12 Nature Conservation: Terrestrial Fauna

12.1 Introduction

12.1.1 Background and scope

This chapter of the EIS provides a review of the existing situation in relation to terrestrial fauna within and adjacent to the project. It also provides an assessment of potential impacts that would need to be mitigated throughout the design, construction, operation and decommissioning phases of the development.

The project traverses a significant area of remnant vegetation. The area affected by the project is relatively large and supports a diversity of habitats, including eucalypt open forest, eucalypt woodlands, wet sclerophyll forest, riparian rainforest, paperbark wetlands, swamps and notophyll vine forest (as described in **Chapter 11, Terrestrial flora**). With such a diversity of habitats and a large area of remnant vegetation it can be expected that the project area would support a high diversity of terrestrial fauna, including some species of conservation significance. The majority of these fauna are likely to be concentrated around the southern portion of the project area from Landsborough to Palmwoods.

In the southern portion of the project area there are several areas of valuable habitat, including: Dularcha National Park, Eudlo Creek National Park and two bioregional wildlife corridors (in the areas around Rose Road and The Pinch Lane). There are also several major waterways that support remnant riparian rainforest, namely: Addlington Creek, South Mooloolah River, Mooloolah River and Eudlo Creek. The areas of valuable habitat in the northern portion of the project area are limited to Paynter Creek and Petrie Creek.

12.1.2 Aims

The aims of the baseline fauna investigations were to identify the terrestrial fauna occurring in areas that would be potentially impacted by the project. Specifically, in order to address the TOR the aims of this study are to:

- undertake seasonal terrestrial vertebrate assessments in accordance with protocols and techniques outlined in 'Guideline for flora and fauna surveys' (Department of Environment And Resource Management 1999)
- assess the presence or likely presence of Endangered, Vulnerable or Rare (EVR) vertebrates as defined under the *Nature Conservation Act 1992* (NC Act) and/or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- determine the presence and areas of high use (if possible) by migratory birds
- identify areas or habitats of high environmental value (for vertebrates) including potential habitat for EVR species
- assess the presence or likely presence of feral and exotic animals
- evaluate the importance of potential corridor vegetation on a local and regional level that is bisected by the project
- highlight potential impacts from the proposed activities that may affect significant vertebrate values
- suggest any requirements for further assessment and develop mitigation strategies (where possible) to alleviate or mitigate potential impacts.

12.1.3 Relevant legislation and policy

There are a number of policies and legislation that are relevant to the conservation of native fauna. The legislation largely relates to the protection of Threatened species and their habitat. Any action undertaken that is likely to result in direct harm to native fauna, particularly Threatened species, and / or their habitat will be subject to assessment under certain pieces of legislation. These are listed in **Table 12.1.3**:

Table 12.1.3: Relevant Commonwealth and State legislation

Legislation/Policy	Implications	Level
Environment Protection Biodiversity Conservation Act 1999 (EPBC Act)	This act aims to protect Threatened species. It requires referral to the federal government for development that may impact listed species.	Commonwealth
Nature Conservation Act 1992 (NC Act) (and Regulations and Conservation Plans)	This act aims to protect Threatened species and recognised conservation areas. It requires application to the Department of Environment and Resource Management for the take of Threatened fauna species.	Queensland
Draft SEQ Koala State Planning Regulatory Provisions	These regulatory provisions require that material change of use associated with clearing of mature koala habitat trees within an area >2500m^2 is referred to the Department of Infrastructure and Planning.	Queensland
Land Protection (Pest and Stock Route Management) Act 2002 (LP Act)	This act defines noxious pests, which are formally referred to in the act as declared pests. It requires management of some declared pests.	Queensland
JAMBA 1974	Agreement between the government of Australia and the government of Japan for the protection of migratory birds in danger of extinction and their environment	International
CAMBA 1986	Agreement between the government of Australia and the government of China for the protection of migratory birds in danger of extinction and their environment	International

It is recognised that other legislation and policies relating to the protection of vegetation would also play an important role in the conservation of native fauna, however, this has been discussed in **Section 11.1.3** of **Chapter 11, Terrestrial flora**.

12.2 Methodology

12.2.1 Review of existing information

Information pertaining to the project area was available due to work that has already been carried out in the region by various government and private bodies for other projects. Some of this information was able to be utilised in a desktop review of the project area.

Information review (existing reports)

A number of reports pertaining to the project area and surrounds were assessed for relevance and used as general background information, including:

- *SEQ Infrastructure Plan and Program* 2008 – 2026
- *Rail Network Strategy for Queensland 2001 – 2011*
- Caboolture to Beerburrum Community Infrastructure Designation, Final Assessment Report (2006), undertaken for Queensland Transport (now the Department of Transport and Main Roads)
- Landsborough to Nambour Route Identification Report (2008), undertaken for Queensland Transport (now the Department of Transport and Main Roads).

Spatial data (mapping)

A number of GIS datasets, including the project, were overlaid on rectified aerial photography. The datasets were:

- rectified aerial photo mosaic (average age of component photos 2007)
- cadastre (Department of Environment And Resource Management, 2007)
- Regional ecosystem (RE) vegetation mapping by the Queensland Herbarium (Version 5.0 with Dec 2006 Amendments) (Department of Environment and Resource Management, 2005)
- Essential Habitat mapping (Version 5.0 with Dec 2006 Amendments) (Department of Environment and Resource Management, 2005)
- Biodiversity Planning Assessment (BPA) mapping (Version 3.4 March 2005) (Department of Environment and Resource Management, 2005).

Additional mapping resources included:

- street directory covering Sunshine Coast area (Gregory's 2007)
- Caloundra City Plan 2004, habitat and biodiversity code overlay mapping
- Maroochy Plan 2000, nature conservation and biodiversity code overlay mapping.

Public databases

Prior to the field investigation, public databases were searched in order to provide background information regarding terrestrial vertebrates known from the region and local area. This included searches of the Queensland museum's fauna database, the Department of Environment and Resource Management's WildNet database, Birds Australia's bird database and the Commonwealth's EPBC Act online protected matters search tool for the project area and surrounds.

Information gained from this phase of the study was used to:

- ensure that survey methods were designed to detect or determine the likely presence of species of significance known from the region
- determine which species were most likely to occur if suitable habitat was located within the project area.

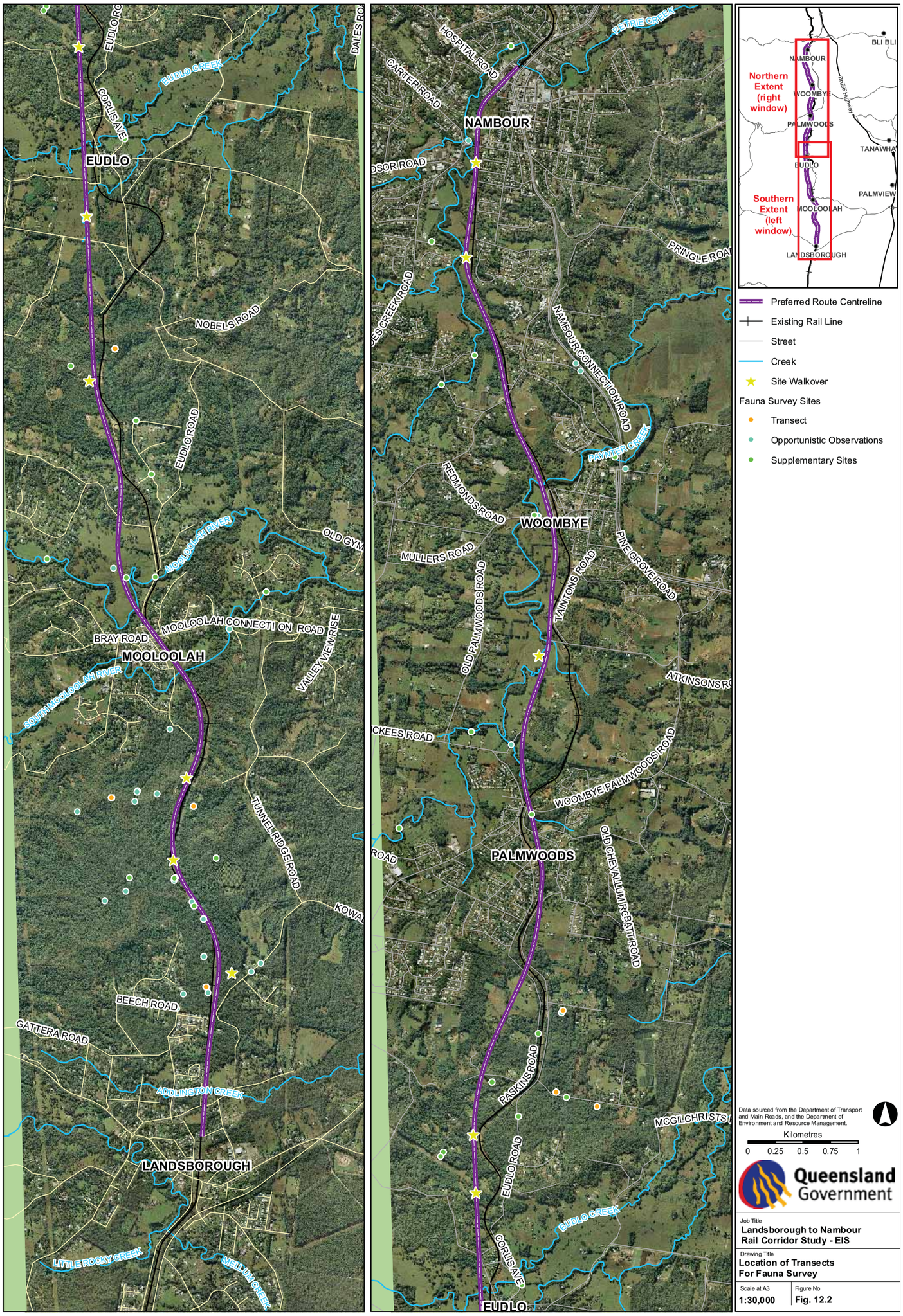
Those species known from recent, nearby records were considered more likely to occur if suitable habitat was located.

12.2.2 Field investigations

The field program involved an initial site investigation on 29 August 2007. While data was collected opportunistically during the site investigation, the main aim was to locate potential trapping areas and accessibility. Following the initial field investigation, two systematic baseline vertebrate surveys were conducted. The first survey was conducted during the cooler months between 3 September 2007 and 7 September 2007 (inclusive). The second was undertaken during the summer period between 29 January 2008 and 2 February 2008. Sampling both winter and summer periods increases the likelihood of encountering species that are not permanently resident or are more cryptic during certain times of the year (e.g. frogs, reptiles and summer migrants). These surveys were undertaken in accordance with the Department of Environment and Resource Management's Queensland Parks and Wildlife Service's Scientific purposes permit WISP02791605 and DPI Animal Ethics Committee Certification CA 2005/10/81.

The systematic surveys involved the establishment of seven transects in representative habitats, particularly those that were likely to be inhabited by EVR species. The location of these transects are shown in **Figure 12.2**. Systematic survey techniques were used within these areas to sample all vertebrate groups. Outside of the systematic survey locations, supplementary sites were established in habitats that were not represented by systematic transects and in locations likely to increase the vertebrate inventory. Not all sampling techniques were deployed at the supplementary sites areas and hence species recorded at these locations were biased towards non-cryptic species.

Figure 12.2: Locations of Transects For Fauna Study



A targeted survey for the frog species *Mixophyes iteratus* and *Litoria olongburensis* was conducted between 29 January 2008 and 2 February 2008 in response to the confirmation of the presence of *M. iteratus* and habitat for *L. olongburensis* in September 2007. The targeted survey was designed to identify the presence, and where possible, extent of these EPBC Act listed species. Techniques used during the targeted survey included spotlighting using head torches, call playback and call detection as well as tadpole collection (*M. iteratus* only).

Further field investigations were conducted in mid October 2008 to provide more detailed information about potential impacts to significant ecological features that may not have been picked up by previous surveys. These investigations involved a targeted site walk-over, such that the alignment of the project was traversed on foot. This was undertaken in areas of high environmental significance (i.e. Dularcha National Park, Eudlo Creek National Park, Mooloolah – Eudlo ridge line etc) where the potential for environmental impacts is greater. This was considered to be the most effective way of determining impacts at the ground level. Observations of the condition of the vegetation were made and the location of any likely habitat for significant fauna species or habitat trees was recorded utilising a hand-held GPS.

Survey techniques

At each of the systematic survey sites, all standard vertebrate survey techniques were used except for harp trapping which requires suitable flyways for efficiency. This technique was used opportunistically. Survey techniques excluding pitfall and box trapping were used at the supplementary survey sites. Standard systematic survey techniques included:

Box traps

At each systematic trapping site, 25 type A elliot traps, two type B elliot traps were placed on ground approximately 5-10 m apart. Each was baited with a mixture of rolled oats, peanut butter, oil and vanilla +/- salami. Trap placement was influenced by vegetation diversity, the size and shape of the vegetation patches and by naturally occurring features such as logs, rock outcrops, tree bases and clumping vegetation. Traps were cleared early each morning and reset in late afternoon in accordance with animal ethics requirements. All traps were operational for four nights during the winter and summer sampling period.

Pitfall traps

At each systematic trapping site, a pitfall trapline was established. Each line consisted of five 20 litre buckets buried flush to the ground surface and connected by a 30 m drift fence. These pitfall traps were operational for four nights and captured small mammals, reptiles and frogs which were released after identification in the early morning and late afternoon.

Diurnal terrestrial searches

Active diurnal searches were undertaken at both systematic and targeted sites (where suitable). Searches involved intensive investigation of ground layer (under logs, rocks and leaf litter), low vegetation (under bark and in tree stumps) and rock crevices for all amphibians, reptiles, bats and animal signs (e.g. scats, owl pellets, orts (bird feeding remnants), remains and tracks). Searches were conducted during the warmer parts of the day when reptile activity was likely to be at its peak.

Diurnal bird censuses

Bird species were targeted at each systematic trapping site for approximately 30 minutes during a single morning period. Species were identified by either direct observation or their calls. In addition, bird species were recorded at all targeted sights. The amount of effort dedicated to the detection of birds in these target location depended on the quality of habitat and bird abundance.

Nocturnal searches

A combination of high-powered spotlights and head torches were used to sample nocturnal mammals (flying, arboreal and terrestrial), birds (owls and nightjars), reptiles and frogs. Nocturnal searches were undertaken at each systematic transect, but only selected target transects based on habitat suitability.

During the spotlighting sessions, species specific detection may have been assisted by the use of call playback surveys undertaken for nocturnal birds and nocturnal mammals using the recordings of Stewart (1998a, b).

Harp trapping

Harp traps for insectivorous bats were positioned opportunistically throughout the project area based on the location of suitable flyways. In most cases these coincided with roadways or small bush tracks which provided adequate breaks in tree canopies. The harp trap was cleared and moved to a new location each day.

Bat call detection

An ANABAT II ultrasonic bat call detection unit and associated ZCAIM interface module were used to capture the calls of insectivorous bat species. The use of the ZCAIM unit allows the ANABAT II detector to be left unattended throughout the night, thereby ensuring that peak activity periods for bats are recorded each night. The unit was positioned in locations where bat activity was likely to be high such as around waterbodies or flyways.

Incidental (opportunistic) records

During the survey period, fauna observations were continuous and species records were obtained outside of the systematic methodology of the survey.

12.2.3 Limitations of study

During the winter survey (early September 2007), two contrasting weather conditions were experienced. Fine weather with warm days (maximum of 23°C) were experienced during the first day while rain clouds moved in late on the second day resulting in virtually continuous rain during the remainder of the survey. In total, approximately 120 mm of rain fell during the week causing localised flooding. These wet conditions were accompanied by significantly cooler temperatures (maximum of 14°C). Typically, wet conditions are ideal for frog species and many reptiles. However, cold temperatures inhibit frog and reptile movement. Consequently, while some frog species were observed breeding and calling during the winter survey, many others may not have been active. The wet conditions were less than ideal for mammal and bird detection. The abundance of surface water also decreased trapping efficiency. Pitfall buckets float free from their holes when the ground becomes saturated, and exposes captured animals to potential drowning. In such cases the pitfall traps must be removed. Both harp trapping and ANABAT detection is not possible during heavy rain due to the risk of equipment damage. The wet and boggy roads made access difficult. Hence minimal movement along forestry tracks was possible.

Temperatures during the summer survey (January 2008) were considerably warmer than the winter survey, both during night and day. The warmer summer months coincide with increased reptile and frog activity as well as the presence of summer bird migrants. Hence summer fauna inventory lists are typically more comprehensive than winter lists. There was also significant rainfall during the summer survey period. Showers and heavy rain periods were frequent during the first few days and 50 mm fell in the first night. During wet conditions many frog species congregate around waterholes to breed, making their detection more likely. However the swollen creeks prevented the collection of tadpoles during the targeted component of the survey. ANABAT usage is limited during rainfall, however the units were used opportunistically while spotlighting in dryer periods.

12.2.4 Assessment of impacts

Impacts on terrestrial fauna have been evaluated with significance criteria. These criteria allow for a standard assessment across all topics covered in the EIS and provide a context for describing the significance of the impact. Significance criteria are in **Table 12.2.4**.

