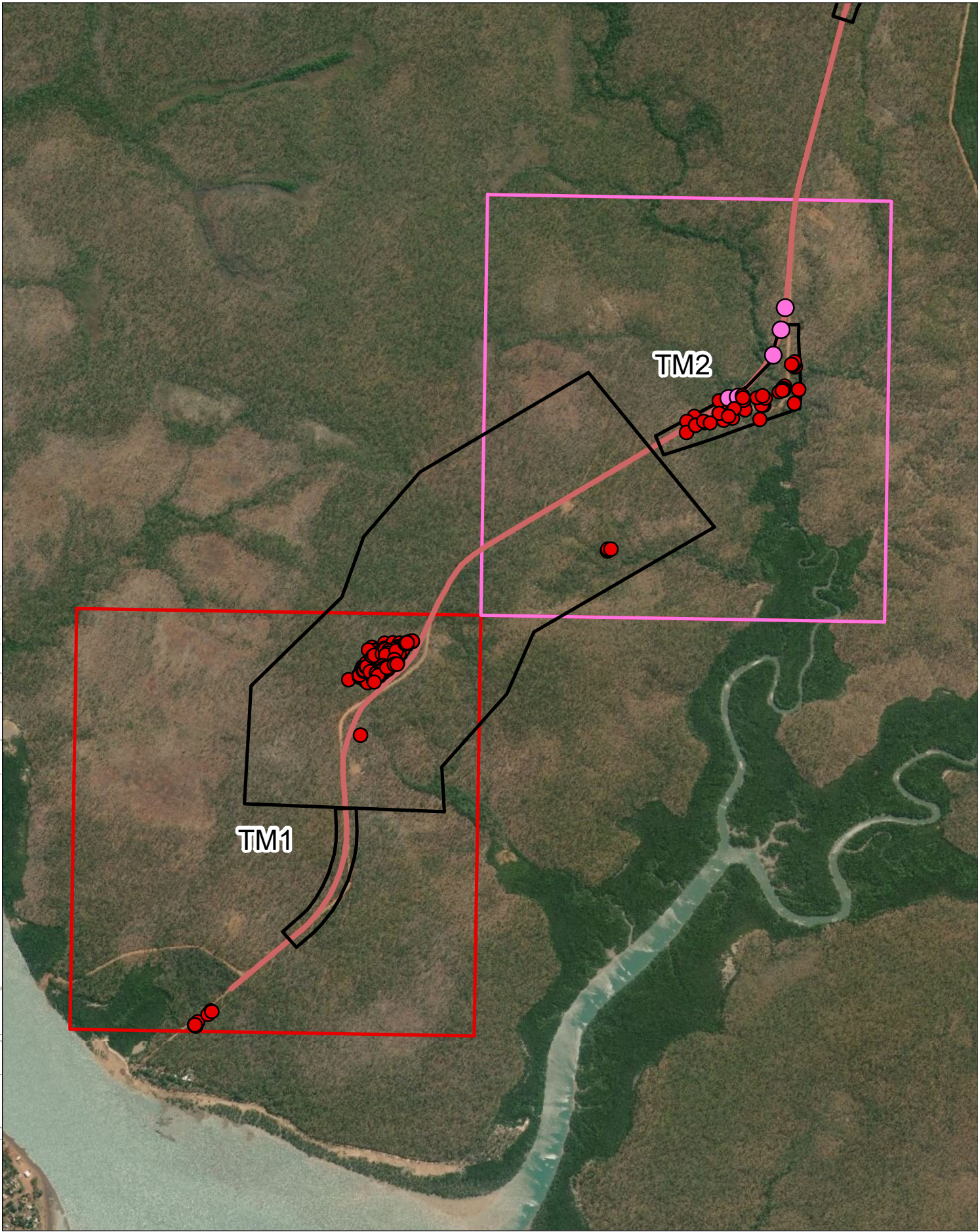


AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



DATUM GDA 1994, PROJECTION MGA ZONE 52

0 0.125 0.25 0.5 0.75

Kilometres

www.aecom.com

Data sources:
 Base Data: Esri, DigitalGlobe
 Field data: AECOM Australia
 AECOM Australia and Esri do not warrant the accuracy or completeness of information in this publication and any person relying upon such information does so on the basis that these companies shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

- *Typhonium mirabile* impact records
- *Typhonium mirabile* records
- Paru Road Preferred Alignment
- Typhonium mirabile* impacted AOO cells
- Typhonium mirabile* records
- Project Area

***Typhonium mirabile* records of occurrence impacted by the recommended project design**

PROJECT ID	60571058
CREATED BY	david.vandenhoek
LAST MODIFIED	24-Feb-2021
VERSION	1

Figure
16

6.0 Significant Impact Assessment

6.1 Threatened fauna

The following threatened fauna species have been confirmed as occurring within the project area at the completion of the January 2021 survey:

- Black-footed Tree-rat
- Pale Field-rat
- Butler's Dunnart
- Partridge Pigeon (eastern)
- Masked Owl (Tiwi)
- Mertens' Water Monitor.

A further four threatened species may occur within the project areas:

- Brush-tailed Rabbit-rat
- Cognate Land Snail
- Yellow-spotted Monitor
- Red Goshawk.

Some threatened species that have been recorded on Melville Island are unlikely to occur within the project area due to a lack of suitable habitat. These include Grey Falcon, False Water Rat, Horsfield's Bushlark and Plains Death Adder. Other species are determined as unlikely to occur due to a lack of recent records, such as Fawn Antechinus.

6.2 Threatened flora

An assessment of habitat, species records and results of the threatened species surveys within the project area has determined the following threatened flora species have been confirmed as occurring:

- *Typhonium jonesii*
- *Typhonium mirabile*

Despite not being recorded during January 2021 surveys *Cycas armstrongii* is considered likely to occur in the project area.

6.3 Threatened species records within the project area

Threatened species records from the January 2021 survey and records sourced from the NR maps website have been combined to determine the level of impact within each of the road alignment project areas.

6.3.1 Red Goshawk

One potential Red Goshawk nest was identified within the Gravel Pit 1 project area. Because the survey was undertaken outside of the Red Goshawk breeding season (June to December) it could not be determined with certainty whether the nest belongs to the species.

