Woolgoolga to Ballina Pacific Highway upgrade

Sections 3-11 Microbat Monitoring Annual Report 2018

NSW GOVERNMENT

W2B Sections 3 – 11 Microbat Management Plan 2018 Annual Monitoring Report

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Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
CPC	Concrete pipe culvert
DPIE	NSW Department of Planning, Industry and the Environment
ELA	Eco Logical Australia
EPA	Environmental Protection Authority
EPA&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*
MCoA	Minister's Conditions of Approval
MMP	Microbat Management Plan
NBMP	Nest Box Management Plans
PC	Pacific Complete
RCBC	Reinforced concrete box culvert
SSTS	Soft soil treatment sites
TfNSW	Transport for NSW

1. Introduction

1.1 Background

Eco Logical Australia Pty Ltd (ELA) was engaged by Transport for NSW (TfNSW) and Pacific Complete (PC), the delivery partner, to undertake microbat monitoring and management of all drainage structures and compensatory habitat associated with the Woolgoolga to Ballina (W2B) Sections 3 – 11 Microbat Management Plan (MMP), prepared by GeoLINK (2015) as part of the Minister's Conditions of Approval (MCoA) for the project.

This 2018 Annual Monitoring Report (Report) is the first in a series of annual monitoring reports, with the remainder to be prepared following the spring monitoring surveys in years 2019, 2021 and if required, 2023 and 2025. A final post construction monitoring report will collate all annual reports and provide a brief executive summary of the results.

This Report provides an overview of the Woolgoolga to Ballina (W2B) road project and microbat management completed to date, before presenting the methods and results of the 2017/18 monitoring events. The discussion and recommendations in this report are based on information gathered from field investigations and monitoring events and aim to inform future microbat monitoring and management within the W2B project as well as future TfNSW projects involving impacts to microbat habitat, exclusion of microbats and provision of alternative microbat habitat.

1.2 W2B Road Project

The Pacific Highway Upgrade Program is a joint commitment by the Australian and New South Wales (NSW) governments to improve the standard and safety of the Pacific Highway between Hexham and the Queensland border. This report relates to one component of this Program, being Sections 3 – 11 of W2B Highway upgrade project. The W2B project was approved under the NSW *Environmental Planning and Assessment Act 1979* (EPA&A) on 24 June 2014 and the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 14 August 2014.

The W2B project extends over approximately 155 kilometres (km) from approximately 6 km north of Woolgoolga to approximately 6 km south of Ballina. The W2B project is divided into 11 sections, with the MMP and this report relating to Sections 3 to 11 (Figure 1 to Figure 9).

At the time of report production, the W2B project is in an active construction phase having completed vegetation clearance, major earthworks and with construction of the new alignment at varying stages of completion through Sections 3 – 11.

1.3 Stakeholders and consultation

In compiling this report several key stakeholders have provided advice and comment including;

1. Transport for NSW – responsible for implementing measures in the MMP. ELA have had several meetings with the TfNSW W2B Environmental Officer responsible for ecological monitoring over the duration of the project, and regular contact with the TfNSW Environmental Officer responsible for overseeing the W2B MMP to discuss issues as they arise, advise on progress and agree upon the approach to actions outlined in the MMP.

2. PC- delivery partner responsible for ensuring the W2B project is delivered according to MCoA and contract specifications. ELA consults with the relevant PC Environmental Officer for each Section at least 4 times a year prior to implementing quarterly monitoring of MMP structures. ELA has also attended meetings with PC Environmental Officers in the early stages of the project prior to installation of compensatory habitat, provided advice when required, advised on progress throughout each year and discussed issues as they have arisen over the lifetime of the project.
3. Environmental Protection Authority – In implementing the MMP, ELA have had several discussions and meetings with Senior Threatened Species Officers from the EPA and TfNSW representatives in regard to the design and installation of alternative microbat habitat required in the vicinity of Section 4 and 5 at Maclean cut and Section 3A at Glenugie.

1.4 Purpose

This Report aims to:

- outline mitigation measures implemented and actions from the MMP undertaken by ELA prior to and during construction to end 2018.
- determine the effectiveness of temporary alternative habitat installed as a compensatory mechanism to minimise the impacts to microbats from the loss of medium and high conservation value drainage structures.
- determine the effectiveness of microbat exclusions undertaken at medium and high conservation/ habitat value drainage structures.
- provide useful information on reproductive status, age class and therefore population dynamics and population survival of local populations of target threatened microbat species throughout and post construction.
- provide results and discussion of the 2017 and 2018 monitoring of drainage structures and alternative habitat identified in the MMP, as well as any additional structures that were identified after production of the MMP, but which are also subject to the provisions of the MMP. Details of additional structures are provided in Section 2.5 below.

This Report does not provide results of microbat occupation of bat boxes installed as part of the W2B Nest Box project. Any microbat boxes installed as a requirement of the Nest Box Management Plans (NBMP) for each Section of W2B will be monitored and reported on separately.

2. Overview of Microbat Management W2B Sections 3 – 11

2.1 Key elements in the development of the MMP

Key documents in the approvals process for management of threatened microbats and their habitat as part of the W2B Sections 3-11 project are outlined below.

- Environmental Impact Statement (RMS 2012)
- Threatened Mammal Management Plan (RMS 2013) – triggered requirement for Project Specific MMP
- Woolgoolga to Ballina Pacific Highway Upgrade Targeted Microbat Surveys – Sections 3 – 11 (GeoLINK 2015a)
- Microbat Management Plan (GeoLINK 2015b)

Key approval dates for the W2B project;

- W2B approved under NSW EPA&A Act on 24 June 2014
- W2B approved under Commonwealth EPBC Act on 14 August 2014.

Key survey dates in development of the MMP;

- Survey of drainage structures within Sections 4 and 5 undertaken by GeoLINK November 2013 / February 2014 (as part of Sections 4 and 5 soft soil treatment site (SSTS) surveys)
- Survey of 119 drainage structures within Sections 3 – 11 undertaken by GeoLINK in July 2014
- Re-survey of 62 drainage structures identified as being of high, medium or low conservation value as microbat habitat within Sections 3 – 11 undertaken by GeoLINK in October to November 2014
- Re-survey of 39 drainage structures identified as being of high, medium or low conservation value as microbat habitat within Sections 3 – 11 undertaken by GeoLINK in February 2015 coinciding with the second Southern Myotis breeding event of the breeding season.

2.2 Microbat Management Plan

In accordance with Section 5.3.5 of the W2B Threatened Mammal Management Plan (RMS, 2013), the results from surveys of drainage structures triggered the requirement for a Project Specific Bat Management Plan. Consequently, the *Woolgoolga to Ballina Microbat Management Plan Sections 3-11* (GeoLINK 2015b), herein referred to as MMP was prepared.

The objectives of the MMP are to:

- Reduce potential for injury or death to microbats
- Provide temporary alternative habitat for excluded microbats
- Provide permanent replacement habitat for microbats.

Consequently, the MMP includes the following information:

- provision of artificial roosting structures including designs, numbers required, locations and timing of installation
- timing of works
- timing of monitoring
- exclusion procedures (techniques and management) prior to demolition work
- monitoring procedures, pre during and post construction
- specifications for the creation of permanent cave-dwelling roosting habitat
- provisions for delivery of environmental inductions to construction and contract staff,
- requirements for pre-works microbat inspections and works supervision prior to, during and following structure demolition or extension
- contingency measures for unexpected finds, the capture and release of healthy microbats and management of injured or dead microbats
- reporting requirements
- corrective actions and performance measures.

The original MMP applies to pre, during and post construction phases of the W2B project and includes 11 drainage structures within Sections 4 to 7 and Section 10. During the detailed design phase of the project after production of the MMP, nine additional drainage structures located in Section 3A, Section 4, Section 5 and Devil's Pulpit were identified as having medium to high conservation habitat value for microbats and, as such are also subject to the provisions of the MMP. Details of when these additional structures were identified and became subject to the provisions of the MMP appear in Table 3 and Table 5.

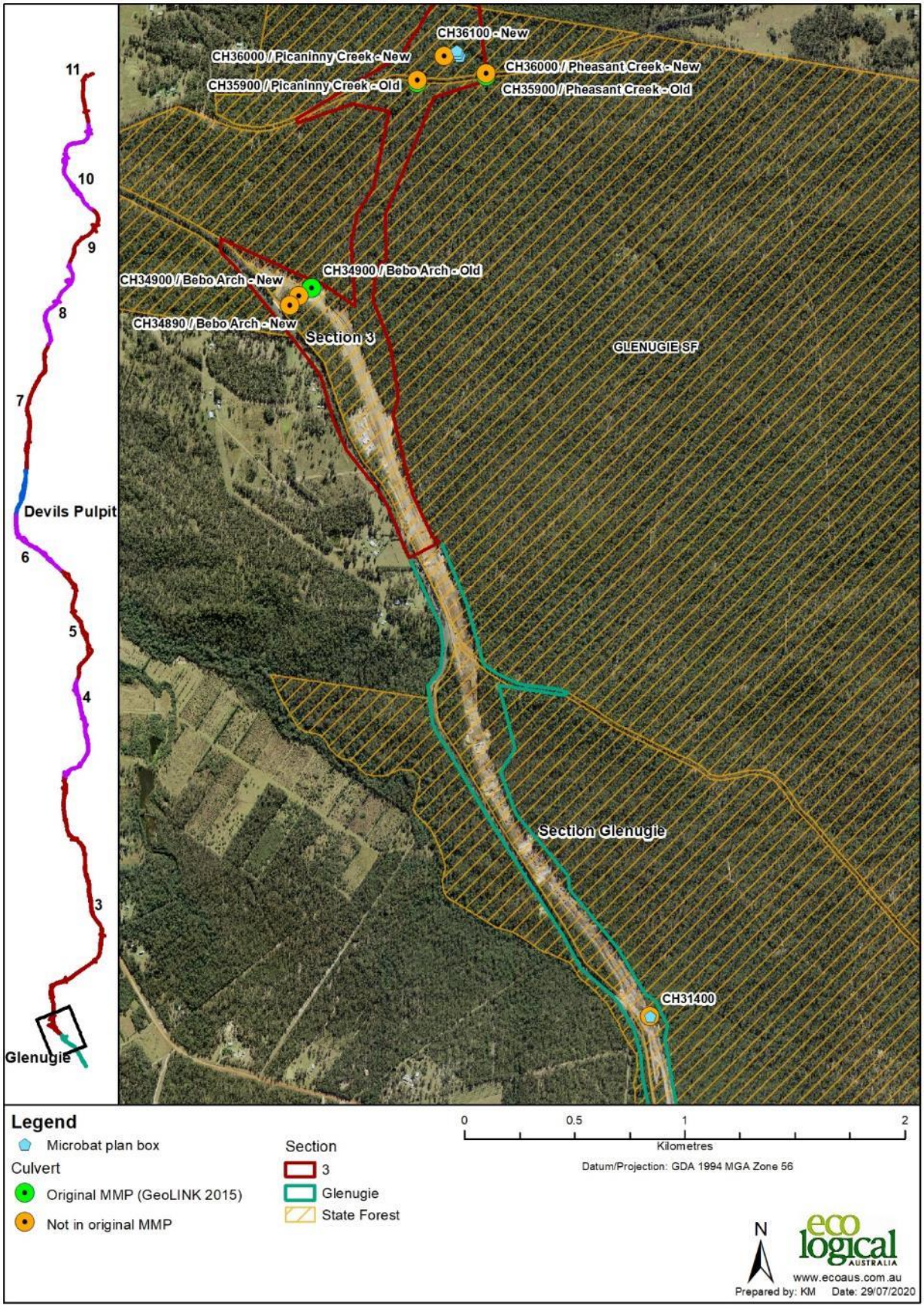

Figure 1: Section 3A Glenugie Link Microbat Monitoring Plan subject drainage structures and bat box locations.

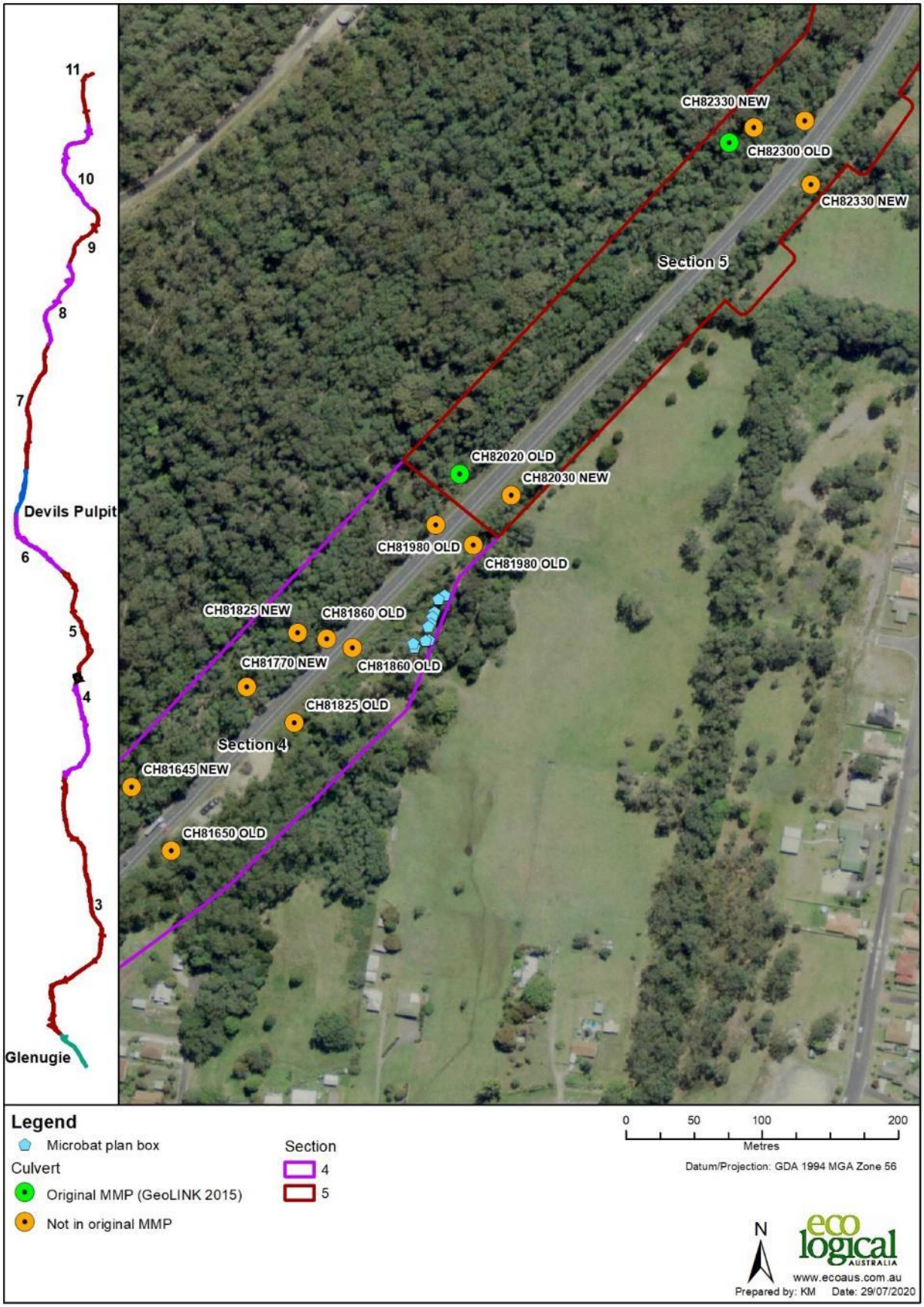

Figure 2: Section 4 / 5 Maclean cut south Microbat Monitoring Plan subject drainage structures and bat box locations.