Table 12.2.4: Significance criteria

Significance	Criteria Description
High Adverse	Impact a major problem. These impacts are likely to be important considerations adversely affecting species of national importance (as identified in the EPBC Act) or State significance (as identified in the Nature Conservation (Wildlife) Regulation 2006). Impacts are to the extent that the Threatened species is removed indefinitely or known habitat can no longer function to provide essential resources for the Threatened species. In a more general sense, a high adverse impact can be defined as an impact on a significant area of habitat such that the result is that fauna diversity and / or abundance is decimated. These impacts are concerns to the project, depending upon the relative importance attached to the issue during the decision making process. Mitigation measures and detailed design work would not remove the impacts upon the affected Threatened species. Adverse residual impacts would predominate.
Moderate Adverse	Impact moderate. These impacts are likely to be important at a national, State or local (as identified within local laws or local planning scheme codes or guidelines) scale. Impacts are to the extent that the habitat of the Threatened species is reduced in size or quality and / or there are ongoing activities that are likely to have adverse implications for the Threatened species in the long-term. Ongoing activities may include: increased traffic resulting in car strike, noise, increased predation through exposure to feral / domestic animals etc. In a more general sense, a moderate adverse impact can be defined as an impact on a significant area of habitat such that the result is a noticeable reduction in fauna diversity and / or abundance. These impacts represent issues where adverse outcomes would be experienced, but mitigation measures and detailed design work can ameliorate some of the consequences upon Threatened species and their habitats. Some residual impacts would still arise. The cumulative impacts of such issues may lead to an increase in the overall impacts upon a particular area or on a particular resource and hence may become key decision making issues.
Low Adverse	Impact recognisable but acceptable. These impacts are likely to be important only at a local scale and are unlikely to be of significant importance in the decision making process. Impacts are minor or short term and can be ameliorated by detailed design work and mitigation measures. Residual impacts are minimal or non-existent and do not cause a decline in fauna diversity or abundance or affect the ability of a Threatened species to exist. These impacts are generally of relevance for enhancing the subsequent design of the project and in the consideration of mitigation or compensation.
Negligible	Minimal change. No impacts or those which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.
Beneficial	Impact beneficial to the environment. There is an increase in the area or quality of habitat affected by the proposal and / or the ability of a vegetation community to provide ecosystem services is enhanced. Similarly, an existing threatening activity or process is ameliorated. These impacts are largely a result of mitigation measures.

12.3 Description of environmental conditions

A variety of land uses occur within the project area. Residential dwellings are located around the townships of Landsborough, Mooloolah, Eudlo, Palmwoods and Nambour. Many areas between these townships support rural residential allotments used for both urban and rural purposes. Large areas of private land support remnant vegetation, especially towards the southern portion of the project area. Field survey was concentrated in areas with remnant vegetation within protected areas and on private land (where access was permitted). A diversity of fauna species were identified during field survey, some of which are listed as significant under various State or federal legislation. The majority of species located in the project area during field investigations have been recorded in the local area previously.

Information collected via desk top review and field survey is presented in the following sections and is focussed on the topics of:

- fauna habitat characteristics
- wildlife corridors
- abundance and diversity of species
- Threatened species
- migratory species
- pests.

12.3.1 Fauna habitat characteristics

Fauna communities are comprised of a range of species that inhabit different niches within a habitat. While some species are generalists and able to effectively compete in a variety of niches, other species are specialists and are found only in habitats that meet specific requirements. It is the presence or absence of these specialist species that is generally the most obvious difference between fauna communities. Habitat therefore, plays a significant factor in determining the composition of a fauna community. Generally, two factors are important: habitat structure and resource availability.

Habitat structure refers to the abundance and complexity of the vegetation and debris. Habitats with abundant shrubs, thick ground cover and dense sub-canopy and canopy are vertically complex and provide abundant shelter sites, particularly for bird species. Horizontal complexity refers to the presence of ground plant species, open areas, fallen timber, rock crevices etc that provide sheltering opportunity for terrestrial species. Habitats with higher vertical and horizontal complexity will generally have higher species diversity. In addition, the availability and types of resources affects the number and type of vertebrate species inhabiting an area. Those habitats with abundant resources may be inhabited by more species, even if they compete, while the presence of a preferred dietary item will facilitate the presence of a particular species (e.g. fruiting bodies for fruit doves). Older and intact stands of remnant vegetation generally have higher habitat complexity and resource availability.

Vegetation within the project area can be divided into seven basic types of habitat based on structure and resource composition. Each of these habitats will support different vertebrate communities, although some habitats will support communities with more specialist species, and hence be more unique than those supporting ubiquitous species. Each habitat type is described below.

Rainforest/notophyll forest

Rainforest and/or notophyll forest habitats are generally consistent with RE 12.12.1, 12.9-10.16 and 12.3.1 within the project area. They are scattered throughout the project area and often restricted to low-lying areas or associated with gullies and creek lines. The largest patches of this habitat type were located within Eudlo Creek National Park. This habitat type is typified by the absence of abundant eucalypts in the canopy.

The canopy consists of vivid green plants such as *Backhousia, Cupaniopsis, Waterhousia, Cryptocarya, Elaeocarpus, Syzygium* and *Ficus* species (**Photo 12.3.1a**). Many of these species are fruiting trees and several frugivores were identified in these habitats during the survey such as Wompoo Pigeon (*Ptilinopus magnificus*), Rose-crowned Fruit-dove (*Ptilinopus regina*), Whiteheaded Pigeon (*Columba leucomela*), Green Catbird (*Ailuroedus crassirostris*), Australian Kingparrot (*Alisterus scapularis*), Common Koel (*Eudynamys scolopacea*), Lewin's Honeyeater (*Meliphaga lewinii*), Olive-backed Oriole (*Oriolus sagittatus*), Varied Triller (*Lalage leucomela*) and Figbirds (*Sphecotheres viridis*).

Beneath the canopy, layers of sub-canopy and tall shrubs were abundant. Often these layers included abundant palms such as *Archontophoenix cunninghamiana* and *Livistona australis*, particularly in low-lying areas with high soil moisture retention (**Photo 12.3.1b**). This provides abundant vertical complexity for rainforest bird species including Eastern Yellow Robin (*Eopsaltria australis*), Pale Yellow Robin (*Tregellasia capito*), Little Shrike-thrush (*Colluricincla megarhyncha*), Golden Whistler (*Pachycephala pectoralis*), Black-faced Monarch (*Monarcha melanopsis*), Spectacled Monarch (*Monarcha trivirgatus*), Rufous Fantail (*Rhipidura rufifrons*), Brown Gerygone (*Gerygone mouki*) and Large-billed Gerygone (*Gerygone magnirostris*). The lack of light penetration to the ground inhibits plant growth and as a result the ground cover is sparse. Furthermore, the lack of light penetration does not allow reptilian species to bask and hence this group of vertebrates is very poorly represented. Only those adapted to shade conditions such as Elf Skink (*Eroticoscincus graciloides*) and Lampropholis (a skink) species are abundant.

At several locations within the project area, the notophyll forests were associated with riparian corridors (RE 12.3.1). These areas provided high quality habitat for the Endangered Giant Barred Frog (*Mixophyes iteratus*) where permanent slow-flowing pools of water were present (**Photo 12.3.1c**).

Low-land rainforest habitats are becoming increasingly uncommon and fragmented in SEQ. Consequently many species reliant on these habitats are either priority species under the BAMM methodology (eg, Rose-crowned Fruit-dove) or already protected under legislation (eg. *Mixophyes iteratus*). Furthermore, rainforest vertebrate communities within the project area are perhaps the most unique, with many species only found in this habitat type.

Riparian habitats are highly susceptible to weed invasion which alters habitat structure and renders these habitats unsuitable for ground dwelling species such as *Mixophyes iteratus*. Considerable weed invasion is already evident in many creeklines throughout the project area. Weed incursion and infestation resulting from increased edge effects, soil disturbance and movement of the propagules of weed species pose a significant threat to these habitats.

Most drainage features within the project area flow in a west to east direction. The significant, mostly perennial waterways present are:

- Addlington Creek (flows into Ewen Maddock Dam and the Mooloolah River)
- South Mooloolah River (a tributary of the Mooloolah River)
- Acrobat Creek (a tributary of Eudlo Creek)
- Eudlo Creek (a tributary of the Maroochy River)
- Paynter Creek (a tributary of the Maroochy River)
- Petrie Creek (a tributary of the Maroochy River).

In addition, many smaller natural waterbodies are present and while significantly large, permanent waterbodies such as storage dams or lakes are absent, many small farm dams are scattered throughout the landscape.

Photo 12.3.1a: Rainforest / notophyll forest

Photo 12.3.1b: Rainforest / notophyll forest with palm understorey

Photo 12.3.1c: Giant Barred Frog (Mixophyes iteratus)

Wet sclerophyll forest

Wet sclerophyll forests within the project area are often in close proximity to rainforests but are distinct in having a tall canopy of eucalypt species, particularly *E. pilularis* and *E. grandis* (RE 12.9-10.14). Beneath the canopy are scattered rainforest shrubs, although generally the sub-canopy is much more open. Bird species such as Lewin's Honeyeater, Black-faced Monarch, White-throated Treecreeper (*Cormobates leucophaeus*), Rufous Fantail and Eastern Yellow Robin are common. Distinct to this community is the dense thick ground cover of predominantly *Pteridium* species (Bracken Ferns) (**Photo 12.3.1d**) or thick sedges beneath low shrubs such as Banksia, Hakea and *Alphitonia* species (**Photo 12.3.1e**). This very dense layer provides ideal habitat for bird species such as Variegated Fairy-wren (*Malurus lamberti*), Eastern Whip-bird (*Psophodes olivaceus*) and White-browed Scrubwren (*Sericornis frontalis*). In addition, the dense layer is highly favoured by small terrestrial mammals, Bush Rats (*Rattus fuscipes*), Yellow-footed Antechinus (*Antechinus flavipes*) and Fawn-footed Melomys (*Melomys burtoni*) were abundant in this

habitat type. Reptile species are not common due to the lack of basking opportunities and the high soil moisture retention. Tall wet eucalypt forests of this nature have become increasingly Rare in SEQ. Efforts should be made to avoid the clearing of this habitat type where possible.

Photo 12.3.1d: Wet sclerophyll with bracken fern

Photo 12.3.1e: Wet sclerophyll with shrubs

Alluvial sclerophyll forest

Eucalypt forests on alluvial soils were not common within the project area. Those that were present where often degraded through cattle grazing activities and the associated introduction of exotic grass species. These communities (typically RE 12.3.11) were typified by a tall, very sparse canopy of *E. tereticornis* (Forest Blue Gum). *Eucalypt tereticornis* is an important tree for several reasons. Firstly, it produces abundant hollows which provide nesting opportunities for hollow obligates. It also provides abundant blossom and is a good source of nectar during the winter months when similar resources are Rare. Finally, its high leaf-nutrient levels make it a favoured browse species for arboreal mammals that feed on leaves such as possums and Koala (*Phascolarctus cinereus*). When flowering, species such as Rainbow Lorikeet (*Trichoglossus haematodus*), Scaly-breasted Lorikeet (*Trichoglossus chlorolepidotus*), Noisy Friarbird (*Philemon corniculatus*), Little Friarbird (*Philemon citreogularis*), Brown Honeyeater (*Lichmera indistincta*), Scarlet Honeyeater (*Myzomela sanguinolenta*) and White-throated Honeyeater (*Melithreptus lunatus*) are common. These species however may be considerably less abundant outside of flowering events. Alluvial plains with their fertile soil are highly susceptible to weed invasion.

Dry hillside sclerophyll forest

Open dry sclerophyll forests with a mix of eucalypt species were common in the project area, particularly on ridgelines such as those occurring along Rose Road and The Pinch Lane. This habitat type often corresponded to RE 12.9-10.4, RE 12.9-10.7 and RE12.9-10.17. The relatively open canopy in these communities included species such as E. crebra, *E. racemosa, E. tindaliae, E. siderophloia, E. propinqua, E. acmenoides and Corymbia intermedia* and *C. gummifera*. The canopy provides a variety of sheltering opportunities including large hollow-bearing trees for species such as Greater Glider (*Petauroides volans*), Brushtail Possum (*Trichosurus vulpecula*) and Australian Owlet Nightjar (*Aegotheles cristatus*). When flowering, these trees provide nectar and blossom for species such as Grey-headed Flying-fox (*Pteropus poliocephalus*), Noisy Friarbird, Scarlet Honeyeater and Brown Honeyeater. Many of the recorded bird species were most common in dry eucalypt forests. Such species included Striated Pardalote (*Pardalotus striatus*), Brown Thornbill (*Acanthiza pusilla*), White-throated Gerygone (*Gerygone olivacea*), Spotted Pardalote (*Pardalotus punctatus*), White-throated Honeyeater, Spangled Drongo (*Dicrurus bracteatus*), Rufous Whistler (*Pachycephala rufiventris*), Varied Sittella (*Daphoenositta chrysoptera*) and Grey Fantail (*Rhipidura fuliginosa*).

The shrub layer, consisting largely of regrowth canopy species or *Acacia*'s is sparse or clumped. The ground layer consists of largely native grasses such as *Triodia* with scattered *Xanthorrhoea* (**Photo 12.3.1f**). Fallen logs and debris from the canopy are common. The increased light penetration and high horizontal ground complexity is favourable for terrestrial species such as reptiles. Many species identified during the survey were far more common or restricted to this habitat type including *Sminthopsis macroura* (Common Dunnart), *Lampropholis delicata* (a skink) and *Carlia vivax* (a skink). These habitats are relatively common within SEQ and they contribute to local corridor movements and large, intact remnants such as the ridges associated with Rose Road and The Pinch Lane.

While slightly less susceptible to weed invasion than forests associated with fertile alluvial soils, dry hillside eucalypt vegetation may be impacted by weed species such as Lantana, resulting in altered habitat structure and increasing fire intensities.

Photo 12.3.1f: Dry hillside sclerophyll forest

Melaleuca wetlands

Low-lying areas dominated by *Melaleuca quinquenervia* (RE 12.3.5) were uncommon within the project area. Three notable areas where associated with low-lying waterways in the southern portion of Dularcha National Park. At these locations the canopy species, *M. quinquenervia*, was often growing in permanently waterlogged soils and as a result, shrub species were uncommon. Emergent aquatic plants such as *Gahnia* and *Philydrum* were common (**Photo 12.3.1g**). Fauna species unique to or considerably more common within this habitat type included White-cheeked Honeyeater (*Phylidonyris nigra*) and Wallum Froglet (*Crinia tinnula*).

Photo 12.3.1g: Melaleuca wetlands

Open pasture

Highly modified habitats where most native vegetation has been removed to facilitate cattle grazing are abundant within the project area. The resulting habitats usually have very simple habitat structure with no vertical complexity and a dense, low ground layer of introduced grasses. Species observed in these areas are often opportunists or generalists such as Cattle Egret (*Ardea ibis*), Australian White Ibis (*Threskiornis molucca*), Straw-necked Ibis (*Threskiornis spinicollis*), Masked Lapwing (*Vanellus miles*), Australian Magpie (*Gymnorhina tibicen*), Magpie lark Willie Wagtail (*Grallina cyanoleuca*), and Pied Butcherbird (*Cracticus nigrogularis*).

In low-lying areas common frog species may become abundant after heavy rainfall, particularly in those areas with some aquatic vegetation (e.g. sedges) or tall, rank grasses. Species that were regularly recorded in these situations include Eastern Sedge Frog (*Litoria fallax*), Graceful Treefrog (*Litoria gracilenta*), Ruddy Treefrog (*Litoria rubella*), Striped Marsh Frog (*Limnodynastes peronii*) and Tusked Frog (*Adelotus brevis*).

Open pastures and similar disturbed, non-native vegetation usually support a high number of weed species. These may be easily transported into nearby native vegetation, having a detrimental effect on important native habitats.

Other habitats

Two other highly modified habitats were observed within the project area. Parks and gardens associated with towns and urban areas are inhabited by a variety of species that are typically generalists. Noisy Miners (*Manorina melanocephala*), Pied Butcherbird, Blue-faced Honeyeaters (*Entomyzon cyanotis*) and House Sparrows (*Passer domesticus*) for example were common. Some of these species are aggressive species that are known to exclude smaller bird species. Finally, some large artificial water bodies such as dams were located within the project area. Kolora Park in Palmwoods was the largest example noted during the survey. Little Pied Cormorant (*Phalacrocorax melanoleucos*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Australasian Grebe (*Tachybaptus novaehollandiae*), Dusky Moorhen (*Gallinula tenebrosa*) and Purple Swamphen (*Porphyrio porphyrio*) were recorded at this location.

12.3.2 Wildlife corridors

Wildlife corridors allow both plants and animals to disperse, migrate or move from one area of habitat to another. They are therefore important to local and regional biodiversity values. Two factors can influence the importance of a corridor (QDMR 2000). Firstly, the intrinsic value of the corridor relates to the quality of vegetation and habitat within the corridor. Corridors that are wide and have excellent habitat have more value than narrow, poor quality corridors. Secondly, the corridor may have high significance if it connects two areas of important remnant vegetation, even if the corridor itself does not have good habitat.

The Biodiversity Assessment and Mapping Methodology (BAMM) process for SEQ has identified corridor values that are considered to be of State, regional or local value. The proposed project bisects two areas mapped as valuable corridors:

1. Vegetation located around Dularcha National Park is considered to be of Local corridor value. This vegetation is therefore considered important for local wildlife movements.
2. Vegetation associated with The Pinch Road is considered to be of State corridor value and is therefore important for State wildlife movements.

