Transport for NSW

Microbat management guidelines

March 2023

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Acknowledgement of Country

Transport for NSW acknowledges the traditional custodians of the land on which we work and live.

We pay our respects to Elders past and present and celebrate the diversity of Aboriginal people and their ongoing cultures and connections to the lands and waters of NSW.

Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the land, waters and seas and their rich contribution to society.

Document control

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Versions

Version	Date	Amendment notes
1.0	Dec 2021	First issue
1.1	March 2023	Rebranded and Brief to undertake a microbat survey and assessment moved from Appendix to separate resource TT1.

Related policy and supporting information

- Transport Environment and Sustainability Policy
- Environment & Sustainability Management Framework

Supporting resource

- **EMF-BD-GD-0012-TT1_Brief to undertake a microbat survey and assessment (Resource 1)**

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Table of contents

1. Introduction

1.1 Background and legislative context

Microbats face ongoing pressures as a direct and indirect consequence of human activities. Construction of, and demolition and maintenance activities on, Transport for NSW (Transport) structures (including bridges, culverts, wharves and jetties), have the potential to impact on microbats.

Transport has a legal obligation under the *Environmental Planning and Assessment Act 1979* (EP&A Act) to assess the impact of activities on the environment including whether an activity is likely to have a significant impact on threatened species and their habitat.

There are three threatened species, Southern Myotis (*Myotis macropus*), Large Bent-winged Bat (*Miniopterus orianae oceanensis*) and Little Bent-winged Bat (*Miniopterus australis*), that often need to be considered when planning activities involving Transport structures. All three species are listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act). None are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Four other threatened microbat species have been recorded in structures: Large-eared Pied Bat (Chalinolobus dwyeri), Little Pied Bat (*Chalinolobus picatus*), Eastern Cave Bat (*Vespadelus troughtoni*) and the Greater Broad-nosed Bat (*Scoteanax rueppellii*) and two further species have some possibility of occurring: Eastern Coastal Free-tailed bat (*Micronomus norfolkensis*) and Inland Forest Bat (*Vespadelus baverstocki*). Interactions with these species on Transport projects are uncommon therefore, they are not included as target microbats in this guideline. This guideline may inform management of bat species other than those listed but were not written with these rare encounters in mind.

1.2 Purpose of the guideline

This guideline is primarily designed for Transport operational maintenance, project development and project delivery staff involved in works impacting structures that may provide microbat habitat and the environment staff that support them.

This guideline provides Transport staff with a framework to manage potential impacts of works on microbats. A risk-based approach has been applied to support Transport staff to make decisions about whether microbats are likely to be impacted by an activity and who should be involved in developing the management strategy.

This guideline will assist Transport staff to:

- Identify the types of structures that might be suitable for microbats.
- Recognise evidence of microbat presence within a structure.
- Determine what the minimum survey requirements are (what, when and how) for target microbat species.
- Determine if impacts to microbats can be avoided through timing of activities.
- Determine if preparation of a Microbat Management Plan (MMP) is warranted.
- Ensure staff and contractors are protected from harm when managing microbats.

1.3 Scope of this guideline

This guideline provides advice on ways to manage potential impacts to microbats for Transport works on structures involving timber and/or concrete bridges, reinforced concrete box culverts (RCBC), concrete pipes, wharves and jetties. Microbats may also roost in structures such as adits, derelict buildings, fence posts and sails but these are rare occurrences that can be managed under an unexpected finds procedure.

This guideline relates only to assessing and mitigating impacts to microbats that use Transport structures and does not relate to projects impacting natural habitats such as hollow-bearing trees and caves or foraging habitat.

The guideline has been prepared for activities undergoing environmental impact assessment under Part 5, Division 5.1 of the EP&A Act. This includes road activities that are subject to Routine Minor Works Procedure and rail activities subject to an EIA checklist as well as decisions about whether the activity is exempt development. This guideline has not been prepared for projects being assessed under Part 4 or Part 5, Division 5.2 of the EP&A Act but may provide useful guidance for such projects.

1.4 Target microbats

The three microbat species (Figure 1) that are the focus of this guideline (termed 'target microbats') are listed as threatened species under the BC Act and are known to use Transport structures as roosting habitats. These are:

- Southern Myotis (*Myotis macropus*), which may also breed in Transport structures.
- Bent-winged bats - Little Bent-winged Bat (*Miniopterus australis*) and Large Bent-winged Bat (*Miniopterus orianae oceanensis)* which roost (they may mate but do not give birth) in Transport structures.

The state-wide distribution of target microbats is shown in Figure 2.

These species use a network of suitable roost sites; individuals change roosts regularly (sometimes nightly) to reduce parasite loads, minimise the risk of predation, and to capitalise on the unpredictable nature of insectivorous prey (Churchill, 2008). All three target microbats may share winter roosting sites.

Southern Myotis may breed in Transport structures over summer (October to April). They generally roost in groups of 10 to 15 individuals, but colonies of over a hundred microbats are possible in structures. They prefer dry or damp roosts (cracks and crevices in concrete culverts and gaps in timber decking) with water below or nearby and minimal human activity. Breeding Myotis will still relocate roosts within the same structure while rearing pups but disturbance can force adults to abandon their offspring. In NSW, females have up to two birthing events each year between October and March.

Bent-winged bats are known to roost (but not breed) in Transport structures. Bent-winged bats, particularly females, will leave their roosts in spring to reach maternity caves for breeding and rearing pups. Bent-wing bats will forage widely and do not require roosts to be in close proximity to forested areas.

Figure 1: Southern Myotis (top), Little Bent-wing (mid) and Large Bent-wing (bottom) bats. Credit: Bruce Thomson (auswildlife.com)

