



W2B Section 3 – 11 Microbat Management Plan 2022-2023 Annual Monitoring Report

Transport for NSW

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Project Manager	Phoebe Smith
Prepared by	Samantha Patch and Phoebe Smith
Reviewed by	Josie Stokes
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Abbreviations

Abbreviation	Description
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
CPC	Concrete Pipe Culverts
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
Km	Kilometres
MCoA	Minister's Conditions of Approval
MMP	Microbat Management Plan
NBMP	Nest Box Management Plan
NSW	New South Wales
PC	Pacific Complete
RCBCs	Reinforced concrete box culverts
RMS	Roads and Maritime Services
SSTS	soft soil treatment site
TfNSW	Transport for NSW
TMMP	Threatened Mammal Management Plan
W2B	Woolgoolga to Ballina

1. Introduction

1.1. Woolgoolga to Ballina Highway upgrade 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, NSW and the Queensland border. This report relates to one component of this Program, namely Sections 3 – 11 of the Woolgoolga to Ballina (W2B) Highway upgrade project. The W2B project was approved under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) on 24 June 2014 and the Commonwealth *Environment 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, NSW. The W2B project is divided into 11 sections, with the Microbat Management Plan (MMP) prepared by GeoLINK (2015b) and this current report relating to Sections 3 to 11 (Figure 1 - Figure 11).

1.2. Background

ANNUAL MONITORING

Sections 3 to 11 of the W2B project involved impacts to several threatened microbat species listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* (now superseded by NSW *Biodiversity Conservation Act 2016*) (BC Act):

- Southern Myotis – *Myotis macropus*
- Large Bent-winged Bat (LgBW) – *Miniopterus orianae oceanensis*
- Little Bent-winged Bat (LtBW) – *Miniopterus australis*

These impacts included the removal and modification to man-made drainage structures (bridges, culverts, concrete pipes etc.) that were being used as roosting habitat (and breeding habitat for Southern Myotis) by threatened microbat species. GeoLINK (2015b) subsequently prepared a MMP for the works as part of the Minister's Conditions of Approval (MCoA) for the project. This MMP included installing both temporary and permanent compensatory microbat habitat structures and required monitoring of these structures and sites.

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 relevant drainage structures and compensatory microbat habitat associated with the Woolgoolga to Ballina (W2B) Sections 3 – 11 Microbat Management Plan prepared by GeoLINK (2015b).

This 2022-2023 Annual Monitoring Report is the third in a series of Annual Monitoring Reports prepared for TfNSW. This report covers the Summer 2021/22 Annual Monitoring Event and the additional monitoring events in Winter 2022 and Summer 2022/23. The Summer 21/22 Annual Monitoring event was undertaken between 1st -3rd February 2022; additional Winter 2022 monitoring event from 16th - 17th August; and Summer 22/23 additional monitoring event undertaken on 2nd February 2023 only.

This report provides an overview of the W2B Highway upgrade project and microbat management completed to date and presents the methods and results of the 2022/23 monitoring events. The discussion and recommendations in this report are based on information gathered from field investigations and monitoring events. This report aims to inform future TfNSW projects that may require microbat monitoring and management in accordance with the TfNSW Microbat Management Guidelines (TfNSW 2023).

ADDITIONAL MONITORING

Additional monitoring of selected subject drainage structures was required for Winter 2022 and Summer 2023 as numbers and breeding status of microbat populations had not attained pre-construction levels. The 2019/20 report recommended that along with the Summer 2021/22 monitoring, additional Winter 2022 and Summer 2022/23 monitoring events be undertaken. This would ensure that all structures including permanent habitat installed in Winter 2021 had been monitored at least once in Winter and Summer post- construction.

The Winter 2022 monitoring event occurred from 16th - 17th of August and the Summer 2022/23 monitoring period was undertaken on 2nd February 2023. Drainage structures surveyed in both winter and summer have previously recorded both Southern Myotis and LgBW and LtBW. Both LgBW and LtBW have previously been recorded during winter within drainage structures, whereas during summer lower numbers occur likely due to migration to the maternity roost. Drainage structures which required additional monitoring events included:

- Glenugie exit box culverts (Winter 2022)
- Pheasants Creek box culvert (Winter 2022 and Summer 2022/23)
- Pheasants Creek Bridge (Summer 2022/23)
- Picaninny Creek culvert (Winter 2022 and Summer 2022/23)
- Greenhill culvert (Winter 2022)
- Maclean cut culverts (Winter 2022)
- Tabbimobile Creek Bridge (Winter 2022 and Summer 2022/23)
- Tabbimobile Creek Overflow Bridge (Winter 2022 and Summer 2022/23)
- Oakey Creek culvert (Summer 2022/23)
- New Oakey Creek overflow culvert (Summer 2022/23)

1.3. Purpose

This report aims to:

- Determine the effectiveness of temporary, alternative habitat installed as a compensatory mechanism, and permanent microbat habitat installed during construction to minimise the impacts to microbats from the loss of medium and high conservation value drainage structures.
- Provide useful information on reproductive status, age class and therefore dynamics and survival of local populations of target threatened microbat species throughout and post-construction.
- Provide results and discussion of the Summer 2022 monitoring of drainage structures and alternative habitat identified in the MMP and as well as any additional structures that were identified after preparation of the MMP (GeoLINK 2015b), but which are also subject to the provisions of the MMP. Details of additional structures are provided in previous microbat monitoring reports (ELA 2020a, ELA 2020b).
- Provide results and discussion of the additional monitoring Winter 2022 and Summer 2023.

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 Section 3 – 11, W2B

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 included:

- Environmental Impact Statement (Roads and Maritime Services 2012)
- Threatened Mammal Management Plan (Roads and Maritime Services 2013) –triggered requirement for a 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 were:

- Approved under the NSW EP&A Act on 24 June 2014.
- Approved under the Commonwealth EPBC Act on 14 August 2014.

Key survey dates in the 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 for microbat habitat within Sections 3 – 11, undertaken by GeoLINK in October - 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 Microbat Management Plan. Consequently, the *Woolgoolga to Ballina Microbat Management Plan Sections 3-11* (GeoLINK 2015b), herein referred to as the MMP, was prepared.

The objectives of the MMP were to:

- reduce potential for injury or death to microbats
- provide temporary alternative habitat for excluded microbats
- provide permanent replacement habitat for microbats.

The MMP included the following information:

- provision of artificial roosting structures, including designs, numbers required, locations and timing of installation

- timing of construction 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 applied to pre, during and post-construction phases of the W2B project and included eleven drainage structures within Sections 4 - 7 and Section 10. During the detailed design phase of the project after preparation 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 were also subject to the provisions of the MMP (GeoLINK 2015b). Details of when these additional structures were identified and became subject to the provisions of the MMP appear can be found in previous years monitoring reports (ELA 2020a, ELA 2020b).

Figure 1 - Figure 11 show the mapped locations of bat boxes and drainage culverts based on data sourced within the original MMP (GeoLINK 2015b).



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WOOLGOOLGA TO BALLINA - SECTION 3 GLENUGIE LINK

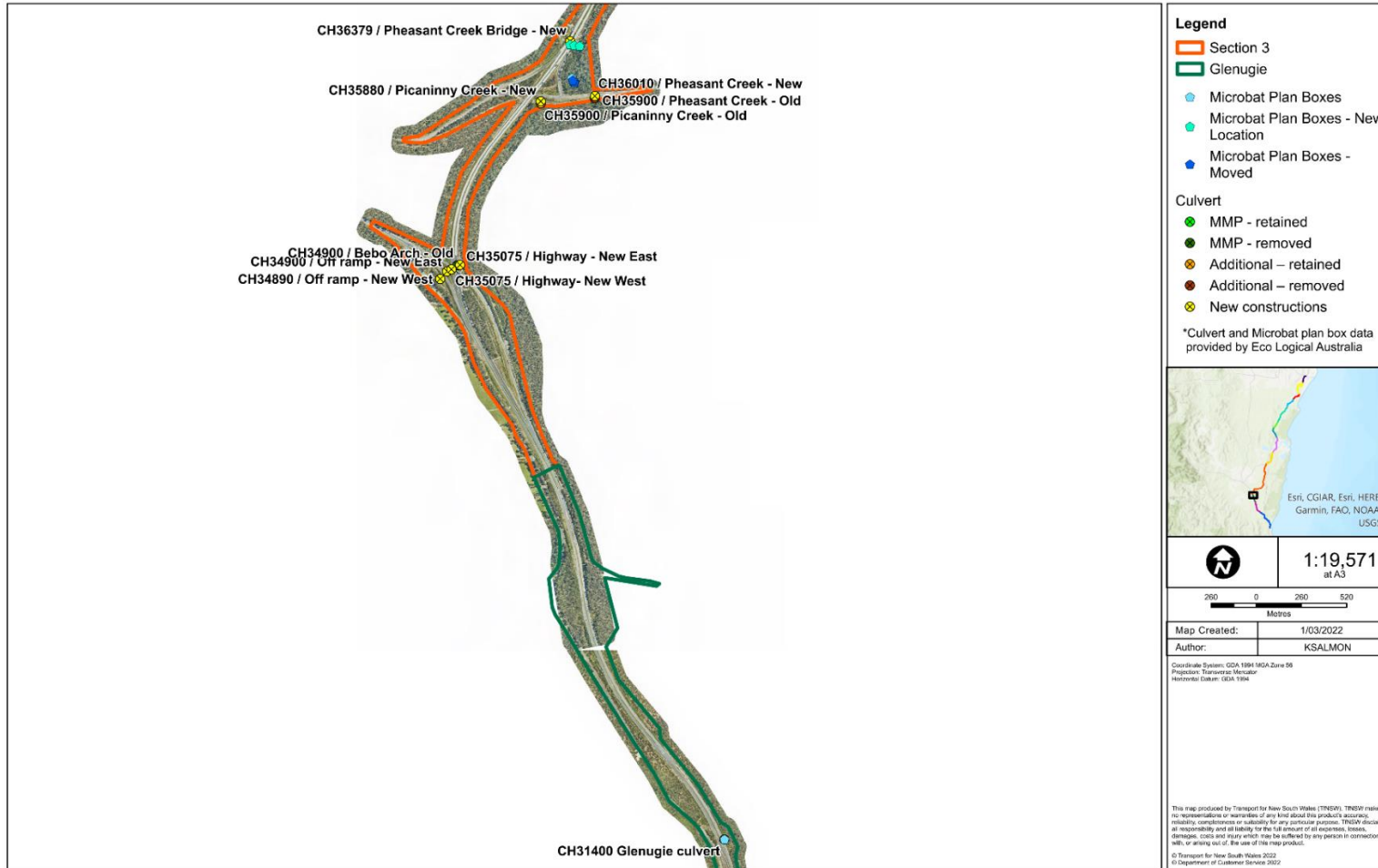


Figure 1: Section 3A Glenugie Link Microbat Monitoring Plan, subject drainage structures and bat box locations



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WOOLGOOLGA TO BALLINA - SECTION 4



Figure 2: Section 4 Greenhill culvert Microbat Management Plan, subject drainage structure and bat box location.



