Part of Section 6 of PER	Matter of NES	Applicable segment along the Tarkine Forest Drive	Objective of safeguard and mitigation measures	Safeguard and mitigation measures	Assessment of the expected or predicted effectiveness of safeguard and mitigation measures (see Section 6.3.3 for further analysis)	Significant residual impact after safeguards and mitigation measures.
6.3.2	Tasmanian devil (Sarcophilus harrisii) EPBC Act status: Endangered	A B C D E F G H I J K L M N ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	Minimise the incidence of roadkill Monitor the incidence of roadkill Minimise noise disturbance to dens in close proximity to construction activities	Inductions and toolbox meetings Daylight hours only operation 60 kph speed limit between dusk and dawn Identification of high risk roadkill spots Move roadkill away from the road corridor Report injured animals or roadkill EPG to manage noise during the construction phase	Likely to be effective	Unlikely
6.3.2	Tasmanian azure kingfisher (*Ceyx azureus diemenensis*) EPBC Act status: Endangered	A B C D E F G H I J K L M N □ □ □ □ ■ □ ■ □ □ □ ■ □ □ □	Avoid disturbing nesting birds in the vicinity of the Rapid River bridge replacement	Conduct pre-construction field survey Fabricate bridge components offsite	Likely to be effective	Unlikely
6.3.2	Tasmanian masked owl (*Tyto novaehollandiae* subsp. castanops) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	Minimise the incidence of roadkill Monitor the incidence of roadkill Plan for the discovery of nesting habitat during vegetation clearance	Inductions and toolbox meetings 60 kph speed limit between dusk and dawn Move roadkill away from the road corridor Report injured animals or roadkill EPG for vegetation clearing	Likely to be effective	Unlikely
6.3.2	Wedge-tailed eagle (*Aquila audax* subsp. Fleayi) EPBC Act status: Endangered	A B C D E F G H I J K L M N ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ Note: The entire study area overlaps potential territories so could be utilised for foraging habitat.	Minimise the incidence of roadkill Monitor the incidence of roadkill Plan for the discovery of unknown nests during vegetation clearance	Inductions and toolbox meetings Identification of high risk roadkill spots Move roadkill away from the road corridor Report injured animals or roadkill EPG for vegetation clearing	Likely to be effective	Unlikely
6.3.2	White-bellied sea eagle (*Haliaeetus leucogaster*) EPBC Act status: Migratory	A B C D E F G H I J K L M N ■ ■ ■ □ □ □ ■ □ □ □ □ □ □ □	Minimise the incidence of roadkill Monitor the incidence of roadkill Plan for the discovery of unknown nests during vegetation clearance	Inductions and toolbox meetings Identification of high risk roadkill spots Move roadkill away from the road corridor Report injured animals or roadkill EPG for vegetation clearing	Likely to be effective	Unlikely

Part of Section 6 of PER	Matter of NES	Applicable segment along the Tarkine Forest Drive	Objective of safeguard and mitigation measures	Safeguard and mitigation measures	Assessment of the expected or predicted effectiveness of safeguard and mitigation measures (see Section 6.3.3 for further analysis)	Significant residual impact after safeguards and mitigation measures.
6.3.2	Australian grayling (*Prototroctes marina*) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N E G K	Minimise the indirect impacts associated with the Rapid River bridge replacement	EPGs to manage the indirect impacts caused by sediment, waste and hydro carbons entering waterways EPG to guide the construction, use and decommission of coffer dams Fabricate bridge components offsite Monitor the effectiveness of water quality mitigation measures	Likely to be effective	Unlikely
6.3.2	Giant freshwater crayfish (*Astacopsis gouldi*) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N E F G H I J K L M N	Avoid direct impacts or adversely impacting suitable habitat	Conduct pre-construction field survey Where practicable cater for in the alignment and depth of new culverts. EPGs to manage the indirect impacts caused by sediment, waste and hydro carbons entering waterways EPG to guide the construction, use and decommission of coffer dams	Likely to be effective	Unlikely
6.3.2	Marrawah skipper (*Oreisplanus munionga* subsp. *larana*) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N A B	Minimise the risk of introduced plants becoming established in habitat supporting the larval food plant	EPG to manage introduced plants	Likely to be effective	Unlikely

6.3.1 Threatened flora

Where direct impact to Arthur River greenhood is anticipated at Tiger Creek, the core population in that area will be protected by the implementation of construction exclusion zones defined in the field by an appropriately qualified person. Appendix A delineates this construction exclusion zone.

All other known sites of Arthur River greenhood, shortspike midge orchid and windswept spider orchid within 25 m of the road verge will be protected by construction exclusion zones defined in the field by an appropriately qualified person.

All construction employees will be informed through inductions and toolbox meetings of the importance of not breaching construction exclusion zones.

The CEMP will include EPGs to manage introduced plants and *Phytophthora cinnamomi* during the construction phase. Appendix C describes these particular EPGs in further detail.

6.3.2 Threatened fauna

Minimisation of roadkill

All construction employees and material transporters will be informed through inductions and toolbox meetings of the importance of reducing roadkill and of responding appropriately if it does occur.

Construction activities will be restricted to daylight hours only. Occasionally, construction activities may be required to operate in between dusk and dawn. At these times, construction and material transport vehicles will be required to adhere to a 60 kph speed limit along the entire Tarkine Forest Drive.

All construction employees and material transporters will be provided with maps identifying high roadkill risk locations along the Tarkine Forest Drive and will be required to pay particular attention to roadkill risk when driving through these locations.

Any roadkill found along the Tarkine Forest Drive will be moved at least 10 m from the edge of the road verge by an authorised person who holds an appropriate permit under the *Nature Conservation Act 2002*.

If an injured or roadkill spotted-tail quoll, Tasmanian masked owl, wedge-tailed eagle and white-bellied sea eagle is found by construction employees, this will be reported to DIER, who in turn will report any findings to the Threatened Species Unit, Biodiversity Conservation Branch (DPIPWE) as soon as practicable. If an injured or roadkill Tasmanian devil is found, this will be reported directly to the STDP on 0427 733 511. Construction employees will be provided with fact sheets which describe the Matters of NES which are at high risk of roadkill during the Construction Phase. If a Matter of NES roadkill is found, the time, date and location will be recorded. This information will be provided to DPIPWE or the STDP, as appropriate to the species.

Environmental Protection Guidelines

The CEMP will include an EPG to manage noise impacts on dens during the construction phase.

To manage the potential impacts of the Rapid River bridge replacement on aquatic habitat, the CEMP will include an EPG to guide the construction, use and decommission of coffer dams.

The CEMP will include EPGs to manage the indirect impacts caused by sediment, waste and hydrocarbons entering waterways for all construction activities associated with the Tarkine Forest Drive.

The CEMP will include an EPG for vegetation clearing which describes management measures for the discovery of nesting habitat for Tasmanian masked owl, wedge-tailed eagle and white-bellied sea eagle.

Appendix C describes these particular EPGs in further detail.

Pre construction surveys

A pre-construction field survey will be undertaken in November to ensure that no nesting Tasmanian azure kingfishers are utilising the river banks of the Rapid River within 100 m of proposed construction activities.

A pre-construction field survey will be undertaken to catch and relocate giant freshwater crayfish which may be utilising suitable habitat where construction activities are proposed.

Design considerations

Where practicable, giant freshwater crayfish passage will be catered for in the alignment and depth of new culverts.

For the Rapid River bridge replacement, site disturbance will be minimised by the use of precast concrete abutments and beams which will be fabricated offsite and transported to the site for installation.

Monitoring

The effectiveness of the mitigation measures in relation to water quality will be assessed against the Baseline Water Quality Monitoring Program (see Section 6.2.1).

6.3.3 Assessment of the expected or predicted effectiveness of safeguard and mitigation measures

Threatened flora

Construction exclusion zones are effective in protecting flora species, provided that the zones are defined in the field by an appropriately qualified person before construction activities commence and that regular monitoring and enforcement of these zones is implemented throughout the Construction Phase.

The core population of Arthur River greenhood at Tiger Creek (estimated at approximately 200 individual plants) will be protected by construction exclusion zones with only 2 outlying plants being directly impacted by construction activities.

Inductions and toolbox meetings are effective ways to communicate the importance of construction exclusion zones and the role they play in protecting threatened flora.

It is likely that the EPGs will be effective in managing the spread of introduced plants and *Phytophthora cinnamomi*.

Threatened fauna

Minimisation of roadkill
Inductions and toolbox meetings are effective ways to communicate speed limits, operational hours, the importance of reducing roadkill for the project and describing the procedures for reporting roadkill.

The risk of roadkill can significantly be reduced by restricting construction activities to daylight hours only and regulating the speed of vehicles between dawn and dusk. The Baseline Roadkill Monitoring Program (see Section 6.6) has also identified high roadkill risk locations along the Tarkine Forest Drive which provides for the identification of locations where drivers must pay particular attention. These are proven and effective measures for reducing the risk of roadkill for spotted-tail quoll, Tasmanian devil, Tasmanian masked owl, wedge-tailed eagle and white-bellied sea eagle.

Removing dead animals from the road corridor will reduce the risk of injury or roadkill to spotted – tail quoll, Tasmanian devil, Tasmanian masked owl, wedge-tailed eagle and white-bellied sea eagle which could be hit by vehicles whilst scavenging.

Environmental Protection Guidelines
The EPGs will be effective in managing noise from construction activities that may impact on spotted-tail quoll and Tasmanian devil dens.

The EPGs will be effective in planning for the discovery of nesting habitat for Tasmanian masked owl, wedge-tailed eagle and white-bellied sea eagle during vegetation clearance.

The EPGs will be effective in managing the impacts on waterways associated with construction activities and bridge replacement. The effectiveness of mitigation measures will be validated with reference to the Baseline Water Quality Monitoring Program.

The EPGs will be effective in managing the spread of introduced plants into habitat supporting the larval food plant for Marrawah skipper.

Pre construction surveys
Pre construction field surveys are effective in determining the presence/absence of species prior to works commencing.

If no nesting Tasmanian azure kingfishers are identified in the November survey then it is unlikely that the proposed bridge replacement will have an indirect impact during the proceeding summer construction period.

Pre-construction surveys of suitable habitat to catch and relocate giant freshwater crayfish are effective in avoiding direct impact on this species.

Design considerations
For bridge replacement, site disturbance and duration of construction time are greatly reduced by the offsite fabrication of bridge components.

Culvert design and alignment are practical measures to avoid the ongoing impacts to this giant freshwater crayfish after the Construction Phase.

6.3.4 Compliance

The safeguards and mitigation measures within the CEMP will also be included in the contract between the contractor and DIER. Therefore, any breach of a safeguard or mitigation measure will constitute a breach of contract.

Part A, B and C of the CEMP will be used in the field by contractors and compliance inspectors to ensure that appropriate on-ground controls are implemented for each component of the proposed action.

Compliance inspections will be undertaken by DIER on a weekly basis. Any identified breaches in relation to a safeguard and mitigation measure contained within the CEMP will be dealt with in the following manner:

- In the first instance the contractor will be provided with a written notice identifying the breach and the measures required to rectify the breach. Any breach will be required to be rectified in a timely fashion
- If the contractor fails to rectify the breach in a timely fashion, then DIER will rectify the breach and seek costs.

6.3.5 Residual impacts and proposed compensatory measures

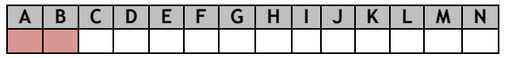
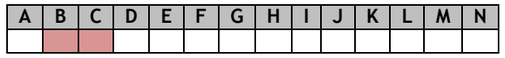
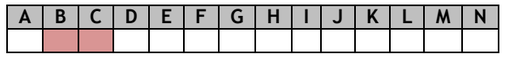
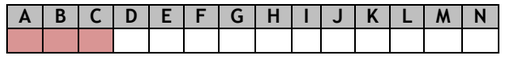
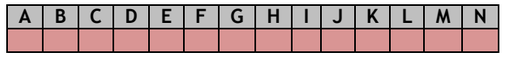
After safeguards and mitigation measures, it is estimated that 2 Arthur River greenhood plants (which have colonised the road verge) will be directly impacted during the Construction Phase of the Tarkine Forest Drive. The core population of this species at Tiger Creek (estimated at approximately 200 individual plants) will be protected by construction exclusion zones.

The direct impact to Arthur River greenhood is not considered to be a significant impact. No offsets are required.

6.4 Operational phase

Table 6.2 provides a description of the safeguards and mitigation measures for the Construction Phase of the Tarkine Forest Drive. In addition, the Table provides a summary of the expected or predicted effectiveness of measures and the identification of residual impacts.

Table 6.2 - Proposed safeguards and mitigation measures for the Operational Phase

Part of Section 6 of the PER	Matter of NES	Applicable segment along the Tarkine Forest Drive	Objective of safeguard and mitigation measures	Safeguard and mitigation measures	Assessment of the expected or predicted effectiveness of safeguard and mitigation measures (see Section 6.4.3 for further analysis)	Significant residual impact after safeguards and mitigation measures.
6.4.1	Arthur River greenhood (*Pterostylis rubenachii*) EPBC Act status: Endangered		Avoid impacts on habitat from tourist vehicles parking off road near Tiger Creek	Vehicle barriers Signage	Likely to be effective	Unlikely
6.4.1	Shortspike midge orchid (*Corunastylis brachystachya*) EPBC Act status: Endangered		Minimise the incidence of wildfire caused by tourists which may impact on summer flowering	Interpretation signage Cigarette butt disposal receptacles Installation of barriers on spur roads	Measures are likely to be a contributing factor in minimising the incidence of wildfire.	There remains a level of uncertainty if a potential wildfire could be as a result of increased tourist visitation.
6.4.1	Western leek orchid (*Prasophyllum favonium*) EPBC Act status: Critically Endangered		There are no safeguards or mitigation measures required for western leek orchid during the Operational Phase of the Tarkine Forest Drive.			
6.4.1	Windswept spider orchid (*Caladenia dienema*) EPBC Act status: Endangered		There are no safeguards or mitigation measures required for windswept spider orchard during the Operational Phase of the Tarkine Forest Drive.			
6.4.1	Spotted-tail quoll (*Dasyurus maculatus* subsp. maculatus) EPBC Act status: Vulnerable		Minimise the ongoing incidence of roadkill in order that the roadkill incidence for this species does not exceed current rates	Please refer to Section 6.6	Please refer to Section 6.6	Please refer to Section 6.6
6.4.2	Tasmanian devil (Sarcophilus harrisii) EPBC Act status: Endangered		Minimise the ongoing incidence of roadkill in order that the roadkill incidence for this species does not exceed current rates	Please refer to Section 6.6	Please refer to Section 6.6	Please refer to Section 6.6

Part of Section 6 of the PER	Matter of NES	Applicable segment along the Tarkine Forest Drive	Objective of safeguard and mitigation measures	Safeguard and mitigation measures	Assessment of the expected or predicted effectiveness of safeguard and mitigation measures (see Section 6.4.3 for further analysis)	Significant residual impact after safeguards and mitigation measures.
6.4.2	Tasmanian azure kingfisher (*Ceyx azureus diemenensis*) EPBC Act status: Endangered	A B C D E F G H I J K L M N ☐ ☐ ☐ ☐ ■ ☐ ■ ☐ ☐ ☐ ■ ☐ ☐ ☐	Higher visitation resulting in increases in recreational boating on Arthur River affecting boat wash			
6.4.2	Tasmanian masked owl (*Tyto novaehollandiae* subsp. castanops) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	Minimise the ongoing incidence of roadkill in order that the roadkill incidence for this species does not exceed current rates Minimise the incidence of wildfire caused by tourists which could impact on nesting habitat	Please refer to Section 6.6 Interpretation signage Cigarette butt disposal receptacles Installation of barriers on spur roads	Please refer to Section 6.6 Measures are likely to be a contributing factor in minimising the incidence of wildfire	Please refer to Section 6.6 There remains a level of uncertainty if a potential wildfire could be as a result of increased tourist visitation.
6.4.2	Wedge-tailed eagle (*Aquila audax* subsp. Fleayi) EPBC Act status: Endangered	A B C D E F G H I J K L M N ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ Note: The entire study area overlaps potential territories so could be utilised for foraging habitat.	Minimise the ongoing incidence of wedge-tailed eagle roadkill in order that the roadkill incidence for this species does not exceed current rates Minimise the incidence of wildfire caused by tourists which could impact on nesting habitat	Please refer to Section 6.6 Interpretation signage Cigarette butt disposal receptacles Installation of barriers on spur roads	Please refer to Section 6.6 Measures are likely to be a contributing factor in minimising the incidence of wildfire	Please refer to Section 6.6 There remains a level of uncertainty if a potential wildfire could be as a result of increased tourist visitation.
6.4.2	White-bellied sea eagle (*Haliaeetus leucogaster*) EPBC Act status: Migratory	A B C D E F G H I J K L M N ■ ■ ■ ☐ ☐ ☐ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Minimise the ongoing incidence o roadkill in order that the roadkill incidence for this species does not exceed current rates Minimise the incidence of wildfire caused by tourists which could impact on nesting habitat	Please refer to Section 6.6 Interpretation signage Cigarette butt disposal receptacles Installation of barriers on spur roads	Please refer to Section 6.6 Measures are likely to be a contributing factor in minimising the incidence of wildfire	Please refer to Section 6.6 There remains a level of uncertainty if a potential wildfire could be as a result of increased tourist visitation.
6.4.2	Australian grayling (*Prototroctes marina*) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N ☐ ☐ ☐ ☐ ■ ☐ ■ ☐ ☐ ☐ ■ ☐ ☐ ☐	Minimise recreational fishing	Interpretation signage	It is likely that education will form an integral part in minimising recreational fishing of Australian grayling.	Unlikely
6.4.2	Giant freshwater crayfish (*Astacopsis gouldi*) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N ☐ ☐ ☐ ☐ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	Minimise the ongoing incidence of roadkill in order that the roadkill incidence for this species does not exceed current rates	Please refer to Section 6.6	Please refer to Section 6.6	Please refer to Section 6.6
6.4.2	Marrawah skipper (*Oreisplanus munionga* subsp. *larana*) EPBC Act status: Vulnerable	A B C D E F G H I J K L M N ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Minimise the incidence of wildfire caused by tourists which could impact on butterfly colonies	Interpretation signage Cigarette butt disposal receptacles Installation of barriers on spur roads	Measures are likely to be a contributing factor in minimising the incidence of wildfire	There remains a level of uncertainty if a potential wildfire could be as a result of increased tourist visitation.

6.4.1 Threatened flora

Suitable vehicle barriers will be constructed with the purpose of protecting the core population of Arthur river greenhood near Tiger Creek. Appropriate signage will also be erected at this location indicating that the area is sensitive habitat and that off-road disturbance should be avoided.