A total of 26 Red Goshawk records occurs on the Tiwi islands, while a total of 120 Red Goshawks are estimated to occur (Woinarski *et al.*, 2000). If the nest observed within Gravel Pit 1 is an active Red Goshawk nest then the pair occupying the nest would comprise an estimated 2% of the population on Melville Island.

6.3.2 Partridge Pigeon

Partridge Pigeon was recorded in five locations during the January 2021 survey. Partridge Pigeons were recorded in two locations in Gravel Pit 1, in two locations within the Creek Road Alignment and in

one location at the south of Gravel Pit 2. Three sightings consisted of solitary Partridge Pigeon whilst two sightings were of a pair.

Partridge Pigeon density on Melville Island has been estimated at 0.33 per ha within a total area of 4,436 ha (Hamel *et al.*, 2008). This comprises an estimated population of approximately 1,460 individuals. The seven Partridge Pigeons identified during the survey represents approximately 0.5% of the population.

6.3.3 Black-footed Tree-rat

Ten Black-footed Tree-rats were recorded within the project area during the January 2021 survey. Two were recorded within the Gravel Pit 2, three were recorded within the Creek Road Alignment and five were recorded within Gravel Pit 1.

One Black-footed Tree-rat record occurs approximately 470 m north of the Creek Road Alignment (Figure 5).

These 11 records represent approximately 6% of the 171 records of the species on Melville Island.

6.3.4 Pale Field Rat

Two Pale Field Rat were recorded during the January 2021 survey, including one within the Creek Road Alignment and one within Gravel Pit 1. No desktop records of the species occur within 1 km of the project area.

A total of 150 Pale Field Rat desktop records occur on the Tiwi islands. The two records from the survey represents approximately 1% of all records.

6.3.5 Butler's Dunnart

Three Butler's Dunnarts were recorded within the project area. One individual was recorded within Gravel Pit 1, one was recorded within Gravel Pit 2 and one was recorded within the Creek Road Alignment. No desktop records of the species occur within 1 km of the project area.

A total of 108 Butler's Dunnart records occur on the Tiwi islands. The three records from the survey represent approximately 3% of all records.

6.3.6 Cognate Land Snail

Cognate Land Snail was not observed during the January 2021 survey.

One Cognate Land Snail records occurs within the Creek Road Alignment (Figure 5). This represents 25% of known Cognate Land Snail records, though the species is likely more widely distributed on Melville Island. The species likely occurs across a wider area within the Creek Road patch of monsoon rainforest.

6.3.7 Mertens' Water Monitor

One Mertens' Water Monitor was recorded incidentally close to a creek within the Creek Road Alignment during the January 2021 survey.

One additional desktop record for Mertens' Water Monitor occurs within the Creek Road Alignment (Figure 5). These two records represent approximately 12% of the 17 records of the species on the Tiwi Islands. Hundreds of records of the species occur on across northern Australia.

6.3.8 Masked Owl

Two Masked owl were recorded during nocturnal call playback surveys for the species, including one bird in the Gravel Pit 1 project area and one in Gravel Pit 2.

Data from the NR Maps database provide six Masked Owl records within the project areas, and a further three records within 1 km. Several records were provided for the database by Great Southern Plantations, the now defunct company that previously conducted Masked Owl monitoring. The main survey method implemented by the company was conducting call-playback surveys along roads on Melville Island at a spacing of every 2 km.

The January 2021 survey and desktop records suggest at least one, and possibly two, Masked Owl territories occur within the Gravel Pit 1 project area, and one territory within Gravel pit 2.

A total of 321 Masked Owl records occur on the Tiwi Islands. Including the recent survey the 11 records within 1 km of the project areas represent approximately 3% of all records of the Tiwi subspecies.

6.3.9 *Typhonium jonesii*

The results of the *Typhonium spp.* survey (Section 4.2.2) shows that there is a total of 661 *Typhonium jonesii* records on Bathurst and Melville Islands. Of these 240 (36.3%) records are located within the project area. If the project placement and design recommended in Section 5.0 is adopted 24 plants will be impacted (19 within the proposed road alignment and 5 within gravel pit GP1-1), having a maximum of 6.5% impact on the AOO cells and 3.6% impact on the entire *T. jonesii* population (refer Section 5.4).

6.3.10 *Typhonium mirabile*

The results of the *Typhonium spp.* survey (refer Section 4.2.2) shows that there is a total of 688 *Typhonium mirabile* records on Bathurst and Melville Islands and of these 565 (82.1%) records are located within the project area. If the project placement and design recommended in Section 5.0 is adopted 20 plants will be impacted within the Creek Road Alignment project area, having a 12% impact on the AOO cell and 2.9% impact on the entire *T. mirabile* population (refer Section 5.4).

6.3.11 *Cycas armstrongii*

Gravel pits

A total of 368 *Cycas armstrongii* plants have been recorded on both Bathurst Island and Melville Island. Of these, two records fall within project areas, with both located in the Gravel Pit 2 project area. Neither record is located within proposed gravel pit areas.

6.4 Significance Impact Assessment to threatened species

A significance of impact assessment has been undertaken for each threatened species identified as likely to occur within the project area within the sections below. Criteria for the assessment follows guidelines provided in the Significant impact guidelines 1.1 (DEWHA 2013). These guidelines provide direction for the assessment of a significant impact, with a “Likely” impact having a greater than 50% chance of happening. If there is scientific uncertainty about the impacts of the action and the impacts are serious or irreversible a precautionary approach must be taken. Therefore, a lack of scientific certainty of the impacts cannot inform a decision that a significant impact will not occur.

6.4.1 Significant Impact Assessment for Red Goshawk

Red Goshawk *Erythrotriorchis radiatus*

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

No

One potential Red Goshawk nest was observed within the Gravel Pit 1 footprint. If this is an active nest it would likely represent the only nest in the project area as the species does not nest within 6 km (Aumann & Baker-Gabb, 1991).

Monitoring of Red Goshawk nests on the Tiwi Islands indicates that breeding success declines when more than 25% of suitable habitat within 4 km of a nest is cleared (Baker-Gabb, 2013).

