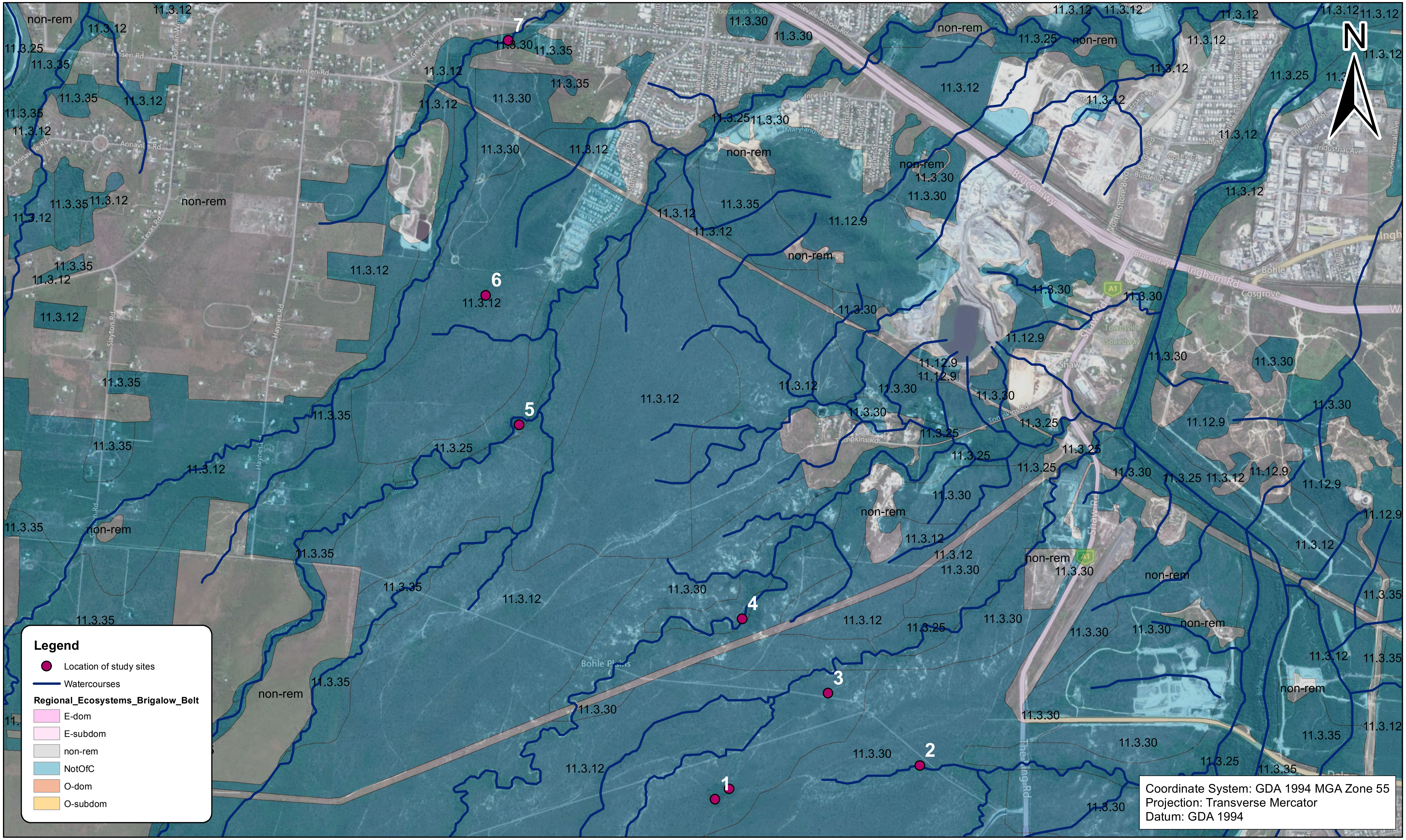

0 550 1,100 2,200 Meters

Reference Scale: 1:22,240

RPS

Figure 1: Location of study sites

Client: AECOM Australia

Date: 22/11/2012	Compiled by: AF	Project Manager: GC	Reference: Fig_1_Location_of_study_sites

Source: Aerial Photograph © Google Earth (2012).

Department of Environment and Resource Management - Regional Ecosystem Vegetation Mapping Version 6.1

Plate 1 Bat Site Survey Site 2

Plate 2 Bat Survey Site 6

Plate 3 Bat Survey Site 7

Following retrieval of the Song Meters, the downloaded data was sent to bat echolocation specialist Greg Ford (Balance! Environmental, Toowoomba) as WAC files. These sequence files were subsequently filtered and identified by comparison with a reference call database, with a range of multivariate statistical analysis used to statistically compare call parameters with similar species. A full description of the echolocation call analysis can be found in **Appendix 1** (Microbat Call Identification Report).

3.0 Results

Bat echolocation calls were analysed by call analyst Greg Ford (Balance! Environmental) and the results described in the Microbat Call Identification Report (**Appendix 1**).

No files were found to contain call signals within the frequency range of Semon's leaf-nosed bat, while approximately 2800 call sequence files contained calls within the likely frequency ranges of the Greater large-eared horseshoe bat and Bare-rumped sheathtail bat. Further analysis showed that no calls from the Greater large-eared horseshoe bat were recorded. Although no calls from the Bare-rumped sheathtail bat could be positively identified, all sites (except Site 4) had calls that are possibly from this species. Analysis of the calls suggests that at least some of the calls were 'search' calls from the Bare-rumped sheathtail bat. Analyst Greg Ford concluded that it is highly probable that this species was present at all sites that provided the echolocation data.