Figure 3: Section 4 / 5 Maclean Cut south Microbat Monitoring Plan, subject drainage structures and bat box locations.



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WOOLGOOLGA TO BALLINA - SECTION 5 MACLEAN CUT NORTH



Figure 4: Section 5 Maclean Cut north Microbat Monitoring Plan, subject drainage structures and bat box locations.



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WOOLGOOLGA TO BALLINA - SECTION 5 MORORO BRIDGE



Figure 5: Section 5 Mororo Bridge Microbat Monitoring Plan, subject drainage structures and bat box locations.

WOOLGOOLGA TO BALLINA - SECTION 5 SERPENTINE CREEK



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



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WOOLGOOLGA TO BALLINA - SECTION 6 TABBIMBLE CREEK



Figure 7: Section 6 Tabbimble Creek Bridge Microbat Monitoring Plan, subject drainage structures and bat box locations.



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WOOLGOOLGA TO BALLINA - SECTION 6 TABBIMBLE CREEK OVERFLOW



Figure 8: Section 6 Tabbimble Creek Overflow Bridge Microbat Monitoring Plan, subject drainage structures and bat box locations.



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WOOLGOOLGA TO BALLINA - SECTION DEVILS PULPIT



Figure 9: Devil’s Pulpit section Microbat Monitoring Plan, subject drainage structures and bat box locations.



Figure 10: Section 7 Oakey Creek Microbat Monitoring Plan, subject drainage structure and bat box location.



Figure 11: 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 that are listed as vulnerable under the BC Act, and in the case of the *Chalinolobus dwyeri* (Large-eared Pied Bat) also listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Table 1 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 (GeoLINK 2015b). The Large-eared Pied Bat has not been recorded on site and is considered to be a vagrant that may only ever temporarily utilise structures along the W2B alignment. There are no specific mitigation measures that were required to be implemented for this species and it is considered that the mitigation measures applied would adequately protect this species from potential impacts associated with the W2B project.

Southern Myotis (*Myotis macropus*) 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 south-bound lane of Mororo Bridge, located over the Clarence River (Figure 5). Another important Southern Myotis roost site that was scheduled for removal was located at Picaninny Creek on Eight Mile Lane at Glenugie (Figure 1). This structure was a culvert 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 (Figure 1) was also identified as roosting habitat for Southern Myotis in January 2018, was required to be removed and also became subject to the provisions of the MMP (ELA 2018a).

Little Bent-winged Bat (*Miniopterus australis*) and Large Bent-winged Bat (*Miniopterus orianae oceanensis*) are known from several locations along the W2B highway alignment. Both species tend to form large over-Wintering colonies numbering in the hundreds to thousands of individuals within various structures along the Pacific Highway between Halfway Creek and Woodburn and are present on-site between February / March and September each year. Two key over-Wintering roosts for Bent-winged Bats that were not be removed or extended within Sections 3-11 of the W2B project are the bridges over Tabbimoble Creek located in Section 6 (Figure 7 and Figure 8).

Several other key Bent-winged Bat over-Wintering roosts that were required to be removed were located within the Bebo Arch in the vicinity of the Glenugie Link (Figure 1) at the southern end of Section 3 (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 (Figure 3 and Figure 4). 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 from GeoLINK (2015b)

Scientific Name	Common Name	BC Act	EPBC Act	Roosting habitat	Project records
<i>Chalinolobus dwyeri</i>	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 (<i>Hirundo ariel</i>) 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).	Not recorded. However, one record occurs within a 10 km radius of the Project footprint (RMS 2012).
<i>Miniopterus australis</i>	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
<i>Miniopterus orianae oceanensis</i>	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 joints 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).
<i>Myotis macropus</i>	Southern 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 2012).	Known. This species has been recorded from a number of locations within Sections 5, 6 and 7 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).

Information on subject drainage structures identified within the W2B project and newly created structures on the W2B alignment can be found in previous reports (GeoLink 2015b, ELA 2020a, ELA 2020b).

2.4. Compensatory habitat installation

2.4.1. Temporary habitat

There was a requirement to create temporary replacement microbat roosting habitat prior to commencement of construction and permanent cave-dwelling roost habitat within new culverts and bridges during the construction period, and once construction was complete. The MMP (GeoLINK 2015b) sets out specifications for design, installation, location and monitoring of the temporary and permanent microbat habitat.

Temporary habitat included the installation of a range of bat boxes and box types within vegetation or non-impacted culverts (depending upon the microbat species 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 - Figure 11 outline the locations and numbers of bat boxes that were installed at or adjacent to each drainage structure, as well as the months of installation for 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 Bent-winged Bats and Large Bent-winged Bats have never been recorded using 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 (six boxes installed in March 2015 as part of a separate project) and Mororo Bridge (four 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 (Table 3, and Figure 1 - Figure 11).

Of the 38 boxes required as part of the W2B MMP (including those installed as permanent replacement habitat), 22 were 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 were all located within the exiting Pacific Highway upgrade alignment and were 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 are 2, 3 or 4-chambered boxes constructed from either timber ply or Cyplas (recycled plastic). Of these, 30 were installed in trees adjacent to the impacted drainage structure (within 200m) and two were installed within culverts, as close as possible to the impacted drainage structure (within 500m). There are six bat boxes constructed from Hebel blocks that were installed to better replicate the darker, more insulated cave-like environments preferred by Little Bent-winged Bats and Large Bent-winged Bats. Five of these six boxes were installed in trees adjacent to the impacted culverts at Maclean Cut.

The remaining Hebel box was designed in a larger style, to accommodate large aggregations of Bent-winged Bats. A prototype multi-chambered Bent-winged Bat box with the capacity to accommodate

approximately 2000 Bent-winged Bats constructed from Hebel blocks was installed in a culvert under the existing Pacific Highway at CH 31400 in early 2019. This Bent-winged Bat box was 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 Plate 1).



Plate 1: Prototype Hebel box designed to accommodate up to 2,000 Bent-winged Bats, installed in a box culvert at Glenugie CH 31400, March 2019.

2.4.2. 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 roosting habitat structures. The permanently created microbat habitat was to have a minimum carrying capacity equal to or greater than that of the original structure with a 15% buffer. Types of permanent microbat habitat that were considered on the W2B project include:

1. Maximum jointing gaps (15-25mm) between cells of reinforced concrete box culverts (RCBCs).
2. Leaving lift holes uncapped and unfilled in Concrete Pipe Culverts (CPC).
3. Roughened concrete culvert obverts (middle third of drainage structure >900 mm diameter for a width of 300 mm) to be installed. This action was to be enacted once construction of new

structures was completed and if the audit of permanent microbat habitat indicated that the carrying capacity of a new structure was below that required to replace lost microbat roosting habitat.

4. Leaving transport holes unfilled on selected new pre-cast concrete bridges.
5. Installation of bat boxes within drainage structures once construction was complete. This action was to be enacted if the audit of permanent microbat habitat indicated that the carrying capacity of a new structure was below that required to replace lost microbat roosting habitat.

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. Discussions between TfNSW, PC, ELA, and construction contractors resulted in lift holes being left open and maximum jointing gaps included in some of the new structures located at Glenugie Link (within new culverts at Pheasants and Picaninny Creek and the new culverts that replaced the Glenugie Bebo Arch) and through Maclean cut (new culverts) where appropriate. A permanent microbat roosting habitat audit was undertaken during spring / Summer 2019 / 2020 and Winter 2020 to provide information on the adequacy of roosting habitat available in newly created structures. This audit could not be completed until construction of all new structures had been completed which was in August 2020 (ELA 2020).

It was necessary to carry out this audit over both a Summer and Winter season following completion of construction in order to capture seasonal differences in usage of structures by different microbat species, with Southern Myotis breeding occurring during spring and late Summer and peak occupancy by Bent-winged Bats species occurring over Winter. Preparation and completion of this report was delayed until the Winter audit of newly built structures could be completed (August 2020) when all newly built structures were available for use by microbats. A further delay to reporting was necessary to allow for documentation of the creation and installation of additional permanent habitat within newly built structures that was required following the audit. These additional permanent habitat creation works were completed in June 2021.

A list of all the newly built structures required to be audited for suitability and carrying capacity of microbat habitat is presented in Table 3 below. It includes the actions undertaken to secure permanent microbat habitat and also provides justification for why certain actions were not taken.

2.5. Microbat exclusion

Microbat exclusion was required at thirteen of the 22 subject drainage structures within the W2B alignment (Geolink 2015b). Two of the 13 impacted structures scheduled to be excluded were not excluded to microbats, the Bebo Arch at CH 34900 and Oakey Creek culvert at CH 122280 for reasons outlined within Exclusion letter report for Bebo Arch and Oakey Creek Culvert (ELA 2018b, ELA 2023).

