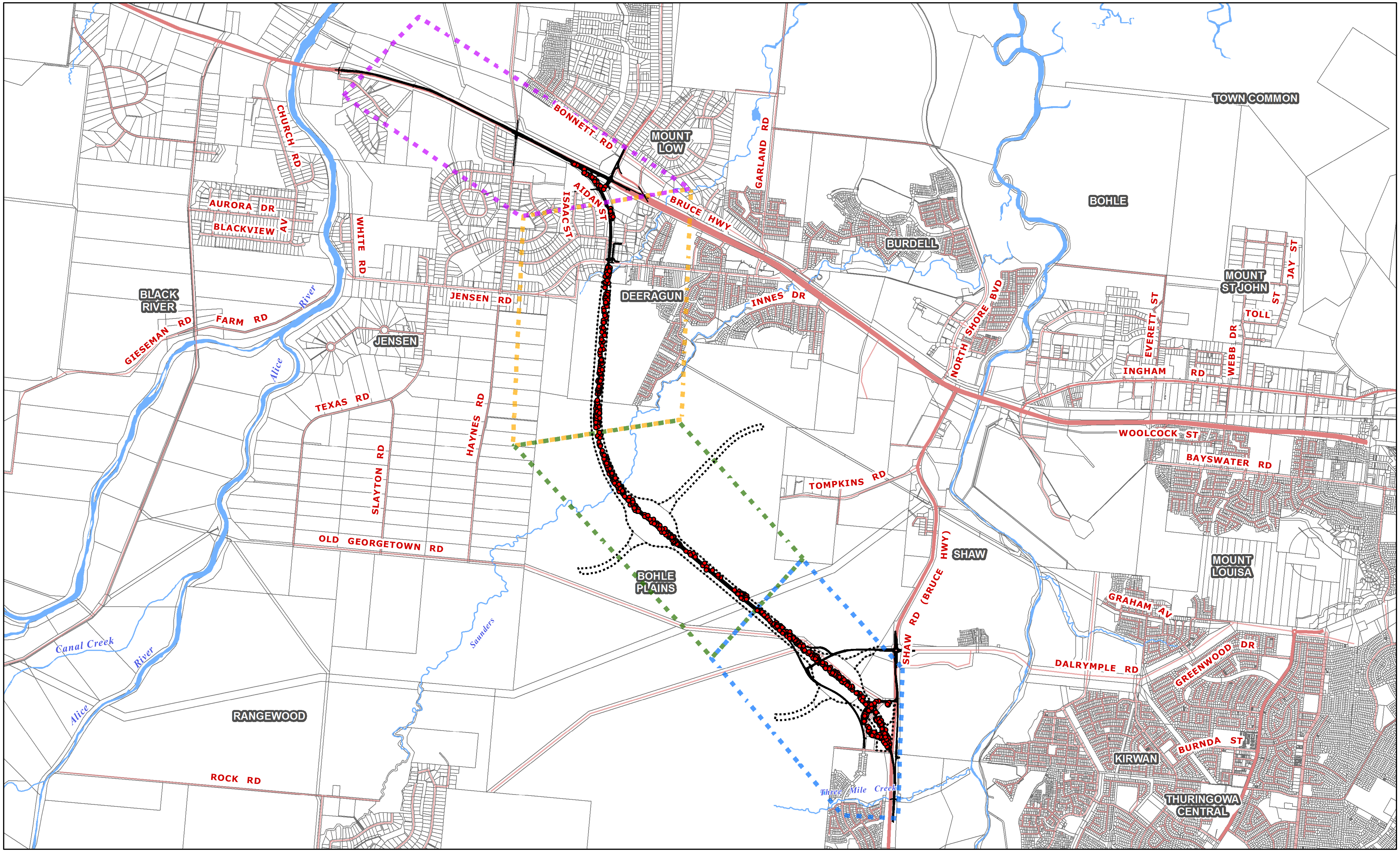


PROJECT ID 60264706
LAST MODIFIED CFS 25-Nov-2013
FILE NAME 60264706G_ENV_32v2

AECOM

N

Scale: 1:40,000
(when printed at A3)