4.0 Discussion and Recommendations

No calls were recorded at any of the sites for the Semon's leaf-nosed bat (*Hipposideros semoni*) or Greater large-eared horseshoe bat (*Rhinolophus philippinensis*). While both of these species have been recorded in open savanna and riparian environments (Churchill 2008), it would seem that there is a tendency towards rainforest, moister forest and taller riparian vegetation (Churchill 2008, Curtis *et al.* 2012). The absence of calls from the study site would suggest that vegetation structure characteristics within the sites samples are suboptimal for these species and are presumed absent from those areas monitored. Similarly, the site would be considered suboptimal for the Coastal sheathtail bat (*Taphozous australis*). This species is generally regarded as occupying habitats close to the sea (Curtis *et al.* 2012), with the closest survey site located approximately 6.5km from the nearest section of coast. They are known to roost in coastal rock shelters such as caves, overhangs and boulder fields (Curtis *et al.* 2012). The closest suitable roosting habitat would be at Many Peaks Range which is located more than 9km from the nearest sample site. Although Ford (2012) noted that a number of echolocation calls could not be definitively separated from *Taphozous* species, it would be reasonable to assume that the proposed alignment is outside the normal zone of foraging habitat and does not contain any suitable roosting habitat. On the basis of the existing surveys undertaken, the proposed road construction is unlikely to have any impact on these species.

Assessment of the potential presence of the Bare-rumped sheathtail bat (*Saccolaimus saccolaimus nudicluniatus*) was less conclusive. The presence of potential habitat was confirmed at several locations along the proposed road route, and areas with particular suitable roosting trees (large *Eucalyptus platyphylla*) with obvious hollows were specifically targeted in the current investigation. Their likely presence in the general area was previously identified in a survey on 23 May 2012 (AECOM 2012a), where full-spectrum calls were clustered closely with those of *S. saccolaimus,* but lacked certain call characteristics necessary for a definitive identification (AECOM 2012a). Recommendations were made at that time for further investigations into the potential presence of *S. saccolaimus.* Although this recording was made approximately 900m to the south west of the proposed alignment, it is presumed that any *S. saccolaimus* may utilise habitat within the proposed alignment for foraging purposes. Although bat echolocation recordings made during the course of the current investigation also didn't produce any calls that could definitively be attributed to *S. saccolaimus*, it was considered that at least some of the recorded calls were probably from this species and that it is highly probable that *S. saccolaimus* was present at all sites that were surveyed (Ford 2012 **Appendix 1**).

The use of open woodland vegetation within the proposed road alignment for foraging by *S. saccolaimus* is therefore highly probable, including the use of creeks as movement corridors and drinking at pools of water along these creeks. The proposed road construction will require the removal of a number of mature *Eucalyptus platyphylla*, a tree species known to be a favoured roost tree for *S. saccolaimus*. Whether or not any of these trees are utilised as roost trees remains unknown, although the distinctive emergence calls (calls made by the bats as they depart the roost tree and begin foraging) were not recorded at any of the potential roost trees in areas surveyed.

4.1 Significant Impact Criteria

Without a better understanding of the value of these particular potential roost trees, it is not possible assess the impact of the proposed road on *S. saccolaimus* using the 'significant impact criteria' set out under *Matters of National Environmental Significance – Significant Impact Guidelines 1.1* (the Guidelines). These criteria are intended to assist in determining whether the impacts of a proposed action on a nationally threatened species are likely to be significant impacts.

The criteria are intended to provide general guidance on the types of actions that will require approval and the types of actions that will not require approval. Comments / responses are provided in relation to each of the significant impact criteria below.

For a Critically Endangered species such as *S. saccolaimus,* an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *Lead to a long-term decrease in the size of a population;*
- *Reduce the area of occupancy of the species;*
- *Fragment an existing population into two or more populations;*
- *Adversely affect habitat critical to the survival of a species;*
- *Disrupt the breeding cycle of a population;*
- *Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*
- *Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;*
- *Introduce disease that may cause the species to decline; or*
- *Interfere with the recovery of the species.*

Schulz and Thomson (2007) notes that the greatest threat to *S. saccolaimus* is habitat loss, with many areas in its range having been cleared for agriculture and urban development. Schulz and Thomson (2007) also note that there are currently no conservation measures specifically aimed at *S. saccolaimus*, with the protection of suitable and potential habitat in conservation reserves being the only measure to reduce any potential decline. AECOM (2012a) lists a number of potential impacts of the proposed ring road on *S. saccolaimus* including:

- Direct clearing of large hollow-bearing trees used for roosting and breeding;
- Dust and noise pollution;
- Night time lighting that may interfere with breeding and foraging behaviour;
- Degradation of habitat (eg by damage from vehicles and heavy machinery);
- Increased habitat fragmentation;
- Pollution or damage to critical water sources;
- Increased weed infestation;
- Increased feral animal abundance;
- Uncontrolled fires;
- Road mortality during and post construction; and
- Disruption of breeding and/or behaviour by noise pollution and human/ vehicular disturbance.

While the loss of tree hollow availability due to land clearance has been listed as a primary threat by Schulz & Thompson (2007), additional potential impacts on *S. saccolaimus* include:

- Timber collection and the targeted removal of hollow-bearing and dead trees along road reserves, in parks and other urban situations;
- Competition for hollows by bees and feral birds such as the Common myna (*Acridotheres tristis*);
- Disease such as Australian bat lyssavirus; and

- The loss of climatic habitat such as tropical forests through climate change (Curtis *et al*. 2012).

The presence of *S. saccolaimus* has been confirmed immediately next to the Bruce Highway south of Townsville, proving the resilience and ability of this species to live and forage safely adjacent to a high volume of traffic. Therefore the impact of traffic movements along the proposed road is unlikely to have a significant impact on any of the significant impact criteria listed above. However, this known site is in a relatively high ecological intactness without the associated influence of increased human encroachment, and many of the potential impacts above cannot be discounted as having a potential influence. The recommended mitigation measures listed in the initial referral for the Townsville Ring Road Flora and Fauna Survey (Referral EPBC 2012/6562) should be adopted to minimise these impacts. Mitigation measures listed in the referral are as follows:

Harming / Loss of Individuals

Should the BRST bat (or Semon's leaf nosed bat) be confirmed during the proposed survey then a species management program (SMP) (inclusive of marking habitat trees for spotter catchers, avoid clearing fringing trees around the construction zone where possible, and using spotter catchers to remove bats) will be prepared. A preliminary species management program will include:

- Staged clearing works to allow bats to leave roosting sites;
- No vegetation clearing to occur at night (bright lights can interfere with bat behaviour);
- Periodic impact noise to encourage bats to leave roosting sites – use of noise cannons is currently the preferred method;
- Additional methods to encourage bats to leave roosting sites is the intrusive method of tapping trees with hollows before clearing;
- Immunised spotter catcher will be on site for the entire clearing exercise to monitor clearing works and assist with clearing hollows as each tree is felled;
- Timing for clearing works will where practicable be outside the breeding season (tropical wet season) so young are not keeping adult bats in roosting sites; and
- Stockpiles will be placed away from concentrations of potential roost trees areas in the green zone that remains.