Interpretation signage in relation to wildfire and cigarette disposal receptacles will be installed at key tourist stopping areas along the Tarkine Forest Drive. These locations include:

- Couta Rocks
- Kanunnah Bridge
- Sumac Lookout Car Park
- Julius River Reserve
- Lake Chisholm
- Tayatea Bridge.

Wood burning barbecues will be removed at Julius River Reserve and replaced with gas barbecues.

Suitable barriers (for example locked boom gates) will be installed on Forestry Tasmania spur roads to block access to fire sensitive areas.

6.4.2 Threatened fauna

Interpretation signage in relation to Australian grayling will be erected at all waterways that this species inhabits along the Tarkine Forest Drive. These locations include:

- Rapid River Bridge
- Frankland River
- Arthur River.

The wildfire mitigations measures identified for Threatened Flora (see Section 6.4.1 above) are also applicable to Threatened Fauna.

Roadkill minimisation during the Operational Phase is discussed below in Sections 6.5 and 6.6.

6.5 Threatened fauna roadkill mitigation

The distribution of roadkill occurs at fine spatial scales, allowing the human and natural factors to be manipulated at this scale to reduce roadkill (Hobday & Minstrell 2008). However, the suitability of any mitigation measure depends on local road conditions and species interactions with the road environment, species behaviour and ecology, and with the density of animals in surrounding habitat (Magnus 2006).

There are two main types of roadkill mitigation measures: changing driver behaviour and changing wildlife behaviour (Clevenger et al 2003, Coffin 2007, Magnus et al 2004).

Changing driver behaviour includes changing driver attitude by increasing public awareness, increasing awareness of roadkill hotspots and slowing speed. Potential ways to alter wildlife behaviour include discouraging wildlife from grazing on roadsides, preventing wildlife from crossing roads or providing safe crossings where prevention is not possible (Magnus et al 2004).

Hobday & Minstrell (2008) noted that there has been a lack of success with interventions aimed at changing animal behaviour. Mitigation that prevents animals from crossing the road (such as fencing) can itself have negative impacts by restricting movements within a population, leading to reduced connectivity and increased population fragmentation, often with associated reductions in genetic diversity (Clevenger et al 2003, Hobday & Minstrell 2008).

Modifying human behaviour is more achievable than hoping to modify animal behaviour (Hobday & Minstrell 2008).

A reduction in the vehicle speed from 100 km/h to 80 km/h was found by Hobday & Minstrell (2008) to potentially decrease overall roadkill by up to 50%. Reduced vehicle speed gives drivers and animals greater time to do 'risk assessment' and avoid collision.

Improving visibility along and alongside roads is another method of giving animals and drivers a greater opportunity to avoid collision (Hobday & Minstrell 2008). This can be achieved through vegetation removal and curve widening, for example (Clevenger et al 2003). It might also mean some species are less secure and flush earlier, providing more time for escape and avoidance (N. Mooney 2012, pers comm., 21 May).

Magnus et al (2004) and Magnus (2006) assessed a range of other roadkill mitigation measures for their utility in reducing wildlife roadkill in Tasmania. The following measures were identified as being likely to reduce wildlife roadkill: escape routes, table drain management, underpasses, wildlife signage, chicanes and speed humps and potentially odour repellents. Light coloured road surfacing was also suggested as potentially useful. Ultrasonic whistles and wildlife reflectors were found to have doubtful application in Tasmania.

Magnus et al (2004) and Magnus (2006) highly recommend the provision of escape routes and consider them as one of the most useful and imperative measures that can be implemented when roads are being upgraded, widened or sealed. Table drain management to reduce roadside resources, such as roadside vegetation and water pooling in drains was also highly recommended.

The installation of warning signage near hot spots to inform drivers that there is a danger of collision with animals at night has also been noted to be a useful measure, despite the acknowledgement that the effectiveness of signs to significantly reduce vehicle speed or collision rate is uncertain (Jones 2000, Magnus et al 2004, Magnus 2006, Thompson 2011).

Further, light coloured pavement may decrease roadkill due to increased visibility because most animals will be more visible on a lighter surface compared to a dark surface. Most Tasmanian wildlife is dark in colour and animals may feel uncomfortable spending extended time on a light coloured road surface due to their increased exposure (Jones 2000, Magnus et al 2004, Magnus 2006). Light coloured pavement at hot spots also has the benefit of alerting drivers to the fact that they are entering a high risk roadkill zone. During the Tarkine Drive Vertebrate Carnivore Assessment Forum it was suggested that there is evidence that road pavement colour can influence the incidence of roadkill.

6.5.1 Developing a model to better understand roadkill

To better understand the processes and systems controlling roadkill rates along the Tarkine Forest Drive, a conceptual model was developed to provide a basis for investigating mitigation options.

The model development and investigations involved:

- Roadkill baseline monitoring
- Analysis of the results

- Roadkill mitigation trials and monitoring and
- Analysis of the trials results.

These steps are described below. The outcomes provide a framework for developing management actions.

Roadkill baseline monitoring

In recognition of the risk of roadkill as a result of the original proposed Tarkine Drive[34], a Carnivore Assessment Forum was held in late July 2009; the forum notes can be found in Appendix F. This forum consisted of Tasmanian scientists and professionals with recent and relevant expertise and experience in roadkill, vertebrate carnivores and DFTD, a veterinarian, and State and Federal Government regulators.

Two of the key recommendations emerging from this forum were for the project team to gather roadkill and traffic data prior to the detailed environmental assessment and construction of the route. This information would provide baseline information of current roadkill rates to compare against the future impacts.

Roadkill surveys and the modelling of roadkill data are recognised as being important in determining the frequency of roadkill, and to identify hotspots and to identify species whose rates of roadkill may be unsustainable to the population (Litvaitis & Tash 2008, Taylor & Goldingay 2004, Taylor & Goldingay 2010). It is also necessary to obtain high quality spatial and temporal data on animal abundance and roadkill for the specific project area to be confident of the mitigation strategy (Ramp et al 2005).

Predictive models to determine higher risk areas for roadkill have been used with some success across a range of spatial scales (Litvaitis & Tash 2008, Malo et al 2004, Ramp et al 2005, Roger & Ramp 2009, Taylor & Goldingay 2004). Predictive models allow the mitigation measures to be placed and assessed at both a landscape and individual point spatial scale (Malo et al 2004).

In October 2009, a 12 month study of the abundance of medium to large mammals on the road began, both as live animals and roadkill. The aim of the study was to collect baseline data needed to inform potential mitigation options. The study was designed to record the species, location and frequency of roadkill, describe the spatial and temporal patterns of roadkill distribution, identify when, where and at what scale roadkill hotspots occurred, and to inform development of effective roadkill mitigation. Only animals seen by the driver of a vehicle were noted (i.e. small animals may not have been recorded).

The following work was undertaken:

1. Roadkill monitoring

- The proposed route of the Tarkine Forest Drive between Sumac Spur 4 to Arthur River township – following Sumac Road, Blackwater Road, Rebecca Road and Temma Road – was monitored once per week for 12 months beginning in October 2009 (for geographic locations see Appendix G)
- Roadkill monitoring was also undertaken daily for 3 x 3 week periods during October 2009, January 2010 and April 2010
- The data recorded were the GPS location of the roadkill, the species and any evidence of scavenging on the carcasses

[34] Please note, this forum refers to the original project scope, not the re-scoped western section only. However, the views and comments regarding roadkill are still relevant to the current project.

- After the roadkill was recorded, the carcasses were not moved. This was to ensure that the monitoring program did not skew the roadkill data. For example, if the roadkill was removed it would have prevented carnivores from scavenging on the carcasses, young at foot from lingering near a roadkilled parent and other conspecifics or other species from investigating a carcass, and therefore would have artificially reduced the exposure of those other animals to being roadkills.

2. Headlight survey

- The aim of the headlight survey was to provide abundance data on animals to compare with the roadkill observations
- Surveys were undertaken daily, at dusk
- The headlight survey was conducted over a period of three weeks at three different times during the year (October 2009, January 2010 and April 2010)
- The data recorded were the GPS location, time of sighting and species
- The headlight surveys were conducted at a speed of 50-60 km/h and commenced at last light, approximately 30 mins after sunset.

The study area for both the roadkill monitoring and the headlight surveys encompassed the busier sections of the route, where existing impacts were likely to be measurable, e.g. from the Sumac Road to Arthur River Township. There were also two reference sections where no modifications to road conditions are proposed. These are approximately 15 km along Roger River Road from Roger River to Kanunnah Bridge and 15 km south from Sumac Spur 4 along Sumac Road.

The start and end points of the surveys alternated between Arthur River (west) and Roger River (north east). If a section of road required backtracking, data was only collected in one direction, to avoid double counting.

3. Traffic counts

There is a requirement to understand the existing traffic flows and speed to provide baseline data for a number of the assessments. Most of the existing route is very lightly trafficked and has no reliable traffic data. However, nine sites for traffic counts were identified, three of which are on gravel roads. Because of the low and highly variable traffic flows, the traffic counters were left in place for three weeks.

Traffic counts occurred in October 2009, January and April 2010 because of the seasonal nature of recreational uses on the northern part of the west coast and the variations in timber harvesting, and these periods also corresponded with the intensive roadkill monitoring and headlight surveys.

Results

A detailed statistical analysis of the data was undertaken in late 2011 by Symbolix.

The objectives of the analysis were to:

- Identify spatial, seasonal and other patterns in activity and roadkill levels
- Identify areas of high activity and roadkill hotspots
- Test the effectiveness of headlight surveys of activity (and other environmental features) to predict roadkill
- Identify and predict areas of high roadkill risk from fauna activity and traffic levels
- Provide insight into how the roadkill numbers will change if road traffic increases to inform impact assessment and adaptive management triggers

- Provide a mechanism for comparing developed and reference stretches of road for ongoing monitoring and compliance.

The key species of interest were the endangered Tasmanian devil *Sarcophilus harrisii* and the vulnerable spotted-tailed quoll *Dasyurus maculatus* but patterns in activity and roadkill were analysed for all species seen.

The work used a kernel analysis to determine roadkill density. This method allows finer resolution than the route-box method sometimes used in similar studies. Regression (linear) models were used to aid the analysis, as is common when identifying predictors.

The data sourced for the analysis is summarised in Table 6.3.

Table 6.3 - Summary of data source for the baseline roadkill analysis

Data	*Headlight survey*	*Roadkill survey*	*Traffic data*	*Environmental (predictors) data*
Coverage:	3x daily observations (21days) Oct 2009, Jan 2010, Apr 2010 Surveys carried out in evening	Weekly surveys Oct 2009 – Sept 2010 (no July) Also 3 x daily observations (21 days) over the same period as the headlight surveys. Surveys carried out in early morning	Hourly Observations, concurrent with Headlight survey. Hourly traffic count and average speed.	Road slope data Vegetation Data Road curvature Road segment

Headlight ('activity') survey

There were three sets of 21 daily headlight observations over the survey period and 2453 unique animal detections were found across the 63 surveys. By far the most common species was the Tasmanian pademelon *Thylogale billardierri* (1484 sightings), followed by the red-necked (aka Bennett's) wallaby *Macropus rufogriseus* (280 sightings) and Tasmanian devil (258 sightings). Eleven spotted-tailed quoll were seen (Appendix H).

Roadkill survey

During the survey, 188 roadkills were recorded, 28 of the 107 sessions recording none. The species list is again dominated by the Tasmanian pademelon (141 records) and the red-necked wallaby (12 records). Five Tasmanian devils and 1 spotted-tailed quoll were recorded as roadkill – all on Roger River Road (Figure 6.2 and Appendix H).

6.5.2 Analysis

The following presents the findings of exploratory data analysis, used to define trends and correlations, and predictive modelling, used to try to establish the features of high roadkill zones.

Scavenge rates

The results of the surveys indicate that there is no significant difference between roadkill observations when there is one day or one week between surveys, suggesting that scavenge rates (and other environmental and anthropogenic factors) are so effective that carcasses do not last significantly longer than a day, on average. This means that we can combine the daily and weekly surveys, without correction for scavenging.

Wildlife activity and roadkill

The location and species patterns within the headlight activity and roadkill data have a strong positive correlation (better than 99% confidence). There is also a definite spatial clustering of activity and also roadkill (Figure 6.3).

The lowest probability of roadkill occurs approximately 25 km from Arthur River (Segment C). There is a peak in roadkill 10 km from Arthur River (Segment B), where roadkill rates are approximately 6 times those of Segment C. There is a secondary peak in roadkill between 35 and 50 km from Arthur River (Segments D and E), being about half the peak of Section B.

This data can be used to answer the question: if there is a road strike or headlight observation on this stretch of road, where is it most likely to occur?

The segments where Tasmanian devils were most frequently observed were, in decreasing order, B, A, E, D & G and spotted-tailed quolls followed a similar pattern. Figure 6.4 shows Tasmanian devil and spotted-tailed quoll sightings (red points) and also roadkill of these species (red crosses and blue cross respectively).

