occurrences of Pigeon Grass. In the long-term, recruitment and growth of native trees and shrubs is likely to 'shade out' and reduce exotic species cover in most relevant areas. Bush regeneration and tree plantings works in localised areas with dense exotic groundcovers would however assist the regeneration process where the density of understorey/ canopy tree recruits is low.
	Prompt management of noxious weeds identified within the corridor. Any noxious weeds identified during monitoring of the corridor should be managed in accordance with <i>Noxious and Environmental Weed Control Handbook (DPI 2007)</i> .	<p><i>Noxious Weed Act 1993</i> (repealed) listed species for the Clarence Valley Council LGA species at the site including: Annual Ragweed (<i>Ambrosia artemisiifolia</i>), Groundsel Bush (<i>Baccharis halimifolia</i>), Camphor Laurel (<i>Cinnamomum camphora</i>) and Fireweed (<i>Senecio madagascariensis</i>). Cover of these species is <5 %.</p> <p>Groundsel Bush and Fireweed are listed under the <i>Biosecurity Act 2015</i> which replaces the <i>Noxious Weed Act 1993</i>.</p>
	A minimum seedling density of 0.5 tree, 1 shrub and 2 groundcover seedlings per square metre within each quadrat.	This performance measure relates to planting densities. The Trans brief for the establishment of fauna connectivity corridor stipulates planting density of 1.75 x 1.75 m spacing, except at in specific locations around Tabbimoble Floodway 2 and 3 bridges which required 0.75 m centres. The current corridor comprises a mix of plantings and natural recruitment.
	Seedling survival of 60 %. If seedling	It is not possible to determine if this performance measure has been met due to the time between the



Mitigation	Performance Measure	Findings to Date
	survival falls below this percentage, a qualified and experienced expert in bush regeneration will assess the requirement for additional seedling planting.	plantings and the monitoring.
	A qualified and experienced expert in bush regeneration to assess whether the regenerating vegetation within the corridor is self-sustaining by spring of Year 6.	The vegetation within the corridor is self-sustaining and showing recovery post the 2019 bushfire. Dense Pigeon Grass in the central to southern sections (quadrats 4 to 8) is likely to reduce recruitment rates of native species in this area. This is primarily triggered by dense occurrences of Pigeon Grass. In the long-term, recruitment and growth of native trees and shrubs is likely to 'shade out' and reduce exotic species cover in most relevant areas. Bush regeneration and tree plantings works in localised areas with dense exotic groundcovers would however assist the regeneration process where the density of understorey/ canopy tree recruits is low.
9.2 Roadkill Monitoring	Lower rates of roadkill in proximity to fauna fencing, rope bridges and fauna underpasses than in sections of the upgrade not near fauna crossing structures.	There is insufficient roadkill data to confirm the effectiveness of the structures in reducing this risk. Furthermore, the fence configuration has changed during the post construction monitoring associated with the W2B works. It is likely that the current updated/ additional fauna fence arrangement will reduce the risk of roadkill for relevant species (e.g. medium sized terrestrial mammals).
	No threatened species recorded as roadkill throughout the length of the Project.	A Koala and Greater Glider roadkills were recorded during Year 6 (refer to Sections 4.1.7 and 4.1.9 respectively).
	<p>If these performance measures are not met, the following contingency measures would be implemented:</p> <ul style="list-style-type: none"> ■ Review/ modify fauna furniture associated with underpass. ■ Review/ modify habitat (i.e. vegetation composition and structure; type and abundance of natural habitat features) adjoining the underpass. 	Transport has reviewed and updated the fauna fencing at Devils Pulpit as part of the W2B project. Remediating scours and preventing the pooling of water at underpass structures is also recommended to improve the function of these structures (refer to Section 4.2.1).

5. Recommendations and Conclusion

5.1 Recommendations

The following recommendations are provided based on assessment of the EMP performance indicators and contingency measures:

- Underpasses: Maintain/ rectify fauna underpasses so they are consistent with EMP design intent, including prevention of scouring/ pooled water C3, C8, C9 and C10; and repairing fauna furniture at all Tabbimoble floodway No.2 and 3 bridges. Transport are currently investigating repair works for these structures.
- Vegetated connectivity corridor: Weed management is triggered by recorded weed cover classes and species occurrences, particularly in the southern half of the corridor. This is primarily triggered by dense occurrences of Pigeon Grass. In the long-term, recruitment and growth of native trees and shrubs is likely to 'shade out' and reduce exotic species cover in most relevant areas. Bush regeneration and tree plantings works in localised areas with dense exotic groundcovers would however assist the regeneration process where the density of understorey/ canopy tree recruits is low. This is currently (October 2021) being investigated.

The following recommendations are provided for Transports consideration:

- Future monitoring programs should be developed with:
 - clear specific aims, performance measures and contingency triggers
 - specific objectives of the mitigation measure being monitored outlined based on the site's characteristics and target species. For example, the frequency of crossings at connectivity structures should be defined (such as dispersal or inter-range movements) for each target species
 - the objective of expanding on existing knowledge from research and other road monitoring projects and avoid replicating well studied parameters
 - consideration of upcoming works which may conflict with the monitoring program or create additional variables that would impact results
 - a program then enables sufficient baseline data to be collected. Trial monitoring programs should be used during the baseline phase to ensure sufficient and meaningful data can be captured by proposed monitoring methods.
- Rope bridge designs should ensure rope material completely extends from pole to pole providing a clear passage and there are no sections with only metal elements.
- Sufficient ecological surveys are undertaken during the design phase of the Project so that the most appropriate fauna connectivity structures for the environment can be selected and located in areas occupied by target species.
- Fauna underpass structures have clear passages at the entrances and within the structure.

GeoLINK (2021) includes additional recommendations specific to Squirrel Glider monitoring.



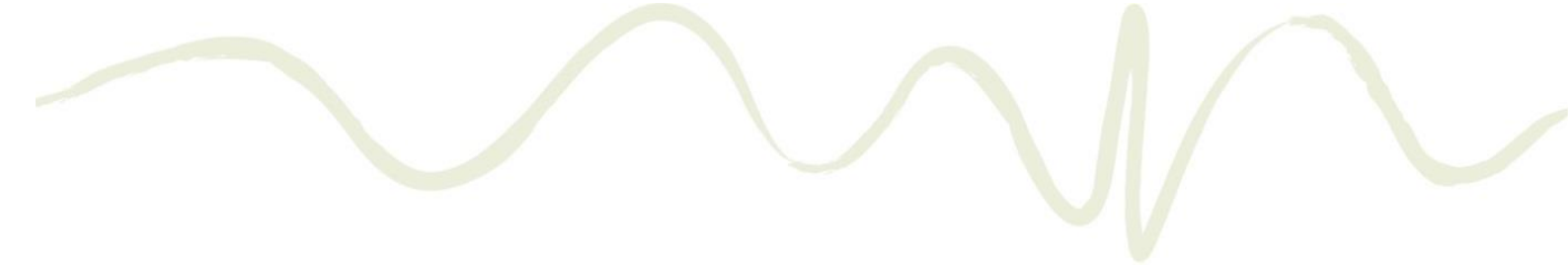
5.2 Conclusion

The post construction terrestrial species monitoring program for the Project has been completed in accordance with the EMP (Hyder 2012) and *Spotted-tailed Quoll Management Plan* (SKM 2012). The monitoring has demonstrated variable success of the mitigation measures monitored relative to the Project objectives. The findings of this project contribute to the expanding knowledge and dataset associated with road impacts and wildlife mitigation developed from research and other monitoring programs in Australia. It can be used to inform future road projects, road retrofit projects with a conservation objective, and as a reference for other projects with an interest with the threatened species that were monitored.



References

- Bond, A. R. F. and Jones, D. N. (2013). Roads and macropods: interactions and implications, in *Australian Mammalogy* <http://dx.doi.org/10.1071/AM13005>
- DPIE (2013). *Action Statement No. 254 Long-nosed Potoroo Potorous tridactylus Flora and Fauna Guarantee Act 1988*. Victorian Government Department of Environment and Primary Industries.
- DoE (undated). *Consultation Document on the Listing Eligibility and Conservation Actions: Petauroides volans (greater glider)*. Australian Government Department of the Environment.
- GeoLINK (2021). *Squirrel Glider Radio Tracking for Post Construction Ecological Monitoring, Devils Pulpit Pacific Highway Upgrade*. Unpublished report prepared for Transport for NSW. GeoLINK Consulting, Lennox Head.
- GeoLINK (2019a). *Second Annual Report for Post Construction Year 3, 4 and 6 Ecological Monitoring Devils Pulpit Pacific Highway Upgrade*. Unpublished report prepared for NSW Roads and Maritime Services. GeoLINK Consulting, Lennox Head.
- GeoLINK (2019). *W2B Devils Pulpit Widened Median Glider Crossing Ability Assessment*. Unpublished report prepared for BMD Construction. GeoLINK Consulting, Lennox Head.
- GeoLINK (2018). *First Annual Report for Post Construction Year 3, 4 and 6 Ecological Monitoring Devils Pulpit Pacific Highway Upgrade*. Unpublished report prepared for NSW Roads and Maritime Services. GeoLINK Consulting, Lennox Head.
- GeoLINK (2015). *Devils Pulpit Pacific Highway Upgrade - Post-construction Monitoring of Oxleyan Pygmy Perch and Surface Water*. Unpublished report prepared for NSW Roads and Maritime Services. GeoLINK Consulting, Coffs Harbour.
- GeoLINK (2012a). *Devils Pulpit Pacific Highway Upgrade - Pre-construction Threatened Fauna Monitoring Results*. Unpublished report prepared for NSW Roads and Maritime Services. GeoLINK Consulting, Lennox Head.
- GeoLINK (2012b). *Devils Pulpit Highway Upgrade – Post Clearing Report*. Unpublished report prepared for John Holland Group. GeoLINK Consulting, Lennox Head.
- Goldingay, R. L. and Taylor, B. D. (2009). Gliding performance and its relevance to gap crossings by the squirrel glider (*Petaurus norfolcensis*), in *Australian Journal of Zoology*, 2009, 57, 99-104, CSIRO Publishing.
- Goldingay, R. L., Taylor, B. D. and Parkyn, J. L. (2019). Movement of small mammals through a road-underpass facilitated by a wildlife rail, in *Australian Mammalogy*, 41(1) 142-146.
- Goldingay, R. L., Taylor, B. D. and Parkyn, J. L. (2018). Use of tall wooden poles by four species of gliding mammal provides further proof of concept for habitat restoration, in *Australian Mammalogy*, 41, 255–261.
- Hyder (2012). *Devils Pulpit Upgrade – Ecological Monitoring Program*. Unpublished report prepared for NSW Roads and Maritime Services. Hyder Consulting Pty, Ltd, North Sydney.



Hyder (2011). *Pacific Highway Upgrade – Devils Pulpit Project – Appendix D. Technical Working Paper – Ecology*. Unpublished report prepared for NSW Roads and Traffic Authority. Hyder Consulting Pty, Ltd, North Sydney.

Lewis, B.D (2015). *Tugun Bypass Project: Long-nosed Potoroo Management: Five Year Review*. Report prepared for Queensland Department of Transport and Main Roads (TMR).

Lewis, B. D. (2014). *Woolgoolga to Ballina Pacific Highway Upgrade Rufous Bettong & Brush-tailed Phascogale Preconstruction Baseline Monitoring Survey*. Unpublished report for NSW Roads and Maritime Services.

Lemckert, F., Mahony, M., Brassil, T. and Slatyer, C. (2006). The biology of the threatened Green-thighed frog *Litoria brevipalmata* (Anura: Hylidae) in the central and mid-north coastal areas of New South Wales, in *Australian Zoologist*: 2006, Vol. 33, No. 3, pp. 337-344.

Mansfield, C. Arnold, A. H., Bell, T. L., and York, A (2017). Habitat characteristics of a threatened arboreal marsupial and its resource use in a degraded landscape: the brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*) in central Victoria, Australia, in *Wildlife Research* 44(2) 153-164.

Meek, P. (2015). *Constraints of Using Camera Traps for Wildlife Monitoring and Ecological Research*. School of Environmental and Rural Science, University of New England.

Niche (2020). *Fauna Underpass and Associated Fauna Fence Monitoring 2018/2019*, Frederickton to Eungai Pacific Highway Upgrade. Unpublished report to Transport for NSW.

NSW National Parks and Wildlife Service (2003). *Recovery Plan for the Yellow-bellied Glider (Petaurus australis)*. NSW National Parks and Wildlife Service, Hurstville.

RMS (2016). *Woolgoolga to Ballina Pacific Highway Upgrade Koala Management Plan*. NSW Roads and Maritime Services.

Sandpiper Ecological (2020a). *Pacific Highway Upgrade – Threatened Gliders Monitoring Program, Annual Report (Year 3)*. Unpublished report to NSW Transport for NSW. Sandpiper Ecological Surveys.

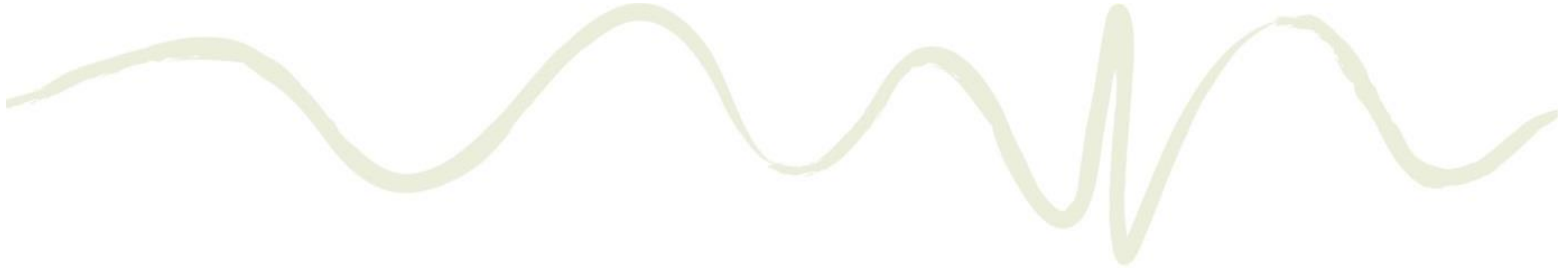
Sandpiper Ecological (2020b). *Nambucca Heads to Urunga Pacific Highway Upgrade: Operational Phase, Year Three; Operational Phase Biodiversity Monitoring – Year Three 2019*. Unpublished report to Transport for NSW.

Sandpiper Ecological (2017). *Pacific Highway Upgrade – Glenugie Operational Phase Fauna Crossing Monitoring Program (years 1 to 3)*. Unpublished report to NSW Roads and Maritime Services. Sandpiper Ecological Surveys.

Sandpiper Ecological (2016a). *Pacific Highway Upgrade – Devils Pulpit: Spotted-tailed quoll (Dasyurus maculatus) status assessment - year 2*. Unpublished report prepared for NSW Roads and Maritime Services.

Sandpiper Ecological (2016b). *Devils Pulpit rope bridge monitoring*. Unpublished report to NSW Roads and Maritime Services. Sandpiper Ecological Surveys.

SKM (2012). *Pacific Highway Upgrade Devils Pulpit – EPBC Act Condition of Approval Spotted-Tailed Quoll Management Plan*. Unpublished report for NSW Roads and Maritime Services.