Minimisation of Clearance

The contractor's Construction EMP will have a strong focus and control over activities that will have an impact on movement, feeding and breeding behaviour of threatened micro bats (and BTF) during construction.

Clearing of roost trees will only occur in the construction zone (nominal 40m clearing width for most of the alignment except at culverts and bridge crossings); cleared logs/stags will be placed in remaining road reserve or adjoining habitat.

Disturbance

As far as practicable, clearing of roost trees will be avoided between December and April (to avoid disturbing microbat breeding activities). Habitat ecology for this bat is not well known, the presumption is that it breeds in the tropical wet season (Schulz & Thomson, 2007). TMR will require that the contractor undertakes regular machinery inspections on all vehicles to ensure compliance with relevant regulations in relation to noise. In particular, exhaust systems will be checked regularly for all construction and other vehicles entering site during construction. This measure is expected to reduce the potential level of noise during construction, although higher noise levels compared to ambient conditions will occur, from heavy machinery and safety reversing beeper operations. It is not known if micro bats would habituate to construction noises.

A fugitive dust program will be included in the construction contract to meet the following performance requirements:

- Zero loads uncovered;
- Dust suppression tools will be used on stockpiles for embankment fill (if stockpiled on site); and
- Water trucks will be used to suppress dust on haul road and generally in the construction zone.

Lighting of the northern and southern connections for safety reasons will be required. Route lighting elsewhere is not required. This is expected to reduce nuisance to bats. This measure is expected to be effective in reducing the likelihood of bats being attracted to insect gathering around light sources, however, Limited construction works will occur at dusk or at night (some pavement and surfacing work may occur at night at the connections to existing roads).

Education and Awareness Mitigation Measures

Provide findings and learning's to relevant academic and study bodies to expand knowledge base on *S. saccolaimus* and other threatened bat species if present from this area. Take opportunities where possible to raise awareness of threatened species management issues and outcomes on the TMR web site, to ensure learning's available to other road projects. If *S. saccolaimus* is found then the results from the various ecological assessments about roost habitat conditions will be published.

General environmental management controls for the site as a whole will inform the Planning and Construction Environmental Management Plans for the project:

- Site inductions to be undertaken by all people working/ entering the site;
- Ensure signage is in place to protect habitat areas outside of the construction zone;
- Erect signage in areas to alert and educate the public on essential fauna/flora habitat post construction;
- Ensure toolbox talks incorporate the significance of threatened species and their habitat on site;
- Ensure the availability of information sheets for threatened species and their habitat;
- Clearing of vegetation should be staged and aim to limit impacts on bats and threatened bird species;
- Avoid night-time construction work if possible;
- A buffer zone around construction should be clearly delineated;
- Implement a Weed Management Plan for the site (this should include a wash down area and weed control through both chemical and mechanical means);
- Implement a Pest Management Plan for the site (this should include the control of pigs and cats);
- Implement a Fire Management Plan for the site for the construction period;
- Ensure appropriate erosion control measures are in place;
- Ensure all rubbish (especially food articles) are removed from site regularly;
- Ensure speed limits are enforced on site during construction to reduce collisions with wildlife;
- Ensure vehicles on site comply with machinery requirements to avoid elevated noise pollution; and
- Ensure vehicles use only approved tracks within and around the construction site.

It is likely that the most significant impacts are likely to be during construction phase and the direct impacts of removing potential habitat trees. It is recommended that following site investigation, if *S. saccolaimus* is confirmed on site, then a Species Management Plan (SMP) should be prepared, including approved mitigation measures.

It should be noted that very little is known of preferred roost trees for *S. saccolaimus*, and we don't know how many roost trees are likely to be utilised by the same animal, and what their tolerance would be to having to relocate to new roost trees. A number of the mitigation measures listed above have previously been accepted by SEWPaC in another referral (EPBC 2012/6294) involving removal or pruning of habitat trees known to be utilised by *S. saccolaimus.*

4.2 Recommendations

Since the current investigation was completed, the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) have made a Request for additional information to the initial referral (EPBC 2012/6562). In particular, the following recommendations have been made for conducting further surveys to quantify the impact of the proposed action on *S. saccolaimus*:

"*It is suggested that targeted tree roost surveys and observations be carried out on trees that are likely to provide roosting habitat for the species. These surveys must be conducted in accordance with the Survey Guidelines for Australia's threatened bats*".

Recommendations and guidelines for minimum search effort for *S. saccolaimus* includes 16 mist net nights, 16 nights of unattended bat detectors and 1-2 hours of tree roost survey/ inspection per survey day. To date, 14 nights of unattended bat detectors have been implemented, and the results reported in the current report. In addition, potential roost trees within the TRR4 alignment have been marked to enable ease of identification during the construction phase. That phase of investigation noted the presence of 58 *Eucalyptus platyphylla* with hollows, however, all inspections of hollows was external.

It is recommended that additional surveys for *S. saccolaimus* be undertaken in the preferred period of August to April after consultation with SEWPaC regarding a suitable methodology, considering the extent of work already undertaken.

Elements of the survey recommendations provided in the Survey Guidelines for Australia's Threatened bats (DEWHA 2010) appear to be contradictory with available information, suggesting that trapping is not a suitable survey method for *S. saccolaimus*. The species performs fast and highly manoeuvrable flight above the canopy resulting in being extremely difficult to capture (Churchill 1998), and cannot be trapped using harp traps (DEWHA 2010). It has been recommended that trip lines over water bodies may be the best chance to capture this species. However, even in the hand, *S. saccolaimus* can be indistinguishable from the more common Yellow-bellied sheathtail-bat (*S. flaviventris*) and tissue samples may be required for genetic analysis (DEWHA 2010). Ethics approvals would be required before any tissue samples could be taken from a Critically Endangered species.