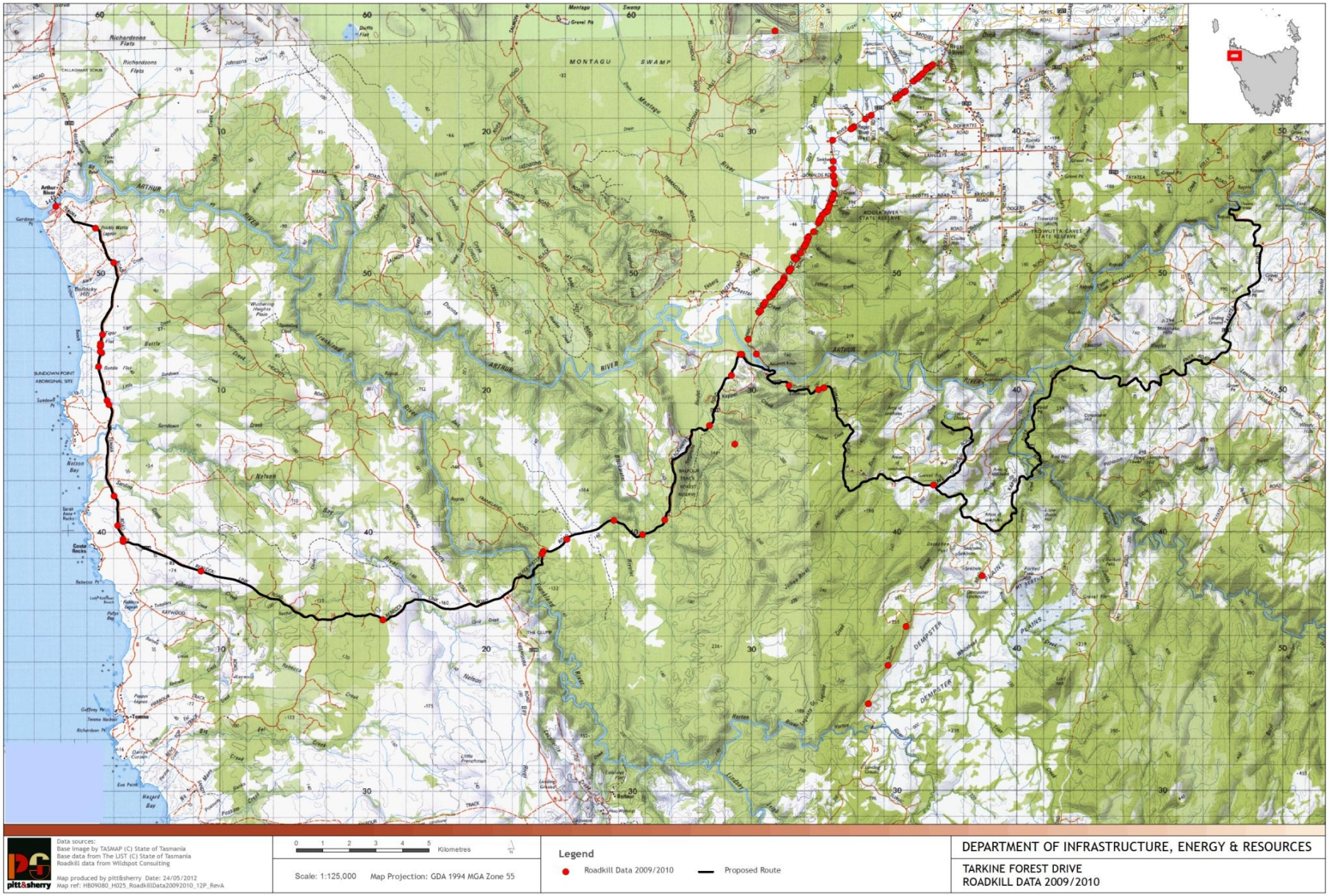


Figure 6.2 - Locations of roadkills

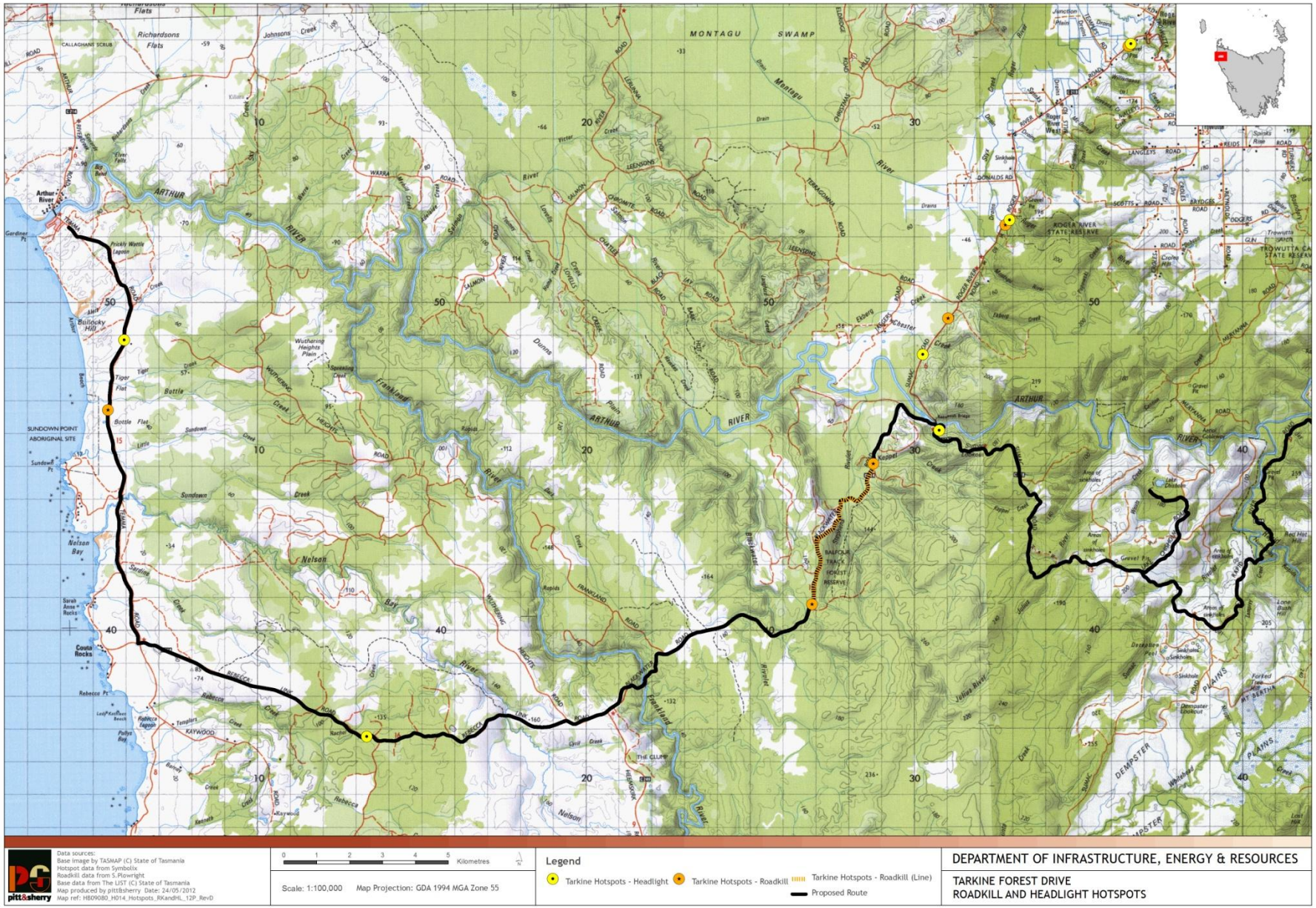


Figure 6.3 - Roadkill and headlight hotspots

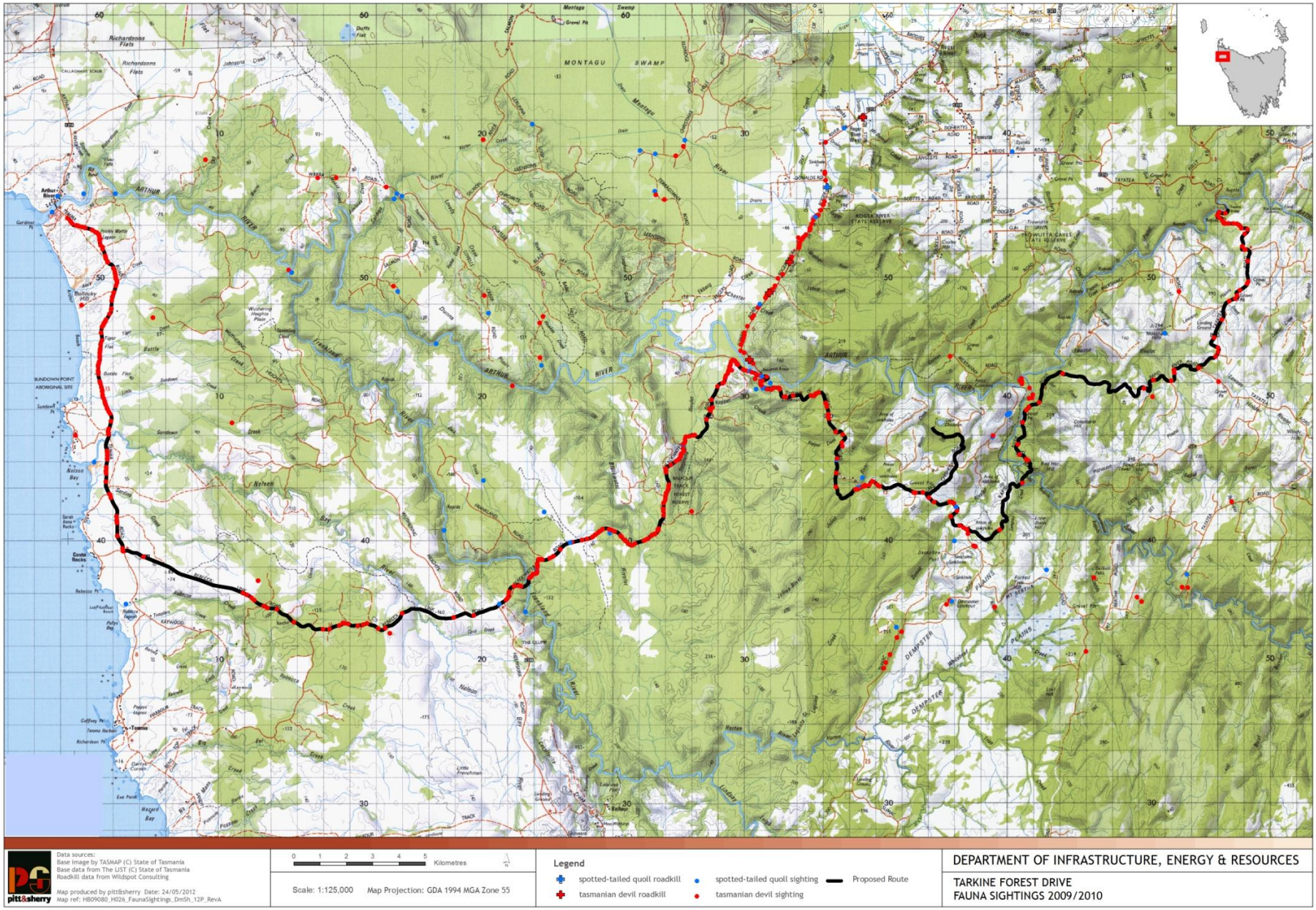


Figure 6.4 - Tasmania devil and spotted-tailed quoll sightings and roadkills

Focus species

The principal aim of the study was to develop an understanding of the 'background' level of Tasmanian devil and spotted-tailed quoll roadkill. Probably due to their rarity (relative to wallabies), these species accounted for 3% and 1% of roadkills respectively, which are nevertheless higher percentages than recorded by Hobday & Minstrell (2008), where Tasmanian devils accounted for 1.5% and spotted-tailed quoll 0.31%.

In order to have confidence in the analysis, greater statistical power is required, so the efficacy of using the entire data set of observations as a surrogate for Tasmanian devils and spotted-tailed quolls was explored.

The level of correlation between Tasmanian devil activity and the other species combined was tested using the Spearman Rank Correlation test and found to be directly correlated at better than 99% confidence. Spotted-tailed quolls are rarer still in the observations but were also found to be positively correlated with the other species combined. These findings mean that patterns and predictive models applied to the entire data set can be deemed to be applicable to Tasmanian devils and spotted-tailed quolls.

Seasonal patterns

Animal activity was lowest in March – April, with higher activity levels recorded in spring and summer[35]. This seasonal effect was not as evident in the roadkill data collected. While the median nightly roadkill counts were lower in April, the variation in roadkill counts made it difficult to assess whether there is a significant seasonal effect.

6.5.3 Predicting roadkill

The above description considered the general patterns of activity and roadkill along the roads surveyed.

The analysis then examined what human and environmental factors increase the likelihood of road strike at a particular location and time of the year. It is important to note that there is still a large random element to roadkill (i.e. whether a particular animal will collide with a vehicle at a particular moment in time or space). However, if a predictive model allows the explanation of a reasonable fraction of the likelihood, then it is of value in developing mitigation measures.

The following predictive findings were developed from data sourced from Roger River Road only. This area had the greatest number of roadkill detections (89) during the three sets of daily observations. It is also an existing sealed road.

The predictions were that:

Human/engineering factors

- As the mean vehicle speed increases, so does the likelihood of collision. A decrease in mean daily speed of one standard deviation (3 km/h) will decrease the probability by ~ 7%
- At the traffic count increases, so does the likelihood of collision. Increasing the traffic count by one standard deviation (50 cars in the case of Roger River Road) in a day will increase the probability of collision by ~ 7%
- There is no change in probability of collision from a change in road slope
- An increase in turning angle showed some decrease in the risk of collision; however, this was not statistically significant.

[35] Activity levels were not recorded during July

Vegetation

- Roadkill probability was highest in wet forest and farmland, and lowest in rainforest
- Interestingly, sites at or within 500 metres of a vegetation transition had a high roadkill probability.

These predictions were used to inform the design of roadkill mitigation trials.

6.5.4 Roadkill mitigation trials

A number of mitigation options have been previously discussed. However, not all of these would be cost effective on a large scale and they would require costly and on-going maintenance to remain effective in the long term. For example, seven wildlife underpasses were constructed on the Arthur River Road (refer to EPBC decision 2003/930) as a result of the sealing of a 12.8 km section of road (Thompson 2008). A review of the efficacy of the mitigation works, undertaken by Landscape Impressions in 2008, found little evidence of larger wildlife using the underpasses, drainage issues with several of the underpasses and concluded that that the design, execution and management of the underpasses were limiting their effectiveness (Thompson 2008).

Given the level of survey work undertaken for the current project and a desire to develop additional simple cost effective mitigation measures, a roadkill mitigation trial was initiated. Many studies of mitigation measures suffer from a lack of replication and a control group. Better designed studies (such as before-after-control-impact) are required to demonstrate effective mitigation strategies (Taylor & Goldingay 2010).

The survey was designed specifically to test for the impact of the mitigation measures (the treatments) on roadkill rates. In real world situations, a lack of replication and randomisation of protocols often limits the generality of the findings. This was addressed through replicating treatment sites and randomising whether a location was a control site or treatment site.

To establish a positive impact we need to be able to establish a change in the roadkill count between before and after the application of the treatment. It must also be established that this change did not occur at a similar site where there was not treatment. Therefore, a paired before-after-control-impact survey has been used. It requires an equal number of control sites for each impact or treatment site.

The control sites had similar characteristics to the treatment sections, including similar:

- Traffic count and speed (before any treatment)
- Roadside vegetation type
- Road surface
- Road shoulder (slope, turning angle etc).

Seasonal differences (including transient effects such as response to a soaking rain) were therefore accommodated.

Roadkill hotspots identified during the analysis of the baseline data were used to inform the placement of on-ground roadkill mitigation trials. Importantly, the selected areas are localised; the impact would therefore be locally constrained. This limits the scope of the roadkill mitigation trials, particularly when compared with the management interventions that will form part of the project proper (discussed later). Three paired trial and control sites were selected (as shown in Figure 6.5): two along Roger River Road and the third on Blackwater Road. All sites were located on uniformly dark, sealed roads.

Figure 6.5 - Mitigation trial sites

A meaningful section of road around each treatment/control point that returns a good measure of impact, yet was not so long as to dilute the intervention effect, was required. To determine an optimal size, the level of clustering of roadkill strikes was analysed. This suggested that locations should be at least 3 km apart (preferably 5 km) and that an area of 1.5 km on either side should be surveyed.

At the 3 trial sites the following mitigation works were implemented:

- Signage to alert drivers that they were entering a wildlife zone, including advisory signs to reduce dusk to dawn speed (Figure 6.6)
- Installation of audible rumble strips (Figure 6.7) – these were trialled because, although there was little research available on their effectiveness, it was anticipated that the noise from them would provide a warning to wildlife on or adjacent to the road. This would provide a greater opportunity for animals to avoid collision. The strips would also alert drivers (via an audible and visual alert) that they were entering a special zone, and accompanying wildlife signage would encourage drivers to reduce speed and/or be more alert. Each rumble strip was 200 mm wide and 10 mm high thermoplastic. The design utilised has recently been confirmed as effective by a study into the relationship between dimensions of audio tactile profiled roadmarkings (rumble strips) by Dravitzki et al for the New Zealand Transport Agency. They found that a separation distance (between individual rumble strips) of 250 mm generated about 2 dB (A) more noise that 500 mm and that decreasing this distance increased the noise level. In the trials a distance of 200 mm was used. Increasing the height of the rumble strip increased the overall noise effect; 6 mm was the highest tested (Dravitzki et al 2012). The Tarkine Forest Drive trials utilised 10 mm high rumble strips
- Roadside and table drain clearance to reduce animal foraging, shelter and improve visibility and to discourage wildlife lingering on the roadside. The clearance width matched the cross section and clearance width proposed for the Tarkine Forest Drive.

Figure 6.6 - wildlife advisory sign

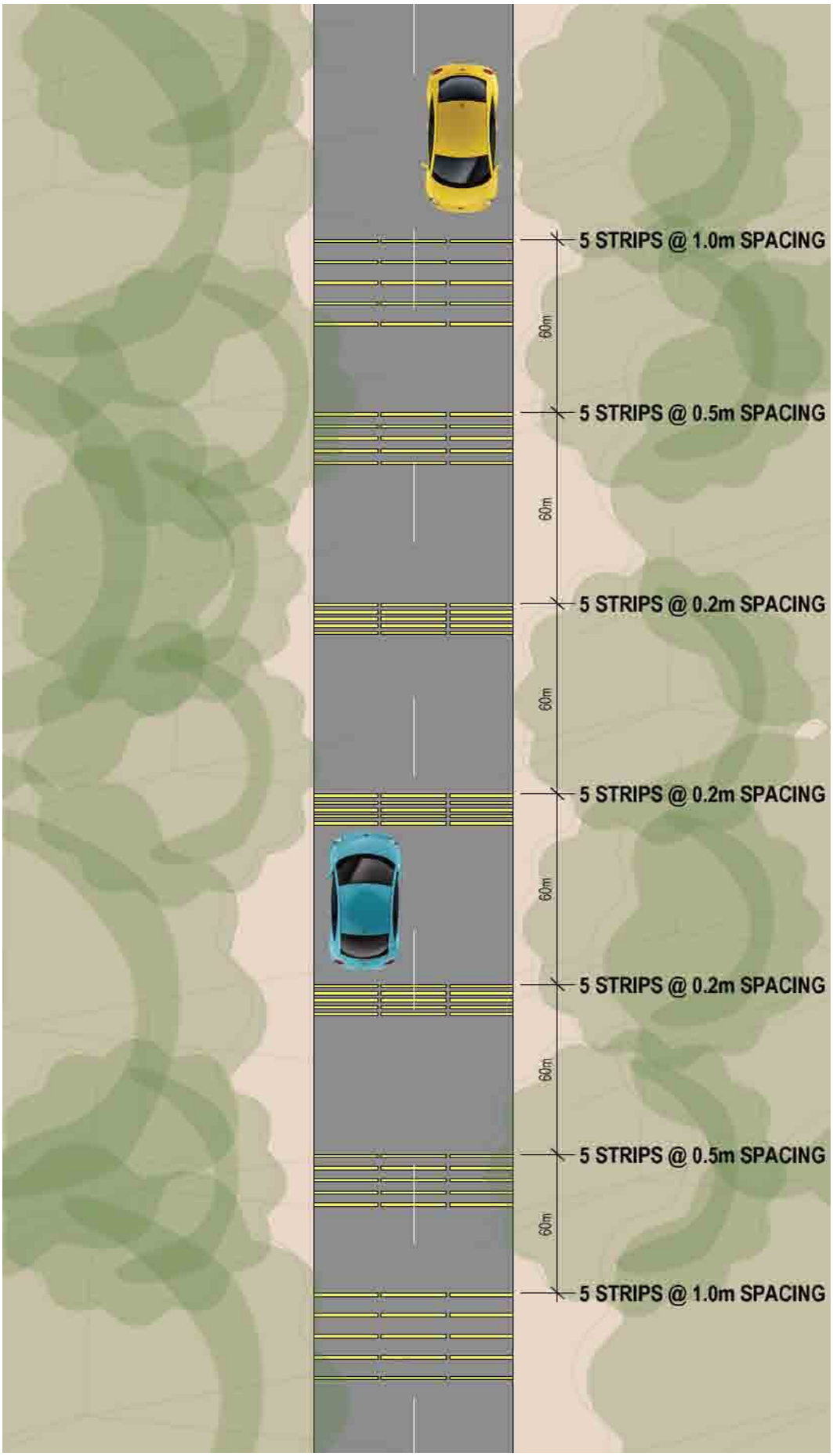


Figure 6.7 - Rumble strip design

At the three control sites no physical works were implemented.

The three paired control and treatment sites were monitored daily for roadkill for a period of 8 weeks during February, March and April 2012.

6.5.5 Results

The analysis concluded at a 99% confidence level[36] that the treatment sites experienced greater than a 50% reduction in roadkill relative to the controls.

Due to the complex nature of impact studies, and the highly variable nature of the data, three analyses were undertaken on the data set: a visual inspection (Figure 6.8 below), a traditional ANOVA (Analysis of Variance of Means), and a more modern GLM (Generalised Linear Model). All three are in agreement as to the success of the treatments (Appendix I).

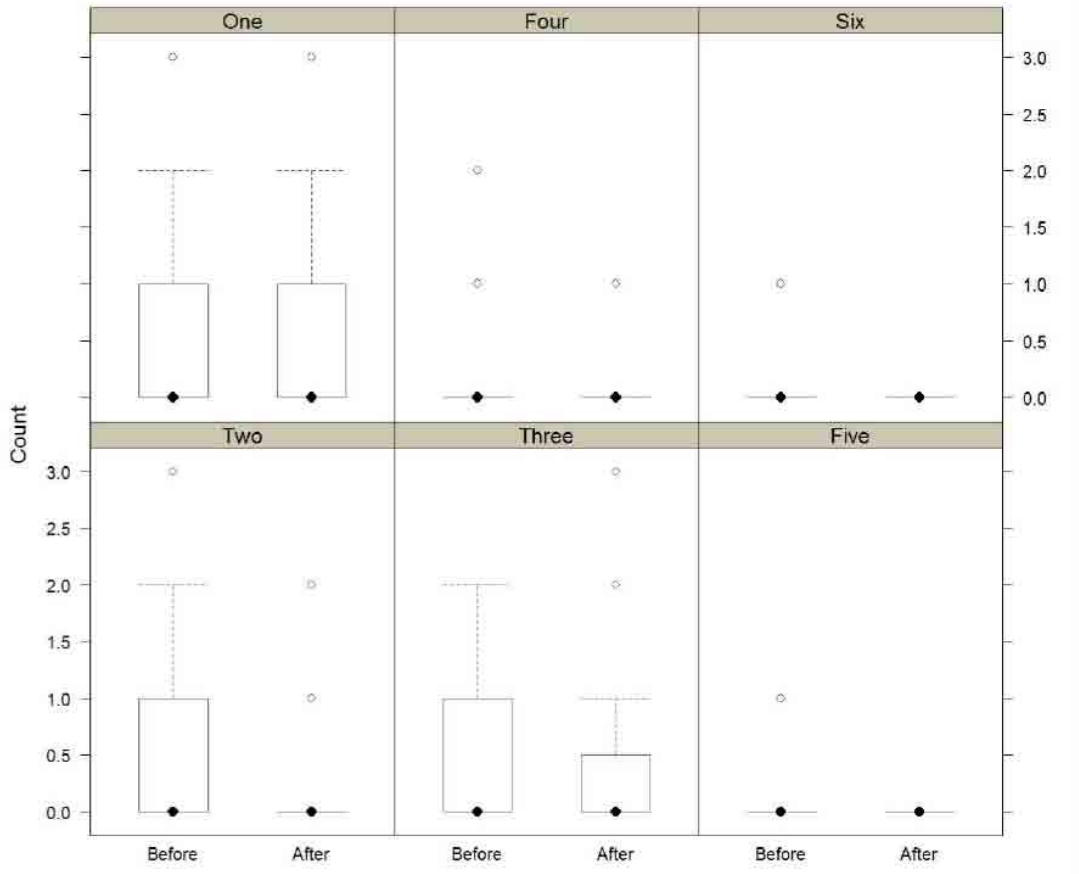


Figure 6.8 - Distribution of nightly roadkill counts before and after mitigation was employed. Sites Two, Three and Five are treatment sites, while Sites One, Four and Six are the paired control sites

The three techniques are staged in order of their complexity of interpretation and depth of insight generated. The inspection (as shown above) shows the direction of potential changes. The ANOVA allocates the variability seen but is unable to determine direction (hence it complements the visual aid). The GLM is a modern technique that incorporates allocation of direction and magnitude to the various factors (i.e. combines aspects of both the visual aid and the ANOVA). The depth of its insight comes at a significant cost of complexity, however.