Soanes, K., Vesk, P. A. and van der Ree, R. (2015). Monitoring the use of road-crossing structures by arboreal marsupials: insights gained from motion-triggered cameras and passive integrated transponder (PIT) tags. *Wildlife Research*: 10.107

Soanes K., Carmody Lobo M., Vesk P. A., McCarthy M. A., Moore J. L. and van der Ree R. (2013). Movement re-established but not restored: inferring the effectiveness of road-crossing mitigation for a gliding mammal by monitoring use, in *Biological Conservation* **159**, 434–441

Taylor, B. D., Goldingay, R. L. and Lindsay, J. M., (2014). Horizontal or vertical? Camera trap orientations and recording modes for detecting potoroos, bandicoots and pademelons in *Australian Mammalogy*, Vol 36, 60-66.

Taylor, B. D. and Goldingay, R. L. (2013). Squirrel glider use of roadside glide poles to cross a road gap, in *Australian Mammalogy* **35**;119.

Triggs, B. (2004). *Tracks, scats and other traces: a field guide to Australian mammals*. Oxford University Press, Melbourne.

WPSQ (undated). Wildlife Preservation Society of Queensland Species Profile.



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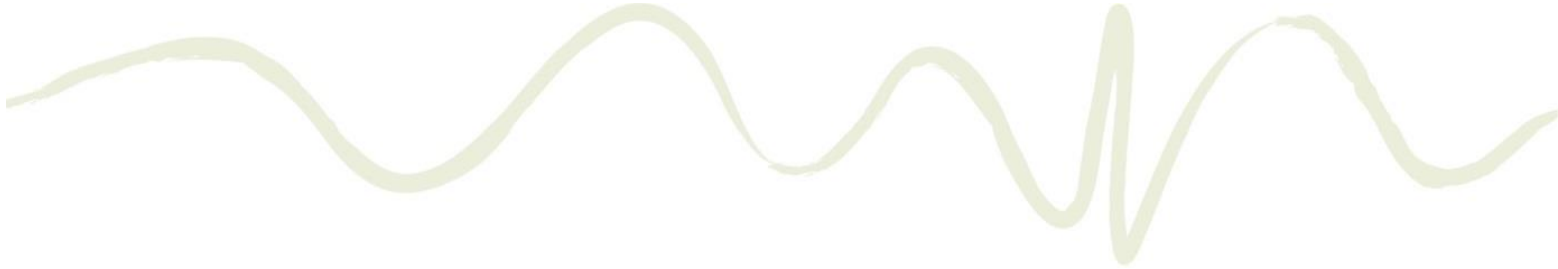


Appendix A

Target Terrestrial Species Monitoring Survey Methodology and Weather Data

Table A1 Rufous Bettong/ Brush-tailed Phascogale Camera Trap Survey Dates and Effort During Year 6 Post Construction Monitoring

Site	Survey Season	Installation Date	Survey Completion Date	No. Trap Nights	No. Camera Traps	Effort (effective trap nights)
Impact Site 1 (west)	Winter	12/08/2020	26/08/2020	14	6	84
Impact Site 1 (west)	Spring	14/10/2020	28/10/2020	14	6	84
Impact Site 1 (west)	Summer	20/01/2021	13/02/2021	14	6*	70
Impact Site 1 (east)	Winter	12/08/2020	26/08/2020	14	6	84
Impact Site 1 (east)	Spring	14/10/2020	28/10/2020	14	6	84
Impact Site 1 (east)	Summer	20/01/2021	13/02/2021	14	6	84
Impact Site 2 (west)	Winter	12/08/2020	26/08/2020	14	6^	70
Impact Site 2 (west)	Spring	14/10/2020	28/10/2020	14	6	84
Impact Site 2 (west)	Summer	20/01/2021	13/02/2021	14	6	84
Impact Site 2 (east)	Winter	9/07/2020	23/07/2020	14	6	84
Impact Site 2 (east)	Spring	12/11/2020	26/12/2020	14	6	84
Impact Site 2 (east)	Summer	1/12/2020	15/12/2020	14	6	84
Impact Site 3 (west)	Winter	10/07/2020	24/07/2020	14	6	84
Impact Site 3 (west)	Spring	12/11/2020	26/12/2020	14	6	84
Impact Site 3 (west)	Summer	1/12/2020	15/12/2020	14	6	84
Impact Site 3 (east)	Winter	9/07/2020	23/07/2020	14	6	84
Impact Site 3 (east)	Spring	12/11/2020	26/12/2020	14	6	84
Impact Site 3 (east)	Summer	1/12/2020	15/12/2020	14	6	84
Impact Site 4 (west)	Winter	10/07/2020	24/07/2020	14	6^	70
Impact Site 4 (west)	Spring	12/11/2020	26/12/2020	14	6	84
Impact Site 4 (west)	Summer	1/12/2020	15/12/2020	14	6	84
Impact Site 4 (east)	Winter	9/07/2020	23/07/2020	14	6	84
Impact Site 4 (east)	Spring	12/11/2020	26/12/2020	14	6	84
Impact Site 4 (east)	Summer	1/12/2020	15/12/2020	14	6	84
Impact Site 5 (west)	Winter	12/08/2020	26/08/2020	14	6	84
Impact Site 5 (west)	Spring	12/11/2020	26/12/2020	14	6^	70
Impact Site 5 (west)	Summer	1/12/2020	15/12/2020	14	6^	70
Impact Site 5 (east)	Winter	12/08/2020	26/08/2020	14	6	84
Impact Site 5 (east)	Spring	12/11/2020	26/12/2020	14	6^	70
Impact Site 5 (east)	Summer	1/12/2020	15/12/2020	14	6^	70
Control site 1	Winter	9/07/2020	23/07/2020	14	6^	70
Control site 1	Spring	12/11/2020	26/12/2020	14	6	84
Control site 1	Summer	1/12/2020	15/12/2020	14	6	84
Control site 2	Winter	9/07/2020	23/07/2020	14	6^	70
Control site 2	Spring	12/11/2020	26/12/2020	14	6	84
Control site 2	Summer	1/12/2020	15/12/2020	14	6	84
Control site 3	Winter	9/07/2020	23/07/2020	14	6^	70
Control site 3	Spring	12/11/2020	26/12/2020	14	6	84
Control site 3	Summer	1/12/2020	15/12/2020	14	6	84
Control site 4	Winter	10/07/2020	24/07/2020	14	6	84
Control site 4	Spring	14/10/2020	28/10/2020	14	6	84
Control site 4	Summer	20/01/2021	13/02/2021	14	6	84
Control site 5	Winter	10/07/2020	24/07/2020	14	6	84
Control site 5	Spring	14/10/2020	28/10/2020	14	6	84
Control site 5	Summer	20/01/2021	13/02/2021	14	6	84
All Sites	Winter	-	-	-	-	1190
All Sites	Spring	-	-	-	-	1232



<i>Site</i>	<i>Survey Season</i>	<i>Installation Date</i>	<i>Survey Completion Date</i>	<i>No. Trap Nights</i>	<i>No. Camera Traps</i>	<i>Effort (effective trap nights)</i>
All Sites	Summer	-	-	-	-	1218
All Impact Sites	All seasons	-	-	-	-	2422
All Control Sites	All seasons	-	-	-	-	1218
Total All Seasons	All seasons	-	-	-	-	3640

^ denotes sites where camera or SD card errors reduced the number of effective traps or trap nights.

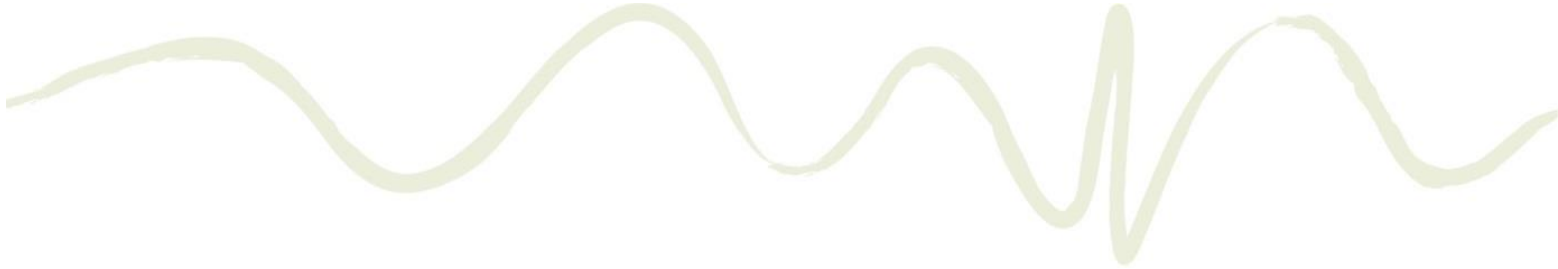
* denotes sites where camera theft reduced the number of trap nights.

Table A2 Spotlighting Survey Dates During Year 6 Post Construction Monitoring

Site	Survey	Date	Transect Length (m)	Call Playback Species
Impact Site 1 (west)	Year 6 Winter Survey 1	14/07/2020	500	Koala
Impact Site 1 (west)	Year 6 Winter Survey 2	12/08/2020	500	Koala
Impact Site 1 (west)	Year 6 Winter Survey 3	20/08/2020	500	Koala
Impact Site 1 (west)	Year 6 Spring Survey 1	15/10/2020	500	Koala
Impact Site 1 (west)	Year 6 Spring Survey 2	11/11/2020	500	Koala
Impact Site 1 (west)	Year 6 Spring Survey 3	19/11/2020	500	Koala
Impact Site 1 (west)	Year 6 Summer Survey 1	12/01/2021	500	Koala
Impact Site 1 (west)	Year 6 Summer Survey 2	20/01/2021	500	Koala
Impact Site 1 (west)	Year 6 Summer Survey 3	11/02/2021	500	Koala
Impact Site 1 (east)	Year 6 Winter Survey 1	14/07/2020	500	Koala
Impact Site 1 (east)	Year 6 Winter Survey 2	12/08/2020	500	Koala
Impact Site 1 (east)	Year 6 Winter Survey 3	20/08/2020	500	Koala
Impact Site 1 (east)	Year 6 Spring Survey 1	15/10/2020	500	Koala
Impact Site 1 (east)	Year 6 Spring Survey 2	11/11/2020	500	Koala
Impact Site 1 (east)	Year 6 Spring Survey 3	19/11/2020	500	Koala
Impact Site 1 (east)	Year 6 Summer Survey 1	12/01/2021	500	Koala
Impact Site 1 (east)	Year 6 Summer Survey 2	20/01/2021	500	Koala
Impact Site 1 (east)	Year 6 Summer Survey 3	11/02/2021	500	Koala
Impact Site 2 (west)	Year 6 Winter Survey 3	20/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Winter Survey 1	14/07/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Winter Survey 2	12/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Spring Survey 1	15/10/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Spring Survey 2	23/10/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Spring Survey 3	19/11/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Summer Survey 1	12/01/2021	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Summer Survey 2	20/01/2021	500	Koala and Yellow-bellied Glider
Impact Site 2 (west)	Year 6 Summer Survey 3	11/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Winter Survey 1	14/07/2020	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Winter Survey 2	13/08/2020	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Winter Survey 3	20/08/2020	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Spring Survey 1	13/10/2020	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Spring Survey 2	23/10/2020	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Spring Survey 3	12/11/2020	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Summer Survey 1	12/01/2021	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Summer Survey 2	4/02/2021	1000	Yellow-bellied Glider
Impact Site 2 (median)	Year 6 Summer Survey 3	11/02/2021	1000	Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Winter Survey 1	12/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Winter Survey 2	18/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Winter Survey 3	20/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Spring Survey 1	13/10/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Spring Survey 2	10/11/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Spring Survey 3	12/11/2020	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Summer Survey 1	14/01/2021	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Summer Survey 2	4/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 2 (east)	Year 6 Summer Survey 3	11/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 3 Winter Survey 1	14/07/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 6 Winter Survey 2	12/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 6 Winter Survey 3	25/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 6 Spring Survey 1	22/10/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 6 Spring Survey 2	9/11/2020	500	Koala and Yellow-bellied Glider

Site	Survey	Date	Transect Length (m)	Call Playback Species
Impact Site 3 (west)	Year 6 Spring Survey 3	19/11/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 6 Summer Survey 1	4/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 6 Summer Survey 2	11/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 3 (west)	Year 6 Summer Survey 3	22/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Winter Survey 1	12/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Winter Survey 2	18/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Winter Survey 3	25/08/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Spring Survey 1	23/10/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Spring Survey 2	9/11/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Spring Survey 3	12/11/2020	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Summer Survey 1	20/01/2021	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Summer Survey 2	4/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 3 (east)	Year 6 Summer Survey 3	22/02/2021	500	Koala and Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Winter Survey 1	9/08/2020	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Winter Survey 2	13/08/2020	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Winter Survey 3	18/08/2020	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Spring Survey 2	9/11/2020	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Spring Survey 1	13/10/2020	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Spring Survey 3	12/11/2020	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Summer Survey 1	14/01/2021	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Summer Survey 2	4/02/2021	1000	Yellow-bellied Glider
Impact Site 4 (median)	Year 6 Summer Survey 3	8/02/2021	1000	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Winter Survey 1	9/08/2020	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Winter Survey 2	13/08/2020	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Winter Survey 3	18/08/2020	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Spring Survey 1	13/10/2020	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Spring Survey 2	9/11/2020	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Spring Survey 3	12/11/2020	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Summer Survey 1	14/01/2021	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Summer Survey 2	14/01/2021	500	Yellow-bellied Glider
Impact Site 4 (east)	Year 6 Summer Survey 3	8/02/2021	500	Yellow-bellied Glider
Impact Site 5 (west)	Year 6 Winter Survey 1	15/07/2020	500	Koala
Impact Site 5 (west)	Year 6 Winter Survey 2	13/08/2020	500	Koala
Impact Site 5 (west)	Year 6 Winter Survey 3	25/08/2020	500	Koala
Impact Site 5 (west)	Year 6 Spring Survey 1	15/10/2020	500	Koala
Impact Site 5 (west)	Year 6 Spring Survey 2	10/11/2020	500	Koala
Impact Site 5 (west)	Year 6 Spring Survey 3	19/11/2020	500	Koala
Impact Site 5 (west)	Year 6 Summer Survey 1	10/12/2020	500	Koala
Impact Site 5 (west)	Year 6 Summer Survey 2	20/01/2021	500	Koala
Impact Site 5 (west)	Year 6 Summer Survey 3	8/02/2021	500	Koala
Impact Site 5 (east)	Year 6 Winter Survey 1	15/07/2020	500	Koala
Impact Site 5 (east)	Year 6 Winter Survey 2	12/08/2020	500	Koala
Impact Site 5 (east)	Year 6 Winter Survey 3	18/08/2020	500	Koala
Impact Site 5 (east)	Year 6 Spring Survey 1	22/10/2020	500	Koala
Impact Site 5 (east)	Year 6 Spring Survey 2	10/11/2020	500	Koala
Impact Site 5 (east)	Year 6 Spring Survey 3	19/11/2020	500	Koala
Impact Site 5 (east)	Year 6 Summer Survey 1	10/12/2020	500	Koala
Impact Site 5 (east)	Year 6 Summer Survey 2	20/01/2021	500	Koala
Impact Site 5 (east)	Year 6 Summer Survey 3	25/02/2021	500	Koala
Impact Site 6 (west)	Year 6 Winter Survey 1	15/07/2020	500	Yellow-bellied Glider
Impact Site 6 (west)	Year 6 Winter Survey 2	13/08/2020	500	Yellow-bellied Glider
Impact Site 6 (west)	Year 6 Winter Survey 3	25/08/2020	500	Yellow-bellied Glider