The Survey Guidelines (DEWHA 2010) recommend tree roost inspection, using a camera technique as described by Reardon (2000). Existing literature suggests that roost entrance holes are generally around 6-7 metres in height (DEHP 2011). A total of 1,057 potential roost trees have been recorded along the alignment, including 107 *Eucalyptus platyphylla* with observed stags and hollows. A burrow scope is available that can be extended to 10m, which would allow examination of many of the 107 *E. platyphylla* trees along the 8km alignment which had observed hollows or stags. The assumption that *S. saccolaimus* primarily utilise this particular tree species for roosting is based on a small sample size, and other tree species with obvious hollows should also be surveyed. If likely bats are detected in a tree hollow, an acoustic recording device can then be deployed on that hollow to determine if the bat species is *S. saccolaimus*. Nocturnal roost observations alone are unlikely to be particularly valuable since *S. saccolaimus* is not readily distinguishable in flight from some other sympatric sheath-tailed bat species (*Taphozous* spp, Yellow-bellied Sheathtail-bat *S. flaviventris*).

In consideration of these factors, it is recommended that additional surveys include additional placement of acoustic recording devices, examination of hollows with an extendable burrow scope, followed by targeting of specific trees with acoustic monitoring where potential *S. saccolaimus* is determined with the burrow scope. The use of mist netting and other capture techniques is not recommended.

To determine the level of significance of these actions, it may be necessary to determine the extent of suitable habitat and presence of *S. saccolaimus* in adjacent habitat

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Appendix I

Microbat Call Identification Report

Microbat Call Identification Report

Prepared for ("Client"):	AECOM (Townsville)
Survey location/project name:	Townsville Ring Road
Survey dates:	10-13 September 2012
Client project reference:	
Job no.:	AECO1207
Report date:	25 September 2012

DISCLAIMER:

The Client acknowledges that the Final Report is intended for the sole use of the Client, and only to be used for the Intended Purpose. Any representation or recommendation contained in the Final Report is made only to the Client. Balance! Environmental will not be liable for any loss or damage whatsoever arising from the use and/or reliance on the Final Report by any third party.

Methods

Data receipt and processing

Bat calls were recorded between sunset and sunrise on four consecutive nights (10-13 September 2012), using four SM2BAT detectors (Wildlife Acoustics, Concord MA, USA). Recorded call data were saved as 1-hour blocks in Wildlife Acoustics' *.WAC* compressed audio format. All *.WAC* files thus recorded were submitted to *Balance Environmental* for processing and analysis.

Data conversion & bat call extraction

The *.WAC* files were processed with Wildlife Acoustics' *Kaleidoscope* (Version 0.1.4) software to extract detected calls as both Anabat sequence files (zero-crossing format) and full-spectrum audio files (*.wav* format).

Zero-crossing analysis

The Anabat sequence files were analysed using *AnalookW* (Corben 2009), with call identification achieved manually in several steps.

1. All sequence files were scanned using filters designed to find calls within the dominant harmonic ranges of three target species (18-28 kHz for *Saccolaimus saccolaimus*; 32-37 kHz for *Rhinolophus phillipinensis*; 70-100kHz for *Hipposideros semoni*).
2. Sonograms for all files that passed the filters were viewed in *AnalookW* and identified, if possible, by comparing them with north Queensland reference calls from the target species. In the case of *S. saccolaimus*, two distinct reference call types were considered: "emergence" calls made by bats exiting a tree roost; and "search" calls made by free-flying bats commuting or foraging in open space.
3. Calls potentially attributable to *S. saccolaimus* were further analysed by extracting a range of time and frequency parameters from characteristic series of pulses and comparing them statistically with parameters from reference calls of *S. saccolaimus* and several species with similar calls (*Taphozous australis, T. georgianus* and *Mormopterus beccarii*). Discriminant Function Analysis was performed using *statistiXL* (Version 1.8; 2007; statistiXL, Nedlands, Western Australia).

Full-spectrum analysis

Call sequence files that were identified as potentially containing *S. saccolaimus* "search" calls during the zero-crossing analysis were also viewed in full-spectrum mode using Wildlife Acoustics' *Song Scope* (Version 4.1.1) software. The main objective of the full-spectrum analysis was to investigate presence and patterns of harmonics in the calls, in particular the unusual "alternating triplet" call structure described by Coles *et al.* (2012).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at http://www.ausbats.org.au/.

Results & Discussion

Three of the four SM2BAT detectors yielded a large quantity of identifiable bat calls; but the fourth detector ("SM04") apparently failed to record (presumably due to equipment malfunction rather than lack of bat activity). Sites represented, sampling dates and data extraction results for the three successful detectors are presented in Table 1. Collectively, they yielded about 2800 call sequence files within the frequency ranges occupied by the dominant harmonics of *S. saccolaimus* (18-28 kHz) and *R. phillipinensis* (32-37 kHz) calls.

No files were found to contain call signals within the frequency range of *H. semoni*.

Table 1. Summary of potential target species echolocation data extracted from the Townsville Ring Road SM2BAT detector data set collected on 10th to 14th September, 2012.

Detector	SM01		SM02		SM03	
Site	Z	G	B	E	C	F
Dates	10-11 Sep	12-13 Sep	10-11 Sep	12-13 Sep	10-11 Sep	12-13 Sep
Total number of Anabat sequence files extracted *	413	965	297	580	489	630
Number of seq. files in *R. phillipinensis* range	0	0	79	134	132	255
Number of files containing *R. phillipinensis* calls	0	0	0	0	0	0
Number of seq. files in *S. saccolaimus* range	413	965	218	446	357	375
Number of files containing possible *S. saccolaimus* calls	86	78	60	376	184	194
Number of *S. saccolaimus* calls positively identified	0	0	0	0	0	0

***** Numbers presented are for the zero-crossing format Anabat sequence files generated in the extraction process. Approximately equivalent numbers of full-spectrum files were also generated.

Rhinolophus phillipinensis

No *R. phillipinensis* calls were found in this data set. All files that were extracted within the relevant frequency range (30-40 kHz) contained only calls from vespertilionids (e.g. *Scotorepens* spp.) or molossids (e.g. *Mormopterus ridei*).