The recommended gravel pit location GP1-1 is close to the potential Red Goshawk nest. This nest is surrounded by suitable habitat patch of approximately 50 ha. Assuming that the gravel pit clears the proposed 6.6 ha of habitat this represents approximately 13% of suitable habitat close to the nest, which is less than the threshold described by Baker-Gabb (2013).

The total size of the project areas is 383.8 ha, and the maximum extent of land clearing within this area is 74.7 ha. The Creek Road Alignment, Gravel Pit 1 and the South Road Alignment occur within a linear distance of 4 km, while the North Road Alignment and Gravel Pit 2 occur within 4 km. The maximum footprint within the north of the project area is 45.1 ha and the maximum footprint in the south is 29.6 ha.

Red Goshawk *Erythrotriorchis radiatus*

Using these estimations of project footprint, a Red Goshawk pair would need to be nesting in an area surrounded (within 4 km) by approximately 2-4% of suitable habitat for the project to negatively impact breeding. It is unlikely that a Red Goshawk pair would nest in such an area, especially given the abundance of suitable habitat on the Tiwi Islands. The project will therefore not impact the breeding success of a Red Goshawk pair and would not lead to a long-term decrease in the size of the Tiwi Islands population.

Reduce the Area of Occupancy of the species**No**

The upper estimate for clearing is 74.7 ha, representing approximately 0.4% of a Red Goshawk territory of 20,000 ha.

The recommended gravel pit location GP1-1 is close to a potential Red Goshawk nest identified in January 2021. This nest is surrounded by suitable habitat patch of approximately 50 ha. Assuming that the gravel pit clears 6.6 ha of habitat this represents approximately 13% of suitable habitat close to the nest, which is less than the threshold described by Baker-Gabb (2013).

The project is unlikely reduce the area of occupancy of the species.

Fragment an existing population into two or more populations**No**

The potential Red Goshawk nest recorded in January 2021 is surrounded by approximately 50 ha of suitable nesting habitat. If a pair using this nest is disturbed by project activities sufficient nesting habitat occurs nearby for the pair to move nests to a different tree.

The project will not impact habitat connectivity, especially given the subject species can fly and has large territories.

Adversely affect the habitat critical to the survival of the species**No**

The project footprint represents approximately 1.7% of the 4,436 ha of woodland habitat that occurs on Melville Island (Hamel *et al.*, 2008). Sufficient suitable habitat for Red Goshawk remains on the Tiwi Islands for the population to survive.

Disrupt the breeding cycle of a population**No**

If construction activities impact a Red Goshawk pair this would likely disrupt breeding for one season, depending on the stage of the breeding cycle during which work is undertaken. A Red Goshawk pair would likely respond by building a new nest within the territory away from construction activities. Impacts would be limited to one Red Goshawk pair and the breeding cycle of the population would remain unaffected.

It is recommended that the nest recorded during January 2021 be monitored during the project.

Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline**No**

As discussed above, the project footprint represents a fraction (~0.4%) of Red Goshawk territory size. Project impacts are unlikely to cause the species decline.

Red Goshawk <i>Erythrotriorchis radiatus</i>
Result in invasive species that are harmful to the species becoming established in the species' habitat
No The action is unlikely to introduce an invasive species that could be harmful to the species habitat.
Introduce disease that may cause the species to decline
No The action is unlikely to introduce a disease that may cause Red Goshawk decline.
Interfere with the recovery of the species
No The action has potential to disturb one pair of Red Goshawk; however, such impacts would likely be limited to one breeding season. The action may impact one out of an estimated 100 Red Goshawk pairs on the Tiwi Islands (Baker-Gabb, 2007), representing 1% of the local population. The action is therefore unlikely to interfere with the recovery of the species

6.4.2 Significant impact assessment for Partridge Pigeon (eastern)

Partridge Pigeon (eastern) <i>Geophaps smithii smithii</i>
Lead to a long-term decrease in the size of a population
No Partridge Pigeon density on Melville Island has been estimated at 0.33 per ha (Hamel <i>et al.</i> , 2008). Using an estimated project footprint of 74.7 ha, the number of Partridge Pigeons potentially affected by the project would be approximately 25, and approximately 1.7% of the estimated total habitat would be impacted. Given that the majority of land clearing would occur at the road alignment project areas, where habitat is likely to be poorer, this figure is likely to overestimate the number of Partridge Pigeons potentially affected.
Reduce the Area of Occupancy of the species
No The estimated project footprint of 74.7 ha represents approximately 1.7% of the 4,436 ha of woodland habitat that occurs on Melville Island (Hamel <i>et al.</i> , 2008), however its proximity adjacent to an existing road is likely to considerably reduce its habitat value. The area of occupancy of the species is therefore unlikely to be reduced significantly by the project.
Fragment an existing population into two or more populations
No The project footprint will not fragment suitable woodland habitat for Partridge Pigeon on Melville Island as the majority of the footprint is located adjacent to an existing road. Woodland habitat on Melville Island will remain contiguous.

Adversely affect the habitat critical to the survival of the species
No The project footprint represents approximately 1.7% of the 4,436 ha of woodland habitat that occurs on Melville Island (Hamel <i>et al.</i> , 2008) and due to its proximity to an existing road is unlikely to be heavily utilised. Sufficient suitable habitat for Partridge Pigeon remains on Melville Island for the population to survive.
Disrupt the breeding cycle of a population
No It is highly unlikely cleared vegetation in the project areas would be utilised for breeding due to existing disturbances. The number of Partridge Pigeons likely to be impacted by the project is approximately 25, representing a small fraction (~1.7%) of the estimated total population of 1,464. The breeding cycle of the Partridge Pigeon population will therefore not be disrupted.
Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline
No Impacts to Partridge Pigeon habitat will be small on a landscape scale. Impacts to the population will be minor, representing approximately 1.7% of the Melville Island population and a smaller fraction of the entire Partridge Pigeon (eastern) population.
Result in invasive species that are harmful to the species becoming established in the species' habitat
No The action is unlikely to introduce an invasive species that could be harmful to the species habitat.
Introduce disease that may cause the species to decline
No The action is unlikely to introduce a disease that may cause Partridge Pigeon decline.
Interfere with the recovery of the species
The project is likely to impact a small fraction (~1.7%) of the population of Partridge Pigeon on Melville Island. The recovery of the species won't be affected.