2.6. Microbat monitoring

In accordance with the TMMP and peer review (Schulz 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:

- Winter (July - August 2014)
- Spring (October - 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, Winter April 2018)

Quarterly visual inspections commenced following the exclusion of impacted structures during construction, commencing 2019 and concluding during 2020 once construction was fully completed. ELA undertook Quarterly microbat surveys over five separate site visits and included inspections of drainage structures and bat boxes within Sections 2, 3A, 4, 5, 6, Devil's Pulpit, 7 and 10:

- 6th and 7th March 2019
- 3rd and 4th July 2019
- 8th and 9th October 2019
- 23rd and 24th January 2020 (delayed Summer monitoring due to 2019-20 bushfires)
- 21st February 2020 (delayed Summer monitoring due to 2019-20 bushfires).

Post construction Biannual monitoring event conducted between 20 and 22nd August 2020 included inspections of newly created drainage structures associated with the original subject drainage structures and bat boxes within Sections 2, 3A, 4, 5, 6, Devil's Pulpit, 7 and 10, as well as an audit of the roosting habitat capacity contained within newly built structures.

Furthermore, incidental observations of various structures occurred in the period between August 2020 and June 2021. Although not part of the scheduled monitoring program, these observations allowed for a greater understanding of the uptake of permanently inhabited structures and provided input into the

ongoing need for monitoring. As per the MMP, monitoring of structures was to occur for two years post construction. Any further monitoring would be dependent upon an assessment of whether microbats were consistently using newly created structures

The 2022-2023 Annual Monitoring Report address monitoring of drainage structures, including both impact and control sites and compensatory habitat installed during construction. Summer 2022 post construction annual monitoring occurred for all drainage structures and compensatory habitat. Additional monitoring was required for Winter 2022 and Summer 2023 at several locations where the number/breeding status of microbat populations had not attained pre-construction levels.

3. Methodology

3.1. Annual and additional monitoring

A series of monitoring inspections have occurred at the subject drainage structures between February 2022 and February 2023. Annual microbat monitoring was required for all subject drainage structures in accordance with the MMP (GeoLINK 2015b). Additional monitoring was required for Winter 2022 and Summer 2022/23 at several locations where the number/breeding status of microbat populations had not attained pre-construction levels.

Table 3 sets out details of each subject drainage structure and the date it was identified to be managed in accordance with the MMP (GeoLink 2015b), as well as dates when monitoring was undertaken. Annual microbat monitoring for W2B Section 3-11 was undertaken from 01/02/2022 to 03/02/2022 by ELA Ecologists Daniel McKenzie and Samantha Patch. Additional microbat monitoring in Winter 2022 and Summer 2023 were required on selected drainage structures. Winter 2022 monitoring event was undertaken from the 16th and 17th of August. Summer 2023 monitoring event was undertaken on the 2nd of February.

Monitoring events 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). Ecologist physically inspect the subject drainage structures and alternative habitat features within W2B section 3-11. The following was recorded:

- Identification code of nest box or habitat feature
- Evidence of microbats (guano 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 box (e.g. Any deterioration, structurally unstable) if applicable
- Date and time of inspection
- Drainage structure/ roost identification number
- Roost features present
- Record of rainfall during monitoring period.

3.2. Compensatory bat box habitat

Compensatory habitat in the form of 38 bat boxes (Plate 2 and Plate 3) 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 Summer event post construction, 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. Bat boxes not used by bats since installation were identified to be relocated into newly created culverts where the newly created structures did not contain bat roosting habitat equal to or greater than that available in the original structures.

3.3. Performance thresholds and corrective actions

Performance thresholds are included in the MMP by GeoLink (2015b) and relevant monitoring components are repeated in Table 2 below. At the completion of construction, monitoring would continue in line with the nest box management plans that have been prepared for respective sections as listed below in Table 2 with Summer and Winter surveys on a bi-annual basis for six years. Corrective actions would be required should the performance criteria not be achieved following two years of monitoring. Following the initial two years of monitoring, if results indicate early uptake consistently, monitoring can cease and is not required for the full six years.

Table 2: Summary of Monitoring Program from the MMP (GeoLink 2015b)

Monitoring Component	Goal	Timing/ Frequency	Performance Threshold	Corrective Actions if Deviation from Performance Criteria
Bat boxes	Successfully provide alternate roost habitat in suitable locations in proximity to the subject drainage structures. Observe uptake, breeding and persistent use of replacement roosting habitat.	<ul style="list-style-type: none"> Day after exclusion from subject drainage structures. Quarterly during construction. Bi-annual Summer and Winter for six years following completion of construction. 	No evidence of usage within two years of installation.	<ul style="list-style-type: none"> Re-locate within adjacent vegetation (changing aspect, move closer to water etc). If not inhabited by microbats following completion of construction on the subject drainage structures, bat boxes would be re-located within the new RCBCs.
Habitat design features within drainage structures	Observe uptake, breeding and persistent use of replacement roosting habitat.	<ul style="list-style-type: none"> Commence six months following installation. Quarterly during construction. Bi-annual Summer and Winter for six years following completion of construction. 	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	<ul style="list-style-type: none"> Modify the design of existing roost features. Consider provision of additional roost features
Control sites	Identify the natural variability of microbats within the Project footprint.	<ul style="list-style-type: none"> Quarterly from pre-exclusion. Quarterly during construction. Bi-annual Summer and Winter for six years following completion of construction. 	N/A	N/A

Table 3: Full list of drainages structures and dates when monitoring occurred at each location

Section	Chainage	Date added to MMP	Location	Construction dates	Exclusion	Control or impact	Monitoring Feb 2022	Monitoring August 2022	Monitoring Feb 2023
2	31400	Feb-19	Glenugie Culvert Bent-winged Bat Box	Existing	No exclusion required	N/A	No (no scheduled monitoring)	Yes	No additional survey required
Glenugie Link	34900	Jan-18	Bebo Arch at southern end of Glenugie Link	Removed Feb 2019	Not excluded - exclusion timed to coincide with a time when no bats were present	Impact	No (removed)	No (removed)	No (removed)
Glenugie Link	35075		Glenugie Link culverts	Newly constructed	No exclusion required	N/A	Yes	Yes	No additional survey required
Glenugie Link	35880		Picaninny Creek, Eight Mile Lane	Newly constructed	No exclusion required	N/A	Yes	Yes	Yes
Glenugie Link	35900	Jan-18	Pheasant Creek, Eight Mile Lane	Removed Sept 2019	Jun-18	Impact	No (removed)	No (removed)	No (removed)
Glenugie Link	35900	Jan-18	Picaninny Creek, Eight Mile Lane	Retained	Jun-18	Impact	Yes	Yes	Yes
Glenugie Link	36010		Pheasant Creek, Eight Mile Lane	Newly constructed	No exclusion required	N/A	Yes	Yes	Yes
Glenugie Link	36379		Pheasant Creek Bridge	Newly constructed	No exclusion required	N/A	Yes	Yes	Yes
4	76450	Mar-19	Greenhill Cut	Newly constructed	No exclusion required	N/A	Yes	Yes	No additional survey required
4	75560	Mar-19	Greenhill Cut	Newly constructed	No exclusion required	N/A	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)
4	81440	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required
4	81600	Dec-17	North of Jubilee Street overbridge, fauna underpass	Removed 2019	Mar-18	Impact	No (removed)	No (removed)	No (removed)
4	81645	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Yes	Yes	No additional survey required
4	81650	Dec-17	North of Jubilee Street overbridge	Removed 2019	Mar-18	Impact	No (removed)	No (removed)	No (removed)
4	81770	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Yes	Yes	No additional survey required
4	81825	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Yes	Yes	No additional survey required

Section	Chainage	Date added to MMP	Location	Construction dates	Exclusion	Control or impact	Monitoring Feb 2022	Monitoring August 2022	Monitoring Feb 2023
4	81825	Dec-17	North of Jubilee Street overbridge CH 81860	Removed 2019	Internal Sept 2017, External Mar 2018	Impact	No (removed)	No (removed)	No (removed)
4	81980	Dec-17	North of Jubilee Street overbridge	Removed 2019	Internal Sept 2017, External Mar 2018	Impact	No (removed)	No (removed)	No (removed)
4	82020	Mar-15	North of Jubilee Street overbridge	Removed 2019	Internal Sept 2017, External Mar 2018	Impact	No (removed)	No (removed)	No (removed)
4	82030	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Yes	Yes	No additional survey required
5	82300	Mar-15	North of Jubilee Street overbridge	Part of structure removed Apr 2018, remainder removed early 2019.	Mar-18	Impact	No (removed)	No (removed)	No (removed)
4	82330	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Yes	Yes	No additional survey required
4	82610	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required
4	82740	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required
5	82860	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required
5	82860	Dec-17	North of Jubilee Street overbridge	Temporary tie-in to upstream as part of Northbound works Apr 2018. Structure removed early 2019.	Mar-18	Impact	No (removed)	No (removed)	No (removed)
5	82970	Mar-19	North of Jubilee Street overbridge	Newly constructed	Excluded during construction of western end	N/A	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required
5	89370	Mar-15	Old Serpentine Channel Bridge	Retained	No exclusion required	Control	Yes	No additional survey required	No additional survey required
5	89400	Mar-15	Serpentine Channel Bridge southbound	Retained	No exclusion required	Control	Yes	No additional survey required	No additional survey required
5	89400		New Serpentine Channel Bridge northbound	Newly constructed	No exclusion required	N/A	Yes	No additional survey required	No additional survey required
5	94090	Mar-15	Old Mororo Bridge (was northbound)	Early works Dec 2017, temporary jetty Feb 2018,	No exclusion required	Control	Yes	No additional survey required	No additional survey required