Saccolaimus saccolaimus

No calls from this survey were definitively attributable to *S. saccolaimus*; however, detailed analysis of call characteristics suggests that at least some of the recorded calls were probably from this species.

Some 978 zero-crossing sequence files contained calls that were possibly from *S. saccolaimus*; however, there were no clear matches with any of the reference calls available for this species. All calls appeared to be "search" calls, but most had highly variable pulse characteristics, often with longer pulse-duration and lower characteristic frequencies than those within the reference data set.

Statistical comparisons between the unknown calls and reference calls from several sympatric species yielded minor further evidence as to the identity of these calls.

Discriminant function analysis produced mostly quite loose groupings for the unknown calls, a consequence of the within-call variability in pulse characteristics. Less than 1/3 of the unknown calls grouped with or close to *S. saccolaimus*, with the remainder often plotting well outside of the known species groups (e.g. see Figure 1). In some cases, however, the ungrouped calls separated distally along the same or similar plane as *S. saccolaimus* when compared with the two *Taphozous* species and *Mormopterus beccarii*. Consequently, it is considered more likely that these calls were from *S. saccolaimus* than from any of the comparison species, but this conclusion is in no way definitive.

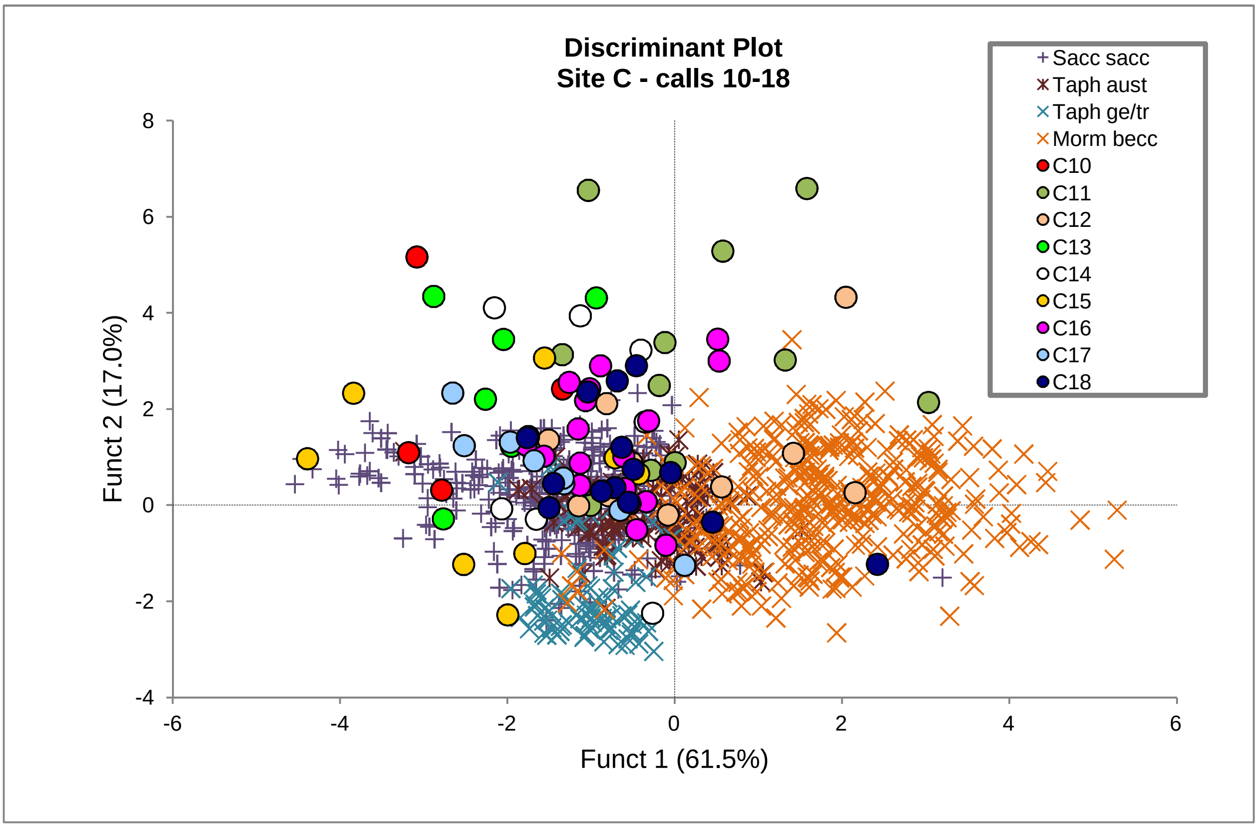

Figure 1 Discriminant Function plot for a typical sample of "unknown" calls recorded at Site C. Four calls (C15, C16, C17 & C18) are very similar to *S. saccolaimus*; whereas the other 5 calls are less well defined. This result is fairly typical of the outputs from discriminant function analyses on data from all sites.

Based on the above analyses, a sub-set of calls that grouped closely with *S. saccolaimus* were selected for visual assessment of full-spectrum sonograms. This process, however, only served to further confuse call identification. Indeed, the lack of multiple clear harmonics in some of the calls that were 'statistically like' *S. saccolaimus* actually reduced the level of certainty that they belonged to *S. saccolaimus.* Furthermore, despite the high probability that most of these calls represented foraging calls, there was no clear evidence of the "alternating triplet" calling pattern attributed to the species by Coles *et al.* (2012).

Conclusion

It is highly probable that *Saccolaimus saccolaimus* was present at all sites that were surveyed during this event. The high degree of variability in call structures, however, means that evidence for the species presence remains somewhat inconclusive.

Clearly, further collections of reference calls and observational studies on the species' calling behaviour are required to provide a more solid basis upon which to reliably identify echolocation calls from surveys such as this one. This is also the case for all species used in the statistical comparisons described above, as it is very likely that the reference data used in this analysis does not contain the full range of call types used bay these bats.

If further evidence is required for the presence of *S. saccolaimus* in the study area, it is recommended that active (hand-held) call detection be undertaken. Visual observations could then be made on the bats being detected, thus providing additional evidence towards species identity, such as flight pattern, foraging behaviour, wing-shape and ventral fur colour.