In addition to these two BAMM recognised corridors, vegetation associated with Eudlo Creek National Park would be likely to provide east-west movement opportunities to local fauna populations. Narrow, riparian vegetation along creek lines and rivers are also known to facilitate fauna movement, particularly vagile species such as birds (Bentley and Catterall, 1997). These may also provide important dispersal and movement corridors for selected EVR species, particularly *Mixophyes iteratus* and *Adelotus brevis*. **Figure 12.3a** indicates location of wildlife corridors in the project area.

12.3.3 Abundance and diversity of species

A total of 158 terrestrial vertebrate species were recorded from the project area (**Appendix F**) including 15 amphibians, 10 reptiles, 109 birds and 24 mammals. Fifteen species of butterflies were opportunistically recorded[1] . The majority of fauna recorded during the field investigation are not the subject of special protection under legislation (i.e. they are currently listed in Queensland's NC Act as 'least concern' wildlife). However, 12 species listed as EVR under State legislation (NC Act) including two species listed under federal legislation (EPBC Act) are known from the project area. An additional two listed species were not detected but local records and suitable habitat suggest they occur. These Threatened species are discussed in **Section 12.3.4**.

A total of nine non-EVR species identified as priority species under the BAMM process were recorded during the field surveys. Several of these species such as Greater Glider, Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Southern Myotis (*Myotis macropus*) and Large Forest Bat (*Vespadelus darlingtoni*) are hollow-dependant fauna and their presence is indicative of old growth eucalypt forests bearing hollows of a variety of sizes.

The presence of *F. tasmaniensis* is particularly noteworthy. Previously, the species was thought to be restricted to highland areas such as the Bunya Mountains, Lamington Plateau and the Granite Belt. Few, if any records of this species have been recorded from lowland areas in SEQ (G. Ford pers. comm). *Ramphotyphlops nigrescens* (a blind snake) and *Sminthopsis murina* (Common Dunnart) are ground dwelling animals and are generally only recorded from locations with an undisturbed native understorey. The remaining identified BAMM species are associated with particular vegetation features. *Syconycteris australis* (Eastern Blossom Bat) is found in locations where blossom and flowering plants are abundant while *Ptilinopus regina* (Rose-crowned Fruit-dove) and *Ailuroedus crassirostris* (Green Catbird) were observed in vegetation containing fruiting bodies. Refer to **Figure 12.3b** for location of indicator species.

The surveys also identified eight non-EVR vertebrates considered to be Migratory under Commonwealth legislation. These migratory species are discussed in **Section 12.3.5**.

12.3.4 Threatened species

Species records obtained from the Queensland museum database, Department of Environment and Resource Management WildNet database and EPBC Act online protected matters search tool are provided in **Appendix F**. These searches are based on a larger area than the project area to capture as many records as possible. Thirty-five significant vertebrate species were identified within the database searches: six amphibians, five reptiles, 16 birds and eight mammals. Six species were identified only from the EPBC Act database, which is predominantly predictive and may return results that are unconfirmed.

Following the field-based site assessment, consideration of the habitats present within the project area and the known ranges of the animals identified from database searches, not all of these species are considered likely to occur. A full account of all EVR species that were not considered likely to occur in the project area can be found in **Appendix F**. Species that were either recorded or considered likely to occur are listed in **Table 12.3.4a**.

1 Systematic survey techniques for butterflies were outside the scope of this survey. However opportunistic sightings of large, readily identifiable species were recorded.

Table 12.3.4a: EVR Vertebrates recorded or likely to occur

Zoological Name	Common Name	Status[1]		Likely[2]
		NC Act	EPBC Act	Occurrence
Butterflies				
Ornithoptera richmondii	Richmond Birdwing	V		Recorded
Amphibians				
Adelotus brevis	Tusked Frog	V		Recorded
Crinia tinnula	Wallum Froglet	V		Recorded
Mixophyes iteratus	Giant Barred Frog	E	E	Recorded
Reptiles				
Eroticoscincus graciloides	Elf Skink	R		Recorded
Birds				
Accipiter novaehollandiae	Grey Goshawk	R		Recorded
Lophoictinia isura	Square-tailed Kite	R		Recorded
Rallus pectoralis	Lewin's Rail	R		Moderate
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		Known
Ninox strenua	Powerful Owl	V		Known
Tyto tenebricosa	Sooty Owl	R		Recorded
Mammals				
Phascolarctos cinereus	Koala (SE QLD)	V		Recorded
Pteropus poliocephalus	Grey-headed Flying-fox	LC	V	Recorded

Notes: Special Status abbreviations are as follows:

Queensland's Nature Conservation Act 1992 (NC Act Status): E = Endangered, V = Vulnerable, R = Rare, LC = Least Concern wildlife. Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act Status): E = Endangered, V = Vulnerable, M = Migratory Species. Department of Environment and Resource Management's Biodiversity Assessment and Mapping Methodology (BAMM Status): Y = Priority fauna in SEQ other than EVR taxa. Definitions as follows:

Recorded = Recorded during BAAM surveys for the project;

Known = Known to occur through previous surveys or discussions with local landholders with reputable vertebrate identification skills;

Low = A low likelihood of occurring

Moderate = A moderate likelihood of occurring with the possibility that transient individuals may use suitable habitats sporadically; and

High = Species expected or considered highly likely to occur.

Richmond Birdwing (Ornithoptera richmondensis)

During the survey one female Richmond Birdwing butterfly was observed on council land off Mooloolah Meadows Road near the Mooloolah River (**Figure 12.3c**). No searches were undertaken during the survey to determine if larval food plants were nearby. The species is also known downstream of the project area in the Beerwah forest reserve. It is likely that scattered individuals may be located throughout the catchment where suitable habitat for the larval food plant is located.

Tusked Frog (Adelotus brevis)

Adelotus brevis was recorded at 41 locations within the project area (**Figure 12.3d**) and is likely to occur at many more. Most areas where pooling water occurred, including creeks, dams and swampy areas, were inhabited by the species. They were also recorded from urban waterbodies with reduced habitat quality. Vegetation around and within Eudlo Creek National Park is mapped as Essential Habitat under the *Vegetation Management Act 1999* (VMA) for *Adelotus brevis*. The species was recorded at Eudlo Creek and suitable habitat is abundant.

Figure 12.3a: Wildlife Corridors

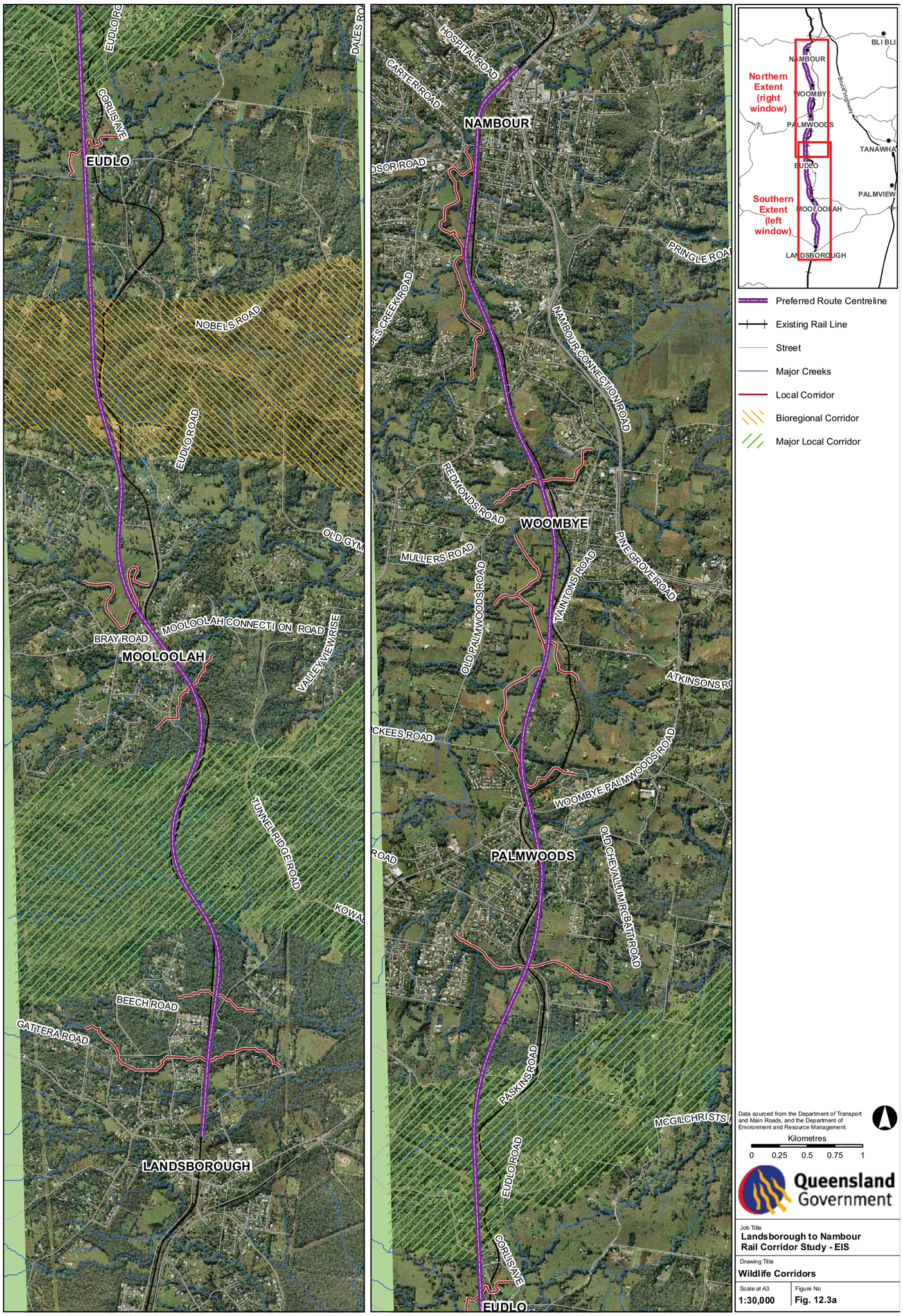


Figure 12.3b: Location of Indicator Species

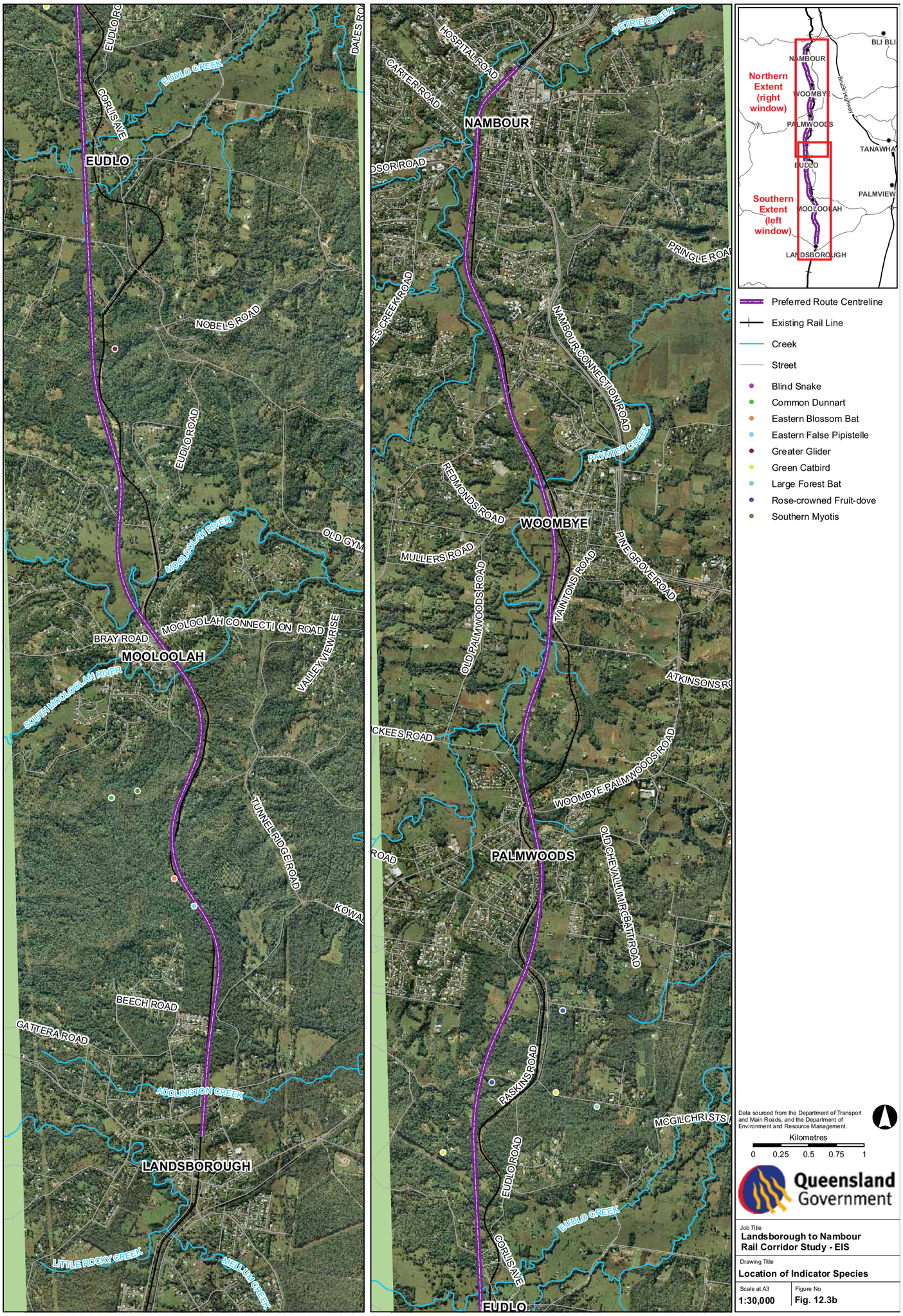


Figure 12.3c: Threatened Fauna (Insects and Reptiles)

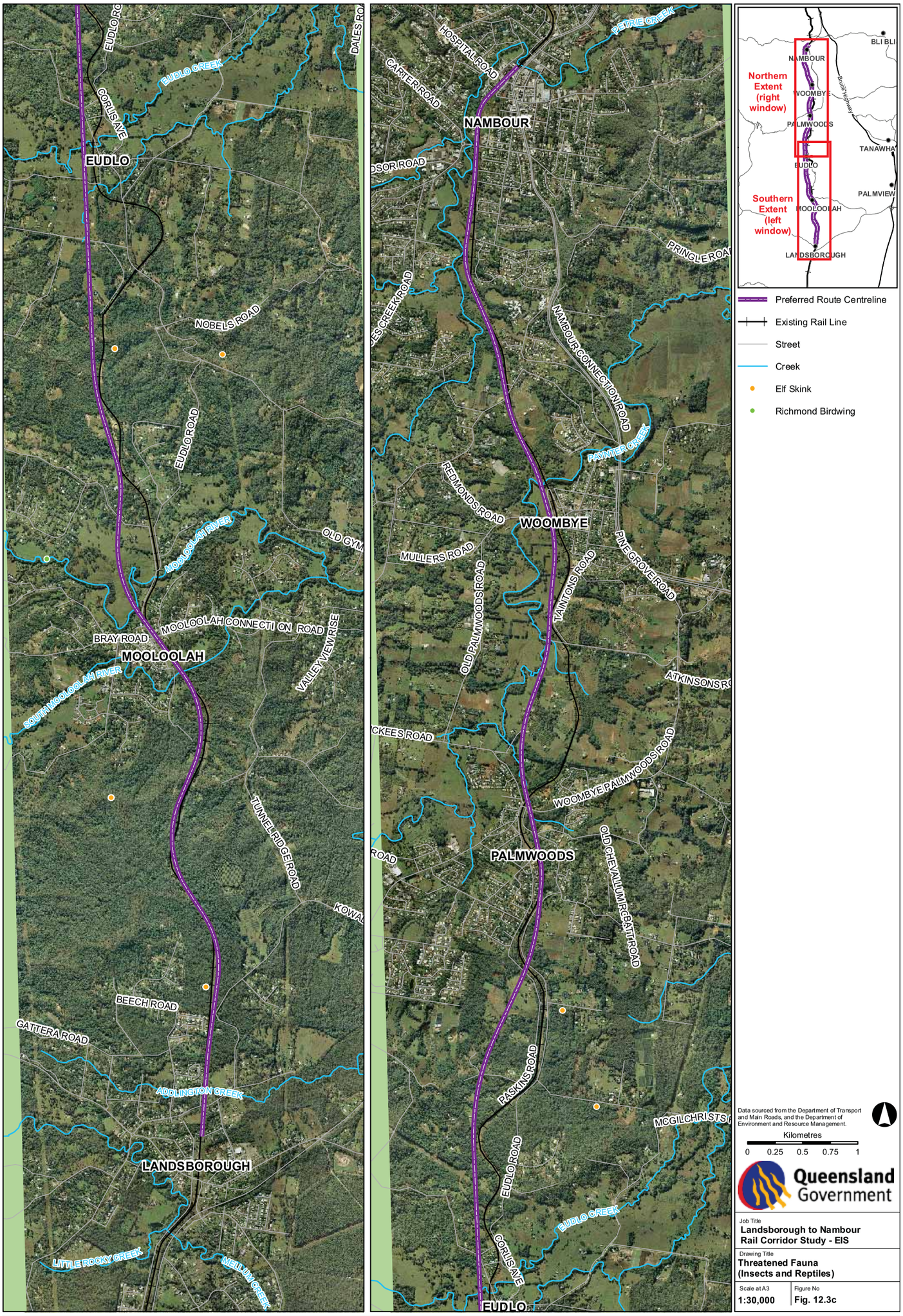


Figure 12.3d: Threatened Fauna (Frogs)