0 500 1,000 Metres

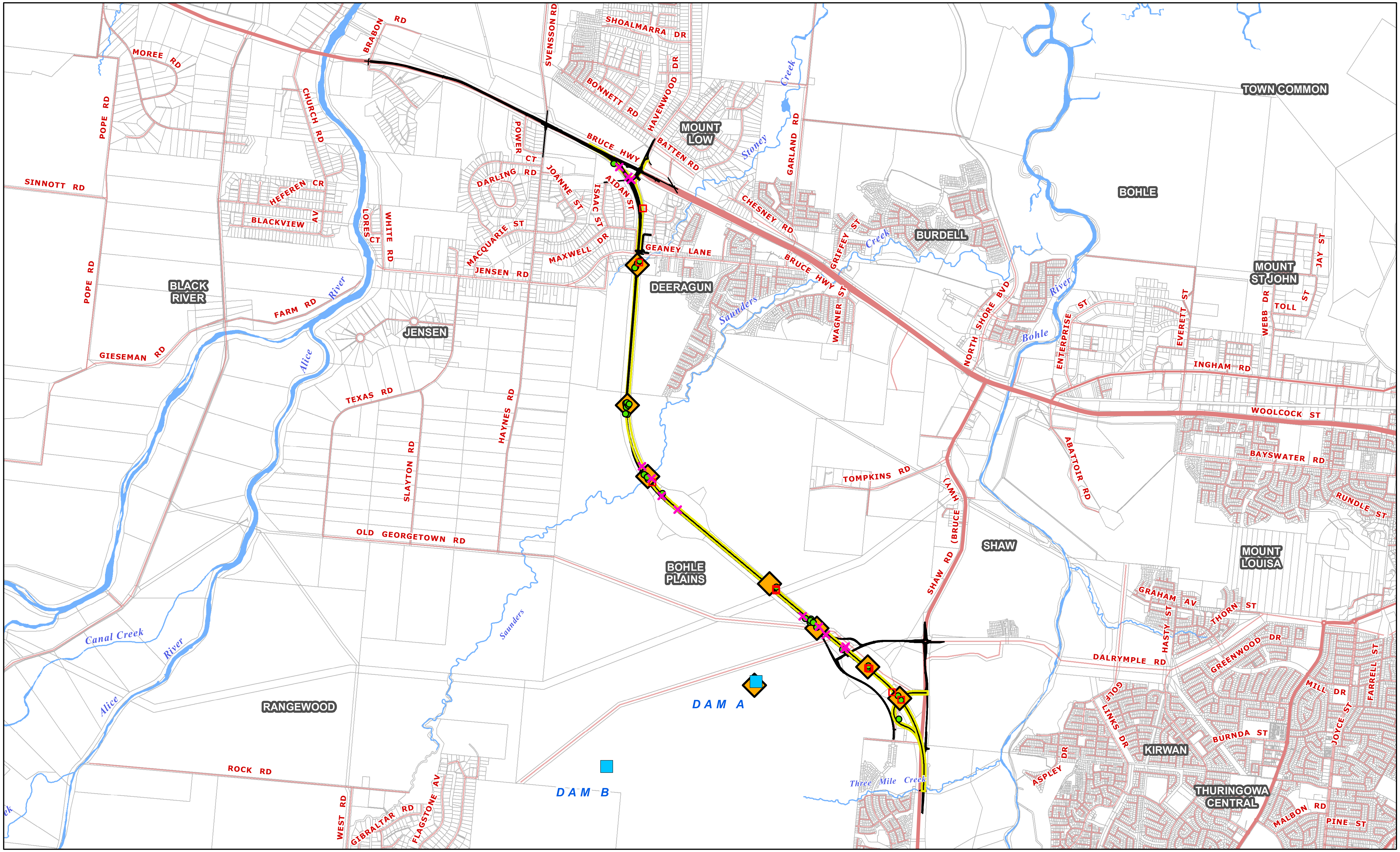
Legend

- Surveyed Trees (1057)
- TRR4 Project
- Resumption Boundary
- Highways
- Main Roads
- Local Roads
- Property Boundary
- Investigation Area 1
- Investigation Area 2
- Investigation Area 3
- Investigation Area 4

TOWNSVILLE RING ROAD SECTION 4

Roost Trees Potentially Suitable for Bare-rumped Sheathtail Bat

Figure 7



PROJECT ID	60264706
LAST MODIFIED	CFS 25-Nov-2013
FILE NAME	60264706_ENV_40v2

AECOM

Cadastre, Study Area, Water body provided by Townsville City Council 2011.
Squatter Pigeon - AECOM 2012 and NRA 2013
BFT Sightings - AECOM 2012 and NRA 2013
StreetPro © 2010 Pitney Bowes Software Pty Ltd
Roads, Watercourse - © 2010 PSMA Australia Pty Ltd

N

Scale: 1:40,000
(when printed at A3)

0 500 1,000 Metres

Legend

- Song Meter Locations
- E. platyphylla (32)
- Stags (9)
- Other Trees (12)
- Dam Locations
- Highways
- Main Roads
- Local Roads
- Survey Corridor
- TRR4 Project
- Property Boundary

TOWNSVILLE RING ROAD SECTION 4

Bare-rumped Sheathtail Bat
Passive Acoustic Monitoring Locations

Figure 8

Table 10 Location of Acoustic Monitoring Sites within the TRR4 Road Reserve and Surrounding Landscape

Site and GPS Coordinates	Description	Recorder Type & Date
1 (-19.294, 146.677) Dam A	On edge of an open farm dam where Bare-rumped sheath-tailed bat were recorded on 23 May 2012.	SM2 BAT+ (23-25 May 2012) SM2 BAT+ (10-11 Sept 2012)
2 (-19.292,146.690)	On the top bank overlooking a dry creek bed between two large *Eucalyptus platyphylla*.	SM2 BAT+ (10-11 Sept 2012)
3 (-19.287,146.684)	On the edge of a dry gully in an open *Melaleuca viridiflora* / *Eucalyptus platyphylla* woodland, some with hollows.	SM2 BAT+ (10-11 Sept 2012)
4 (-19.283,146.679)	On the edge of a small creek with small puddles of water present and some large *Eucalyptus platyphylla.*	SM2 BAT+ (17-20 Dec 2012
5 (-19.272,146.665)	In woodland adjacent to a dry creek bed, with a very large hollow-bearing *Eucalyptus platyphylla* in close proximity. Access via Tompkins Rd.	SM2 BAT+ (12-14 Sept 2012)
6 (-19.264,146.663)	In open woodland area dominated by large old-growth *Eucalyptus platyphylla* with numerous hollows. Access via Millbrae St, Deeragun	SM2 BAT+ (12-14 Sept 2012)
7 (-19.249,146.664)	Along edge of Stoney Creek with large pools of water present – accessed via Geaney Lane, Deeragun	SM2 BAT+ (12-14 Sept 2012)
8 (1 19.272, 146.665)	On edge of a small pool in an otherwise dry creek bed, potentially the only water within several kilometre radius, with large hollow-bearing *Eucalyptus platyphylla* in close proximity.	Anabat (23-26 Dec 2012)

Table 11 Summary of Survey Effort for Bare-rumped Sheathtail Bat

Technique	Survey Effort (Time)	On alignment or adjacent habitat	In preferred period for surveying bats (Aug-April)	Spectrum Analysis	Outcome
Acoustic monitoring	3 nights	Adjacent	No, in May[1]	Full spectrum analysis certainly confirmed the high probability that those calls which clustered with *S. saccolaimus* in the discriminant analysis were from that species. There was, however, no clear evidence of the alternating triplet pulse pattern described by Coles et al. (2012)[2]	Bare rumped sheath tail bat very likely present. No emergent calls.
	4 nights	Adjacent	Yes, September[3]	From the full spectrum analysis and application of Song Scope it was concluded no calls were definitively attributed to *S. saccolaimus*, but detailed analysis of call characteristics suggest that some of the	Bare rumped sheath bat highly probable (foraging calls). No emergent calls No calls were attributable to the threatened *H. semoni* or *R.*

Technique	Survey Effort (Time)	On alignment or adjacent habitat	In preferred period for surveying bats (Aug-April)	Spectrum Analysis	Outcome
				recorded calls were probably from this species [4]	*phillipinensis*
	8 nights	Alignment	Yes, September[3]	As above[4]	As above[4]
	8 nights	Alignment	Yes, December[5]	Full spectrum analysis and application of Song Scope call recogniser yield positive identification of *S. saccolaimus*[6]	Bare rumped sheath tail bat considered highly probable [6]. No emergent calls
Day Time Roost Searches – visual	36 hrs	Alignment	Yes, August [7]	No bats seen	
Day Time Roost searches – burrow scope	15 hrs	Alignment	Yes, December[5]	No bats seen	
Other Analytical methods		Alignment		Survey to locate, map and rate suitability of trees as potential roost trees[7]	
		Alignment and Adjacent habitat		Lidar analysis of vegetation communities and prediction of hollows[5]	

References: (1) AECOM, 2012a, (2) Balance! Environmental (May 2012), (3) RPS (2012), (4) Balance! Environmental (September 2012), (5) RPS (2013), (6) Balance! Environmental (February 2013), and (7) AECOM (2012b).