Section	Chainage	Date added to MMP	Location	Construction dates	Exclusion	Control or impact	Monitoring Feb 2022	Monitoring August 2022	Monitoring Feb 2023
				piling Mar 2018, bridge construct May 2018. Structure retained					
5	94090	Mar-15	Mororo southbound northbound)	Bridge (now temporary jetty Feb 2018, piling Mar 2018, bridge construct May 2018. Structure retained.	No exclusion required	Control	Yes	No additional survey required	No additional survey required
5	94090		Mororo Bridge new (southbound)	Newly constructed	No exclusion required	N/A	Yes	No additional survey required	No additional survey required
6	101610	Mar-15	Old Tabbimoble Creek Bridge	Retained	No exclusion required.	Control	Yes	Yes	Yes
6	101610	Mar-15	Tabbimoble Creek Bridge southbound	Retained	No exclusion required.	Control	Yes	Yes	Yes
6	101610		Tabbimoble Creek Bridge northbound	Newly constructed	No exclusion required	N/A	Yes	Yes	Yes
6	102900	Mar-15	Old Tabbimoble Overflow Bridge	Retained	No exclusion required	Control	Yes	Yes	Yes
6	102900	Mar-15	Tabbimoble Overflow Bridge southbound	Retained	No exclusion required.	Control	Yes	Yes	Yes
6	102900		New Tabbimoble Overflow Bridge northbound	Newly constructed	No exclusion required	N/A	Yes	Yes	Yes
Devil's Pulpit	106170	Mar-15	62.14km south of Ballina, south of Pine Rd	Structure removed 31 Jan – 15 Apr 2019.	May-18	Impact	No (removed)	No (removed)	No (removed)
Devil's Pulpit	106185		New fauna underpass box culvert northbound	Newly constructed	No exclusion required	N/A	Yes	No additional survey required	No additional survey required
Devil's Pulpit	106190	Dec-17	Fauna underpass box culvert	Structure removed 31 Jan – 15 Apr 2019.	May-18	Impact	Yes	No additional survey required	No additional survey required
Devil's Pulpit	106230		Devil's Pulpit culvert with bat box	Existing	No exclusion required	N/A	Yes	No additional survey required	No additional survey required
7	122190		New Oakey Flat culvert	Newly constructed	No exclusion required	N/A	No (high water flow)	No additional survey required	Yes
7	122280	Mar-15	Oakey Flat # 3 Oakey Creek	Removed 2019	Not excluded – safety and access issues	Impact	No (removed)	No (removed)	No (removed)
7	122280		New Oakey Flat # 3 Oakey Creek	Newly constructed	No exclusion required	N/A	No (high water flow)	No additional survey required	Yes
7	122550		New Oakey Creek overflow	Newly constructed	No exclusion required	N/A	No (high water flow)	No additional survey required	Yes

Section	Chainage	Date added to MMP	Location	Construction dates	Exclusion	Control or impact	Monitoring Feb 2022	Monitoring August 2022	Monitoring Feb 2023
10	157400	Mar-15	Saltwater Creek, south of Coolgardie Road	Retained	No exclusion required	Control	Yes	No additional survey required	No additional survey required

4. Results

4.1. Annual and additional monitoring

4.1.1. Control sites

There were 13 control sites inspected during the Summer 2022 monitoring period (Table 4). There are some trends forming from the monitoring data gathered at the control sites, but these must be interpreted with caution.

Similar to previous monitoring events, Old Serpentine Creek Bridge supports a large number of Southern Myotis. There were over 100 Southern Myotis recorded roosting and breeding with large guano piles beneath in Old Serpentine Creek Bridge. Evidence of a successful breeding event in February 2022 is illustrated in Plate 2 with pups present. During July 2019 monitoring, Old Serpentine Creek Bridge also supported Large Bent-winged Bats during winter. The number of Large Bent-winged Bats at this site is characterised by large fluctuations with anywhere between no Bent-winged Bats present and up to 131 (recorded once only during pre-construction surveys). This suggest that Serpentine Channel Bridges appears to represent temporary roosting for Bent-winged Bats.

The four timber bat boxes (four chambered) installed beneath Mororo bridge continue to support a permanent colony of Southern Myotis. Over 200 Southern Myotis were recorded roosting in the four timber bat boxes (Four Chambered) in February 2022. The number of Southern Myotis is similar to that recorded during baseline surveys which recorded between 127 up to 255+ Southern Myotis. The Summer 2022 result indicates that the Southern Myotis population centred on Mororo Bridge and Old Serpentine Bridge are in good health.



Plate 2: Cluster of Southern Myotis (including pups) recorded at Old Serpentine Bridge February 2022

The results for Saltwater Creek culvert during the February 2022 monitoring period indicate continuous use of this culvert by bats. Saltwater Creek culvert recorded two Southern Myotis (Plate 3). Previous monitoring events have recorded occupancy of a small number of Little Bent-winged Bats (12 LtBW in July 2019, 1 LtBW in October 2019, 1 LtBW in Jan/Feb 2020). Baseline surveys at Saltwater Creek culvert recorded up to one Large Bent-Winged Bat.



Plate 3: Two Southern Myotis recorded at Saltwater Creek, February 2022

Results at Old Tabbimoble Creek Bridge and Old Tabbimoble Creek Overflow Creek Bridge are interesting because the number and species of microbats present at these locations have fluctuated between monitoring events since the beginning. During February 2022 monitoring event Southern Myotis were recorded within both Old Tabbimoble Creek Bridge (8 bats) and Old Tabbimoble Creek Overflow Creek Bridge (8 bats). Additionally, one Chocolate Wattled Bat (*Chalinolobus morio*) individual was observed within the Old Tabbimobile Creek Overflow Creek Bridge. Evidence of previous microbat utilisation was evident at both Old Tabbimoble Creek Bridge and Old Tabbimoble Creek Overflow Creek Bridge as guano and discolouration either from urine or staining at entrance and exit point of roost were recorded. Previously, on two occasions Old Tabbimoble Creek Bridge was used by Southern Myotis as a breeding site during previous monitoring events (Summer of 2018 and January 2020). The numbers of Southern Myotis ranged between 2-8 between Summer 2022-Summer 2023. This is still greater than Southern Myotis recorded in Baseline data (max = 2 SM).

Old Tabbimoble Creek Bridge and Old Tabbimoble Overflow Bridge are both previously known to be used by hundreds of Little Bent-winged Bats during Winter prior to construction. During the February 2022 monitoring no Little Bent-winged Bats were recorded. This is similar to previous Summer monitoring events where Little Bent-winged Bat numbers decrease during this period. This is consistent with the literature that shows Bent-winged Bats migrate to maternity caves from October-March/April (Dwyer 1964, White 2011). Additional monitoring was required for all Tabbimoble Creek bridges and overflow bridges as numbers of Little Bent-winged Bats have not attained pre-construction levels.

This additional monitoring in Winter 2022 and Summer 2023 recorded similar numbers and species of microbat present to previous years, indicating a fluctuation between seasonal events. During winter Little Bent-winged Bats were more dominate than in Summer. During Winter 2022 monitoring Tabbimoble Creek recorded 65 Little Bent-winged Bats, three Large Bent-winged Bats and two *Nyctophilus* sp (Plate 4). Prior to commencement of works Old Tabbimoble Creek recorded up to 553 Little Bent-winged Bats in July 2014. Old Tabbimoble Creek Overflow Bridge recorded greater than 500 Little Bent-winged Bats, four Large Bent-winged Bats, five Southern Myotis and 1 *Nyctophilus* sp. The results for Old Tabbimoble Overflow Creek Bridge during the Winter 2022 monitoring indicate greater use of Little Bent-winged Bats than has been recorded at any time in the past.

Similar to previous years, small numbers of Southern Myotis were recorded within Old Tabbimoble Creek Bridge and Old Tabbimoble Creek Overflow Bridge. During Summer 2023, seven Southern Myotis and two Little Bent-winged Bats were recorded at Old Tabbimoble Creek Bridge. Six Southern Myotis and one dead Little Bent-winged Bat were recorded at Old Tabbimoble Creek Overflow Bridge during Summer 2023 monitoring. Guano was present within both Old Tabbimoble Creek Bridge and Old Tabbimoble Creek Overflow Bridge. Old Tabbimoble Creek Bridge on three previous occasions were used by Southern Myotis as a breeding site during Summer (Feb 2018, September 2018, Jan/Feb 2020). However, the site does not appear to support a permanent breeding Southern Myotis colony as prior to Feb 2020, Southern Myotis have only been recorded in (≥ 8).



Plate 4: Large Cluster of Little Bent-Winged Bats recorded at Old Tabbimoble Creek Bridge, August 2022

Table 4: Results from monitoring inspections at the control sites from Summer 2022, Winter 2022 and Summer 2023

Date added into MMP	Location	Baseline survey results (2014/2015), min and max # bats recorded	Monitoring March 2019	Monitoring July 2019	Monitoring Oct 2019	Monitoring Jan/Feb 2020	Monitoring Aug 2020	Monitoring February 2022	Monitoring August 2022	Monitoring Feb 2023
Mar 2015	Old Serpentine Creek Bridge	Min: No bats Max: 40 LgBW	17 SM in bridge	6 SM and 51 LgBW in bridge, 11 SM in boxes	50 SM and old large guano pile under roughened section of bridge deck	70 SM (incl pups)	100 SM	100+ SM, and possible other species second northern section, guano and stain areas in northern most section.	No additional survey required	No additional survey required
Mar 2015	Serpentine Creek Bridge South Bound	Min: 131 LgBW, 10 SM Max: 131 LgBW, 10 SM	No bats recorded	No bats recorded	1 unknown spp.	2 SM	5 LgBW in bridge	7 SM	No additional survey required	No additional survey required
Jun 2019	New Serpentine Creek Bridge North Bound	Newly constructed July 2019	Not constructed	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No additional survey required	No additional survey required
Mar 2015	Old Mororo Bridge	Min: 1 SM Max: 2 SM	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No additional survey required	No additional survey required
Mar 2015	Mororo Bridge North Bound	Min: 127 SM incl pups Max: 255+ SM	400+ SM in boxes	150+ SM in boxes	210+ SM in boxes	310+ SM in boxes	240+	200+ SM in box	No additional survey required	No additional survey required
Jun 2019	New Mororo Bridge South Bound	Newly constructed	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	2 SM	No additional survey required	No additional survey required
Mar 2015	Old Tabbimoble Creek Bridge	Min: 2 SM Max: 553 LtBW, 10 Nycto, 2 SM, 1 Vsp	No bats recorded	656 LtBW	Guano	18+ SM	2 SM, 85 LtBW	8 SM, evidence of where bats have been hanging on concrete	65 LtBW, 3 LgBW, 2 SM, 2 <i>Nyctophilus</i> sp., guano, Evidence of roosting	2 LtBW, 7 SM, Guano, Evidence of roosting
Mar 2015	Tabbimoble Creek Bridge South Bound	Not separated from Old Tabbimoble Ck Bridge in baseline data	No bats recorded	No bats recorded	No bats recorded	No bats recorded - fire and flood	No bats recorded	No bats recorded	No bats recorded	No bats recorded
Jun 2019	New Tabbimoble Creek Bridge North Bound	Newly constructed	Not constructed	No bats recorded	No bats recorded	No bats recorded - fire and flood	No bats recorded	No bats recorded	No bats recorded	No bats recorded