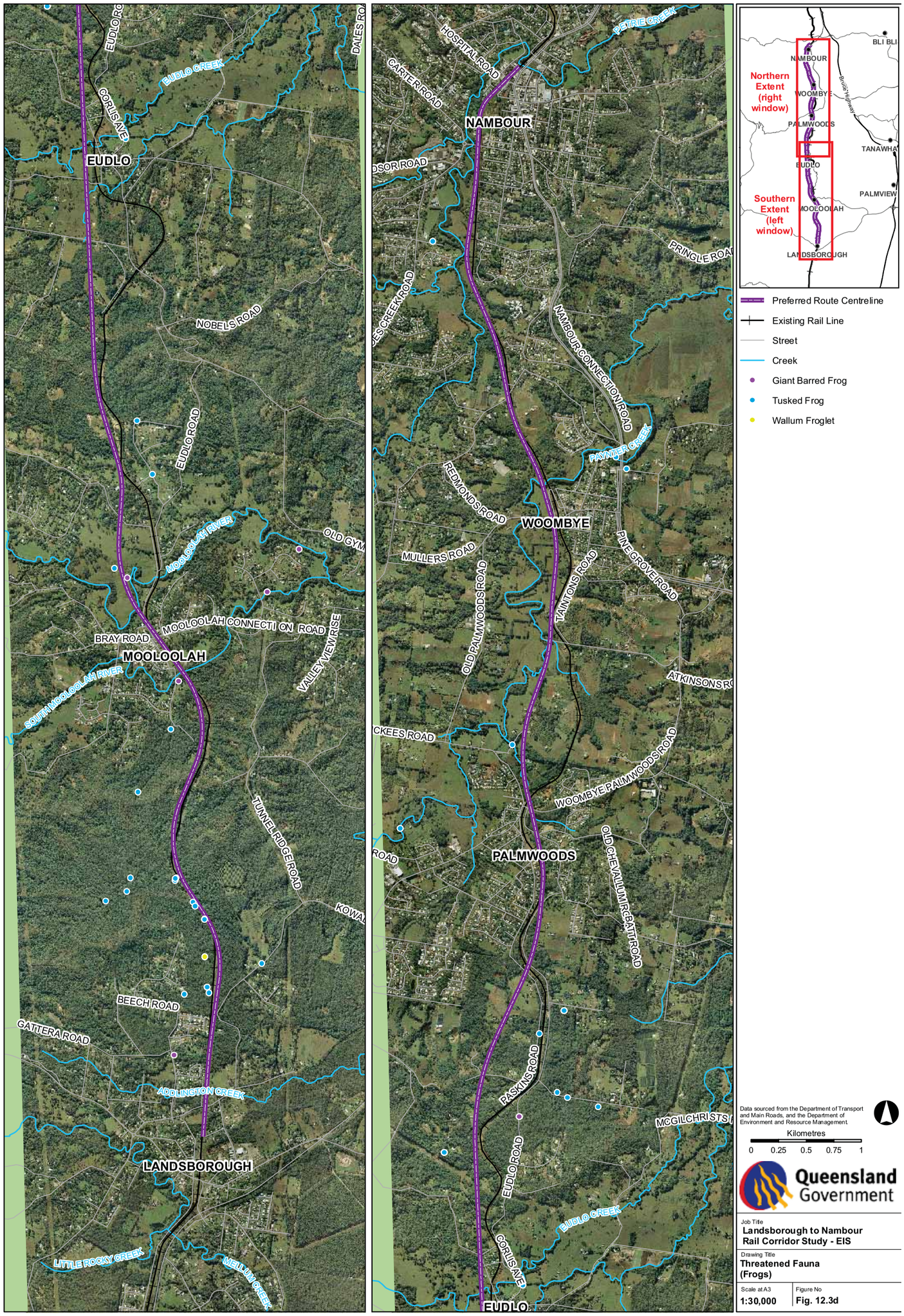
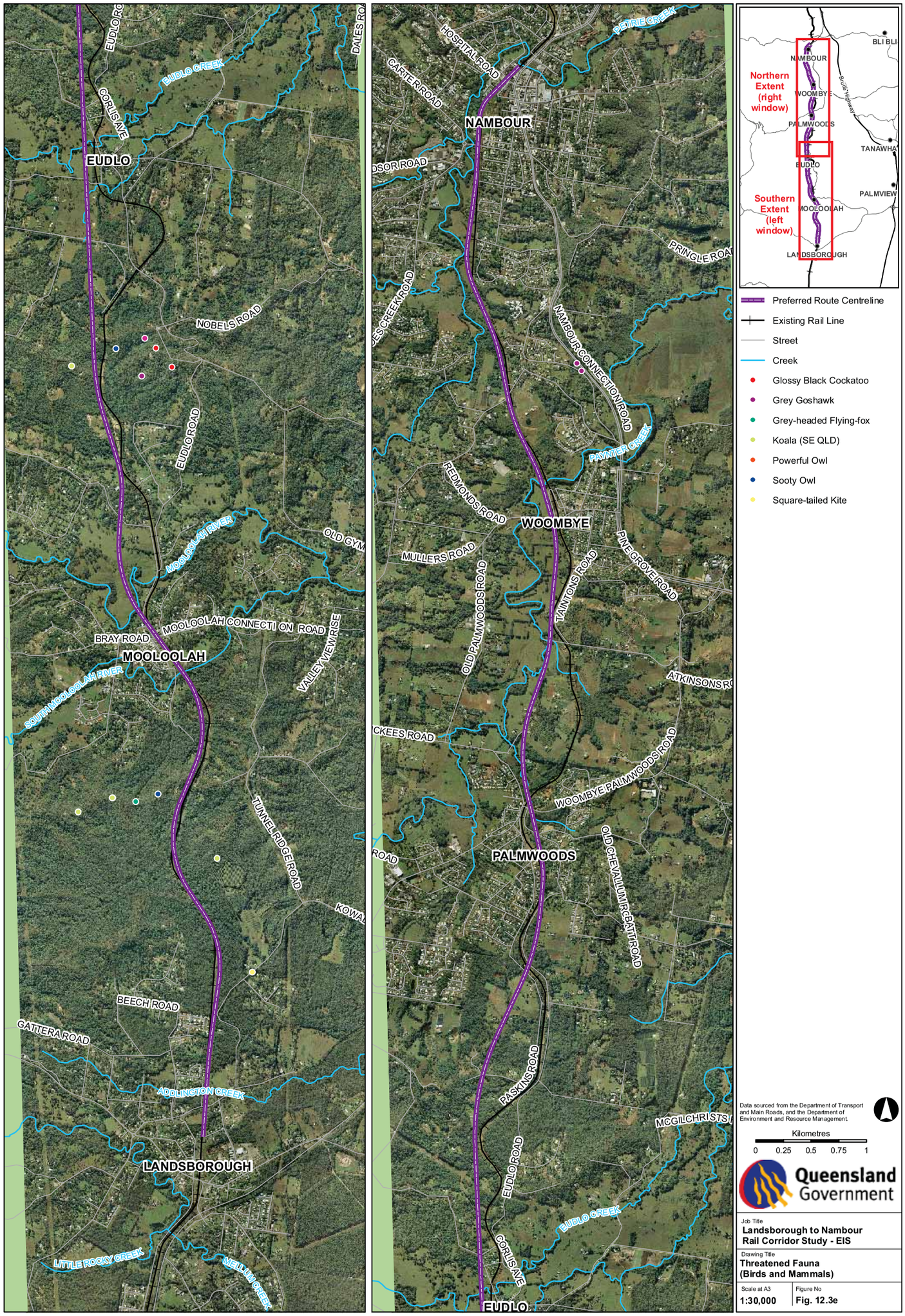


Figure 12.3e: Threatened Fauna (Birds and Mammals)



Wallum Froglet (Crinia tinnula)

Crinia tinnula was recorded at one location within Dularcha National Park during the winter survey (**Figure 12.3d**). It was associated with a small low-lying area dominated by *Melaleuca quinquenervia*. Such areas are uncommon within the project area, restricted to three consecutive minor creeklines in the southern portion of Dularcha National Park. Vegetation in the southern portion of Dularcha National Park is mapped as 'Essential Habitat' for *Crinia tinnula*.

Giant Barred Frog (Mixophyes iteratus)

Mixophyes iteratus has been identified from six locations, four from within the Mooloolah River catchment, one from along Addlington Creek and one from within Eudlo Creek National Park (**Figure 12.3d**). Vegetation and habitat values at Addlington Creek have been reduced due to the presence of weed species. In particular, increased light penetration along vegetation edges has allowed the encroachment of thick exotic grasses, smothering the ground in several areas. This thick ground cover inhibits movement of this large terrestrial frog species and reduces the amount of habitat available for their use. Despite this, these records were identified through the collection of tadpoles, which indicate the presence of a breeding population.

In contrast to Addlington Creek, habitat within Eudlo Creek National Park is excellent. The extensive rainforest habitat along the banks of the creekline provides large areas for foraging and undercut banks provide breeding opportunities (preferred location for ovipositing). No adults were located within this area, despite searches. However tadpoles collected during the aquatics survey (WBM) indicated that the population is breeding. In total, five adult *M. iteratus* were recorded within the project area along the Mooloolah River and its anabranches. These records originate from three separate locations, both upstream and downstream of the current and proposed rail alignments. In addition, tadpoles of the species were collected during the aquatics survey from the south Mooloolah branch (WBM). The species is also known to occur on the Mooloolah River downstream of the project area to at least as far as the Bruce Highway (e.g., Beerwah Forest Reserve - M. Sanders unpublished data).

Although there are stretches along the Mooloolah River within the project area where habitat values have been reduced due to clearing of riparian vegetation to a narrow strip and the presence of thick weeds, it is generally considered that there are significant stretches of the river that provide valuable habitat for the species. In particular, stretches of riverbank with more extensive habitat were recorded around 'the hairpin' (496053E, 7040202N), near a council reserve off Mooloolah Meadows Road (495 326E, 7040 320N) and off Suzen Court (496 625E, 7040 330N). The greater availability of habitat and associated resources at these locations is likely to result in higher abundance of the species. These areas would represent 'core habitat' within the local context, facilitating the continued presence of the species in less extensive habitats upstream and downstream. Lemckert and Brassil (2000) found that *M. iteratus* restricted their movements to 20 m either side of the river bank and suggested that 30 m buffers were adequate for the preservation of the species in logged forests. Areas along the Mooloolah River catchment with relatively extensive habitat, and the presence of individuals in areas with considerably narrower riparian vegetation suggest that the species' local population is healthy. All areas of riparian vegetation along the Mooloolah River and anabranches could be considered suitable habitat for *M. iteratus*.

This species was the main subject of a referral to DEWHA, which appears in **Appendix F**.

Elf Skink (Eroticoscincus graciloides)

Twelve individual *Eroticoscincus graciloides* were recorded during the field surveys from five locations within the project area and an extra record has been noted from previous assessments in the area (**Figure 12.3c**). Most records during the survey occurred in typical habitat for this species – mesic vegetation that often retains soil surface moisture. However it was also regularly recorded from a trapping location positioned within an open grassy eucalypt forest. The species is expected to be ubiquitous throughout the project area in most mesic vegetation. Elf Skinks are also known to inhabit parks and gardens and are therefore unlikely to be restricted to remnant vegetation, although highest abundances of the species are expected in areas where native vegetation persists.

Grey Goshawk (Accipter novaehollandiae)

Two Grey Goshawks were observed during the assessment, both in the northern portion of the project area near the Nambour Connection Road (**Figure 12.3e**). In addition, local landholders have provided GPS coordinates of a known Grey Goshawk nest tree located off Tunnel Ridge Road south of Palmwoods. It is not currently clear if all three records represent the same resident pair or two pairs.

Square-tailed Kite (Lophoictinia isura)

One Square-tailed Kite has been recorded during the survey on Tunnel Ridge Road south of Mooloolah (**Figure 12.3e**). However the species is well represented in databases, has been recorded in the area by landholders, and suitable eucalypt forest habitat is common. It is therefore likely that the species is more widespread and common than indicated by this single record.

Lewin's Rail (Rallus pectoralis)

No Lewin's Rails were recorded during the field surveys within the project area. However, the species has been recorded from the local area. Suitable habitat where the species might occur is largely restricted to a wetland body located near Jubilee Drive in Palmwoods (495 926E, 7048 849N). Thick grasses and sedges in this area are typical habitat for the species.

Glossy Black Cockatoo (Calyptorhynchus lathami)

No Glossy Black-Cockatoos were identified during the field surveys and no feeding signs (orts) were located despite targeted searches. However, discussions with landholders familiar with the species and its identification indicated that this species moves through the area on a seasonal basis. The study team has been provided with GPS coordinates for two feed trees that are used by the species located off The Pinch Lane (**Figure 12.3c**).

Generally, foraging resources (*Allocasuarina torulosa* and *A. littoralis*) were scarce in the project area. Trees were restricted to small groves or scattered individuals on ridge lines. Highest observed *Allocasuarina* densities occur along the ridgeline crossed by The Pinch Lane and along Rose Road. These areas provide the best foraging habitat for Glossy Black-Cockatoos. However the lack of abundant resources and feeding signs suggest that they may only be occasionally used, or as suggested by locals, used seasonally. Glossy Black-Cockatoos nest in large hollow-bearing trees, usually located near abundant foraging resources and permanent water. Given the lack of abundant resources it seems unlikely that the species nests in the area despite the presence of large hollow-bearing trees.

Powerful Owl (Ninox strenua)

No Powerful Owls were recorded during the field surveys. However, discussions with land holders familiar with the species identified a roost located off The Pinch Lane (**Figure 12.3e**). Powerful Owl habitat within the project area occurs extensively within Dularcha National Park and adjacent Mooloolah Forest Reserve as well as within eucalypt woodlands and mesic gullies along The Pinch Lane ridge. They may also sporadically occur in other well forested areas such as around Eudlo Creek National Park. However the species is not common within highly fragmented small patches of forest and therefore likely to be restricted to large habitat areas.

Sooty Owl (Tyto tenebricosa)

Sooty Owls were recorded twice during the survey, once on The Pinch Lane and once in the northern section of Dularcha National Park (**Figure 12.3e**). These two observations are likely to represent two separate territories.

Koala (Phascolarctus cinereus)

Koala's were recorded five times during the surveys from four locations (**Figure 12.3e**). The majority of records occurred in the southern section of the project area in vegetation associated or nearby to Dularcha National Park. One record was from vegetation near Tunnel Ridge Road. Local land holders on Rose Road and The Pinch Lane also indicated that Koalas are present. Highest quality habitat for the species is predominantly restricted to dry eucalypt forest ridges where primary food tree species such as *E. propinqua* occur, although some food tree species (*E. microcorys*) are also scattered in the wet gullies. Vegetation in the two areas where Koala records originated is likely to provide both habitat and potential movement opportunities. Some areas around Mooloolah Valley and Landsborough are mapped as Urban Koala Areas under the Draft SEQ Koala State Planning Regulatory Provision. The project intersects with these areas around Mooloolah Valley (**Figure 12.3f**).

Grey-headed Flying Fox (Pteropus poliocephalus)

Two Grey-headed Flying-foxes were observed during the summer survey in the northern section of Dularcha National Park (**Figure 12.3e**) feeding on *Corymbia* blossom. Grey-headed Flying-foxes are known to travel up to approximately 50 km in a night in search of foraging resources such as abundant blossom or fruit. The nearest known flying-fox camp is situated near the Nambour Landfill, less than three kilometres from the northern portion of the project area and approximately 22 km from the southern-most extent. Consequently the entire project area is within reach of individuals originating from this camp.

Diet is composed of both nectar and blossom resources as well as fruiting bodies. Consequently almost all areas of native vegetation are likely to be utilised by the local population. In particular, the species favours fruiting trees, which occur in low-lying rainforest remnant such as those located along Paynter Creek, Petrie Creek and the Mooloolah River. In addition, winter flowering eucalypts such as *E. tereticornis* are important for providing resources during periods when other dietary components are scarce.

Table 12.3.4b describes habitat, distribution, breeding and threats to each of these species.