6.1.8.1 Spectrum Results

The May spectrum analysis confirmed the presence of a range of non-threatened bat species listed below:

- Gould's wattled bat (*Chalinolobus gouldii*)
- Western broad-nosed bat (*Scotorepens balstoni*)
- Eastern cave bat (*Vespadelus troughtoni*)
- Little bent-wing bat (*Miniopterus australis*)
- Eastern bent-winged bat (*Miniopterus orianae oceanensis*)
- Northern freetail bat (*Chaerephon jobensis*)
- Beccari's free-tailed bat (*Mormopterus beccarii*)
- Eastern little free-tailed bat (*Mormopterus ridei*)
- Yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris)*

Other species were not reliably identified from this data set in this first analysis included:

- Little broad-nosed bat *(Scotorepens greyii)* and/or Northern Broad-nosed bat (*Scotorepens sanborni)*
- Little pied bat (*Chalinolobus picatus*)
- Hoary wattled bat (*Chalinolobus nigrogriseus*)
- Adams's pipistrelle (*Pipistrellus adamsi)* and/or Inland Forest bat (*Vespadelus baverstocki)*
- Bare-rumped sheathtail bat *(Saccolaimus* and similar species (Fc≈18-27kHz)).

The analysis of the September results indicated that Semon's leaf-nosed bat (*Hipposideros semoni*) and greater large-eared horseshoe bat (*Rhinolophus philippinensis*) were not recorded in or near the alignment, and an assessment of the vegetation structure characteristics indicated that these are sub optimal for these species which prefer rainforest, moister forest and taller riparian vegetation, and therefore presumed absent from the alignment. Similarly the site is considered too far from the coast to support coastal sheathtail bat (*Taphozous australis*).

The September results also indicated that while calls could not be definitively attributed to *S. saccolaimus* it was considered that some of the recorded calls were probably from this species and that it was highly probable that *S. saccolaimus* was present. Further that the woodland in and around the alignment is probably used for foraging, with the creeks used as movement corridors and that bats would drink at pools of water along these creeks. Whether or not the mature poplar gums (*Eucalyptus platyphylla*) known to occur on the alignment would be used for roosting, remained undetermined (RPS, 2012), and consequently an assessment of whether the proposed road would create a significant impact on the bare-rumped sheathtail bat remained unresolved.

The December results indicated that manual identification of data yielded a large number of calls potentially attributable to *S. saccolaimus* on both detectors and across all nights of survey. Application of the call recogniser also yielded positive identification but fewer calls attributed to the species because of high call quality and goodness of fit limits. Song scope call spectrographs of those sequences attributed as probable for this bat, revealed no clear evidence of the alternating triplet pattern and only few calls included evidence of the harmonics usually associated with this species in high quality recordings. This was attributed to the sensitivity settings on the SM2BAT detector. The final conclusion of the spectrum analysis was that it is highly probable that *S. saccolaimus* was present at all sites surveyed in December, and this was as strong a certainty that was achievable from passive acoustic monitoring in determining that the bat is present in the area (RPS 2013).

6.1.8.2 Tree Roost Survey

The objective of the tree roost survey was to understand the distribution and abundance of suitable bat roost trees that could be directly impacted by road construction and to support mitigation measures for the works. Daytime roost searches were undertaken over four nine hour days by two people during which time the number and type of potential roost sites were recorded by GPS, assessed and ranked. Additionally evidence of bat presence (droppings at the base of trees and stages) was sought for the poplar trees (*Eucalyptus platyphylla*) encountered that were observed to have hollows and stags. Potential roost trees considered to be possible hollow-bearing trees if they were:

- Any tree observed to have hollows,
- Any gum tree (smooth bark with a diameter breast height (dbh) ≥ 20 cm,
- Any other tree with a dbh ≥ 30 cm, and
- Any dead tree (stag) with a dbh ≥ 15 cm.

Relative significance of potential roost trees was then determined as follows:

1. Stags and poplar gum observed to have hollows,
2. Stags and poplar gum with dbh ≥ 40 cm, and other trees with dbh ≥ 40 cm observed to have hollows,
3. All other trees observed to have hollows,
4. Stags with dbh ≥ 15 cm and poplar and other gums with dbh ≥ 20 cm,
5. Other trees with dbh ≥ 30 cm.

A total of 1,057 potential roost trees were identified, of which 496 (47%) were identified as poplar gum, 141 (13%) were other gum-barked eucalypts, 114 (11%) were ironbark eucalypts and 24 (2%) were bloodwood eucalypts, most likely Dallachy's Gum *Corymbia dallachiana*, narrow leaved ironbark *Eucalyptus crebra* and Clarkson's or grey bloodwood *Corymbia clarksoniana* respectively. In addition, out of the total number of potential roost trees 223 (24%) were stags with a dbh≥15 cm. The majority (83%) of the trees recorded had a dbh < 30 cm, only a small number 81 (8%) had a dbh > 40 cm, of these, 47 (58%) had one or more hollow.

A total of 134 (13%) potential roost trees and stags were observed to have hollows. Proportionally, of the potential live roost trees, poplar gum was most likely to contain hollows particularly in comparison to narrow leaved ironbark. Of the 496 poplar gum recorded as potential roost trees, 58 (12%) contained hollows whereas only 7 (6%) of the 114 ironbarks contained hollows. In addition, most of the hollows found in narrow leaved ironbark were located at the base of the tree.

The majority of hollows were located at either 0-5 m in height (39%) or 5-10 m in height (48%), only a small number of trees (13%) had hollows 10-15 m in height. Poplar gum trees tended to have hollows higher than stags, 77% of hollows in poplar gum were located at more than 5 m in height whereas only 33% of hollows in stags were located at more than 5 m in height. The majority of hollows (40%) recorded were within the 5-10 cm diameter range.

Only 38 trees were observed to have multiple hollows, the majority (28) of which were located in poplar gum. The largest number of hollows found in one single tree was six. Two poplar gum trees were recorded with six hollows each. The larger poplar gums with multiple hollows were generally located in riparian zones where many of the larger trees were recorded.