[36] There is a difference in meaning between the common usage of the word "confidence" and its statistical usage, which is often confusing to the layman. In statistics, the word "confidence" is a technical term used to indicate how rare an outcome has to be before the writer will accept it as significant. For example, 99% confidence in this context means that the reduction in roadkill produced by this trial is likely to happen by chance 1% of the time.

In summary, the three approaches to the before-after-control-impact designed data are:

1. A box plot, which shows a strong contraction of roadkill in the treatment sites (before to after) that is not reflected in the controls. The treatment sites (two, three and five) all show a contraction in the rate of roadkill. The control sites (one, four and six) show no change before and after.
2. An ANOVA that suggests that there is no significant difference between Time or Treatment factors individually (this is good and expected) yet the combination of Treatment and Time is significant to better than 99% confidence
3. A GLM approach that suggests that the direction of change due to the treatments is downward (a reduction in road strike) to 99% confidence, and a measure of its effect to be an average 59% reduction in roadkill.

The quantum of the roadkill reduction is very marked and confirms the use of the proposed road cross section (vegetation clearance zone) and rumble strips as an extremely effective tool for mitigating roadkill on the Tarkine Forest Drive. These measures, plus additional measures will therefore be implemented to mitigate the risk of roadkill.

6.6 Roadkill minimisation plan

Successful management intervention is only likely to succeed when there is an appropriate level of understanding and awareness of roadkill patterns and causes.

The factors contributing to vehicle-wildlife collisions, based on the previous discussion, are:

- Vehicle speed, volume and time of day/year travelled
- Driver awareness, attitude and experience
- Roadside vegetation, road width and barriers
- Adjacent habitat
- Animal abundance.

Each of these factors has been assessed and is discussed below. In some instances, the nature of the factor or the mitigation strategy proposed has meant that a detailed site assessment is not necessary and for them the mitigation plan has taken a whole of route approach, rather than focus on specific areas of concern. In other instances, the route has been characterised into areas of high, medium and low risk to inform the design and placement of mitigation options.

6.6.1 Vehicle speed, volume and time of day/year travelled

Vehicle speed

The Tarkine Forest Drive is approximately 92.7 km long. The nature of the road alignment (horizontal and vertical) is highly variable. The speed at which vehicles can currently travel is also highly variable, both across the route as a whole and also within individual sections. Sealing the road has the potential to increase the speed at which vehicles travel and as the mean speed increases, so does the likelihood of strike.
The post construction operating speed for the road in a westerly direction has been modelled. The operating speed of a road is predominately controlled by the horizontal alignment of the road. The methodology used to estimate the operating speed is fully described in the Austroads Guide to Road Design Part 3 Geometric Design.

In summary the following steps were undertaken:

- Each section of the road was divided into groups of similar radius curves, individual isolated curves and straights

- Assuming an approach speed based on the preceding road alignment and the speed values and the acceleration and deceleration rates provided in Part 3 of the Austroads Guide, the operating speed of vehicles on the alignment element being considered was calculated. The exit speed from one element was used as the approach speed for the following element.

Figure 6.9 below describes the general characteristics of the operating speed post construction. To enable the route to be described, a polynomial best fit curve, or smoothing, was applied to the speed points generated from the operating speed analysis. From this information it was possible to characterise the project area into different "speed zones" for the basis of determining the risk of roadkill.

Segments A, B, C, D & E are the faster parts of the route, where the operating speed generally ranges between 70 and 100 km/h. The remainder of the route (F to P) is slower, where the operating speed is predominantly less than 80 km/h.

From an operating speed perspective, Segments A, B, C, D & E are the highest risk sections of the route.

The analysis of operating speed has resulted in the speed limit being reduced in many sections of the route. The following speed limits will apply to the Tarkine Forest Drive route:

- Arthur River to Spur Rebecca (sections A, B & C) - 80km/h
- Spur Rebecca to Western Explorer (section D) – 80 km/h
- Western Explorer to Rapid River Rd (sections E,F,G,H,I,J) -70 km/h
- Rapid River Road (section K) - 50 km/h
- Tayatea Road (section L&M) -70 km/h.

These are shown in Appendix J.

Traffic volume

Nine traffic counters were placed along the route (Appendix K) for three periods of three weeks (October 2009, January 2010 and April 2010).

There is a clear trend for the majority of vehicles to be on the road between 0600 hrs 1900 hrs, with very little traffic (ranging from zero to less than 2 vehicles per hour) travelling outside this time period (Figure 6.9).

This is important for roadkill risk because it is well established that the dusk to dawn period is of most concern for mammal roadkill.

The Benefit Cost Analysis has forecast an additional ~ 44,000 visitors per year by 2025. If vehicle occupancy of 1.5 persons is assumed, which is a very conservative estimate, the **additional** annual average daily traffic in 2025 can be expected to be 80 vehicles. In reality there will be fewer vehicles than this during winter and greater during summer, however there is no reliable means for estimating this.

The Tarkine Forest Drive involves the upgrading of existing roads with the intent to develop the tourist potential of the north west region by creating a self-drive experience for visitors. It is thought that the majority of additional traffic expected on the road will be tourists. These drivers will usually be travelling during daylight hours and they will generally be unfamiliar with the road, less focussed on 'getting from A to B' and more focussed on viewing the surrounding environment and wary of colliding with an animal. They are therefore likely to be travelling at relatively low speeds and outside the high roadkill risk period (dusk to dawn).

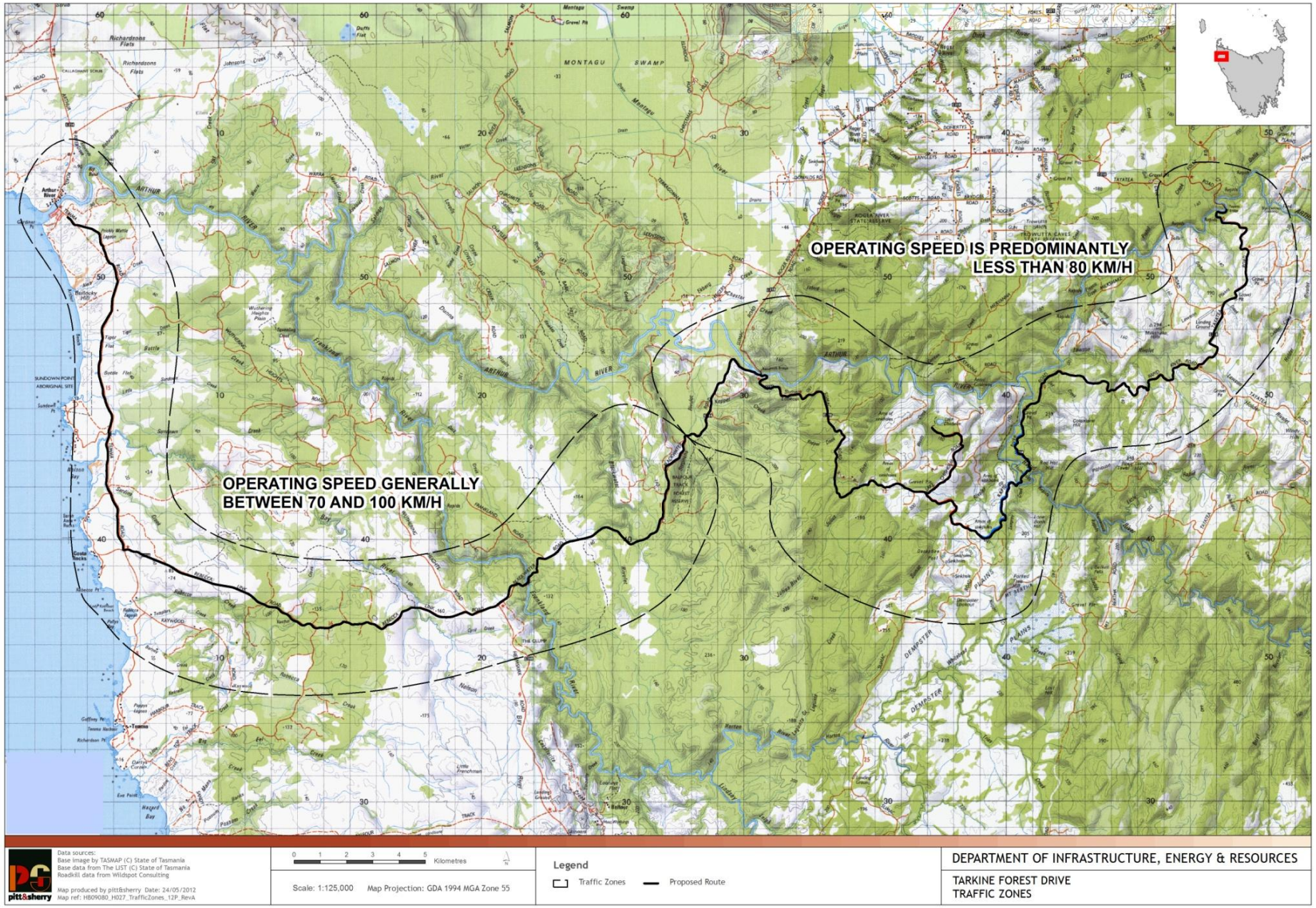


Figure 6.9 - Operating Speed of the route

The general shape and appearance of the ADT summary (Figure 6.10) is therefore unlikely to significantly change beyond an increase in the peak period (0800hrs – 1800hrs) once the Tarkine Forest Drive is developed.

The traffic monitoring adequately captures all current traffic on the areas surveyed. The additional traffic associated with tourists has been discussed above.

Shree Minerals propose to develop a magnetite/hematite mine near Nelson Bay River in north western Tasmania. The site is located east of Couta Rocks and approximately 7 km northeast of Temma. The transport of product will utilise Rebecca Road, Blackwater Road and Sumac Road, all part of the proposed Tarkine Forest Drive.

This development was recently (August 2012) approved under the Tasmanian *Environmental Management and Pollution Control Act 1994* and is currently subject to assessment pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*. It is expected that these processes will adequately manage any additional traffic impacts associated with this development.

That notwithstanding, the development of the Tarkine Forest Drive roadkill mitigation strategy has considered the potential impacts of this development.

Shree Minerals propose an additional 34 product vehicle movements per day for years 2 to 10 of the mine, a 34% increase on the existing traffic movements on these roads (**pitt&sherry** 2011). Shree has committed to the following actions to mitigate against this increase in traffic and increased risk of roadkill:

- No product transport will commence post civil twilight
- A daily worker transport bus will be provided to and from the site
- All employees will be educated on the known roadkill hotspots on the transport network and of the importance of reducing roadkill and of responding appropriately if it does occur. This will include encouragement of workers (and the worker bus) to reduce speed to below 50 kph during the dawn to dusk period (**pitt&sherry** 2011).

These measures, of themselves, reduce the potential for roadkill to an insignificant level. However, when included with the comprehensive adaptive mitigation strategy outlined for the Tarkine Forest Drive, they are likely to result in limited if any additional roadkill in the areas involved.

The development of the Tarkine Forest Drive is unlikely to alter the travel patterns of the majority of local users, meaning the traffic volumes during the dusk to dawn period will not alter significantly from the current levels. There may be a marginal increase in drivers choosing to use the eastern section of the Tarkine Forest Drive (east of Kanunnah Bridge) to travel to and from the west coast, who have previously gone via Arthur River Road. If this occurs, it is likely to result in reduced roadkill on the Arthur River Road.

The area north of Arthur River township is acknowledged as having increased roadkill as a result of a recent road upgrade, and there are questions over the effectiveness of the roadkill mitigation measures previously implemented. In 2003, Circular Head Council sealed 12.8 km of the Arthur River Road between Marrawah and Arthur River. The roadkill data collected for this section of road between 2003 and 2008 indicate an increase in all roadkill including a trend of increased Tasmanian devil and spotted-tailed quoll roadkill[37] (Thompson 2008).

[37] Although there was not enough data to demonstrate a statistically significant change

Any diverting of local traffic from the Arthur River Road to the Tarkine Forest Drive is considered beneficial from a roadkill risk perspective. The rigorous process undertaken in baseline monitoring, analysis, mitigation and adaptive management for the Tarkine Forest Drive ensures that this section of road has a decreased risk of and level of roadkill that what is the current situation on the Arthur River Road.

Time of day/year

The main change in traffic associated with the development of the Tarkine Forest Drive is expected to be additional tourist traffic during the day. The risk of roadkill associated with this type of traffic is minimal, given that there will be little change to traffic volumes in the dusk to dawn period. Very few tourist vehicles will be travelling outside of daylight hours and those that will be can be expected to be travelling at low speeds (see previous discussion on vehicle speed).

The section of the Tarkine Forest Drive between Tayatea Bridge and Kanunnah Bridge currently sees very little local, and essentially no through traffic. This is unlikely to change as a result of the development. This renders this component of the route very low risk from a roadkill perspective given the discussion above about the nature of tourist traffic expected.

This summary of traffic volume and likely changes as a result of the proposed development put the risk of roadkill into context. It is considered that the only additional roadkill risk as a result of the Tarkine Forest Drive will be that existing local or through traffic utilising the eastern part of the route (from Kanunnah Bridge to Arthur River) to travel at greater speeds than is currently the case.

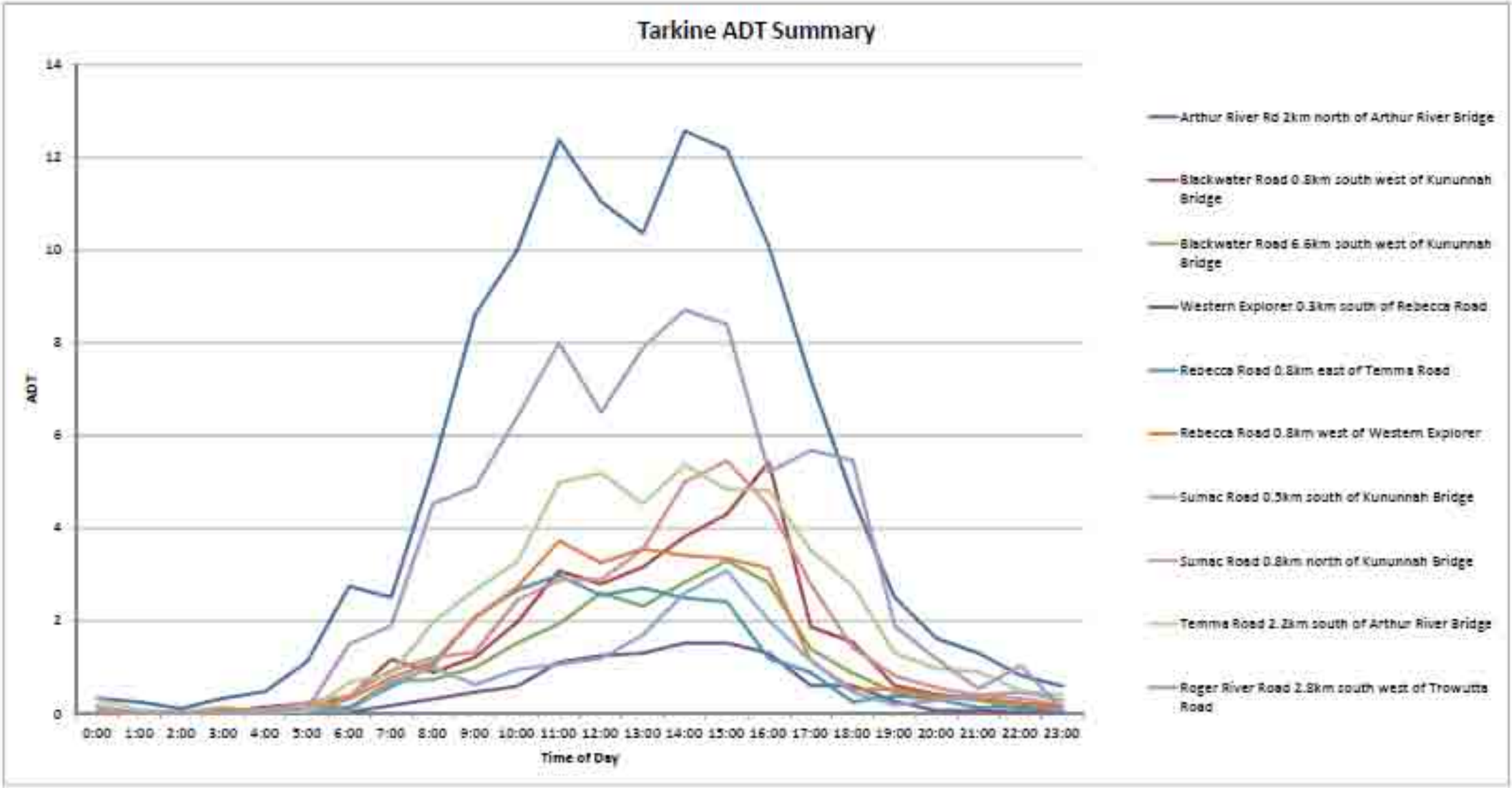


Figure 6.10 - Average Daily Traffic Summary

6.6.2 Driver awareness, attitude and experience

There are two main types of roadkill mitigation measures – changing driver behaviour and changing wildlife behaviour (Clevenger et al 2003, Coffin 2007, Magnus et al 2004). Changing driver behaviour includes changing driver attitude by increasing public appreciation and increasing awareness of roadkill hotspots.