Figure 12.3f: Koala Habitat

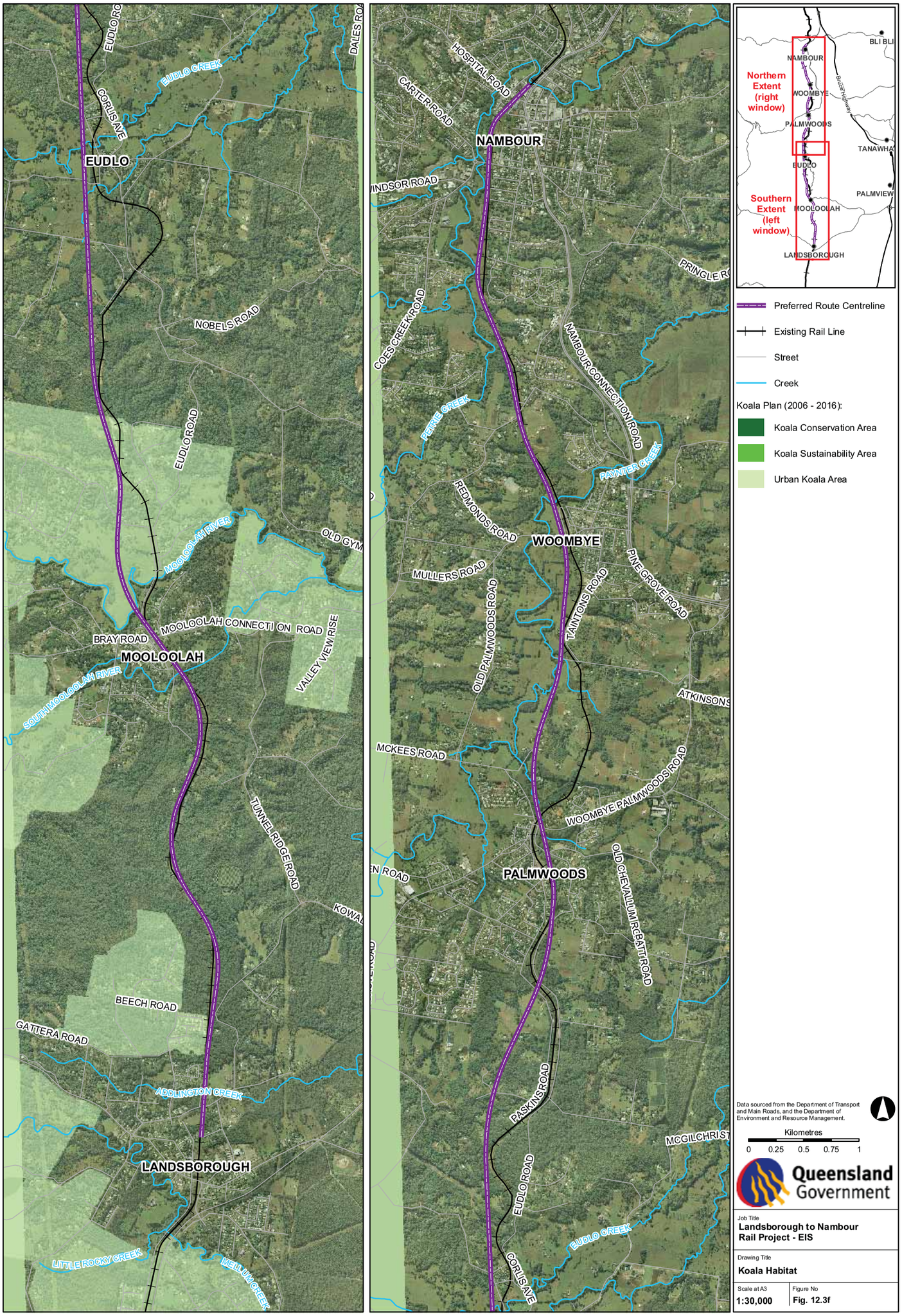


Table 12.3.4b: Habitat, distribution, breeding and threats to significant species in the Project area

Species	Habitat	Distribution	Breeding	Threats
Richmond Birdwing (*Ornithoptera richmondensis*)	Subtropical rainforest, littoral rainforest and gallery forest. Larval food plant Pararistolochia praevenosa.	Grafton, NSW to Maryborough, Qld	September – November and February - April	Climatic stress Reduction in extent of habitat Loss of larval food plant Weed invasion, particularly Dutchman's Pipe
Tusked Frog (*Adelotus brevis*)	Rainforest, wet sclerophyll, dry sclerophyll, woodland and vine forest. In low numbers in open grazing country	Clarke Range, Qld to Moss Vale, NSW and as far inland as Carnarvon Gorge, Qld.	September - April	Destruction and disturbance of habitat, although they can tolerate some habitat modification. Reduction in water quality. Chytrid fungus Predation of eggs and tadpoles by exotic fish, including mosquito fish (*Gambusia holbrooki*) Increased ultraviolet radiation
Wallum Froglet (*Crinia tinnula*)	Low pH freshwater swamps on low nutrient soils or wallum habitat. Vegetation includes heathland, sedgeland, Melaleuca swamp and Banksia woodland.	Bundaberg and Fraser Island, Qld to Kurnell in mid-eastern NSW	Autumn to late winter Spring to late summer	Loss of habitat through clearing for infrastructure and housing Canal developments Drainage projects
Giant Barred Frog (*Mixophyes iteratus*)	Edges of deep, slow flowing creeks with over-hanging banks in riverine rainforest or wet sclerophyll forest. Require a relatively undisturbed habitat. Movement is restricted to 20 m from the stream.	Historically widespread from Sydney to Conondale Ranges, Qld. The stronghold now exists between Nambucca River and Mary River catchments.	Spring to early Autumn	Disturbance to stream headwaters Clearing and disturbance of habitat Domestic stock damaging bank stability Weed invasion
Elf Skink (*Eroticoscincus graciloides*)	Vine thickets, wet sclerophyll forests and rainforest. Shelters beneath leaf litter, logs, stones	Extreme south-east corner of Queensland from Fraser Island to Ipswich	Spring to mid-summer	Habitat modification Clearing for development
Grey Goshawk (*Accipter novaehollandiae*)	Temperate, sub-tropical and tropical rainforest, tall open forest, woodlands, gorges, watercourses and farmland.	Coastal areas throughout Australia	August to December	Habitat loss
Square-tailed Kite (*Lophoictinia isura*)	Heathlands, woodlands, forests, tropical and subtropical rainforests, timbered watercourses, hills and gorges with abundant small birds.	Mostly in coastal and sub-coastal areas on the east and west of Australia.	Year round	Clearing of forest and woodland Loss of woodland prey species Too frequent fires Shooting and egg collection

Table 12.3.4b: continued

Species	Habitat	Distribution	Breeding	Threats
Lewin's Rail (*Rallus pectoralis*)	Wet heaths and wetland habitats dominated by rushes, reeds, rank grass, creeks and paddocks.	Eastern Australia north from around Kangaroo Island in South Australia to Port Douglas, Qld	Year round	Habitat loss Drainage and river diversion Inappropriate fire regime Grazing and trampling
Glossy Black Cockatoo (*Calyptorhynchus lathami*)	Feeds exclusively on seeds of *Allocasuarina torulosa* and *A. littoralis*.	Patchy distribution throughout eastern Australia south from Eungella to Gippsland and inland to south-central Queensland.	March to August	Habitat clearance Loss of hollows Inappropriate fire regime Grazing that impedes growth of feed trees Fragmentation and increased predation by aggressive edge species.
Powerful Owl (*Ninox strenua*)	Mountain rainforests, gullies and forest margins, hilly woodlands, pine plantations and gardens. Prefers mature vegetation where arboreal mammals are abundant.	Victoria north to Eungella, Qld. Most common around the Great Dividing Range.	May to August	Clearing of habitat Loss of hollows
Sooty Owl (*Tyto tenebricosa*)	Wet eucalypt forest and rainforest with emergent trees.	East of the Great Dividing Range,Victoria to Cooloola.	July to October	Clearing for agriculture Increased fire Dieback
Koala (*Phascolarctus cinereus*)	Eucalypt woodland	Queensland, Victoria and South Australia	Year round	Habitat destruction Fragmentation Bushfire Disease Dog attack Road strike
Grey-headed Flying Fox (*Pteropus poliocephalus*)	Rainforest, open eucalypt forest, woodlands, Melaleuca swamp and Banksia woodland where fruit is abundant. Roosts are typically near waterways.	Rockhampton, Qld to East Gippsland, Victoria – but concentrated in Qld.	Spring	Loss of habitat Loss of winter resources Culling in agricultural areas Electrocution Lead accumulation Inappropriate fire regimes

12.3.5 Migratory species

Eight non-EVR species listed as migratory under the EPBC Act have been identified within the project area. These species include:

- *Ardea alba* Great Egret
- *Ardea ibis* Cattle Egret
- *Haliaeetus leucogaster* White-breasted Seaeagle
- *Hirundapus caudacutus* White-throated Needletail
- *Merops ornatus* Rainbow Bee-eater
- *Monarcha melanopsis* Black-faced Monarch
- *Monarcha trivirgatus* Spectacled Monarch
- *Rhipidura rufifrons* Rufous Fantail

Great Egrets and Cattle Egrets inhabit similar areas, although Great Egrets are less likely to be observed away from water while Cattle Egrets are readily observed in cattle paddocks. Both species are common within the area, neither are in decline and none have what could be considered an important population within the project area.

White-breasted Sea-eagles, which are largely restricted to significant waterbodies, lakes and the shoreline are likely to be only occasionally present as they fly over the project area. This species, and the White-throated Needletail which is an aerial specialist, would not be impacted by activities on the ground.

Rainbow Bee-eaters are a ubiquitous species in SEQ during summer months. They occur in a vast number of habitats including open pastoral land and well vegetated areas where they either forage above the canopy or sally from emergent dead branches. The nature and scale of the proposed project would not affect this species.

Black-faced Monarchs, Spectacled Monarchs and Rufous Fantails were regularly recorded in wet eucalypt and rainforest habitats within the project area. They are common within the local area, are not declining and do not have populations which should be considered to be 'important' (as defined under the EPBC Act).

All observed migratory species identified during the survey are common within the local area and unlikely to be significantly impacted by the proposed activities. Local records and suitable habitat suggest that three additional migratory species are also likely to occur: *Gallinago hardwickii* (Latham's Snipe), *Apus pacificus* (Fork-tailed Swift) and *Myiagra cyanoleuca* (Satin Flycatcher). None of these species are expected to occur in sufficient numbers to constitute a 'significant proportion' of their population and none are likely to have 'important populations' within the project area. Referral of the project in relation to migratory species to the Department of Environment and Water Resources under guidelines provided in the EPBC Act is not considered necessary.

12.3.6 Pests

Five feral vertebrate species were noted during the survey:

- *Bufo marinus* Cane Toad
- *Streptopelia chinensis* Spotted Turtle-dove
- *Passer domesticus* House Sparrow
- *Vulpes vulpes* European Fox
- *Canis familiaris* Dog/Dingo.

Under the *Land Protection (Pest and Stock Route Protection) Act 2002* (LPA), European Foxes and Dogs (other than domestic dogs) are considered to be Class 2 pests. During the survey, prints of dogs were regularly observed, however it was not possible to attribute these to feral dogs or dingos as domestic dogs were common.

Two European Foxes were recorded during the survey, one at Tania Lane, Eudlo and the other near the Mooloolah River west of the current railway route. Under the LPA:

'*A Class 2 pest is one that is established in Queensland and has, or could have a substantial adverse economic, environmental, or social impact. The management of these pests requires coordination and they are subject to local government-, community or landowner-led programs. Landowners must take reasonable steps to keep land free from Class 2 pests.*'

12.4 Information provided by the community

Throughout the project there has been on-going community consultation. Details of activities and information releases is discussed in **Chapter 1, Section 1.9**. Issues raised through feedback on the Route Identification Report and in the 'Township Options' consultation are captured in **Table 12.4**.

Table 12.4: Issues raised during community consultation

Issues Raised	Response	Section
Potential for a wide cutting immediately south of the proposed Mooloolah / Eudlo tunnel. This area is a designated green corridor. It has significant fauna and flora and a recognised koala habitat.	The importance of this area as a corridor has been recognised. A tunnel is proposed here. Part of the tunnel will be built underground avoiding surface disturbance and the remainder would undergo cut and cover construction. Tunnels have been lengthened to reduce the cut. Rehabilitation post-construction would allow retention of the corridor.	**Chapter 21, Special management areas, section 21.9**

Table 12.4: continued

Issues Raised	Response	Section
The project is identified as passing right through an Endangered ecosystem (notophyll rainforest) at Mooloolah. This Endangered ecosystem has significance at a State level.	The project passes through mapped Endangered remnant vegetation on South Mooloolah and Mooloolah River. The location of the rail had made use of existing breaks in the vegetation. Clearing will be minimised by the design of the bridge. Clearing of mapped Endangered remnant vegetation is required to be offset in accordance with the VMA Act.	Chapter 21, Special management areas, sections 21.6 and 21.8
Native animals in the Palmwoods area include *Petaurus gracilis* the Mahogany Glider, *Phascolarctos cinereus* the Koala, *Saproscincus rosei* rose-shaded skink, *Crinia tinnula* Wallum frog and *Accipiter novaehollandiae* Grey goshawk. There are > 50 species of birds.	Fauna surveys have been conducted as part of the EIS process. Species of significance or habitat where they are likely to occur were noted. A pre-construction survey would also be conducted to ensure significant fauna species within the construction zone are allowed to move on prior to clearing.	Chapter 12, Nature conservation: Terrestrial fauna, section 12.5.5 and 12.5.6
Large families of black cockatoos and rainforest 'whip birds' are often sighted in the rainforest area on the eastern side of Jubilee Drive in Palmwoods.	There are two areas of remnant vegetation to the east of Jubilee Drive. The rail would be on structure here and would result in the removal of less than 10% of the vegetation. Hence, the majority of the habitat is retained.	Chapter 12, Nature conservation: Terrestrial fauna, section 12.5.1

12.5 Assessment of potential impacts and mitigation measures

The Queensland Government is committed to ecologically sustainable development, such that the Department of Transport and Main Roads (and other transport portfolio partners, i.e. QR) must have regard to the Transport Portfolio Environmental Framework (TPEF). The framework guides the work of the State's transport agencies and aims to improve the environmental performance of the transport system, and in the long term, create a transport system that is environmentally sustainable. One of the key outcomes of the TPEF is 'demonstrated reduced impacts from transport on the quality of the environment'.

With regards to the potential impacts of the project on ecological values, the Department of Transport and Main Roads has made an undertaking to strive towards a policy of 'no net loss' for biodiversity. This policy assumes that appropriate compensatory measures would be undertaken by the Department of Transport and Main Roads to ameliorate the impacts of the project on the project area. Acceptable compensatory measures include (but are not limited to) habitat acquisition and rehabilitation. It is the Department's intent that areas of equal or higher conservation value would be sought for acquisition and / or rehabilitation (in line with the offsets policy under the VM Act) to compensate for the loss and / or degradation of natural habitat within and adjacent to the project.

The impacts of the project on the ecological values of the area will be the result of the construction of a double track railway that stretches 20.9 kilometres between Landsborough and Nambour. The width of the corridor will allow for the safe construction of the ultimate four track configuration to allow for future upgrades, if and when desired. The extent of earthworks for the construction will vary depending on terrain and design. There are areas of earthworks involving cuttings and embankments and also areas where the rail will be required to be built on structure (e.g. over waterways and flood prone areas) or within a tunnel (e.g. under a high ridge line). The narrowest parts of the corridor will be where the rail is on structure or where sensitive areas require minimisation of clearing. The footprint may be wider at stations or within areas of difficult topography that require more earthworks. During construction, the area required for earthworks (construction zone) will be cleared of all vegetation and levelled for the laying of the tracks. Generally, the proposed actions would remove only a small linear portion of vertebrate habitat values in the project area. Habitats immediately adjacent to disturbance zones provide habitats of the same type and value.

The main potential impacting processes to terrestrial fauna associated with the construction and operation of the project are:

- clearing of remnant vegetation
- habitat fragmentation and reduction in corridor functionality
- decreasing condition of habitat (unviable patch size / edge effects)
- introduction of feral animals
- fauna mortality and animal welfare
- removal of significant species.

12.5.1 Clearing of remnant vegetation

Potential impact

Vegetation clearing would be required for the project infrastructure, temporary facilities and access tracks associated with construction and would ultimately result in the removal of some fauna habitat from the project area.

Variations in habitat values for biodiversity and species of conservation significance are linked to patch size, structural complexity and contribution to local movement corridors. A higher proportion of the project area is located in areas affected by rural residential style development, but the proposed rail still traverses a significant amount of remnant vegetation. The most widespread vegetation type within the project area is tall sclerophyllous open forest.

In wetter areas it tends to be dominated by RE 12.9-10.14 and in drier areas, further up slope, the vegetation tends to be dominated by RE 12.9-10.17. This vegetation type is generally associated with large patch size, connectivity and a degree of structural complexity. In places where these areas incorporate waterways and remnant riparian vegetation, they support the highest values to native fauna.

Essentially the removal of remnant vegetation would result in a reduction of available habitat and resources for terrestrial fauna within the project area, which may result in a decrease in fauna abundance. As no one area of remnant vegetation or an entire regional ecosystem is being removed, there would not be an impact on the diversity of habitats within the project area. Hence, it is very unlikely that the clearing associated with the proposed railway development would result in the local extinction of any terrestrial fauna species.

Table 12.5.1 indicates the amount of vegetation to be cleared from each habitat type within the project area.

Table 12.5.1: Areas of clearing within various habitat types

Habitat type	Regional ecosystems	Area impacted
Rainforest / Notophyll forest	RE 12.3.1	1.06 ha
Wet sclerophyll forest	RE 12.9-10.1 RE 12.9-10.14	12.08 ha
Alluvial sclerophyll forest	RE 12.3.2	4.63 ha
Dry hillside sclerophyll forest	RE 12.9-10.4 RE 12.9-10.7 RE 12.9-10.17	3.76 ha
Melaleuca wetlands	RE 12.3.5	0.18 ha
Open pasture and other habitats	N/A	64.63 ha

Proposed mitigation

Generally, the proposed actions would remove only a small linear portion of vertebrate habitat values in the project area. Areas immediately adjacent to disturbance zones provide habitats of the same type and value. Nevertheless, impacts associated with the clearing of vegetation may be reduced by considering the following management actions. These strategies will be carried over into the detailed design phase, where applicable.