Site	Survey	Date	Transect Length (m)	Call Playback Species
Impact Site 6 (west)	Year 6 Spring Survey 1	15/10/2020	500	Yellow-bellied Glider
Impact Site 6 (west)	Year 6 Spring Survey 2	10/11/2020	500	Yellow-bellied Glider
Impact Site 6 (west)	Year 6 Spring Survey 3	19/11/2020	500	Yellow-bellied Glider
Impact Site 6 (west)	Year 6 Summer Survey 1	10/12/2020	500	Yellow-bellied Glider
Impact Site 6 (west)	Year 6 Summer Survey 2	20/01/2021	500	Yellow-bellied Glider
Impact Site 6 (west)	Year 6 Summer Survey 3	8/02/2021	500	Yellow-bellied Glider
Control site 1	Year 6 Winter Survey 1	12/08/2020	500	Yellow-bellied Glider
Control site 1	Year 6 Winter Survey 2	18/08/2020	500	Yellow-bellied Glider
Control site 1	Year 6 Winter Survey 3	20/08/2020	500	Yellow-bellied Glider
Control site 1	Year 6 Spring Survey 1	13/10/2020	500	Yellow-bellied Glider
Control site 1	Year 6 Spring Survey 2	10/11/2020	500	Yellow-bellied Glider
Control site 1	Year 6 Spring Survey 3	12/11/2020	500	Yellow-bellied Glider
Control site 1	Year 6 Summer Survey 2	4/02/2021	500	Yellow-bellied Glider
Control site 1	Year 6 Summer Survey 3	11/02/2021	500	Yellow-bellied Glider
Control site 1	Year 6 Summer Survey 1	14/01/2021	500	Yellow-bellied Glider
Control site 2	Year 6 Winter Survey 1	12/08/2020	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Winter Survey 2	18/08/2020	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Winter Survey 3	25/08/2020	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Spring Survey 1	23/10/2020	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Spring Survey 2	9/11/2020	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Spring Survey 3	12/11/2020	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Summer Survey 1	20/01/2021	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Summer Survey 2	4/02/2021	500	Koala and Yellow-bellied Glider
Control site 2	Year 6 Summer Survey 3	11/02/2021	500	Koala and Yellow-bellied Glider
Control site 3	Year 6 Winter Survey 1	9/08/2020	500	Koala
Control site 3	Year 6 Winter Survey 2	13/08/2020	500	Koala
Control site 3	Year 6 Winter Survey 3	18/08/2020	500	Koala
Control site 3	Year 6 Spring Survey 1	13/10/2020	500	Koala
Control site 3	Year 6 Spring Survey 2	9/11/2020	500	Koala
Control site 3	Year 6 Spring Survey 3	12/11/2020	500	Koala
Control site 3	Year 6 Summer Survey 1	14/01/2021	500	Koala
Control site 3	Year 6 Summer Survey 2	4/02/2021	500	Koala
Control site 3	Year 6 Summer Survey 3	8/02/2021	500	Koala
Control site 4	Year 3 Winter Survey 1	14/07/2020	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Winter Survey 2	13/08/2020	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Winter Survey 3	25/08/2020	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Spring Survey 1	15/10/2020	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Spring Survey 2	23/10/2020	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Winter Survey 3	12/11/2020	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Summer Survey 1	12/01/2021	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Summer Survey 2	20/01/2021	500	Koala and Yellow-bellied Glider
Control site 4	Year 6 Summer Survey 3	11/02/2021	500	Koala and Yellow-bellied Glider
Control site 5	Year 6 Winter Survey 1	14/07/2020	500	Yellow-bellied Glider
Control site 5	Year 6 Winter Survey 2	13/08/2020	500	Yellow-bellied Glider
Control site 5	Year 6 Winter Survey 3	25/08/2020	500	Yellow-bellied Glider
Control site 5	Year 6 Spring Survey 1	15/10/2020	500	Yellow-bellied Glider
Control site 5	Year 6 Spring Survey 2	23/10/2020	500	Yellow-bellied Glider
Control site 5	Year 6 Spring Survey 3	12/11/2020	500	Yellow-bellied Glider
Control site 5	Year 6 Summer Survey 1	12/01/2021	500	Yellow-bellied Glider
Control site 5	Year 6 Summer Survey 2	20/01/2021	500	Yellow-bellied Glider
Control site 5	Year 6 Summer Survey 3	11/02/2021	500	Yellow-bellied Glider
Control site 6	Year 6 Winter Survey 1	15/07/2020	500	Koala



Site	Survey	Date	Transect Length (m)	Call Playback Species
Control site 6	Year 6 Winter Survey 2	20/08/2020	500	Koala
Control site 6	Year 6 Winter Survey 3	25/08/2020	500	Koala
Control site 6	Year 6 Spring Survey 1	22/10/2020	500	Koala
Control site 6	Year 6 Spring Survey 2	10/11/2020	500	Koala
Control site 6	Year 6 Spring Survey 3	19/11/2020	500	Koala
Control site 6	Year 6 Summer Survey 1	14/01/2021	500	Koala
Control site 6	Year 6 Summer Survey 2	8/02/2021	500	Koala
Control site 6	Year 6 Summer Survey 3	22/02/2021	500	Koala

Table A3 Weather Conditions During Nocturnal Surveys During Year 6 Post Construction Monitoring

Date	Survey Type	Temperature	Wind	Cloud Cover	Moon Phase	Humidity	Evidence of Rain within 24hrs	Evidence of Rain within 48hrs	Rainfall (mm)*	Comments	Flowering Resources Observed
14/07/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	Light (leaves moving)	0-25 %	No moon	Low	No	No	0.6mm in 24hrs, 0.6mm in 48hrs	Last quarter moon phase. Variable wind from light to moderate.	Low and uncommon Forest Red Gum Low and uncommon Narrow-Leaved Red Gum
15/07/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	Light (leaves moving)	0-25 %	No moon	Low	No	No	0mm in 24hrs, 0.6mm in 48hrs	Occasional moderate wind gusts.	Low Forest Red Gum Low and uncommon Narrow-Leaved Red Gum Low Broad-leaved Paperbark Low <i>Angophora woodsiana</i>
9/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	Moderate (branches moving)	0-25 %	No moon	Moderate	No	Yes	0.2mm in 24hrs, 0.2mm in 48hrs	-	-
12/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	Light (leaves moving)	0-25 %	No moon	Moderate	No	No	0	-	Low <i>Angophora woodsiana</i>
13/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	No wind	0-25 %	No moon	Moderate	No	No	0.2mm in 24hrs, 0.2mm in 48hrs	-	Low <i>Angophora woodsiana</i> Low Narrow-Leaved Red Gum Low Tindal's Stringybark
18/08/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	Light (leaves moving)	26-50 %	No moon	Moderate	No	No	0mm in 24hrs, 0mm in 48hrs	-	-
20/08/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	Light (leaves moving)	0-25 %	No moon	Low	No	No	0	Occasional moderate wind gusts.	Low Forest Red Gum Low Turpentine
25/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	No wind	0-25 %	26-50 %	Low	No	No	2.4mm in 24hrs, 2.4mm in 48hrs	Late shower/ storm passed between 9:00 and 9.30pm.	-
13/10/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	No wind	0-25 %	No moon	Moderate	No	No	0	Last quarter moon phase, late rise.	Medium <i>Melaleuca sieberi</i> Low Tindal's Stringybark
15/10/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	No wind	0-25 %	0-25 %	Moderate	No	No	0	-	Low Turpentine
22/10/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	26-50 %	High	No	No	0	-	-
23/10/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	26-50 %	26-50 %	High	No	No	0.4mm in 24hrs, 0.4mm in 48hrs	-	Medium Turpentine Medium Tindal's Stringybark
9/11/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	0-25 %	Moderate	No	No	0.8mm in 24hrs, 0.8mm in 48hrs	-	-
10/11/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	0-25 %	0-25 %	Moderate	No	No	0mm in 24hrs, 0.8mm in 48hrs	-	Low Northern Grey Ironbark
11/11/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	0-25 %	Moderate	No	No	0	-	-

Date	Survey Type	Temperature	Wind	Cloud Cover	Moon Phase	Humidity	Evidence of Rain within 24hrs	Evidence of Rain within 48hrs	Rainfall (mm)*	Comments	Flowering Resources Observed
	playback)										
12/11/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	0-25 %	Moderate	No	No	0	-	Low Northern Grey Ironbark Low Tindal's Stringybark
19/11/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	No wind	0-25 %	0-25 %	Moderate	No	No	0	-	-
10/12/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	0-25 %	Moderate	No	No	3.2mm in 24hrs, 3.2mm in 48hrs	-	High <i>Angophora woodsiana</i>
14/12/2020	Threatened Frogs - Year 6 Summer Survey 1	Mild (15-20°C)	No wind	76-100 %	No moon	High	Yes	Yes	118.6mm in 24hrs, 160.4mm in 48hrs	Rain during survey.	-
15/12/2020	Threatened Frogs - Year 6 Summer Survey 2	Warm (>20-28°C)	No wind	0-25 %	No moon	High	Yes	Yes	17.4mm in 24hrs, 136mm in 48hrs	-	-
7/01/2021	Threatened Frogs - Year 6 Summer Survey 3	Warm (>20-28°C)	No wind	76-100 %	No moon	High	Yes	Yes	18.8mm in 24hrs, 51.4mm in 48hrs	-	-
12/01/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	0-25 %	No moon	Low	Yes	Yes	0	-	High <i>Angophora woodsiana</i>
14/01/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	0-25 %	No moon	Moderate	No	No	0	-	Medium <i>Angophora woodsiana</i> Low Pink Bloodwood
20/01/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	76-100 %	26-50 %	High	Yes	Yes	3.2mm in 24hrs, 7mm in 48hrs	Light showers during survey.	Medium Pink Bloodwood Low Narrow-Leaved Red Gum
4/02/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	0-25 %	No moon	High	No	Yes	0	-	Low Broad-leaved Paperbark Medium Pink Bloodwood
8/02/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	26-50 %	No moon	High	Yes	Yes	1.4mm in 24hrs, 1.4mm in 48hrs	Light showers during survey.	Light Broad-leaved Paperbark Medium Pink Bloodwood
11/02/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	26-50 %	No moon	Moderate	Yes	Yes	0mm in 24hrs, 6mm in 48hrs	-	Medium Broad-leaved Paperbark Medium Pink Bloodwood
18/02/2021	Threatened Frogs - Year 6 Summer Survey 4	Warm (>20-28°C)	No wind	76-100 %	0-25 %	High	Yes	Yes	11.4mm in 24hrs, 59.6mm in 48hrs	-	-
22/02/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	0-25 %	51-75 %	High	Yes	Yes	0mm in 24hrs, 3mm in 48hrs	Not able to survey in optimal moon phase due to prolonged wet weather when the moon phase was suitable.	High Pink Bloodwood
25/02/2021	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	26-50 %	51-75 %	High	Yes	Yes	0mm in 24hrs, 3mm in 48hrs	Bright moon phase not avoidable due to rain.	High Pink Bloodwood
14/07/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	Light (leaves moving)	0-25 %	No moon	Low	No	No	0.6mm in 24hrs, 0.6mm in 48hrs	Last quarter moon phase. Variable wind from light to moderate.	Low and uncommon Forest Red Gum Low and uncommon

Date	Survey Type	Temperature	Wind	Cloud Cover	Moon Phase	Humidity	Evidence of Rain within 24hrs	Evidence of Rain within 48hrs	Rainfall (mm)*	Comments	Flowering Resources Observed
											Narrow-Leaved Red Gum
15/07/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	Light (leaves moving)	0-25 %	No moon	Low	No	No	0mm in 24hrs, 0.6mm in 48hrs	Occasional moderate wind gusts.	Low Forest Red Gum Low and uncommon Narrow-Leaved Red Gum Low Broad-leaved Paperbark Low <i>Angophora woodsiana</i>
9/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	Moderate (branches moving)	0-25 %	No moon	Moderate	No	Yes	0.2mm in 24hrs, 0.2mm in 48hrs	-	-
12/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	Light (leaves moving)	0-25 %	No moon	Moderate	No	No	0	-	Low <i>Angophora woodsiana</i>
13/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	No wind	0-25 %	No moon	Moderate	No	No	0.2mm in 24hrs, 0.2mm in 48hrs	-	Low <i>Angophora woodsiana</i> Low Narrow-Leaved Red Gum Low Tindal's Stringybark
18/08/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	Light (leaves moving)	26-50 %	No moon	Moderate	No	No	0mm in 24hrs, 0mm in 48hrs	-	-
20/08/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	Light (leaves moving)	0-25 %	No moon	Low	No	No	0	Occasional moderate wind gusts.	Low Forest Red Gum Low Turpentine
25/08/2020	Threatened mammals (spotlighting/ call playback)	Cool (10-15°C)	No wind	0-25 %	26-50 %	Low	No	No	2.4mm in 24hrs, 2.4mm in 48hrs	Late shower/ storm passed between 9:00 and 9.30pm.	-
13/10/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	No wind	0-25 %	No moon	Moderate	No	No	0	Last quarter moon phase, late rise.	Medium Melaleuca sieberi Low Tindal's Stringybark
15/10/2020	Threatened mammals (spotlighting/ call playback)	Mild (15-20°C)	No wind	0-25 %	0-25 %	Moderate	No	No	0	-	Low Turpentine
22/10/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	26-50 %	High	No	No	0	-	-
23/10/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	26-50 %	26-50 %	High	No	No	0.4mm in 24hrs, 0.4mm in 48hrs	-	Medium Turpentine Medium Tindal's Stringybark
9/11/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	0-25 %	Moderate	No	No	0.8mm in 24hrs, 0.8mm in 48hrs	-	-
10/11/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	No wind	0-25 %	0-25 %	Moderate	No	No	0mm in 24hrs, 0.8mm in 48hrs	-	Low Northern Grey Ironbark
11/11/2020	Threatened mammals (spotlighting/ call playback)	Warm (>20-28°C)	Light (leaves moving)	0-25 %	0-25 %	Moderate	No	No	0	-	-

*Rainfall data is from the Woolgoolga to Ballina Pacific Highway Upgrade Darcy's Road weather station. Rainfall is recorded at 9am for the listed dates.