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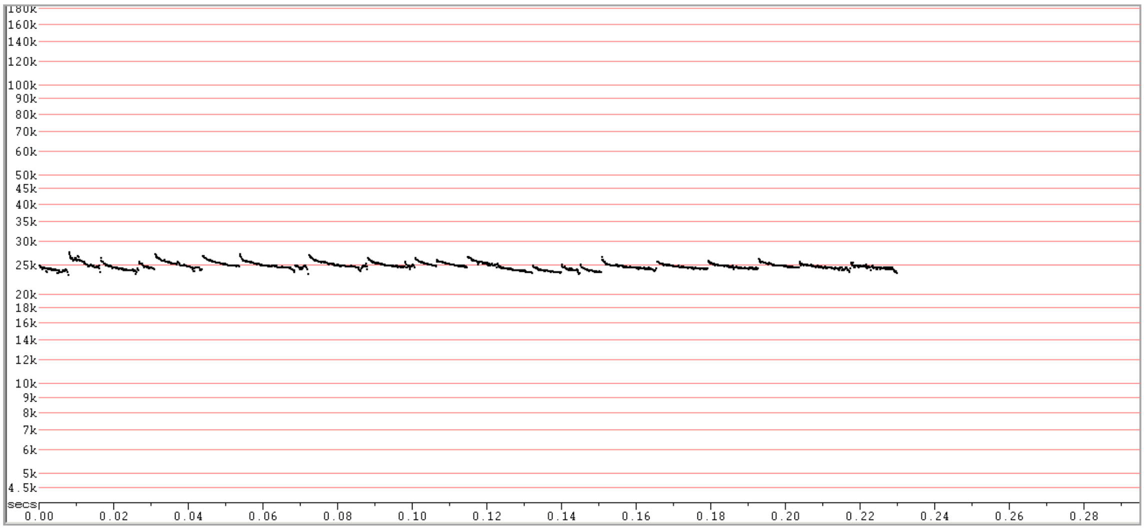

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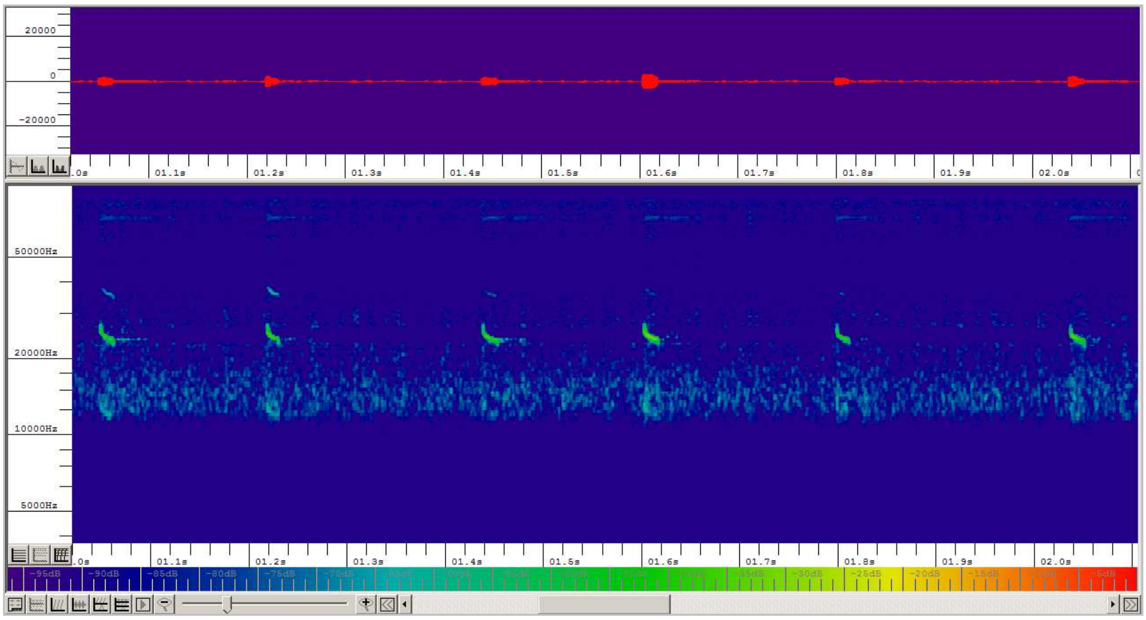

b

Figure 2 Representative calls, probably attributable to *Saccolaimus saccolaimus*, recorded during the Townsville ring-road survey, 10-14 September 2012.

- **a)** *AnalookW* sonogram - 10msec per tick; time between pulses removed
- **b)** *Song Scope* sonogram of part of the same call

Townsville Ring Road, Stage 4

Assessment of Bare-rumped Sheathtail Bat

Prepared by:

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Document Status

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1.0	Ring Road Threatened Bat survey	G. Calvert	A. McArthur	21 March 2013
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Approval for Issue

Name	Signature	Date
Laurence Liessmann	Laurence Liessmann	22 April 2013

Contents

Tables

Figures

Appendices

1.0 Introduction

Ecological investigations into the proposed route of Townsville Ring Road (Stage 4) have determined the need for detailed assessment of the potential for threatened bat species to occur. While most threatened bat species have been assessed as not occurring due to a lack of acoustic records and an absence of suitable habitat, the Bare-rumped sheathtail bat (*Saccolaimus saccolaimus*) is considered likely to occur. This bat species is listed as 'Critically Endangered' pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The presence of the Bare-rumped sheathtail bat in the vicinity of the proposed alignment was determined by AECOM ecologists using a recording made with a Song Meter 2 (SM2 BAT+) ultrasonic bat detector on the night of 23 May 2012. The location of the recording was at a small farm dam located approximately 900m to the south west of the proposed alignment, in Area 4 of the survey region (AECOM 2012a).

Additional acoustic monitoring along the proposed alignment was undertaken (RPS 2012b), from which it was determined that although no calls could be positively identified as the Bare-rumped sheathtail bat, it is highly probable that they were present at all sites that provided the echolocation data.