Design

Ecological data collected during desktop and field based studies was utilised to inform the design of the project, especially with regard to minimising the amount of significant fauna habitat to be removed. Some of the design elements that have been incorporated into the project are:

- The majority (75%) of the project traverses open pastures.
- Stations have been located as close as possible to existing stations or located in areas of low habitat value.
- The project has been kept as close as possible to the existing alignment in significant areas of habitat, such as Dularcha National Park.
- Tunnel methods have been utilised in areas where earthworks would result in a large amount of clearing of remnant vegetation.
- The width allowed for the construction of the corridor has been minimised, where possible, in sensitive areas through the use of retaining walls and tunnels.
- Bridges or culverts over significant waterways have been designed to reduce the amount of clearing required. This is essential at Addlington Creek (north), South Mooloolah River and Mooloolah River.
- Bridges have generally been located in areas where the riparian vegetation has been degraded or is narrow, to reduce the impact on higher quality vegetation.

Construction

Whilst the selection of the preferred route for the project has endeavoured to avoid areas of significant habitat, there are several sections within the project area where these values could not be avoided due to existing development or topography. Removal of native vegetation in these areas would need to be managed to ensure it is limited to that which is necessary and minimise harm to retained vegetation. In order to document the proposed management of the vegetation clearing on site, a VMP has been prepared for the project (**Chapter 22, Environmental management plans**). The VMP incorporates mitigation measures as listed:

- A Vegetation clearing permit/s will be obtained from the Department of Environment And Resource Management as required under the VMA Act.
- Surveyors shall be instructed to notify the environmental officer if remnant vegetation requires clearing for line-of-site, location of pegs etc. The environmental officer shall conduct an inspection to ensure that the vegetation to be removed does not consist of Threatened species.
- Clearing along the proposed rail corridor should be limited to the amount necessary to undertake earthworks and shall aim to minimise the construction corridor where possible.
- Installation of vegetation clearance markers (e.g. flagging tape, marker paint, high visibility poly-web fencing) prior to the commencement of vegetation clearance. Vegetation clearing shall be limited to the construction footprint. Construction equipment and personnel would not be permitted outside the construction footprint.
- Where possible, lopping or pruning of trees within the clearing zone is preferable to completely removing them. Pruning shall be undertaken in accordance with *Australian Standard AS 4373-2007 – Pruning of Amenity Trees.*

- Within areas where clearing must occur for construction purposes (but is outside of the actual footprint of the track and safety zones), clearing to ground level shall be minimised. If possible, slashing of existing vegetation layers or clearing with minimal ground disturbance (e.g. chain saw) shall be undertaken so that the soil seed bank is retained.
- Felled vegetation shall be economically salvaged as appropriate, such as mulching of smaller stems and branches, and sale of larger timber to contractors.
- Hollow logs, rocks and large debris shall be salvaged for use for habitat enhancement within areas for rehabilitation.
- Limiting any necessary slashing to a minimum height of 200 mm will allow for the retention of ground layer and understorey vegetation elements in all areas not directly utilised for infrastructure construction or access track purposes.
- Access tracks shall be located in conjunction with the environmental officer to avoid mature, remnant trees as much as possible.
- Intended vehicle access tracks to and along the infrastructure route shall be identified and marked at the commencement of the construction phase, to prevent the development of multiple access tracks.
- Features such as fill stockpiles, access tracks, site facilities etc. shall be located within the construction zone or in areas of existing disturbance.
- Storage of all materials and wastes (including general human waste) shall be restricted to designated areas that are at least 50 m away from waterway corridors. These shall be designed to ensure no off-site impacts occur (e.g. bunding should be placed around fuel and chemical storage areas).
- Soil stability shall be maintained in all disturbed areas, by means of erosion control mechanisms, including sediment barriers, berms, batters, fabric covers and/or mulching, temporary and permanent drains, etc.
- An experienced spotter catcher would be engaged to check vegetation for the presence of fauna immediately prior to its clearing. Mitigation for potential fauna mortality is included in **Section 12.5.5**.
- Penalties will be imposed for unauthorised clearing of defined protected vegetation or clearing of remnant vegetation without the direction of a fauna spotter-catcher.

Operation

Once the rail has been constructed there will be no further requirement for clearing of remnant vegetation. The rail corridor would be maintained on a regular basis through weed management and pruning of overhanging vegetation. During the operational phase, the focus on remnant vegetation would shift to the management of the offsetting and rehabilitation program. The location and securing of areas required for offsetting remnant vegetation as per the VM Act would be undertaken prior to operation. These areas would be the focus of the VMP (**Chapter 22, Environment management plans**). Mitigation would be as follows:

- Management of vegetation offsets to replace areas of remnant regional ecosystems removed by the proposed railway development. Offsets would be in line with the policy of the Department of Environment And Resource Management for vegetation management offsets, which is triggered under the VM Act. Refer to **Section 11.6** for more information regarding offset requirements. The final extent of offsets required and offset areas will be defined during the detailed design phase once the amount of clearing required has been finalised.
- Control and/or removal of any weeds in the corridor that have been introduced or exacerbated as a result of the works, with the aim being to leave the site in equivalent condition (or better, in terms of weeds) to prior to construction. The environmental officer shall take before and after photographs and site notes to verify the condition of the site.
- Weed establishment will be prevented on bare ground and in areas of revegetation.
- Rehabilitation of areas necessary for construction, but not required for the operational phase of the railway. For example, areas disturbed by construction of the bridges. Rehabilitation would aim to re-establish the original regional ecosystems present prior to disturbance.
- Rehabilitation shall be more specifically addressed within the VMP for detailed design, particularly: progressive staging of rehabilitation, recommended native species, incorporation of Threatened flora, recommended planting densities, incorporation of understorey where canopy species are excluded by structure and monitoring.

The operational phase would be overseen by an environmental officer, who would periodically monitor weed cover, replanting success and report necessary maintenance to operational management.

Decommissioning of existing railway

Sections of the existing railway route that would not be in operation and are located in ecologically significant areas would be rehabilitated. This would include the removal of all structures (fences, tracks, ballast etc), ripping of the surface, and reseeding using native species. Areas recommended for rehabilitation are:

- Addlington Creek (north)
- Dularcha NP
- North of Dularcha NP – Rose Road and surrounds
- Mooloolah River
- The Pinch Lane and surrounds (bioregional corridor)
- Eudlo Creek NP.

These areas are also discussed in **Chapter 21, Special management areas**. The existing rail corridor is approximately 20 – 25 metres. In order to rehabilitate the corridor, the following activities would need to be conducted:

- removal of any fencing or sound proofing
- removal of rail infrastructure (including track and overhead powerlines)
- removal of embankment (i.e. ballast)
- removal of contaminated materials

It should be noted that there is potential for the rail verges to be contaminated due to almost 100 years of weed control, including spraying of herbicide. It is likely that the contaminated material would need to be removed from site prior to rehabilitation. This is further dealt with in **Chapter 5, Geology and soils**.

- restoration of topography to suit existing landscape
- delineation of any recreational tracks
- site preparation (decompacting / ripping and topsoil) in area for planting
- mulching in area for planting
- planting (tubestock or seeding or hydromulching)
- regular maintenance (e.g. weed management) and monitoring.

Residual impact

The impact of habitat loss on terrestrial fauna is considered to have more severe short-term impacts, rather than long-term impacts, due to the offsets and rehabilitation proposed. Given the amount of clearing of remnant vegetation (21.71 ha) to be cleared and the mitigation measures to be employed, it is considered that the impact in the short-term would be **Moderate adverse** and the long-term impact would be **Low adverse**.

12.5.2 Habitat fragmentation and reduction in corridor functionality

Potential impact

Habitat fragmentation is a reduction in the continuity of a habitat through disturbance or loss. It often results in the creation of several small habitat patches (with varying degrees of connectivity) within a previously large and continuous remnant. The survival of species within habitat patches (whether small, large and/or isolated) depends, in part, on their ability to disperse. Discontinuity of suitable habitat linkages may present physical and psychological barriers that can impede or even prevent movement between habitats. The capacity to disperse is not equal among species. Native small ground dwelling mammals are often significantly affected by fragmentation because of their inability (either physically or psychologically) to traverse even a small distance of exposed ground. Arboreal mammals may move across open ground over a short distance, depending on movement capabilities of the species. For example, gliders are generally restricted to approximately 30 – 40 m whilst koalas are known to walk distances of 200 m to locate better habitat. Highly mobile taxa, like macropods, or birds are less affected by the introduction of cleared corridors within an area of habitat.

Isolation of fauna populations in small remnants increases their vulnerability to local extinction as a result of stochastic events (e.g. fire, drought and disease) and can decrease their genetic viability in the long term. The capacity of a habitat area to support a range of fauna is also influenced by its extent. Very small habitat areas may be unable to sustain animals with large territories / home ranges. Fauna restricted to these and relatively narrow / linear habitats, which support a high edge to area ratio, may be exposed to increased predation and competition from species in adjoining areas.

While railways do not sever wildlife corridors as significantly as roadways due to lower traffic volume, the proposed four carriageway alignment would be significantly wider than an average railway route. This would pose a barrier to less vagile species, particularly if large chain wire fences are constructed along the edges of the railway to prevent public access. The proposed realignment dissects three areas where vegetation is less influenced by fragmentation: 1. Dularcha National Park and Mooloolah forest reserve (Rose Road), 2. the mountain range between Mooloolah and Eudlo (The Pinch Lane), and 3. Eudlo National Park and surrounds. The first two of these areas are also recognised as bioregional corridors.

The project also crosses several water ways that are important to wildlife movement at a local scale. Currently, the existing railway dissects all these habitats. In all of these situations, the project would simply result in moving the dissection created by the railway from one location to another.

Proposed mitigation

Due to the nature of the rail corridor (linear infrastructure), it is not possible to avoid traversing areas that are acting as bioregional and local wildlife corridors. The most plausible mitigation method to decrease the effects of fragmentation and potential isolation of fauna populations is to provide sufficient places for them to cross the rail corridor safely. These strategies will be carried over into the detailed design phase, where applicable.

Design

Potential locations of crossing structures along the project have been identified in the initial planning stages of the project. The type of structure to be installed would vary depending on the locations. Overpasses with revegetation (land bridges) or tunnels are highly effective and preferred. However, bridges and culverts are also effective as underpasses in low-lying areas. Accordingly, fauna friendly crossing structures have been considered wherever possible in the design of the railway. Three crossing designs were considered:

1. Fauna bridges or overpasses are either constructed by tunnelling underground and leaving the ground surface intact or by construction of a bridging structure over the disturbance corridor. These allow replanting (where necessary) of native vegetation and placement of sheltering structures (e.g. fallen timber, rocks and debris) to facilitate safe passage. It is the most effective and preferred fauna crossing structure as it facilitates the movement of the greatest range of terrestrial fauna groups.
2. When required, fauna underpasses are usually constructed where a road or rail alignment crosses a river or creek line. Within significant fauna corridors, bridging structures are preferred where the footings are located in the channel or on the high bank, avoiding soil disturbance and allowing the growth of native vegetation. Bridges are preferred over culverts as they allow greater light penetration, natural substrates and increased sheltering opportunities.
3. Culvert underpasses are a less expensive alternative to the bridging structures and are usually located in low-lying areas. The traditional box style culvert may be slightly modified to include raised ridges that allow dry passage through the culvert. A minimum height of 3 m is recommended to allow passage of macropods.

Fauna overpasses and underpasses are facilitated by the use of exclusion fences and planting of native vegetation around the access points to the crossing structure. When combined with guide or exclusion fencing, these structures can facilitate fauna movement safely from one side of the railway to the other. Landscape treatments at entry points are considered crucial with regard to the attractiveness and safety of the underpass option for fauna. Higher numbers of animals and species are recorded in culverts with vegetated approaches or entrances, or those contiguous with native vegetation (Former Department of Main Roads, now Department of Transport and Main Roads, 2000).

When designing underpass structures, the accepted approach is that the larger and more natural the space, the more likely it is to be utilised. As such, the most desirable underpasses are those associated with bridging the embankments of watercourses. This allows for the maintenance of natural ground surface, the establishment of some vegetation where light allows, and the provision of 'furniture' such as poles, ropes and other runways to accommodate a range of fauna. The greater escape options offered by bridging structures as opposed to narrow culvert or dedicated underpass tunnels increases the potential success of these structures.

Chenoweth (2003) provides a summary of design principles for underpasses. This summary is reproduced in **Table 12.5.2**.

Table 12.5.2: Summary of design principles for fauna underpasses (Chenoweth [2003])

Principle	Recommendations	Additional design principles
Location / Placement of crossing	The distance between crossings is such that animals do not have to travel far to find a crossing; Underpasses/overpasses are located where cover from adjoining habitat or topography comes close to the railway on both sides; Crossings are located away from sources of disturbance such as dogs, houses, noise and pollutants; and Several overpasses, underpasses or tunnels are included to provide options and loops for animals to avoid disturbance, and to provide a more natural distribution of populations.	The location of crossings should give consideration to traditional routes. If exclusion fencing is employed then the distance between crossings should be considered against the species in the area to ensure fauna are not trapped in the event of fire.
Landscaping	Vegetation on the approach to crossings should therefore: 1. provide protective cover for animals approaching the crossing, particularly small to medium-sized animals 2. not obstruct access 3. not obstruct view of, or disguise, the entrance to the crossing 4. be representative of natural habitat of native species 5. attract native species to the crossing rather than onto the rail corridor	Work by Goosem (2003) indicated that by planting a corridor of rainforest vegetation (favourable to target species) from the edge of a natural stand of rainforest to the underpass that fauna was funnelled into the structure. The AMBS (2002a)* later recorded that foxes, wallabies and to a lesser degree dogs made more passages through underpasses where vegetation was further away (ie 50m) from the underpass opening, whereas species such as brushtail possums made more crossings where the vegetation was closer. Modifications to the design of the crossing apron can allow revegetation closer to the underpass.

Table 12.5.2: continued

Principle	Recommendations	Additional design principles
Box culverts	Must have unobstructed view of the far side of the culvert (must be a minimum of 3x3 m for wallabies and kangaroos; Must be designed so as to minimise the chance of water puddling;	Crossings should include at least one dry cell (ie raised culvert).
Underpass floors	Studies by Pieters (1992)* indicated that echidna, wallaby, kangaroos, possums and water rats utilise culverts with concrete floors. Use textured or natural substrate flooring where possible.	Small animals have been shown to be deterred by open spaces, therefore if large underpasses are to be utilised then a natural substrate with furniture should be utilised.
Furniture – hollow logs	Provides safe passage for smaller mammals and refuge from predators.	Although no statistical analysis could be undertaken there was evidence that fauna utilise poles and logs in underpasses through the presence of scratches (AMBS, 2002a, b)*.
Furniture – refuge poles	May encourage arboreal mammals to utilise tunnels, along with refuge from predators.	Although no statistical analysis could be undertaken there was evidence that fauna utilise poles and logs in underpasses through the presence of scratches (AMBS, 2002a b)*.
Furniture - ledges	Ledges have been demonstrated to be used by small fauna and should be placed in dry culverts.	Require ramp up and down on each side of culvert.
Detritus/silt traps	Have a deleterious effect on the range of fauna likely to utilise a culvert. They should therefore be designed and located as not to impede fauna movement.	Yanes, Velasco and Suarez (1995)* also note that detritus pits also form a barrier to fauna movement and should therefore be eliminated or modified by using ramps.
Lighting	Artificial lighting may be detrimental in underpasses.	Skylights may facilitate movement in underpasses greater than 30 m in length.

Construction

The primary measures to mitigate potential impacts of habitat fragmentation on large areas of remnant vegetation are related to incorporating fauna crossing mechanisms into the design of the railway and managing the crossing structures during the operational phase. In terms of construction, the most appropriate mitigation measures are related to the minimisation of corridor width and retention of ground cover and understorey vegetation under bridges. Hence, the mitigation measures described in **Section 12.5.1** (construction) are also appropriate to lessen the impacts of habitat fragmentation.

Operation

A significant element of the success of such structures is on-going maintenance. Fauna underpasses, guide fencing and verge treatments require regular monitoring and maintenance to ensure their effectiveness and to allow remedial actions to be taken if trouble spots are recorded. Underpass structures are most effective when regularly maintained. Long, rank grasses, dense weed infestations and wet conditions are characteristic of bridge and culvert underpasses; however these conditions are not attractive to some species, which may be deterred from using a crossing structure under these circumstances. In areas where maintenance is difficult, the installation of a timber pole above the ground to the entrance and through the underpass may offer the best solution to facilitate use by arboreal mammals.

At underpass locations, regular weed control, slashing of grasses, and removal of silt that may cause water to pond, is necessary. In addition, where appropriate vegetation is not already in place, a rehabilitation program should ensure that the preferred conditions are provided and maintained.

A fauna crossing management and maintenance plan has been incorporated into a Fauna Management Plan (**Chapter 22, Environmental management plans**) to ensure full consideration of ongoing maintenance obligations.

Decommissioning of existing railway

Sections of the existing railway route that would not be in operation and are located in ecologically significant areas would be rehabilitated. This would include the removal of all structures (fences, tracks, ballast etc), ripping of the surface, and reseeding using native species. Areas recommended for rehabilitation are:

- Addlington Creek (north)
- Dularcha NP
- North of Dularcha NP – Rose Road and surrounds
- Mooloolah River
- The Pinch Lane and surrounds (bioregional corridor)
- Eudlo Creek NP.

Residual impact

The mitigation measures proposed would reduce the impacts that would be created by fragmentation of habitat and reduced corridor functionality. However, it is not possible to ensure the safe local migration of fauna species at the same rate that occurs at present because the larger railway would represent a more significant barrier to movement. For this reason the impact of the proposed railway development in relation to habitat fragmentation and corridor functionality is **low – moderate adverse**.