Appendix B

Nest Box Monitoring Locations and Results

Table B1 Year 6 Post Construction Nest Box Monitoring Installation Data and Results

Site	Nest Box No.	Date Installed	Easting	Northing	Nest Box Height (m)	Tree Species	DBH (cm)	Nest Box Orientation	Tree Height (m)	Year 6 Winter Monitoring		Year 6 Spring Monitoring		Year 6 Summer Monitoring	
										Date	Results	Date	Results	Date	Results
Impact Site 2 (west)	1	26/07/2017	521701	6762394	9	Small-fruited Grey Gum	40	SW	26	22/07/2020	Nil spp. Nil evidence of use.	20/10/2020	Nil spp. Nil evidence of use.	29/01/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (west)	2	26/07/2017	521638	6762383	9	Red Mahogany	35	SW	25	22/07/2020	Nil spp. Old leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material. Ants.
Impact Site 2 (west)	3	26/07/2017	521584	6762311	8	Bloodwood	35	E	24	22/07/2020	Nil spp. Nil evidence of use.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (west)	4	26/07/2017	521525	6762282	12	Spotted Gum	40	SW	26	22/07/2020	Nil spp. Leaf nesting material.	20/10/2020	Nil spp. Leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material. Ants.
Impact Site 2 (west)	5*	26/07/2017	521488	6762244	14	Grey Ironbark	50	SW	31	-	-	-	-	-	-
Impact Site 2 (west)	6	26/07/2017	521456	6762166	12	Spotted Gum	45	SW	33	22/07/2020	Nil spp. Old leaf nesting material. Ants.	20/10/2020	Nil spp. Old leaf nesting material. Ants.	29/01/2021	Nil spp. Old leaf nesting material. Ants nest.
Impact Site 2 (median)	1*	26/07/2017	521825	6762370	10	Red Mahogany	50	S	27	-	-	-	-	-	-
Impact Site 2 (median)	2	26/07/2017	521772	6762341	13	Red Mahogany	60	E	27	22/07/2020	Nil spp. Old leaf nesting material.	22/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (median)	3	26/07/2017	521757	6762307	7	Swamp Box	50	SW	24	22/07/2020	Nil spp. Old leaf nesting material.	22/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (median)	4	26/07/2017	521709	6762282	10	Grey Ironbark	40	S	28	22/07/2020	1 x female, 1 x male Squirrel Glider.	22/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (median)	5	26/07/2017	521665	6762261	11	Swamp Box	50	SE	28	22/07/2020	Nil spp. Nil evidence of use.	22/10/2020	Nil spp. Nil evidence of use. Ants	1/02/2021	Nil spp. Nil evidence of use.
Impact Site 2 (median)	6	26/07/2017	521632	6762191	8	Spotted Gum	40	SE	28	22/07/2020	Nil spp. Leaf nesting material.	22/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (east)	1	27/07/2017	521894	6762345	12	Red Mahogany	50	S	25	22/07/2020	Nil spp. Leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (east)	2	27/07/2017	521806	6762234	11	Spotted Gum	40	SW	27	22/07/2020	Nil spp. Ants.	20/10/2020	Nil spp. Ants.	29/01/2021	Nil spp. Ants.
Impact Site 2 (east)	3	27/07/2017	521768	6762166	8	Red Mahogany	30	SE	22	22/07/2020	Nil spp. Old leaf nesting material.	20/10/2020	Nil spp. Very old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (east)	4	27/07/2017	521720	6762116	11	Spotted Gum	40	SW	29	22/07/2020	Nil spp. Fresh leaf nesting material.	20/10/2020	Nil spp. Fresh leaf nesting material.	29/01/2021	1 x adult Squirrel Glider. Sex undetermined. Dispersed when establishing line.
Impact Site 2 (east)	5	27/07/2017	521687	6762085	15	Stringy Bark	40	SW	29	22/07/2020	Frog (<i>Litoria sp.</i> dispersed). Old leaf nesting material.	20/10/2020	Nil spp. Very old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Impact Site 2 (east)	6	27/07/2017	521644	6762026	10	Spotted Gum	30	S	25	22/07/2020	Nil spp. Old leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Impact Site 3 (west)	1*	11/08/2017	522612	6763123	10	Red Mahogany	45	S	20	-	-	-	-	-	-
Impact Site 3 (west)	2*	11/08/2017	522634	6763156	12	White Mahogany	65	S	25	-	-	-	-	-	-
Impact Site 3 (west)	3	11/08/2017	522645	6763207	8	Spotted Gum	40	S	25	23/07/2020	Nil spp. Old leaf nesting material.	22/10/2020	1 x glider. Species not confirmed, dispersed during setup. Old leaf nesting material.	1/02/2021	2 x Squirrel Gliders: 1 male, 1 unknown sex.
Impact Site 3 (west)	4*	11/08/2017	522695	6763226	12	Stringy Bark	40	S	20	-	-	-	-	-	-
Impact Site 3 (west)	5	11/08/2017	522716	6763250	12	Swamp Box	55	S	25	23/07/2020	Nil spp. Nil evidence of use.	22/10/2020	Nil spp. Nil evidence of use.	1/02/2021	Nil spp. Nil evidence of use.
Impact Site 3 (east)	1	27/07/2017	522834	6763203	9	Red Mahogany	40	SE	26	23/07/2020	Nil spp. Fresh leaf nesting material.	20/10/2020	Nil spp. Fresh leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 3 (east)	2	27/07/2017	522779	6763146	10	Blackbutt	30	S	28	23/07/2020	Nil spp. Old leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 3 (east)	3	27/07/2017	523467	6764328	11	Red Mahogany	30	SW	25	22/07/2020	Nil spp. Old leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material. Termites on outside and within box.
Impact Site 3 (east)	3	27/07/2017	522745	6763100	11	Spotted Gum	40	S	27	23/07/2020	Nil spp. Old leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 3 (east)	4	27/07/2017	522717	6763062	9	Red Mahogany	30	E	24	23/07/2020	Nil spp. Fresh leaf nesting material. Droppings on lid.	20/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Fresh leaf nesting material.
Impact Site 3 (east)	5	27/07/2017	522655	6762996	12	Spotted Gum	40	SW	26	23/07/2020	Nil spp. Fresh leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material. Gecko (likely Robust Velvet Gecko)	1/02/2021	1 x female Squirrel Glider adult.

Site	Nest Box No.	Date Installed	Easting	Northing	Nest Box Height (m)	Tree Species	DBH (cm)	Nest Box Orientation	Tree Height (m)	Year 6 Winter Monitoring		Year 6 Spring Monitoring		Year 6 Summer Monitoring	
										Date	Results	Date	Results	Date	Results
													Oedura robusta).		
Impact Site 4 (west)	1*	11/08/2017	523320	6764536	8	Stringy Bark	45	S	25	-	-	-	-	-	-
Impact Site 4 (west)	2*	11/08/2017	523302	6764501	8	Stringy Bark	55	S	30	-	-	-	-	-	-
Impact Site 4 (west)	3*	11/08/2017	523284	6764450	10	Stringy Bark	50	S	30	-	-	-	-	-	-
Impact Site 4 (west)	4*	11/08/2017	523270	6764391	15	Bloodwood	35	S	30	-	-	-	-	-	-
Impact Site 4 (west)	5*	11/08/2017	523246	6764347	8	Blackbutt	120	S	35	-	-	-	-	-	-
Impact Site 4 (west)	6*	11/08/2017	523216	6764293	10	Blackbutt	65	E	30	-	-	-	-	-	-
Impact Site 4 (median)	1^	11/08/2017	523391	6764279	8	Bloodwood	80	S	25	23/07/2020	Nil spp. Nil evidence of use.	-	-	-	-
Impact Site 4 (median)	2*	11/08/2017	523385	6764336	8	Smudgy Apple	40	S	25	-	-	-	-	-	-
Impact Site 4 (median)	3*	11/08/2017	523405	6764386	10	Smudgy Apple	60	S	25	-	-	-	-	-	-
Impact Site 4 (median)	4*	11/08/2017	523442	6764445	10	Smudgy Apple	55	S	30	-	-	-	-	-	-
Impact Site 4 (median)	5*	11/08/2017	523468	6764494	12	Smudgy Apple	50	S	25	-	-	-	-	-	-
Impact Site 4 (east)	1*	27/07/2017	523513	6764408	8	Red Mahogany	40	S	25	-	-	-	-	-	-
Impact Site 4 (east)	2*	27/07/2017	523486	6764362	9	Bloodwood	45	SW	26	-	-	-	-	-	-
Impact Site 4 (east)	4	27/07/2017	523438	6764249	8	Bloodwood	65	SE	25	22/07/2020	Nil spp. Nil evidence of use.	20/10/2020	Nil spp. Nil evidence of use.	29/01/2021	Nil spp. Ants. Nil evidence of use.
Impact Site 4 (east)	5	27/07/2017	523408	6764202	8	Smudgy Apple	40	S	25	22/07/2020	Nil spp. Leaf nesting material and scent.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Impact Site 4 (east)	6*	27/07/2017	523553	6764450	8	Red Mahogany	45	E	24	-	-	-	-	-	-
Impact Site 6 (west)	1	26/07/2017	524788	6767065	10	Scribbly Gum	50	S	20	23/07/2020	Nil spp. Fresh leaf nesting material.	22/10/2020	Nil spp. Fresh leaf nesting material. Ants nest.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 6 (west)	2	26/07/2017	524782	6767007	12	Stringy Bark	35	S	25	23/07/2020	Nil spp. Leaf nesting material.	22/10/2020	Nil spp. Fresh leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Impact Site 6 (west)	3	26/07/2017	524710	6766877	15	Blackbutt	40	SE	30	23/07/2020	1 x glider dispersed when establishing rope and glided to hollow-bearing stag close by. Either Sugar Glider or Squirrel Glider.	22/10/2020	1 x Squirrel Glider female (dispersed when setting line) one dependant juvenile in box.	1/02/2021	2 x gliders, including 1 adult female. Female dispersed during climb. Species not confirmed.
Impact Site 6 (west)	4	26/07/2017	524678	6766843	12	Bloodwood	40	S	20	23/07/2020	Nil spp. Fresh leaf nesting material.	22/10/2020	Nil spp. Fresh leaf nesting material.	1/02/2021	Nil spp. Fresh leaf nesting material.
Impact Site 6 (west)	5*	26/07/2017	524657	6766761	8	Stringy Bark	40	S	27	-	-	-	-	-	-
Control site 1	1	27/07/2017	522303	6762009	11	Spotted Gum	45	E	30	22/07/2020	Nil spp. Old leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Leaf nesting material.
Control site 1	2	27/07/2017	522354	6762008	9	Spotted Gum	30	S	27	22/07/2020	Nil spp. Leaf nesting material	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Control site 1	3	27/07/2017	522423	6762010	8	Red Mahogany	45	E	27	22/07/2020	Nil spp. Leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material. Odour.
Control site 1	4	27/07/2017	522517	6761981	8	White Mahogany	45	SW	24	22/07/2020	Nil spp. Nil evidence of use.	20/10/2020	Nil spp. Nil evidence of use.	29/01/2021	Nil spp. Ants.
Control site 1	5	27/07/2017	522568	6761980	14	Grey Ironbark	45	S	30	22/07/2020	Nil spp. Leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material. Termites.
Control site 2	1	11/08/2017	523210	6762772	10	Bloodwood	40	S	20	23/07/2020	Unidentified glider dispersed from nest box and glided to stag with hollows. Suspected Squirrel due to bush tail. Fresh leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Control site 2	2	11/08/2017	523251	6762765	12	Scribbly Gum	45	S	25	23/07/2020	Nil spp. Fresh leaf nesting material.	20/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Control site 2	3*	11/08/2017	523305	6762777	15	Blackbutt	60	SE	30	-	-	-	-	-	-
Control site 4	4	11/08/2017	523340	6762777	10	Bloodwood	50	S	25	23/07/2020	Nil spp. Nil evidence of use. Box slightly fire	20/10/2020	Nil spp. Nil evidence of use.	1/02/2021	Nil spp. Old leaf nesting

Site	Nest Box No.	Date Installed	Easting	Northing	Nest Box Height (m)	Tree Species	DBH (cm)	Nest Box Orientation	Tree Height (m)	Year 6 Winter Monitoring		Year 6 Spring Monitoring		Year 6 Summer Monitoring	
										Date	Results	Date	Results	Date	Results
2											damaged.				material.
Control site 2	5	11/08/2017	523405	6762789	8	Turpentine	45	S	25	23/07/2020	Nil spp. Nil evidence of use.	20/10/2020	Nil spp. Old leaf nesting material.	1/02/2021	Nil spp. Old leaf nesting material.
Control site 4	1	26/07/2017	521084	6763138	8	Spotted Gum	40	S	28	22/07/2020	Nil spp. Old leaf nesting material.	22/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Control site 4	2	26/07/2017	521093	6763099	9	Spotted Gum	45	SE	28	22/07/2020	2 x Squirrel Gliders. Dispersed when establishing line.	22/10/2020	3 x Squirrel Gliders in nesting material. One dispersed when installing string. At least two remained in the box.	29/01/2021	Nil spp. Old leaf nesting material.
Control site 4	3	26/07/2017	521134	6763032	10	Small-fruited Grey Gum	45	E	27	22/07/2020	Nil spp. Fresh leaf nesting material.	22/10/2020	Nil spp. Fresh leaf nesting material and musty smell indicative of recent usage.	22/10/2020	Nil spp. Old leaf nesting nesting material.
Control site 4	4	26/07/2017	521155	6762979	12	Grey Ironbark	40	S	30	22/07/2020	Nil spp. Fresh leaf nesting material.	22/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Control site 4	5	26/07/2017	521195	6762945	12	Grey Ironbark	30	SE	20	22/07/2020	2 x Squirrel Gliders. Dispersed when arborist began climbing.	22/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Control site 5	1	26/07/2017	521045	6763490	12	Grey Ironbark	75	S	32	22/07/2020	Nil spp. Ants.	22/10/2020	Nil spp. Ants.	29/01/2021	Nil spp. Ants.
Control site 5	2*	26/07/2017	521026	6763553	15	Blackbutt	55	SW	32	-	-	-	-	-	-
Control site 5	3	26/07/2017	521030	6763633	9	Bloodwood	55	SW	28	22/07/2020	1 x Lace Monitor	22/07/2020	Nil spp. Leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material. Remnant of bees nest.
Control site 5	4	26/07/2017	521016	6763719	9	Swamp Box	45	S	23	22/07/2020	Nil spp. Old leaf nesting material.	22/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Old leaf nesting material.
Control site 5	5	26/07/2017	521012	6763758	7	Narrow-leaved Red Gum	40	E	24	22/07/2020	1 x Lace Monitor	22/10/2020	Nil spp. Old leaf nesting material.	29/01/2021	Nil spp. Fresh leaf nesting material.

* Nest box was not monitored during Year 6 because it was burnt in the 2019 bushfire

^ Not monitored after Year 6 Winter due to the removal of access track.