It is most likely that the majority of wildlife vehicle collisions currently occurring in the north west are due to local road users. Given the nature of the traffic changes facilitated by the development of the Tarkine Forest Drive, predominantly an increase in day time tourist traffic, it is likely that local road users will continue to account for the majority of collisions with wildlife. An education program is therefore considered important in promoting and enhancing fauna friendly attitudes and behaviours on the roads in the area, perhaps with the caveat that significantly increased roadkill might result in inconvenient mitigation measures.

It has been suggested that the installation of warning signage to inform drivers that there is a danger of collision with animals is a useful measure (Jones 2000, Magnus et al 2004, Magnus 2006, Thompson 2011) although warning signs are notoriously unreliable in increasing road safety in general and reducing speed in particular. The use of light coloured pavement will further alert drivers that they are within a high risk roadkill zone.

A detailed community awareness program will be developed as part of the CEMP prior to construction.

The following actions and initiatives are proposed to raise community awareness and change driver behaviour:

1. Installation of interpretative signage at the start and end points of the route (plus at Kanunnah Bridge)
2. Provision of literature that can be taken away (leaflets) from the interpretative signage locations and at all tourist stops along the route
3. Wildlife advisory signs at Tayatea Bridge, Roger River Road, Kanunnah Bridge, Arthur River and at the beginning (from both approach directions) of the roadkill hot spots; these signs will advise of a 45 km/h dusk to dawn speed
4. Media articles in local newspapers
5. Information pamphlets distributed to all property owners at Arthur River, Couta Rocks and associated areas south of Arthur River township
6. Specific pamphlets distributed to other key stakeholders, such as 4WD and camping clubs and local schools (as another means of influencing driver behaviour)
7. In addition if it is demonstrated that particular individuals are regularly speeding (through the speed management regime outlined later in this document) then the particular drivers will be cautioned in writing; if the speed triggers are continuously exceeded then there will be targeted statutory enforcement to ensure compliance.

6.6.3 Roadside vegetation, road width and barriers

The width of the existing road and also the proximity of vegetation (which may act as a grazing resources or shelter) to the existing sealed edge of the road is highly variable.

The current route generally has no safety barriers present (apart from bridge crossings and their approach), infrastructure which can impede animal movements, especially when hurrying from the road.

The table drains vary in profile but generally tend to allow unimpeded animal movement. There are some sections within steep cut or fill that would present a complete barrier to animal movement.

The Tarkine Forest Drive road works will establish a common cross section (width of road) and table drain design (Figure 6.11) to counter the roadkill risks associated with areas of narrow road or where vegetation is very close to the pavement.

The width of vegetation clearance proposed is the same as was tested during the roadkill mitigation trials and is substantially wider than what currently exists across much of the route. Pavement material will be extended across the base of the table drains to ensure limited opportunity for vegetation re-growth.

The construction of better table drains along the route, which at present typically either do not exist or are very poorly formed, will aid in the transport of water and reduce water pooling directly adjacent to the road. This will also reduce the likelihood of vegetation growth and drinking water attracting animals to the roadside.

The installation of safety barriers will only be in areas with very steep drops. The proposed road cross section (see Figure 6.11) has been designed to prevent water pooling adjacent to the road and also to not impede animal passage. Any deficient curves that are proposed to be widened will be widened on the inside, unless there are significant topographical features that render it unfeasible. Widening on the inside of the corners will improve visibility and reduce grassy habitats that attract herbivores, decreasing the risk of roadkill.

6.6.4 Adjacent habitat

The Tarkine Forest Drive project area has a variety of natural habitats including various forests (Appendix L). Tasmanian devils are known to favour dry and mixed sclerophyll forest and coastal heath, while tall or dense, wet forests are less used (Jones & Barmuta 2000 in SEWPAC 2012). However, roads through the latter can be especially convenient for devils to traverse areas of dense ground cover.

Tasmanian devil occurs widely throughout the study area. The greatest concentrations are along the western seaboard from Couta Rocks to Arthur River where the habitat in this area is considered to be more suitable (Northbarker 2011, DPIPWE trapping and spotlighting data)

Based on adjacent vegetation, the route can be divided into the following landscape characteristics for Tasmanian devils (see Appendix K):

- Area 1 – very favourable habitat, high roadkill risk
- Areas 3 and 5 – moderately favourable habitat, moderate roadkill risk
- Areas 2 & 4 – least favourable habitat, low roadkill risk.

It is more difficult to characterise the route for the spotted-tailed quoll, as the species inhabits a large range of habitats, including rainforests, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, on beaches and sometimes in grassland or pastoral areas adjacent to forests (SEWPAC 2012b).

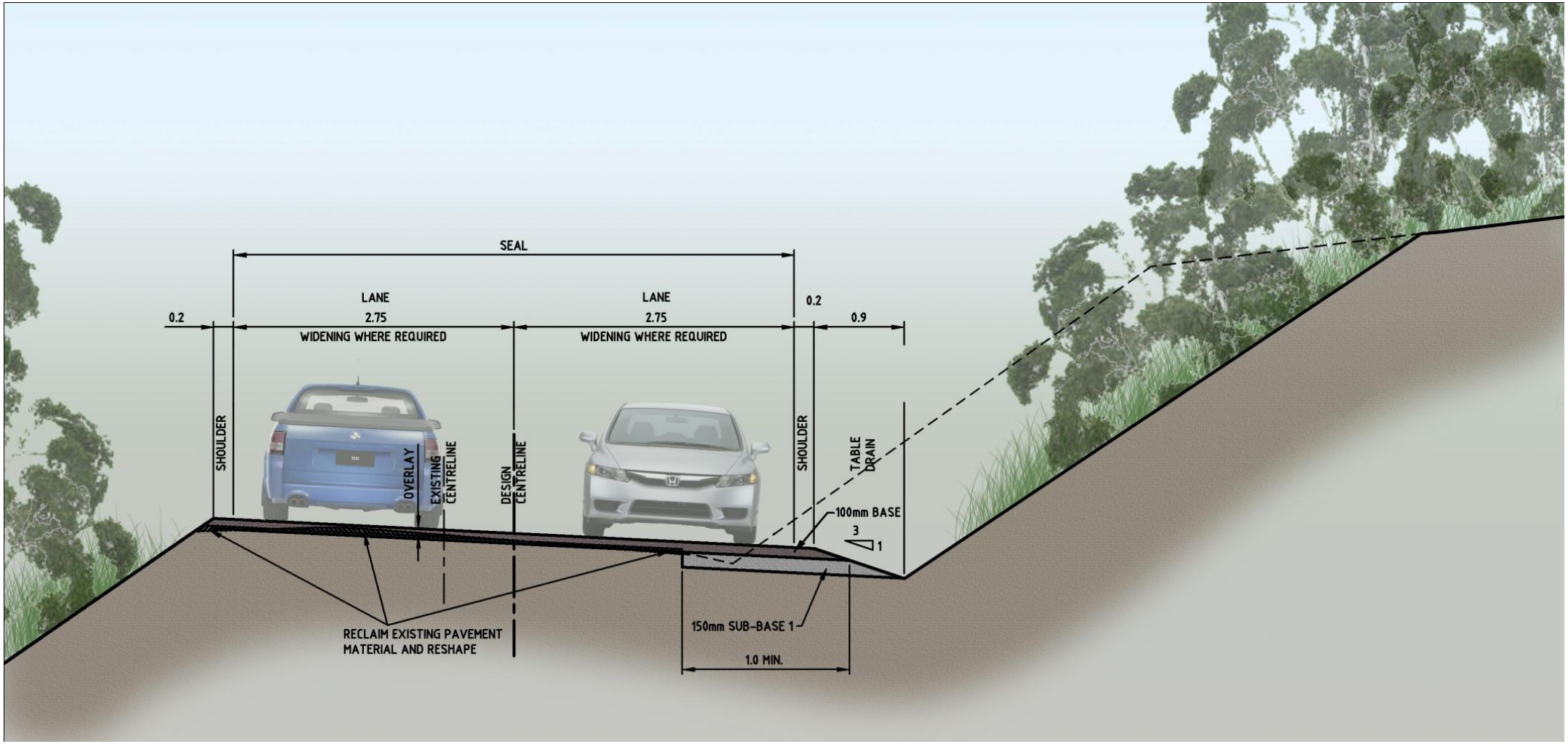


Figure 6.11 - Typical cross section

6.6.5 Animal abundance

Inspection of sections of the road which had high roadkill incidence resulted in the identification of the presence of Tasmanian devil and possibly spotted-tailed quoll through numerous scats, including regularly used latrines. These sites were subsequently shown to be frequented by devils on a daily basis by using remote camera sensors.

This suggests that the presence of scats and latrines of devils is a useful method for identifying sections of road, which may be additional to those highlighted in the headlight survey results, with high incidence of activity and for which special measures can be considered to mitigate the risk of roadkill. During the Tarkine Drive Vertebrate Carnivore Assessment Forum it was noted that walking the road verges to look for signs (scats & tracks) of devils and quolls would give an indication of presence and absence, helping to identify areas of activity along the road.

In March 2012 a survey of the entire route was undertaken by bicycle. This method ensured a high level of inspection, being more efficient than a foot survey and more effective than a vehicle survey.

There is a clear spatial trend of scats being found on existing sealed roads and at, or directly adjacent to, the junctions with forestry spur roads (Appendix M). The prevalence of scats recorded on sealed roads is thought to be because they may persist longer in a detectable form, rather than an indication on abundance (on sealed verses unsealed roads); a specific follow up inspection found scats at most junctions (gravel or otherwise) with spur roads, or a very short distance along the spur road.

Tasmanian devils are known to use runways in forests to move around and transect the landscape (Tarkine Drive Forum 2009) and the prevalence of a significant number of forestry spur roads in limited or no use along the route provide ideal opportunities for devil movements. In the areas where these roads intersect with the Tarkine Forest Drive, there may be an increased risk of roadkill. In areas where scats have been found and the traffic mix and speed environment is of concern it is appropriate to implement mitigation measures.

6.6.6 Mitigation actions

From the combined results of the previous assessments it has been possible to categorise the Tarkine Forest Drive into different roadkill risk zones. Note, however, that the factors of driver awareness, roadside vegetation (clearance zones), road width and roadside barriers were not used in this risk rating because these factors will be managed consistently across the entire route.

The risk ratings developed to inform the mitigation strategy are:

- Very high risk – this refers to an area that is an existing roadkill hotspot, has demonstrated high animal abundance (headlight survey) and activity (scats present), has suitable surrounding habitat, tends to allow higher vehicle speeds, a location where the traffic mix is of concern[38] and where the road geometry provides obvious animal/vehicle blind spots. The northern part of segment B is considered very high risk
- High risk – this refers to the area that is an existing roadkill hotspot, has high animal activity (headlight survey), tends to allow higher vehicle speeds, and is a location where the traffic mix is of concern. This area does not have any obvious road geometry issues creating animal/vehicle blind spots. The western part of segment E is considered to be a high risk area

[38] By this we mean receives local and through vehicle traffic, as opposed to predominantly tourist traffic, as is the case for the route east of Kanunnah Bridge

- Moderate risk – these areas have demonstrated high levels of animal activity, tend to allow higher vehicle speeds, and are locations where the traffic mix is of concern. The southern portion of segment B and all of segment D are considered moderate risk
- Low risk – the remainder of the route (and generally speaking, the eastern section of the route (from Tayatea Bridge to Kanunnah Bridge) has a low risk of roadkill as a result of the traffic character of this area).

This risk categorisation has informed the development of a mitigation hierarchy with consequent actions (Appendix N). The hierarchy proposed is:

- Very high risk areas – Primary mitigation treatment
- High risk area – Secondary mitigation treatment
- Moderate risk area – Tertiary mitigation treatment
- Low risk area – No mitigation treatment beyond the general treatments, such as vegetation clearance and table drain management.

An outline of the mitigation actions proposed for each step in the hierarchy follows.

Primary mitigation treatment (Appendix O)

- Vegetation clearance and table drain design
- Rumble strips
- Light coloured pavement
- Road alignment amendments to improve visibility.

Secondary mitigation treatment

- Vegetation clearance and table drain design
- Rumble strips
- Light coloured pavement.

Tertiary mitigation treatment

- Vegetation clearance and table drain design
- Rumble strips or light pavement, depending on the nature of the individual locations.

Remainder of the route

- Vegetation clearance and table drain design.

A detailed community awareness program, as previously outlined, will accompany these measures.

Additional mitigation actions will be implemented, as required, should roadkill rates rise as a result of the operation of the Tarkine Forest Drive. These measures will be implemented in a structured and strategic way following appropriate monitoring to confirm increased impact. This process is discussed in detail in the following section.

6.7 Monitoring plan

The adaptive management proposed for the Tarkine Forest Drive is not a random trial and error process but rather involves systematically monitoring outcomes to test assumptions. By monitoring before and after the disturbance we are able to learn how the natural system responds to the changes, so that the process can be finetuned through future interventions.

Following construction, we propose an ongoing strategy to assess and address any increase in roadkill as a result of these development works. This proposed strategy will continue to use an adaptive management framework to monitor, evaluate and mitigate the potential impact to key species from roadkill.

This staged approach to risk management is designed to allow potential changes to be flagged through an ongoing, operational monitoring strategy. This allows for changes to be identified and investigated quickly so that appropriate mitigation strategies can be employed.

Pre-construction monitoring and analysis of roadkill patterns along the proposed Tarkine Forest Drive and nearby roads provides information on baseline levels of roadkill for different road sections. This information has been used to set expected roadkill carcass detection rates over a given time period and for individual passes. These expected counts will provide trigger levels for escalating investigation and management. These triggers are outlined in the following Adaptive Management Framework.

At all stages, monitoring will be used to support and provide triggers for management adaptations. This is a precautionary approach, where monitoring is instigated with the specific aim of supporting management.

Figure 6.12 summarises the adaptive management framework.

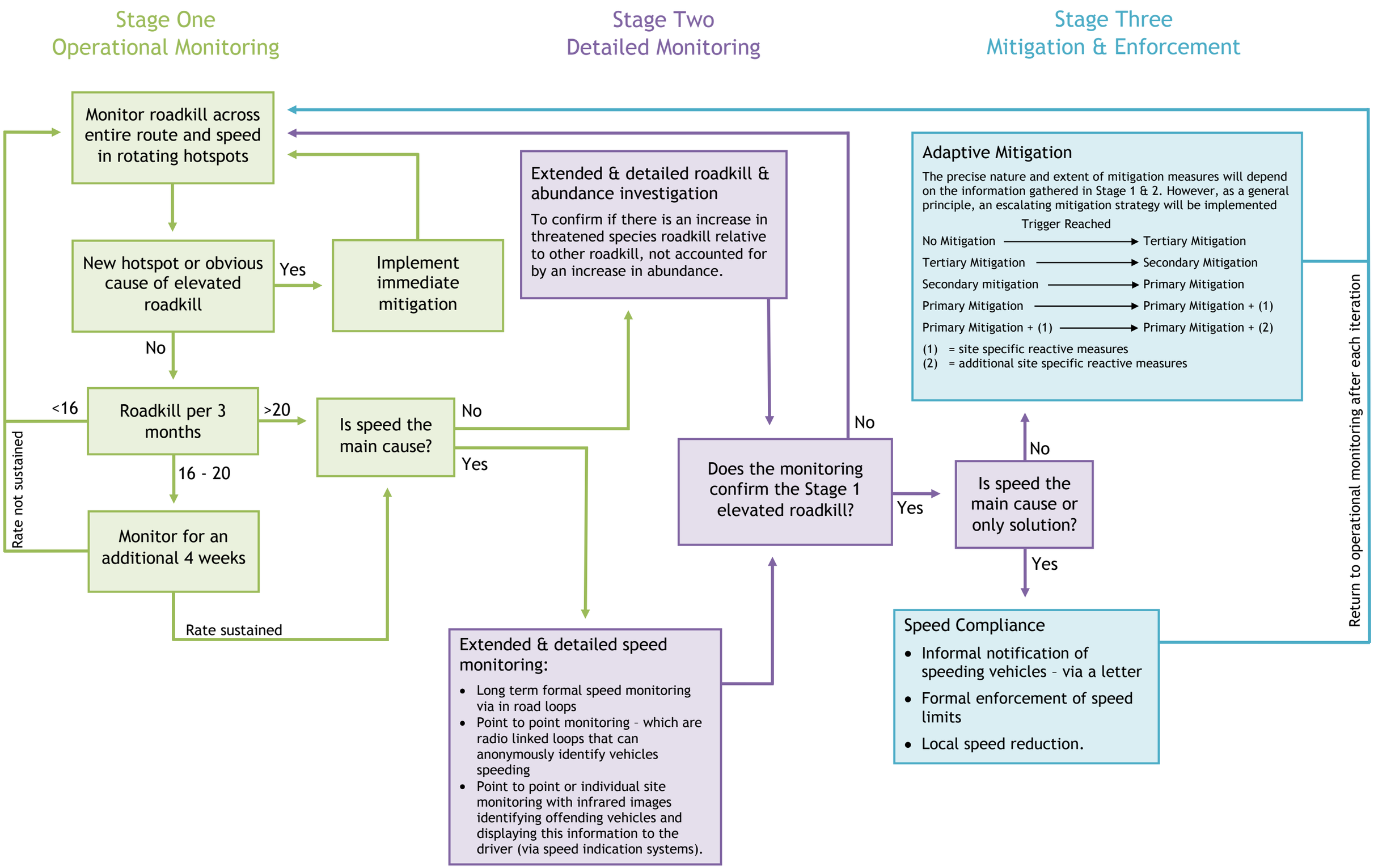


Figure 6.12 - adaptive management framework

Stage 1 - operational monitoring

This stage will see the road maintenance workers recording instances of all roadkill and the segment(s) of road on which they occur.

Data will be collected by staff driving the road as part of regular maintenance works, on a minimum of a weekly basis. A set of standard data sheets will be provided to ensure that data is recorded consistently, even if the data is collected by different staff members.

This information will be assessed quarterly, and compared to the range of expected nightly counts, and the expectation over three months. Notes collected during operational monitoring will also be assessed, as these could provide immediate insight into unusual events.