6.4.3 Significant impact assessment for Masked Owl (Tiwi)

Masked Owl (Tiwi) <i>Tyto novaehollandiae melvillensis</i>
Lead to a long-term decrease in the size of a population
No The population size of the subspecies has been estimated at 1000 mature individuals occupying an area of 500,000 ha (Garnett <i>et al.</i> , 2011). Assuming that there are 500 breeding pairs on the Tiwi Islands, this would give a territory size of 1000 ha per Masked Owl pair. Despite the low reliability of these figures noted by Garnett <i>et al</i> (2011) this is consistent with the home ranges of 500-1000 ha recorded for other Masked Owl subspecies (Kavanagh & Murray, 1996).

Monitoring of Masked Owl on Melville Island has indicated a mean distance between nests of 2.34 km, with a minimum nest distance of 659 m (n=31). This figure is lower than the lowest inter-nest distance of 1.5 km recorded for the species on the mainland, indicating that resources such as prey and nesting hollows may be in greater abundance on the Tiwi Islands (Indicus, 2008).

Two Masked Owls were recorded during call playback surveys. One was recorded within Gravel Pit 1 and one within Gravel Pit 2, approximately 11.3 km apart. These results indicate that there is likely at least one territory within each gravel pit, whilst desktop records obtained from NR Maps indicate that two Masked Owl territories potentially occur within the Gravel Pit 1 area (refer Section 2.6). Masked Owl territories are dynamic and would likely shift over time.

To summarise, data acquired during the field survey, by Indicus (2008) and from the NR Maps website indicate that the project area may occur within up to three Masked Owl territories. However, assuming a Masked Owl territory size of 1,000 ha, and a project footprint of 74.7 ha, the project will only impact a small portion (7.5%) of one territory for the species. The project is therefore unlikely to lead to a long-term reduction in the Masked Owl population of the Tiwi Islands.

Reduce the Area of Occupancy of the species

No

The area of occupancy of the Masked Owl on the Tiwi Islands is estimated at 500,000 ha (Garnett *et al.*, 2011). The project footprint represents an insignificant portion (~0.015%) of the total area of occupancy.

Fragment an existing population into two or more populations

No

The project footprint will not fragment suitable woodland habitat for Masked Owl on the Tiwi Islands. Woodland habitat will remain contiguous and connectivity will not be impacted, especially given the species ability to fly.

Adversely affect the habitat critical to the survival of the species

No

As discussed above the project footprint represents approximately 0.015% of the total area of occupancy of the species on the Tiwi Islands. Sufficient critical habitat remains for the species to survive.

Disrupt the breeding cycle of a population

No

As discussed above, the project area may occur within up to three Masked Owl territories. If hollows that are used for breeding are removed the breeding success of 1-3 Masked Owl pairs may be impacted, out of an estimated total of 500 pairs (Garnett *et al.*, 2011).

Disruption to the breeding cycle would be small and localised. The project therefore won't disrupt the breeding cycle of the Masked Owl population on the Tiwi Islands.

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

No

The project may impact up to 0.6% of the Masked Owl population on the Tiwi Islands, and reduce the area of occupancy by approximately 0.015%. The scale of these impacts is insufficient to cause a decline in the species population.

Result in invasive species that are harmful to the species becoming established in the species' habitat
No The action is unlikely to introduce an invasive species that could be harmful to the species habitat.
Introduce disease that may cause the species to decline
No The action is unlikely to introduce a disease that may cause Masked Owl decline.
Interfere with the recovery of the species
No The project may impact a small portion (~0.6%) of the Masked Owl population on the Tiwi Islands. The recovery of the species therefore won't be impacted.

6.4.4 Significant impact assessment for Brush-tailed Rabbit-rat

Brush-tailed Rabbit-rat <i>Conilurus penicillatus</i>
Lead to a long-term decrease in the size of a population
No Research by Davies <i>et al</i> (2017, 2018) indicates that decline of Brush-tailed Rabbit-rat on Melville Island is strongly linked to feral cats. Of 82 trap sites analysed by Davies <i>et al</i> (2018), three occurred near Paru Road in the vicinity of the project area. The species was not detected at these sites. However, the species may still occur within the project area. Brush-tailed Rabbit-rat was not recorded during the January 2021 field survey. The project footprint represents a small portion of suitable habitat for the species on Melville Island. The project therefore won't cause a long-term decrease in the size of the Brush-tailed Rabbit-rat.
Reduce the Area of Occupancy of the species
No Davies <i>et al</i> (2017, 2018) has suggested that populations of Brush-tailed Rabbit-rat have retracted to areas where feral cats are less likely to occur and shrub density is high. Of the three sites in the vicinity of the project area surveyed in 2015 feral cats were detected at one site, and no Brush-tailed Rabbit-rats were detected (Davies <i>et al.</i> , 2017). The project therefore might consist of habitat that is not preferred by the species. The project footprint represents a small portion of the area of occupancy of Brush-tailed Rabbit-rat on Melville Island. The decrease in area of occupancy would therefore be minor.
Fragment an existing population into two or more populations
No The clearance of a small amount of woodland habitat could fragment the territory of a small number of Brush-tailed Rabbit-rats, and expose individuals traversing the project area to the threat of feral cat predation.