Appendix C

Fauna Underpass Monitoring Results

Table C1

Summary of Fauna Underpass Monitoring Results During the Year 6 Reporting Period

	C3			C6			C6 Pipes			C7			C8			C9			C10			NBT3			SBT3			NBT2			SBT2			Total				
	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC	NR	RCC	UCC		
Antechinus sp.	4			4	1	1				1					1									2	1	1							12	2	2			
Bandicoot sp.											1				1					3			16	15	15							21	15	15				
Black Rat	7			157	133	89	3	2	1	57	50	49	37	32	30	1	1	1	6	6	6	13	3	3	53	25	15	8	1	1	10	4	4	352	257	199		
Bush Rat															1					4			1				3	1	1				9	1	1			
Cane Toad				9	1	1	8			1			4					4	1	1	6			1			2			3			38	2	2			
Cat	5			10	8	5	2			18	14	12	18	15	10			7	2	2							1	1	1				61	40	30			
Common Brushtail Possum										2	2	2				1																		3	2	2		
Eastern Blue-tongue Lizard										1													1	1	1								2	1	1			
Eastern Grey Kangaroo	1														2	2	1				57	51	49	84	77	77	18	16	16	5	5	5	167	151	148			
Eastern Water Dragon	6			79	45	24	1			15	9	5	44	21	14	4	1	1	9	6	3	12	7	7	31	9	8	6	4	3	50	21	17	257	123	82		
Eastern Water Skink																												1					14			15		
European Fox																											2	2	2	1				3	2	2		
European Hare																				1						1	1	1	1	1	1	1	1	3	2	2		
Green Tree Frog												1									2			2						3	1	1	8	1	1			
Green Tree Snake																	1																	1				
House Mouse				10	4	2														9			16	3	2	2			4				41	7	4			
Lace Monitor	2			4	3	3	12	8	4	75	71	59	55	43	34	12	11	8	15	9	7	4	4	4	7	6	6	8	8	8	7	7	6	201	170	139		
Land Mullet										2	2	2																							2	2	2	
Longnosed Bandicoot				2	2	2				2	2	2																							4	4	4	
Macropod sp.	1						2			8	5	3	1	1	1	7	6	5				12	9	8	27	27	27				1			59	48	44		
Northern Brown Bandicoot																					4	3	3	13	12	12	2							19	15	15		
Red-bellied Black Snake																											1						1			2		
Red-necked Wallaby									1						2			4			34	31	27	48	46	43	4	4	3	3	3	3	96	84	76			
Ringtail Possum															1	1	1																	1	1	1		
Rodent	1			23	10	4	8			15	8	5	17	4	3	3	1	1	3			22			29	6	5	12	3	2	14	1	1	147	33	21		
Shortbeaked Echidna	2									5	5	5	1	1	1																			8	6	6		
Skink sp.						1						1						2						1			4	1	1	9	1	1	18	2	2			
Striped Marsh Frog																											1							1				
Sun Skink																									1			2					2			5		
Swamp Wallaby	1									61	40	21	3	3	3	18	13	12	3	2	1	44	40	38	88	79	75	10	10	10	29	29	29	257	216	189		
Water Rat										1	1	1																1						7	2	2		
Grand Total	30	0	0	298	207	131	37	10	5	265	209	166	183	120	96	54	36	30	58	27	21	228	148	139	421	307	287	89	52	49	157	73	68	1820	1189	992		

NR = No. of records

RCC = No. of complete crossings

UCC = No. of unique complete crossings

NBT2 = Northbound bridge over Tabbimoble Floodway No.2

NBT3 = Northbound bridge over Tabbimoble Floodway No.3

SBT2 = Southbound bridge over Tabbimoble Floodway No.2

SBT3 = Southbound bridge over Tabbimoble Floodway No.3

Table C2 Underpass Scat/ Track Search Results for Year 6 Post Construction Monitoring

Date	Site	Season	Survey Number	Species	Identification Confidence	Recording Type	Direction of Movement	Complete Crossing	Comments
3/8/2020	NBT2	Winter	1	Rattus sp.	Probable	Scats	-	-	-
3/8/2020	NBT2	Winter	1	Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Probable	Scats	-	-	-
3/8/2020	NBT3	Winter	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Tracks	East-west and west-east	Yes	-
3/8/2020	NBT3	Winter	1	Elapid sp.	Definite	Carcass	-	-	-
3/8/2020	NBT3	Winter	1	Southern Myotis (<i>Myotis macropus</i>)	Definite	Present	-	-	Individual roosting in scupper.
3/8/2020	SBT2	Winter	1	Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Probable	Scats	-	-	-
3/8/2020	SBT2	Winter	1	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
3/8/2020	SBT2	Winter	1	Antechinus sp.	Probable	Scats	-	-	-
3/8/2020	SBT2	Winter	1	Rattus sp.	Definite	Scats	-	-	-
3/8/2020	SBT2	Winter	1	European Fox (<i>Vulpes vulpes</i>)	Probable	Scats	-	-	-
3/8/2020	SBT3	Winter	1	Macropod sp.	Probable	Scats	-	-	Likely Eastern Grey Kangaroo or Red-necked Wallaby
3/8/2020	C3	Winter	1	Rattus sp.	Probable	Tracks	Non-directional	No	Habitation activity.
3/8/2020	C3	Winter	1	Approx. 1800 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Large guano deposits.
3/8/2020	C6	Winter	1	Rattus sp.	Definite	Scats	-	-	-
3/8/2020	C6	Winter	1	5 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins in fauna underpass and lift hole in the culverts to the south. Minor guano deposits.
3/8/2020	C6	Winter	1	Cat (<i>Felis catus</i>)	Definite	Tracks	Non-directional	No	-
3/8/2020	C7	Winter	1	Water Rat (<i>Hydromys chrysogaster</i>)	Probable	Scats	-	-	-
3/8/2020	C7	Winter	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Tracks	East-west	Yes	-
3/8/2020	C7	Winter	1	Cat (<i>Felis catus</i>)	Probable	Tracks	East-west	Yes	-
3/8/2020	C7	Winter	1	7 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Minor guano deposits.
3/8/2020	C7	Winter	1	2 Eastern Crevice Skink (<i>Egernia mcphreei</i>)	Definite	Present	-	-	Sheltering in cell join.
3/8/2020	C7	Winter	1	Lace Monitor (<i>Varanus varius</i>)	Possible	Tracks	Incomplete	No	-
3/8/2020	C8	Winter	1	Approx. 350 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Moderate guano deposits.
3/8/2020	C9	Winter	1	9 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Guano deposits.
3/8/2020	C9	Winter	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Tracks	East-west and west-east	Yes	-
3/8/2020	C10	Winter	1	Green Tree Frog (<i>Litoria caerulea</i>)	Definite	Present	-	-	Sheltering in cell join.
3/8/2020	C10	Winter	1	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
3/8/2020	C10	Winter	1	Approx. 1000 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Large guano deposits.
27/8/2020	NBT2	Winter	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
27/8/2020	NBT2	Winter	2	Rattus sp.	Definite	Scats	-	-	-
27/8/2020	NBT3	Winter	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Tracks	East-west and west-east	Yes	-
27/8/2020	NBT3	Winter	2	Macropod sp.	Probable	Scats	-	-	Likely Eastern Grey Kangaroo or Red-necked Wallaby
27/8/2020	NBT3	Winter	2	Eastern Grey Kangaroo (<i>Macropus giganteus</i>)	Probable	Tracks	East-west	Yes	-
27/8/2020	NBT3	Winter	2	1 Eastern Bent-winged Bat (<i>Miniopterus orianae oceanensis</i>)	Definite	Present	-	-	Roosting in scupper.
27/8/2020	SBT2	Winter	2	Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Probable	Scats	-	-	-
27/8/2020	SBT2	Winter	2	Green Tree Frog (<i>Litoria caerulea</i>)	Probable	Scats	-	-	-
27/8/2020	SBT2	Winter	2	Antechinus sp.	Definite	Scats	-	-	-
27/8/2020	SBT2	Winter	2	Water Rat (<i>Hydromys chrysogaster</i>)	Definite	Scats	-	-	-
27/8/2020	SBT2	Winter	2	Macropod sp.	Probable	Scats	-	-	-
27/8/2020	SBT2	Winter	2	Water Dragon (<i>Intellagama lesueurii</i>)	Definite	Present	-	-	-
27/8/2020	SBT3	Winter	2	Macropod sp.	Probable	Scats	-	-	Likely Eastern Grey Kangaroo or Red-necked Wallaby
27/8/2020	SBT3	Winter	2	Rattus sp.	Probable	Scats	-	-	-
27/8/2020	SBT3	Winter	2	Sun Skink (<i>Lampropholis delicata</i>)	Definite	Present	-	-	-
27/8/2020	SBT3	Winter	2	Macropod sp.	Probable	Tracks	East-west	Probable	Likely Eastern Grey Kangaroo or Red-necked Wallaby
27/8/2020	C3	Winter	2	Rattus sp.	Probable	Scats	-	-	-
27/8/2020	C3	Winter	2	Approx. 1650 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Large guano deposits.
27/8/2020	C3	Winter	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
27/8/2020	C6	Winter	2	2 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins in fauna underpass and lift hole in the culverts to the south. Minor guano deposits.
27/8/2020	C6	Winter	2	Cat (<i>Felis catus</i>)	Definite	Tracks	Non-directional	No	-

Date	Site	Season	Survey Number	Species	Identification Confidence	Recording Type	Direction of Movement	Complete Crossing	Comments
27/8/2020	C6	Winter	2	Cane Toads (<i>Rhinella marina</i>)	Definite	Present	-	-	In pooled water within culvert.
27/8/2020	C7	Winter	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Tracks	East-west	Yes	-
27/8/2020	C7	Winter	2	Cat (<i>Felis catus</i>)	Probable	Tracks	East-west	Yes	-
27/8/2020	C7	Winter	2	5 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Guano present.
27/8/2020	C7	Winter	2	Cat (<i>Felis catus</i>)	Possible	Tracks	East-west	Unknown	-
27/8/2020	C8	Winter	2	Approx. 220 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Moderate guano deposits.
27/8/2020	C9	Winter	2	10 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Guano present.
27/8/2020	C9	Winter	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Tracks	East-west and west-east	Yes	-
27/8/2020	C9	Winter	2	1 Eastern Bent-winged Bat (<i>Miniopterus orianae oceanensis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Guano present.
27/8/2020	C9	Winter	2	Antechinus sp.	Possible	Scats	-	-	-
27/8/2020	C10	Winter	2	Water Rat (<i>Hydromys chrysogaster</i>)	Probable	Scats	-	-	-
27/8/2020	C10	Winter	2	Approx. 750 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Large guano deposits.
27/8/2020	C10	Winter	2	Green Tree Frog (<i>Litoria caerulea</i>)	Definite	Present	-	-	Sheltering in cell join.
18/9/2020	NBT2	Spring	1	Rattus sp.	Definite	Scats	-	-	-
18/9/2020	NBT2	Spring	1	Water Dragon (<i>Intellagama lesueurii</i>)	Definite	Scats	-	-	-
18/9/2020	NBT3	Spring	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Tracks	East-west and west-east	Yes	-
18/9/2020	NBT3	Spring	1	Eastern Grey Kangaroo (<i>Macropus giganteus</i>)	Probable	Tracks	East-west	Yes	-
18/9/2020	NBT3	Spring	1	Macropod sp.	Probable	Scats	-	-	Likely Eastern Grey Kangaroo or Red-necked Wallaby
18/9/2020	NBT3	Spring	1	Rattus sp.	Definite	Scats and tracks	-	-	-
18/9/2020	NBT3	Spring	1	Striped Marsh Frog (<i>Limnodynastes peronii</i>)	Definite	Present	-	-	-
18/9/2020	NBT3	Spring	1	Martin's Bar-sided Skink (<i>Eulamprus martini</i>)	Definite	Present	-	-	-
18/9/2020	SBT2	Spring	1	Antechinus sp.	Probable	Scats	-	-	-
18/9/2020	SBT2	Spring	1	Rattus sp.	Probable	Scats	-	-	-
18/9/2020	SBT2	Spring	1	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
18/9/2020	SBT3	Spring	1	Rattus sp.	Definite	Scats	-	-	-
18/9/2020	SBT3	Spring	1	Sun Skink (<i>Lampropholis delicata</i>)	Definite	Present	-	-	-
18/9/2020	SBT3	Spring	1	Macropod sp.	Probable	Tracks	East-west	Likely	-
18/9/2020	C3	Spring	1	Approx. 55 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Large guano deposits.
18/9/2020	C3	Spring	1	Rattus sp.	Probable	Tracks	Non-directional	-	Habitation activity.
18/9/2020	C3	Spring	1	Cane Toads (<i>Rhinella marina</i>)	Definite	Present	-	-	Sheltering in cell near pooled water.
18/9/2020	C6	Spring	1	Rattus sp.	Definite	Scats	-	-	Underpass cleaned as part of construction works.
18/9/2020	C7	Spring	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	East-west	Yes	-
18/9/2020	C7	Spring	1	Cat (<i>Felis catus</i>)	Probable	Tracks	East-west	Yes	-
18/9/2020	C7	Spring	1	Lace Monitor (<i>Varanus varius</i>)	Possible	Tracks	Incomplete	-	-
18/9/2020	C8	Spring	1	Water Dragon (<i>Intellagama lesueurii</i>)	Definite	Present	-	-	-
18/9/2020	C9	Spring	1	3 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Guano present.
18/9/2020	C9	Spring	1	Antechinus sp.	Probable	Scats	-	-	-
18/9/2020	C9	Spring	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	East-west and west-east	Yes	-
18/9/2020	C10	Spring	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Definite	Scats	-	-	In culvert
18/9/2020	C10	Spring	1	Short-beaked Echidna (<i>Tachyglossus aculeatus</i>)	Probable	Tracks	East-west	Yes	-
18/9/2020	C10	Spring	1	Approx. 50 Little Bent-winged Bats (<i>Miniopterus australis</i>)	Definite	Present	-	-	Roosting in culvert cell joins. Guano present.
18/9/2020	C10	Spring	1	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
18/9/2020	C10	Spring	1	Rattus sp.	Probable	Scats	-	-	-
12/11/2020	NBT2	Spring	2	Rattus sp.	Definite	Scats	-	-	-
12/11/2020	NBT2	Spring	2	Amphibian	Possible	Scats	-	-	-
12/11/2020	NBT2	Spring	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Possible	Scats	-	-	-
12/11/2020	NBT2	Spring	2	Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Possible	Scats	-	-	-
12/11/2020	NBT3	Spring	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	East-west	Yes	-
12/11/2020	NBT3	Spring	2	Macropod sp.	Probable	Scats	-	-	Likely Eastern Grey Kangaroo or Red-necked Wallaby
12/11/2020	SBT2	Spring	2	Antechinus sp.	Probable	Scats	-	-	-
12/11/2020	SBT2	Spring	2	Rattus sp.	Probable	Scats	-	-	-
12/11/2020	SBT2	Spring	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-