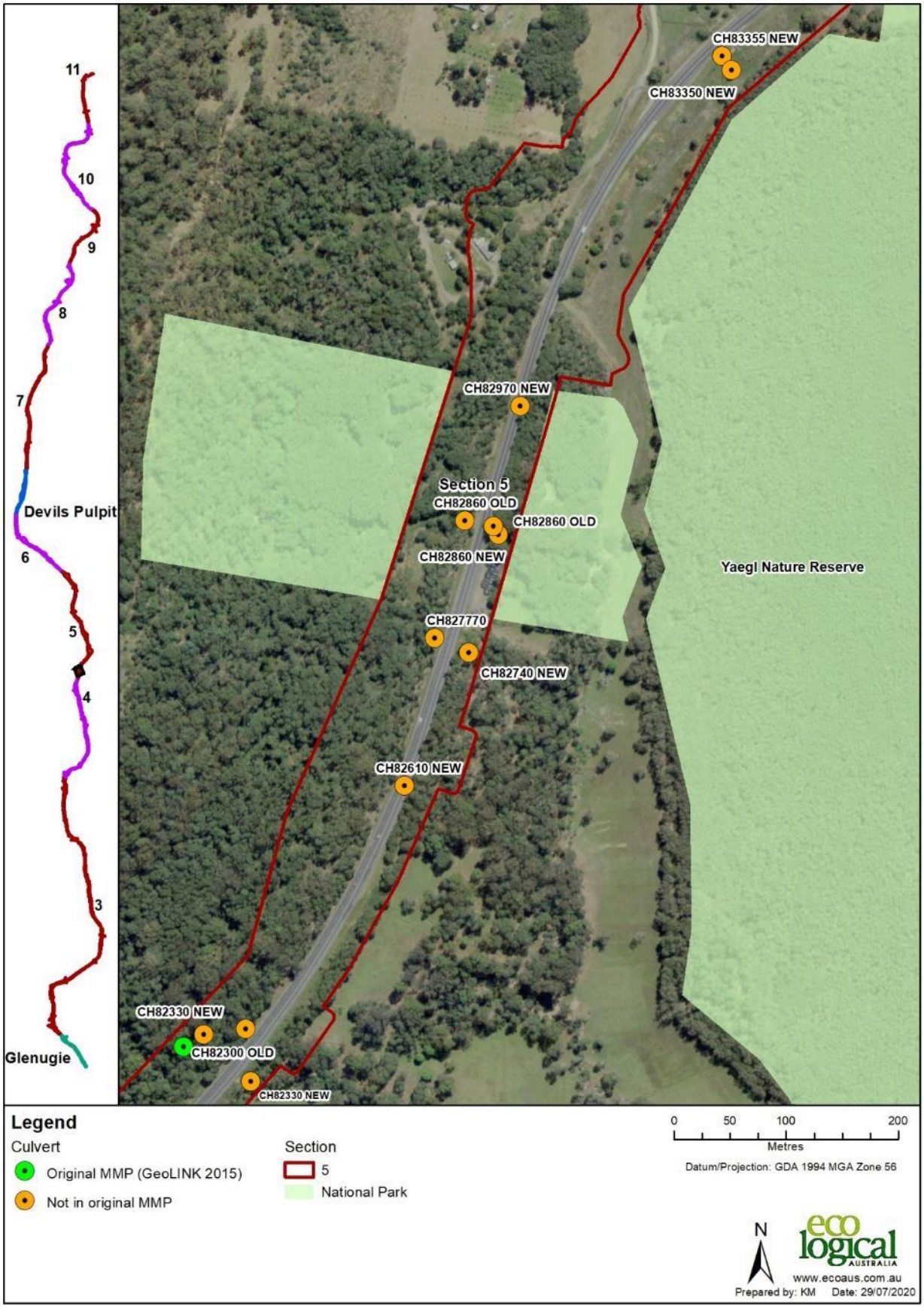

Figure 3: Section 5 Maclean cut north Microbat Monitoring Plan subject drainage structures and bat box locations.

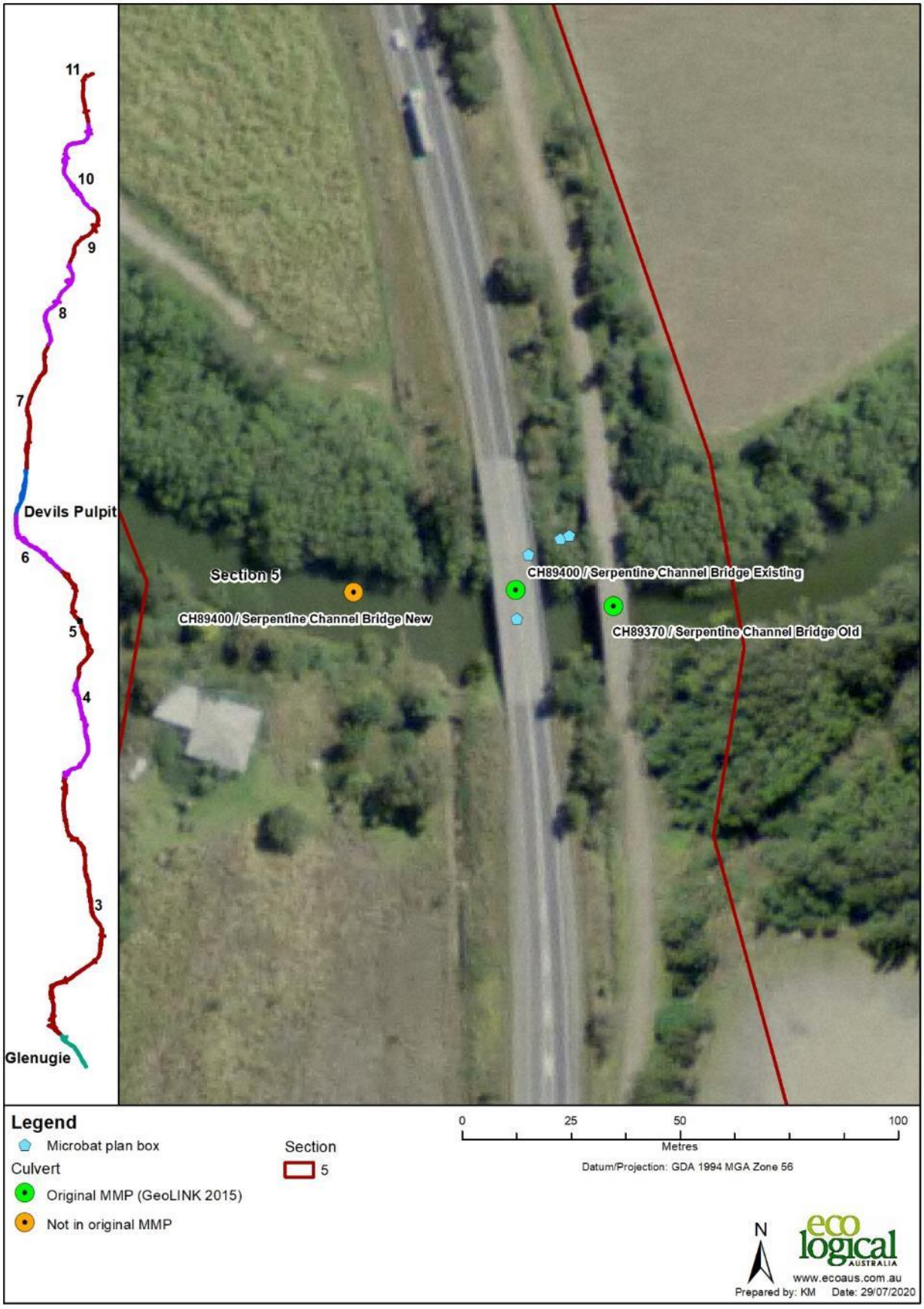

Figure 4: Section 5 Serpentine Creek Microbat Monitoring Plan subject drainage structures and bat box locations.

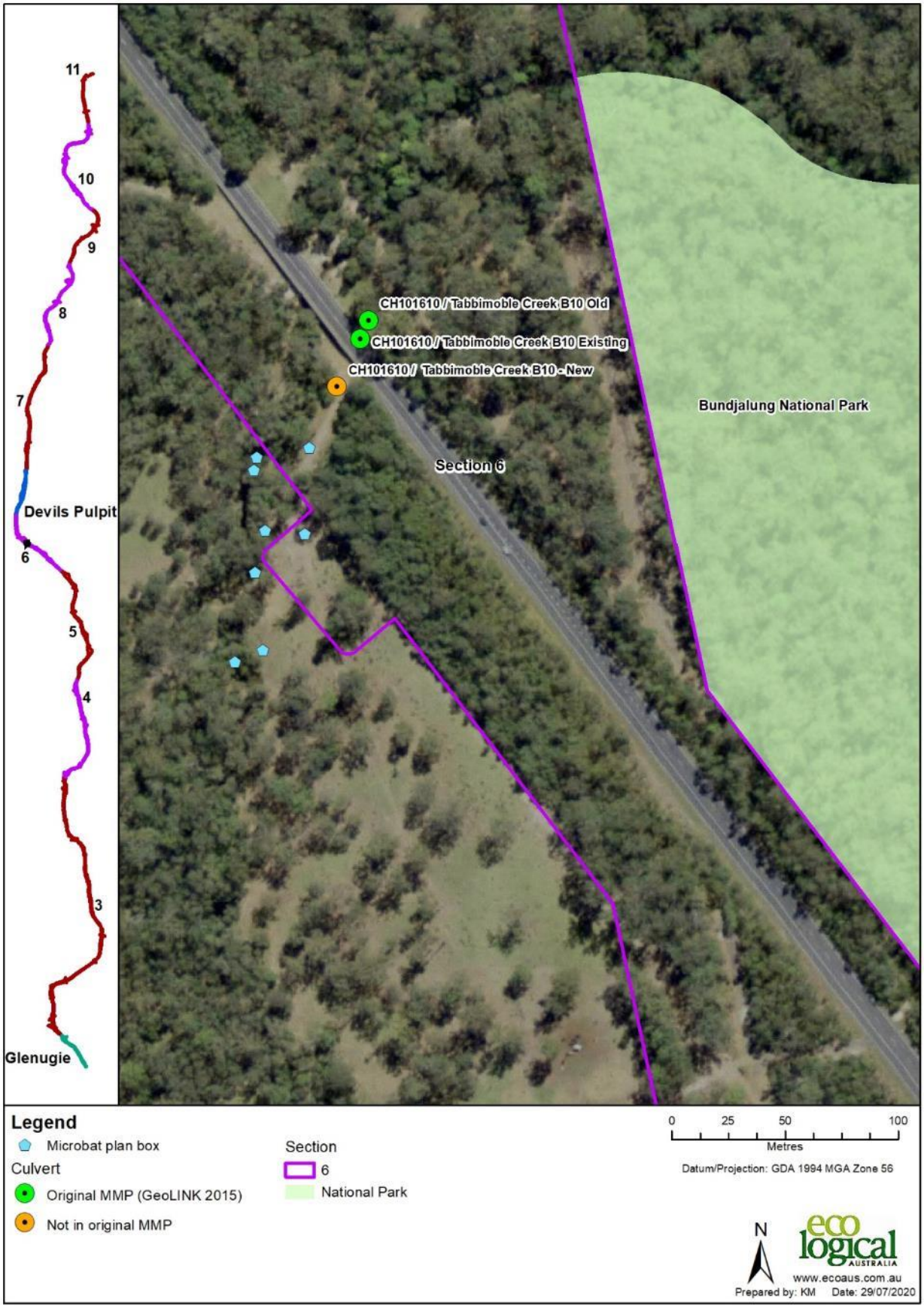

Figure 5: Section 6 Tabbimoble Creek Bridge Microbat Monitoring Plan subject drainage structures and bat box locations.