Pursuant to the EPBC Act, the project has been referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), who have determined that the proposed two-laned road construction and deferred duplication constitute separate projects and can be referred separately. Hence, calculations used in the present report refer only to clearing for the initial construction phase.

Since submission of the referral (EPBC 2012/6562) to SEWPaC, a request for additional information has been received to quantify the impact of the proposed action on *S. saccolaimus*:

> "*It is suggested that targeted tree roost surveys and observations be carried out on trees that are likely to provide roosting habitat for the species. These surveys must be conducted in accordance with the Survey Guidelines for Australia's threatened bats*".

RPS Australia Pty Ltd (RPS) was commissioned by AECOM to undertake an assessment of the Bare-rumped sheathtail bat within the proposed alignment area, to address the information request from SEWPaC.

2.0 Methodology

SEWPaC recommendations and guidelines for minimum search effort for *S. saccolaimus* includes 16 mist net nights, 16 nights of unattended bat detectors and 1-2 hours of tree roost survey/ inspection per survey day. Prior to the present study, 14 nights of unattended bat detectors have been implemented.

The use of trapping as recommended in the survey guidelines was not implemented as it is not a demonstrated survey method for *S. saccolaimus* and its likely ineffectiveness was confirmed in discussions with Terry Reardon (author of the *Survey Guidelines for Australia's threatened bats*). The species performs fast and highly manoeuvrable flight above the canopy resulting in being extremely difficult to capture (Churchill 1998), and cannot be trapped using harp traps (DEWHA 2010). It has been recommended that trip lines over water bodies may be the best chance to capture this species. However, even in the hand, *S. saccolaimus* can be indistinguishable from the more common Yellow-bellied sheathtail-bat (*S. flaviventris*) and tissue samples may be required for genetic analysis (DEWHA 2010).

In consideration of these factors, and following discussions with Terry Reardon, Greg Ford (Bat acoustic expert Balance! Environmental, Toowoomba) and Heidi Crook (SEWPaC, Canberra), the following field methodology was agreed upon:

- It was recommended that additional surveys for *S. saccolaimus* be undertaken in the preferred period of August to April;
- Burrow scope investigations of tree hollows with a 90^0 nest box inspection camera system (http://www.starweb.com.au/inspection_cameras.html#nestboxcamera) undertaken by two persons for 3 hours per day for 5 days along the alignment (15 hours);
- An additional 8 nights passive acoustic monitoring with a Song Meter 2 (SM2 BAT+) will be undertaken at sites not previously monitored;
- Where burrow scope investigations indicate that there is a high possibility of *S. saccolaimus* presence, Anabats and motion-sensitive game cameras will be installed to record emergence calls and additional imagery to confirm species identification; and
- To determine the level of significance of the proposed action, it is necessary to determine the extent of suitable habitat and presence of *S. saccolaimus* in adjacent habitat, and this was to be achieved by using a combination of site inspections, aerial photo interpretation and LiDAR data analysis.

The focus of the present study was aimed at addressing the significant impact guidelines for a critically endangered species such as *S. saccolaimus,* and therefore, the present study also aimed to assess the availability of suitable habitat and the impact of the proposed road construction on that habitat, as well as addressing the presence or absence of the threatened bat species itself within the proposed alignment.

2.1 Acoustic Monitoring

The survey guidelines for the Bare-rumped sheath-tailed bat recommends a survey effort of '16 detector nights' using unattended bat detectors for areas less than 50 hectares in size. Prior to the present survey, 14 nights of unattended bat detectors have been implemented and it was agreed that an additional 8 nights passive acoustic monitoring with a Song Meter 2 (SM2 BAT+) would be undertaken at sites not previously monitored. Acoustic monitoring was undertaken at the locations shown in **Table 1** and **Figure 4** below. Songmeters were deployed at these locations from 17-20 December 2012.

Table 1 Location and Description of Acoustic Survey Sites

Site No.	Coordinate (Lat / Long)	Site Description
4	-19.283,146.679	On the edge of a small creek with no water present and some large *Eucalyptus platyphylla (*see **Figure 1**).
8	-19.272,146.665	On edge of a small pool of water in an otherwise dry creek bed, potentially the only water within several kilometre radius, with large hollow-bearing *Eucalyptus platyphylla* in close proximity (See **Figure 2**).

At each location, the Song Meter 2 devices were mounted as high as practicable to reduce interference from surrounding vegetation. The microphone was placed in a vertical position and the device strapped to as narrow a tree as possible to reduce the potential blockage of sound waves from the tree trunk. The recorders were programmed to start recording before dusk and stopped after dawn, so that the entire nights bat activity would be recorded. The location of each deployment was recorded with a hand-held Garmin GPS in GDA94 (MGA55) and a brief description of the vegetation and habitat recorded.

Unfortunately, a Song Meter (SM04) at Site 8 suffered a malfunction that resulted in it failing to record any data, and this malfunction was not detected until after completion of the survey. In the absence of additional Song Meter devices, an Anabat was deployed at Site 8 for four survey nights from 23-26 December 2012, to ensure a total of 8 survey nights were recorded.

Downloaded data was sent to bat echolocation specialist Greg Ford (Balance! Environmental, Toowoomba) for analysis. These sequence files were subsequently filtered and identified by comparison with a reference call database, with a range of multivariate statistical analysis used to statistically compare call parameters with similar species. All analyses were aimed at detecting and demonstrating the presence of *Saccolaimus saccolaimus*. A full description of the echolocation call analysis methodology can be found in **Appendix 1** (Microbat Call Identification Report).

Figure 1 Placement of Songmeter at Site 4

Figure 2 Placement of Songmeter at Site 8

2.2 Burrow Scope Investigations

The Survey Guidelines (DEWHA 2010) recommend tree roost inspection, using a camera technique as described by Reardon (2000). Existing literature suggests that roost entrance holes are generally around 6-7 metres in height (DEHP 2011). A total of 1,057 potential roost trees have been recorded along the alignment, including 107 *Eucalyptus platyphylla* with observed stags and hollows (AECOM 2012a). Each of the mapped trees with an obvious hollow was investigated.