All potential roost trees, i.e. those containing hollows with or without persistent bark, were checked for the presence of bat scats. No scats were observed during the survey period. However, many of the potential roost trees had tree hollows located in elevated branches, and during this survey the field team were unable to access these hollows.

6.1.8.3 Burrow Scope Investigations and LiDAR Analysis

Fifty six hollow bearing trees were investigated for the presence of the bare-rumped sheath tail bat during December (RPS 2013 found in Appendix C). Eighty eight hollows were observed on these trees and fifty nine of them were explored with a burrow scope (the rest of the hollows were beyond the reach of the burrow scope i.e. higher than 6 m). No microbats were found or flushed during this investigation. Observations of tree hollows within the alignment revealed only two juvenile blue winged kookaburras, an Australian owlet-nightjar and many invertebrates.

During the burrow scope investigation, ten 50 X 50 m replicate plots were established in the various regional ecosystems within and adjacent to the road reserve where data on canopy tree species, average height and number of hollows was recorded. From this data relative percentage abundances of different tree species in each vegetation community was derived using combined LiDAR and aerial photo interpretation, and ground truthed waypoints to accurately identify tree species (RPS, 2013). This was coupled with the GPS waypoints and shape files of the individual trees from the tree hollow survey. From this an assessment of the suitability of vegetation communities within and adjacent to the TRR4 alignment was made to determine the likely abundance of suitable roost trees in the broader contiguous remnant vegetation.

The following information was fed into the GIS analysis to calculate the abundance of tree hollows in the broader landscape:

- Tree species observed to have hollows and those species which never have hollows;
- Height of different tree species with hollows present and height below which hollows are absent
- Proportion of different species over 10 m in height in each regional ecosystem
- Frequency of hollows per unit area in each regional ecosystem, and
- Abundance / frequency of potential hollow bearing trees per unit area in each regional ecosystem.

A number of assumptions were made in calculating abundance as follows:

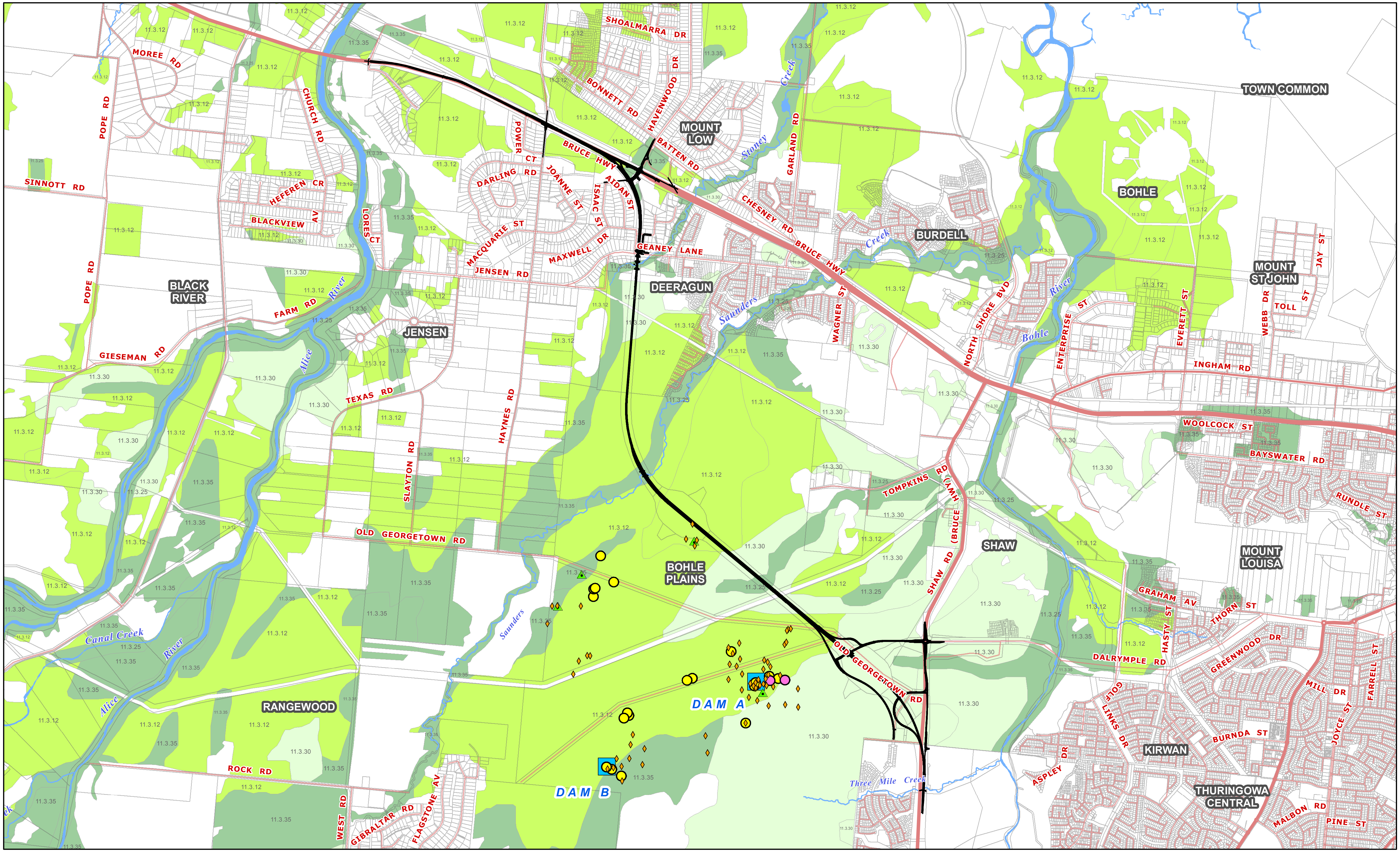
- The probability and relative abundance of tree hollows calculated for each species remains consistent across the landscape

- Narrow leaved ironbark does not significantly contribute to potential available roosts despite being frequently hollow, they rarely have external openings into these cavities, and
- Other species do not make a significant contribution to potential roost hollows in the landscape.

LiDAR analysis coupled with a GIS model was then used to map the approximate density of tree hollows across the broader area (3,138 ha) (methodology discussed in RPS, 2013 Appendix C). Tree species mostly likely to contain hollows were considered to be mature poplar gum, grey bloodwood and Dallachy's gum. Hollows were rare in narrow leaved ironbark, and broad leaved tea tree (*Melaleuca leucadendra*). Using the existing regional ecosystem mapping, field data, LiDAR imagery separating trees less than 10m high and aerial photo interpretation, the broader area of continuous vegetation was divided into the following vegetation polygons:

- *Melaleuca viridiflora* woodland (RE 11.3.12)
- *Eucalyptus crebra* woodland (RE 11.3.30)
- *Eucalyptus platyphylla* woodland (RE 11.3.35) including 11.3.25 b riverine wetland or fringing riverine wetland *Melaleuca leucadendra* and or *M. fluviatilis*, *Nauclea orientalis* open forest, and
- Non remnant.