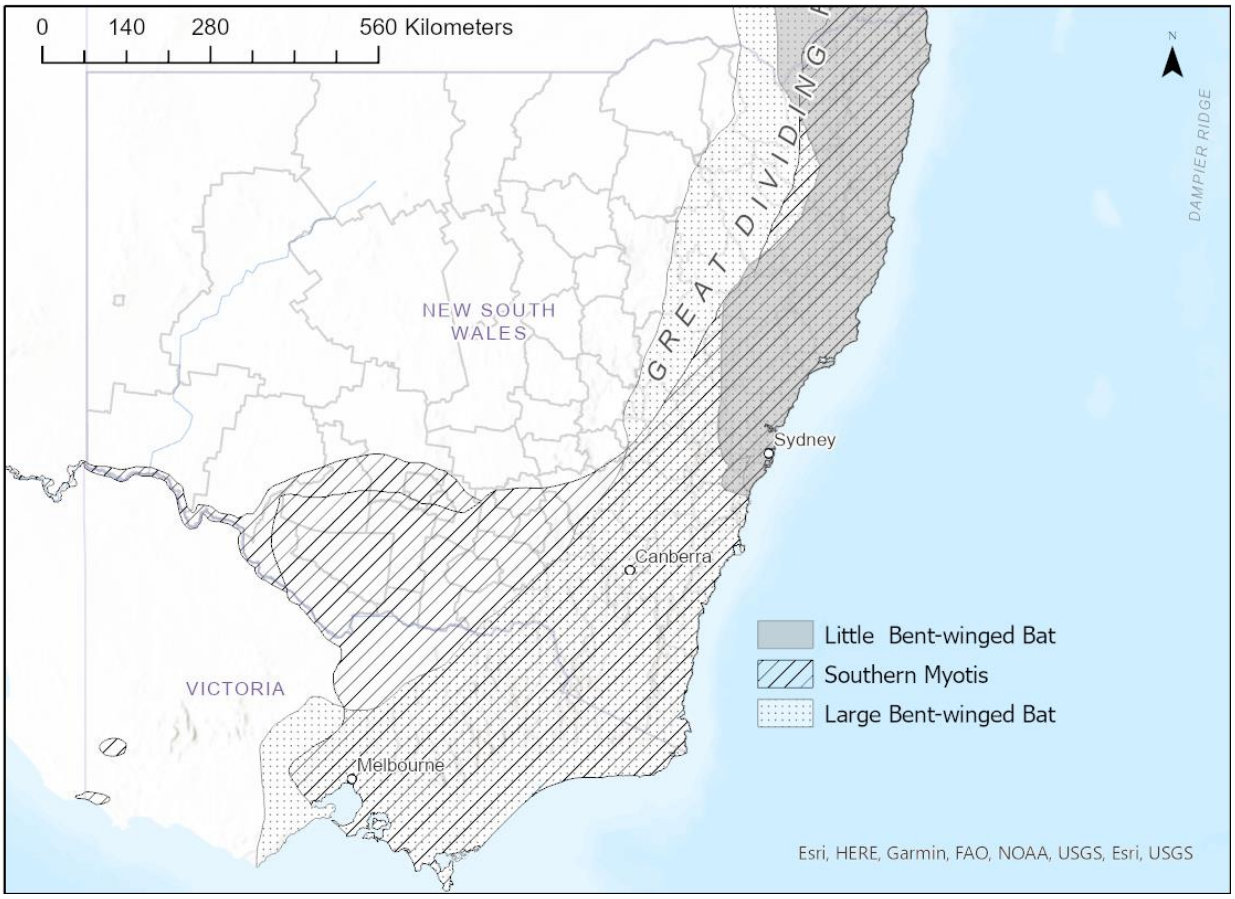


Figure 2: Distribution of target microbats in NSW (Credit: Australasian Bat Society CC BY 4.0)

1.5 Health risks of working with microbats

Bites from bats in Australia can carry Australian Bat Lyssavirus (ABLV), a virus similar to rabies that can be fatal if not treated rapidly with vaccinations. Contact or exposures to bat faeces, urine or blood do not pose a risk of exposure to ABLV, nor does working near bat-roosting areas, as long as microbats are not handled (NSW Health, 2021).

Staff and contractors must not handle bats (even injured bats) unless they have:

- up-to-date lyssavirus (rabies) vaccinations
- experience/training handling microbats.

If handling microbats is required, engage a **qualified ecologist/microbat specialist** vaccinated against lyssavirus.

If you have been bitten or scratched by a microbat, wash the wound thoroughly for at least five minutes and seek medical advice within 12 hours of the incident.

Additional information can on ABLV be found from the following Health NSW sources:

- Rabies and Australian bat lyssavirus infection fact sheet - Fact sheets (nsw.gov.au)
- Rabies and other lyssavirus infections (including Australian Bat Lyssavirus) control guidelines - Control guidelines (nsw.gov.au)

The Australian Bat Society has also prepared ABS safe bat handling guidelines on the safe handling of bats.

Microbats often occupy confined spaces. Transport staff must consider the potential risks and pre-requisite training required before entering confined spaces.

2. Preliminary microbat assessment

2.1 Introduction

The issue of whether a culvert, bridge, wharf or other structure could be providing habitat for microbats and whether a Microbat Management Plan (MMP) is required routinely arises in the course of works undertaken by Transport.

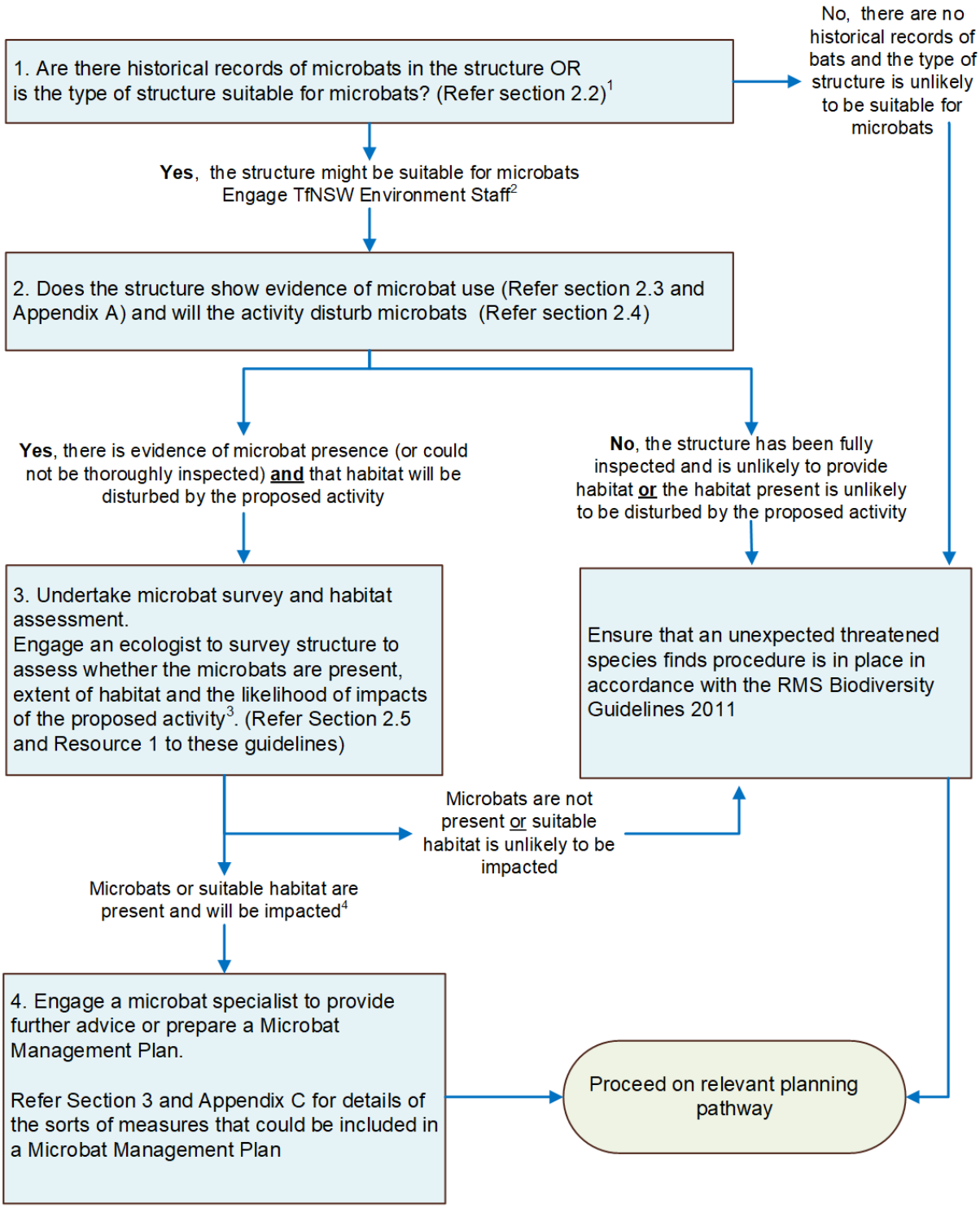
In many areas of NSW there is little to no information about the potential presence of microbats in Transport structures. The preliminary assessment process described below is designed for these situations and involves a series of steps to determine the risk of microbat presence, whether a microbat survey is required and whether a MMP should be prepared.