<p>Despite this, suitable Brush-tailed Rabbit-rat habitat on Melville Island will remain contiguous. Potential impacts will be small and localised, and the existing population will not become fragmented.</p>
<p>Adversely affect the habitat critical to the survival of the species</p>
<p>No</p> <p>As discussed above, the project footprint represents a small portion of suitable habitat for Brush-tailed Rabbit-rat on Melville Island. Sufficient critical habitat remains for the species to survive.</p>
<p>Disrupt the breeding cycle of a population</p>
<p>No</p> <p>As discussed above, the project may impact a small number of individuals. Impacts will be small and localised and won't affect the breeding cycle of the majority of the Brush-tailed Rabbit-rat population on Melville Island.</p> <p>It is unlikely cleared vegetation in the project areas would be utilised for breeding due to existing disturbances.</p>
<p>Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline</p>
<p>No</p> <p>The clearance of a small amount of woodland habitat could fragment the territory of some Brush-tailed Rabbit-rats, and expose individuals traversing the project area to the threat of feral cat predation.</p> <p>These impacts will be small, localised and are unlikely to lead to a decline of the species.</p>
<p>Result in invasive species that are harmful to the species becoming established in the species' habitat</p>
<p>No</p> <p>The action is unlikely to introduce an invasive species that could be harmful to the species habitat.</p>
<p>Introduce disease that may cause the species to decline</p>
<p>No</p> <p>The action is unlikely to introduce a disease that will cause Brush-tailed Rabbit-rat to decline.</p>
<p>Interfere with the recovery of the species</p>
<p>No</p> <p>The project may impact a small portion of the Brush-tailed Rabbit-rat population on Melville Island. The recovery of the species is therefore unlikely to be impacted.</p>

6.4.5 Significant impact assessment for Black-footed Tree Rat

Black-footed Tree-rat <i>Mesembriomys gouldii</i>
Lead to a long-term decrease in the size of a population
<p>No</p> <p>A total of 10 Black-footed Tree-rats were recorded during the January 2021 field survey (including motion-activated camera records). Five records are within the Gravel Pit 1 area, three are within Gravel Pit 2 and two are within the Creek Road Alignment. Trapping undertaken in the vicinity of the project area in 2015 failed to detect the species (Davies <i>et al.</i>, 2018).</p> <p>Black-footed Tree-rats on the mainland have been found to have an average home range of 67.3 ha in unfragmented habitat, and 27.1 ha in fragmented habitat. The area within which individuals' den (shelter during the day) has been found to average 16.9 ha in unfragmented habitat, and 6.5 ha in fragmented habitat (Rankmore, 2006).</p> <p>The project footprint consists of seven separate areas, ranging from an impact area of 2.4 ha in the Southern Road alignment to 34.0 ha within the proposed GP2-1. Given the average home range (67.3 ha) of the species in unfragmented habitat the project footprint is unlikely to comprise an entire home range of an individual but may traverse the home range of several Black-footed Tree-rats. The species has been found to respond positively to low levels of habitat fragmentation by persisting within smaller home ranges (Rankmore, 2006). The project therefore may not cause a decline in the Black-footed Tree-rat population, but merely reduce the area within which individuals can forage and shelter.</p> <p>The project footprint represents a small portion of suitable habitat for the species on Melville Island. The project therefore won't cause a long-term decrease in the size of the Black-footed Tree-rat.</p>
Reduce the Area of Occupancy of the species
<p>No</p> <p>On the mainland Black-footed Tree-rat has been found to have an average home range of 67.3 ha in unfragmented habitat, and 27.1 ha in fragmented habitat. The area within which individuals' den (shelter during the day) has been found to average 16.9 ha in unfragmented habitat, and 6.5 ha in fragmented habitat (Rankmore, 2006).</p> <p>The species has been found to respond positively to low levels of habitat fragmentation by persisting within smaller home ranges. Whilst the area of occupancy may be reduced, the size of the project footprint is small at a landscape scale.</p>
Fragment an existing population into two or more populations
<p>No</p> <p>Fragmentation of habitat can reduce the home range of Black-footed Tree-rat, but it has been found to adapt and responded positively (Rankmore, 2006). Woodland habitat within the project area will remain contiguous following road construction and will not become fragmented.</p>
Adversely affect the habitat critical to the survival of the species
<p>No</p> <p>The size of the project footprint is small at a landscape scale. Sufficient critical habitat remains for the species to survive.</p>
Disrupt the breeding cycle of a population
<p>No</p>

As discussed above, the project may impact a small number of individuals. Impacts will be small and localised and won't affect the breeding cycle of the majority of the Black-footed Tree-rat population on Melville Island.

It is unlikely cleared vegetation in the project areas would be utilised for breeding due to existing disturbances.

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

No

The clearance of a small amount of woodland habitat could fragment the territory of some Black-footed Tree-rats. The species has been found to respond positively to low levels of habitat fragmentation by persisting within smaller home ranges (Rankmore, 2006).

Impacts will be small and localised and are unlikely to lead to a decline of the species.

Result in invasive species that are harmful to the species becoming established in the species' habitat

No

The action is unlikely to introduce an invasive species that could be harmful to the species habitat.

Introduce disease that may cause the species to decline

No

The action is unlikely to introduce a disease that will cause Black-footed Tree-rat to decline.

Interfere with the recovery of the species

No

The project may impact a small portion of the Black-footed Tree-rat population on Melville Island. The recovery of the species is unlikely to be impacted.

6.4.6 Significant impact assessment for Pale Field-rat

Pale Field-rat *Rattus tunneyi*

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

No

Two Pale Field-rats were during the January 2021 survey, including one within the Creek Road Alignment and one at Fauna Site 3. Suitable breeding habitat for the species occurs within the Creek Road Alignment. The species also occurs within open woodland with a tussock grass understorey (QLD Museum, 2019).

Trapping on Melville Island undertaken in 2015 recorded an 80% reduction in trapping success for Pale Field-rat compared to trapping undertaken during 2000-2002 (Davies *et al.*, 2018).

The project footprint represents a small portion of suitable habitat for the species on Melville Island. The project therefore won't cause a long-term decrease in the size of the Pale Field-rat.