Date added into MMP	Location	Baseline survey results (2014/2015), min and max # bats recorded	Monitoring March 2019	Monitoring July 2019	Monitoring Oct 2019	Monitoring Jan/Feb 2020	Monitoring August 2020	Monitoring February 2022	Monitoring August 2022	Monitoring February 2023
Mar 2015	Old Tabbimoble Overflow Bridge	Min: No bats Max: 166 LtBW, 1 LgBW, 1 Nsp, 2 SM	6 SM in bridge	298+ LtBW and 5 SM in bridge	Guano	No bats recorded - fire and flood	9 LtBW	8 SM, 1 CWB Guano	~574 LtBW, 4 LgBW, 5 SM, 1 Nyctophilus sp., Guano	6 SM, 1 dead LtBW, Guano
Mar 2015	Tabbimoble Creek Overflow Bridge South Bound	Not separated from Old Tabbimoble Ck Overflow Bridge in baseline data	No bats recorded	No bats recorded	No bats recorded	No bats recorded - fire and flood	No bats recorded	No bats recorded	No bats recorded	No bats recorded
Jun 2019	New Tabbimoble Creek Overflow Bridge North Bound	Newly constructed	Not constructed	No bats recorded	Guano (fresh)	No bats recorded - fire and flood	No bats recorded	No bats recorded	No bats recorded	No bats recorded
Mar 2015	Saltwater Creek, south of Coolgardie Rodd	Min: No bats Max: 1 LgBW	Guano (fresh)	12 LtBW	1 LtBW in culvert	1 LtBW in culvert (dead), fresh guano, large pile of old guano	Guano (old)	2 SM	No additional survey required	No additional survey required

SM = Southern Myotis, ELB = Eastern Long-eared Bat, LgBW = Large Bent-winged Bat, LtBW = Little Bent-winged Bat, Nsp = *Nyctophilus sp.*, Vsp = *Vespadelus sp.*, CWB = Chocolate Wattle Bat

4.1.2. Impact sites

During the Summer 2022 annual monitoring period there were 14 structures that were monitored, and they are listed along with results of monitoring events in Table 5. Additional Winter and/or Summer monitoring events were required at several impact sites where the numbers / breeding status of microbat populations had not attained pre-construction levels. Devil's Pulpit was the only impact site that did not require any additional monitoring events.

Glenugie Link Culvert (CH35075) was built in place of the Bebo Arch in 2019. February 2022 monitoring recorded eight Large Bent-winged Bats and 10 dead bats potential *Miniopterus* sp. Large guano deposits and staining on roughened obvert patches were recorded indicating previous roosting. The low numbers during the February 2022 monitoring period are due to the summer migration patterns away from winter roosting sites to summer maternity sites by Bent-winged Bats.

Additional monitoring of Glenugie Link Culvert (CH 35075) in August 2022 indicated an increase in Little Bent-winged Bats from February 2022 to August 2022. Greater than 1000 Little Bent-winged Bats and 12 Large Bent-winged Bats were recorded within Glenugie Link Culvert (CH 35075) during the August 2022 monitoring (Plate 5). Glenugie Link Culvert appear to represent temporary roosting habitat for Bent-winged Bats. The new culverts contain roosting habitat with a capacity for >2000 Bent-winged Bats in the expansion joins designed to provide microbat roosting habitat and in roughened concrete patches on the obvert of the culverts.

The additional monitoring at Glenugie Culvert Bent-winged Bat Box (CH 31400) indicate greater use of this Hebel box by bats than has been recorded at any time in the past. Inspection of the Bent-winged Bat box at CH 31400 has recorded five Little Bent-winged bats during the August 2022 monitoring. Past monitoring events have only recorded evidence of microbat use within the Bent-winged Bat box at CH 31400.



Plate 5: Little Bent-winged Bats at Glenugie Link Culvert (CH35075), August 2022

The newly constructed Picaninny Creek Culvert (CH 35880) is a longer but lower four cell concrete box culvert (Plate 6). Similar to past monitoring events, February 2022 monitoring only recorded evidence of bat use by light guano. Additional monitoring events in August 2022 and February 2023 recorded no Southern Myotis within the newly constructed Picaninny Creek Culvert (CH 35880). However, during the August 2022 monitoring period two Little Bent-winged bats and one Large Bent-winged Bat was recorded within the tallest box culvert out of the four. Although it is used by bats as evident by additional August 2022 monitoring the low height of this culvert makes it unlikely to be used by Southern Myotis (Plate 6).

The expansion foam was removed from the original Picaninny Creek culvert (CH 35900) during the additional August 2022 monitoring as suggested in the 2019/20 monitoring report. However, the additional monitoring in February 2023 identified no signs of bat use since the removal of expansion foam. Environmental changes have occurred outside the original Picaninny Creek culvert which may reduce its suitability as a roosting and breeding habitat location for Southern Myotis in the short to medium term. These changes include the removal of vegetation surrounding the culvert, landform and drainage changes (which reduce levels of water moving through the culvert), and reduced levels of protection from the elements of weather. Southern Myotis are unlikely to use structures for roosting/breeding where there is no permanent water.

The new Pheasants Creek culvert is a 5 cell RCPC, with all lift holes left unfilled and uncapped and maximum joint gaps in many of the expansion joints. The original Pheasants Creek culvert hosted small aggregations of Southern Myotis prior to construction, with two maternity colonies present in the adjacent Picaninny culvert. There have been occasional observations of Southern Myotis utilising the new Pheasants Creek Culvert, with four Southern Myotis present in February 2022, 10 Little Bent-winged Bats and two Southern Myotis present in August 2022 and one Southern Myotis recorded in February 2023. Baseline survey in 2014/2015 recorded between 6-7 SM occupying the new Pheasants Creek.

To date there has been no evidence of the re-establishment of a maternity colony of Southern Myotis at Picaninny or Pheasants Creek. The three x four chambered bat boxes installed in trees along Pheasants Creek have never been used. These boxes were installed beneath the new Pheasants Creek Bridge in February 2021 (Plate 7). No microbats have been recorded within these boxes.



Plate 6: Newly constructed Picaninny Creek four cell culvert (CH 35880), Eight Mile Lane, Glenugie Link, Section 3A



Plate 7: Three x four chambered bat boxes installed beneath the new Pheasants Creek Bridge, February 2023

There were no microbats recorded in the culverts at Maclean Cut by ELA during the February 2022 monitoring, however there was evidence of small to moderate sized aggregation having been present between monitoring events in the form of guano piles beneath exclusion joins in one of the culverts (CH 82030). Additional monitoring undertaken in August 2022 also recorded guano within CH 82030 and four Little Bent-winged Bats in another culvert (CH 82330) (Plate 8). This is the first-time microbats have been recorded within the new culverts at Maclean Cut.

Greenhill Box culvert and a Bent-winged Bat Box constructed from Hebel blocks were implemented into the monitoring to compensate habitat loss of Maclean Cut Culverts. During February 2022 monitoring no microbats were recorded. As mentioned previously the low number may be due to the Summer migration away from Winter roosting sites to Summer maternity sites by Bent-winged Bats. Additional Winter 2022 monitoring of the Greenhill Box culvert recorded approximately 26 Little Bent-winged bats and one *Nyctophilus* sp. within one of the expansion cracks (Plate 9). This is the most microbats recorded within Greenhill Box culvert since monitoring commenced. No microbats were recorded within the Bent-winged Bat Box installed in Green Hill Box Culvert. Greenhill Box Culvert may surpass as a potential alternative roosting site to Maclean Cut culverts, however additional Winter monitoring would be required to determine this.



Plate 8: Three Little bent-wing Bats recorded at Maclean Cut (CH 82330), August 2022



Plate 9: Little Bent-wing Bats recorded at Greenhill Box culvert (CH 76450), August 2022

The Devil's Pulpit tie-in section contained two impacted concrete box culverts, one of which was also a fauna underpass. No evidence of microbats was recorded during February monitoring period. The most that has been recorded in past monitoring events within Devil's Pulpit's tie-in section is evidence of microbat use in the form of guano.

Due to excess rainfall prior to February 2022 monitoring event, water levels and flow within Oakey Creek culverts were too high to inspect. Only one culvert at Oakey Creek could be inspected during the February 2022 monitoring period. New Oakey Creek Overflow (CH 122550) recorded three adult Southern Myotis and one Juvenile during February 2022. The results from the additional monitoring undertaken in February 2023 at Oakey Creek indicates greater use of these culverts by bats than has been recorded previously and signs of breeding. A total of 21 Southern Myotis were recorded throughout the three culverts. New Oakey Flat culvert (CH 122190) contained five Southern Myotis, one of which was a subadult. New Oakey Flat (CH 122280) recorded six Southern Myotis within the bat box and three Southern Myotis in the culvert. New Oakey Creek Overflow (CH 122550) recorded. Field observations noted suitable *Melaleuca* forest habitat with fly ways surrounding Oakey Creek culverts (Plate 10).