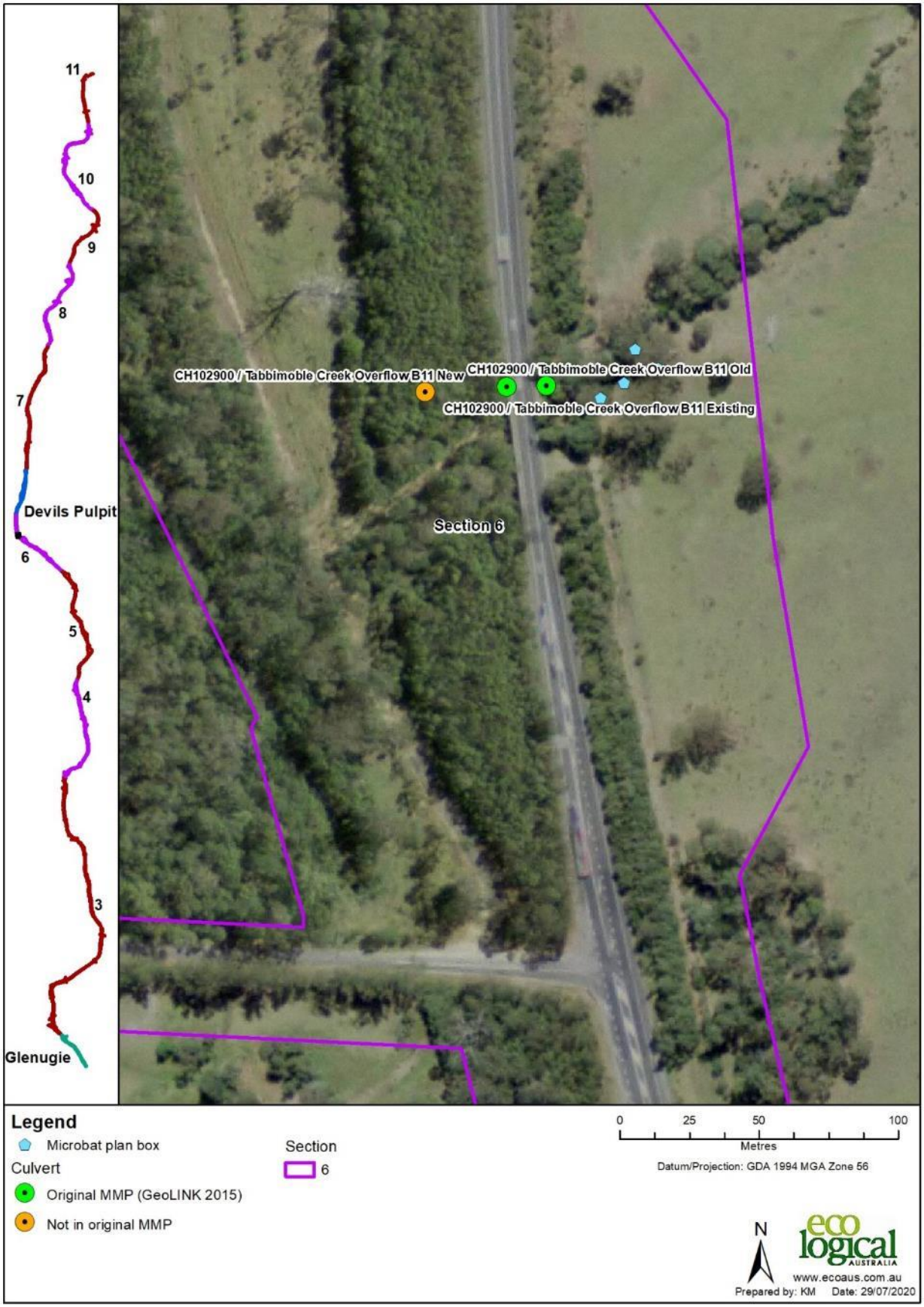

Figure 6: Section 6 Tabbimoble Creek Overflow Bridge Microbat Monitoring Plan subject drainage structures and bat box locations.

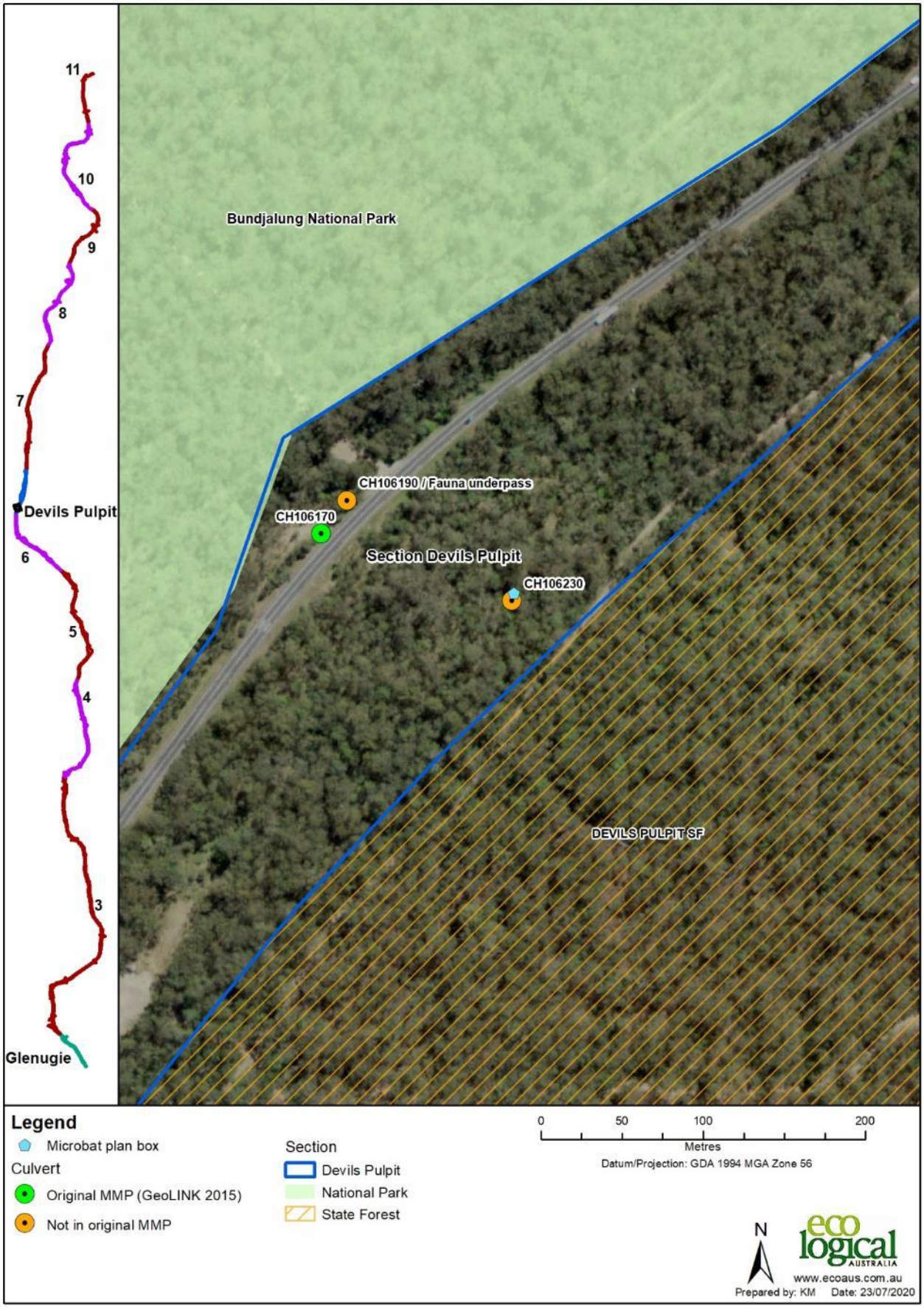

Figure 7: Devils Pulpit section Microbat Monitoring Plan subject drainage structures and bat box locations.

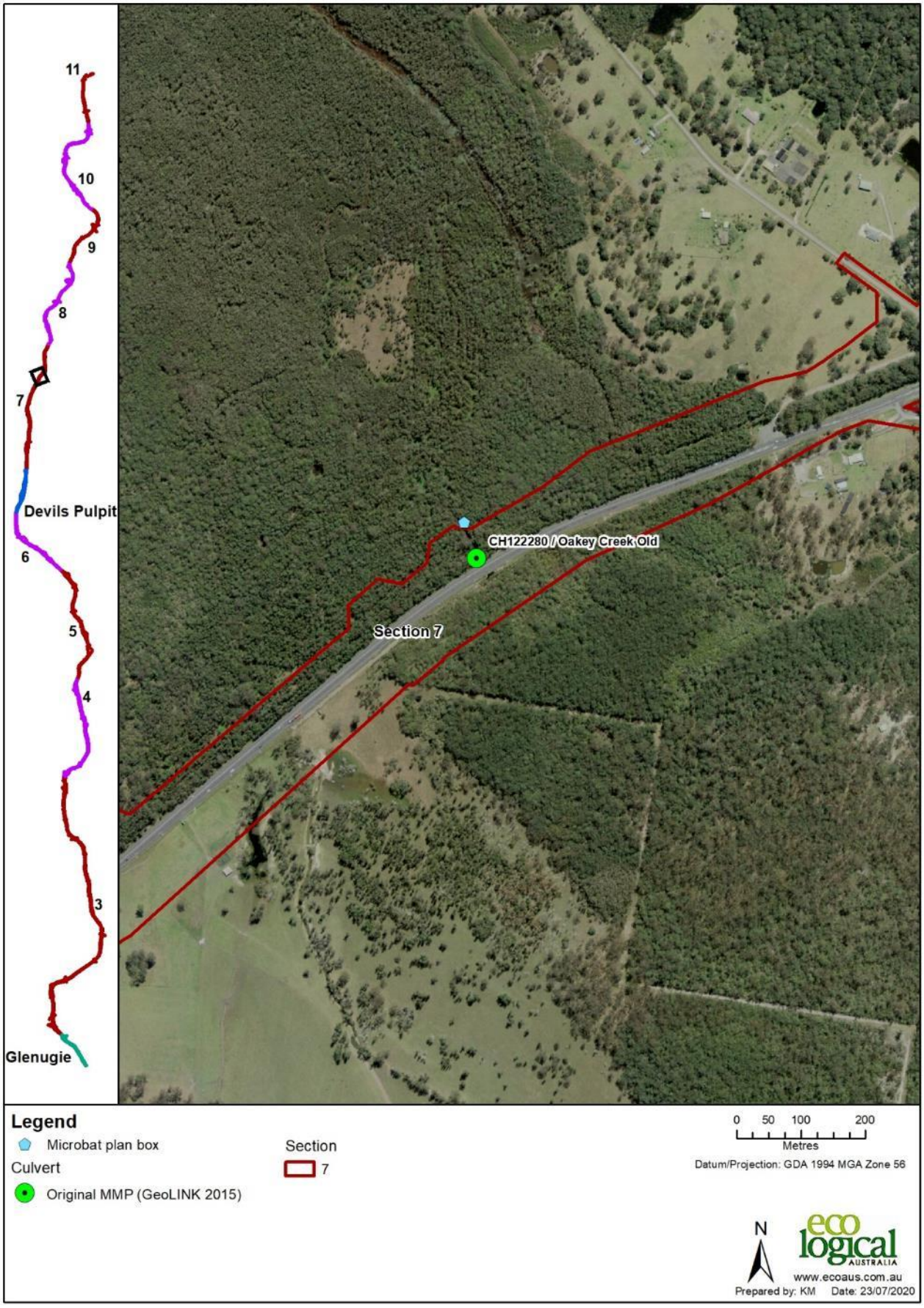

Figure 8: Section 7 Oakey Creek Microbat Monitoring Plan subject drainage structure and bat box location.

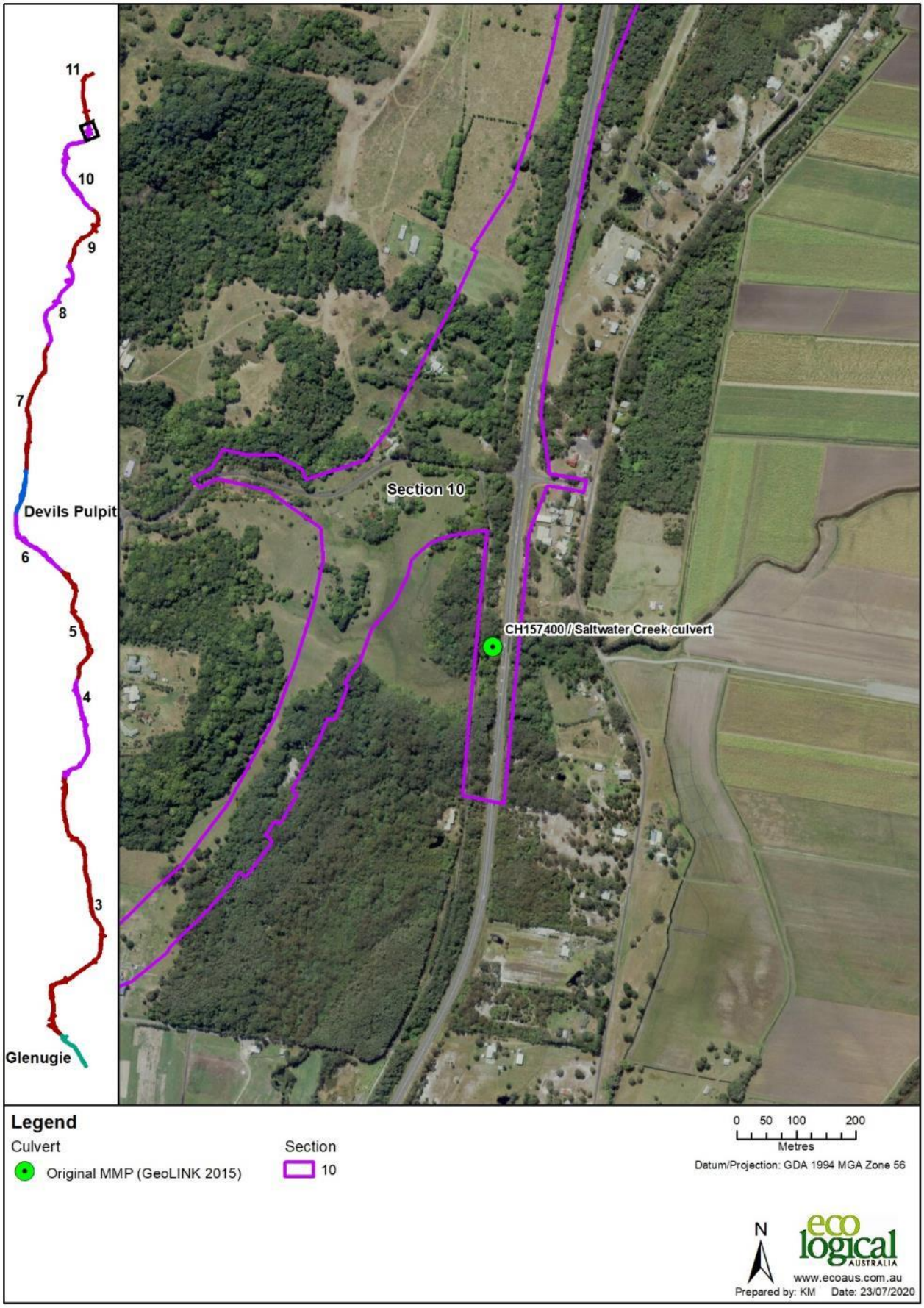

Figure 9: Section 10 Saltwater Creek Microbat Monitoring Plan subject drainage structure location.

2.3 Subject Microbat Species

There are four subject microbat species identified in the MMP. Table 1 (GeoLINK 2015b) outlines the conservation status of each species and provides details of their known records in relation to the W2B project following surveys undertaken by GeoLINK during preparation of the MMP.