Figure 9 indicates the revised mapping of vegetation communities from this analysis and shows the extent of the poplar gum and Melaleuca woodlands mostly likely to contain hollows which transect the TRR4 alignment in a west east manner, and the greater extent of narrow leaved ironbark woodlands in the broader landscape which are less likely to provide roost sites for microbats. From this mapping RPS calculated the clearing percentages compared to the broader landscape that would be impacted by the proposed road (as presented in Table 14). This and other impacts on the Bare-rumped sheathtail bat are discussed in Section 6.2.3.



PROJECT ID 60264706
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FILE NAME 60264706_ENV_61v3

AECOM

Cadastre, Study Area, Water body provided by Townsville City Council 2011.
Squatter Pigeon - AECOM 2012 and NRA 2013
BFT Sightings - AECOM 2012 and NRA 2013
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N

Scale: 1:40,000
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0 500 1,000 Metres

Legend

- NRA Field BTF Sighting and Nest Records (December 2012, April 2013 data)
- Squatter Pigeon AECOM Survey
- Squatter Pigeon NRA Survey
- BTF Sightings (AECOM Survey)
- Dam Locations
- Highways
- Main Roads
- Local Roads
- TRR4 Project
- Property Boundary

RE for Bare-rumped Sheathtail Bat
- Roosting (optimal)/foraging
- Roosting (marginal)/foraging
- Roosting (very marginal)/foraging

TOWNSVILLE RING ROAD SECTION 4

Current Extent of Poplar Gum and Melaleuca Woodlands in the Bohle Plains and Adjacent Landscape

Figure 9

6.2 Potential Impacts on MNES

Provide a discussion on all potential direct and indirect impacts of the proposal on the listed threatened species or communities. Types of indirect impacts may include, but are not limited to: changes to water quality, introduction of pathogens and edge effects either during or post construction.

Response:

6.2.1 Direct Habitat Loss

Reduction in native vegetation within the TRR4 corridor would result from the clearing of vegetation for the road footprint. The proposed footprint would result in the clearing of 54.28 ha of remnant vegetation and 9.78 ha of non-remnant vegetation.

The regional ecosystems (REs) that would require clearing for the footprint are listed in Table 12 below. None of the REs have an 'Endangered' or 'Of Concern' status under the VM Act, or are listed as Threatened Ecological Communities under the EPBC Act. RE 11.3.25 has an 'Of Concern' Biodiversity status.

Table 12 Regional Ecosystems within the Construction Footprint

Regional Ecosystem	Description	Area (ha)
11.3.35	*Eucalyptus platyphylla*, *Corymbia clarksoniana* woodland on alluvial plains	1.42
11.3.12	*Melaleuca viridiflora* with occasional *M. argentea* +/- *M. dealbata* woodland to open woodland on alluvial plains	20.48
11.3.25b	Riverine wetland or fringing riverine wetland. *Melaleuca leucadendra* and/or *M. fluviatilis*, *Nauclea orientalis* open forest.	2.40
11.3.30	*Eucalyptus crebra* or *E. paedoglauca* and *Corymbia dallachiana* woodland.	29.98
Totals		
Non remnant		9.78
Remnant		54.28

Direct threats posed by the construction of the TRR4 road relates primarily to vegetation clearance and loss of an estimated 55 hectares of remnant vegetation.

In respect to BTF habitat on Lot 1 SP232873, and within close proximity of TRR4, the BTF dry season habitats and breeding habitats are considered of the upmost importance (Figure 6 and Figure 7 above). The following habitat will be cleared:

- 36 ha of remnant vegetation in this section
- 0 ha of dry season higher probability BTF habitat and 31 ha of supporting habitat; and
- 10 ha of breeding season higher probability BTF habitat and 19 ha of supporting habitat.

The potential indirect impacts relate to displacement of BTF as a result of:

- acoustic changes due to road noise (interfering with avian communication and behaviours); and
- visual changes (light and reflection impacts);
- potential increased prevalence of predatory birds (magpies and butcher birds).

Of these impacts, noise from the use of the road is considered to have potential to change BTF behaviour, and is therefore considered to be the most likely indirect impact that could affect the quality of BTF habitat that is not directly impacted by road construction requirements (earthworks, vegetation clearance, and bridge and culvert construction in waterways) (NRA, 2013).

NRA also considered and concluded that indirect impacts, although unlikely could include (based on their understanding of the project) the following:

- BTF deaths due to collisions with vehicles, although unlikely as BTF are rarely seen along busy roads, and there is a low likelihood of individuals being hit by vehicles. However, to further reduce this risk the project has decided not to plant BTF preferred grasses on the embankments, as previously suggested in the referral. This update will also provide bank stability and weed management benefits.
- Pollution from the road directly impacting birds. NRA concluded this was rare and more likely to be associated with an accidental spill.
- Loss of water sources from excavation. Based on the current design and field survey of BTF, it is unlikely that excavation will result in loss of water critical to BTF.
- Weeds and sedimentation. NRA concluded that these should be minimal if the project EMP addresses these possible impacts.

In reviewing the literature on noise related impacts on avifauna, NRA have summarised the following findings in relation to traffic noise.

Traffic noise has the potential to change bird behaviour by creating noise related hearing damage and or behavioural changes in the following ways:

- *decrease in time spent feeding (Quinn et al 2006)*
- *reduce the ability for birds to communicate by masking their calls*
- *impair the ability of a bird to detect predators (and prey for carnivorous birds)*
- *decrease hearing sensitivity (temporary or permanent ear damage), and*
- *increase stress (Dooling & Popper 2007, Kociolek et al 2011).*

Most of the above relate to the masking effects of traffic noise on bird behaviour which are the more likely to impact on BTF habitat quality of the land adjacent to TRR4 road reserve, and at the same time are also the less definitively understood or able to be predicted in terms of likely impact.