Date	Site	Season	Survey Number	Species	Identification Confidence	Recording Type	Direction of Movement	Complete Crossing	Comments
12/11/2020	SBT2	Spring	2	Egernia sp.	Definite	Present	-	-	-
12/11/2020	SBT2	Spring	2	Amphibian	Possible	Scats	-	-	-
12/11/2020	SBT3	Spring	2	Swamp Wallaby (Wallabia bicolor)	Definite	Scats	-	-	-
12/11/2020	SBT3	Spring	2	Sun Skink (Lampropholis delicata)	Definite	Present	-	-	-
26/11/2020	C3	Spring	2	Two dead Little Bent-winged Bats (Miniopterus australis)	Definite	Present; guano	-	-	-
26/11/2020	C3	Spring	2	Rattus sp.	Definite	Scats	-	-	-
26/11/2020	C3	Spring	2	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
26/11/2020	C3	Spring	2	Common Brushtail Possum (Trichosurus vulpecula)	Possible	Scats	-	-	-
26/11/2020	C3	Spring	2	Swamp Wallaby (Wallabia bicolor)	Probable	Scats and tracks	Non-directional	No	Eastern side of culvert
3/8/2020	C6	Spring	2	Rattus sp.	Probable	Scats	-	-	-
3/8/2020	C6	Spring	2	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
3/8/2020	C6	Spring	2	Cane Toad (Rhinella marina)	Definite	Present	-	-	Within and around pooled water
3/8/2020	C6	Spring	2	Swamp Wallaby (Wallabia bicolor)	Possible	Scats	-	-	Pipe culverts to the south.
26/11/2020	C7	Spring	2	Rattus sp.	Probable	Scats	-	-	-
26/11/2020	C7	Spring	2	Swamp Wallaby (Wallabia bicolor)	Probable	Tracks	East-west	Yes	-
26/11/2020	C8	Spring	2	Rattus sp.	Probable	Scats	-	-	-
26/11/2020	C8	Spring	2	Swamp Wallaby (Wallabia bicolor)	Probable	Tracks	West-east	Yes	-
26/11/2020	C8	Spring	2	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
26/11/2020	C9	Spring	2	Water Dragon (Intellagama lesueurii)	Definite	Present at entrance; scats	-	-	-
26/11/2020	C9	Spring	2	Rattus sp.	Definite	Scats	-	-	-
26/11/2020	C9	Spring	2	Swamp Wallaby (Wallabia bicolor)	Probable	Scats and tracks	West-east	Yes	-
26/11/2020	C10	Spring	2	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
26/11/2020	C10	Spring	2	Common Brushtail Possum (Trichosurus vulpecula)	Probable	Scats	-	-	-
20/1/2021	NBT2	Summer	1	Amphibian	Probable	Scats	-	-	-
20/1/2021	NBT2	Summer	1	Rattus sp.	Definite	Scats	-	-	-
20/1/2021	NBT2	Summer	1	Swamp Wallaby (Wallabia bicolor)	Definite	Tracks	Non-directional	No	-
15/2/2021	NBT3	Summer	1	Swamp Wallaby (Wallabia bicolor)	Definite	Scats and tracks	East-west and west-east	Yes	-
15/2/2021	NBT3	Summer	1	Eastern Grey Kangaroo (Macropus giganteus)	Probable	Tracks	East-west and west-east	Yes	-
15/2/2021	NBT3	Summer	1	Rattus sp.	Definite	Scats	-	-	-
15/2/2021	NBT3	Summer	1	Amphibian	Probable	Scats	-	-	-
15/2/2021	NBT3	Summer	1	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
15/2/2021	NBT3	Summer	1	Martin's Bar-sided Skink (Eulamprus martini)	Definite	Present	-	-	-
20/1/2021	SBT2	Summer	1	Antechinus sp.	Probable	Scats	-	-	-
20/1/2021	SBT2	Summer	1	Rattus sp.	Definite	Scats	-	-	-
20/1/2021	SBT2	Summer	1	Egernia sp.	Probable	Present	-	-	Not able to be captured to confirm identification
20/1/2021	SBT2	Summer	1	Amphibian	Probable	Scats	-	-	-
20/1/2021	SBT2	Summer	1	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
15/2/2021	SBT3	Summer	1	Cane Toad (Rhinella marina)	Definite	Present	-	-	-
15/2/2021	SBT3	Summer	1	Swamp Wallaby (Wallabia bicolor)	Probable	Scats and Tracks	East-west and west-east	Yes	-
15/2/2021	SBT3	Summer	1	Macropod sp.	Probable	Scats	-	-	Likely Eastern Grey Kangaroo or Red-necked Wallaby
15/2/2021	SBT3	Summer	1	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
15/2/2021	SBT3	Summer	1	Rattus sp.	Definite	Scats	-	-	-
20/1/2021	C3	Summer	1	Rattus sp.	Definite	Scats and tracks	Non-directional	Unknown	Habitation activity.
20/1/2021	C3	Summer	1	Lace Monitor (Varanus varius)	Probable	Tracks	East-west	Unknown	-
20/1/2021	C3	Summer	1	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
20/1/2021	C3	Summer	1	Water Rat (Hydromys chrysogaster)	Probable	Scats	-	-	-
20/1/2021	C3	Summer	1	1 Little Bent-winged Bats (Miniopterus australis)	Definite	Present	-	-	Roosting in culvert cell join. Guano present.
20/1/2021	C6	Summer	1	Water Dragon (Intellagama lesueurii)	Probable	Scats	-	-	-
20/1/2021	C6	Summer	1	Amphibian	Probable	Scats	-	-	-
20/1/2021	C6	Summer	1	Rattus sp.	Definite	Tracks	East-west and west-east	Yes	Pipe culvert to south
20/1/2021	C6	Summer	1	Lace Monitor (Varanus varius)	Probable	Tracks	Incomplete	Unknown	Pipe culvert to south
20/1/2021	C6	Summer	1	Cane Toad (Rhinella marina)	Definite	Present	-	-	Pipe culvert to south

Date	Site	Season	Survey Number	Species	Identification Confidence	Recording Type	Direction of Movement	Complete Crossing	Comments
20/1/2021	C7	Summer	1	Amphibian	Probable	Scats	-	-	-
20/1/2021	C7	Summer	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	East-west and west-east	Yes	-
20/1/2021	C7	Summer	1	Cat (<i>Felis catus</i>)	Probable	Tracks	N/A	No	At western end of culvert
20/1/2021	C7	Summer	1	Lace Monitor (<i>Varanus varius</i>)	Probable	Tracks	West-east	Yes	-
20/1/2021	C8	Summer	1	Amphibian	Probable	Scats	-	-	-
20/1/2021	C8	Summer	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	N/A	No	At western end of culvert
20/1/2021	C8	Summer	1	Lace Monitor (<i>Varanus varius</i>)	Probable	Tracks	Incomplete	Unknown	-
20/1/2021	C9	Summer	1	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	East-west and west-east	Yes	-
20/1/2021	C10	Summer	1	Water Rat (<i>Hydromys chrysogaster</i>)	Probable	Tracks	Non-directional	No	Habitation activity.
20/1/2021	C10	Summer	1	Cane Toads (<i>Rhinella marina</i>)	Definite	Present	-	-	100's of toadlets and one adult in culvert.
15/2/2021	NBT2	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
15/2/2021	NBT2	Summer	2	Rattus sp.	Definite	Scats	-	-	-
20/1/2021	NBT3	Summer	2	Amphibian	Probable	Scats	-	-	-
20/1/2021	NBT3	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
20/1/2021	NBT3	Summer	2	Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Possible	Scats	-	-	-
15/2/2021	SBT2	Summer	2	Rattus sp.	Definite	Scats	-	-	-
15/2/2021	SBT2	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
20/1/2021	SBT3	Summer	2	Cane Toad (<i>Rhinella marina</i>)	Definite	Present	-	-	-
20/1/2021	SBT3	Summer	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Scats and tracks	Non-directional	Unknown	-
20/1/2021	SBT3	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
15/2/2021	C3	Summer	2	Rattus sp.	Definite	Scats and tracks	Non-directional	Unknown	Habitation activity.
15/2/2021	C3	Summer	2	Lace Monitor (<i>Varanus varius</i>)	Probable	Tracks	East-west	Yes	-
15/2/2021	C3	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
15/2/2021	C3	Summer	2	Water Rat (<i>Hydromys chrysogaster</i>)	Probable	Scats	-	-	-
15/2/2021	C3	Summer	2	Amphibian	Probable	Scats	-	-	-
15/2/2021	C3	Summer	2	Cane Toad (<i>Rhinella marina</i>)	Definite	Carcass	-	-	-
15/2/2021	C6	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
15/2/2021	C6	Summer	2	Amphibian	Probable	Scats	-	-	-
15/2/2021	C6	Summer	2	Rattus sp.	Definite	Tracks	East-west and west-east	Yes	Pipe culvert to south
15/2/2021	C6	Summer	2	Lace Monitor (<i>Varanus varius</i>)	Probable	Tracks	Incomplete	Unknown	Pipe culvert to south
15/2/2021	C6	Summer	2	Cane Toad (<i>Rhinella marina</i>)	Definite	Carcass	-	-	Pipe culvert to south
15/2/2021	C7	Summer	2	Amphibian	Probable	Scats	-	-	-
15/2/2021	C7	Summer	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	East-west and west-east	Yes	-
15/2/2021	C7	Summer	2	Possum	Possible	Scats	-	-	-
15/2/2021	C8	Summer	2	Amphibian	Probable	Scats	-	-	-
15/2/2021	C8	Summer	2	Swamp Wallaby (<i>Wallabia bicolor</i>)	Probable	Tracks	East-west	Yes	-
15/2/2021	C8	Summer	2	Cat (<i>Felis catus</i>)	Probable	Tracks	N/A	No	At western end of culvert
15/2/2021	C8	Summer	2	Lace Monitor (<i>Varanus varius</i>)	Probable	Tracks	East-west and west-east	Yes	-
15/2/2021	C8	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
15/2/2021	C8	Summer	2	Rattus sp.	Definite	Scats	-	-	-
15/2/2021	C9	Summer	2	Lace Monitor (<i>Varanus varius</i>)	Possible	Scats and tracks	West-east	Yes	-
15/2/2021	C9	Summer	2	Rattus sp.	Definite	Scats	-	-	-
15/2/2021	C9	Summer	2	Water Dragon (<i>Intellagama lesueurii</i>)	Probable	Scats	-	-	-
20/1/2021	C10	Summer	2	Possum	Possible	Scats	-	-	-
20/1/2021	C10	Summer	2	Lace Monitor (<i>Varanus varius</i>)	Probable	Tracks	Unclear (could be both directions)	Yes	-
20/1/2021	C10	Summer	2	Rattus sp.	Definite	Scats	-	-	-
20/1/2021	C10	Summer	2	Cane Toads (<i>Rhinella marina</i>)	Definite	Present	-	-	100's of toadlets and four adults in culvert.
4/12/2020	C6	Summer	Opportunistic	Cane Toads (<i>Rhinella marina</i>)	Definite	Present	-	-	Within and around pooled water
4/12/2020	C6	Summer	Opportunistic	Water Dragon (<i>Intellagama lesueurii</i>)	Definite	Present	West-east	Yes	-



Appendix D

Restoration of Vegetation Connectivity Corridor Results

Table D1 Vegetation Quadrat Results for Year 3 Autumn, Year 4 Spring and Year 6 Spring Post Construction Monitoring

TREES (T1) > 3m			Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8		
Scientific name	Common name	Native/ Weed	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp
<i>Acacia concurrens</i>	Curracabah	Native							3	2											1	1			1	
<i>Allocasuarina littoralis</i>	Black Sheoak	Native				1	1		1	1		1	1						1			1	1			
<i>Banksia ericifolia subsp. ericifolia</i>	Heath-leaved Banksia	Native																				1				
<i>Callistemon salignus</i>	Willow Bottlebrush	Native																1	1			1				
<i>Eucalyptus tereticornis</i>	Forest Red Gum	Native	1			1	1	1	1	1	1	1	1	2	1	1	1	2	2	2	1	2	1			
<i>Lophostemon suaveolens</i>	Swamp Box	Native	1	1	1	1	2	2	3	4	5	2	2	4	2	2	2	1	1	2	2	2	2	2	2	3
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	Native	5	5	6	3	3	3	1	1		2	1	2				2	2	1				2	2	1
<i>Melaleuca sieberi</i>	Sieber's Paperbark	Native	1											1							1	1				
Number of native species			4	2	2	4	4	3	5	5	2	4	4	4	2	2	2	4	5	3	5	7	2	2	3	2
Number of exotic species			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Height (m)			6	6	7	5	5	8	6	6	10	6	6	8	5	5	7	6	6	8	6	6	7	6	6	8
Cover of native species*			5	6	6	3	3	3	4	4	5	3	3	4	2	2	2	4	4	3	2	2	2	3	2	3
Cover of exotic species*			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*Cover score

Class	Percentage Cover
1	<5% sparse
2	<5% common
3	5-25%
4	26-50%
5	51-75%
6	76-100%

Table D1 Vegetation Quadrat Results for Year 3 Autumn, Year 4 Spring and Year 6 Spring Post Construction Monitoring

SHRUBS (T2) < 3m			Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8			
Scientific name	Common name	Native/ Weed	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	Yr 3 A	Yr 4 Sp	Yr 6 Sp	
<i>Acacia concurrens</i>	Curracabah	Native				1	1		3	2	2							1	1		1	1	1			2	
<i>Acacia melanoxylon</i>	Blackwood	Native																			1	1					
<i>Allocasuarina littoralis</i>	Black Sheoak	Native	1			1	1		1	1		1	1					1	1								
<i>Amyema congener</i>	Mistletoe	Native		1																					1	1	
<i>Baccharis halimifolia</i> *	Groundsel Bush	Weed	1			1	1	1	1	1		1	1	1											1	1	
<i>Banksia ericifolia</i> subsp. <i>ericifolia</i>	Heath-leaved Banksia	Native	1	1		1	1	1	1	1	1	1	1	1				1	1								
<i>Banksia oblongifolia</i>	Swamp Banksia	Native				1	1	1	1	1	1	1	1	1				1	1		1	1					
<i>Callistemon pachyphyllus</i>	Wallum Bottlebrush	Native				1	1		1	1		1						1	1		1	1					
<i>Callistemon salignus</i>	Willow Bottlebrush	Native													1	1		1	1	1	1	1					
<i>Cinnamomum camphora</i> *	Camphor Laurel	Weed																								1	
<i>Eucalyptus tereticornis</i>	Forest Red Gum	Native			1	1	1		1	1		1	1	2	1	1	1	1	1	2	1	2	1	2	1	1	
<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>	Cheese Tree	Native							1																		
<i>Leptospermum brachyandrum</i>	Teatree	Native	1	1	1																						
<i>Lophostemon suaveolens</i>	Swamp Box	Native	1	1	1	1	2	2	3	4	4	1	2	3	2	2	1	2	2	2	2	2	2	2	2	2	
<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark	Native				1	1	1																			
<i>Melaleuca nodosa</i>	Prickly-leaved Paperbark	Native	1	1		1	1		1	1	1	1	1			1	1				2	2	1				
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	Native	2	2		2	2	2	1	2	1	1	1		1	1	1	1	1	2	1	1	1	2		1	
<i>Melaleuca sieberi</i>	Sieber's Paperbark	Native	2	2	2	1	1	2	1	1	1	1	1	1	1	1		1	1		1	1	1				
<i>Melaleuca thymifolia</i>	Thyme Honey-myrtle	Native			2																						
Number of native species			7	7	5	10	11	7	11	11	7	9	8	4	5	5	4	11	10	4	10	10	6	4	3	3	
Number of exotic species			1	0	0	1	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	
Height (m)			2	2	1	3	3	2	4	4	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	
Cover of native species*			3	3	3	3	3	3	4	4	4	3	3	3	2	2	2	3	3	3	3	2	2	3	2	2	
Cover of exotic species*			1	0	0	1	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0

*Cover score

Class	Percentage Cover
1	<5% sparse
2	<5% common
3	5-25%
4	26-50%
5	51-75%
6	76-100%

Table D2 Photo Point Results for Year 6 Spring Monitoring



Q1



Q2



Q3



Q4



Q5



Q6



Q7



Q8



Appendix E

Roadkill Monitoring Results

Table E1 Roadkill Monitoring Survey Dates and Results for Year 6 Post Construction Monitoring