Southern Myotis is the only one of the four species known to use drainage structures as maternity roosting habitat. There are several known maternity colonies located along the W2B project alignment. The largest permanently occupied Southern Myotis roosting site that will not be removed or extended is located within four bat boxes installed under the existing southbound lane of Mororo Bridge over the Clarence River. Another important Southern Myotis roost site that will be removed is located at Picaninny Creek on Eight Mile Lane at Glenugie. This structure was not identified in the original MMP but became subject to the provisions of the MMP once it was identified as a Southern Myotis maternity roost site in January 2018 (ELA 2018a). An adjacent culvert on Pheasants Creek, Eight Mile Lane was also identified as roosting habitat for Southern Myotis in January 2018 and also became subject to the provisions of the MMP (ELA 2018a).

Little Bent-winged and Large Bent-winged Bats are known from several locations along the W2B highway alignment. Both species tend to form large overwintering colonies numbering in the hundreds to thousands of individuals and are present on site between February / March and September each year. Two key overwintering roosts for Bent-winged Bats that will not be removed or extended are the bridges over Tabbimoble Creek located in Section 6. Several other key Bent-winged Bat overwintering roosts that will be removed as part of the W2B project are located within the Bebo Arch at Glenugie (not identified in the original MMP but subject to the provisions of the MMP upon identification in February 2018), and multiple culverts at Maclean cut. Whilst two of the larger known Bent-winged Bat roost sites at Maclean cut were identified in the MMP, there were five additional culverts that were identified in 2017 (BGC Contracting 2017, GeoLINK 2018a) as having medium to high conservation value or had low conservation value but were in close proximity to high conservation value habitat and therefore became subject to the provisions of the MMP.

Table 1: W2B Subject microbat species, conservation status, roosting requirements and species records

Scientific Name	Common Name	BC Act	EPBC Act	Roosting habitat	Project records
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Typically requires sandstone escarpments (or occasionally volcanic rock types) to provide roosting habitat that is adjacent to higher fertility sites that are used for foraging. Roosting has also been observed in disused mine shafts, caves, overhangs and disused Fairy Martin (*Hirundo*	Not recorded. However, one record occurs within a 10 km radius of the Project footprint (RMS, 2012).

Scientific Name	Common Name	BC Act	EPBC Act	Roosting habitat	Project records
				ariel) nests. It also possibly roosts in the hollows of trees. The structure of primary nursery roosts appears to be very specific, i.e. Arch caves with dome roofs with indentations (DoE 2014).	
Miniopterus australis	Little Bent-winged Bat	V		Caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings are the preferred roosting habitats (OEH 2012). Maternity colonies are restricted to specific maternity caves (predominantly limestone) (Van Dyck and Strahan, 2008). Only five nursery sites /maternity colonies are known in Australia (OEH 2012).	Known. One Little Bent-winged Bat was observed roosting in a lifting point of drainage structure 506006 in Section 4 (SSTS) in July 2014. 262 Little Bent-winged Bats were observed roosting in 17 groups between the jointing gaps of a RCPC in Section 4 in July 2014. 72 Little Bent-winged Bats were also observed roosting between the jointing gaps of a RCPC in Section 5 in July 2014. 553 Little bent-winged Bats were observed roosting in 24 groups between the jointing gaps of the concrete planks of Tabbimoble Creek Bridge (BN7555) in July 2014. 166 Little Bent-winged Bats were observed roosting in 11 groups between the jointing gaps of the concrete planks of Tabbimoble overflow (BN7532). No maternity roost sites are known or likely within the Project footprint. 221 records within a 10 km radius of the site (RMS, 2012).

Scientific Name	Common Name	BC Act	EPBC Act	Roosting habitat	Project records
Miniopterus orianae (previously known as *Miniopterus schreibersii*)	Large Bent-winged Bat	V		Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures (OEH, 2012; Van Dyck and Strahan, 2008).	Known. 131 Large Bent-winged Bats were observed roosting between the jointing gaps of the New Serpentine Creek Bridge in July 2014. 40 Large Bent-winged Bats were observed roosting on rough concrete and in the expansion joins of the Old Serpentine Creek Bridge in July 2014. Individual Large Bent-winged Bats were also observed at Tabbimoble Overflow (BN7532), Saltwater Creek Bridge (BN2167) and the adjacent RCPC on Saltwater Creek (506170) in Section 10 in July 2014. However, no maternity roost sites are known or likely within the Project footprint. 20 records within a 10 km radius of the site (RMS, 2012).
Myotis macropus	Southern (Large-footed) Myotis	V		This species prefers caves, mines, tree hollows, aqueduct tunnels and under bridges/ culverts and in dense vegetation (the latter in the tropics) in the vicinity of bodies of slow-flowing or still water (Van Dyck and Strahan, 2008). Forages over streams and pools catching insects and small fish by raking their feet across the water surface (OEH 2014).	Known. This species has been recorded from a number of locations within Sections 5, 6 and 7 only within the project footprint during GeoLINK surveys in 2014 and 2015. Maternity roost sites located in Section 3A on Picaninny Creek and Pheasants Creek by ELA in 2018. 29 records within a 10 km radius of the site (RMS, 2012).

2.4 Subject Drainage Structures

Drainage structures such as bridges and culverts are known to provide roosting habitat for the four threatened subject microbat species described in **Section 2.3** above, along with numerous other non-threatened microbat species. The W2B project requires removal, extension or disturbance to existing drainage structures along the alignment. The drainage structures along the W2B alignment were categorised as being of high, medium or low conservation value as microbat habitat following surveys

undertaken by GeoLINK in 2014 and 2015. Placement of drainage structures into each of the three categories was dependent upon historical records of occupation, survey results, availability of roosting space within each structure, microbat species presence or evidence of use by microbats. Table 2 below provides details of the criteria used to assign drainage structures to each category and is reproduced from Table 1.3 of the MMP (GeoLINK 2015b).

Table 2: Categories of conservation value microbat habitat and criteria used to assign drainage structures to each category

Conservation / Habitat Value	Criteria
High	Known to provide breeding habitat for threatened species (i.e. Southern Myotis) or;
	Known to provide non-breeding roosting habitat for large numbers (i.e.>50) of threatened species (e.g. known to support large numbers of Bent-winged Bats over winter); or
	Supports one or more of the federally listed Large-eared Pied Bat.
Medium	Does not satisfy high conservation / habitat value category;
	Provides non-breeding roosting habitat for small numbers (i.e. <50) of threatened species; or
	Medium to large guano accumulations and / or stains present indicative of the occurrence of moderate numbers of microbats or medium to long-term usage (threatened / non-threatened status unknown); or
	Potentially suitable for breeding Southern Myotis. For example, access under bridge / into culvert >500 mm diameter, presence of large cavities (e.g. >20 mm wide and >100 mm deep), directly adjacent to/ over open water, low inundation susceptibility; or
	Supports protected cavities providing good potential long term roosting habitat; however, no bats or evidence of roosting bats present; and/or
	In proximity to open surface water, however provides mainly exposed roosting opportunities (e.g. cavities <50 mm deep, or rough concrete), offering limited potential for breeding roosting; and/or
	Supports a breeding colony of non-threatened microbats.
Low	Does not satisfy high or medium conservation/ habitat value categories; and
	Individual microbats or very small numbers of non-breeding microbats (e.g. <5) present; or
	Small guano accumulations and/ or stains present indicative of the occurrence of small numbers of microbats or short-term usage; or
	Provides mainly exposed roosting opportunities (e.g. cavities <50 mm deep, or rough concrete) offering limited potential for use as breeding habitat; or
	Not in proximity to open water.
	Roosting habitat of similar value locally is common and would be duplicated by culverts and bridges on the new highway upgrade.

Drainage structures categorised as being of medium or high conservation value as microbat habitat were considered to be the subject drainage structures for the purposes of the MMP and specific mitigation measures and management actions are associated with each of these structures. Low conservation value structures were considered to be locally common and / or would be duplicated by culverts and bridges constructed as part of the new highway (GeoLINK 2015b).

Of the 11 subject drainage structures identified in the original MMP, seven high value and four medium value structures were identified (Table 3). However, at the time of production of the MMP only three of the 11 subject drainage structures were expected to be impacted by W2B construction works through either removal or extension. The remaining eight structures were expected to be retained and would serve as control sites for comparison with impacted sites throughout the monitoring period. At the time of the MMP's preparation detailed designs for the Project had not been completed.

2.5 Additional Structures

Once detailed designs were finalised, several changes to the status of the subject drainage structures were required. Pre-clearing surveys and surveys conducted on new impact areas resulting from project design changes during 2017 and 2018 identified nine additional drainage structures of high or medium conservation value, or of low value but in close proximity to high conservation value structures as microbat habitat which required management under the provisions of the MMP. One structure originally identified as a control site; Devil's Pulpit CH 106190 became an impact site (GeoLINK 2018c). Seven structures would be retained and will act as control sites.

Five of the additional structures were identified during pre-clearing surveys conducted in Sections 4 and 5 in the vicinity of Maclean cut during 2017 (BGC Contracting 2017, GeoLINK 2018a). The pre-clearing reports recommended including these additional culverts and elevating the conservation / habitat value of two other culverts in this area from low to medium because evidence of microbat occupation was found where there had been none previously. Some culverts from the Maclean cut area categorised as low value were recommended to be included in the list of subject drainage structures. The reason for including these low conservation / habitat value structures was because of their proximity to medium to high conservation / habitat value structures and the risk of microbats relocating into them following exclusion from the medium or high conservation / habitat value structures.

Three structures not previously surveyed in the Glenugie Link section were identified as high conservation / habitat value following targeted microbat surveys triggered by design changes in that area (ELA 2018a, GeoLINK 2018b).

The final additional structure to be included in the Plan was a fauna underpass in the Devil's Pulpit tie-in Section at CH 106190. Although not previously listed as medium or high conservation value microbat habitat, ELA recommended inclusion of this structure because of its proximity to a subject drainage structure listed as medium value that will be extended or removed as part of the Project. The additional structure is a fauna underpass and contained potential microbat roosting sites. There was a risk of microbats relocating to this structure following exclusion from the adjacent medium value structure.

Upon identification of these additional structures, a work program was developed in consultation with PC, EPA, W2B Environmental Representative and TfNSW to identify the quantity and quality of alternative roosting habitat required to be provided temporarily during construction and permanently within the newly created structures, critical timing of exclusion device installation, and monitoring requirements. The status of several the structures identified in the original MMP were also changed from non-impacted to impacted following the detailed design phase of the project which post-dated preparation of the original MMP. The full suite of management measures and recommendations included in the MMP for the original 11 subject drainage structures also applied to the nine additional structures from the date they were identified.

The complete list of all 20 structures requiring management and monitoring is included as Table 3. Of the 20 sites, 13 are impact sites and seven are control sites. Microbat exclusion occurred at 11 of the 13 impact sites.

2.6 Compensatory habitat installation

2.6.1 Temporary Habitat

There is a requirement to create temporary replacement habitat prior to commencement of construction and permanent cave-dwelling roost habitat within new culverts/bridges throughout construction and once construction is complete. The MMP sets out specifications for design, installation, location and monitoring of the temporary and permanent microbat habitat.

Temporary replacement habitat includes the installation of a range of bat boxes and box types within vegetation or non-impacted culverts (dependent upon the species of microbat involved) adjacent to the impacted drainage structures. The number and size of bat boxes to be installed at each location was specified in the MMP and calculated to include a 15% increase on the maximum number of microbats observed at each location. Table 3 and Figure 1 to Figure 9 outline the locations and numbers of bat boxes that were installed at /adjacent to each drainage structure as well as the dates of installation of each of those boxes.

Southern Myotis is known to inhabit a range of bat box types installed both under bridges and culverts or within trees adjacent to permanent water bodies. Little and Large Bent-winged Bats have never been recorded in bat boxes attached to trees, and only in small numbers or individually in boxes beneath bridges and culverts.

Ten bat boxes that form part of the control sites in the MMP were installed at Serpentine Creek (6 boxes installed in March 2015 as part of a separate project) and Mororo Bridge (4 boxes installed in 2013 as part of a separate project) prior to the commencement of the W2B highway upgrade project by GeoLINK. Subsequently, and based on the MMP, pre-clearing survey reports and ELA calculations, a further 28 bat boxes were installed as temporary replacement habitat by ELA at sites spread between Glenugie and Oakey Creek (Figure 1 to Figure 9).

Of the 38 boxes required as part of the W2B MMP, 22 have been installed at control locations as a precautionary measure (drainage structures to be retained), and 16 were installed at impact sites (drainage structure to be removed or extended). It is important to note that the control locations are all within the exiting Pacific Highway upgrade alignment and have been subject to varying degrees of vegetation clearance and construction activities for the new highway alignment (within 10 – 50 m of each structure).

Most (32) bat boxes installed are 2, 3 or 4 chambered boxes constructed from either timber ply or Cyplas and supplied by Hollow Log Homes. Of these 30 were installed in trees adjacent to the impacted drainage structure (within 200 m) and 2 were installed within culverts as close as possible to the impacted drainage structure (within 500 m). There are 6 bat boxes constructed from Hebel blocks that have been installed to better replicate the darker and more insulated cave-like environments preferred by Little Bent-winged and Large Bent-winged Bats. Five of these were installed in trees adjacent to the

impacted culverts at Maclean cut and the remaining is a larger style box designed to accommodate large aggregations of Bent-winged Bats and is described below.

A prototype multi-chambered Bent-winged Bat box with the capacity to accommodate approximately 2000 Bent-winged Bats constructed from Hebel blocks is planned to be installed in a culvert under the existing Pacific Highway at CH 31400 in early 2019. This Bent-winged Bat box is designed to provide permanent replacement habitat and to replicate the expansion jointing gaps used by Bent-winged Bats in the Bebo Arch at CH 34900 (Figure 1 and Figure 10).