In some parts of NSW, there is a good understanding about the potential presence of microbats in Transport structures and long standing practices in place to manage potential impacts. In these situations, undertaking Steps 1-3 of the risk assessment flowchart (Figure 4) is unlikely to be necessary or may be modified to the circumstances. Consultation with the relevant Environment Manager is recommended.

In some cases, a MMP may have been prepared for the same structure previously. If that MMP is less than five years old, it may provide suitable guidance to manage microbat impacts arising from subsequent projects with comparable impacts. The relevant Environment Manager can advise on the appropriateness of reusing an existing MMP if required.

Where a separate biodiversity assessment is being prepared as part of the environmental impact assessment process, the assessment of potential microbat impacts and development of suitable mitigation strategies would be undertaken in accordance with Transport Biodiversity assessment guidelines (EMF-BD-GD-0010). These Transport *Microbat management guidelines* would inform this process but strict adherence of the preliminary microbat assessment flowchart would not be necessary.

Figure 3: Southern Myotis roosting in rotted timber in Monkerai Bridge. Credit: Transport



[1] Where an existing MMP was prepared for the structure within the last 5 years, if still relevant, this plan can be implemented and the steps in this flow chart are not required

[2] Project management and environment staff must agree on responsibility for subsequent steps

[3] If the project is maintenance or minor work, further assessment is required (in accordance with the Environmental Assessment Procedure for Routine Maintenance and Minor Work), prepare an Minor works or Project REF or EIA Checklist (for rail) under Part 5 Division 5.1 including an Assessment of Significance

[4] Consider if alternate methods can avoid impacting microbats

Figure 4: Microbat assessment flowchart for works on Transport structures

The following sections provide more detail on each of the steps in the flowchart.

2.2 Checking for historical records and likely habitat suitability

This step involves checking for historical records of microbats within the structure and checking the structure to determine if it may provide habitat. This step can be completed with assistance of environment staff at the discretion of the project/operational manager.

Transport staff including environment staff, bridge engineers, bridge inspectors, work supervisors and team leaders, previous Transport MMPs, and the NSW BioNet | NSW Environment and Heritage database bionet.nsw.gov.au are all potential sources of information on the likely presence of microbats within a structure.

When considering if they type of structure may provide habitat, the following list contains structures that are unlikely to be used by the target species as significant roosts or breeding habitat (i.e., possibly only irregular opportunistic use by individuals):

- Pipes less than 900 mm diameter and culverts less than 900mm high.
- Structures less than 1.2 metres high that lack grab holes, or where entrances are blocked by overgrown vegetation, grids, grates and floodgates which inhibit microbat access.
- 100% metal or plastic structures (e.g., plastic-lined culverts or steel Armco culverts) with smooth surfaces that prevent microbats from roosting.
- Structures that are permanently or frequently inundated.
- Locations exposed to direct sunlight or rain.

Further consideration of microbats is not necessary for these structures unless there are known historical records of microbat presence in the structure (when an inspection should be undertaken). The details of this step should be outlined in any reporting undertaken as part of the works.

For all other structures, an inspection should be undertaken to determine if any evidence of microbats or their habitat is present. It is important to remember that even if a microbat roost is not in active use, it might be occupied at another time of year (e.g., during the breeding period for Myotis) – See Appendix D.

2.3 Assessing possible microbat presence and habitat potential

The next step in the process is to inspect potential microbat roosting habitat within the structure to identify any evidence of bat activity. Environment staff should be engaged at this point and agreement reached on respective responsibilities for this step onwards. A list of potential microbat-roosting habitat is provided in Table 1 and photos of microbats roosting in structures are provided at Appendix A.

Individual microbats are typically not clearly visible, but signs of microbat activity include:

- audible sounds of bat calls 'squeaking'
- bat scats/guano
- roosting bats concealed within the structure e.g. between culvert joins, lift holes or cracks
- discolouration or staining from urine
- presence of parasitic bat flies (Nycteribiid and Streblid)
- musty animal smells.

If there is no evidence of microbat activity and thorough inspection was possible, then no further consideration of microbats is recommended. The details of this investigation and outcome of this process should be outlined in the assessment documentation.

If evidence of microbats habitat was found or where a thorough inspection was not possible due to difficulties accessing the structure or inspecting all potential habitat features, proceed to the next step which involves considering whether the proposed activity will disturb microbats.

Table 1: Microbat habitat within structures

Potential habitat feature to inspect	Southern Myotis	Bent-winged bats
Concrete structures		
Grab holes in culverts and bridge decking and girders	✓	✓
Expansion joints in concrete plank and Super-T bridges	✓	✓
Parapet of Super-T girders on bridges	✓	✓
Semi-open concrete abutments	✓	✓
Under concrete bridge piles	✓	✓
Scuppers on bridges and culverts	✓	✓
Join seals between reinforced concrete box culverts and BEBO arches	✓	✓
Aggregate/roughened sections of concrete and exposed steel reinforcement in culverts and stormwater drains	✓	✓
Roughened exposed areas and uneven surfaces including closure pours and the space between concrete girders and diaphragms under bridges	✓	✓
Purpose-built microbat habitat	✓	✓
Fairy Martin, Welcome Swallow and Paper/Mud Wasp nests under bridges or in culverts	✓	✓
Cavities below pile caps in bridges	✓	✓
Bridges and wharves with protected concrete joins between decking, girders and/or headstock	✓	✓
Concrete structures		
Timber jetties and wharves with cavities from rotting timber or design features. Habitat not exposed to rain or direct sunlight	✓	
Bridges – including the timber decking, split stringers, secondary stringers, cross girders, truss and support beams	✓	✓
Any dry vertical space/crack with a preference for over water.	✓	✓

2.4 Assessing likely disturbance

This step involves considering whether the proposed activity is likely to disturb microbats or their habitat. This can occur by:

- Direct disturbance of microbats and roosts (the presence of workers close to habitat).
- Indirect disturbance through impacts such as noise, vibration, lighting, microclimate and air-quality impacts.
- Loss or modification of potential roosting and breeding habitat (when structures are removed or roosts within them are no longer accessible).

Examples of activities with the potential to impact microbats or their roosting habitat is provided in Table 2.

When considering the disturbance to microbat habitat, consider whether the activity would raise the baseline disturbance beyond that which is already present. For example, bat habitat underneath a busy timber bridge may be more tolerant of noise and vibration than a rural concrete bridge with occasional use.