Season	Date	Survey No.	Species	Lane	Fauna Fencing Present	Comment	Approx. Age of Carcass	Easting	Northing
Winter	9/07/2020	Opportunistic	Dove	Northbound	Yes	-	1 day	524002	6765346
Winter	10/07/2020	1	Northern Brown Bandicoot	Southbound	Yes	-	< 1 week	524144	6765552
Winter	15/07/2020	2	-	-	-	Nil roadkill detected	-		
Winter	12/08/2020	3	Unidentifiable Bird	Southbound	Yes	-	1 week	524319	6765870
Winter	20/08/2020	4	Unidentifiable Bird	Northbound	Yes	-	< 1 week	521090	6761313
Winter	26/08/2020	Opportunistic	Greater Glider	Northbound	Yes	In winter 2020, only one lane per lane was open	2 days	522022	6762587
Spring	18/09/2020	1	Short-beaked Echidna	Northbound	Yes	Fencing on western side but not at median	1 day	523183	6764024
Spring	2/10/2020	2	Lace Monitor	Northbound	Yes	Fencing not likely to be a barrier to Lace Monitor	1 week	523564	6764788
Spring	8/10/2020	3	-	-	-	Nil roadkill detected	-		
Spring	22/10/2020	4	-	-	-	Nil roadkill detected	-		
Spring	12/11/2020	Opportunistic	Little Red Flying-fox	Bundjalung Rest Area	No	-	1 day	522508	6763137
Summer	1/12/2020	1	Koala	Northbound	Yes	-	1 week	522129	6762673
Summer	1/12/2020	1	Little Red Flying-fox	Northbound	Yes	At Bundjalung Rest Area exit	3 days	522287	6762792
Summer	1/12/2020	1	Red-necked Wallaby	Bundjalung Rest Area	No	-	1 week	522625	6763490
Summer	1/12/2020	1	Unidentifiable Bird	Southbound	Yes	-	1 week	524019	6765336
Summer	1/12/2020	1	Unidentifiable Bird	Southbound	Yes	Medium sized bird	< 1 week	521266	6761610
Summer	20/01/2021	2	Cane Toad	Northbound	Yes	-	< 1 week	521305	6761822
Summer	20/01/2021	2	Kookaburra	Southbound	Yes	-	1-2 weeks	524133	6765524
Summer	20/01/2021	2	Little Red Flying-fox	Northbound	Yes	-	1-2 weeks	521171	6761449
Summer	20/01/2021	2	Unidentifiable Bird	Southbound	Yes	-	1 day	523049	6763651
Summer	20/01/2021	2	Cane Toad	Northbound	Yes	-	1 week	521686	6762321
Summer	4/02/2021	3	Magpie	Southbound	Yes	-	1 week	523002	6763561
Summer	15/02/2021	4	Carpet Python	Southbound	Yes	-	1 week	522885	6763363
Summer	15/02/2021	4	Cane Toad	Northbound	Yes	-	< 1 week	521681	6762172
Summer	15/02/2021	4	Crow	Northbound	Yes	-	2 days	524176	6765668
Summer	15/02/2021	4	Carpet Python	Northbound	Yes	-	< 1 week	522530	6763000



Appendix F

Rufous Bettong/ Brush-tailed Phascogale Camera Trap Results

Table F1

Year 3 Rufous Bettong and Brush-tailed Phascogale Camera Trap Results - Number of Traps that Recorded Each Species at Each Site per Season

	Impact Site 1 (west)			Impact Site 1 (east)			Impact Site 2 (west)			Impact Site 2 (east)			Impact Site 3 (west)			Impact Site 3 (east)			Impact Site 4 (west)			Impact Site 4 (east)			Impact Site 5 (west)			Impact Site 5 (east)			Control Site 1			Control Site 2			Control Site 3			Control Site 4			Control Site 5			Total No. of Sites/Species				
	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	Impact	Control
Antechinus sp.	2		3	1	1	1	3	1	2			3	2	1	3	2		3	2	1	1	1	5		4	2	2	2	1	1	1	2			2			1	1	2			10	4	14					
Bandicoot																																												2	1	3				
Black Rat	1																																											3	1	4				
Brown Antechinus			1																																									4	0	4				
Brush-tailed Phascogale	1		1		2		2	3																																				6	2	8				
Bush Rat	4	4	4	4	4	6	3	4	2	5	6	1	4	5		5	4	1		1	2	3	2	1	3	4	6	6	5		6	5	3	4	2	1	4	1	1	5	4	3	6	6	1	10	5	15		
Common Brushtail Possum	3	1	2	3	5	2	3	5	3																																				7	4	11			
Common Ringtail Possum	1																																												3	0	3			
Dingo / Wild Dog				1	1	2	1																																						6	3	9			
Eastern Grey Kangaroo	1	1		1	2																																								6	4	10			
Fawn-footed Melomys						2																																						1	2	4				
Feral Cat																																													2	0	2			
Feral Cat or Dog																																														1	0	1		
House Mouse	1		1				1	1	2																																				5	0	5			
Koala							1																																						1	2	3			
Long-nosed Bandicoot	4	1	5	3	4	3		1	4	4	1	1	1		2	4	1		1	2	1	3	2	1	2	5	4	1	4		5	2	1	2		2	1	2		4	1	5	6	10	5	15				
Long-nosed Potoroo																																														2	3	5		
Macropod sp.																																														0	1	1		
Native Mouse																																														2	0	2		
Northern Brown Bandicoot	3	2	2	2	2	2	2	1	2	2	3	1	6	4	1	4	3	1	3	3	3	4	2	3	5	1	1	5	3		1	2	1	3	5	1	2	3	2	2		2	1	10	5	15				
Red-necked Pademelon																																															1	4	5	
Red-necked Wallaby			1	1			1																																							7	3	10		
Rodent	1			1				1		2																																				6	0	6		
Short-beaked Echidna	1				1			3	3	5	3	1		1		2	2	2	1	3		1	1				3	1	1		3		2		1	2	1	4				2	1	10	5	15				
Short-eared Possum			3	1	1	2																																							2	2	7			
Swamp Rat																																														2	1	3		
Swamp Wallaby	4	4	1	5	6	5	4	4	4	4	4	1	2	3	1	2	4	1	3	4	3	4	3	2	6	5	3	1	1		3	4	2	3	4	4	5	3		2	2		4	3	10	5	15			
Wild Dog																																														1	0	1		
Yellow-footed Antechinus	1	4	1	1	5	3				2	6		5	1		5	1	1		1	3	5		1	3	5	1	3	2		5	4		4	4	1	3	5	2	1	1		3	1	9	5	14			
No. Species/Site	14	7	12	12	12	10	10	9	9	10	7	6	11	10	7	9	9	6	9	11	10	10	9	7	11	12	8	12	10	5	9	11	7	9	5	9	8	8	4	13	10	8	10	12	7	Mean	4.9	2.3	7.2	
																																															SD	3.43	1.95	5.06

W = Winter
Sp = Spring
Su = Summer

Table F1

Year 4 Rufous Bettong and Brush-tailed Phascogale Camera Trap Results - Number of Traps that Recorded Each Species at Each Site per Season

	Impact Site 1 (west)			Impact Site 1 (east)			Impact Site 2 (west)			Impact Site 2 (east)			Impact Site 3 (west)			Impact Site 3 (east)			Impact Site 4 (west)			Impact Site 4 (east)			Impact Site 5 (west)			Impact Site 5 (east)			Control Site 1			Control Site 2			Control Site 3			Control Site 4			Control Site 5			Total No. of Sites/Species						
	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	Impact	Control	Total	
Antechinus sp.	3	1	3	4	1	2	5	1	2	2	1	2	1	4	4	3	6	4	2	1	2	1	1	4	3	2	1	6	1	4	5	1	2	4	2	1	3	3	3	5	3	4	10	5	15							
Bandicoot sp.				1	1																																							2	4	6						
Black Rat				1								1																																4	4	8						
Brown Hare																																												0	1	1						
Brush-tailed Phascogale	2	1	2	2	1	1	1	1	2																		2																		5	2	7					
Bush Rat	6	5	6	6	4	4	6	4	4	5	4	5	6	3	5	6	4	5		1	2	3	3		2	3	4	5	1	2	5	1	5	4	5	4		2	1	4	3	6	6	6	10	5	15					
Common Brushtail Possum	3	3	3	4	2	1	6	3	3									4	5	4				4	5	4	1	1		2	3	1			2	3	1									6	3	9				
Common Dunnart	2						2		2											2	3					1																			4	0	4					
Common Ringtail Possum	1	1																																											2	1	3					
Dingo / Wild Dog / Cat					1																1																								4	3	7					
Dusky Antechinus																																														1	0	1				
Eastern Grey Kangaroo														1	1	1	1	2	3	3	1		2																						7	2	9					
Fawn-footed Melomys		1			1																																									3	2	5				
Feathertail Glider																																														1	0	1				
Feral Cat																																														2	1	3				
House Mouse	1		1	1			2																																							6	2	8				
Koala				1																																										3	1	4				
Long-nosed Bandicoot	6	3	4	4	2	2	1	2	2	5	2	1	3		3	4		2	4	3	2	1	3	1	1	2	2	4	1	1	5	2	4	3	2	1	1	1	1	1	1	4	4	4	10	5	15					
Long-nosed Potoroo																																																3	3	6		
Macropod sp.				1	1																																										7	2	9			
Northern Brown Bandicoot	3	4	4	5	4	2	6	4	2	1		1	4	4	2	4	2	3	2	2	1	3	2		1	5	3	2		2	2	3	1		3	4	4	4	2	2	3	1	5	3	2	10	5	15				
Petaurus sp.																																																0	1	1		
Possible Native Mouse																																															3	1	4			
Red-necked Pademelon		1	2		1	1																																									4	4	8			
Red-necked Wallaby				1																																											4	2	6			
Rodent sp.				2																																											7	4	11			
Short-beaked Echidna		3			3		2	4	3																																					2	1	10				
Short-eared Brushtail Possum	1	2		2	3		2	4	3																																						5	1	6			
Squirrel Glider																																															1	0	1			
Swamp Rat																																															4	1	5			
Swamp Wallaby	5	3	4	2	3	4	4	4	4	4	3	4	2	3	1	4	3	3	4	4	6	3	5	4	3	6	6	2	1	1	2	2	2	5	3	1	5	1	3	2	1	2	1	1	10	5	15					
Water Rat																																																1	0	1		
Yellow-footed Antechinus	5	4	1	1	3	3	1	4		5	4	1	5	2	2	1	4	3	3	3		1	3	1	2	1																				9	5	14				
No. Species/Site	12	13	10	14	15	10	11	13	12	8	12	8	13	10	10	10	9	10	10	13	11	8	13	9	9	10	7	9	12	11	13	16	10	12	13	8	7	12	7	12	10	9	9	13	9	Mean	4.8	7.2				
																																																	SD	3.27	1.80	4.84

W = Winter
 Sp = Spring
 Su = Summer

Table F1

Year 6 Rufous Bettong and Brush-tailed Phascogale Camera Trap Results - Number of Traps that Recorded Each Species at Each Site per Season

	Impact Site 1 (west)			Impact Site 1 (east)			Impact Site 2 (west)			Impact Site 2 (east)			Impact Site 3 (west)			Impact Site 3 (east)			Impact Site 4 (west)			Impact Site 4 (east)			Impact Site 5 (west)			Impact Site 5 (east)			Control Site 1			Control Site 2			Control Site 3			Control Site 4			Control Site 5			Total No. of Sites/Species					
	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	W	Sp	Su	Impact	Control	Total
Antechinus sp.	1	1		3	2	2	4	1	1	1	1	1	1	1	1	1	2	1	2	1	2	1	3	1	1	1	1	2	1	2	3			4	1	2	2	1	2	2	1		1	1	2	2	2	2	9	4	13
Black Rat		1			2	1				1			1			2			3	2	3	2			3	2	3	2			1	1		1	1		2	1		2	1		1	1	2	2	2	4	9	5	14
Brush-tailed Phascogale		1														1						1						1																					4	2	6
Bush Rat	2	1	3	2	1	3	3	1	4	2	1	2	5	5	5	1	2	6				2	4	4	3	6	5	1	3					1	2	6	1	3	5	1	1	4	4	3	5	3	2	1	9	5	14
Common Brushtail Possum	1	3	1	4	2	2				1	4	1										4	4	3							1	2	4				1	1	2	1	1	1				1	1	1	5	5	10
Common Dunnart							1																														1	1					1			2	2	4			
Dingo / Wild Dog				1																																										3	2	5			
Eastern Grey Kangaroo	2	2	4		3	1	1	1	2		1	1		1	1	1	1	3	4	1		1	1	2	1	1	3	3	4		1						2	1	1				1	1	1	10	4	14			
Fawn-footed Melomys		1			1		1						1												1						1	1	1							1	1	1				6	5	11			
House Mouse	5	5	3	6	6	4	4	5	2	1	5	5	6	6	6	2	2	6	5	5	6	2	3	5	5	5	5	5	5	5	4			4	4	1	6			2	5	6	6	3	2	5	2	10			
Long-nosed Bandicoot	1	1	1				3	3	1	1	1	1				2		1				2	1	1	2		1	2	1	2							3	1	2				4			8	4	12			
Long-nosed Potoroo																																														0	2	2			
Macropod sp.																																														2	0	2			
Native Mouse																						2																								2	1	3			
Northern Brown Bandicoot		1	1		1	1	3	1			1		6	4	1				2	5	5	2	1	1		2	1	4						1	3	2	2	1	1	1	1	1	3	3	1	9	5	14			
Red-necked Pademelon	1	1					3	2																																						2	1	2			
Red-necked Wallaby		1											2	4	1													2	3	3	4	5														6	2	8			
Rodent	1															2	1														2															3	1	4			
Short-beaked Echidna	1	2		1	1			3	2		2	4				1	2	3	5	3	3	2	4	3	2	1	2							3			3	2		1	6	4	3	3	2	1			10	4	14
Short-eared Possum								4	4	1	1	2	1									1																								3	0	3			
Sugar Glider										1																																				1	0	1			
Swamp Rat							1	1								2									1						3	4	4													7	2	9			
Swamp Wallaby	5	2	4	3	5	5		1	3	3	2	4	5	4	3	6	4	3				2	1	4	6	4	2	3	3	1				1	4	1	2	2	3		3	5	4	2	3	4	3	4	5	10	15
Water Rat																																														0	1	1			
Wild Pig	1			2																																										2	1	3			
Yellow-footed Antechinus	2			2	1		1	3		2						6	1	6	1	4	2	2	2	2	6	3	3	2																		4		4			
No. Species/Site	12	13	8	9	9	9	11	12	9	10	9	8	10	7	11	7	8	10	11	12	12	9	11	10	11	10	9	9	10	7	9	9	8	10	11	8	13	11	7	8	10	12	12	9		Mean	5.4	2.9	8.3		
																																														SD	3.55	1.84	5.16		