2.6.2 Permanent Habitat

The MMP describes a range of permanent cave-dwelling microbat roosting habitat that could be created in each new structure built within the vicinity of medium and high conservation value bat roost habitat structures. The permanently created microbat habitat is to have a minimum carrying capacity equal to or greater than that of the original structure. Types of permanent microbat habitat that have been, or will potentially be created on the W2B project include;

1. maximum jointing gaps (15-25mm) between cells of concrete pipe culverts (CPCs) and reinforced concrete box culverts (RCBCs);
2. leaving lift holes in CPCs uncapped and unfilled,
3. roughened concrete culvert obverts (middle third of drainage structure >900 mm diameter for a width of 300 mm) – to be installed if required once construction of new structures is complete and carrying capacity of each new structure has been determined.
4. leaving transport holes unfilled on some of the new pre-cast concrete bridges
5. installation of bat boxes within drainage structures once construction is complete - to be confirmed if required once construction of new structures is complete and carrying capacity of each new structure has been determined

Creation of permanent microbat habitat in the form of recessed chambers, blind culverts, maximum jointing gaps in all fauna underpasses and cavity maximisation and concrete feature replication on new bridges were considered during the detailed design phase of the W2B project. To date, discussions between TfNSW, PC, ELA, and construction contractors have resulted in lift holes being left open and maximum jointing gaps included in some of the new structures located at Glenugie (within new culverts at Pheasants and Picaninny Creek and the new culvert that replaced the Bebo Arch) and Maclean cut (new culverts) where appropriate.

New drainage structures are being considered as host sites for the installation of permanent habitat as they are located within 500 m of medium and high conservation value microbat habitat that will be impacted by the project. The list of permanent habitat features being considered for each new drainage structure in proximity to the impacted structures is included in Table 4.

At this stage there have been no bat boxes relocated and installed within new drainage structures because construction is still actively progressing. Once construction of new structures is complete, an audit of the newly created structures will be undertaken to determine the carrying capacity of each structure and allowing recommendations to be made about whether additional permanent microbat habitat is required to be installed in the form of bat boxes or roughened obverts. ELA will arrange for procurement of additional boxes following consultation with PC / TfNSW if the boxes already installed have become inhabited and / or it is not appropriate to relocate them into the new structures.

Table 3: Subject drainage structures requiring mitigation and management as part of the W2B MMP, additional structures included post MMP production are marked with an asterisk*.

Portion	Section	Chainage	Location	Feature Type	Planned Construction Action	Conservation Value	Control or Impact	Box installation required and date of install	No. of boxes	Exclusion required	Exclusion completed
A	3A Glenugie Link*	34900*	Bebo Arch at southern end of Glenugie Link	Bebo	Remove	High	Impact	Bent-winged Bat box with capacity for 2000 Bent-winged Bats required to be installed in culvert at CH 31400.	1	Yes	Not undertaken, demolition planned during off season Feb 2019
A	3A Glenugie Link*	35900*	Pheasant Creek, Eight Mile Lane	CPC	Remove	High	Impact	Installed 1 box in a tree Mar 2018	1	Yes	Internally Jun-18, culvert left open as flyway for Southern Myotis
A	3A Glenugie Link*	35900*	Picaninny Creek, Eight Mile Lane	CPC	Remove	High	Impact	Installed 2 boxes in trees Mar 2018	2	Yes	Jun-18
A	4	81600*	North of Jubilee Street overbridge, fauna underpass	CPC	Remove	Low	Impact	N/A	0	Yes	Mar-18
A	4	81650*	North of Jubilee Street overbridge	CPC	Remove	Low	Impact	N/A	0	Yes	Mar-18
A	4	81825*	North of Jubilee Street overbridge	CPC	Remove	Medium (changed from Low)	Impact	Installed 4 boxes in trees Feb 2018 (incl 2 Hebel)	4	Yes	Internally Sept 2017, externally March 2018

Portion	Section	Chainage	Location	Feature Type	Planned Construction Action	Conservation Value	Control or Impact	Box installation required and date of install	No. of boxes	Exclusion required	Exclusion completed
A	4	81980*	North of Jubilee Street overbridge	RCBC / Fauna underpass	Remove	Low	Impact	N/A	0	Yes	Internally Sept 2017, externally March 2018
A	4	82020	North of Jubilee Street overbridge	CPC	Remove	High	Impact	Installed 4 boxes in trees Sept 2017 (incl 2 Hebel)	4	Yes	Internally Sept 2017, externally March 2018
B	5	82300	North of Jubilee Street overbridge	CPC	Remove	High	Impact	Installed 2 boxes in trees Sept 2017 (incl 1 Hebel)	2	Yes	Mar-18
B	5	82860*	North of Jubilee Street overbridge	RCBC	Remove	Medium (changed from Low)	Impact	N/A	0	Yes	Mar-18
B	5	89370	Old Serpentine Creek Bridge	Concrete bridge cast in situ	Likely retain	Medium	Control	2 boxes installed by GeoLINK 2015	2	No	Not required
B	5	89400	New Serpentine Creek Bridge	PPLNK	Retain	High	Control	4 boxes installed by GeoLINK 2015	4	No	Not required
B	5	94090	Mororo Bridge north	STRUS	Retain	High	Control	N/A	0	No	Not required
B	5	94090	Mororo Bridge south	PTROG	Retain	High	Control	4 boxes installed by GeoLINK 2013	4	No	Not required
B	6	101610	Tabbimoble Creek	PPLNK	Retain	High	Control	Retained but 8 boxes installed in trees as a precautionary measure Feb 2017	8	No	Not required

Portion	Section	Chainage	Location	Feature Type	Planned Construction Action	Conservation Value	Control or Impact	Box installation required and date of install	No. of boxes	Exclusion required	Exclusion completed
B	6	102900	Tabbimoble Overflow	PPLNK	Retain	High	Control	Retained but 4 boxes installed in trees as a precautionary measure Feb 2017	4	No	Not required
B	Devils Pulpit	106170	62.14km south of Ballina, south of Pine Road	CPC	Extend or remove	Medium	Impact	Installed 1 box in adjacent culvert at CH 106230 April 2018	1	Yes	May-18
B	Devils Pulpit	106190*	Fauna Underpass	RCBC / Fauna underpass	Extend or remove	Medium (ELA)	Impact	None	0	Yes	May-18
C	7	122280	Oakey Flat # 3 Oakey Creek	RCBC	Remove	Medium	Impact	Installed 1 box in a tree Nov 2016	1	Yes	Not undertaken, low risk of microbat habitation, safety risk to install exclusion devices, letter of justification to TfNSW
D	10	157400	Saltwater Creek, south of Coolgardie Road	RCBC	Retain	Medium	Control	None	0	No	Not required

* Subject drainage structures incorporated after production of the original MMP

Table 4: Details of selected drainage structures on the new Pacific Highway alignment of the W2B project and potential permanent habitat features being considered.

Portion	Section	Chainage	Location	ID	Feature Type	Dimensions No. of cells x length (m) x width (mm) x height (mm)	Permanent habitat features considered	Bat box installation	Comments and location of original impacted structure
A	3AB	34665	Glenugie	CL-034665	RCP	1 x 30 x 1200	Maximum jointing gaps (20mm) in central third of culvert.	No	To be confirmed. Original Bebo Arch removed CH 34900
A	3AB	34825	Glenugie	CL-034825	RCP	1 x 82 x 1500	Consider obvert roughening via application of 300mm wide strip of tiling grout to central 3rd of cell joints if there is inadequate roosting habitat provided by RCBC at CH 35075.	No	To be confirmed. Original Bebo Arch removed CH 34900
A	3AB	35075	Glenugie	CC-035075	RCBC	2 x 56 x 2400 x 2400	Leave lift points open (no capping or filling). Maximum jointing gaps (20mm) in central third of culvert. If jointing gaps are not adequate, then a Hebel Bentwing Bat box will be required.	Potential	To be confirmed. Permanent habitat must have capacity for 2000 Bent-winged Bats. Potentially install Hebel box design running longitudinally through CC-035075 culvert with single slot. Original Bebo Arch removed CH 34900.
A	3AB	35880	Eight Mile Lane	CL-035880	RCBC	5 x 54 x 3000 x 1800	Leave lift points open (no capping or filling). Consider obvert roughening via application of 300mm wide strip of tiling grout to central 3rd of cell joints if there is inadequate roosting habitat provided by structures at CH	No	To be confirmed. Original culverts removed CH 35900

Portion	Section	Chainage	Location	ID	Feature Type	Dimensions No. of cells x length (m) x width (mm) x height (mm)	Permanent habitat features considered	Bat box installation	Comments and location of original impacted structure
							35880, CH 36010, CH 36075 and CH 36379.		
A	3AB	36010	Eight Mile Lane	CL-036010	RCBC	5 x 28 x 3000 x 1800	Leave lift points open (no capping or filling). Consider obvert roughening via application of 300mm wide strip of tiling grout to central 3rd of cell joints if there is inadequate roosting habitat provided by structures at CH 35880, CH 36010, CH 36075 and CH 36379.	No	To be confirmed. Original culverts removed CH 35900.
A	3AB	36075	Eight Mile Lane	CL-036075	RCBC	5 x 33 x 3000 x 1200	Leave lift points open (no capping or filling).	No	To be confirmed. Original culverts removed CH 35900
A	3AB	36379	Eight Mile Lane	Pheasant Creek	BRIDGE	45 (l) 3.6 (h)	Leave lift holes open on Super T's (no capping or filling). If culverts at CH 35880, CH 36010 and CH 36075 as well as lift holes at this location do not provide adequate habitat for Southern Myotis then bat boxes will be required to be installed.	Potential	To be confirmed. Permanent habitat must have capacity for 110 Southern Myotis. Potentially install lattice style boxes under Pheasant Creek Bridge. Original culverts removed CH 35900.
A	4	81645	Maclean cut	CL-081645	RCP	1 x 53 x 1200	Maximum jointing gaps (20mm) in central third of culvert.	No	To be confirmed. Original culverts removed CH 81825 – 82300.

Portion	Section	Chainage	Location	ID	Feature Type	Dimensions No. of cells x length (m) x width (mm) x height (mm)	Permanent habitat features considered	Bat box installation	Comments and location of original impacted structure
A	5	82030	Maclean cut		RCP	1200mm	Maximum jointing gaps (20mm) in central third of culvert.	No	To be confirmed. Permanent habitat must have capacity for 650 Bent-winged Bats. Maximum jointing gaps required because culverts too small for box installation (boxes take up > 10% of area). If capacity not attained through maximum jointing gaps, other solutions will need to be considered. Original culverts removed CH 81825 – 82300.
A	5	82330	Maclean cut		RCP	1350mm	Maximum jointing gaps (20mm) in central third of culvert.	No	To be confirmed. Original culverts removed CH 81825 – 82300.
B	5	83100	Maclean cut	Bridge B01 (Koala Drive)	BRIDGE	26	Leave lift holes open on Super T's South Bound (no capping or filling)	No	To be confirmed. Original culverts removed CH 81825 – 82300.
B	5	Serpentine CK Bridge 89370	Serpentine Creek Channel				Leave lift holes open on Super T's North Bound (no capping or filling)	No	To be confirmed. Original bridges retained at CH 89370 and CH 89400.

Portion	Section	Chainage	Location	ID	Feature Type	Dimensions No. of cells x length (m) x width (mm) x height (mm)	Permanent habitat features considered	Bat box installation	Comments and location of original impacted structure
B	5	Mororo CK Bridge 94090	Mororo Bridge over the Clarence River				Leave lift holes open on Super T's South Bound (no capping or filling)	No	To be confirmed. Original bridges retained at CH 94090
B	6	106185	Devil's Pulpit	CF-106185	RCBC	1 x 14.75 x 2100 x 2100	Leave lift holes open (no capping or filling). Consider installation of a single bat box if lift holes and expansion joints are not adequate.	Potential	To be confirmed. Permanent habitat must have capacity for 30 bats. Original culvert CH 106170
B	6	106185	Devil's Pulpit	CF-106185	RCBC	1 x 20 x 2100 x 2100	Leave lift holes open (no capping or filling).	No	To be confirmed. Original culvert CH 106190
C	7	122266	Oakey Creek	CC-122270	RCBC	7 x 39 x 2400 x 1800	Leave lift holes open (no capping or filling). Consider installation of a single bat box if lift holes and expansion joints are not adequate.	Potential	To be confirmed. Permanent habitat must have capacity for 30 Southern Myotis. Original culvert removed CH 122280
C	7	122547	Oakey Creek	CC-122550	RCBC	3 x 40 x 3000 x 2400	Leave lift holes open (no capping or filling). Consider obvert roughening via application of 300mm wide strip of tiling grout to central 3rd of cell joints if there is inadequate roosting habitat provided by structures at CH 122266.	No	To be confirmed. Original culvert removed CH 122280

2.7 Microbat Exclusion

Microbat exclusion is required if any direct works (i.e. removal or extension) are undertaken on medium or high conservation value microbat habitat structures. Thirteen of the 20 structures required exclusions to be carried out (Table 3). Two of the 13 impacted structures were not excluded to microbats during the monitoring period, the Bebo Arch at CH 34900 and Oakey Creek culvert at CH 122280 for reasons outlined below.

The Bebo Arch was occupied each year between late February/March and September by overwintering Little Bent-winged (and occasionally Large Bent-winged) Bats. Timing of works at this structure were scheduled to avoid the overwintering period for Bent-winged Bats and structure removal was not scheduled to occur until 2019. For this reason, exclusion was not undertaken at the Bebo Arch during 2018. In conjunction with the removal of the Bebo Arch, a prototype Bent-winged Bat box was planned to be installed in a nearby culvert at CH 31400 (Figure 10) to provide permanent cave-dwelling habitat for Bent-winged Bats.

Figure 10: Bent-winged Bat box designed to accommodate up to 2000 Bent-winged Bats, installed in a box culvert at Glenugie CH 31400.

Oakey Creek culvert (Figure 11) contained a very small amount of shallow and exposed roosting habitat. The culvert contained deep (>1.5m) permanent water during all inspections and there were concerns over the practicality of installing and more importantly maintaining the integrity of exclusion devices. Due to these concerns and the relatively low risk of microbat habitation a decision was made to leave the Oakey Creek culvert open to microbats (ELA 2018b). This decision was made in consultation with EPA and a W2B environmental representative.

Figure 11: Looking east through Oakey Creek culvert, one of the impacted subject drainage structures along the W2B alignment showing current and previous high water levels (staining half way up culvert walls).

2.8 Microbat Monitoring

In accordance with the TMMP and peer review (Shultz 2013), pre-construction monitoring surveys of drainage structures within Sections 3 to 11 and listed in the original MMP were undertaken by GeoLINK to provide baseline data relating to current usage by microbats, as follows:

- Winter (July to August 2014)
- Spring (October to November 2014)
- Summer (February 2015).