Reduce the Area of Occupancy of the species

Possible

<p>Despite the lack of desktop records the field survey confirmed that the species occurs within the project area, specifically within the Creek Road Alignment where an individual was caught in an Elliot trap and at Fauna Site 3 where an individual was recorded on a motion-activated camera. However, the project footprint represents a small portion of suitable habitat for the species on Melville Island. Whilst the area of occupancy may be reduced, the size of the project footprint is small at a landscape scale.</p>
<p>Fragment an existing population into two or more populations</p>
<p>No</p> <p>The clearance of a small amount of riparian and woodland habitat could fragment the territory of a small number of Pale Field-rats.</p> <p>Despite this, suitable Pale Field-rat habitat on Melville Island will remain contiguous. Potential impacts will be small and localised, and the existing population won't become fragmented.</p>
<p>Adversely affect the habitat critical to the survival of the species</p>
<p>No</p> <p>As discussed above, the project footprint represents a small portion of suitable habitat for Pale Field-rat on Melville Island. Sufficient critical habitat remains for the species to survive.</p>
<p>Disrupt the breeding cycle of a population</p>
<p>No</p> <p>The project may impact a small number of individual Pale Field-rats. Impacts will be small and localised and won't affect the breeding cycle of the majority of the population on Melville Island.</p>
<p>Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline</p>
<p>No</p> <p>The clearance of a small amount of woodland habitat could fragment the territory of some Pale Field-rats. Project impacts will likely be restricted to the cleared areas and the species will persist in nearby habitat.</p> <p>Impacts will be small and localised and won't affect the breeding cycle of the majority of the Pale Field-rat population on Melville Island.</p>
<p>Result in invasive species that are harmful to the species becoming established in the species' habitat</p>
<p>No</p> <p>The action is unlikely to introduce an invasive species that could be harmful to the species habitat.</p>
<p>Introduce disease that may cause the species to decline</p>
<p>No</p> <p>The action is unlikely to introduce a disease that will cause Pale Field-rat to decline.</p>
<p>Interfere with the recovery of the species</p>
<p>No</p>

The project may impact a small portion of the Pale Field-rat population on Melville Island. The recovery of the species is unlikely to be impacted.

6.4.7 Significant impact assessment for Butler's Dunnart

Butler's Dunnart *Sminthopsis butleri*

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

No

Three Butler's Dunnart were recorded within the project area during the January 2021 survey, one within Gravel Pit 1, one within Gravel Pit 2 and one within the Creek Road Alignment.

Home range size for the species is unknown. One radio-tracked individual was recorded to cover 1.4 ha over a period of seven days (Potter, 2017). The project footprint likely comprises the territory of several individual Butler's Dunnart.

The project footprint represents a small portion of suitable habitat for the species on Melville Island. The project therefore won't cause a long-term decrease in the population of Butler's Dunnart.

Reduce the Area of Occupancy of the species

Possible

The January 2021 survey confirmed the presence of the species within the project area.

An area of approximately 650,000 ha comprises suitable habitat for Butler's Dunnart across the Tiwi Islands (Potter, 2017). The project footprint represents a small portion of suitable habitat for the species on the Tiwi Islands, and is insignificant at a landscape scale.

Fragment an existing population into two or more populations

No

The clearance of a small amount of woodland habitat could fragment the territory of a small number of Butler's Dunnart.

Despite this, suitable Butler's Dunnart habitat on Melville Island will remain contiguous. Potential impacts will be small and localised, and the existing population won't become fragmented.

Adversely affect the habitat critical to the survival of the species

No

As discussed above, the project footprint represents a small portion of suitable habitat for Butler's Dunnart on Melville Island. Sufficient critical habitat remains for the species to survive.

Disrupt the breeding cycle of a population

No

The project may impact a small number of individual Butler's Dunnarts. Impacts will be small and localised and won't affect the breeding cycle of the majority of the population on Melville Island.

It is unlikely cleared vegetation in the project areas would be utilised for breeding due to existing disturbances.

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

No

As discussed above, the project may impact a small number of individuals. Impacts will be small and localised and won't affect the breeding cycle of the majority of the Butler's Dunnart population on Melville Island.

Result in invasive species that are harmful to the species becoming established in the species' habitat

No

The action is unlikely to introduce an invasive species that could be harmful to the species habitat.

Introduce disease that may cause the species to decline

No

The action is unlikely to introduce a disease that will cause Butler's Dunnart to decline.

Interfere with the recovery of the species

No

The project may impact a small portion of the Butler's Dunnart population on Melville Island. The recovery of the species is unlikely to be impacted.

6.4.8 Significant impact assessment for Mertens' Water Monitor

Mertens' Water Monitor *Varanus mertensi*

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

No

One Mertens' Water Monitor was observed within the Creek Road Alignment during the January 2021 survey. The species is semi-aquatic and inhabits areas close to water, therefore is unlikely to occur within the North or South road Alignments or the gravel pits.

Poisoning from Cane Toad poison is the main threat to the Mertens Water Monitor. Cane Toads are absent from the Tiwi Islands therefore it is reasonable to assume that the species population in the area remains stable.

The project footprint represents a small portion of suitable habitat for Mertens Water Monitor on Melville Island. The project therefore won't cause a long-term decrease in the population of the species.

Reduce the Area of Occupancy of the species

No

Suitable Mertens' Water Monitor habitat comprises less than 10 ha of the project footprint. The project footprint represents a small portion of suitable habitat for the species on the Tiwi Islands, and is insignificant at a landscape scale.

Fragment an existing population into two or more populations

No

Suitable Mertens' Water Monitor habitat on Melville Island will remain contiguous. Potential impacts will be small and localised, and the existing population won't become fragmented.

Adversely affect the habitat critical to the survival of the species
No As discussed above, the project footprint represents a small portion of suitable habitat for Mertens' Water Monitor on Melville Island. Sufficient critical habitat remains for the species to survive.
Disrupt the breeding cycle of a population
No Impacts to Mertens' Water Monitor will be small and localised and won't affect the breeding cycle of the majority of the population on Melville Island.
Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline
No As discussed above, the project footprint represents a small portion of suitable habitat for Mertens' Water Monitor on Melville Island. Sufficient critical habitat remains for the species to survive.
Result in invasive species that are harmful to the species becoming established in the species' habitat
No The action is unlikely to introduce an invasive species that could be harmful to the species habitat.
Introduce disease that may cause the species to decline
No The action is unlikely to introduce a disease that will cause Mertens' Water Monitor decline.
Interfere with the recovery of the species
No The project may impact a small portion of the Mertens' Water Monitor population on Melville Island. The recovery of the species is unlikely to be impacted.