Table 2: Activities likely to disturb microbats

Activity	Description of activity	How this could impact microbats
Bridge (heritage and non-heritage) and tunnel cleaning, maintenance and repair	Activities required to clean, maintain or repair timber, concrete and masonry bridges and tunnels including pressure spraying (e.g., mechanical, jet wash or water-blasting activities).	Bridge slab jacking/bearing replacement disturbs roosting spaces, bridge cleaning or vibrations could dislodge fairy martin nests which are used by microbats for roosting. Microbats may abandon their pups from stress caused by high noise and vibration during intensive repair works. Containment setups can block access in and out of roosting crevices.
Other timber bridge element work	Activities required for the replacement and rehabilitation of timber deck elements, including the installation of a spray seal timber deck.	Timber elements may host microbat roosts. Roost entrances could be blocked or roosts removed
Demolition and repair of disused structures	Activities involving the demolition or repair of disused buildings including timber and masonry structures.	Property adjustment works such as boundary adjustments which impact potential roosting microbats within timber structures.
Wharves (under deck)	Wharves (under deck).	Activities required to repair and perform maintenance under the decking of wharves
Routine pavement maintenance	Routine pavement maintenance.	Routine pavement maintenance in close vicinity to a culvert or bridge involving increased noise or vibration.
Drainage works	Activities required for cleaning, maintenance, reconstruction or repair or extension of drainage structures including culverts of any size and pipes greater than 900 mm.	Pressure-cleaning inspections can disturb habitat. Covering up grab holds when repairing or extending pipe culverts removes habitat. Grouting cracks can seal up roost entrances. Headwall and wingwall crack repairs may remove or seal habitat, etc.

After inspecting the structure, determine if any habitat present will be disturbed by the proposed activity. If there are no impacts to any habitats then no further consideration of microbats is needed. The details of this investigation and outcome of this process should be outlined in the assessment documentation.

If there is evidence of microbat presence (or if the structure could not be thoroughly inspected) and that habitat will be disturbed by the proposed activity, then a microbat survey should be conducted by a **suitably-qualified** ecologist.

2.5 Undertaking microbat survey and habitat assessment

The microbat survey involves contracting an ecologist to undertake the survey in accordance with accepted industry practice (see Appendices E and F).

The purpose of the survey is to determine the extent of habitat and the species, approximate number, location and breeding status of any animals found. The survey should also consider the potential impact of the activity on any microbats detected and their habitats.

An **ecologist** is expected to undertake surveys using the most appropriate survey method for the site to ensure the survey is comprehensive. This may include:

- A thorough inspection of the structure including an assessment of habitat (may include use of thermal imaging cameras if available).

- Monitoring for microbat calls using acoustic detectors (such as Anabat), which may assist in the assessment/identification of the species present.
- Undertaking fly-out / fly-in survey, typically using a thermal camera (observing when microbats exit and leave the roost at dusk/dawn).
- Consideration of the likely impact (and proposed timing) of the activity on any microbats.

A brief template for engaging an ecologist to undertake the microbat survey and assessment is provided in EMF-BD-GD-0012-TT1 (Resource 1) (including a provisional item should a MMP need to be prepared by a microbat specialist).

If the survey determines that microbats are not present or unlikely to be impacted, then no further consideration of microbats is recommended. The details of this investigation and outcome of this process should be outlined in the assessment documentation.

If the survey determines that microbats are present and are likely to be impacted, then a MMP should be prepared by a suitably qualified microbat specialist.

Section 3 provides detail on the types of measures that could be included in a MMP. Appendix C details some successful case studies undertaken by Transport along with a summary of measures implemented by Transport in selected MMPs prepared since 2013.

3. Managing impacts on microbats

Where the proposed activity involves an unavoidable impact to microbats or their habitat, impact management should be applied to minimise these impacts.

Management measures should be detailed in the MMP prepared by a **suitably-qualified microbat specialist** prior to the commencement of activities that may cause impacts. Table 3 lists the most commonly used measures along with guidance as to how and when they should be applied. This table should be used to guide the development of the MMP in consultation with a microbat specialist.

Microbat management is a specialised field and there are a limited number of suitable specialists working in this area. Transport's Environment and Sustainability team can provide further information on suitable microbat specialists as required.

Appendix C includes case studies of examples of successful microbat management along with a summary of MBMPs prepared by Transport since 2013 (Table 4).

Table 3: Measures taken by projects to mitigate the impacts on microbats

Impact management measure	Description	Timing and duration	Considerations
Myotis: Seasonal restrictions	Where Southern Myotis is present, activities should not occur that will disturb habitat during the breeding period from October to April (see Appendix D) without additional measures being taken to reduce impacts (including an MMP).	While works are being done on structures that impact Southern Myotis.	Where 10 or more Southern Myotis are present OR there is any confirmed breeding.
Myotis: Hours of work restrictions	Adult Southern Myotis will leave the roost at dusk to forage, flying in and out of roosts all night. Activities undertaken at night may reduce the impacts on microbats present in the structure, as individuals can relocate to roosts that are less disturbed. This measure is not appropriate where juvenile Myotis are present.	While works are being done on structures that impact Southern Myotis.	Where 10 or more Southern Myotis are roosting (and not breeding) in the structure.
Bent-winged bats: Hours of work restrictions	Where Bent-winged bats are present, this restriction would only apply from March to October because both Bent-winged bat species are likely to leave the structures for their maternity caves from October to February each year. See Appendix D for details.	While works are being done between March and October on structures that impact Bent-winged bats.	Where 10 or more Bent-winged bats are roosting in the structure noting a small number of male bats may still be present in the structure during the breeding season.
Project staging	Careful staging of project activities can minimise impacts to target microbats and their habitat particularly where indirect impacts are anticipated. This measure requires careful monitoring to ensure that unintended impacts to threatened microbat species are not occurring.	Throughout the project.	When impacts to target microbats are possible.
Pre-construction microbat survey	Undertaking microbat surveys to determine if target microbats are present prior to the activity commencing can allow application of mitigation measures to avoid and minimise impacts.	Same timing as pre-clearing surveys.	All projects where target microbats or suitable habitat is present.

Impact management measure	Description	Timing and duration	Considerations
Site induction	This involves training construction personnel on the microbat mitigation measures, including their responsibilities, how to identify microbats (e.g., signs), what to do if microbats are encountered within the work area (e.g., unexpected finds procedure) and personal safety practices when working around microbats.	Induction package prepared prior to works commencing.	Microbat presence confirmed or anticipated within a structure.
Daily inspection of structures	Work areas should be inspected everyday where microbat habitat is present, but not in active use or where construction activities are being undertaken in close proximity to known habitat. This would ensure that microbats are not present in the structure before starting the activity. A daily bat inspection checklist is provided at Appendix B.	Prior to commencement of works every day for the duration of the project.	Microbat presence confirmed within a structure.
Microbat welfare	Where injured microbats are found during the activity, contact should be made with a suitably accredited wildlife care organisation such as WIRES. The contact details of the relevant organisation should be known by the site supervisor and ecologist. Injured animals should not be handled by construction staff.	Have contact details available prior to commencement of works (where microbats are present).	Microbats present or after unexpected finds.
Exclusion	Involves preventing microbats from returning to the structure by installing exclusion devices. This strategy is only suitable in certain situations and requires careful management and monitoring.	Outside of the breeding period for the species (for Myotis).	Where a significant impact is otherwise expected to microbats in a structure.
Capture and removal	This involves capturing microbats in bat boxes installed near roost sites in order to move them to a new (safer) location nearby.	Outside the breeding period for the species (for Myotis).	Bat boxes must be inspected daily.
Containment	This involves preventing bats from leaving a roost site during the day and is used where planned disturbance (usually noise) may cause microbats to abandon a roost during the day (which increases predation risk).	Outside the breeding period for the species (for Myotis).	Can reduce ventilation or create hot/humid microclimate.
Supplementing habitat	This measure can be provided alongside exclusion measures and involves supplementing the habitat excluded or lost with artificial roost boxes installed on the structure or in the surrounding environment.	Prior to microbat exclusion or impact, until impacts to habitat have concluded.	When exclusion (above) is taking place or existing microbat habitat within a structure is being removed. Most successful for Southern myotis and limited success for Bentwing bats. May not be required where Transport or another public authority is already committed to managing breeding habitat within 10km.