12.5.3 Decreasing condition of habitat

Potential impact

Clearing for infrastructure within areas of remnant vegetation would increase the boundary to area ratio of several vegetation communities and increase the potential for edge effects, as described in **Chapter 11, Terrestrial flora**. The impact of increasing edge effects on fauna relate primarily to a decrease in the effective area of habitat (due to weed invasion) and an increase in competition for resources with aggressive pest or 'edge' species. Depending on the disturbance and the shape of the remaining remnant patch, the processes associated with habitat edges may extend well into a habitat area resulting in the eventual displacement of more sensitive native fauna.

The project dissects three areas where vegetation is less influenced by fragmentation: 1. Dularcha National Park and Mooloolah forest reserve (Rose Road), 2. the mountain range between Mooloolah and Eudlo (The Pinch Lane), and 3. Eudlo National Park and surrounds. The first two of these areas are also recognised as bioregional corridors. The extent of new edge created by the project is 4.85 km. The project also crosses several water ways that are more susceptible to edge effects and disturbance due to the narrow width of the riparian vegetation (resulting in a high perimeter to area ratio).

Proposed mitigation

The mitigation measures described in **Section 11.5.5, Chapter 11, Terrestrial flora** would be effective in the mitigation of impacts of edge effects on terrestrial fauna.

Residual impact

Whilst the mitigation measures proposed would reduce some impacts that would be created by edge effects, it is not possible to avoid degradation of the habitat qualities of the remaining remnant areas. Essentially, the proposed railway development would result in the replacement of large remnants with good quality habitat with smaller remnants with a higher edge to area ratio. For this reason the impact of edge effects created by the rail corridor on fauna is **low-moderate adverse**.

12.5.4 Introduction of feral animals

Potential impact

The current assessment and previous studies have recorded the presence of a variety of introduced fauna species, including house mouse, black rat, dog, fox, feral cat, brown hare, cane toad and several bird species. Evidence of occurrence for these taxa was mostly concentrated in areas close to rural residential or residential developments. Most pest species are assumed to have resident populations in these areas, though their abundance is likely to vary. Feral animals threaten populations of native wildlife in two main ways: direct predation (e.g. foxes, cats, dogs) or competition for limited resources (e.g. bird species, rodents, cane toads, pigs).

Of the introduced species recorded, foxes are identified as 'declared' Class 2 pest animals under the Regulations of the *Land Protection (Pest and Stock Route Management) Act 2002*. Section 77 of the Land Protection Act places the responsibility on the owner of land to take reasonable steps to keep the land free from these species. Furthermore, the EPBC Act lists predation (foxes, feral pigs and cats), competition, land degradation (feral pigs), and disease transmission (feral pigs and cats) as key threatening processes to a variety of faunal groups (Environment Australia 1999a, 1999b and DEH 2005a). The biological effects, including lethal toxic ingestion, caused by Cane Toads are also listed as a key threatening process under the EPBC Act (DEH 2005b).

Feral animals are more likely to penetrate areas of habitat that have been disturbed. Hence, habitats that are suffering the impacts of edge effects would often be associated with a population of feral animals. As identified in **Section 12.5.2**, the construction of the project would bisect several contiguous areas of habitat. Essentially, the proposed railway development would result in the creation of a corridor of disturbance, which may facilitate movement of feral species (such as foxes, dogs and cats), and the creation of disturbed environments that may be attractive to feral species.

Proposed mitigation

In order to reduce the penetration of natural habitat by introduced pest species, it is necessary to minimise the clearing of remnant vegetation and reduce edge effects. Hence, the mitigation measures described in **Section 11.5.1** and **Section 11.5.5, Chapter 11, Terrestrial flora** would be effective in the management of pest species. However, there are some additional strategies that would specifically target the control of feral animals. These strategies will be carried over into the detailed design phase, where applicable.

Design

Implementation of design features for permanent structures (e.g. stations, maintenance sheds, etc.) and temporary site facilities (e.g. construction site offices. etc.), which minimise harbourage of mammalian pests and roost opportunities for problematic bird species (particularly gulls, ibis and pigeons) is recommended.

Construction

Implementation of a program to ensure strict litter control throughout the construction site is recommended. This is to be supported by: site-wide signage; an adequate number of litter bins (which by design exclude birds and vermin); bin clearance on a regular basis; daily maintenance of crib rooms to ensure cleanliness; educational signage within crib rooms on the linkage between poor waste management practices, increases in pest animal populations and subsequent impacts to native fauna. This has been incorporated into the waste management section of the EMP (**Chapter 22, Environmental management plans**).

Operation

Feral animal control strategies would be developed and implemented under a feral animal control plan. Queensland Rail already has a pest management strategy in place and will be responsible for pest control activities conducted along the alignment. Key measures of the control plan would include:

- design and implementation of an ongoing trapping and eradication program that targets pest animals

Trapping procedures would be undertaken by suitably trained personnel.

- design and implementation of an ongoing systematic monitoring program to detect the occurrence of feral animals and to assess the success of the trapping and eradication program.

Decommissioning of existing railway

Sections of the existing railway route that would not be in operation and are located in ecologically significant areas should be rehabilitated. This should include the removal of all structures (fences, tracks, ballast etc), ripping of the surface, and reseeding using native species. Areas recommended for rehabilitation are:

- Addlington Creek (north)
- Dularcha NP
- North of Dularcha NP – Rose Road and surrounds
- Mooloolah River
- The Pinch Lane and surrounds (bioregional corridor)
- Eudlo Creek NP.

Residual impact

It has been identified that a considerable portion of the project corridor is supporting populations of feral animals. In this sense the proposed railway development would not result in the introduction of feral species into the area. However, the railway may facilitate the immigration of feral animals into other areas of natural habitat, where they have not been previously.

The mitigation strategies listed would help to manage the impacts associated with high numbers of feral animals. In this case, it is considered that the development of the project would result in a **low adverse** impact in relation to the introduction of feral animals.

12.5.5 Fauna mortality

Potential impact

There are potentially two sources of direct impact on fauna populations during the life of the proposed project. Firstly, there is a direct risk presented to the welfare of native fauna during the construction stage of the development. Secondly, there is an ongoing risk of train strike during the operational phase of the project. These are discussed below:

Construction

There are a couple of issues of animal welfare caused by the clearing of habitat. Firstly, there is the chance that the clearing operations and subsequent construction would directly result in the death of some native fauna. Fauna may be killed or injured by the machinery involved in the site works or could be killed fleeing from the area of works by falling trees or debris. Often reptiles and frogs are most affected by machinery as they tend to remain hidden in ground cover. Arboreal mammals and birds are more likely to be impacted by falling trees and other debris. Secondly, the removal of habitat would result in displacement of mobile species (e.g. birds and mammals) to similar habitats in the surrounding area. Individual animals which can not establish new territories in other habitats (either in the surrounding area or within the project area) are likely to migrate from the area, increasing their susceptibility to accidents and predation. These animals often perish as a result of failure to compete for resources with animals that are able to defend established territories. It is likely that the clearing activities would result in the death of some individual animals, however, it is unlikely that any species would be Threatened with local extinction as a result of the proposed removal of habitat.

Operation

Road mortality has been implicated in the decline of wildlife populations, including species of conservation significance (e.g. Mallick et al. 1998; Jones 2000; Taylor and Goldingay 2004) though there is little research that has investigated fauna mortality related to the operation of railways (Bennett 1991). The majority (75%) of the project has been located through areas of relatively low biodiversity significance. This combined with the low-medium frequency of services (approximately every 15 minutes, throughout the day) would indicate that the likelihood of incidents of fauna strike in these areas is very low. However, in places where the project traverses large areas of remnant vegetation (e.g. Dularcha National Park, Eudlo National Park and the bioregional corridors), the proximity of the vegetation to the track and the high habitat quality would increase chances of fauna strike.

Proposed mitigation

In order to reduce the chance of fauna mortality occurring throughout the lifetime of the project, it is necessary to implement mitigation measures that would influence the construction and operational phase of the railway. These strategies will be carried over into the detailed design phase, where applicable.

Design

Exclusion or guide fencing for wildlife has been employed successfully throughout the world to minimise the impacts of roadways on fauna, with positive outcomes for reducing road-kill numbers. The principles behind these structures are also applicable to rail corridors. Unlike many overseas species, Australian native fauna do not follow traditional migratory patterns over generations, their movements are unpredictable, and the use of exclusion or guide fencing to manage their movement must be carefully considered.

It is recommended that fencing be installed to minimise fauna-train collision and to guide fauna to road underpasses. Due to the unpredictable movement and dispersal patterns of the fauna it is not possible to ensure that all animals are guided to these crossing points, hence the aim is to minimize, rather than prevent casualties. The location of fencing must be determined on a case-by-case basis considering local conditions, taking into account a range of management considerations. Furthermore, it is possible for exclusion or guide fencing to create difficulties for fauna. These difficulties are related to:

- the requirement for removal of trees and shrubs within 3 m of guide fencing
- any role a guide fence plays in preventing escape from predators or fire
- interrupting the normal movement patterns of individuals.

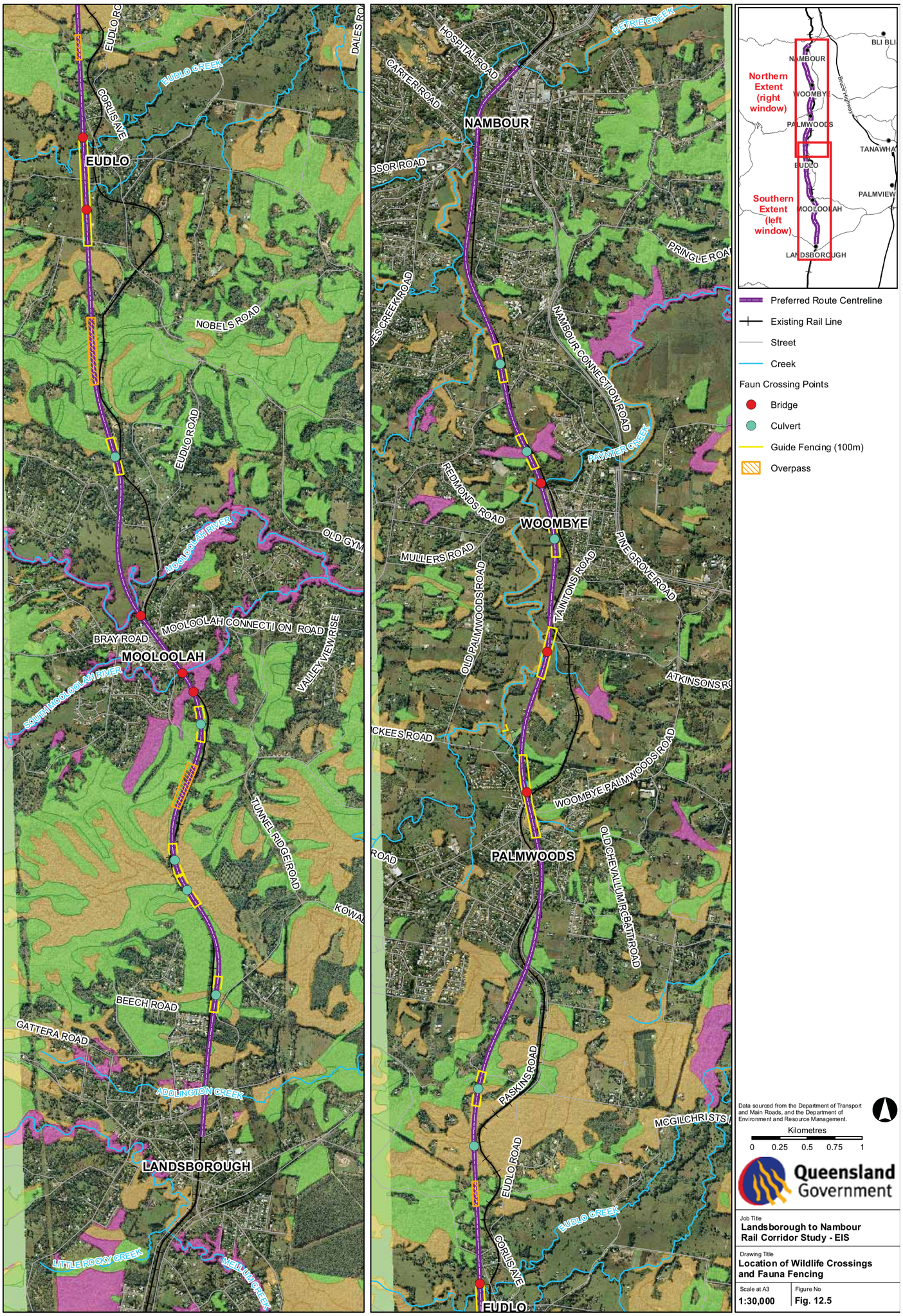
These potentially negative aspects must be considered against the risk for an individual animal crossing the railway at a dangerous location. In consideration of the low-medium frequency of trains and the importance of continued fauna movement through the region, no exclusion fencing has been recommended at this stage. All fencing shall be fauna friendly. If fauna strike becomes an issue in a location during the operational phase of the project, the merits of exclusion fencing will be considered at that time.

The following specific design features for fauna exclusion fencing are recommended:

- Fencing shall be positioned to allow fauna movement to crossings (culverts, bridges etc). Current fencing runs along the railway across the front of culverts inhibiting fauna access.
- The fence needs only be 1.2 m high, with 80 cm strip of metal (such as colorbond) attached to the top rail on the exclusion (bushland) side of the fence.
- Clearing or maintenance of overhanging branches as branches can be retained that are further than 1.5 m above the fence.
- An area 3 m from the fence needs to be cleared and maintained to prevent animals from jumping onto or over the fence from nearby trees and shrubs.
- As there will always be individuals that enter the rail corridor and are confronted by fenced areas, it is important to provide opportunities for those individuals to leave the railway. To accommodate re-entry by larger, non-arboreal species, it is recommended that earth mounds are set against the inside (rail side) of the fencing at 50 m intervals.
- It is not possible or practical to provide crossing areas along the full length of the project. Outside of the fenced areas, the railway can be treated so that fauna are not attracted to the rail side, thereby reducing train and fauna interactions. In particular, verge treatment which requires the removal of low vegetation, such as shrubs, herbs and grasses, from the verge of the railway for a distance of 3m, increases the visibility of fauna about to cross a railway and reduces sudden panic movements when startled by train noise.

Fauna guide fencing would be constructed within 100 m of either side of a fauna crossing structure. It is likely that a large proportion of the railway would be required to be fenced to prevent public access. In significant habitat areas where fencing is required, the fencing would be fauna friendly with a 30 cm gap at the bottom to allow movement beneath. It is important to note that, before any exclusion or guide fencing is installed, the treatment for safe crossing must be installed first. The installation of fauna exclusion fencing and guide fencing is indicated in **Figure 12.5**.

Figure 12.5: Location of Wildlife Crossings and Fauna Fencing



Construction

To minimise the adverse direct impacts on a variety of terrestrial fauna (mammals, reptiles, frogs and birds) during vegetation clearance, a fauna management plan has been developed (**Chapter 22, Environmental management plans**). The plan would provide strategies and actions to avoid / minimise fauna mortality during vegetation clearance and disturbance to fauna within adjoining habitat areas during the construction phase. Strategies include:

- Wildlife assessment / rescue services are to be engaged prior to vegetation clearing, to assess appropriate site clearing approaches to minimise deleterious impacts to fauna. Spotter/catcher services are to be employed until all clearing has ceased.
- The location of nests / dens or fauna would be clearly marked with flagging tape and these areas would be buffered by 10 m and retained until the fauna has moved on of its own volition.
- Development and implementation of protocols for any displaced fauna are to be relocated to more suitable similar habitat within the surrounding area.
- Fauna exclusion fences will prevent fauna re-entering the construction site.
- Where possible, the timing of vegetation clearance (particularly remnant vegetation associated with waterways) would be selected in order to minimise impacts (direct and indirect disturbances) to affected fauna habitats during optimum breeding periods.
- Habitat enhancements will be established to retain remnant habitat within the project (e.g. artificial roost boxes for microbats).

Operation

As the clearing phase of the project is not ongoing, mitigation of fauna mortality at the operational phase would concentrate on the effectiveness of fauna exclusion fencing. Some of the ongoing mitigation measures are as follows:

- monitoring of the condition of fence lines required to ensure that there has been no damage to the fence and that guide fences and exclusion fences are operational
- repair of fences as required
- monitoring of fauna strike incidents, so that any 'hot spot' areas can be identified and measures put in place to ameliorate the problem.

Residual impact

With the implementation of the mitigation strategies cited in this section, and other parts of the EIS, it is considered that the construction and operation of the project in relation to fauna mortality resulting from incidents with trains and during construction is a **low adverse** impact.

12.5.6 Removal of significant species

Potential impact

Through a review of existing information and the findings of the current habitat assessments and fauna surveys, a variety of Rare and Threatened species have been identified within the project area. These fauna species have been specifically addressed below:

Richmond Birdwing (Ornithoptera richmondii)

Some areas which provide suitable habitat for the larval food plant *P. praevenosa* would be lost due to the project. However these losses may be mitigated through replanting strategies. The butterfly readily crosses large canopy gaps and fragmentation of existing habitats is not likely to affect movement patterns.