Plate 10: *Melaleuca* spp. forest outside of Oakey Creek Culverts, February 2023

Table 5: Results from monitoring inspections at the impact sites from previous report and Summer 2022, Winter 2022 and Summer 2022

Section	Chainage	Location	Construction dates	Baseline survey results (2014/2015), min and max # bats recorded	Monitoring March 2019	Monitoring July 2019	Monitoring Oct 2019	Monitoring December 2019 - Postponed to Jan/Feb 2020 due to bushfires	Monitoring August 2020	Opportunistic Monitoring Feb 2021	Opportunistic Monitoring 25 March 2021	Opportunistic Monitoring 31 March 2021	Opportunistic Monitoring June 2021	Monitoring February 2022	Monitoring August 2022	Monitoring Feb 2023
2	31400	Glenugie Culvert Bent-winged Bat Box	Existing	Min: Guano Max: 2000 LtBW	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	Fresh guano on ground and in box, likely only roosting by singles or pairs	No (no scheduled monitoring)	Fresh guano on ground and in box, likely only roosting by singles or pairs	Fresh guano on ground, likely only roosting by singles or pairs	No (no scheduled monitoring)	5 LtBW in Hebel Box	No additional survey required
Glenugie Link	35075	Glenugie Link culverts	Newly constructed	Min: Guano Max: 2000 LtBW (same structure as above)	No (active construction)	No (active construction)	Guano (moderate - large) beneath central expansion joins indicating large aggregations of bats have been present over Winter.	No bats recorded	780+ LtBW, roughly half in each series of 4 culverts, using widened expansion joins, large guano piles beneath other joins. 3 LgBW in a separate expansion join	7 LtBW incl 4 dead and 1 injured (rescued), large guano piles, bat bug casings and staining on roughened obvert patches	13 LtBW incl 2 dead, two separate clusters in expansion joins, large guano piles, bat bug casings and staining still present	250+ LtBW across 2 joins, incl 1 injured bat hanging from outside expansion join, unable to be rescued, large guano piles, bat bug casings and staining still present	1300+ LtBW using widened expansion joins towards middle of culverts, large guano piles beneath other patches	8 LgBW, large guano deposits, ~11 dead bat staining on roughened obvert patches	1,020 LtBW, 12 LgBW	No additional survey required
Glenugie Link	35880	Picaninny Creek, Eight Mile Lane	Newly constructed	Min: 26 SM incl 9 pups Max: 33+ SM	No (active construction)	No (active construction)	Guano (light) beneath many expansion joins, likely Eastern Horseshoe Bat due to low height of culvert.	No (flooded)	No (no habitat for Southern Myotis)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	Only some signs of guano and where they have been hanging from the roof	2 LtBW, 1 LgBW (three other cells too low to ground)	No bats recorded
Glenugie Link	35900	Pheasant Creek, Eight Mile Lane	Removed Sept 2019	Min: 6 SM Max: 7 SM incl 2 pups	No bats recorded (internal exclusions only)	Guano (light) (internal exclusions only)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)
Glenugie Link	35900	Picaninny Creek, Eight Mile Lane	Retained	Min: 26 SM incl 9 pups Max: 33+ SM	No bats recorded (exclusions in place)	No bats recorded (exclusions in place)	No bats recorded (exclusions in place)	No bats recorded (external exclusions removed)	No bats recorded	Expansion foam in place	Expansion foam in place	Expansion foam in place	No (no scheduled monitoring)	Expansion foam in place	Expansion foam removed	No bats recorded
Glenugie Link	36010	Pheasant Creek, Eight Mile Lane	Newly constructed	Min: 6 SM Max: 7 SM incl 2 pups	2 SM	5 LtBW, 1 SM	1 SM in lift hole, guano (light)	No bats recorded	Guano (light) beneath most lift holes	2 SM as singles in Cell 3 and Cell 5,	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	4 SM, guano	10 LtBW, 2 SM, guano	1 SM, guano

Section	Chainage	Location	Construction dates	Baseline survey results (2014/2015), min and max # bats recorded	Monitoring March 2019	Monitoring July 2019	Monitoring Oct 2019	Monitoring December 2019 - Postponed to Jan/Feb 2020 due to bushfires	Monitoring August 2020	Opportunistic Monitoring Feb 2021	Opportunistic Monitoring 25 March 2021	Opportunistic Monitoring 31 March 2021	Opportunistic Monitoring June 2021	Monitoring February 2022	Monitoring August 2022	Monitoring Feb 2023
							beneath many lift holes	(recently flooded)		guano in all cells beneath grab holes and some expansion joins, Rhino guano as well						
Glenugie Link	36379	Pheasant Creek Bridge	Newly constructed	Min: 6 SM Max: 35+ SM including pups across two culverts (same structures as above)	No (active construction)	No bats recorded (very limited habitat available - potential location for Southern Myotis bat box)	No (not part of MMP)	No (not part of MMP)	No bats recorded (very limited habitat available - potential location for Southern Myotis bat box)	No bats recorded	No (no monitoring)	No (no monitoring)	No (no monitoring)	No bats recorded	No additional survey required	No bats recorded
4	76450	Greenhill Cut	Newly constructed	Min: Guano, bat bugs, heavy staining Max: 330+ LtBW across two culverts at Maclean cut	No bats recorded - potential location for Bent-winged Bat Box	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	Guano, light scattering under several expansion joins	No (no monitoring)	No (no monitoring)	8 LtBW using widened expansion joint at E end of culvert, guano pile beneath.	No bats recorded	~26 LtBW, 1 Nsp	No additional survey required
4	75560	Greenhill Cut	Newly constructed	No relevant baseline	No bats recorded - potential location for Bent-winged Bat Box	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No (not part of MMP)	No additional survey required
4	81440	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: No bats	No (excluded)	No (excluded)	No (active construction)	No (active construction)	No bats recorded	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	No additional survey required
4	81645	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: Guano	No (excluded)	No (excluded)	No (active construction)	No (active construction)	No bats recorded	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	No bats recorded	No bats recorded	No additional survey required
4	81770	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: No bats	No (excluded)	No (excluded)	No (active construction)	No (active construction)	No bats recorded	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	Poor habitat - not required	No bats recorded	No bats recorded	No additional survey required

Section	Chainage	Location	Construction dates	Baseline survey results (2014/2015), min and max # bats recorded	Monitoring March 2019	Monitoring July 2019	Monitoring Oct 2019	Monitoring December 2019 - Postponed to Jan/Feb 2020 due to bushfires	Monitoring August 2020	Opportunistic Monitoring Feb 2021	Opportunistic Monitoring 25 March 2021	Opportunistic Monitoring 31 March 2021	Opportunistic Monitoring June 2021	Monitoring February 2022	Monitoring August 2022	Monitoring Feb 2023
4	81825	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: Guano	No (excluded)	No (excluded)	No (active construction)	No (active construction)	No bats recorded	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	No bats recorded	No bats recorded	No additional survey required
4	82030	North of Jubilee Street overbridge	Newly constructed	Min: Guano, bat bugs, heavy staining Max: 330+ LtBW across two culverts at Maclean cut	No (excluded)	No (excluded)	No bats recorded	Yes	Yes	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Guano	Guano	No additional survey required
4	82330	North of Jubilee Street overbridge	Newly constructed	Min: Guano, bat bugs, heavy staining Max: 330+ LtBW across two culverts at Maclean cut	No (excluded)	No (excluded)	Guano (moderate amount) beneath most expansion joints as well as bat bug casings	Guano (moderate amount) beneath most expansion joints as well as bat bug casings	Guano (moderate amount) beneath most expansion joints as well as bat bug casings	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	No bats recorded	4 LtBW in lift holes - Lots of guano	No additional survey required
4	82610	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: No bats	No (excluded)	No (excluded)	No bats recorded	Guano (light)	No bats recorded	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	No additional survey required
4	82740	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: No bats	No (excluded)	No (excluded)	No bats recorded	No bats recorded	No bats recorded	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	No additional survey required
5	82860	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: Guano	No (excluded)	No (excluded)	No bats recorded	No bats recorded	No bats recorded	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	No additional survey required
5	82970	North of Jubilee Street overbridge	Newly constructed	Min: No bats Max: No bats	No (excluded)	No (excluded)	No bats recorded	No bats recorded	No bats recorded	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	Poor habitat – not required	No additional survey required
Devil's Pulpit	106185	New fauna underpass box culvert northbound	Newly constructed	Min: No bats Max: Guano	No (not constructed)	No (not constructed)	No (active construction)	No (active construction)	1 LtBW	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No bats recorded	No additional survey required	No additional survey required

Section	Chainage	Location	Construction dates	Baseline survey results (2014/2015), min and max # bats recorded	Monitoring March 2019	Monitoring July 2019	Monitoring Oct 2019	Monitoring December 2019 - Postponed to Jan/Feb 2020 due to bushfires	Monitoring August 2020	Opportunistic Monitoring Feb 2021	Opportunistic Monitoring 25 March 2021	Opportunistic Monitoring 31 March 2021	Opportunistic Monitoring June 2021	Monitoring February 2022	Monitoring August 2022	Monitoring Feb 2023
Devil's Pulpit	106190	Fauna underpass box culvert	Structure planned to be removed 31 Jan – 15 Apr 2019.	Min: No bats Max: 50+ LtBW/LgBW	No (excluded)	No (excluded)	No (active construction)	No (excluded)	No bats recorded (external exclusion removed)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No bats recorded	No additional survey required	No additional survey required
Devil's Pulpit	106230	Devil's Pulpit culvert with bat box	Existing	Min: No bats Max: Guano	No bats recorded	No bats recorded	Guano (very light) beneath box and on box walls	No bats recorded	No bats recorded	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No bats recorded	No additional survey required	No additional survey required
7	122190	New Oakey Flat culvert	Newly constructed	Min: No bats Max: 5 SM incl pup	No (not constructed)	No (not constructed)	No (active construction)	No (active construction)	No bats recorded (very limited habitat available - potential location for Southern Myotis bat box)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	Unable to monitor due to high water flow through culvert	No additional survey required	5 SM (one subadult)
7	122280	Oakey Flat # 3 Oakey Creek	Removed 2019	Min: No bats Max: 5 SM incl pup	No bats recorded	No bats recorded	No bats recorded	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)	No (removed)
7	122280	New Oakey Flat # 3 Oakey Creek	Newly constructed	Min: No bats Max: No bats	No (not constructed)	No (not constructed)	No (active construction)	No (active construction)	No bats recorded (very limited habitat available - potential location for Southern Myotis bat box)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No bats recorded	Unable to monitor due to high water flow through culvert	No additional survey required	6 SM in box, 3 SM in culvert
7	122550	New Oakey Creek overflow	Newly constructed	Min: No bats Max: No bats	No (not constructed)	No (not constructed)	No (active construction)	No (active construction)	No bats recorded (very limited habitat available - potential location for Southern Myotis bat box)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	No (no scheduled monitoring)	4 x SM (1 flying juvenile present), Guano	No additional survey required	7 SM (one pup), Gaps filled with debris from recent flooding

SM = Southern Myotis, LgBW = Large Bent-winged Bat, LtBW = Little Bent-winged Bat, NSP= *Nyctophilus* sp

4.2. Compensatory bat box habitat

Four of the 37 bat boxes (11%) were occupied by microbats during February 2022, all of which occurred at Mororo Bridge. Similar to previous monitoring, Southern Myotis were recorded in large numbers within all four bat boxes beneath Mororo Bridge (Plate 11). Southern Myotis also breed in the boxes beneath Mororo Bridge.