Impact management measure	Description	Timing and duration	Considerations
Creating habitat	Incorporating recesses and roughened surfaces within a structure can provide long-lasting habitat opportunities for microbats.	Considered during project design, implemented during construction.	When existing microbat habitat within a structure is being removed. May not be required where Transport or another public authority is already committed to managing breeding habitat within 10km.
Noise minimisation	Efforts to reduce noise should be applied where noise levels are expected to significantly exceed what can be typically expected at a structure. This could include undertaking works at night (and outside the breeding period) or by installing measures to dampen noise.	Prior to commencement of works if noise impacts are likely.	Work must stop if Microbats observed leaving roosts in large numbers in immediate response to the activity. Mitigation must then be reconsidered
Monitoring	Monitoring is a critical component of any MMP. Depending on the circumstances, monitoring can occur before, during and after disturbance, and include other populations / structures in the locality. Table 4 summarises the approaches taken for 13 Transport projects involving the preparation of an MMP. Copies of these plans are also available from Environment and Sustainability. Appendix C also contains case studies of each of these strategies in practice.	Project ecologist/ microbat specialist to determine.	Whenever habitat in a structure is removed and new habitat is provided.

4. Conclusion

As the owner of a large number of bridges, culverts and other structures that provide habitat for microbats, Transport has an important role to play in protecting microbat habitat and contributing to the ongoing conservation of microbat species in NSW.

Transport, working with microbat specialists and other Agencies, has successfully managed a number of projects with potential to damage microbat habitat. However, with careful management works were undertaken in a way that protected microbats from disturbance and, in some cases, created new supplementary habitat for microbats to occupy.

Transport developed many insights about how best to manage activities that may impact microbats and these guidelines seek to bring these learnings together and provide guidance and support to Transport staff dealing with microbats in the future.

Transport has also established a dedicated SharePoint link for sharing of microbat management plans including all those referenced in these Guidelines. Transport staff can upload or browse these files from the Environment and Sustainability SharePoint page.

Transport looks forward to many more years of microbat management success and ongoing improvement in microbat protection and management.

Definitions

Term	Definition
Activity	Transport for NSW construction or maintenance project.
AoS	Assessment of Significance. The '5-part test' to determine whether an activity being assessed under Part 5 Division 5.1 of the Environmental Planning & Assessment Act 1979 will have a significant impact on threatened species or threatened ecological communities under the NSW Biodiversity Conservation Act 2016.
Breeding period	The months where bats mate, are pregnant, carrying or supporting pups, where the roost may be permanently occupied at times during the breeding period.
Breeding habitat	All areas of potential breeding habitat on the subject land where breeding individuals of a threatened bat species are determined to be present.
Ecologist	An ecologist familiar with microbat survey, identification techniques and impact assessment. An ecologist may also be a microbat specialist.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species or ecological community, including any biotic or abiotic component (BAM 2020).
Lyssavirus	A rabies-like virus carried in the saliva of some bats and can be fatal if medical attention is not sought out quickly after exposure.
Maternity roost	A maternity site (also known as maternity roosts or maternity camps) is a location (a roost or camp) where female bats give birth and form nursery colonies.
Microbat	A bat of small size that mainly eats insects. Most are members of scientific suborder Yangochiroptera (formerly Microchiroptera).
MMP	Microbat Management Plan. A plan created by a microbat specialist to avoid, mitigate and/or minimise the impacts of a project on microbats present in a structure.
Microbat specialist	A person with a minimum of three years' experience in managing microbat issues, including working knowledge of microbat exclusion and preparing Microbat Management Plans.
Roost	A place where bats shelter during the day. Some species roost only in tree hollows, others only in caves, and others in a mixture of natural and artificial structures. At different times of the year or life stages bats may use different roosts or camps.
Target microbats	Means the microbat species that are the target of this guideline. They are Southern Myotis (Myotis macropus), Large Bent-winged Bat (*Miniopterus orianae oceanensis*) and the Little Bent-winged Bat (*Miniopterus australis*).
Threatened species	Species listed as 'vulnerable', 'endangered' or 'critically endangered' under the *Biodiversity Conservation Act 2016* (BC Act).

Target microbats

Target microbat	Other names
Southern Myotis	Scientific name: *Myotis macropus* (formerly *Myotis adversus*). Other names: Large-footed Myotis, Large-footed Fishing Bat.
Large Bent-winged Bat	Scientific name: *Miniopterus orianae oceanensis (formerly Miniopterus schreibersii oceanensis).* Other names: *Eastern Bent-winged Bat, Common Bent-winged Bat.*
Little Bent-winged Bat	Scientific names: *Miniopterus australis.* Other name: Little Long-fingered Bat.

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Appendix A: Microbat habitat

This appendix provides photos showing where microbats have been found in built structures.

Little Bent-winged Bats inside a culvert join. Credit: Kris Le Mottee

Guano at the base of a culvert join, indicating bat presence. Credit: Kris Le Mottee

Expansion joint with staining from water leakage or microbat usage. Credit: Eco Logical

Unsealed longitudinal joins between concrete Super-T girders provide cavities/ habitat similar to gaps in concrete plank bridge decking which are known breeding roosts for Southern Myotis. Credit: GeoLINK.

Scupper being used by roosting microbats. Staining around a cavity and presence of bat flies (Nycteribiids) indicates a high level of use by microbats. Credit: Kate Dallimore.

Old bridge decking providing suitable microbat habitat. Credit: Transport for NSW.

Southern Myotis breeding habitat between span piles. Credit: Kate Dallimore.

Known Southern Myotis breeding roost within unsealed joint gaps and voids within a 1200 mm 3-cell concrete pipe culvert. Credit: Veronica Silver, GeoLINK.

Southern Myotis roosting on obvert on roughened concrete and exposed reinforcement.
Credit: Kate Dallimore.

Southern Myotis roosting on exposed reinforcement on the obvert of a culvert.
Credit: Kate Dallimore.

Southern Myotis in concrete bridge (Dora Creek Bridge Pacific Highway) roosting in corner between decking, headstock and girder.
Credit: David Andrighetto, GeoLINK.

Pile cap cavities used by Southern Myotis in concrete bridge (Dora Creek Bridge Pacific Highway).
Credit: David Andrighetto, GeoLINK.

Appendix B: Daily bat inspection checklist

Inspection details			
Project name		Project number	
Project location			
Inspected area (e.g., pier/span number)			
Inspector's name			
Inspector's role			
Inspection date	DD MMM YY	Inspection time	

	Inspection	Check	Comments
1	**Look in all areas containing microbat habitat** e.g., between gaps in the cross decking above the girders, in grab holes of culverts etc.	☐ No ☐ Yes	
2	**Look for any guano (bat faeces) around work area.**	☐ No ☐ Yes	
3	**Listen for any microbat chatter/calls.**	☐ No ☐ Yes	
4	**Any other dark or protected areas that bats might be?**	☐ No ☐ Yes	

Bat presence?		Comments
Any bats or evidence of bats found?	☐ No ☐ Yes	
If '*Yes*' work MUST stop. PDM or Work Supervisor MUST be contacted immediately.		