6.4.9 Significant impact assessment for Yellow-spotted Monitor

Yellow-spotted Monitor <i>Varanus panoptes</i>
Lead to a long-term decrease in the size of a population
No Yellow-spotted Monitor was not detected during the January 2021 survey. No records of Yellow-spotted Monitor occur within 1 km of the project area. The species may be present as suitable habitat occurs within the project area. Poisoning from Cane Toad poison is the main threat to the Yellow-spotted Monitor. Cane Toads are absent from the Tiwi Islands, therefore it is reasonable to assume that the species population in the area remains stable.

<p>The project footprint represents a small portion of suitable habitat for Yellow-spotted Monitor on Melville Island. The project therefore won't cause a long-term decrease in the population of the species.</p>
<p>Reduce the Area of Occupancy of the species</p>
<p>No</p> <p>The project footprint represents a small portion of suitable habitat for the species on the Tiwi Islands, and is insignificant at a landscape scale.</p>
<p>Fragment an existing population into two or more populations</p>
<p>No</p> <p>Suitable Yellow-spotted Monitor habitat on Melville Island will remain contiguous. Potential impacts will be small and localised, and the existing population won't become fragmented</p>
<p>Adversely affect the habitat critical to the survival of the species</p>
<p>No</p> <p>As discussed above, the project footprint represents a small portion of suitable habitat for Yellow-spotted Monitor on Melville Island. Sufficient critical habitat remains for the species to survive.</p>
<p>Disrupt the breeding cycle of a population</p>
<p>No</p> <p>Impacts to Yellow-spotted Monitor will be small and localised and won't affect the breeding cycle of the majority of the population on Melville Island.</p>
<p>Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline</p>
<p>No</p> <p>As discussed above, the project footprint represents a small portion of suitable habitat for Yellow-spotted Monitor on Melville Island. Sufficient critical habitat remains for the species to survive.</p>
<p>Result in invasive species that are harmful to the species becoming established in the species' habitat</p>
<p>No</p> <p>The action is unlikely to introduce an invasive species that could be harmful to the species habitat.</p>
<p>Introduce disease that may cause the species to decline</p>
<p>No</p> <p>The action is unlikely to introduce a disease that will cause Yellow-spotted Monitor decline.</p>
<p>Interfere with the recovery of the species</p>
<p>No</p> <p>The project may impact a small portion of the Yellow-spotted Monitor population on Melville Island. The recovery of the species is unlikely to be impacted.</p>

6.4.10 Significant impact assessment for Cognate Land Snail

Cognate Land Snail <i>Amphidromous cognatus</i>
Lead to a long-term decrease in the size of a population
<p>No</p> <p>Four records of Cognate Land Snail occur on Melville Island, one of which is located within the Creek Road Alignment. The small number of records likely reflects the lack of survey effort, and the on the species is probably more widely distributed within monsoon rainforests on the island. The project footprint represents a small portion of suitable habitat for Cognate Land Snail on Melville Island. The project therefore won't cause a long-term decrease in the population of the species.</p>
Reduce the Area of Occupancy of the species
<p>No</p> <p>The Creek Road Alignment contains 25% of known Cognate Land Snail records, though the species is likely more widely distributed on Melville Island. The species likely occurs across a wider area within the Creek Road patch of monsoon rainforest.</p> <p>Approximately 81,600 ha of rainforest habitat occurs on Melville Island (Woinarski <i>et al.</i>, 2003b). The area to be cleared within the Creek Road Alignment is 4.2 ha and represents a small portion (~0.005%) of suitable habitat. Whilst the area of occupancy may be slightly reduced, the size of the project footprint is small at a landscape scale.</p>
Fragment an existing population into two or more populations
<p>No</p> <p>Suitable habitat for the Cognate Land Snail on Melville Island will remain contiguous. Potential impacts will be small and localised, and the existing population will not become fragmented.</p>
Adversely affect the habitat critical to the survival of the species
<p>No</p> <p>As discussed above, the project footprint represents a small portion of suitable habitat for Cognate Land Snail on Melville Island. Sufficient critical habitat remains for the species to survive.</p>
Disrupt the breeding cycle of a population
<p>No</p> <p>Impacts will be small and localised and won't affect the breeding cycle of the majority of the Cognate Land Snail population on Melville Island.</p>
Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline
<p>No</p> <p>Impacts to Cognate Land Snail will be small and localised and are unlikely to lead to a decline of the species.</p>
Result in invasive species that are harmful to the species becoming established in the species' habitat
<p>No</p>

The action is unlikely to introduce an invasive species that could be harmful to the species habitat.
Introduce disease that may cause the species to decline
No The action is unlikely to introduce a disease that will cause Cognate Land Snail to decline.
Interfere with the recovery of the species
No The project may impact a small portion of the Cognate Land Snail population on Melville Island. The recovery of the species is unlikely to be impacted.

6.4.11 Significant impact assessment for *Cycas armstrongii*

<i>Cycas armstrongii</i>
Lead to a long-term decrease in the size of a population
No Populations of <i>Cycas armstrongii</i> form large patches of individuals within Eucalypt open forests and woodlands within the Darwin, Coburg and Tiwi regions. The species dominant habitat is located on well-draining deep red soils which are ideal areas for clearing and development. Clearing of habitat and changes in fire regime are the main threats to the species (Kerrigan, 2006). Impacts within the project footprint are relatively small in size and are not considered significant to the species given the large distribution and density of the population across its range.
Reduce the Area of Occupancy of the species
No Only two known records are recorded within the project area (Gravel Pit 2, see section 2.5) and will not be impacted by the proposed development. Therefore, there is no known reduction to the area of occupancy of the species.
Fragment an existing population into two or more populations
No The high population density of <i>Cycas armstrongii</i> within its preferred habitat makes it highly unlikely that the proposed development would result in fragmentation of the species.
Adversely affect the habitat critical to the survival of the species
No <i>Cycas armstrongii</i> forms relatively dense populations within its preferred habitat of Eucalypt open forest and woodlands on well drained soils. This vegetation and soil type are dominant across the entire range of the species. Given the relatively small size of the project area, the proposed development is highly unlikely to adversely affect <i>Cycas armstrongii</i> habitat.
Disrupt the breeding cycle of a population
No