No microbats were recorded in compensatory bat boxes (Table 6) located at the following sites during February 2022 monitoring period:

- Section 3A CH 35900 Picaninny and Pheasants Creek bat boxes (3 boxes)
- Section 4 CH 76450 Greenhill culvert bat box (1 box)
- Section 4/ 5 CH 81900 Maclean cut bat boxes (10 boxes)
- Section 5 CH 89400 Serpentine Channel bat box (6 boxes)
- Section 6 CH 10161 Tabbimoble Creek Bridge bat boxes (8 boxes)
- Section 6 CH 10290 Tabbimoble Creek Overflow Bridge bat boxes (4 boxes)
- Section 6 CH 106230 Devil's Pulpit bat box (1 box)

There were few instances of pest species occupying the bat boxes, with occasional instances of spiders, spider egg sacs and mud wasp nests. It was not considered likely that pest species were excluding microbats from using any of the boxes for a sustained period of time, nor is intervention deemed necessary. Overall, the compensatory bat boxes remained in good condition throughout the monitoring period.

During additional monitoring of selected drainage structures in August 2022 and February 2023 there were multiple instances of microbats recorded occupying bat boxes. Glenugie Culvert (CH 31400) had five Little Bent-winged Bats within the Hebel prototype Bent-winged Bat Box. This is the greatest number of Little Bent-winged Bats recorded within boxes throughout the W2B monitoring. First record of Southern Myotis utilising the bat box within Oakey Flat (CH 122280) recorded during February 2023.



Plate 11: Southern Myotis (with pups) in bat boxes beneath Mororo Bridge, February 2022

Table 6: Details of compensatory bat boxes and results of 2019/2020 and Summer 2022 monitoring

Section	Chainage	Date added into MMP	Location	Monitoring March 2019	Monitoring July 2019	Monitoring Oct 2019	Monitoring Jan/Feb 2020	Monitoring Aug 2020	Monitoring February 2022	Monitoring August 2022	Monitoring February 2023
2	31400	Mar-19	Glenugie culvert bat box (1 x Bent-winged Bat Hebel box)	No bats recorded	1 Little Bent-winged Bat	No bats recorded	No bats recorded	Guano (small amount)	Not monitored	5 LtBW	No (no scheduled monitoring)
3	36100	Mar-18	Pheasants Creek bat boxes (3 x Southern Myotis)	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No (no scheduled monitoring)	No (no scheduled monitoring)
4	76450	Jul-21	Greenhill culvert bat box (1 x Bent-winged Bat Hebel box)	Not installed	Not installed	Not installed	Not installed	Not installed	No bats recorded	No bats recorded	No (no scheduled monitoring)
4	81900	Sep-17	Maclean cut bat boxes (6 x bat boxes, 4 x Hebel boxes)	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No (no scheduled monitoring)	No (no scheduled monitoring)
5	89400	Mar-15	Serpentine Channel bat boxes (6 x Southern Myotis)	No bats recorded	11 Southern Myotis (7 in one box, 4 in another box)	No bats recorded	No bats recorded	1 Southern Myotis	No bats recorded	No (no scheduled monitoring)	No (no scheduled monitoring)
5	94090	Mar-13	Mororo Bridge North Bound bat boxes (4 x Southern Myotis)	400+ Southern Myotis	150+ Southern Myotis	210+ Southern Myotis	310+ Southern Myotis	240+ Southern Myotis	+200 Southern Myotis	No (no scheduled monitoring)	No (no scheduled monitoring)
6	101610	Feb-17	Tabbimoble Creek Bridge bat boxes (8 x bat boxes)	No bats recorded	3 Long-eared Bats (species unknown)	No bats recorded	No bats recorded - significant fire and flood damage to some boxes	12 Eastern Long-eared Bats in one box	No bats recorded	No (no scheduled monitoring)	No (no scheduled monitoring)
6	102900	Feb-17	Tabbimoble Creek Overflow Bridge bat boxes (4 x bat boxes)	No bats recorded	No bats recorded	No bats recorded	No bats recorded - no fire or flood damage	No bats recorded, leaves in box, possible Feathertail Glider nest	No bats recorded	No (no scheduled monitoring)	No (no scheduled monitoring)
Devil's Pulpit	106230	Apr-18	Box culvert south bound bat box (1 x bat box)	No bats recorded	No bats recorded	Guano (small amount)	No bats recorded	No bats recorded	No bats recorded	No (no scheduled monitoring)	No (no scheduled monitoring)
7	122280	Nov-16	Oakey Flat # 3 Oakey Creek bat box (1 x Southern Myotis)	No bats recorded	No bats recorded	No bats recorded	No bats recorded	No bats recorded	Unable to monitor due to high water flow through culvert	No (no scheduled monitoring)	No bats recorded

4.3. Performance thresholds – Summary

The MMP (GeoLink, 2015b) monitoring component and the associated performance thresholds are shown in Table 2. A number of sites within the W2B highway upgrade project have met the performance thresholds Table 7. Following the initial two years of monitoring, if results indicate early uptake consistently, monitoring can cease and is not required for the full six years. Corrective actions were required for Maclean Cut and Eight Mile Lane as the performance criteria was not achieved following the two years of monitoring.

Whilst there has been intermittent use by small numbers of microbats in the new structures on Eight Mile Lane by Southern Myotis, there is not enough data to determine whether a clear trend exists in the numbers of Southern Myotis roosting within these structures. No evidence of Southern Myotis breeding has been recorded in the new structures on Eight Mile Lane during this time, including the Summer 2021/22/23 monitoring event despite the site being a maternity roost prior to construction. Corrective actions were undertaken in the structures at Eight Mile Lane to try and encourage stable numbers and a breeding colony of Southern Myotis back to the area. This involved the removal of expansion foam from the Original Picaninny Creek culvert during the Winter 2022 monitoring period.

The new culverts within Maclean Cut did not have the required capacity to accommodate up to 650 Bent-winged Bats and none of the boxes installed in trees have been used. Corrective action for Maclean cut included the installation of one Bent-winged Bat box (Hebel box) within Green Hill culvert in June 2021 capacity for > 650 Bent-winged Bats as compensatory habitat for lack of roosting capacity in new culverts at Maclean cut.

Table 7: Performance threshold results

Section	Location	Monitoring Component	Performance thresholds	Performance thresholds met (Yes/No)
2	Glenugie Culvert Bent-winged Bat Box (CH31400)	Bat boxes	No evidence of usage within two years of installation.	Yes – evidence of usage
2	Glenugie Culvert (CH31400)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	Guano recorded but microbats only recorded within hebel box. No recommendations required.
Glenugie Link				
3a	Pheasants Creek bat boxes (3 x Southern Myotis)	Bat boxes	No evidence of usage within two years of installation.	No - no evidence of microbat usage
3a	Glenugie Link culverts (CH 35075)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	Yes – LtBW in roosting numbers similar to original Bebo arch

Section	Location	Monitoring Component	Performance thresholds	Performance thresholds met (Yes/No)
3a	Picaninny Creek, Eight Mile Lane (CH 35880)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	No – low numbers of microbat species recorded. SM individuals absent.
3a	Picaninny Creek, Eight Mile Lane (CH 35900)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	No – foam removed in Winter 2022, and no microbats/evidence recorded in Summer 2023. Only one monitoring event has occurred since removal of foam
3a	Pheasant Creek, Eight Mile Lane (CH 36010)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	Yes – small numbers of SM recorded at each monitoring event with LtBW recorded during Winter 2019 and 2022
3a	Pheasant Creek Bridge (CH36379)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	No – no microbats/evidence recorded
Greenhill				
4	Greenhill Cut Hebel bat box (CH 76450)	Bat boxes	No evidence of usage within two years of installation.	No – no microbats/evidence recorded
4	Greenhill Cut (CH 76450)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	Yes – LtBW recorded in Winter monitoring events
Maclean*				
4/5	Maclean cut bat boxes (10 bat boxes)	Bat boxes	No evidence of usage within two years of installation.	No – no microbats/evidence recorded
4/5	North of Jubilee Street overbridge (CH 81645)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	No – no microbats/evidence recorded

Section	Location	Monitoring Component	Performance thresholds	Performance thresholds (Yes/No)	met
4/5	North of Jubilee Street overbridge (CH 81770)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	No – microbats/evidence recorded	no
4/5	North of Jubilee Street overbridge (CH 81825)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	No – microbats/evidence recorded	no
4/5	North of Jubilee Street overbridge (CH 82030)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	Yes - guano	
4/5	North of Jubilee Street overbridge (CH 82330)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	Yes – LtBW and guano	
Devil's Pulpit					
6	New fauna underpass box northbound bat box (CH 106185)	Bat boxes	No evidence of usage within two years of installation.	Yes – guano recorded in previous monitoring events	
6	New fauna underpass box northbound (CH 106185)	Habitat design features within structures	Evidence of usage is confirmed consistently (numbers not decreasing over two years).	Yes – previous monitoring events recorded one LtBW and 1 LgBW.	

*In 2019/20 it was found culverts at Maclean cut did not have the required capacity to accommodate up to 650 Bent-winged Bats and boxes showed no signs of utilisation. A larger style Bent-winged Bat box was installed at Greenhill culvert to augment the existing culvert in June 2021, resulting in LtBW aggregating during Winter. Due to lack of microbat habitat (as determined by previous monitoring events) the remaining Maclean cut impact sites were excluded from monitoring.