Attempts have been made to quantify the indirect impacts of noise on BTF habitat by applying a model of road traffic noise to provide estimates on the potential extent of noise levels which could be overlain with the BTF habitat mapping. In a subsequent review of this work, the findings were considered speculative, particularly in attempting to quantify the impacts of traffic noise on BTF communication and the extent that noise will travel into the woodland habitat surrounding the TRR4 road reserve by using an acoustic model used to quantify impacts on human health. It remains possible that traffic noise could decrease the quality of the BTF habitat within a few hundred metres from the road. Possible effects could include partial to complete abandonment of some areas and or decreased fitness of BTF that reside close to the road.

The project is committed to mitigating noise impacts on BTF by using a dense graded asphalt road pavement which provides a quieter surface, rather than a bituminous seal (chip seal) which was the surface proposed and costed for the TRR4 business case.

Much of the modelled BTF habitat that would be lost to road construction activities occurs between chainage 19500 and 24500 in four lane main alignment section, and associated with the southern connection infrastructure (Dalrymple interchange, loops and laydown areas and the Kalynda Parade extension (refer to Figure 2).

The Dalrymple loops and Kalynda Parade extension are about 1 km away from Dam 1, one of the primary BTF water sources in the adjacent state land. Dam 1 and surrounding habitat is the most likely area that indirect impacts would influence habitat values over time.

In summary it is anticipated that the likely impacts from TRR4 will revolve around the following:

- Direct habitat loss, and
- Indirect impacts associated with a decrease in habitat connectivity as a result of the barrier effect caused by the road and displacement of BTF near the road in response to visual impacts (light and reflections), noise impacts and the increased prevalence of predatory birds (that predate on eggs and chicks such as magpies and butcher birds) being attracted to roadside habitat.

6.2.2 Significant Impact Criteria Assessment – Black-throated Finch

The likelihood that a significant impact on Black-throated Finch could occur as a result of the proposed road is discussed below for each of the significance impact criteria for endangered species.

Lead to a long-term decrease in the size of a population

The significant impact guidelines under the EPBC Act, define a ‘population of a species’ as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

The definition of a population can be interpreted in a number of ways:

- Regional scale. The Townsville population of BTFs is considered to be a regionally important population e.g. “Long term preservation of the black throated finch (southern) population in the Townsville area is critical to the survival of the subspecies. Loss of a stable population in this area would contribute significantly to the risk of extinction” (EPBC Act policy statement 3.13).
- Sub-population scale. Habitat modelling suggests that the Townsville population may comprise at least two smaller sub-populations (NRA, 2006) one the north west of Ross River dam and one to the south west of Ross River dam.
- Local population. The local population comprises of colonies of BTF that use habitats along and near the TRR4 Project.

The long term viability of BTF populations in a given area is reliant on interconnected areas of core and supporting habitat (NRA, 2013). The two BTF populations/colonies numbers found using the TRR4 road reserve and the land adjacent are likely to fluctuate between seasons (NRA, 2013). It is likely that present population experiences increased isolation, since suitable habitat no longer occurs to the east and habitats to the south and north are deteriorating. BTF populations presumably occur to the west though the extent, quality and therefore viability of these habitats are unknown.

Considering the above criteria, it is concluded that proposed action may result in significant impact on BTF at all three population levels.

Reduce the area of occupancy of the species

It is expected that the TRR4 project will reduce the area of occupancy at the local population level. It is possible that the project may reduce the population at the sub population and regional level also.

Fragment an existing population into two or more populations

The TRR4 project will lead to habitat fragmentation and has the potential to split the local population into two, although BTF have not been recorded in the TRR4 surveys to the north west of the road reserve to date. However habitat fragmentation created by the road may increase isolation in the broader habitat. NRA have indicated in their reporting for this project that the core habitat and centre of BTF activity is to the western side of the TRR4 corridor, and therefore the project will have minimal impact on access to the core habitats. Concurrently, large areas of supporting and ancillary habitat occur on the eastern side of the alignment and therefore the road may affect access to these areas in the future. Further those supporting habitats are important in times of ecological stress such as after fire and are significant in the persistence of a species in a landscape. Access to this type of habitat will be reduced by the road, but not lost to the species in the broader area.

Adversely affect habitat critical to the survival of the species

Habitat critical to the survival of a species or ecological community’ refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

DEWHA, 2009, hereafter referred to as “BTF guidelines” suggests that the character and quality of the habitat may be significantly diminished if an action results in the following (the assessment assumes BTFs occur nearby).

- Net loss or degradation of water sources (either permanent or seasonal) in the locality.
- Widespread or indiscriminate loss of trees, including known nesting trees within 1 km of a water source. A decrease in tree recruitment capacity which limits the areas ability to be self-sustaining.
- The degradation of foraging habitat (grassland) where known BTF records exist, including intensified biomass reduction or stocking rates.

Examples of actions that may lead to the loss, degradation and/or fragmentation of BTF habitat and may have significant impact are:

- Clearing of grassland
- Damming or disrupting the natural flow of creeks and rivers
- Earthworks or excavation
- Pasture improvement
- Changes in biomass management regimes
- Construction of roads, structures and/or hard surfaces
- Construction of temporary or permanent structures for storage or accommodation
- The introduction of domestic animals
- The introduction of exotic plants, particularly exotic grasses
- Substantial increase in human traffic and or recreational activities.

The primary impacts anticipated as a result of TRR4 are direct habitat loss and indirect impacts relating to the barrier effects of the road, and displacement of BTF near the road as a result of visual pollution (lights, reflections), and noise pollution. From these impacts combined it is considered that the project may adversely affect habitat critical to the survival of the population in the local area.

Disrupt the breeding cycle of a population

Breeding in Townsville occurs in the late wet season and / or early dry season (NRA, 2007). April is usually late wet season and within the core breeding period for BTFs with adult BTFs either preparing to breed or caring for eggs, nestlings or attending to young. During this time, movements are usually restricted with birds remaining in close proximity to their nesting sites (NRA, 2007).

The presence of suitable vegetation for breeding/ nests near seasonal semi-permanent water sources is critical for the survival of BTF populations. Field observations at TRR4 Project area found many suitable water sources such as small creeks, stock dams as permanent water sources and pools along the Bohle and Black River (NRA July, 2012).

Clearance for road construction is likely to take place in June 2014, outside of what is considered to be the reproduction cycle of BTF as it is best predicted to occur. It is unlikely that the construction works will significantly disrupt the breeding cycle of the local population.

Within the project area breeding season habitat has been modelled as occurring across and adjacent to the TRR4, with 10.4 ha of breeding season higher probability BTF habitat, 23.56 ha of supporting habitat and 1.96 ha of lower probability habitat that will be lost as a consequence of the vegetation clearance required for road development. Table 13 below indicates that this is a small percentage loss of the larger area of BTF, however if TRR4 acts as a barrier, then it is possible that 38 % of breeding habitat could be lost by longer term habitat contraction as a consequence of the project.