Burrow scope investigations of tree hollows with a 90^0 nest box inspection camera system (http://www.starweb.com.au/inspection_cameras.html#nestboxcamera) were undertaken by two persons for 15 hours along the alignment. All hollows were observed closely and carefully on approach in case any bats were flushed. The 90° tree top Inspection Camera was mounted on the end of an aluminium extension pole, with additional wood extension for higher tree hollows. Hollows were inspected to a maximum height of 6 metres. The camera was raised to the height of the tree hollow, with the angle of the camera adjusted to obtain optimal views within the tree hollow. Live video feed captured with the burrow scope camera was transmitted via an electrical cable to a 3.6" high resolution LCD video monitor held by a second person. The best available view was captured and recorded onto an SD card. It was found that the LED lights provided with the camera were inadequate to illuminate most tree hollows, so were supplemented with an additional high-powered LED. The modified burrow scope is shown in **Figure 3** below.

Figure 3 Modified Burrow Scope for Inspecting Tree Hollows

Potentially suitable tree hollows were assessed within the clearing footprint of the proposed road using tree roost survey data provided by AECOM ecologists (AECOM 2012a). The abundance of hollow type per tree species along the proposed alignment in shown in **Table 2** below.

Table 2 Abundance of Potential Hollow-bearing Trees Along the Proposed Road Alignment (AECOM 2012a)

Species/Bark type	Potential roost trees with observed hollows	Total number of hollows	Total number per height category (m)			Total number per diameter category (cm)				
			0-5	5-10	10-15	0-5	5-10	10-20	20-30	>30
Eucalyptus platyphylla	58	106	24	60	22	20	43	33	6	2
Stags (dead trees)	49	58	39	17	2	15	24	13	3	3
Corymbia dallachiana	10	12	4	7	1	3	7	2	0	0
Eucalyptus crebra	7	10	5	4	1	3	3	2	2	0
Corymbia clarksoniana	6	7	2	5	0	2	3	1	0	1
Corymbia tessellaris	4	4	2	2	0	3	0	1	0	0
Total	**134**	**197**	**76**	**95**	**25**	**46**	**80**	**52**	**11**	**6**

At each location, data was recorded including:

- Tree species;
- Tree alive or dead;
- No. hollows present;
- No. hollows investigated; and
- Results.

Of the potential roost trees previously mapped (AECOM 2012a), a total of 56 trees were investigated for the potential presence of Bare-rumped sheathtail bats within hollows, to a maximum height of approximately six metres. A number of hollows could not be searched as they were at a height beyond the reach of where the burrow scope could be accurately positioned. A total of 15 hours was spent in searching tree hollows, which did not allow for every potential roost tree identified by AECOM to be searched. Many trees previously identified as potentially containing hollows (AECOM 2012a) were inspected and found not to have any hollows that could be searched with the burrowscope.

It was initially proposed that if likely bats were detected in a tree hollow, then an acoustic recording device and motion-sensitive camera would then be deployed on that hollow to determine if the bat species is *S. saccolaimus*. Since no likely bats were detected, or observed to be flushed from any hollows, this component of the field investigation was not undertaken. A map showing the location of tree hollows investigated is shown in **Figure 4** below, being a subset of trees previously mapped by AECOM (2012a).

2.3 Habitat Suitability - Tree Hollow Abundance

Assessment of the potential significance of tree clearing for the proposed road footprint required determining the extent of suitable habitat both within and adjacent to the impact area. To determine the significance of the habitat to be cleared, we proposed to:

- Determine the actual extent of regional ecosystems in vegetation contiguous with the project area;
- Determine the percentage of that habitat type being cleared using GIS;
- Determine the frequency of suitable roost trees and hollow abundance within different Regional Ecosystems; and
- Determine the general abundance of suitable roost trees within adjacent habitat.

Regional Ecosystem boundaries were determined using a combination of existing Regional Ecosystem mapping (Version 6.1), ground-truthed vegetation plots, LiDAR imagery showing tree height, crown density and crown width, and aerial photo interpretation. Regional Ecosystem mapping (Version 6.1) was found to be inaccurate at the scale required for this project, and vegetation polygons were refined using the combined techniques described above. This was shown to be particularly useful in separating out vegetation types that were unlikely to have many tree hollows (e.g. weed infestations, low growing broad-leaved paperbark communities and woodland regrowth). Aerial photo interpretation was found to be more useful than LiDAR data for separating eucalypt species of similar height but different colour signatures on high-resolution aerial photographs.

To determine abundance of tree hollows, ten (10) representative replicate 50 X 50m plots were established in different Regional Ecosystems within the contiguous patch size being impacted by the proposed road alignment. Within these plots, the vegetation was described with regards to canopy tree species and average height, and the number of hollows recorded. Additional information regarding relative percentage abundances of different tree species in different vegetation communities was derived using combined LiDAR and aerial photo interpretation, using specific ground-truthed waypoints to accurately identify particular tree species. This information was combined with GPS waypoints / shape files of individual trees along the proposed road alignment that were assessed to have hollows. The presence of suitable Bare-rumped sheathtail bat habitat in the general area is assumed in vegetation communities contiguous with the proposed road alignment where those areas have a similar abundance of suitable habitat.

To determine the abundance of suitable roost trees across the contiguous block of remnant vegetation, the following information was determined from site inspections and aerial photo interpretation:

- Tree species observed to have hollows and which never have hollows;

- Height of different tree species with hollows present and the height below which hollows are absent;
- Proportions of different tree species >10m height in different Regional Ecosystems;
- Frequency of hollows per unit area in different Regional Ecosystems; and
- Abundance / frequency of potential hollow-bearing trees per unit area of different Regional Ecosystems.

In calculating the abundance of tree hollows across the broader landscape, we make the following assumptions:

- The probability and relative abundance of tree hollows calculated for a particular species remain consistent across the landscape;
- Narrow-leaved ironbark (*Eucalyptus crebra*) do not significantly contribute to potential available roosts since although they are frequently hollow, they rarely have external openings into these cavities; and
- Other tree species not specifically listed do not make a significant contribution to potential roost hollows in the landscape.

A map showing the location of the contiguous remnant patch of vegetation is shown in **Figure 4** below.