5. Discussion

Post construction annual microbat monitoring was undertaken at all drainage structures and bat boxes during February 2022. Additional monitoring events during August 2022 and February 2023 were undertaken at several locations where the numbers / breeding status of microbat populations had not attained pre-construction levels. Expansion foam was removed from lift holes and expansion joints at Picaninny Creek culvert to assist in re-establishment of a maternity colony of Southern Myotis in the vicinity of Pheasants Creek and Picaninny Creek.

The use of compensatory bat boxes had poor results at both impact and control sites during the Summer 2022 Annual monitoring. Only four bat boxes at Mororo Bridge were recorded being used during the Annual Monitoring. Similar to past monitoring events bat boxes at Mororo Bridge were occupied by large numbers of Southern Myotis. The main reason for low bat boxes utilisation is because out 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. As mentioned in previous monitoring reports, bat boxes installed in trees, often along creeklines but not always over permanent waterways only provide sub-optimal placement of boxes for the target species which are primarily subterranean roosting species, particularly the Bent-winged Bats. To date no Southern Myotis or Bent-winged Bats have been recorded in Cyplas boxes.

However, additional monitoring within some drainage structures provided desirable results within Oakey Creek and Glenugie, and in addition where Bat boxes were moved into these culverts as a corrective action. The first record of Southern Myotis was recorded in a Bat box at Oakey Creek, and a large proportion of Little Bent-winged Bats were recorded within the Hebel box at Glenugie.

Similar to the last monitoring report, the 2022/23 monitoring period has seen three target species; Little Bent-winged Bats, Large Bent-winged Bats and Southern Myotis inhabiting newly installed structures or bat boxes along the W2B alignment.

Prior to construction it was known that large aggregations of Little Bent-winged Bats and some Large Bent-winged Bats over-Wintered occurred in numerous structures impacted by the W2B project. Design detail of bridges and culvert are therefore an important component where impacts to microbat roosting habitat in structures have been identified. The impact of different designed bridges and culverts are evident throughout the monitoring of drainage structures along W2B Hwy.

Due to limited bat habitat implemented within the design of some of the newly built drainage structures throughout the W2B Hwy low numbers of bat occupancy has occurred. The newly constructed bridges at both Tabbimoble Creek Bridge and Tabbimoble Overflow Bridge have had minimal success in recording occupancy of targeted bat species. In comparison, both retained structures including Old Tabbimoble Creek Bridge and Old Tabbimoble Overflow Bridge have recorded large numbers of Little Bent-winged Bats occupancy within expansion joints during Winter monitoring events.

New culverts built within Maclean Cut contain some bat habitat in the form of lift holes and expansion joints, however to date only four Little Bent-winged Bats have been recorded occupying Maclean Cut culverts. Evidence of small to moderately sized aggregations have been present between monitoring events in the form of guano piles beneath most exclusion joints and bat bug casings around several of the lift holes of the two main culverts suitable as microbat roosting habitat at CH 82030 and CH 82330.

However, the new structures were required to contain habitat for up to 650 bats to allow for expansion of the colony and errors associated with minimal monitoring of the culverts prior to preparation of the MMP. Greenhill Box culvert and a Bent-winged Bat Box constructed from Hebel blocks were implemented into the monitoring to compensate habitat loss of Maclean Cut Culverts. The prototype Bent-winged Bat box installed has not yet been successful. However, within the Greenhill Box culvert approximately 26 Little Bent-winged bats and one *Nyctophilus sp.* individuals were recorded within the expansion cracks.

The newly constructed Glenugie Link Culvert (CH35075) built in place of Bebo Arch contains good bat habitat which was implemented within the culvert design. Large numbers of Little Bent-winged Bats and some Large Bent-winged Bats have been observed occupying Glenugie Link Culvert (CH35075) during the Winter monitoring. Roosting habitat includes the widened expansion joints which ascertain bat numbers similar to that observed in the original Bebo arch. Glenugie Link Culvert (CH35075) contain roosting habitat for > 2000 Bent-winged Bats in the widened expansion jointing gaps created in the mid sections of each cell of both sets of 4 culverts at this location.

It is suggested that the detailed design drawings for newly built structures include at least 4 x widened expansion joints per culvert cell (aiming for minimum width of 20mm) leaving lift holes unfilled and uncapped as standard specifications going forward for any projects where impacts to microbat roosting habitat in structures have been identified.

Similar to the previous microbat monitoring report, there is a lack of evidence that a maternity colony of Southern Myotis has been able to re-establish within the newly constructed culverts at Picaninny Creek and Pheasants Creek on Eight Mile Lane. Whilst there have been observations of small groups and individual Southern Myotis at the new Pheasants Creek culvert, no evidence of breeding has been observed and the numbers are below those recorded prior to construction commencing. As such corrective actions were undertaken. During the additional monitoring undertaken in August 2022 expansion foam within lift holes and expansion joints was removed. This was aimed at encouraging uptake by Southern Myotis. However, the February 2023 monitoring resulted in no evidence of microbats reoccurring within the Original Picaninny Creek culvert. Nevertheless, monitoring only occurred 6 months later over one monitoring period and perhaps too early to determine whether Southern Myotis populations will return. It is recommended that another monitoring event occurs at Eight Mile Lane to survey the reoccurrence of Southern Myotis.

In comparison, the results at Oakey Creek culverts are encouraging for Southern Myotis despite low occupancy seen in previous monitoring events. This may have been due to high water levels as a result of heavy rainfall throughout late 2020 to mid-2022 producing debris and potentially excluding microbats from the culvert. However, during February 2023 monitoring Oakey Creek indicates greater use of these culverts by Southern Myotis than has been recorded previously and signs of breeding. It is recommended another monitoring event occurs at Oakey Creek to survey Southern Myotis numbers.

Southern Myotis were known to have maternity colonies located along the W2B project alignment. Mororo bridge was one of the only known maternity colonies which was not removed or extended as part of the W2B project alignment. Mororo Bridge south, has supported a permanent colony of Southern Myotis within four bat boxes installed beneath the bridge from before construction commenced, throughout construction and into the operational phase of the project. 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) or four chambered timber box. Installation of Cyplas roost boxes for Southern Myotis and Bent-winged Bats should be avoided as a temporary compensatory habitat measure as they have not been proven to show successful uptake by either species.

A maternity colony of Southern Myotis is now centred on Serpentine Channel Bridge, where none was detected prior to commencement of works.

Significant positive results from this monitoring period include:

- Reoccurrence of large maternity colony of Southern Myotis at Serpentine Channel Bridges
- Southern Myotis maternity population numbers at Mororo Bridge equal to or greater than numbers recorded prior to construction
- Most Little Bent-winged Bats recorded within prototype Hebel Bent-winged Bat Box at Glenugie CH 31400 section 3-11 W2B Hwy
- Increasing numbers of Little Bent-winged Bats returning to roost in the new box culverts at Glenugie Link, such that numbers are now equal to, or exceed maximum numbers recorded in original structure that was removed
- Cluster of Little Bent-winged Bats within an expansion joint in the Greenhill Box culvert CH 76450
- Breeding population seen within Oakey Creek Culverts
- Tabbimoble Overflow Creek Bridge during the Winter 2022 monitoring indicate greater use of Little Bent-winged Bats than has been recorded at any time in the past

It should be noted severe weather events have occurred during the period 2019 – 2023; notably 2019-20 bushfires (detailed within the 2019/20 Annual Monitoring Report) and 2020-21 flooding events. Such weather events have the potential to impact/affect microbat populations within W2B impact and control sites. The impact of the bushfires on native fauna is subject to ongoing investigation. Besides immediate fire mortalities, further post-fire deaths are expected to occur due to additional indirect impacts (e.g. starvation, reduced shelter and increased feral predator attacks).

6. Conclusion and recommendations

Most of the impact and control sites have evidence of consistent microbat usage meeting the performance criteria, in particular the reoccurrence of a large maternity colony of Southern Myotis at both Serpentine Channel Bridge and Mororo Bridge. The timber bat boxes at Mororo Bridge are often at capacity and the local population of Southern Myotis would benefit from installation of at least 6 new timbered four-chambered boxes of similar size or with a capacity to accommodate up to 500 Southern Myotis at this location be installed under Mororo Bridge. Accordingly, TfNSW have worked in consultation with a microbat specialist, and have recently (October 2023) installed 6 additional timbered four-chambered microbat boxes beneath Mororo Bridge (Plate 12 and Plate 13).

However, in the long term this is not considered a sustainable solution for a maternity roost of Southern Myotis of this size. It is recommended that if a project is developed within the 10km radius of Mororo

Bridge, that TfNSW consults with a microbat specialist to recommend suitable options for incorporating long-term roosting and breeding habitat for Southern Myotis.

Corrective actions were required for Maclean Cut and Eight Mile Lane as the performance criteria were not achieved following the previous two years of monitoring. The corrective actions of the removal of expansion foam from Pheasant Creek Culvert at Eight Mile Lane has not showed any success in maternity colony of Southern Myotis re-establishing. It is recommended that seasonal monitoring is undertaken for Southern Myotis and Bent-winged Bats to satisfy the above recommendations. This would include a further Winter 2025 and Summer 2025 monitoring event for structures associated with Eight Mile, Pheasants CK, Greenhill culvert and Maclean Cut. This will allow for follow-up monitoring of drainage structures at Eight Mile Lane and Greenhill culvert where the corrective actions have been undertaken.

It is also recommended future projects incorporate bat roosting and breeding habitat within the initial design of drainage structures; at least four expansion joints per culvert, lift holes left unfilled/uncapped. For more bat habitat design suggestion follow the Microbat Management Guidelines (TfNSW, 2023) in future culvert and bridge design. Installation of Cyplas roost boxes for Southern Myotis and Bent-winged Bats should be avoided as a temporary compensatory habitat measure, as there is no evidence of them occupying Cyplas in NSW.



Plate 12: Four additional timbered four-chambered microbat boxes beneath Mororo Bridge (October 2023).



Plate 13: Two additional timbered four-chambered microbat boxes beneath Mororo Bridge (October 2023)

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