Certification

.....	.....	.....
Inspected by	Signature	Date
.....	.....	.....
Sighted by (Site Supervisor)	Signature	Date

Appendix C: Case studies

Knowledge sharing

This Appendix provides a brief summary of the microbat management strategies applied to 13 Transport projects (Table 4) and then further detail showcasing three successful microbat management initiatives at Briner Bridge, Sportsman's Creek Bridge and Barrington Bridge.

Transport microbat management plans including those listed below can be accessed here.

Note: The advice in some of these examples predates the release of these guidelines and may not conform to the advice provided in these guidelines.

Table C1: Summary of mitigation measures used in previous Transport Microbat Management Plans

Project	Target microbat	Exclusion	Install boxes in structure	Install boxes nearby	Relocation of roost boxes	Created habitat in structure	Staged habitat removal	Noise mitigation	Scheduling	Monitoring
Oxley Highway to Kempsey Pacific Highway Upgrade North Coast May 2013	All target microbats	✓	✓	✓			✓	✓	Exclusion to occur outside of breeding period and winter prior to works.	✓
Mororo Bridge, Grafton Northern Rivers July 2013	Southern Myotis	✓	✓	✓					Install boxed prior to exclusion. Exclusion to remove habitat prior to breeding period.	✓
Woolgoolga to Glenugie Pacific Highway Upgrade (Sections 1-2), North Coast Sept 2014	All target microbats	✓	✓	✓	✓	✓			Exclusion one season prior to works during breeding season.	✓
Woolgoolga to Ballina (Sections 3-11), North Coast April 2015	All target microbats Southern Myotis	✓	✓	✓	✓	✓			Exclusion to remove habitat prior to breeding period OR outside of breeding period.	✓
Marom Creek culvert Northern Rivers August 2015	All target microbats	✓				✓	✓		Outside of breeding season.	✓

Project	Target microbat	Exclusion	Install boxes in structure	Install boxes nearby	Relocation of roost boxes	Created habitat in structure	Staged habitat removal	Noise mitigation	Scheduling	Monitoring
McFarlane Bridge, Northern Rivers July 2015	Southern Myotis	✓	✓		✓				Exclusion to remove habitat prior to breeding period	✓
Sportsmans Creek bridge Northern Rivers March 2016	Southern Myotis	✓	✓	✓	✓	✓	✓		Outside of breeding season.	✓
Berry to Bomaderry Upgrade Southern Highlands July 2016	Southern Myotis	✓	✓		✓	✓			Outside of breeding season and winter.	✓
Barrington Bridge (new bridge construction), Hunter Valley March 2018	Southern Myotis		✓		✓	✓		✓	High-risk activities outside of breeding period.	✓
Monkerai Bridge Hunter Valley April 2018	Little Bent-wing Southern Myotis	✓		✓		✓			Exclusion installed outside of breeding season.	✓
Barrington Bridge (maintenance) Hunter Valley October 2018	Southern Myotis	✓	✓					✓	Low-risk maintenance activities inside breeding season with daily inspections	✓
Briner Bridge Hunter Valley October 2018	Southern Myotis	✓	✓		✓	✓	✓	✓	Outside of breeding season.	✓
Lions Park and Baileys Bridge road culverts, Kyogle Mid-north coast August 2016	Southern Myotis	✓	✓				✓		No restrictions but stop works within 10 metres of breeding bats or two metres of non-breeding roosting bats.	✓

Briner Bridge

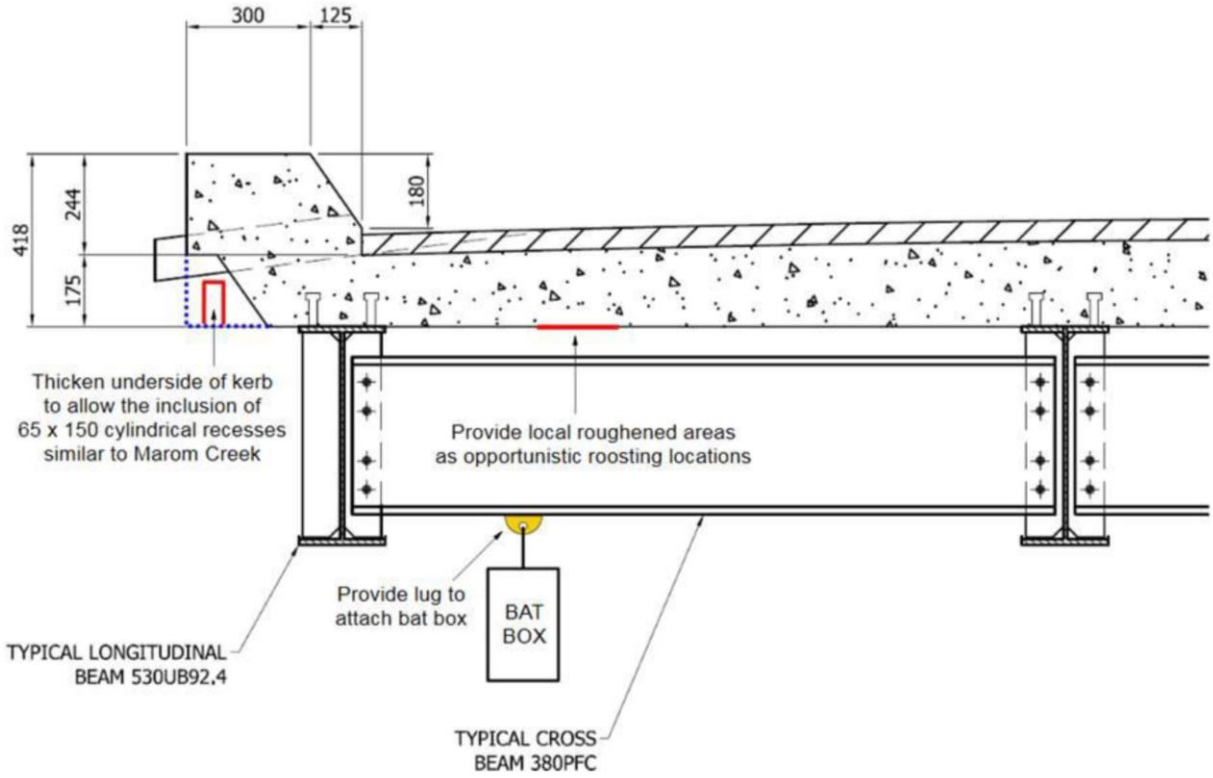
Briner Bridge (left) and temporary bridge (right). Credit: Transport

The Briner Bridge project involved:

- Increasing the width of the bridge deck to 5.4 metres between barriers to allow two cars to pass.
- Restoration of truss spans including replacement of timber elements.
- Temporary bridge for public access (and microbat habitat) during works.