W = Winter
 Sp = Spring
 Su = Summer



Appendix G

Spotlighting and Call Playback Results

Table G2 Spotlighting and Call Playback Results

Site	Date	Season	No. Animals	Sex	Age Class	No. of Dependant young	Species	Behaviour	Comments	Easting	Northing
Impact Site 1 (west)	20/08/2020	Winter	1	Unknown	Unknown	0	Yellow-bellied Glider	Calling independent of call playback	No visual	521219	6761812
Impact Site 1 (west)	12/01/2021	Summer	1	Unknown	Unknown	0	Squirrel Glider	Very fast, in lower canopy on branch of Forest Red Gum	-	521192	6761665
Impact Site 1 (west)	20/01/2021	Summer	1	Unknown	Unknown	0	Yellow-bellied Glider	At least one calling independent of call playback	50m to west, no visual	521155	6761762
Impact Site 1 (east)	14/07/2020	Winter	1	Unknown	Unknown	0	Squirrel Glider	In canopy of Pink Bloodwood	Probable ID. Partial visual	520990	6761092
Impact Site 1 (east)	20/08/2020	Winter	1	Unknown	Adult	0	Squirrel Glider	Perched on Small-Fruited Grey Gum limb	Probable ID.	520947	6761015
Impact Site 1 (east)	15/10/2020	Spring	1	Unknown	Adult	0	Short-eared Brushtail Possum	In canopy of Forest Red Gum	-	521052	6761309
Impact Site 1 (east)	11/02/2021	Summer	1	Unknown	Adult	0	Squirrel Glider	In fork of Forest Red Gum	Probable ID. Partial visual	521044	6761296
Impact Site 2 (west)	14/07/2020	Winter	1	Unknown	Adult	0	Greater Glider	Perched in top of Small-Fruited Grey Gum	-	521647	6762370
Impact Site 2 (west)	12/08/2020	Winter	1	Unknown	Unknown	0	Squirrel Glider	Calling, glided from Small-Fruited Grey Gum to west	-	521354	6761989
Impact Site 2 (west)	15/10/2020	Spring	1	Unknown	Adult	0	Greater Glider	In canopy of Spotted Gum	-	521326	6761938
Impact Site 2 (west)	15/10/2020	Spring	1	Unknown	Adult	0	Greater Glider	Perched in top of canopy of Northern Grey Ironbark	-	521614	6762337
Impact Site 2 (west)	15/10/2020	Spring	1	Unknown	Unknown	0	Greater Glider	In canopy of Spotted Gum	-	521687	6762402
Impact Site 2 (west)	23/10/2020	Spring	1	Unknown	Adult	0	Greater Glider	Top of canopy of Small-Fruited Grey Gum	-	521625	6762354
Impact Site 2 (west)	19/11/2020	Spring	1	Unknown	Adult	0	Brush-tail Possum	Resting in canopy of large Forest Red Gum	Probable ID. High up and obscured by foliage	521422	6762117
Impact Site 2 (west)	19/11/2020	Spring	1	Unknown	Adult	0	Greater Glider	Resting in canopy of Spotted Gum	-	521668	6762381
Impact Site 2 (west)	19/11/2020	Spring	1	Unknown	Unknown	0	Sugar Glider	Resting high in canopy of Spotted Gum	Probable ID, based on thin tail and profile	521668	6762400
Impact Site 2 (west)	12/01/2021	Summer	1	Unknown	Unknown	0	Sugar Glider	Sat still for several minutes, on limb of Forest Red Gum with many hollows	-	521474	6762208
Impact Site 2 (west)	12/01/2021	Summer	1	Unknown	Unknown	0	Brush-tail Possum	Sat still for long time.	Very high in canopy	521457	6762140
Impact Site 2 (west)	20/01/2021	Summer	1	Unknown	Adult	0	Greater Glider	Perched high in canopy in foliage	-	521516	6762181
Impact Site 2 (west)	20/01/2021	Summer	1	Unknown	Adult	0	Greater Glider	Perched up in tree limbs	-	521582	6762332
Impact Site 2 (median)	20/08/2020	Winter	1	Unknown	Unknown	0	Squirrel Glider	On Blackbutt trunk. Still on detection	-	521817	6762415
Impact Site 2 (median)	13/10/2020	Spring	1	Female	Adult	0	Squirrel Glider	Moving through Acacia sp. understorey	-	521322	6761777
Impact Site 2 (median)	12/01/2021	Summer	1	Unknown	Adult	0	Feathertail Glider	Moving through canopy	-	521806	6762333
Impact Site 2 (median)	4/02/2021	Summer	1	Male	Subadult	0	Sugar Glider	Foraging for invertebrates on stingybark	-	521637	6762163
Impact Site 2 (median)	11/02/2021	Summer	1	Unknown	Adult	0	Sugar Glider	Perched in fork, high in canopy of Small-Fruited Grey Gum	-	521534	6762059
Impact Site 2 (east)	18/08/2020	Winter	1	Unknown	Adult	0	Squirrel Glider	Foraging on honeydew on trunk of Spotted Gum	-	521553	6761946
Impact Site 2 (east)	20/08/2020	Winter	1	Unknown	Adult	0	Powerful Owl	Roosting in Spotted Gum	Spotlight result. No call	521701	6761993
Impact Site 2 (east)	13/10/2020	Spring	1	Unknown	Unknown	0	Yellow-bellied Glider	Calling in response to call-playback	No visual	521717	6762139
Impact Site 2 (east)	23/10/2020	Spring	1	Unknown	Adult	0	Yellow-bellied Glider	Calling in response to call-playback	-	521634	6762049
Impact Site 2 (east)	12/11/2020	Spring	1	Unknown	Unknown	0	Bandicoot sp.	Calling	-	521740	6762057
Impact Site 2 (east)	4/02/2021	Summer	1	Unknown	Adult	0	Yellow-bellied Glider	Calling in response to call-playback	-	521635	6761943
Impact Site 3 (west)	9/11/2020	Spring	1	Male	Adult	0	Yellow-bellied Glider	Calling in response to call-playback	Heard twice far in the distance to the east	523038	6764006
Impact Site 3 (west)	4/02/2021	Summer	1	Unknown	Adult	0	Long-nosed Bandicoot	Foraging	-	522789	6763795
Impact Site 3 (west)	4/02/2021	Summer	1	Unknown	Adult	0	Sugar Glider	Foraging	-	522762	6763774
Impact Site 3 (west)	11/02/2021	Summer	1	Unknown	Adult	0	Greater Glider	Perched in branch high in Blackbutt.	-	522861	6763873
Impact Site 3 (west)	22/02/2021	Summer	1	Unknown	Adult	0	Squirrel Glider	Foraging in flowering Pink Bloodwood	Probable ID	522823	6763824
Impact Site 3 (east)	12/08/2020	Winter	1	Unknown	Adult	0	Squirrel Glider	Foraging	-	522719	6763040
Impact Site 3 (east)	18/08/2020	Winter	1	Unknown	Unknown	0	Petaurus sp.	Gliding, observed mid air	Sugar or Squirrel Glider, partial visual	522947	6763367
Impact Site 3 (east)	12/11/2020	Spring	1	Unknown	Adult	0	Masked Owl	Calling, first distant then close. One call from near rope bridge	Not observed	522762	6763137
Impact Site 4 (median)	13/08/2020	Winter	1	Unknown	Adult	0	Squirrel Glider	Perched in top of Spotted Gum	-	521621	6762206
Impact Site 4 (median)	12/11/2020	Spring	1	Unknown	Unknown	0	Bandicoot sp.	Fled in long grass	-	523746	6764883
Impact Site 4 (median)	14/01/2021	Summer	1	Unknown	Adult	0	Feathertail Glider	Gliding and landing on flowering <i>Angophora woodsiana</i>	-	523488	6764603
Impact Site 4 (median)	14/01/2021	Summer	1	Unknown	Adult	0	Sugar Glider	Moving along trunk of flowering Pink Bloodwood	-	523570	6764588
Impact Site 4 (median)	14/01/2021	Summer	1	Unknown	Adult	0	Sugar Glider	Foraging in <i>Angophora woodsiana</i>	-	523439	6764376
Impact Site 4 (median)	14/01/2021	Summer	1	Unknown	Adult	0	Squirrel Glider	Grooming in Blackbutt	-	523492	6764449
Impact Site 4 (median)	4/02/2021	Summer	1	Unknown	Adult	0	Brush-tail Possum	Foraging in top canopy of Blackbutt	-	523721	6764872
Impact Site 4 (median)	8/02/2021	Summer	1	Unknown	Adult	0	Squirrel Glider	Climbing down trunk of Small-Fruited Grey Gum.	-	523547	6764584
Impact Site 4 (east)	9/08/2020	Winter	1	Unknown	Adult	0	Greater Glider	Perched in horizontal branch of Tindal's Stringybark	-	523925	6764358

Impact Site 4 (east)	18/08/2020	Winter	1	Unknown	Adult	0	Greater Glider	Climbed up tree, remained in fork.	-	523926	6764284
Impact Site 4 (east)	13/10/2020	Spring	1	Unknown	Adult	0	Squirrel Glider	Perched in canopy of Tindal's Stringybark	-	523984	6764292
Impact Site 4 (east)	9/11/2020	Spring	1	Unknown	Adult	0	Sugar Glider	Climbing and foraging.	-	524042	6764325
Impact Site 4 (east)	9/11/2020	Spring	2	Unknown	Unknown	0	Macropod sp.	Disturbed, fled into bush	-	524027	6764258
Impact Site 4 (east)	9/11/2020	Spring	1	Unknown	Adult	0	Greater Glider	Perched in large Blackbutt	-	523735	6764290
Impact Site 4 (east)	12/11/2020	Spring	1	Unknown	Adult	0	Greater Glider	Perched on limb of large tree.	-	523856	6764358
Impact Site 4 (east)	14/01/2021	Summer	1	Unknown	Adult	0	Sugar Glider	Perched high in canopy.	Probable ID	524007	6764325
Impact Site 4 (east)	14/01/2021	Summer	1	Unknown	Adult	0	Greater Glider	Perched in canopy of <i>Angophora woodsiana</i>	-	523585	6764347
Impact Site 4 (east)	4/02/2021	Summer	1	Unknown	Adult	0	Greater Glider	Perched in top branches of White Mahogany	-	523917	6764327
Impact Site 5 (west)	19/11/2020	Spring	1	Unknown	Adult	0	Sugar Glider	Foraging in canopy	Probable ID	524017	6766196
Impact Site 5 (west)	19/11/2020	Spring	3	Male	Adult	0	Red-necked Wallaby	Two males fighting, one additional wallaby	-	524363	6766174
Impact Site 5 (east)	18/08/2020	Winter	1	Unknown	Adult	0	Sugar Glider	Foraging along limbs of <i>Corymbia</i> sp.	-	524830	6766251
Impact Site 5 (east)	22/10/2020	Spring	1	Unknown	Adult	0	Brush-tail Possum	Perched in tree branch	-	524713	6766279
Impact Site 5 (east)	10/11/2020	Spring	1	Unknown	Subadult	0	Greater Glider	Perched mid-canopy in Swamp Box	-	524819	6766163
Impact Site 5 (east)	20/01/2021	Summer	1	Unknown	Unknown	0	Feathertail Glider	Gliding between trees	-	524683	6766275
Impact Site 6 (west)	15/07/2020	Winter	1	Unknown	Adult	0	Greater Glider	Perched mid-canopy in Blackbutt	-	524557	6766628
Impact Site 6 (west)	19/11/2020	Spring	1	Unknown	Unknown	0	Feathertail Glider	Glided away when disturbed	-	524480	6766419
Control site 1	12/08/2020	Winter	1	Unknown	Unknown	0	Bandicoot sp.	Calling	No visual	522493	6761994
Control site 1	13/10/2020	Spring	1	Unknown	Adult	0	Brush-tail Possum	In branch of Spotted Gum	-	522612	6762007
Control site 1	14/01/2021	Summer	1	Unknown	Adult	0	Yellow-bellied Glider	Calling independent of call playback	-	522439	6762095
Control site 2	12/08/2020	Winter	1	Unknown	Unknown	0	Yellow-bellied Glider	Call heard in response to call playback	Call 100m north of transect	523640	6762904
Control site 2	12/08/2020	Winter	1	Unknown	Unknown	0	Bandicoot sp.	Calling	-	523774	6762894
Control site 2	18/08/2020	Winter	1	Unknown	Adult	0	Greater Glider	Perched in Blackbutt	-	523237	6762765
Control site 2	23/10/2020	Spring	1	Unknown	Unknown	0	Sugar Glider	Calling	Not observed	523651	6762777
Control site 2	9/11/2020	Spring	1	Unknown	Adult	0	Sugar Glider	Self-grooming in fork of tree	-	523812	6762894
Control site 2	9/11/2020	Spring	1	Unknown	Adult	0	Masked Owl	Calling twice, briefly and relatively quietly	Probable ID	523501	6762851
Control site 2	12/11/2020	Spring	1	Unknown	Subadult	0	Northern Bandicoot	Running across track	-	523325	6762788
Control site 2	20/01/2021	Summer	1	Unknown	Unknown	0	Feathertail Glider	Foraging in flowering Pink Bloodwood	-	523199	6762769
Control site 2	4/02/2021	Summer	1	Unknown	Subadult	0	Squirrel Glider	Feeding	-	523294	6762813
Control site 3	13/10/2020	Spring	1	Unknown	Unknown	0	Squirrel Glider	Foraging near flowering <i>Melaleuca sieberi</i>	Probable ID, glimpse of bushy tail, brief eye shine. Obscured by epicormic growth. Partial visual	524321	6764071
Control site 3	9/11/2020	Spring	1	Unknown	Unknown	0	Brush-tail Possum	Calling	Possible ID, calling to NE. No visual	524620	6764040
Control site 3	9/11/2020	Spring	1	Unknown	Unknown	0	Masked Owl	Calling	Possible ID, calling to south	524169	6764121
Control site 4	14/07/2020	Winter	1	Unknown	Unknown	0	Yellow-bellied Glider	Calling	-	521067	6763344
Control site 4	13/08/2020	Winter	1	Unknown	Unknown	0	Squirrel Glider	In canopy of Spotted Gum	Possible ID, not clearly observed	521098	6763111
Control site 4	13/08/2020	Winter	1	Unknown	Unknown	0	Yellow-bellied Glider	Calling independent of call playback	-	520964	6763124
Control site 4	15/10/2020	Spring	1	Male	Unknown	0	Yellow-bellied Glider	Calling	-	521086	6763087
Control site 4	23/10/2020	Spring	1	Unknown	Unknown	0	Yellow-bellied Glider	Calling	-	521084	6763121
Control site 4	12/11/2020	Spring	1	Unknown	Adult	0	Yellow-bellied Glider	Calling	-	521070	6763158
Control site 4	12/11/2020	Spring	1	Female	Adult	1	Brush-tail Possum	Perched in tree	-	521325	6762789
Control site 4	12/11/2020	Spring	1	Unknown	Adult	0	Petaurus sp.	entered hollow	Sugar or Squirrel Glider, entered hollow before ID	521315	6762799
Control site 4	12/01/2021	Summer	2	Unknown	Unknown	0	Greater Glider	Roosting in Northern Grey Ironbark	Possible female with near mature subadult	521326	6762765
Control site 5	14/07/2020	Winter	1	Unknown	Unknown	0	Yellow-bellied Glider	Calling	-	521054	6763368
Control site 5	23/10/2020	Spring	1	Unknown	Unknown	0	Sugar Glider	Still in upper branches	Probable ID, partly obscured by branches	521027	6763612
Control site 5	12/11/2020	Spring	1	Unknown	Unknown	0	Sugar Glider	In burnt stag, calling twice during spotlighting	-	521006	6763716
Control site 6	8/02/2021	Summer	1	Unknown	Unknown	0	Sugar Glider	Calling	Calling from south, no visual	522282	6764783
Control site 6	22/02/2021	Summer	1	Unknown	Unknown	0	Petaurus sp.	Foraging on blossom in Pink Bloodwood	Sugar or Squirrel Glider, partial visual	521928	6764884
Control site 6	22/02/2021	Summer	1	Unknown	Adult	0	Brush-tail Possum	Perched in <i>Angophora woodsiana</i>	-	522192	6764819



Appendix H

Threatened Frog Survey Results