If the trigger level is exceeded, then Stage 2 will be invoked. The ongoing monitoring applies a precautionary approach to risk management. Because it is unstructured, it is inappropriate to use this monitoring data as a formal, statistical rate of road strike. However, it does allow for increased roadkill to be identified and acted upon swiftly, when a potential effect is identified.

Baseline studies, undertaken over approximately 50% of the route, indicated an average nightly roadkill rate of 0.46 per night (excluding control zones). Over the entire length proposed for sealing we expect the baseline rate to therefore be double what was recorded within the baseline study area, which is marginally less than one roadkill per night, so a baseline trigger rate was set to be 0.9 per night.

The expected rate of 0.9 per night refers to the expected ***average roadkill rate***. To measure this rate with confidence requires a number of samples (nights). On any given night, we would expect the actual ***count*** to be slightly more or less than the actual rate. That is, we would not be surprised to find two roadkills on a given night, but would not expect to see 20.

To set the trigger values, we calculate what the expected *count* might be after a given number of nights, if the average *rate* remains at 0.9 per night. The expected count depends on the overall rate and the number of nights of survey. This is done using the 95% and 99% confidence intervals.

After one night, if the long term average rate is 0.9/night, we expect to count between 0 and 3, and only expect to be outside this one in twenty nights.

After three months of weekly surveys (12 in total), this rate should result in less than 16 total strikes (95% confidence interval, or a one in twenty occurrence). More than 20 strikes are not expected (99% confidence interval, or one in 100 occurrence) and so would immediately trigger stage two.

In addition this stage will see continuous monitoring of traffic mix (cars, trucks etc), traffic speed and vehicle travel times through traffic counters located in select roadkill hotspots and rotated on a regular basis. If roadkill levels exceed the specified triggers then the information from the traffic counters will be reviewed to determine if traffic speed, mix or vehicle travel times are factors.

Why all species?
Baseline data was collected for a portion of the proposed sealing route. This confirmed that patterns in road strike of all species are correlated to the patterns for carnivorous marsupials. By monitoring overall road strike rates, we enable potential increases to be detected earlier than by tracking only one or two species. Any increase in the overall rate of road strike will be considered as a potential increase for species of interest, and will instigate further investigation.

Stage 2 - formal monitoring

If a potential increase in roadkill is detected (beyond the expected range), Stage 2 management is triggered.

It is possible that the Stage 1 monitoring will also provide information that would allow mitigation measures straight away. For example, there might be a clear indication that increased roadkill is associated with, say, increased carrion in a particular area. This could trigger carrion clean up as an immediate mitigation measure.

Otherwise, Stage 1 monitoring might indicate an increase in counts but provide no further information. In this case, Stage 2 would be likely to instigate a period of formal monitoring of the area. This would be designed to answer the following questions:

- Is there any change to the impact on threatened species?
- What is the spatial pattern of roadkill (e.g. are there any new hotspots)?
- Is there a change in animal abundance?
- Has DFTD been recorded within the project area?
- Is there any external change to traffic (e.g. other unforseen developments)?
- Is speed a factor in the elevated roadkill?
- Who is speeding and when are they speeding?

It is important to ensure that mitigation is effective and not poorly focussed (which could actually contribute to a negative impact). For example, it is important to distinguish between a flat, 'global' increase that requires a global mitigation program, or a localised peak of activity, which can support a much more intense, yet localised, mitigation approach. Stage two seeks to focus the discussion on appropriate and effective mitigation measures, not to quantify the impact. It necessarily depends upon the nature of the concern raised in Stage 1.

The purpose of Stage 2 is to develop a targeted response to triggers in Stage 1. Where a significant increase in roadkill has been identified from Stage 1 then further investigation is undertaken to confirm the initial suggestion. This will involve intense sampling of roadkill of a defined period. It will also require context by establishing whether or not there is any relationship with elevated densities or activities of wildlife on the road. This requires a period of headlight surveys. The intensity of distribution of the survey is dependent upon nature of data from Stage 1. It may be across the entire route or spatially defined. Effective monitoring will require tailoring the investigation to Stage 1 outcomes.

Any qualitative observations such as elevated proportions of vertebrate carnivore losses, changes in roadkill arising from localised changes in traffic activity from unforseen action bringing increased traffic volumes eg. a cultural or sporting event or intensive forestry activity etc can also be triggers for Stage 2. It is not possible to predict all triggers resulting from Stage 1 and so the design of the methodology is not prescriptive.

In relation to speed there are a number of more robust methods of speed monitoring that will be utilised if excessive speed is demonstrated during the Stage 1 monitoring, they are:

- Long term formal speed monitoring via in road loops
- Point to point monitoring – which are radio linked loops that can anonymously identify vehicles speeding

- Point to point or individual site monitoring with infrared images identifying offending vehicles and displaying this information to the driver (via speed indication systems).

Stage 3 - mitigation

To be effective, an adaptive management program must be able to identify, or suggest, where the potential impact is occurring. If a significant increase in roadkill has been confirmed and the nature of the increase identified mitigation steps can then be discussed and instigated based on this information.

The exact nature and extent of measures will depend on the information gathered in Stage 1 and 2. If the increased impact is demonstrably speed related then an escalating strategy will be applied:

- Road users speeding will be notified informally of exceeding the speed limit
- If through the continued operational monitoring this does not reduce vehicles speeding associated with roadkill then legal speed enforcement will occur in the relevant areas.

In instances where vehicles exceeding the posted speed limit are not determined to be the causal factor in elevated roadkill the following mitigation actions will be implemented. As a general principle, the process will involve an escalating mitigation strategy: at sites where triggers are met, the site will move up one level of the mitigation hierarchy (e.g. Tertiary is elevated to Secondary, Secondary sites are elevated to Primary). Additional measures (above what is currently proposed) will be utilised as required. These measures will follow after it has been demonstrated through the stage 1 & 2 trigger levels, within the adaptive management framework above, that current mitigation measures are not working.

The measures will involve (as a minimum):

- Construction of animal escape routes. While the road cross section proposed for the majority of the route is unlikely to trap or channel wildlife on the road, if through the detailed stage 2 monitoring and investigations it becomes apparent that there are roadside barriers contributing to roadkill then appropriate mitigation measures responding to this will be implemented
- Low maintenance technical solutions, such as vehicle triggered roadside lighting – these use sensors to detect an approaching vehicle and then illuminate the road. These are expected to effectively warn animals (both on the road and also the roadside) of approaching vehicles and provide enough time for effective escape. They will also improve driver visibility
- A progressive reduction in speed limit in problem areas. It is expected that the reduction would occur in 10 km/h increments, e.g. 80 to 70 km/h and the 70 to 60 km/h and finally 60 to 50 km/h.

After implementation of a measure, Stage 3 includes a feedback cycle into the operational monitoring.

If after moving through the various mitigation options outlined above, i.e. Primary Treatment with roadside lighting and a reduction of the speed limit (with enforcement) to 50km/h in hotspots and the trigger levels continue to be exceeded then DSEWPaC, DPIPWE and the STDP will be consulted regarding the appropriate additional measures or offsets.

6.7.1 Assessment of the expected or predicted effectiveness of safeguard and mitigation measures

The previous detailed discussion, including robust statistical analysis (BACI study) of the mitigation trials demonstrates that the roadkill mitigation measures are likely to be effective. The Adaptive Management Framework will ensure that should any unanticipated impacts occur, then they will be effectively mitigated in a timely fashion.

It is likely that vehicle barriers and signage will be effective in protecting the core habitat for Arthur River greenhood near Tiger Creek.

It is likely that education and practical measures (for example, cigarette disposal receptacles and the removal of wood burning barbecues) will form an integral part in minimising the incidence of wildlife caused as a result of tourist visitation. It may be the case that higher tourist visitation to the Tarkine area may increase surveillance and reporting of wildfire. There remains a level of uncertainty if a potential wildfire could be as a result of increased tourist visitation.

The installation of suitable barriers (for example boom gates) on Forestry Tasmania spur roads will be effective in blocking access to fire sensitive areas.

It is likely that education will form an integral part in minimising recreational fishing of Australian grayling.

6.7.2 Cost of mitigation measures

Table 6.4 describes the estimated costs of roadkill mitigation measures.

Table 6.4 – Estimated costs of roadkill mitigation measures

Mitigation Measure	Estimated Cost (Exc. GST)
Rumble strips	$204,000
Light coloured pavement	$45,000
Road alignment amendments to improve visibility	$262,640
TOTAL	$511,640

6.7.3 Compliance

The critical operational roadkill compliance issue is speed. The impact of vehicle speed on roadkill risk has been discussed previously in this document. Vehicle speed, alongside traffic volumes, is recognised as probably the most important human factors explaining wildlife collisions (Clevenger et al 2003, Hobday & Minstrell 2008, Hobday 2010, Jones 2000, Taylor & Goldingay 2010). Accordingly speed reduction plays an integral role in the mitigation actions.

The posted speed limit on the Tarkine Forest Drive will be between 50 - 80km/h. In addition, if the adaptive management framework stage 1 & 2 triggers are continuously exceeded as a result of vehicle speed, then a defined reduction in the speed limit at the hotspots will be the “fail safe” response. In order for the reduction in speed limit to be effective it must be accompanied by some form of speed monitoring and enforcement or compliance. The measures to ensure compliance have been outlined in the adaptive management framework.

6.7.4 Residual impacts and proposed compensatory measures

What are the changes that the Tarkine Forest Drive will promote, relevant to roadkill?

There will be no change to habitat and animal abundance and activity should also be stable. The traffic volume on the route will increase but it has been demonstrated that this will be predominantly tourist traffic - a forecast ~ 44,000 additional visitors per year by 2025, resulting in an expected 80 extra vehicles per day, the majority of which will be travelling during daylight hours.

An extensive research effort and subsequent mitigation strategy has been developed to ensure that appropriate safe guards have been put in place, to mitigate against the increase in vehicle numbers and also increase in speed (assumed as a result of transitioning the road from gravel to sealed). Furthermore, the nature of the adaptive management proposed will ensure that if, in the unlikely event that the mitigation measures are not effective, the measures will be amended or altered to ensure no significant impact ensues.

This adaptive mitigation strategy will ensure that there is no residual significant impact and as such we believe an offset is not required.

However, through the planning, development and ultimate operation of the Tarkine Forest Drive a significant body of research has been undertaken and a number of important discoveries have been made (such as the effectiveness of rumble strips) and so DIER wish to see this important information more widely disseminated. In addition DIER will be undertaking a number of other voluntary actions to reduce the threat of roadkill in areas surrounding the Tarkine Forest Drive and elsewhere on the road network. These are summarised below.

- Roadkill mitigation sites are to be installed and maintained on non-DIER roads approaching the Tarkine Forest Drive: Roger River Road (2 additional) and Arthur River Road (2 new). These are discussed in more detail below
- Wildlife Warning Signs Trials (Intelligent Transport System-based Active Wildlife Signs) on East Coast roads - The trial includes
  - The selection of 15 high roadkill sites (on the Tasman and Arthur Highways) which currently have no wildlife signage and no reduction in speed limits
  - Initial baseline monitoring of each of the sites for an appropriate period prior to installation of wildlife warning signs and also vehicle speed monitoring
  - Once treatments (five control sites, five static wildlife warning signs and five active wildlife warning signs) are in place, monitor and record roadkill, continue to record vehicle speed
  - The results will be analysed and inform future DIER signage strategies
- DIER will be developing an extensive public education program associated with the Tarkine Forest Drive and roadkill more generally- this is outlined in more detail in section 6.6.2.
- Establishment of an interagency Tasmanian devil roadkill working group to ensure all information and initiatives are shared to maximise value of investments into research and mitigation
- Installation of light aggregate in 3 Tasmanian devil roadkill hotspots when resurfacing works are programmed
- DIER to formalise a system of roadkill data collection on known Tasmanian devil roadkill hotspots within the road network. An “app” is currently being developed for this purpose. Subsequent data will be collated and analysed to inform future decisions related to mitigation

- DIER will formally distributes the results of the roadkill work done to date on the Tarkine Forest Drive through journal papers / articles to ensure the lessons learned are broadly distributed, particularly the success of the rumble strips
- DIER will formally reports on the success of light coloured pavement on the Tarkine Forest Drive after the first 12 months of operation – in the form of a report to SEWPaC, STDP, and also through a journal article or similar, that has broad readership/reach
- DIER have recently met with the Program Manager and Director of the Save the Tasmanian Devil Program with the aim of determining which priorities of the program could be aided by DIER input / resources. We expect to be able to determine any additional measures resulting from this collaboration prior to the Minister announcing the decision on the Tarkine Forest Drive.

These measures are important when considered in their totality, as they provide a number of tangible, measurable on-ground measures that directly reduce a key (albeit secondary to DFTD) threat to the Tasmanian devil. Importantly these measures are directly related to the increased potential impact (roadkill) this project may cause.

In addition some of the measures capitalise on and disseminate the extensive research efforts undertaken for the Tarkine Forest Drive, ensuring that many within and outside of Tasmania will also benefit from this work.

While not mentioned above in the voluntary actions, something that must not be overlooked is the fact that on three roadkill hotspots in the Tarkine area (one on the route and two on Roger River Road) there has been mitigation measures in place since February 2012 – this have been delivering a reduction in roadkill prior to any increased impact or risk of impact associated with the project development. In the 2 years they will be in place prior to any part of the proposed route becoming operational these sites (prior to mitigation) would be expected to experience approximately 420 detectable road strikes for all animals combined (based on the average number of strikes per night per location). A 50% reduction in detectable road strikes (based on the results of the BACI study) would be 210. In the baseline roadkill collection for this project Tasmania devils accounted for 3% of the roadkill detected. If we assume that of the 210 decrease in detectable roadkill of total animals that Tasmanian devils will account for 3%, this would results in approximately 3 less Tasmanian devils being killed per annum (or 6 devils prior to the route becoming operational) as a result of these measures.

Roger River Road

Roger River Road has displayed elevated levels of roadkill during the baseline study. Through the roadkill baseline monitoring, four roadkill hot spots have been highlighted - two of these hot spots have already had successful mitigation treatment (as part of the roadkill mitigation trials). It is proposed to install mitigation treatments at the two remaining hot spots on Roger River Road to further reduce roadkill.

Across the four hotspots we could expect approximately 300 detectable road strikes for all animals per annum (based on the average number of strikes per night per location), a 50% decrease or 150 animals, is a significant reduction in roadkill. If we assume that of the 150 decrease in roadkill of total animals that Tasmanian devils will account for 3%, this would results in approximately 4 less Tasmanian devils being killed per annum on Roger River Road as a result of these measures.

Arthur River Road

A 12.8 km section of Arthur River Road, north of Arthur River (refer to EPBC decision 2003/930) is recognised as having elevated roadkill levels – this section of road has been discussed in more detail elsewhere is this submission.

Roadkill species and locations have been monitored along this section of Arthur River Road since 2002. We were provided with a yearly summary of counts for all species, and more detailed information on Tasmanian devils. The Tasmanian devil data provided consisted of the year of survey and the location of the roadkill, measured in kilometres south from Marrawah cattle grid. This information is summarised in Table 6.5 below.

Table 6.5 – Number of roadkill finds per year

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Tas. Devil records	33	17	20	35	23	28	31	29	23	19	3
All other species	-	70	132	123	103	179	193	201	191	237	43

To choose potential sites for mitigation trials, we undertook a 'hotspot' analysis to identify areas of higher roadkill density.

There are two clear areas with higher roadkill density.

	Location
Site 1	9.8 km south of Marrawah cattle grid
Site 2	4.0 km south of Marrawah cattle grid

Across the two hotspots we could expect approximately 140 detectable road strikes for all animals per annum (based on the average number of strikes per night per location). The installation of rumble strips could again be expected to reduce roadkill by approximately 50% or 70 animals. The relative percentage of Tasmanian devils in the roadkill collected from this section of road varies and is greater than the 3% found in our baseline study. However, conservatively applying the 3% ratio would result in a reduction in Tasmanian devils roadkill at the two hotspots by approximately 2 per annum.

The potential reduction in roadkill at these locations (approximately 6 per annum) is significant and is a major benefit of the development of the Tarkine Forest Drive.

6.8 Monitoring and research

The adaptive management proposed for the Tarkine Forest Drive is not a random trial and error process but involves systematically monitoring outcomes to test assumptions. By monitoring before and after the disturbance it is possible to learn how the natural system responds to the changes, so that the process can be finetuned through future interventions.

Following the construction phase, it is proposed that an ongoing strategy to assess and address any increase in roadkill as a result of the project. This proposed strategy will continue to use an adaptive management framework to monitor, evaluate and mitigate the potential impact to matters of NES from roadkill.

This staged approach to risk management is designed to allow potential changes to be flagged through an ongoing, informal monitoring strategy. This allows for changes to be identified and investigated quickly so that appropriate mitigation strategies can be employed.

Pre-construction monitoring and analysis of roadkill patterns along the proposed Tarkine Forest Drive and nearby roads provides information on baseline levels of roadkill for different road sections. This information will be used to set expected roadkill carcass detection rates both for a given section over a given time period and for individual passes. These expected counts will provide a trigger levels for escalating investigation and management.

At all stages, monitoring will be used to support and provide triggers for management adaptations. This is a precautionary approach, where monitoring is instigated with the specific aim of supporting management.

6.9 Contingency arrangements

Because of the complexities of habitat distribution and the dynamics of wildlife populations and behaviour and the inevitable variety of vehicles and driver motivations and experience (some careful some not, some capable, some not), there can be no single, fixed mitigation solution. Management and mitigation measures should adapt to the findings of ongoing monitoring that measures their effectiveness over time, with the aim of steady and progressive improvement, using an adaptive management approach.

Adaptive environmental management recognizes the complex and interrelated character of ecosystems, with flexibility stressed within the process to account for any changes in conditions or the emergence of new evidence (Briassoulis 1989, Lawrence 2000). It provides a means to continue to manage and benefit in the face of uncertainty (Allan 2002, Briassoulis 1989). Because of the complexities of natural systems, predicting their response over the long term to up-front management measures is difficult. The best way to optimise those measures is to allow them to evolve in response to observations, to learn from experience.

Adaptive management involves an evaluation of the issue, the development of a concept of what is occurring and what appears to be needed, followed by the implementation of initial management measures and then the monitoring of their outcomes. Importantly, the next stage involves comparing the results with the predictions and developing an understanding of what works and why, and also what does not work and why (Salafsky et al 2001).

By monitoring before, during and after the disturbance, we are able to learn how the natural system responds to the changes, so that the process can be fine-tuned through subsequent interventions. Adaptive management addresses criticisms of conventional environmental management practices which often do not allow for the uncertainty of outcomes from policy implementation (Allan 2002, Ladson and Argent 2002, Salafsky et al 2001).