Table 13 Breeding Habitat Loss by TRR4 as a Percentage Loss of the Larger State Lot

BTF habitat (breeding season) type	Removed by TRR4 (ha)	Balance Remaining in Lot 1 SP232873 (ha)	Percentage Loss %
Higher probability BTF habitat	10.42	682.566[1]	1.52%
Higher probability BTF supporting habitat	23.56	896.56[2]	2.62%
Lower probability BTF habitat	1.96	210.43	0.93%
Lower probability BTF supporting habitat	-	165.33	0%
Total	**35.96**	**1,954.89**	**5.07%**

1. 42.50 ha in the north eastern section and 640.056 in the south western section
2. 558.47 in the north eastern section and 338.09 in the south western section

The project will take care to minimise activities that could disrupt breeding success by staggered vegetation clearance cognisance of breeding season, using spotter catchers to identify nesting on the alignment and applying protective controls, to reduce disruption to the breeding cycle (refer to the EMP commitments in Appendix E). However breeding habitat will be lost to a varying degrees and this may be significant.

Modify, destroy, remove, isolate or decrease the availability of habitat to the extent that the species is likely to decline

As the above discussion indicates, loss of breeding habitat in an already declining population is likely to act in a cumulatively adverse manner.

Result in an invasive species harmful to that species becoming established in their habitat

While TRR4 has the potential to result in invasive weeds, especially grasses this is a risk that can be managed. On the project site the invasive weed species rat's tail grass, stylo, and snakeweed are already present and impacting the habitat condition within the road reserve and on adjacent land. In dense stands these species have the potential to exclude grasses that BTFs prefer. The risk that these could spread through construction activities will be addressed by on ground mitigation and management, and is thought this risk can be managed via a range of measures (see Appendix E). It is not thought there is a high risk that a new invasive species will become introduced in the road reserve or an existing species remain uncontrolled.

Introduce disease that may cause the species to decline

Diseases are not a known or listed threat for the species.

Interfere with the recovery of the species

Ongoing loss of habitat will generally interfere with the recovery of the species at all population levels.

It is anticipated that there will be a significant residual impact on Black-throated Finch as a result of TRR4.

6.2.3 Significant Impact Assessment - Bare-rumped Sheathtail Bat

The landscape assessment of the distribution of potential tree hollow roosts discussed in Section 6.1.8 revealed broad trends in habitat availability for the Bare-rumped sheathtail bat across the broader landscape and assisted in both identifying the location of larger individual trees most likely to contain hollows, and those species that would not provide roosting habitat. This assessment indicated that there is likely to be a higher abundance of suitable hollows in *Melaleuca viridiflora* woodland than previously thought.

Table 14 provides an estimate of the impact of clearing potential roosts in tree hollows for TRR4 in relation to the adjacent habitat.

Table 14 Estimated Impact of Clearance on Potential Roosts in Tree Hollows within the Proposed Road and Adjacent Landscape (as updated from RPS 2013, to include revised design footprint)

<table>
<tr><th>Regional Ecosystem</th><th>Vegetation community</th><th>Proposed clearance (ha)</th><th>Extent in adjacent area (ha)</th><th>% of total being cleared</th><th>Hollows / ha</th><th>Estimated hollows in adjacent area</th></tr>
<tr><td>11.3.12</td><td>Melaleuca viridiflora woodland on alluvial plains</td><td>20.48</td><td>511</td><td>4%</td><td>37.58</td><td>19,203</td></tr>
<tr><td>11.3.25b</td><td>Riverine wetland or fringing riverine wetland</td><td>2.4</td><td rowspan="2">304</td><td rowspan="2">1.2% (3.82 ha)</td><td rowspan="2">36.35</td><td rowspan="2">11,050</td></tr>
<tr><td>11.3.35</td><td>Eucalyptus platyphylla, Corymbia clarksoniana woodland on alluvial plains</td><td>1.42</td></tr>
<tr><td>11.3.30</td><td>Eucalyptus crebra, Corymbia dallachiana woodland on alluvial plains</td><td>29.98</td><td>1672</td><td>1.79</td><td>3.78</td><td>6,320</td></tr>
<tr><td>Non remnant</td><td>-</td><td>9.78</td><td>449</td><td></td><td>0</td><td>NA</td></tr>
<tr><td>Remnant</td><td>As in above REs</td><td>54.28</td><td>2,487</td><td>2.18%</td><td>-</td><td>-</td></tr>
</table>

From these survey and other forms of assessment it has been determined that it is unlikely that there will be a significant residual impact on the bare rumped sheath bat by the proposed road. Assessment against each of the significant impact criterion for this critically endangered species is summarised below and discussed in some detail in Appendix C (RPS 2013).

Lead to a long term decrease in the size of a population

No populations are currently known to be under threat (Schulz & Thomson 2007). There is no estimate of the size of the population of Bare-rumped Sheath tail bat in the vicinity or population density, although the recovery plan for the species suggests that they occur at low densities in the region (Schulz & Thomson 2007). Despite over 50 hours of searching hollows using observation and burrow scope investigations no bats were found, although they are presumed to be foraging in the woodlands area. It has been calculated that there are 11,050 tree hollows in the broader landscape, and the removal of hollows for the road equates to 1.2 %. Given these results it is concluded that the removal of trees during construction for the proposed road is unlikely to lead to a long term decrease in the size of the population.

Expected operational impacts that could affect the bat includes high traffic levels, which bring increased noise, light, risk of road mortality and potential disruption of breeding behaviour by noise pollution and human and vehicular disturbance. RPS reviewed the literature on disturbances to bats and concluded that:

- Bare-rumped Sheathtail bats can occur in immediate proximity to a major road thoroughfare
- Impacts of light, noise and vibration from regular traffic are not likely to have significant impacts
- Mortality from road kill does not appear to pose a significant threat, and
- Bare-rumped sheath tail bats may become habituated to traffic disturbance.

The operational impacts of the road are unlikely to lead to a significant long-term decrease in the size of the population.