Tusked Frog (Adelotus brevis)

Direct impacts are expected to occur on populations of this species due to the loss of habitat to facilitate the crossing of waterways by the rail corridor. Most habitat loss would occur along less significant waterways where culverts are installed, requiring the clearing of streambank and aquatic vegetation. Less long-term impacts would occur at bridges, particularly if bridge structures are set back from the low bank, retaining natural stream bank formation and allowing vegetation growth. While Tusked Frogs are relatively tolerant of indirect impacts such as deterioration in water quality, these impacts may affect populations downstream of construction activities. Mitigation measures should be implemented to reduce the severity and/or duration of these impacts.

Wallum Froglet (Crinia tinnula)

The project is not expected to result in the direct disturbance or loss of existing, known *C. tinnula* habitat. The proposed options may have indirect impacts such as altered water quality from increased sedimentation and hydrocarbon / chemical pollution. With appropriate planning and mitigation strategies, both direct and indirect impacts can be minimised.

Giant Barred Frog (Mixophyes iteratus)

The species is known from several waterways in the project area, Addlington Creek, South Mooloolah River, Mooloolah River and Eudlo Creek. The project intersects the Mooloolah River, which is known to support relatively extensive *M. iteratus* habitat. The project has been located so that it crosses a small section of the river at a point where the vegetation does not meet remnant criteria, hence reducing impacts on the surrounding good quality habitat. Impacts associated with waterway crossings in areas known to support *M. iteratus* may include:

- the fragmentation of populations through the loss of traditional dispersal / movement routes
- reduction of habitat quality, particularly along newly created habitat edges through the introduction of weed species and increased light penetration
- loss of habitat quality downstream through increased sediment loads and pollution from construction materials, liquids and chemicals
- decreased bank stability (important for oviposition) resulting from increased water velocities due to the loss of riparian vegetation and increased impervious surfaces upstream
- increased predation and competition as exotic species utilise the created vegetation gaps to access previously inaccessible habitats.

Elf Skink (Eroticoscincus graciloides)

Some areas inhabited by this species would be lost as a result of the proposed project. However, in the context of surrounding habitat and the species' versatility, impacts could be expected to be minor and localised. Fragmentation of existing, connective habitats may also segregate previously continuous populations. This is a small reptile that can persist within small areas of habitat, and populations are known to exist in isolated areas (e.g. parks and gardens), and while fragmentation of habitats is not likely to cause serious deleterious effects on local populations, mitigation strategies should be employed to ensure that existing habitat connections are maintained.

Grey Goshawk (Accipiter novaehollandiae)

The proposed activities would result in the loss and fragmentation of some habitats that are likely to be currently used as hunting areas by resident Grey Goshawks. However, the species is considered to be highly mobile, readily crossing areas of unsuitable habitat. Consequently these impacts would be minor and localised. Grey Goshawks will tolerate some minor disturbance around their nest trees without abandonment (Marchant and Higgins 1993). However they are unlikely to tolerate significant disturbance associated with the construction of a railway and may abandon nest sites in close proximity to the rail.

Square-tailed Kite (Lophoictinia isura)

The proposed rail construction would result in the loss and fragmentation of existing habitat. However, the species is highly mobile and regularly observed crossing large expanses of unsuitable habitat to access areas of favourable habitat. Impacts are therefore likely to be localised and minor. No nesting trees of this species are known to occur within the impact areas.

Lewin's Rail (Rallus pectoralis)

The level of impact on this species depends largely on how regularly habitats within the Project area are utilised by the species. No individuals were observed during the surveys although riparian rainforest was present within the project area. Impacts on habitat are likely through bridge crossings. Secondary impacts through sedimentation of waterways may also occur. However, these habitats are usually tolerant of such impacts and unlikely to be significantly affected.

Glossy Black- Cockatoo (Calyptorhynchus lathami)

Clearing of vegetation containing *Allocasuarina* food trees may occur where the project passes through open eucalypt forest. This is, however, predominantly restricted to two ridge lines within the project area. The severity of impacts will depend on the nature of the disturbance at these locations. Should the railway pass through the ridges via tunnels, then very little impact is expected.

If, however, the rail route is constructed using cuttings, then the disturbance would be more notable. Nevertheless, foraging resources are not common and their loss is not considered likely to significantly impact local populations. Glossy Black-Cockatoos are highly agile species able to cross large areas of unsuitable habitat and fragmentation caused by the construction of the project is not likely to impact on traditional movement patterns.

Powerful Owl (Ninox strenua) and Sooty Owl (Tyto tenebricosa)

Linear habitat loss would occur as a result of the construction of the rail corridor. However the disturbance is likely to be restricted to approximately a 60 m corridor, which would be readily crossed by Powerful Owls and Sooty Owls. No nest trees have been located within the disturbance area and provided that none are disturbed by the project, breeding would not be directly affected. Impacts on this species are likely to be restricted to indirect impacts resulting from the loss of prey density. Powerful Owls and Sooty Owls largely feed on arboreal mammals, which are abundant within the project area. Impacts on arboreal prey species are expected to be localised.

Koala (Phascolarctos cinereus)

Clearing activities may result in the felling of trees inhabited by Koalas causing serious injury or death. Appropriate mitigation measures can largely negate this impact. Some habitat loss would also occur, however as clearing would be largely restricted to a linear strip of approximately 60 m wide, the loss of this habitat is not considered severe in the context of habitat available within the surrounding area. The greatest potential impact to Koalas is the loss of connectivity between habitats that would result from the construction of the rail route and associated facilities, as well as increasing long-term mortality rates through rail strike. Mitigation measures may be implemented to reduce the severity of impacts.

As the development would occur in an Urban Koala, the material change of use will be assessed against the *Draft South East Queensland Koala State Planning Regulatory Provisions* by Department of Infrastructure and Planning (DIP). For a development that will result in clearing of >2500m2 and result in the loss of mature koala habitat trees an 'Offset for net benefit to koalas and koala habitat' (Schedule 3) must be provided. Calculating this offset requires an assessment of the area and quality of koala habitat that will be lost. Generally, high quality habitat will require a greater offset. The offset must be in or adjoining the same urban koala area or adjoined to a contiguous cluster. It must be currently under threat or cleared and be legally secured by the applicant. A Memorandum of Understanding undertaking to find and secure and offset must be supplied to the Department of Infrastructure and Planning by the Department of Transport and Main Roads.

Grey-headed Flying-fox (Pteropus poliocephalus)

No known roosts occur within the project area and hence impacts are restricted to the loss of foraging vegetation. Losses would occur wherever native vegetation removal is required. In the context of surrounding habitat and resources it is unlikely that the loss of habitat for the railway construction would be significant.

Proposed mitigation

The mitigation measures listed in **Section 12.5.1** and **Section 12.5.5** would also be effective to reduce the likelihood of impacts on populations of significant species. Thirteen significant species have been identified within the project area. In the lead time to construction, a suitably qualified ecologist would undertake a field survey of the area of works. In the event that a nest / den / roost of a Threatened species is located a Threatened Fauna Management Plan that is specific to the site would be prepared. Some aspects of this plan may need to be implemented prior to construction commencing, i.e. relocation or habitat rehabilitation programs.

Management recommendations for targeted species are summarised in the following section and it is expected that these mitigation strategies will be carried through to the detailed design phase of the project, as applicable.

Richmond Birdwing (Ornithoptera richmondii)

Operation

- Revegetation of disturbance zones not required for operation shall include the planting of *P. praevenosa* where suitable.
- All *A. elegans* identified during revegetation and construction shall be removed.

Tusked Frog (Adelotus brevis), Wallum Froglet (Crinia tinnula) and Giant Barred Frog (Mixophyes iteratus)

Design

- The project shall minimise the impact on waterways and creeklines by avoiding these areas as much as possible.
- Large culverts or preferably bridge structures shall be located in those areas where habitat for *Mixophyes iteratus* and *C. tinnula* occurs. This would allow movement of individuals to alternative areas of habitat.
- Where bridges are possible, bridge footings / abutments shall be set back at least 20 m from the natural waterway bank with a bridge height that would allow retention of rainforest understorey at the site or treatment of the area under the bridge to convey movement of the frogs. It would be advantageous to separate tracks in some locations to maximise light penetration under the bridge. This would reduce habitat disturbance and allow native vegetation and flood debris to accumulate in which the species may shelter.
- Where bridges are possible, bridge footings / piers / abutments should avoid placement within the water channel where possible. If this is unavoidable due to structural constraints, footings / piers / abutments within the water channel must be designed to minimise impacts on the natural flow of the waterway.

Construction

- Construction shall avoid peak breeding times around November to February.
- Soft-construction methods are recommended for bridges, where footings are put in place with minimal clearing and pre-fabricated units are then installed.
- Spotter-catchers shall conduct pre-clearing surveys for *M. iteratus* and relocate individuals where possible. If relocation is not possible, areas of high frog activity shall be flagged and avoided until activity has decreased.
- Hydrocarbons shall not be stored within 100 m of creeklines and waterways.
- All areas where soil, chemicals and hydrocarbons are stored should be bunded to avoid surface flow into creeklines.
- Sediment control structures shall be established during construction to reduce sediment loads entering waterways.

- Soil disturbance shall be minimised to avoid excess surface flow carrying sediments into waterways.
- Areas under bridges within known *M. iteratus* habitat shall be mulched with leaf litter prior to rehabilitation. Disturbed banks shall be stabilised and revegetated as soon as possible and habitat enrichment with logs and other large debris undertaken.

Operation

- On-going weed management shall be essential around and under bridge crossings, especially in *M. iteratus* habitat.
- Vegetation around and within Eudlo Creek National Park is mapped as Essential Habitat under the VM Act) for *Adelotus brevis*. In order to satisfy the codes relating to Essential Habitat under the VM Act, habitat offsets would be necessary if clearing of this habitat occurs. Policies relating to habitat offsets are discussed in **Section 11.6, Chapter 11, Terrestrial flora**.
- Vegetation in the southern portion of Dularcha National Park is mapped as 'Essential Habitat' for *Crinia tinnula*. Consequently, any clearing of this habitat would require and offset strategy. Policies for suitable habitat off-sets are outlined in **Section 11.6, Chapter 11, Terrestrial flora**.

As *Mixophyes iteratus* was subject to a referral to DEWHA, more detail on the management of this species is shown in **Appendix F**.

Elf Skink (Eroticoscincus graciloides)

Design

- Bridge footings shall be positioned back from waterway banks to allow fauna passage and vegetation regrowth.
- Overpasses could be considered in suitable locations where the rail route could include either a tunnel or cut and refill structure.

Grey Goshawk (Accipiter novaehollandiae)

Construction

- Construction shall occur outside of breeding season (August – December) to avoid excessive disturbance to breeding pairs.

Square-tailed Kite (Lophoictinia isura)

Construction

- Clearing of large trees in riparian areas will be minimised to protect potential nest trees.

Lewin's Rail (Rallus pectoralis)

Design

- In the area of most suitable habitat located near Jubilee Drive in Palmwoods, the rail is set on pylons to minimise habitat disturbance.
- The bridging structure shall be sufficiently high above the ground surface to allow reed and grass regrowth.

Glossy Black- Cockatoo (Calyptorhynchus lathami)

Operation

- Revegetation of disturbed areas shall include seeding with *Allocasuarina littoralis* and *A. torulosa*. This would help establish a foraging source to compensate resources lost through the construction of the project.

Powerful Owl (Ninox strenua) and Sooty Owl (Tyto tenebricosa)

Design

- To ensure that populations of prey species are maintained, fauna crossing structures should be incorporated into the design of the project. Such structures may include overpasses (tunnels or cut and refill) and/or underpasses.

Construction

- Clearing shall be kept to a minimum to avoid the loss of Owl habitat.
- Pre-clearing surveys shall be undertaken along the project to check for potential nesting trees and to ensure such trees are not in current use.

Operation

- Rehabilitation of cleared areas not required for operational works shall be undertaken to increase foraging habitat.

Koala (Phascolarctos cinereus)

Design

Fauna crossing structures and guide fencing shall be sympathetic to Koala requirements. Details of particular relevance to Koalas include:

- The realignment design shall consider tunnelling beneath the two ridges located at Rose Road and near The Pinch Road. This would ensure that current movement corridors are not altered and reduce habitat loss.
- Bridges shall be constructed at large waterway crossings and their footings should be set back from the waterway edge to allow dry passage.

- Fauna friendly culverts shall be used at all other creek and waterway crossings. These large box-style culverts have raised edges to allow dry passage. Retreat posts shall also be installed outside the entrance to the culvert to allow predator avoidance.
- Fauna exclusion fencing shall only be used within 100 m either side of fauna crossing structures in order to guide Koalas into crossing structures.
- Safety fences shall only be used in those areas where public access is possible or likely (ie, near roadways etc). Whenever used, safety fences shall be constructed with a gap of approximately 30 cm at ground level to allow koalas to move underneath the fence.
- Safety fences shall not be positioned or pass in front of culverts and bridges. Rather, they should be positioned above the culverts so that passage is not hindered.

Construction

- Clearing shall be minimised wherever possible to avoid the unnecessary loss of koala habitat. Clearance zones shall be clearly delineated to avoid accidental clearing.
- A qualified spotter/catcher shall be present during clearing activities to ensure that clearing does not result in the injury or death of individual koalas. Clearing shall proceed under the direction of the spotter/catcher.

Operation

- Revegetation of disturbance areas not used during construction shall include native koala feed tree species suitable for the replanting situation (eg, *E. propinqua* on ridges and *E. microcorys* in gullies).

Grey-headed Flying-fox (Pteropus poliocephalus)

Operation

- Disturbed areas of vegetation not required for operational use shall be rehabilitated using native flowering and fruiting tree species suitable for their locations (eg, *Syzygium* in gullies, *E. tereticornis* on floodplains and *E. propinqua* on ridgelines).
- Overhead wires are to be fauna-proofed to reduce the risk of electrocution.

Residual impact

With the implementation of the mitigation strategies in this section, and other parts of the EIS, it is considered that construction and operation of the project in relation to significant fauna is a **low adverse** impact with potential for **moderate adverse** impact on *M. iteratus*.

12.6 Summary and conclusions

The project traverses a significant area of remnant vegetation. The area affected by the project is relatively large and supports a diversity of habitats, including eucalypt open forest, eucalypt woodlands, wet sclerophyll forest, riparian rainforest, paperbark wetlands, swamps and notophyll vine forest. The diversity of habitats and large area of remnant vegetation has lead to a high diversity of terrestrial fauna, including some species of conservation significance within the project area. Clearing of remnant vegetation would effect 25% of the project between Landsborough and Nambour and occur in all the habitat types identified. The greatest area of impact would be around the southern portion of the project area from Landsborough to Palmwoods, where a large number of fauna seem to be concentrated in large areas of remnant vegetation.

Due to the linear nature of the rail infrastructure it has not been possible to avoid the areas identified as valuable habitat, including: Dularcha National Park, Eudlo Creek National Park, two Bioregional wildlife corridors (in the areas around Rose Road and The Pinch Lane) and the major waterways that support remnant riparian rainforest (Addlington Creek, South Mooloolah River, Mooloolah River, Eudlo Creek, Paynter Creek and Petrie Creek). Clearing, construction and rail operation in these areas would need to be managed to ensure impacts on terrestrial fauna are minimised as far as possible.

A summary of impacts of the project on terrestrial fauna, proposed mitigation and rating of impacts after mitigation is shown in **Table 12.6**.

Table 12.6 Summary of Impacts and Mitigation (Fauna)

Potential Impact	Mitigation Strategy	Residual Impact Significance
Clearing of remnant vegetation	▪ avoid significant areas where possible ▪ engage environmental officer for construction phase ▪ limit clearing to that which is necessary and clearly indicate construction zone ▪ enforce penalties for clearing protected vegetation ▪ limit access tracks ▪ rehabilitation and offsets.	moderate adverse (short-term) and low adverse (long term)
Habitat fragmentation and reduction in corridor functionality	▪ installation of bridges with footings / abutments set back 20 m from the low bank, particularly at South Mooloolah River and Mooloolah River ▪ culverts to be designed to allow fauna movement particularly at Addlington Creek (north) ▪ use of tunnels and land bridges (cut and cover construction methods) in areas where connectivity is important (i.e. wildlife corridors) ▪ rehabilitation and offsets ▪ re-establishment of vegetation on decommissioned railway in areas where connectivity is important.	low – moderate adverse
Decreasing condition of habitat	▪ avoid clearing in small (<2 ha) remnant patches, where possible Weed management along new edges ▪ buffer plantings along new edges.	moderate adverse
Introduction of feral animals	▪ design of permanent structures to minimise the harbouring of pests ▪ waste management on construction sites ▪ mitigation of edge effects ▪ rehabilitation ▪ ongoing trapping and eradication program.	low adverse
Fauna mortality and animal welfare	▪ pre-construction surveys to identify nests, dens or roosts to be buffered from construction until fauna moves on or is relocated (whichever is most appropriate) ▪ timing of construction to avoid peak breeding seasons around spring and early summer ▪ presence of a spotter-catcher during all clearing operations ▪ fauna proofing of over head wires ▪ exclusion fencing and guide fencing around fauna crossings ▪ monitoring of fauna / train collisions to identify any 'hot spots' that need to be managed.	low adverse
Removal of significant species	▪ constraining corridor clearing widths to minimum ▪ avoidance of high quality habitat ▪ pre-construction surveys and employment of a spotter-catcher during clearing activities ▪ rehabilitation post disturbance ▪ incorporation of needs of significant species into the design of bridges and fauna crossings.	low adverse (most species) and moderate adverse (for *M. iteratus*)