Within this context, there is limited risk of reaching thresholds that constitute a significant impact. However, if after the final mitigation options are implemented and Stage 1 and 2 roadkill triggers are exceeded, then DSEWPaC, DPIPWE and the STDP will be contacted and the appropriate next steps (such as an offset) will be negotiated. It is difficult to provide specific measures at this stage because unless and until these triggers are reached we will not know what species, impact and issues are creating concern. Without this knowledge no reasonable arrangements can be suggested beyond consultation with the appropriate regulators.

6.10 Other statutory or policy basis

6.10.1 Threatened Species Protection Act 1995

Many of the Matters of NES are also listed under the *Threatened Species Protection Act 1995* (Tas).

Under the *Threatened Species Protection Act 1995* (TSP Act) a person must not knowingly, without a permit, take any specimen of listed flora or fauna (section 51 (1) (a) of the TSP Act).

Under the TSP Act, *take* includes:

> *kill, injure, catch, damage, destroy and collect*

Further information in relation to the listing status of matters of NES is provided in Table 6.6.

Table 6.6 - TSP Act listing status for matters of NES

Matter of NES	TSP Act listing
Arthur River greenhood (*Pterostylis rubenachii*)	endangered
Shortspike midge orchid (*Corunastylis brachystachya*)	endangered
Western leek orchid (*Prasophyllum favonium*)	endangered
Windswept spider orchid (*Caladenia dienema*)	endangered
Spotted-tail quoll (*Dasyurus maculatus* subsp. *maculatus*)	rare
Tasmanian devil (*Sarcophilus harrisii*)	endangered
Tasmanian azure kingfisher (*Ceyx azureus diemenensis*)	endangered
Tasmanian masked owl (*Tyto novaehollandiae* subsp. *castanops*)	endangered
Wedge-tailed eagle (*Aquila audax* subsp. *Fleayi*)	endangered
White-bellied sea eagle (*Haliaeetus leucogaster*)	vulnerable
Australian grayling (*Prototroctes maraena*)	vulnerable
Giant freshwater crayfish (*Astacopsis gouldi*)	vulnerable
Marrawah skipper (*Oreisplanus munionga* subsp. *larana*)	endangered

6.10.2 Weed Management Act 1999

All of the introduced plants recorded (or could occur due to suitable habitat) are listed as declared under the *Weed Management Act 1999* (Tas). Of the Weeds of National Significance, only blackberry and gorse were recorded from the study area.

6.10.3 *Phytophthora cinnamomi*

Under the EPBC Act, *Phytophthora cinnamomi* is listed as a key threatening process.

A Threat Abatement Plan (Environment Australia 2002 as cited in Rudman 2005) has been prepared to co-ordinate national action to limit the impact of *Phytophthora cinnamomi*. Under the Tasmanian Regional Forest Agreement (1997) the state agreed to participate in the production of the Threat Abatement Plan (Rudman 2005).

The Threatened Species Strategy for Tasmania (2000) identifies *Phytophthora cinnamomi* as a threat to species and community conservation in the state. In addition, the implementation of the national threat abatement plan is identified as an action under the Threatened Species Strategy for Tasmania. As a signatory to the Tasmanian Regional Forest Agreement (1997), the state agrees to improve the management of species listed under the EPBC Act, a number of which are at risk from *Phytophthora cinnamomi* (Rudman 2005).

Phytophthora cinnamomi management prescriptions have been incorporated into various industry codes of practice or standard operating procedures such as within the Forest Practices Code, Quarry Code of Practice, Mineral Exploration Code of Practice, Draft Reserve Management Code of Practice, Forestry Tasmania Management Decision Classification System. State environmental impact assessment processes take into account *Phytophthora cinnamomi* issues where relevant. In some circumstances provisions of the *Plant Quarantine Act 1997* applies to *Phytophthora cinnamomi* (Rudman 2005).

6.10.4 State policy on water quality management 1997

A baseline water quality monitoring program has been initiated to investigate water quality data and to ensure that any potential project impacts on the waterways are monitored, controlled or managed appropriately.

6.11 Agency responsibility

Details of the state agencies responsible for endorsing or approving the various proposed mitigation measures and monitoring programs are summarised in Table 6.7.

Table 6.7 - Responsible agencies

Mitigation Measure	Agency responsible
Construction phase	
Threatened flora and fauna	PCAB
Weed management	DPIPWE
Plant and animal pathogen management	DPIPWE
Operational phase	
Roadkill mitigation	DIER
Driver behaviour	DIER
Monitoring	
Surface water quality	Waratah Wynyard / Circular Head Councils
Roadkill	DPIPWE
Devil movement	DPIPWE

7. Other approvals and conditions

The PER must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:

- *Details of any local or State Government planning scheme, or plan or policy under any local or State Government planning system that deals with the proposed action, including*
- *What environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy*
- *How the scheme provides for the prevention, minimisation and management of any relevant impacts*
- *A description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the EPBC Act), including any conditions that apply to the action*
- *A statement identifying any additional approval that is required*
- *A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.*

7.1 Planning framework and Local Government requirements

The Tasmanian Resource Management and Planning System (RMPS) was established to achieve sustainable outcomes from the use and development of the State's natural and physical resources. Several pieces of legislation embody the aims of the RMPS.

Within the context of the RMPS the proposed action will be considered against:

- State Policies and Projects Act 1993
- Land Use Planning and Approvals Act 1993.

7.1.1 State Policies and Projects Act 1993

The *State Policies and Projects Act 1993* establishes the process to put in place State Policies in relation to the RMPS of Tasmania. State policies seek to ensure a consistent and coordinated approach and incorporate the minimum amount of regulation necessary to achieve their objectives of managing natural resources. State Policies are implemented through their integration into Local Government Planning Schemes.

Currently there are three State Policies:

- State Coastal Policy 1996
- State Policy on Water Quality Management 1997
- State Policy on Protection of Agricultural Land 2009.

State Coastal Policy 1996

The purpose of the *State Coastal Policy 1996* is to implement the sustainable development objectives of the RMPS in Tasmania's coastal areas. The policy is based on the following three core principles that address these objectives:

- Natural and cultural values of the coast shall be protected
- The coast shall be used and developed in a sustainable manner
- Integrated management and protection of the coastal zone is a shared responsibility.

The *State Coastal Policy 1996* is applicable to all Tasmanian State waters and land (excepting Macquarie Island) within one kilometre inland of the high-water mark.

The policy is only applicable to part of the western section of the proposal, between the Arthur River and Couta Rocks, as this section of the road is within one kilometre of the high-water mark.

State Policy on Water Quality Management 1997

The purpose of the *State Policy on Water Quality Management 1997* is to achieve the sustainable management of Tasmania's surface water and groundwater resources by protecting or enhancing their qualities while allowing for sustainable development in accordance with the objectives of the RMPS.

Pursuant to the *State Policy on Water Quality Management 1997*, the proposed development must comply with the relevant objectives of section 35 - Road Construction and Maintenance. The objectives of these sections are outlined below:

Section 35. Road construction, maintenance and drainage

> *35.1.1 Road construction and maintenance operations will be carried out in accordance with the guidelines or code of best practice developed pursuant to this Policy, or employ other measures consistent with best practice environmental management, to prevent erosion and the pollution of streams and waterways by runoff from sites of road construction and maintenance.*

A baseline surface water monitoring program has been initiated to investigate water quality data and to ensure that any potential project impacts on the waterways are monitored, controlled or managed appropriately.

The management measures that will be applied to ensure compliance with this policy include:

- Construction areas will be clearly demarcated in contract documents so that disturbed areas are kept to a minimum and no unnecessary soil or vegetation disturbance occurs
- Where required, erosion and sediment control measures such as silt stop fencing, sediment traps and erosion control matting will be installed prior to the commencement of construction activities
- Overland drainage flow will be diverted away from disturbed areas and bare soil to outfalls with sediment traps to reduce the potential for erosion
- Rehabilitation and revegetation of disturbed areas will occur as soon as practicable on completion of construction to reduce the potential for ongoing soil erosion to occur
- Stockpiled materials will be managed to ensure that dust and potential runoff is minimised and does not enter watercourses
- Erosion control measures and sediment traps will be regularly monitored; sediment material will be collected and disposed of on site.

State Policy on the Protection of Agricultural Land 2009

The purpose of the State Policy on the Protection of Agricultural Land 2009 is to:

> *Conserve and protect agricultural land so that it remains available for the sustainable development of agriculture, recognising the particular importance of prime agricultural land.*

The main objective of the *State Policy on the Protection of Agricultural Land 2009* is to ensure that the productive capacity of agricultural land is appropriately recognised and protected in the use and development of agricultural land.

The policy focuses on protecting prime agricultural land (land capability classes 1, 2 and 3) from conversion to non-agricultural uses or from being fettered from being used for agricultural activities.

The land adjacent to the proposed action has not been mapped for land capability. However, an estimation of the likely land capability classes can be made based on the known geology, land systems and land usage. The development can be broadly divided into the following two groups:

- The majority of the alignment (Segments C to P) is protected in reserves (State Forests, State Reserves and Conservation Areas) and would be excluded from agricultural use (classified as Exclusion Areas in land capability mapping). If converted to agricultural land, the areas outside reserves would likely be classified as land capability Class 6 (land marginally suitable for grazing because of severe limitations) or Class 7 (land with very severe to extreme limitations which make it unsuitable for agricultural use)
- The land on the western side of the alignment (Segments A and B), some of which is used for extensive grazing. This land is likely to be classified as Class 5 land (land with slight to moderate limitations to pastoral use but which is unsuitable for cropping) and/or Class 6 Land (land only marginally suited to grazing activities due to severe limitations).

There is unlikely to be any prime agricultural land (Class 1, 2 or 3) present along the proposed route. In addition the majority of the works are confined to the existing road reserve, with only very minor excursions expected onto the adjacent land in discrete locations.

7.1.2 Land Use Planning and Approvals Act 1993

Under the *Land Use Planning and Approvals Act 1993* (LUPAA) Councils are required to administer the development and use of land within their municipal boundary. The assessment of development and use is undertaken in accordance with the relevant planning scheme(s).

The proposed action is located within the boundary of the Circular Head Municipality. The proposed use and development will be assessed in accordance with the *Circular Head S.46 Planning Scheme No. 1 1995 As Consolidated at the 2nd June 2003*.

Circular Head S.46 Planning Scheme No.1 1995

The proposed action is within the Conservation and Forest Resources Zones of the *Circular Head S.46 Planning Scheme No.1 1995*. No Special Areas of the scheme appear to apply.

The use or development will be defined as a Road. The Planning Scheme recognises some development that is exempt from planning approval at Clause 2.3.1. The provision of maintenance and repair of infrastructure (including bridges) is listed as being exempt, therefore not requiring Council approval.

Circular Head Council have confirmed in writing that the works are exempt from planning approval.

7.2 Other state legislation

7.2.1 Environmental Management and Pollution Control Act 1994

The proposed action is not listed as a Level 2 activity under Schedule 2 of the *Environmental Management and Pollution Control Act 1994*. Consequently, no requirement to provide an Environmental Impact Assessment under this act has been identified.

However, a Level 1 activity (one assessed under LUPAA) can be "called in" by the Director of the Environmental Protection Authority for assessment by the Environmental Protection Authority. This has not occurred to date.

7.2.2 Threatened Species Protection Act 1995

A permit to "take", pursuant to the Tasmanian *Threatened Species Act 1995*, will be sought from the Policy and Conservation Assessment Branch of DPIPWE for the numbers of the relevant species that will be impacted.

The DPIPWE contact is:

Rebecca Pinto
Section Head
Policy and Conservation Assessment Branch
GPO Box 44, HOBART, TAS, 7001
Ph: (03) 6216 4252

7.2.3 Aboriginal Relics Act 1975

An Aboriginal heritage survey has been undertaken for the proposed action. The background research and field investigations found no new Aboriginal heritage sites within the designated survey areas. The investigation did confirm a number of known Aboriginal Heritage Sites (as listed on the Tasmanian Aboriginal Site Index) adjacent to the proposed road development on Segment D, but outside the area of disturbance. Appropriate construction controls will be implemented to ensure no inadvertent damage to these sites.

7.2.4 Historic Cultural Heritage Act 1995

An historic cultural heritage assessment has been undertaken for the proposed action. There are no sites within or adjacent to the study area currently on the Tasmanian Heritage Register, therefore no statutory approvals pursuant to this legislation are required.

7.3 Other approvals

7.3.1 Parks and Wildlife Service

A Reserve Activity Assessment has been submitted to the Tasmanian Parks and Wildlife Service for sections of the road which are within conservation or other reserved areas, such as the Arthur Pieman Conservation Area.

The Arthur-Pieman Conservation Area Management Plan 2002 applies to all use and development proposed for this Conservation Area.

7.3.2 Land tenure and management

The Crown Solicitor's Office has identified a legislative impediment to DIER carrying out the Project on the FT controlled portions of the proposed site. The Minister for Infrastructure (through DIER) does not have any legislative ability to construct roads on State Forest.

To overcome this and enable DIER to obtain sufficient legal control to undertake the Project, it is proposed to change the status of the parts of the State Forest that are relevant to the Project.

This has been and will be done by a combination of:

- Making the existing forest roads public roads under s.27 of the *Forestry Act 1920* (Tas)
- Revoking the State Forest status of the land by way of the process under s.15 of the *Forestry Act 1920* (Tas).

DIER made the existing forestry roads public with FT's consent on 1 April 2012. DIER is now seeking to revoke the status of the State Forest land for all areas outside the existing road footprint (e.g. widening) – this will require the approval of both Houses of Parliament. Contracts for construction will be awarded, once all land management issues have been resolved.

There is considerable benefit in DIER assuming control over the road. It ensures a consistent maintenance program over the entire length of the road, the safeguarding of the environmental assets of the area and enhances the capacity for cross government stewardship and promotion of the area to maximise its future potential.

7.4 Non statutory approvals

The following non statutory approvals and agreements are required:

- Circular Head Council - It will be necessary to come to an agreement with CHC regarding changes to Temma Road.

8. Consultation

Include details of any consultation about the action, including:

- *Any consultation that has already taken place*
- *Proposed consultation about relevant impacts of the action, including consultation with relevant experts on the threatened species listed in section 4*
- *If there has been consultation about the proposed action, any documented response to, or result of, the consultation*
- *Identification of affected parties, including a statement mentioning any organisations or communities that may be affected and describing their views. This includes the relevant Save the Tasmanian Devil Program managers and researchers, with details provided in the PER on any of the Program's developments in relation to Tasmanian Devil mortalities and the resultant implications for the proposed action.*

Substantial stakeholder engagement was undertaken as part of the initial Tarkine Road project and has continued throughout the rescoping phase of the project. The stakeholder engagement program for the initial project was designed to ensure that a large number of stakeholders involved had the opportunity to understand the project and communicate with the project team. In particular, DIER was keen for interested parties to understand how the environment would be considered and protected during the design and construction process. The need to capture as many stakeholder views as possible has been a critical element of this project.

Throughout 2009 and 2010 DIER ran information sessions on the northwest coast, one in Wynyard and another in Smithton. Briefings were also held for the Circular Head Tourism Association members, Smithton Progress Association, councils in the region and businesses in the Circular Head and Burnie Regions. DIER staff also attended the North West Regional Tourist Forum in Strahan as well as briefing the Advance Burnie Committee. DIER has actively responded to and addressed issues raised by stakeholders, through design revision, the provision of detailed communication materials and the ongoing scheduling of briefings. In addition DIER utilised an email service for the stakeholders who are interested in receiving regular updates.

The stakeholder engagement for the re-scoped Tarkine Forest Road has built on this previous work to ensure the community and key stakeholders such as the Tarkine National Coalition, Tarkine Discussion Group, Cradle Coast Authority and Councils remain fully informed of the revised project and continue to have the opportunity to communicate with the project team.

Two key local stakeholder representative groups – the Tarkine Discussion Group (hosted by the Cradle Coast Authority) and the Tarkine National Coalition have been regularly consulted regarding the proposal over the past 18 months, this consultation will continue as project planning progresses.

The nature and extent of Aboriginal Heritage sites and landscape values within the area has been assessed, with no sites at risk from the proposed works. The Aboriginal Heritage investigation team has commenced consultation with Indigenous stakeholders and Aboriginal Heritage Tasmania.

8.1 Persons/agencies consulted

A Carnivore Assessment Forum was held in late July 2009, the forum notes can be found in the Appendices. This forum consisted of Tasmanian scientists and professionals with recent and relevant expertise and experience in roadkill, vertebrate carnivores and DFTD, a veterinarian, and State and Federal Government regulators.

The attendees were:

- Randy Rose (retired academic from the School of Zoology at the University of Tasmania)
- Barrie Wells (Veterinarian)
- Chloe Lucas (Roadkill Network)
- Clare Hawkins (Threatened Species Zoologist, DPIPWE)
- Nick Mooney (Section Head, Wildlife Monitoring and Management, DPIPWE)
- David Pemberton (Threatened Species Section, DPIPWE)
- Andrew Sharman (Program Manager, Save the Tasmanian Devil Program, DPIPWE)
- Rodrigo Hamede (PhD student, "Contact Networks in Wild Tasmanian Devils: Social Behaviour & Devil Facial Tumour Disease")
- Shannon Troy (PhD student "Landscape Ecology of the Tasmanian Spotted-Tailed Quoll")
- Andrew North (Ecologist, North Barker)
- Karen Ziegler (Ecologist, North Barker)
- Menna Jones (Scientific Advisor, Save the Tasmanian Devil Program, DPIPWE)
- Andrew Harvey (Senior Natural Values Assessment Officer, Development and Conservation Assessment Section, DPIPWE)
- Raymond Brereton (Senior Ecologist, Hydro Consulting, for **pitt&sherry**).

Since the forum the following persons or Local and State Government Agencies have been consulted:

- Policy and Conservation Assessment Branch of the Department of Primary Industries, Parks, Water and the Environment – Manager (Fionna Bourne)
- Policy and Conservation Assessment Branch of the Department of Primary Industries, Parks, Water and the Environment – Manager Assessments (Rebecca Pinto)
- Parks and Wildlife Service – NW Regional Manager (Geoff Coles) and NW Regional Planner (Allen Carmen-Brown)
- Threatened Species Section of the Department of Primary Industries, Parks, Water and the Environment – Senior Zoologist (Clare Hawkins)
- Save the Tasmanian Devil Program – Director (Howell Williams)
- Save the Tasmanian Devil Program – Program Manager (Phil Bell)
- Forestry Tasmania – NW Regional Manager (Nigel Foss), NW Senior Forester (Craig Butt) and NW Division Research & Development (Sue Jennings)
- Circular Head Council – General Manager (Greg Winton)
- Cradle Coast Authority – Executive Chairman (Roger Jaensch)
- Kings Run Wildlife Tours - Geoff King
- Tarkine National Coalition – Scott Jordan.