Briner Bridge had a resident population of Southern Myotis that would have been impacted by the project without an MMP. Monitoring confirmed a population of ~120 individuals, but there was no other habitat within 10 kilometres of the waterway. In order to minimise the impacts of the project, the MMP implemented the following:

- The bat population was surveyed to determine habitat and breeding sites in the existing bridge structure prior to construction.
- Exclusion measures were used to create staged removal of habitat within the bridge structure.
- Bat boxes were relocated from Briner Bridge to temporary bridge.
- All construction personnel were trained on how bats affected their work.
- Alternative habitat in the form of additional bat boxes on the temporary bridge was created.
- The project provided bat boxes on, and adjacent to, Briner Bridge - both on the replacement bridge and within 100m.
- Three types of compensatory habitat for microbats were created in the refurbished bridge:
  - roughened cylindrical recesses on the underside of the kerb
  - concrete pipe sections with roughened areas under deck / above girders over water
  - attachment lugs for bat boxes on each cross girder over water.
- Daily inspections of habitat occurred along with monitoring/mitigation of high-vibration / noise activity.



Note: Concrete pipe sections (65mm x 150 mm) would be adhered to local roughened areas under deck as shown above.

Figure C1: Briner Bridge bat box and in-structure habitat

Sportsmans Creek

Sportsmans Creek bridges old (top) and new (bottom) prior to demolition of the old bridge. Credit: Transport

Sportsman Creek was the first project in Australia to incorporate microbat habitat directly into the structure. The large size of the bat population (>300) and the potential for significant impacts warranted the preparation of a Species Impact Statement (SIS) and the concurrence of the then Office of Environment and Heritage.

The project involved creation of a new bridge and demolition of the old timber truss bridge which was home to microbats. The new bridge was constructed prior to the demolition of the old bridge to maintain public access and microbat habitat. Specific management actions included:

- Bat boxes were temporarily installed under the original bridge one month prior to the microbat exclusion (breeding) period of May to October (inclusive).
- Following this installation, exclusion devices were installed on sections of the original bridge without roosting microbats. Further exclusion was staged.
- Once occupied, the bat boxes were then transferred from the original bridge to the new one.
- Ongoing monitoring assessed the effectiveness of all measures so additional contingency measures could be implemented (in consultation with the Department of Planning and Environment (DPE) and Transport).

Refer details next page.

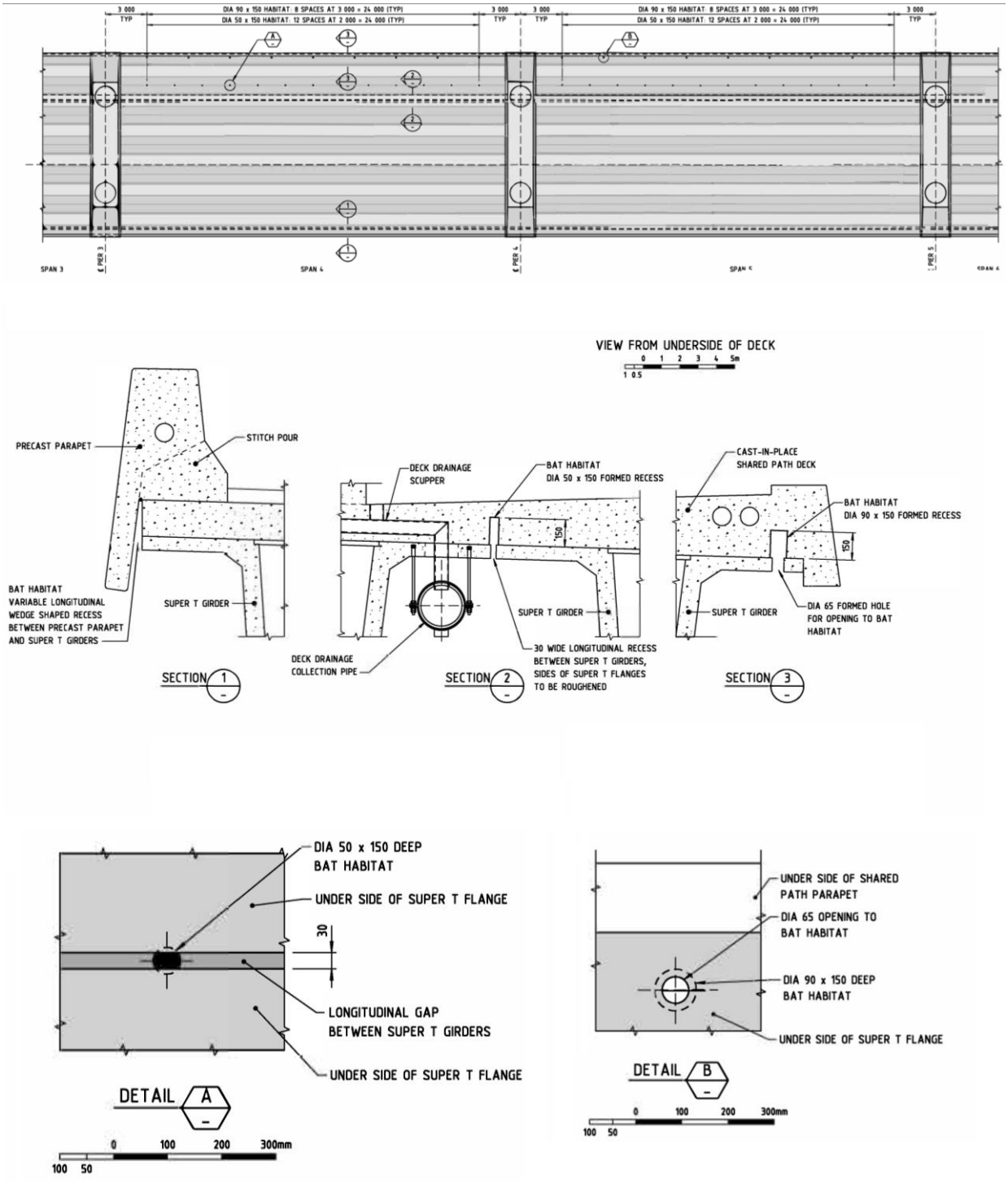


Figure C2: Bat habitat details

Barrington Bridge

New bridge (Barrington). Credit: Transport

Two Microbat Management Plans were created for these projects – one for construction of the new bridge (March) and one for maintenance of the old bridge (October).

- Construction of the new bridge required measures to prevent disruption of the microbats in the nearby original timber truss bridge.
- Microbat species were identified by use of scaffolding to inspect the habitat.
- All works were classified by microbat risk (noise output), with high risk activities occurring outside of the breeding period.
- Noise was managed with timing, use of screens and monitoring.
- Bat boxes and new habitat were installed within the new bridge, which would assist in mitigating the effects of maintenance on the old bridge.

Barrington timber truss bridge. Credit: Amie Nicholas

The maintenance works on the old timber truss bridge were more sensitive. Southern Myotis roosts were present throughout the bridge.

- Ten bat boxes installed in March, months prior to works.
- Microbat numbers and were estimated and locations mapped by direct survey.
- Works were staged, using hand tools for minimal amounts of time at a single location.
- Microbats were excluded from roost sites during the day only and re-opened at nights.
- If a breeding roost was identified, works around that area would be delayed.

Microbats were monitored while works occurred, to ensure that measures were effective.