Pre-construction monitoring surveys of additional drainage structures added after production of the original MMP were also undertaken but owing to time constraints imposed by the construction schedule generally only occurred over a period of less than 12 months. ELA undertook pre-construction microbat surveys of the following drainage structures:

- Section 3A Bebo Arch Glenugie Link (Spring September 2018, Summer December 2018)
- Section 3A Pheasants Creek culvert Eight Mile Lane (Summer February 2018)
- Section 3A Picaninny Creek culvert Eight Mile Lane (Summer February 2018)
- Sections 4-5 Maclean Cut (Summer December 2017 - February 2018)
- Devil's Pulpit tie in Section (Summer December 2017, Autumn April 2018)

This report addresses monitoring of drainage structures, including both impact and control sites, exclusions and compensatory habitat installed during construction. The MMP (GEOLINK 2015b) sets out the monitoring schedule, including the following specifications:

- Quarterly visual inspections to commence following the exclusion of impacted structures during construction, commencing in 2017 and expected to cease at the end of 2019, but may be required into 2020 until construction has been completed.
- Biannual visual inspections post construction for up to 6 years, expected to commence in 2020 and cease in 2026.
- Post construction biannual monitoring may cease after 2 years at any particular site if populations of bats have stabilised at that site.

3. Methodology

A series of monitoring inspections occurred at the subject drainage structures from December 2017 to 2018, as determined by the construction schedule in line with requirements under the MMP (GeoLINK 2015b). In addition, as pre-clearing surveys were undertaken and design changes were finalised, the list of impacted drainage structures was extended. Additional drainage structures were incorporated into the monitoring contract at different times as the construction schedule evolved.

Table 5 sets out the details of each subject drainage structures and the date it was identified to be managed in accordance with the MMP (GeoLINK 2015b), as well as dates when monitoring was undertaken. Monitoring involved a diurnal visual inspection of the internal and external features of each drainage structure using a torch, binoculars and camera, noting exclusion devices (if present) and compensatory habitat/bat boxes (if present).

In accordance with the requirements of the MMP, the following information was recorded during each monitoring inspection:

- Date and time of inspection
- Identification code of bat box or subject drainage feature
- Evidence of microbats (bats, guano, bat bugs and/or staining)
- Number of microbats present
- Identification of species
- Indications of breeding activity
- Occurrence of any pest species such as feral bees
- Condition of the bat roost / bat box (e.g. any deterioration, structurally unstable) if applicable
- Roost features present
- Record of rainfall during monitoring period.

Pre-construction monitoring surveys were undertaken in the first quarter during 2017 at drainage structures and bat boxes within Sections 4, 5 and 6. These initial inspections were undertaken by ELA at the request of PC Environmental Officers prior to construction commencing in those areas. These monitoring inspections were not required under the MMP but provided valuable information on the status of microbat colonies since the last surveys conducted for production of the MMP in 2015. Monitoring of structures commenced in Sections 4, 5 and 6 in December 2017 in line with the commencement of construction activities at or near the subject drainage structures and following exclusion activities at the respective structures. Monitoring dates during 2017 were as follows:

- 22 February 2017 (pre-construction / pre exclusion monitoring / box installation)
- 8 March 2017 (pre-construction / pre exclusion monitoring)
- 19 and 26 September 2017 (pre-exclusion monitoring and exclusion Maclean cut Sections 4 and 5)
- 20th December 2017 (commencement of quarterly post exclusion monitoring Maclean cut Sections 4 and 5).

During 2018 MMP quarterly monitoring events were split over 8 separate site visits that included inspections of drainage structures and bat boxes within Sections 3A, 4, 5, 6, Devil's Pulpit, 7 and 10:

- 25th January 2018
- 22nd February 2018
- 15th-16th March 2018
- 18th April 2018
- 30th May 2018
- 19th-21st June 2018
- 4th-6th September 2018
- 13th-14th December 2018.

3.1 Compensatory Habitat / Bat Boxes

Compensatory habitat in the form of bat boxes (Figure 12 and Figure 13) constructed from a range of materials and designs were located within Sections 3A, 4, 5, 6, Devil's Pulpit, 7 and 10 (Table 3). All bat boxes were inspected by an ELA ecologist during each quarterly event, unless access to the boxes was prevented for safety reasons related to adverse site conditions or active construction activity in proximity to the boxes. Information on occupancy and box condition was recorded. Any damage to bat boxes was identified, documented and forwarded to PC, for approval of proposed corrective actions.

Figure 12: A single chamber bat box (LHS) and a four-chambered bat box (RHS) constructed from Cyplas (recycled plastic) in a tree adjacent to the impacted structures in Section 4, Maclean cut.

3.2 Roost Exclusion Devices

Exclusion of drainage structures was carried out in Sections 3A, 4 and Devils Pulpit during 2018.

Timing the installation of roost exclusion devices is critical and must occur the season before the works are undertaken at each structure. Inspections of structures were undertaken diurnally prior to enacting any exclusions. In cases where no microbats were present during diurnal structure inspections, internal cavities were filled, and exclusion devices were installed across the entrances to all drainage structures immediately following the inspections.

In cases where microbats were present during inspections, or if there was uncertainty about whether microbats were present (Picaninny Creek and Pheasants Creek culverts on Eight Mile Lane at CH 35900), a nocturnal emergence survey followed by another visual inspection of the culverts was undertaken prior to installing one-way valves over the internal cavities. The ecologist then returned to the culverts

Figure 13: A single chamber timber bat box (upper feature) and a Hebel bat box with four core holes (lower feature behind tree trunk) installed in a tree adjacent to impacted structures in Section 4, Maclean cut.

at dawn the following morning to inspect them for the presence of microbats, and once satisfied that the culverts were free of microbats, removed the one-way valves and sealed the internal cavities (Pheasants Creek and Picaninny Creek culverts). Exclusion devices were then installed across the entrance to the Picaninny Creek culvert whilst Pheasants Creek culvert was left open to maintain the integrity of the flyway under Eight Mile Lane along Pheasants Creek. Blocking internal cavities prevents large numbers of microbats from roosting diurnally within the cavities whilst blocking the external entrances to structures prevents microbats from using the structures as nocturnal feeding perches, nocturnal roost sites or flyways. The integrity of the structure for drainage purposes must be retained. Timber lintels to which heavy duty plastic sheeting was attached were used to block structure entrances (Figure 14 and Figure 15). Expanding foam was used to seal internal cavities.

Partial exclusions (internal cavities blocked) reduce the risk of large colonies of microbats roosting within a structure but allow microbat passage through the structure, which may be important for some species to retain connectivity between foraging areas. Complete exclusions were undertaken at ten structures and a partial exclusion was undertaken at Pheasants Creek where it was considered important to retain a flyway for Southern Myotis along the creek and through the culvert (Table 3). All exclusions were carried out over a single day / night (i.e. no multiple night exclusions were required) and none involved the capture or hand removal of microbats. Internal exclusions were occasionally carried out on separate days to external exclusions (Maclean cut).

Monitoring of roost exclusion structures was undertaken at the same time as drainage structure and bat box monitoring to ensure that exclusion structures remained intact and effective. Any damage to exclusion structures was identified, documented and forwarded to PC for approval of proposed corrective actions.

Figure 14: External exclusion for microbats using heavy duty plastic sheeting across a culvert outlet, Devil's Pulpit tie in, Woolgoolga to Ballina Pacific Highway upgrade, May 2018.

Figure 15: Internal view of exclusion device for microbats using heavy duty plastic sheeting across a culvert outlet, Devil's Pulpit tie in, Woolgoolga to Ballina Pacific Highway upgrade, April 2018.

3.3 Control Sites

Control sites were identified as drainage structures classified as high or medium conservation / habitat potential that will not be subject to direct impacts and where construction of the new highway is at least 20 m away from the structure. Some of the original control sites listed in the MMP have become impact sites with detailed design and updates to the project alignment. There are seven control sites and these are identified in the list of subject drainage structures in Table 3. Control sites occur in Sections 5, 6 and 10 of the W2B project and consist of the existing Pacific Highway Bridge and old Pacific Highway Bridge over Serpentine Channel on Chatsworth Island, the existing Pacific Highway Bridge and old Pacific Highway Bridge at Mororo over the Clarence River, the existing Pacific Highway Bridges over Tabbimoble Creek and Tabbimoble Creek overflow and a box culvert on Saltwater Creek, Coolgardie in the far northern end of the W2B project. Control sites were monitored to determine microbat utilisation and, if present, record any changes in population dynamics over time. This information will be compared to the population dynamics recorded at the impact sites to assist in assessing the impact of construction on microbat populations.

4. Results

4.1 Compensatory Habitat / Bat Boxes

There have been multiple instances of microbats recorded occupying bat boxes throughout 2017 and 2018, including boxes where repeated and sustained occupancy has been recorded. Of the 37 bat boxes installed prior to the end of 2018, 12 (32%) were occupied by microbats at least once and 1 recorded evidence of microbat occupancy in the form of guano stuck on the wall of the box and on the ground beneath the box.

At least three species of microbat have been recorded in bat boxes including two threatened species (* listed as Vulnerable under the BC Act);

- Southern Myotis*
- *Nyctophilus bifax* (Eastern Long-eared Bat)*,
- *Nyctophilus gouldi* (Gould's Long-eared Bat) (Figure 16)

There were occasions when it was not possible to identify *Nyctophilus* spp. to species level because of the restricted view of the bats in the box and there is potential for another *Nyctophilus* species, *N. geoffroyi* (Lesser Long-eared Bat) to be present within the W2B alignment. The occurrence of the Eastern Long-eared Bat in a bat box is notable because this is one of the few recorded instances of this threatened species roosting within a bat box.

Figure 16: *Nyctophilus gouldi* (Gould's Long-eared Bat) recorded in a timber bat box in June 2018 along Tabbimoble Creek.

Southern Myotis were recorded occupying two boxes in small numbers (<5) at Serpentine Channel during spring, summer and autumn but not overwinter (Dec 2017, Mar 2018, Sept 2018). Southern Myotis were also recorded in large numbers (**Figure 17**) in all four Mororo Bridge boxes during spring, summer, autumn and winter inspections (Mar 2017, May 2018, Sept 2018, Dec 2018). Southern Myotis also breed in the boxes beneath Mororo Bridge. In both locations, bat boxes were installed under bridges over permanent waterways, the preferred habitat of Southern Myotis.

Figure 17: One of the four bat boxes installed beneath Mororo Bridge full of Southern Myotis.

The records of *Nyctophilus* spp. have all been from five of the eight bat boxes installed along Tabbimoble Creek on the western side of Tabbimoble Creek Bridge (CH 101610) with at least one box occupied by microbats during spring, summer, autumn and winter inspections (Mar 2018, June 2018, Sept 2018, Dec 2018). *Nyctophilus* spp. occurred as either a single individual (Sept 2018), in groups of 4 (Mar 2018, Sept 2018) and in groups of 8 individuals of the one species (June 2018, Dec 2018).

Sites where no microbats have been recorded in bat boxes during the monitoring period are as follows;

- Section 3A CH 35900 Picaninny and Pheasants Creek bat boxes (3 boxes)
- Section 4/ 5 CH 81900 Maclean cut bat boxes (10 boxes)
- Section 6 CH 106230 Devil's Pulpit bat box (1 box)
- Section 7 CH 122280 Oakey Creek bat box (1 box)

There were few instances of pest species occupying the bat boxes with occasional instances of spiders, spider egg sacs, mud wasp nests and in one instance a leaf nest which was presumed to have been made by *Acrobates sp*. (Feather Gliders). In most cases the occurrence of pest species was transitory and present for only one or two consecutive monitoring visits. It was not considered likely that pest species

were excluding microbats from using any of the boxes for a sustained period, nor do we consider intervention is required.

Overall, the boxes remained in good condition throughout the monitoring period. The condition of the boxes is recorded during each inspection and intervention will be recommended when / if required.

4.2 Control sites

There are seven control sites that have been inspected regularly during the monitoring period (Table 6). It is not possible at this stage of monitoring to discern any clear trends form the monitoring data gathered at the control sites due to;

- the small numbers of bats involved at certain control sites (Serpentine Creek, Saltwater Creek)
- the fact that monitoring to date has only captured one year of data and a comparison between seasons across years is more informative as bat utilisation of roost sites is often seasonal (all sites)
- many of the control sites are in proximity (<20m) to active construction areas which may have caused disturbance to the bat colonies that use these control sites (Serpentine Creek Bridge, Mororo Bridge, Tabbimoble Creek and Tabbimoble Creek Overflow).

Only one location; Mororo Bridge has a permanent colony of Southern Myotis and the numbers of bats present at this site dropped significantly during the September 2018 monitoring event, which coincided with a period of active construction adjacent to the bridge. The four Mororo Bridge bat boxes recorded permanent occupation by Southern Myotis throughout the monitoring period with between 77 (Sept 2018) and in excess of 300 Southern Myotis (Mar 2017) present at any one time (Table 6). Southern Myotis breed in these boxes and numbers fluctuate throughout the year with maximum colony sizes recorded in autumn after the second breeding event of the summer. However, numbers may also change in response to climatic conditions affecting the availability of food. Potential disturbance of the site may also cause bats to select alternative roost sites within the locality. The construction of the new Pacific Highway southbound Mororo Bridge could have caused disturbance in the form of daily noise above ambient levels. Some Southern Myotis may have responded to this disturbance by selecting alternative roost sites elsewhere within the locality during the construction period.

The numbers of Southern Myotis present at Serpentine Creek appears to have remained relatively stable throughout the monitoring period with less than 15 Southern Myotis present at any one time (Figure 18). Once again, there was a decrease in numbers to only 3 Southern Myotis recorded during the Sept 2018 monitoring event which coincided with a period of active construction adjacent to the site.

The situation at Tabbimoble Creek and Tabbimoble Creek Overflow is interesting because the number and species of microbats present at these locations has fluctuated dramatically between monitoring events (Table 6). The sites are known to be used by large numbers of Little Bent-winged Bats (hundreds) over winter and into spring (Sept 2018) (Figure 19). Tabbimoble Creek Bridges were used by Southern Myotis as a breeding site during summer (March) 2018, but the site does not appear to support a permanent breeding colony of Southern Myotis with no records of this species during monitoring inspections conducted during summer (December) 2017. Tabbimoble Creek Overflow Bridges are a less preferred roosting location for both Little Bent-winged Bats and Southern Myotis with fewer numbers

of each species recorded at this location. Construction activity at both Tabbimoble Creek and Tabbimoble Creek Overflow has been actively occurring for the duration of the monitoring period.

The first evidence of microbat occupation at Saltwater Creek culvert during the monitoring period was an observation of guano within the culvert in summer (December) 2018 indicating recent occupation by microbats.