Reduce the area of occupancy of the species

Native vegetation clearance for the proposed road is calculated at about 55 ha, within a much larger continuous remnant woodland of over 3,000 ha (bounded by Hervey Range Road to the south and the Bruce Highway to the north). Table 13 above indicates that 3.82 ha of suitable and optimal roosting habitat (open woodland) communities with large hollow bearing eucalypts would be removed or (1.2%) would be cleared for the road. There is also other large remnant patches in the region connected by strips of woodlands and riparian corridors further afield in eucalypt woodlands extending from north of the Burdekin River up to the east coast to Taylors Beach near Ingham and inland to include Hervey Range – an area of about 750,000 ha (RPS 2013). This places the TRR4 alignment within a broader area of about 194, 395 ha of predicted distribution centred on Townsville. It is concluded that the proposed road alignment is unlikely to reduce the occupancy of the bat beyond the area of vegetation clearance, and given that the Bare-rumped Sheathtail bat forages for insects at height (up to 80 m) it is thought likely that the bat would still continue to use the airspace above the road as foraging habitat.

Fragment an existing population into two or more populations

It is not considered likely that the road corridor will form a barrier to this bat's movement or fragment an existing population for given that the species is known from a range of habitat types including grassy beach dunes and forest clearings and they are known to fly over open water and between land masses. Therefore a road corridor is unlikely to inhibit their movement.

Adversely affect habitat critical to the survival of a species – roosting habitat

Impacts on roosting and foraging habitat are described in the recovery plan for this species as critical to the survival of the species. However there is not sufficient information about the species to support provision of critical habitat mapping in the plan. As discussed earlier LiDAR assessment coupled with photo interpretation and site inspections has indicated that poplar gum (one of the known roost trees for the Bare-rumped Sheathtail bat) is distributed in specific areas in the landscape, primarily along watercourses and low lying areas including across the TRR4 road reserve. This analysis has also revealed that the State Government regional ecosystem mapping has possibly overestimated its abundance in the broader contiguous remnant patch. Further the analysis reveals that there are other gum species (grey bloodwood and Dallachys gum) which also provide a high frequency of hollows in vegetation communities nearby. These species are not known to be preferred as roosting trees, however that they could be used cannot be discounted either (particularly given recent literature from Sri Lanka where the species was rediscovered after 75 years using a coconut palm *Cocos nusifera* where one of the hollow entrances had probably been formed by a black-rumped flameback woodpecker (Nanayakkara, Ranil P., *et al* 2012).

Extrapolation from the percentage levels of clearance relative to the likely remaining habitat presented in Table 13 earlier indicate that no significant adverse impacts on roosting habitat critical to the Bare-rumped sheathtail bat is likely to occur as a result of road construction works.

Adversely affect habitat critical to the survival of a species – foraging habitat

It is considered highly probable that the Bare-rumped Sheathtail bat uses the open woodland vegetation in the road reserve as well as the surrounding vegetation, particularly the creeks as movement corridors and for drinking. Based on both literature and on the passive acoustic monitoring results it is presumed that suitable foraging habitat in and around the road reserve includes all of the regional ecosystems in the project area as well as a broader array of vegetation communities, even if some of those vegetation communities are more marginal. Given the extent of these ecosystems in the landscape, the percentage clearance in relation to the broader landscape for the road itself is not likely have a significant adverse impact.

Disrupt the breeding cycle of a population

Clearance for road construction is likely to take place in June 2014, outside of what is considered to be the reproduction cycle of the bat as best it is known. It is unlikely that the construction works will significantly disrupt the breeding cycle of the local population.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The broad area of suitable habitat as discussed above, the bats low frequency occupancy of tree hollows, ability to move and disperse over broad areas of unsuitable habitat and ability to forage over cleared open areas lead to the conclusion that the proposed road is unlikely to significantly modify, remove, isolate, or decrease the availability of quality of habitat to the extent that it is likely to decline locally.

Result in invasive species that are harmful to a critically endangered species becoming established in that species habitat

As the bare-rumped sheath tail bat is generally known to roost in hollows high in trees, it is considered well protected from predation from cats, foxes, wild dogs and cane toads. It is more likely that the road corridor once developed and if not well managed could introduce range of invasive weeds, particularly large robust grass species that could alter fuel loads. The introduction of exotic grass species and related changing fire regimes present the risk of decreasing tree canopy cover over time. This potential impact will be managed by the following measures:

Planting of non-invasive and or sterile grasses on the road embankments is a primary objective of the stabilisation and reinstatement objectives of the project. The intent behind this draws from lessons learnt on previous phases of the Ring Road, where planting species not suitable to solodic material in the embankment fill, steepness of batters, and without cognisance of the local government mowing practises (machinery and regularity of mowing – which have consequences for the cut height of vegetation), resulted in soil erosion, weed invasion and failure of plantings. Planting objectives on the final road embankment areas are to achieve a stable vegetated surface with species which are known to survive local soil conditions, will quickly cover bare ground, and which has minimal risk of plant failure, soil erosion and which can be mown by TMR's contractual arrangements and machinery provided by Townsville City Council.

TMR will implement routine inspections for invasive grass species particularly in areas that have been modified during and post construction.

Management measures as previously outlined in the TRR4 referral and EMP will also assist in managing the risk of invasive species. Key amongst these is the land management plan being prepared by TMR environment officers for the road reserve.

Introduce disease that may cause the species to decline

As discussed in RPS 2013 the most likely diseases that could affect the bare-rumped sheath tail bat are Hendra virus and lyssavirus. For the reasons provided it is not thought that the road development would introduce either of these diseases as they are not thought to be carried by humans, soil or machinery. It is possible that removal of trees and reduction of hollows may reduce roosting opportunities in the future and lead to increased numbers of bats sharing roost positions. However considering that the bare-rumped bat is a colonial roosting species (4 to 40 individuals, Curtis *et al* 2013) then opportunities for cross infection are already high and unlikely to be increased through the proposed road.

Interfere with the recovery of the species

There are currently no conservation measures aimed at the bare-rumped sheath tail bat, with protection of suitable and potential habitat in conservation reserves being the only measure to reduce any potential decline. Primary threats are likely to include:

- Loss of tree hollow availability due to land clearance (Schulz & Thompson, 2007)
- Timber collection and targeted removal of hollow bearing and dead trees along road reserves, in parks and in other urban areas
- Competition for hollows by bees and feral birds like the common myna
- Disease such as lyssavirus
- Loss of climatic habitat through climate change (Curtis *et al* 2012).

However given that Bare-rumped sheath tail bat has been confirmed immediately adjacent to the Bruce Highway south of Townville suggesting that it is a resilient species that is able to live and forage adjacent to a high volume of traffic, it is thought that the incidence of traffic adjacent to the remaining bat habitat will not interfere unduly with the bat and its persistence in the remaining woodlands.