Appendix D: Timing restrictions for microbats

Months coloured red are affected by timing restrictions. Months coloured orange may be indirectly affected and green-coloured months present no restriction:

		J	F	M	A	M	J	J	A	S	O	N	D
When are microbats present in structures?	Myotis	**Any time of year**											
	Bent-winged Bats	Not present		**Outside of breeding period**								Not present	

Myotis can be present at any time of year. Bent-winged bats breed in maternity caves from November to February.

		J	F	M	A	M	J	J	A	S	O	N	D
When are target microbats breeding?	Myotis	Breeding period				Non-breeding					Breeding period		
	Bent-winged Bats	Breeding period			Non-breeding							Breeding period	

Myotis breed in structures from October to April. Bent-winged bats breed from November to February, but not in structures.

		J	F	M	A	M	J	J	A	S	O	N	D
When can they be surveyed?	Myotis	Any time of year											
	Bent-winged Bats	Not present		Outside of breeding period								Not present	

Myotis roosting in structures can be surveyed at any time of year but Bent-winged bats will breed outside of structures and cannot be surveyed at that time. See also Appendix E for BAM survey guidelines and how they apply to Transport projects.

		J	F	M	A	M	J	J	A	S	O	N	D
When do seasonal restrictions apply?	Myotis	Breeding period				Seasonal restrictions do not apply					Breeding period		
	Bent-winged Bats	Seasonal restrictions do not apply											

Seasonal restrictions only apply to Myotis, and only in the breeding period. Bent-winged bats are not present in structures while breeding.

		J	F	M	A	M	J	J	A	S	O	N	D
When do daily activity restrictions apply?	Myotis	Breeding period				Timing restrictions					Breeding period		
	Bent-winged Bats	No timing restrictions			Timing restrictions							No timing restrictions	

When Myotis is present, daily activity restrictions only apply outside of the breeding periods from May to September.

If ONLY Bent-winged bats are present, timing restrictions are in place from March to October. No timing restrictions apply during Bent-winged bats' breeding seasons, as they are not present in structures.

Appendix E: Microbat survey and BAM survey guidelines

Relevant Biodiversity Assessment Method (BAM) survey guidelines have been used where appropriate in the development of these guidelines. However, they were developed by the NSW DPE primarily for facilitating BAM-related assessments and therefore aspects of the guidelines are not always relevant to the environmental impact assessments undertaken by Transport. This section seeks to identify and explain the differences.

Southern Myotis

Appendix D of these *Microbat Management Guidelines* states that Southern Myotis can be surveyed in Transport structures at any time of year. This is in contrast to Section 3.1 of the BAM Guidelines which state that surveys targeting this species can only occur from October to March (see Figure 1) to maximise the likelihood of identifying breeding individuals.

As Southern Myotis has been demonstrated to be present in Transport structures at all times of the year, no seasonal restrictions apply to surveys undertaken for the purpose of these guidelines. In addition, the survey effort specified in the BAM guidelines is targeting habitat up to 2.5 kilometres of waterway and this is unlikely to be appropriate to the scale of most Transport projects.

A microbat specialist should determine the appropriate techniques, effort and timing for surveys depending on the structure as well as the likelihood of breeding habitat being present. The application of any survey techniques chosen should be consistent with the descriptions provided in the BAM Guidelines.

Southern myotis *Myotis macropus*

Site	Potential habitat is <2.5km riparian length.		
Survey method	**Survey period**	**Total effort**	**Min. no. of nights/time searching**
Harp trap or mist net	October–March	16	4
Roost search (buildings, bridges etc)	October–March	1 per structure	30 minutes per feature
Acoustic detection	October–March	16	4

Survey methods: *Harp trap or mist net* placed in areas of potential habitat. For larger water bodies mist nets may be necessary. Traps or nets should be set beside or preferably over pools of water along creeks or rivers, particularly in flat or areas of low relief if present. Traps can be set under bridges or culverts, or overhanging branches. The survey may use only mist nets, or a combination of harp traps and mist nets.

Roost search: Any bridges, tunnels, culverts or other structures identified as potential breeding habitat should be searched for bats or signs of bats (guano etc). A torch should be used and attention paid to inspecting cracks or seams in the roof. A handheld bat detector can alert the searcher to ultrasonic calls. If bats or signs of bats are observed, the bats may need to be captured to identify species and breeding status using traps, nets or other methods.

Potential habitat: The range of PCTs associated with the species (as per the TBDC) within 200 meters of any medium to large permanent creeks, rivers, lakes or other waterways (i.e. with pools/ stretches 3m or wider) (Anderson et al. 2005).

Figure E1: Guidelines for survey of Southern Myotis (State of NSW and Office of Environment and Heritage, 2018) CC BY 4.0

Appendix D of the *Microbat management guidelines* states that Bent-winged Bats can be surveyed from March to October. This is in contrast to Section 3.4 of the BAM guidelines which state that targeted surveys can only occur during the breeding period from December to February (Figure 2 of the BAM guidelines) in proximity to known breeding habitats (caves). The primary intention of BAM targeted surveys for Bent-winged bats is to identify breeding colonies.

Bent-winged Bats are not known to breed in Transport's structures but have been recorded roosting in Transport's structures outside of their breeding period. Therefore, restricting surveys to the breeding period (where only a small number of males might be present, if any) is not appropriate for assessing Transport's structures. Consequently, surveys should be undertaken from March to October when Bent-winged Bat species may be roosting in Transport's structures.

In addition, targeted survey for Bent-winged Bats in Section 3.4 of the BAM guidelines requires the use of harp traps during the breeding season in proximity to potential maternity caves in order to determine the breeding status and individuals caught. This method is not appropriate for Bent-winged Bats that may roost in Transport's structures outside of the breeding season.

Additional methods to survey Bent-winged Bats in Transport's structures are roost searches and acoustic recording. A microbat specialist should determine the appropriate techniques, effort and timing for surveys depending on the structure. The application of any survey techniques chosen should be consistent with the descriptions provided in the BAM Guidelines.

Little bentwing-bat *Miniopterus australis*

Site	Per cave/mine/tunnel		
Survey method	**Survey period**	**Total effort**	**Minimum number of nights**
Harp trap	Dec.- Feb.	8	4

Survey methods: *Harp traps* should be placed close to exits of caves, mines or tunnels identified as survey habitat. Care should be taken to monitor traps to avoid overcrowding. Age, sex and reproductive status of captured bats must be assessed and recorded. At a minimum of two traps per night over two nights, repeated at least two weeks later is required.

Potential breeding habitat: Caves, tunnels, mines or other structures known or suspected to be used by *M. australis* including species records in the NSW BioNet Atlas with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature.

Eastern bentwing-bat *Miniopterus schreibersii oceanensis*

Site	Per cave/mine/tunnel		
Survey method	**Survey period**	**Total effort**	**Minimum number of nights**
Harp trap	Dec.- Feb.	8	4

Survey methods: *Harp traps* placed close to exits of caves, mines or tunnels identified as survey habitat. Care should be taken to monitor traps to avoid overcrowding. Age, sex and reproductive status of captured bats must be assessed and recorded. At a minimum of two traps per night over two nights, repeated at least two weeks later is required.

Potential breeding habitat: Caves, tunnels, mines or other structures known or suspected to be used by *M. schreibersii oceanensis* including species records in the NSW BioNet Atlas with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature.

Figure E2: Guidelines for survey of Bent-winged Bats (State of NSW and Office of Environment and Heritage, 2018) CC BY 4.0

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