The Cradle Coast Authorities Tarkine Discussion Group has been regularly consulted during the last 18 months on the projects progress. This group includes representatives from the Cradle Coast Authority, Local and State Government, local businesses and the Tarkine National Coalition.

With the exception of Geoff King and Scott Jordan, those mentioned above were all supportive of the proposed development and associated environmental management recommendations. Geoff King has not expressed a view on the proposed development; Geoff was consulted specifically regarding the roadkill data collection on Arthur River Road.

The Tarkine National Coalition (TNC) has previously expressed concerns over the original proposal. More recently it was the TNC's wish to see the current project split into two components (and two separate referrals), for the areas from Tayatea Bridge to Kanunnah Bridge as stage 1 and Kanunnah Bridge to Arthur River as stage 2. This approach was not supported by the Tasmanian Government and the project was referred as a whole, to potentially be built in two stages over two separate summers.

The TNC has continued to offer its qualified supported to the proposal on the proviso that DIER could prove the proposed mitigation measures were effective. The results of the mitigation trials and the contents of the PER more generally have been presented to the Campaign Manager of the TNC (Scott Jordan) on two occasional, once during a Tarkine Discussion Group Meeting and a second time individually for a period exceeding 2 hours. On both occasions Mr Jordan expressed satisfaction at the results of the trials, but sought further evidence of the efficacy of light coloured pavement. A separate presentation to representatives of the TNC Board and some members occurred during the period that the Draft PER was advertised. No concerns were raised in this meeting.

In April 2012, Andrew Sharman (then Program Manager, Save the Tasmanian Devil Program, DPIPWE) was invited to a meeting to discuss the project and proposed mitigation framework. He declined the invitation and suggested that Clare Hawkins (Threatened Species Zoologist, DPIPWE) was the most appropriate representative of DPIPWE to attend. Clare was happy with the investigations undertaken and expressed a desire to review the results of the mitigation trials, once available. A summary of the results and mitigation strategy have been provided to Clare for information and comment.

The Project was presented the Manager of Assessment (Rebecca Pinto), Policy Conservation Branch in early November. She endorsed the approach taken and in particular supported the robust nature of the baseline work, BACI trial study and adaptive mitigation strategy proposed.

On the 4th of December 2012 the project, and in particular the roadkill baseline study, trials and adaptive mitigation strategy, were presented to the Director and Program Manager of the Save the Tasmanian Devil Program. Both provided substantial positive feedback on the approach and results, with no concerns raised.

8.1.1 Additional consultation

The following individuals have been consulted regarding specialist matters throughout the project development:

- Sue Jennings, Division Forest Research and Development, Forestry Tasmania, Smithton. Useful information on weed management practices, sources of weed infestations, extent of phytophthora and fire history. Supportive of the opportunity for a coordinated weed management of the road
- Bob Hamilton, Parks & Wildlife Service, Arthur River. Cooperative in providing roadkill information along Temma Road. Bob is supportive of investigating mechanisms to tackle this issue in line with the adaptive management strategy
- Dr David Obendorf, Vetenarian. Consulted on the relationship between conservation and anthropogenic processes with respect to Tasmanian devils and DFTD
- Malcolm Wells, (Native orchid enthusiast) – Consulted on his observations of orchids in area

- Mark Wapstra, EcoTas, Ecologist – Consulted on his observations of orchids and other threatened flora in area
- Janine Cranney, native orchid enthusiast – on site meeting top looked at orchid habitats that she knew
- Phil Collier, President Threatened Plants Tasmania – Consulted on TPTs activities in area and referenced their reports.

8.2 On-going consultation

In addition to the key specialist within the project team (outlined below), the following groups or individuals will be consulted throughout the development phase of the Tarkine Forest Drive:

- The Cradle Coast Authorities, Tarkine Discussion Group
- Circular Head Council
- Policy and Conservation Assessment Branch of the Department of Primary Industries, Parks, Water and the Environment
- Threatened Species Section of the Department of Primary Industries, Parks, Water and the Environment – Senior Zoologist (Clare Hawkins)
- The Save the Tasmanian Devil Program.

During the operational phase of the Tarkine Forest Drive DIERs Environment Officer will monitor the effectiveness of the roadkill mitigation in accordance with the adaptive management framework previously outlined and manage all necessary further actions – this will include consultation with appropriate specialists (such as Wildlife Biologists) if and as the need arises throughout the operation monitoring of the roadkill.

9. Environmental record of person proposing to take the action

The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

- *The person proposing to take the action*
- *For an action for which a person has applied for a permit, the person making the application.*

Also include in the PER any details of the Proponent's environmental policy and planning framework.

9.1 Proceedings against the Proponent

No proceedings under Commonwealth or State law for the protection of the environment or the conservation and sustainable use of natural resources have been taken against the proponent or the Department of Infrastructure, Energy and Resources.

9.2 Environmental policy and planning framework

In working to meet the transport needs of Tasmania, the Department of Infrastructure, Energy and Resources (DIER) strives to achieve contemporary community environmental goals and meet appropriate State and National environmental standards.

DIER takes responsibility for sustainable management of biodiversity, land, soil and water resources in Tasmanian transport corridors.

DIER policy highlights are:

- Conform to appropriate State and Federal environmental legislation
- Improve the integration of land use and transport planning, support public transport, cycling and multiple occupancy vehicles
- Maintain the integrity of our natural, Aboriginal and historic heritage
- Meet community needs in landscaping of transport facilities
- Improve management and disposal of materials
- Reduce the environmental impacts of construction and maintenance of transport infrastructure
- Protection of threatened plant and animal species
- Control the spread of weeds and soil pathogens in transport corridors
- Reduce the environmental impacts of emergencies and accidents
- Reduce the environmental impacts of vehicle noise.

9.3 Environmental record

The Department of Infrastructure, Energy and Resources has a proven track record of applying best management practice on environmental issues associated with road construction.

9.3.1 Representative projects

DIER has a proven track record of applying best management practices on environmental issues. The following projects are a testimony to DIER best practice:

- Bass Highway, Ulverstone to Penguin Stages 1 and 2
- Construction of McGee's Bridge at Sorell, including management of issues related to wetlands of international significance (Ramsar)
- Bass Highway, Westbury-Hagley Bypass
- Brighton Bypass.

9.3.2 Environmental information systems

DIER maintains a road information database which identifies the location of significant environmental sites and features, including:

- Threatened species populations, native vegetation remnants and fauna habitat
- Aboriginal cultural heritage sites
- Historic heritage sites
- Weed occurrence and significance
- Erosion occurrence and significance.

9.3.3 Environmental risk assessment

In 2000, North Barker and Associates undertook a biological risk assessment on land managed by the Department.

This report identified that a number of threatened plant species were entirely dependent on road reserves for their continued survival and that many road reserves are crucial for protection of threatened native grassland communities. Following this, the Department developed a management plan for the highest priority conservation sites. DIER identified that the protection of the 43 highest priority sites in the management plan would play an important role in ensuring the survival of Tasmania's threatened species and that appropriate management was crucial.

9.3.4 Conservation sites management

Greening Australia, Tasmania was engaged by DIER in 2005 to implement the "Conservation Sites Management Plan" (High Priority Botanical Sites – Environmental Works, Contract No. 1075) over five years, at the sites. These areas have been identified as having significant natural values such as threatened vegetation types and populations of threatened plants. DIER has made a commitment to retain these values. DIER is currently reviewing the success of the Project and looking at ways to increase the number and diversity of sites actively managed across the road network. This will include both threatened flora species and native vegetation communities.

9.3.5 EPBC Act referrals

DIER has made a number of EPBC referrals prior to the current referral, the most recent being:

- 2009/4757: Brighton Bypass, Southern Section
- 2009/4762: Brighton Bypass, Northern Section
- 2008/4537: Brighton Transport Hub
- 2008/4445: Kingston Bypass Project Stage 1 – Channel Highway, Kingston, Tasmania

- 2008/4344: Tea Tree Secondary Road Pavement and Junction Improvements, east of Brighton, TAS.

Earlier referrals include:

- 2007/3892; 2007/3807; 2007/3526; 2007/2553
- 2006/3007; 2006/2005; 2006/1963
- 2003/1301; 2003/1266
- 2002/842; 2002/733; 2002/667
- 2001/500; 2001/241.

10. Economic and social matters

The economic and social impacts of the action, both positive and negative, must be analysed. Matters of interest may include:

- *Details of any public consultation activities undertaken, and their outcomes*
- *Projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis or similar studies*
- *Employment opportunities expected to be generated by the project (including construction and operational phases)*
- *Details of changes to public access to the area and surrounding regions arising from the road development*
- *Implications for tourism activities (both existing and projected) in the region*
- *Any monitoring programs to monitor ongoing changes to economic and social characteristics potentially affected by the proposed action.*

Economic and social impacts must be considered at the local, regional and national levels. Details of the relevant cost and benefits of alternative options to the proposed action, as identified in section 3 above, must also be included.

A Benefit Cost Analysis has been developed for the Tarkine Forest Drive and is provided in Appendix D.

11. Information sources

For information given in a draft PER, the draft must state:

- *The source of the information*
- *How recent the information is*
- *How the reliability of the information was tested*
- *What uncertainties* (if any) are in the information.

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11.2 Reliability of information

While no specific reliability testing was undertaken on the reports produced, all reports are in accordance with generally accepted environmental consulting practice. A conservative approach was adopted in all investigations.

The project has been managed under the lead consultants **pitt&sherry** ISO9001 Quality System for which they hold third party certification, QAS License No. 4522 (QM16-01).

The vegetation assessment has not identified all vascular flora due to the limitations of the sampling technique. Sampling has been undertaken to a level to assist with vegetation community identification. Threatened flora habitat has been identified applying current knowledge of the species.

Targeted surveys have been undertaken only at selected sites identified in the earlier assessment.

All threatened plant species known from the Natural Values Atlas and the EPBCA Protected Matters Report are considered in the light of habitat suitability. The fauna assessment is predominantly limited to the identification of habitat of significant fauna species known from the area based on the interpretation of database records for threatened fauna. Field surveys for fauna were limited to four nights of headlight survey and the opportunistic recording of fauna that were encountered including tracks and other signs that indicated their presence (e.g. scats and footprints).

11.3 Study team

Key members of the study team are provided in Table 11.1.

Table 11.1 – Key members of the study team

Person	Company	Role	Qualifications & Experience	Input responsibilities
Peter Douglas	**pitt&sherry**	Project Director	Company Director	Project oversight
Brian Williams	**pitt&sherry**	Project Manager	Consulting engineer	Project Management and road design
Selena Dixon	DIER	Manager Major Project Approvals	Planner	Project review and oversight
Andrew Fowler	DIER	Project Manager (client)	Engineer	Project Management
Phil Cantillon	DIER	Project Director (client)	Engineer	Project oversight
Pat Dwyer	PD Construction	Construction input	Engineer	Review road design and mitigation measures for constructability
Dion Lester	**pitt&sherry**	PER author	Consulting environmental scientist	Preparation of PER
Dr Ian Woodward	**pitt&sherry**	PER Review	Consulting environmental scientist	Preparation of PER
Jim Lockley	**pitt&sherry**	Water sampling	Consulting environmental scientist	Surface and groundwater sampling
Charlie Livesey	**pitt&sherry**	PER author	Consulting environmental scientist	Preparation of PER
Doug Tangney	**pitt&sherry**	Water sampling	Consulting environmental scientist	Surface and groundwater sampling
Michael Walsh	**pitt&sherry**	GIS mapping	GIS	Map preparation
Andrew North	NorthBarker	Flora and fauna surveys	Consulting ecologist	Flora and fauna survey
Simon Plowright	Wildspot	Field monitoring	Consulting field surveyor	Roadkill and green and gold frog surveys
Nick Mooney	Consultant	Wildlife advice	Consulting biologist	Advice on quoll and devil impact mitigation
Dr Stuart Muir	Symbolix	Statistical Analysis	Consulting statician	Statistical analysis
Dr Elizabeth Stark	Symbolix	Statistical Analysis	Consulting statician	Statistical analysis

12. Conclusion

An overall conclusion as to the environmental acceptability of the proposal must be provided, including discussion on compliance with principles of ESD and the objects and requirements of the EPBC Act. Reasons justifying undertaking the proposal in the manner proposed must also be outlined.

Measures proposed or required by way of offset for any unavoidable impacts on NES matters, and the relative degree of compensation, must be restated here.

The Tarkine's natural and cultural heritage is unique, and has the potential to become a powerful, sustainable visitor experience. The Tarkine Forest Drive recognises the flagship attributes and core values of the Tarkine and provides targeted investment to allow maximisation of the tourism potential of the area.

The proposed action utilises existing road and bridge infrastructure, with the rebuilding of two existing bridges (across the Nelson Bay River and Rapid River) and some additional works associated with tourist facilities. No new roads are proposed, only an upgrade of existing roads.

An extensive series of background surveys and monitoring programs has been undertaken, commensurate with the environmental and heritage values present. The extent of baseline environmental monitoring, particularly roadkill, undertaken for this project is unparalleled in a Tasmanian context.

The impact of the proposed works must be put in context. Two plants of Arthur River greenhood (on the edge of a colony) will be directly impacted during the Construction Phase. Other potential direct and indirect impacts on matters of NES associated with the Construction Phase can effectively be mitigated by pre construction surveys, site specific construction control measures and Environmental Protection Guidelines. All safeguards and mitigation measures will be contained within the CEMP and will be required to be followed by the contractor.

The direct impact to Arthur River greenhood is not considered to be a significant impact. No offsets are required in relation to this species.

A potential facilitated impact on wildlife could occur during the Operational Phase of the project. Increased traffic may result in a higher incidence of roadkill or injury to individual animals.

This is considered the most significant issue associated with the Tarkine Forest Drive.

The traffic volume on the route will increase but it has been demonstrated that this will be predominantly tourist traffic - a forecast ~ 44,000 additional visitors per year by 2025, resulting in an expected 80 extra vehicles per day, the majority of which will be travelling during daylight hours.

An extensive research effort and subsequent mitigation strategy has been developed to ensure that appropriate safe guards have been put in place, to mitigate against the increase in vehicle numbers and also increase in speed (assumed as a result of transitioning the road from gravel to sealed). Furthermore, the nature of the adaptive management proposed will ensure that if the mitigation measures are not effective then the measures will be amended or altered to ensure no significant impact ensues.

If through the monitoring and adaptive management process the impact from roadkill reaches an unacceptable level (which is defined as exceeding the stage 2 trigger levels following exhaustion of the final mitigation option) then consultation will occur with DSEWPAC, the DPIPWE and the STDP as to the specific offset required. It would be premature to specify an offset at this stage given the precise objectives (and MNES) of the offset cannot be defined unless and until the precise impact is realised. Any offset developed will be done in consultation with the stakeholders mentioned above and in accordance with the department's draft EPBC Offsets Policy.

In addition to the well documented socioeconomic benefits from the project, there are a number of ways in which the proposed action promotes ecologically sustainable development, as follows.

The roadkill mitigating strategy associated with the project includes an extensive community education program. This education program will have benefits that will reach well beyond the project footprint and could go some way to reducing roadkill on other roads in Tasmania.

DIER has already invested significant resource in baseline and general research around roadkill - in particular, proving the success of audible rumble strips as a means of reducing roadkill. DIER is further committed to regularly monitor roadkill on the Tarkine Forest Drive and adapting the mitigation actions in a process of continual learning.

The continual roadkill data collection and further information on successful mitigation options adds significantly to the corpus of information on roadkill and roadkill mitigation. It is well documented that many studies of mitigation measures suffer from a lack of replication and a control group (Taylor & Goldingay 2010). The work undertaken to date provides a statistically rigorous baseline to move forward with further research and offers the potential for lessons to be applied across the entire road network in Tasmania. DIER is committed to sharing the results of the research undertaken to date and further results through the development and implementation of the roadkill mitigation plan.

Other State Government Agencies (such as DPIPWE and the Save the Tasmanian Devil Program), Local Government in Tasmania and indeed other State's road authorities will significantly benefit from the research to date and also the further monitoring and reporting once mitigation treatments are implemented. These further benefits will be lost if the project does not proceed.

There are two areas outside the Tarkine Forest Drive (Roger River Road and a 12.8km section of Arthur River Road, north of Arthur River) that are recognised as having existing elevated roadkill. As part of the mitigation strategy for the Tarkine Forest Drive the existing hot spots on these roads will have appropriate treatments (rumble strips) applied – the details are outlined in Section 6. These benefits will be lost if the project does not proceed.

Given its prominence in the community since the announcement of the original project in 2008/09, the three years hiatus in making a start to this revised project means there is a now a high expectation from the community that it be commenced and completed as soon as possible.

In summary, the development of the Tarkine Forest Drive in the manner proposes provides much needed economic stimulus to the north west region of Tasmania, while recognising the important natural assets of the Tarkine area.

The success of the Tarkine Forest Drive as a visitor experience is contingent on it being a nature based experience. It is imperative that the development occurs in a disciplined framework. The conservation of biodiversity and promotion of sustainable infrastructure is central to the development and implementation of the Tarkine Forest Drive. The development of the Tarkine Forest Drive concept has occurred over many years, with multiple stakeholder and general community involvement. The extensive involvement of stakeholders groups, such as the Tarkine Discussion Group, with its diverse, but representative membership, is testament to DIERs commitment in achieving a benchmark project both ecologically and socially.

The precautionary principle is a fundamental component of Ecologically Sustainable Development and is defined by the following

> *Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (Principle 15 of the Rio Declaration (1992)*

Conceptually, this is a powerful statement with significant ramifications for the onus of proof. Practically, it can be used to guide triggers for action, or adaptive management. One of the main implications of the precautionary principle for operational management is that triggers should be designed to move (to action) before impacts are confirmed.

This is an important distinction, as traditional statistical and inferential concepts are relied upon less. In other words, having 99% statistical confidence in an impact is of little use if it takes so long to establish this level of confidence that the impact becomes irreversible. On the other hand, detecting a potential impact can be used to invoke precautionary actions but this is not the same as irrevocable proof that the development has resulted in an impact.

In the same way, the place of monitoring and evaluation in a precautionary adaptive management framework is to provide alerts, to describe and confirm trends, and to test the efficacy of treatments, rather than as a simple compliance measure.

The Tarkine Region provides a unique and powerful wilderness experience, the Tarkine Forest Drive will improved access to the region for all Tasmanians and tourists, allowing visitors to experience the areas wilderness and heritage values safely and conveniently.