Figure 18: Three Southern Myotis roosting in an expansion joint beneath the existing Serpentine Creek Pacific Highway Bridge, March 2017.

Figure 19: Little Bent-winged Bats roosting within an expansion joint under Tabbimoble Creek Bridge,

4.4 Impact sites

During the 2017 - 2018 monitoring period there were thirteen (13) impact sites that were regularly monitored, and they are listed along with results of monitoring events in Table 7. Most of the impact sites were required to have compensatory bat boxes installed in the adjacent vegetation or a nearby culvert / bridge prior to conducting exclusions of the structures. During the 2017-2018 monitoring period, this was achieved for 11 of the 12 structures where compensatory habitat was required (Table 3).

The exclusion of the Glenugie Link Bebo Arch at CH 34900 was not scheduled to occur until 2019 and box installation for this structure required the development of a prototype Bent-winged Bat box based upon replicating the expansion jointing gaps used as roosting habitat within the Bebo Arch. Installation of the prototype Bent-winged Bat box is scheduled for early 2019.

Installation of both timber and Hebel bat boxes adjacent to Maclean cut was achieved prior to exclusion of the structures in accordance with the MMP. However, Bent-winged Bats are not known to roost in bat boxes in large numbers, and are not known to roost in bat boxes placed in trees. There were no suitable non-impacted culverts within the project alignment that could have been used as alternative habitat by the large numbers (hundreds) of Little and Large Bent-winged Bats previously recorded in culverts at Maclean cut. Efforts to search for alternative culvert / cave locations outside the project alignment within a 5 km radius of the impacted culverts that may have provided suitable alternative roost sites for large numbers of Bent-winged Bats or that could accommodate the prototype Bent-winged Bat box design described above did not result in suitable alternatives being identified.

There were no microbats recorded in the culverts at Maclean cut by ELA during the 2018 monitoring period, nor any evidence of large aggregations having been present between monitoring events. Evidence of previous microbat occupation in the form of small guano deposits was recorded in three culverts in Maclean cut during inspections in January 2018 (Table 7). It is possible that storm events washed away any evidence of large aggregations during the 2018 monitoring period, but it is also possible that even the low level disturbance introduced by early works and vegetation clearance in the vicinity of the Maclean culverts was enough to cause Bent-winged Bats to find alternative winter roosts.

As a result of the lack of evidence of microbat habitation in culverts at Maclean cut during 2018, and after lengthy discussions between ELA, TfNSW and EPA, it was concluded that the culverts would be excluded without provision of an identified alternative subterranean roost nearby, despite searches being conducted to that effect. Owing to the construction schedule through Maclean cut, the new culverts were being constructed prior to removal of the old culverts and these new culverts were to be made available to microbats as soon as possible during the construction process.

At the end of the 2018 monitoring period there were two of the 13 impacted structures that had not been excluded; the Glenugie Link Bebo Arch at CH 34900 and Oakey Creek culvert at CH 122280. The Bebo Arch was not scheduled to be removed until 2019. There were no microbats observed at Oakey Creek culvert during inspections conducted in December 2017, January, February, March and May 2018. As stated in Section 2.6 above and owing to the lack of evidence of microbat occupation at Oakey Creek throughout the monitoring period as well as the practical difficulties in securing exclusion devices, a case was made to keep Oakey Creek culvert open.

Similarly, the culvert at Pheasants Creek CH 35900 (Figure 20) was only partially excluded to microbats, with the internal holes and gaps sealed using expanding foam. This was due to the need to maintain a flyway for Southern Myotis along the creek line at this location whilst removing the chances of large breeding aggregations inhabiting the culvert prior to demolition. There was a small amount of guano recorded in the culvert during Sept 2018 inspections, but no further evidence of microbat usage recorded in Dec 2018.

The Devil's Pulpit tie-in section contained two impacted drainage structures, both box culverts, one of which was also a fauna underpass. There had been evidence of microbats in the form of a small amount of guano observed in the culvert during Jan 2018. A single Large Bent-winged Bat was roosting in an expansion joint during inspections prior to exclusion of both structures in March 2018. The exclusion was delayed by a day and no further evidence of microbats was recorded at this location during the 2018 monitoring period.

Figure 20: Glenugie Link Section 3A Pheasants Creek culvert, January 2018.

4.5 Roost exclusion devices

There were no instances of failed exclusion devices recorded during the monitoring period.

Table 5: Dates when each drainage structure was subject to the MMP requirements, dates for construction commencement and dates that monitoring was undertaken.

Section	Chainage	Date added into MMP	Location	Construction Impact Dates	Exclusion date	Control or Impact	No. of boxes	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018
Glenugie Link	34900	Jan-18	Bebo Arch at southern end of Glenugie Link	To be removed Feb 2019	Not excluded – exclusion timed to coincide with a time when no bats were present	Impact	1	No, not yet in MMP	Yes (GeoLINK/ELA)	No site access	No, bats known to be present over winter, monitoring required from Sept to determine when the colony leaves, and if any bats remain over summer	Yes	Yes
Glenugie Link	35900	Jan-18	Pheasant Creek, Eight Mile Lane	Structure to be removed 2019.	June 2018	Impact	1	No, not yet in MMP	Yes (GeoLINK/ELA)	Yes	Yes	Yes	Yes
Glenugie Link	35900	Jan-18	Picaninny Creek, Eight Mile Lane	Structure to be removed 2019.	June 2018	Impact	2	No, not yet in MMP	Yes (GeoLINK/ELA)	Yes	Yes	Yes	Yes
4	81600	Dec-17	North of Jubilee Street overbridge, fauna underpass	Structure to be removed 2019.	Mar 2018	Impact	0	No, not yet in MMP	Yes	Yes	No site access	No site access	No site access

Section	Chainage	Date added into MMP	Location	Construction Impact Dates	Exclusion date	Control or Impact	No. of boxes	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018
4	81650	Dec-17	North of Jubilee Street overbridge	Structure to be removed 2019.	Mar 2018	Impact	0	No, not yet in MMP	Yes	Yes	No site access	Yes	No site access
4	81825	Dec-17	North of Jubilee Street overbridge	Structure to be removed 2019.	Internal Sept 2017, External Mar 2018	Impact	4	No, not yet in MMP	Yes	Yes	No site access	Yes	Yes (boxes only – no access to culverts to check exclusion devices)
4	81980	Dec-17	North of Jubilee Street overbridge	Structure to be removed 2019.	Internal Sept 2017, External Mar 2018	Impact	0	No, not yet in MMP	Yes	Yes	No site access	Yes	No site access
4	82020	Mar-15	North of Jubilee Street overbridge	Structure to be removed 2019.	Internal Sept 2017, External Mar 2018	Impact	4	No, construction not commenced	Yes	Yes	No site access	Yes	Yes (boxes only – no access to culverts to check exclusion devices)
5	82300	Mar-15	North of Jubilee Street overbridge	Part of structure removed Apr 2018, remainder to be removed early 2019.	Mar 2018	Impact	2	No, construction not commenced	Yes	Yes	No site access	Yes	Yes (boxes only – no access to culverts to check exclusion devices)

Section	Chainage	Date added into MMP	Location	Construction Impact Dates	Exclusion date	Control or Impact	No. of boxes	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018
5	82860	Dec-17	North of Jubilee Street overbridge	Temporary tie-in to upstream as part of Northbound works Apr 2018. Structure to be removed early 2019.	Mar 2018	Impact	0	No, not yet in MMP	Yes	Yes	No site access	Yes	No site access
5	89370	Mar-15	Old Serpentine Creek Bridge	Structure retained.	No exclusion required.	Control	2	Yes	Yes	Yes	No site access	Yes	Yes
5	89400	Mar-15	New Serpentine Creek Bridge	Structure retained.	No exclusion required.	Control	4	Yes	Yes	Yes	No site access	Yes	Yes
5	94090	Mar-15	Mororo Bridge north	Early works Dec 2017, temporary jetty Feb 2018, piling Mar 2018, bridge construct May 2018. Structure retained.	No exclusion required.	Control	0	Yes	No boat available	No boat available	Yes	Yes	Yes

Section	Chainage	Date added into MMP	Location	Construction Impact Dates	Exclusion date	Control or Impact	No. of boxes	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018
5	94090	Mar-15	Mororo Bridge south	Early works Dec 2017, temporary jetty Feb 2018, piling Mar 2018, bridge construct May 2018. Structure retained.	No exclusion required.	Control	4	Yes	No boat available	No boat available	Yes	Yes	Yes
6	101610	Mar-15	Tabbimoble Creek	Structure retained.	No exclusion required.	Control	8	Yes	Yes	Yes	Yes	Yes	Yes
6	102900	Mar-15	Tabbimoble Overflow	Structure retained.	No exclusion required.	Control	4	Yes	Yes	Yes	Yes	Yes	Yes
Devils Pulpit	106170	Mar-15	62.14km south of Ballina, south of Pine Rd	Structure to be removed 31 Jan – 15 Apr 2019.	May 2018	Impact	1	No, construction not commenced	Yes	Yes	Yes	Yes	Yes
Devils Pulpit	106190	Dec-17	Fauna Underpass	Structure to be removed 23 Jan – 29 Apr 2019.	May 2018	Impact	0	No, construction not commenced	Yes	Yes	Yes	Yes	Yes
7	122280	Mar-15	Oakey Flat # 3 Oakey Creek	Structure to be removed late 2019.		Impact	1	No, construction	Yes	Yes	Yes	Yes	Yes

Section	Chainage	Date added into MMP	Location	Construction Impact Dates	Exclusion date	Control or Impact	No. of boxes	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018
								not commenced					
10	157400	Mar-15	Saltwater Creek, south of Coolgardie Rd	Structure retained.	No exclusion required.	Control	0	No, construction not commenced	Yes	Yes	Yes	Yes	Yes

Table 6: Results from monitoring inspections carried out at the seven control sites within the W2B alignment between February 2017 and December 2018.

Section	Chainage	Date added into MMP	Location	Monitoring Feb / Mar 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018	Baseline survey results (2014/2015), min and max # bats recorded
5	89370	Mar-15	Old Serpentine Creek Bridge	1 SM in box, 10 SM in bridge	0	3 SM in bridge, 4 SM in box	No site access	3 SM in box	0	Min: No bats Max: 40 LgBW
5	89400	Mar-15	New Serpentine Creek Bridge	0	0	0	No site access	0	0	Min: 131 LgBW, 10 SM Max: 131 LgBW, 10 SM
5	94090	Mar-15	Mororo Bridge north	0	Not monitored – no boat access.	Not monitored – no boat access	0	0	0	Min: 1 SM Max: 2 SM
5	94090	Mar-15	Mororo Bridge south	300+ SM incl pups	Not monitored – no boat access	Not monitored – no boat access	210+ SM	77+ SM	100+ SM incl pups	Min: 127 SM incl pups Max: 255+ SM
6	101610	Mar-15	Tabbimoble Creek	3 SM	0	27 SM + pups in old bridge	226 LtBW in 12 locations, 8 SM in 5 locations	571 LtBW, 19 SM	0	Min: 2 SM Max: 553 LtBW, 10 Nycto, 2 SM, 1 Vesp
6	102900	Mar-15	Tabbimoble Overflow	1 LBW	0	2 SM	5 LtBW in 2 locations	103 LtBW, 1 GLEB	0	Min: No bats Max: 166 LtBW, 1 LgBW, 1

Section	Chainage	Date added into MMP	Location	Monitoring Feb / Mar 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018	Baseline survey results (2014/2015), min and max # bats recorded
										Nycto, 2 SM.
10	157400	Mar-15	Saltwater Creek, south of Coolgardie Road	No construction not commenced,	0	0	0	0	Guano	Min: No bats Max: 1 LgBW

GLEB = Gould's Long-eared Bat, LtBW = Little Bent-winged Bat, LgBW = Large Bent-winged Bat, Nycto = *Nyctophilus* sp, SM = Southern Myotis, Vesp = *Vespadelus* sp.

Table 7: Results from monitoring inspections of subject drainage structures carried out at the impact sites within the W2B alignment between February 2017 and December 2018.

Section	Chainage	Date added into MMP	Location	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018	Baseline survey results from MMP (2014/2015) and pre-clearing reports (2017/2018) min and max # bats recorded
Glenugie Link	34900	Jan-18	Bebo Arch at southern end of Glenugie Link	No, not yet in MMP	0	No site access	Not monitored, bats known to be present over winter, monitoring required from Sept to determine when the colony leaves, and if any bats remain over summer	200+ LtBW	0	Min: No bats (summer) Max: >100 LtBW/LgBW
Glenugie Link	35900	Jan-18	Pheasant Creek, Eight Mile Lane	No, not yet in MMP	7 SM incl 2 pups	6 SM	8 SM, partial exclusion (internal one-way valve)	Guano - small amount, internal	0 - internal exclusion only	Min: 6 SM Max: 7 SM incl 2 pups 6 SM

Section	Chainage	Date added into MMP	Location	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018	Baseline survey results from MMP (2014/2015) and pre-clearing reports (2017/2018) min and max # bats recorded
							installed June 2018.	exclusion only		
Glenugie Link	35900	Jan-18	Picaninny Creek, Eight Mile Lane	No, not yet in MMP	26 SM in three separate locations including pups in 2 separate breeding clusters	33 SM in two separate locations including pups in 2 separate breeding clusters	0, exclusions installed June 2018.	0, exclusions in place	0, exclusions in place	Min: 26 SM incl 9 pups Max: 33+ SM
4	81600	Dec-17	North of Jubilee Street overbridge, fauna underpass	No, not yet in MMP	0	0, exclusions in place Mar 2018.	No site access, exclusions in place	No site access, exclusions in place	No site access, exclusions in place	Min: No bats Max: Guano

Section	Chainage	Date added into MMP	Location	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018	Baseline survey results from MMP (2014/2015) and pre-clearing reports (2017/2018) min and max # bats recorded
4	81650	Dec-17	North of Jubilee Street overbridge	No, not yet in MMP	0	0, exclusions in place Mar 2018	No site access, exclusions in place	0, exclusions in place	No site access, exclusions in place	Min: No bats Max: Guano
4	81825	Dec-17	North of Jubilee Street overbridge	No, not yet in MMP	0	0, exclusions in place Mar 2018	No site access, exclusions in place	0, exclusions in place	No site access, exclusions in place	Min: No bats Max: Guano
4	81980	Dec-17	North of Jubilee Street overbridge	No, not yet in MMP	0	0, exclusions in place Mar 2018	No site access, exclusions in place	0, exclusions in place	No site access, exclusions in place	Min: No bats Max: No bats
4	82020	Mar-15	North of Jubilee Street overbridge	No, construction not commenced	0, internal exclusions in place Sept 2017.	0, exclusions in place externally Mar 2018	No site access, exclusions in place	0, exclusions in place	No site access, exclusions in place	Min: Guano Max: 262 LtBW

Section	Chainage	Date added into MMP	Location	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018	Baseline survey results from MMP (2014/2015) and pre-clearing reports (2017/2018) min and max # bats recorded
5	82300	Mar-15	North of Jubilee Street overbridge	No, construction not commenced	Guano - small amount, internal exclusions in place Sept 2017	0, exclusions in place externally Mar 2018	No site access, exclusions in place	0, exclusions in place	No site access, exclusions in place	Min: Guano Max: 72 LtBW
5	82860	Dec-17	North of Jubilee Street overbridge	No, not yet in MMP	Guano - small amount	0, exclusions in place Mar 2018	No site access, exclusions in place	0, exclusions in place	0, exclusions in place	Min: no bats Max: Guano
Devil's Pulpit	106170	Mar-15	62.14km sth of Ballina, sth of Pine Rd	No, construction not commenced	Guano - small amount	1 LgBW	0, exclusions in place May 2018	0, exclusions in place	0, exclusions in place	Min: No bats Max: Guano
Devil's Pulpit	106190	Dec-17	Fauna Underpass	No, not yet in MMP	0	0	0, exclusions in place May 2018	0, exclusions in place	0, exclusions in place	Min: No bats Max: 50+ LtBW/LgBW

Section	Chainage	Date added into MMP	Location	Monitoring Feb / March 2017	Monitoring Dec / Jan 2017/2018	Monitoring Feb / March 2018	Monitoring June 2018	Monitoring Sept 2018	Monitoring Dec 2018	Baseline survey results from MMP (2014/2015) and pre-clearing reports (2017/2018) min and max # bats recorded
7	122280	Mar-15	Oakey Flat # 3 Oakey Creek	No, construction not commenced	0	0	0	0	0	Min: No bats Max: 5 SM incl pup

LgBW = Large Bent-winged Bat, LtBW = Little Bent-winged Bat, SM = Southern Myotis.

5. Discussion

The start dates of microbat monitoring (2017-2018) of the subject drainage structures and compensatory bat boxes along the W2B alignment was staggered in line with the varying dates of construction commencement at each location, and has been characterised by changes and updates to the list of structures and timing of works. These changes and updates were a result of the finalisation of detailed designs for the project that occurred after preparation of the original MMP (GeoLINK 2015b). Regardless, the mitigation actions outlined in the MMP were applied to all structures. Exclusions were undertaken in all cases prior to construction commencement. In some cases, clearing of vegetation may have commenced in an area prior to exclusion, clearing of vegetation never occurred within the immediate area surrounding the structure containing roosting habitat until after exclusion had been undertaken. Post exclusion monitoring was undertaken where construction activities allowed safe access quarterly each year following exclusion.

The majority of actions required to be undertaken at each subject drainage structure were completed in the correct sequence; pre- exclusion monitoring, installation of compensatory bat boxes, exclusion of impacted structures and quarterly monitoring of structures and boxes throughout the construction period.

The use of compensatory bat boxes has had poor results at impacted sites with only one box (out of a total of 15 installed) being utilised adjacent to the impacted structures (Pheasants Creek, Picaninny Creek, Maclean cut, Oakey Creek, Devil's Pulpit). However, boxes installed at control sites (Serpentine Creek, Mororo Bridge and Tabbimoble Creek / Overflow) have had a much greater rate of occupancy, including habitation by one of the target species, Southern Myotis. The main reason for this is that of the four target microbat species, only Southern Myotis is known to regularly use bat boxes and prefers to inhabit boxes when installed under bridges or in culverts directly over water. All boxes installed at impacted sites have been installed in trees, often along creek lines but not always over permanent waterways. There were no available, suitable culvert or bridge structures present within the W2B alignment in close proximity to the impacted sites. This monitoring data at impacted and control sites has provided useful information for future road project.

Although installation of both timber and Hebel bat boxes adjacent to Maclean Cut was achieved prior to exclusion of the structures in accordance with the MMP (GeoLINK 2015b), monitoring data to date indicates the installed boxes have not provided suitable alternative habitat for the Little Bent-winged Bats and Large Bent-winged Bats known to inhabit the Maclean Cut culverts in large numbers over winter.

There have been no records of the remaining three target species (Little Bent-winged Bats, Large Bent-winged Bats and Large-eared Pied Bats) inhabiting bat boxes installed as compensatory habitat. It was known prior to construction that large aggregations of Little Bent-winged Bats and some Large Bent-winged Bats overwintered in numerous structures impacted by the W2B project. Sites that can accommodate large aggregations of bats are uncommon in the landscape. Where impacts to roosting habitat cannot be avoided on existing structure upgrades or structure extensions, and where possible, careful temporal staging of works under the supervision of a microbat ecologist should be applied to target works when these species are absent from the winter roost sites (late Sept – mid February on the

North-coast of NSW). Given that it has not yet been proven to be effective to offset construction phase impacts to large aggregations of Bent-winged Bats using bat boxes, this issue requires ongoing investigation into effective mitigation measures when impacts cannot be avoided. Whilst we have planned the trial of a prototype Bent-winged Bat box that could accommodate 2,000 Bent-winged Bats, constructed from Hebel blocks and resembling a series of expansion joints, to date Bent-winged Bats are not known to roost in boxes of any type in large numbers.

The exclusion methodology outlined in the MMP and followed during the implementation of this project throughout 2017 and 2018 has been successful. There were only two instances of bats present at a structure immediately prior to exclusion (Devil's Pulpit and Pheasants Creek), largely as a result of effective scheduling and timing of the exclusion events. There were no bats harmed during the exclusion process and simple single night exclusions were all that was required in each case. There were no instances of bats recorded at structures that had been completely excluded (internally and externally). There was one instance where evidence was found of bats using a structure (a small amount of guano present) after it had been partially excluded and in that case the structure had been left open as a flyway with limited exposed roosting habitat remaining within the structure (Pheasants Creek). The exclusion devices have remained intact and functional throughout the monitoring period. Construction works have not been halted as a result of unexpected finds of microbats in any of the pre-existing subject drainage structures.

Interpretation of monitoring results is limited, given that there has been a little over one full year of monitoring data collected. Microbat utilisation of a structure often changes throughout the year and a comparison of utilisation rates at similar times of year over many years is more likely to provide useful information on population trends. In addition to this, microbat numbers fluctuate in response to climatic conditions, the build-up of parasites at a roost location and are likely to be affected by disturbance from construction activities (noise and vibrations).

For many of the sites, active construction was occurring in close proximity for a large portion of the monitoring period, including designated control sites where construction was occurring within 50 m of the control structures. This raises concerns over the integrity of control sites, however the availability of suitable, alternative control sites outside the alignment remains a limiting factor. Some monitoring of the control structures was undertaken outside of the MMP by ecologists employed by the construction contractor. If works had the potential to impact roosting bats at the control sites additional controls / monitoring was put in place to reduce those impacts. Additional controls were introduced at varying times in line with construction requirements at Maclean cut, Mororo Bridge, Tabbimoble Creek Bridges and Tabbimoble Overflow Bridges sites. These measures were all administered and carried out by the ecologist employed by the construction contractor and consisted of a range of actions including additional inspections of the structures for microbats prior to certain works, procedures guiding when and how machinery and heavy plant started up and approached the works area, no-go zones restricting people and plant from sensitive roost sites, minimising non essential human presence in proximity to structures with roosting bats, installing exclusion materials in expansion cracks closest to the works area, and removing mud nests that could be used as microbat roosting habitat from the temporary bridge set up to construct the new Mororo Bridge.

There was a large reduction in numbers of Southern Myotis at Mororo Bridge during the monitoring period (from 300+ to 77) which was most pronounced in Spring 2018. However, during pre-construction

surveys carried out in October / November 2014 and February 2015 numbers of bats in the boxes at this site did fluctuate from 127+ to 255+. Because we have not gathered enough data on fluctuations in numbers of Southern Myotis throughout the year at this site it is difficult to attribute the reduction to construction activities, but it certainly must be considered as a possible cause.

Consideration of adaptive management responses to bat conservation are required given that the uptake of bat boxes has been minimal for boxes installed in trees adjacent to impacted structures, Bent-winged Bats are not utilising alternative habitat provided and Southern Myotis numbers have fluctuated at a key control site, including a decline in numbers coinciding with construction activities in proximity to the roost.

Table 4.2 of the MMP outlines corrective actions if deviations from performance criteria are observed. These include moving installed boxes within adjacent vegetation (changing the aspect, proximity to water) if they have not been utilised by microbats during construction and re-locating them into newly created culverts following completion of construction. The proposed course of action for the installed boxes at both impact and control sites are set out below.

Boxes installed along Pheasants Creek as compensatory habitat for roosting habitat being lost from Pheasants Creek and Picaninny Creek culverts should remain in place for 2019. These boxes are in the best location for Southern Myotis directly over water. If still unused after completion of 2019 monitoring then boxes should be relocated into the new Pheasants Creek or Picaninny Creek culverts.

There is no gain to be made from moving boxes to other trees at Maclean Cut given the target species (Bent-winged Bats) is only rarely known to roost in boxes installed under culverts and bridges, and then being in small numbers. The unused boxes are unable to be moved into the adjacent newly created culverts because the culverts are too small for box installation. Any unused boxes could be relocated into other culverts as required with consultation with EPA following the completion of construction.

The boxes underneath and in adjacent vegetation at Serpentine Creek were not installed as part of this project. Serpentine Creek is a control site and any existing boxes attached to the bridges whether used or unused should remain where they were originally placed.

The four boxes underneath Mororo Bridge (south) were also not installed as part of the W2B project. Mororo Bridge is a control site and any existing boxes attached to the bridge whether used or unused should remain where they were originally placed. Significant degradation of these boxes has been noted during monitoring inspections, with the timber permanently coated with excretions (guano and urine) from the bats. The boxes are often at capacity and the local population of Southern Myotis would benefit from installation of at least 6 new boxes of similar size or with a capacity to accommodate up to 500 Southern Myotis at this location.

It is recommended, although not required as part of the W2B project, that the additional boxes be constructed from a mixture of marine grade ply manufactured in a lattice style (proven to be successful for Southern Myotis at numerous sites throughout NSW) and from Cyplas as this material is not likely to react with guano and urine and create an unhealthy environment in the bat boxes. A mixture of materials is recommended because long term usage of Cyplas boxes by Southern Myotis (or any microbat species) has not been documented as this material is new to the market.

The 12 boxes installed adjacent to Tabbimoble Creek Bridges (eight boxes) and Tabbimoble Creek Overflow Bridges (four boxes) have had the most success in terms of bat occupation, although not by any of the target species. Both sites are control sites and boxes were installed as an additional measure to provide compensatory habitat in case bats were displaced by works in proximity to both control roost sites. Given several of the eight Tabbimoble Creek boxes have been used they should remain in place.

The single box installed in a culvert at Devil's Pulpit as compensatory habitat for roosting habitat being lost from an adjacent culvert and fauna underpass has not yet been used. It should remain in place for 2019. The culvert is still the best place for this box to be located as it is catering for unknown bat species with prior evidence of occupation being only in the form of guano. Even if still unused after completion of 2019 monitoring then the box should remain in the culvert.

The single box installed in a tree at Oakey Creek as compensatory habitat for Southern Myotis roosting habitat being lost from an adjacent culvert has not yet been used. It should remain in place for 2019 as it lies directly over Oakey Creek, an ideal location for Southern Myotis. If still unused after completion of 2019 monitoring, then the box should be relocated into the new Oakey Creek culvert.

Certain elements of the MMP were required to be implemented by the project ecologist appointed by the construction contractor rather than the contractor engaged to implement the MMP. These include elements of the MMP that relate to potential triggers and adaptive management responses as follows;

- requirement for pre-works checks on the day prior to starting works and on the day works commence,
- preparation of an EWMS with measures to minimise risks to microbats required when construction activities could impact microbats,
- an induction of all personnel involved with construction activities to communicate microbat management requirements,
- reporting of any microbat mortality to DoE and EPA,
- preparation of an adaptive management response plan if microbat mortality is recorded, and
- calling a halt to construction and conducting a review of the MMP procedures for exclusion and removal of microbats.

For this model of mixed responsibility for implementation of the MMP to function effectively and provide a holistic view of impacts to microbats throughout construction a high level of communication between all parties must be maintained. It is critical that all parties are aware of actions undertaken to monitor and protect microbats at subject drainage structures by any party even if those actions are not directly referenced in the MMP. It is recommended that all parties share the results of actions undertaken as they occur.

Potential triggers or adaptive measures that could be considered for future projects when works are occurring in proximity to control structures include:

- Improved, regular and more formalised communication and data exchanges between all parties with responsibilities for implementing and overseeing the MMP particularly throughout the period of construction adjacent to a control structure.
- Excluding bats from the site prior to works and changing the status of the site from control to impact.

- Installing additional bat boxes at a nearby, suitable location (if warranted at a specific site).
- Shifting work schedules to night work, to avoid daytime bat disturbance (if warranted at a specific site).
- If a significant roost site is impacted, consideration of installing alternative cavern-like structures *in situ* (e.g. new culverts) for Bent-winged Bats prior to impacting existing structures. Although it must be recognised this would not often be feasible.
- Expand the project footprint and allow monitoring of bat populations / structures, installation of alternative compensatory habitat within a 5-10 km radius of significant roost sites within the existing project footprint.
- Consider where feasible additional screening to mitigate increase in the level of light / noise / vibration / dust / between control sites and construction areas.

Activities from the MMP (GeoLINK 2015b) to be undertaken during 2019 include:

- Installation of a prototype Bent-winged Bat box within a box culvert at Glenugie CH 31400.
- Quarterly monitoring of all structures and compensatory bat boxes during 2019.
- Auditing of all newly created structures to determine the microbat roosting capacity contained within new structures.
- Provision of advice on the amount of permanent bat habitat required to meet requirements of the MMP.
- Finalise the types of, and locations where permanent microbat habitat features need to be created / installed in new structures.

Recommendations for 2019 monitoring events include:

- Continue quarterly monitoring of existing, additional and relevant newly built structures as per the MMP, including the newly installed prototype Bent-winged Bat box at CH 31400, to ascertain if it can accommodate up to 2,000 Bent-winged Bats.

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