<p>The project area is relatively minor in size in comparison with the species extent of occurrence. Therefore, the proposed development is highly unlikely to affect habitat critical to the survival of the species.</p>
<p>Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline</p>
<p>No</p> <p>The project area is relatively minor in size in comparison with the species extent of occurrence. Therefore, the proposed development is highly unlikely to affect habitat critical to the survival of the species.</p>
<p>Result in invasive species that are harmful to the species becoming established in the species' habitat</p>
<p>No</p> <p><i>Cycas armstrongii</i> populations can be majorly impacted by the spread of weed grasses including Gamba Grass and Perennial Mission Grass. These grasses are responsible for an increase in fire frequency and intensity within Eucalypt open forest and woodlands which result in increased stem mortality and reduction in the population. There are a number of records of both of these grasses on the Island and quarantine measures and management plans are in place to prevent the grassy weeds along roadsides on Melville Island. The proposed development should put in place an integrated weed management plan which enforces weed hygiene protocols for all plant and equipment associated with the proposed development. Follow up weed survey and monitoring should be put in place upon completion of the project to ensure weed populations do not impact on the species.</p> <p>The project is unlikely to introduce harmful species within <i>Cycas armstrongii</i> habitat.</p>
<p>Introduce disease that may cause the species to decline</p>
<p>No</p> <p>There are no known diseases that affect the species.</p>
<p>Interfere with the recovery of the species</p>
<p>No</p> <p>The proposed development will only have minor impact on <i>Cycas armstrongii</i> habitat and will therefore not interfere with any recovery plans put in place for the species.</p>

6.4.12 Significant impact assessment for *Typhonium jonesii*

<p><i>Typhonium jonesii</i></p>
<p>Lead to a long-term decrease in the size of a population</p>
<p>No</p> <p>The project footprint proposes to impact a total of 24 known records of <i>Typhonium jonesii</i> located within the project area, having a maximum of 13% impact on the AOO cells and 4.3% impact on the entire <i>T. jonesii</i> population (refer Section 5.4).</p>

Reduce the Area of Occupancy of the species
<p>No</p> <p>The results of the <i>Typhonium spp.</i> survey show that the proposed development will have a maximum 6.5% impact on a <i>Typhonium jonesii</i> AOO cell and that the proposed development is unlikely to result in a reduction in the Area of Occupancy of the species. (refer Section 5.4).</p>
Fragment an existing population into two or more populations
<p>No</p> <p>Results of the <i>Typhonium spp.</i> survey show that the <i>Typhonium jonesii</i> is scattered across the project area. Records proposed for impact do not fragment an existing population.</p>
Adversely affect the habitat critical to the survival of the species
<p>No</p> <p>Eucalyptus open forests and woodland on plateaux, which forms critical habitat for the species is the dominate habitat on the western side of Melville Island where the species occurs. The species is spread across five subpopulations, two of which are intersected by the project area (DENR, 2018). It is highly unlikely that the project will adversely affect the habitat critical to the survival of the species.</p>
Disrupt the breeding cycle of a population
<p>No</p> <p><i>Typhonium spp.</i> subpopulation are defined as a group of plants with a minimum distance of 5 km between records (DENR, 2018). This is thought to be the distance that pollinators can travel between plants and maintain genetic diversity within the subpopulation. As the current known records form a linear north south transect across the project area and given that the majority of existing records will be avoided, it is unlikely that the project will disrupt the breeding cycle of the two subpopulations intersected.</p>
Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline
<p>No</p> <p>Eucalyptus open forests and woodland on plateaux, which forms critical habitat for the species is the dominate habitat on the western side of Melville Island where the species occurs. The species is spread across five subpopulations, two of which are intersected by the project area (DENR, 2018). It is highly unlikely that the project will adversely affect the habitat critical to the survival of the species.</p>
Result in invasive species that are harmful to the species becoming established in the species' habitat
<p>No</p> <p><i>Typhonium jonesii</i> populations can be majorly impacted by the spread of weed grasses including Gamba Grass and Perennial Mission Grass. These grasses are responsible for an increase in fire frequency and intensity within Eucalypt open forest and woodlands which result impacts to the species. There are a number of records of both of these grasses on the Island and quarantine measures and management plans are in place to prevent the grassy weeds along roadsides on Melville Island. The proposed development will put in place an integrated weed management plan which enforces weed hygiene protocols for all plant and equipment associated with the proposed</p>

development. Follow up weed survey and monitoring should be put in place upon completion of the project to ensure weed populations do not impact on the species.

The project is unlikely to introduce harmful species within *Typhonium jonesii* habitat.

Introduce disease that may cause the species to decline

No

There are no known diseases that affect the species.

Interfere with the recovery of the species

No

The project is not considered to be interfering with the recovery of the species.

6.4.13 Significant impact assessment for *Typhonium mirabile*

Typhonium mirabile

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

No

The project footprint proposes to impact a total of 20 known records of *Typhonium mirabile* located within the Creek Road Alignment project area, having a 12% impact on the AOO cell and 2.9% impact on the entire *T. mirabile* population (refer Section 5.4).

Reduce the Area of Occupancy of the species

No

The results of the *Typhonium* spp. survey show that the proposed development will have a maximum 12% impact on a *Typhonium mirabile* AOO cell and that the proposed development is unlikely to result in a reduction in the Area of Occupancy of the species. (refer Section 5.4).

Fragment an existing population into two or more populations

No

The proposed development placement and design as outlined in Section 5.0 diverts the Paru Road preferred alignment around a high density patch of *Typhonium mirabile* (refer Section 4.2.2) to avoid impacting and splitting the patch in two. Adoption of the preferred alignment will make it unlikely that the proposed development will fragment the *Typhonium mirabile* populations within the project area.

Adversely affect the habitat critical to the survival of the species

No

A 250 m buffer has been applied to habitat patch 4b - *Erythrophleum chlorostachys* woodland on upland drainage as this area supports a high density patch of *Typhonium mirabile* which is considered significant for conservation of the species (refer Section 4.2.2). No gravel pits are proposed for development within the 250 m buffer, however given current development constraints Paru Road preferred option passes through the buffer but avoids directly impacting the patch. The adoption of the development placement and design outlined in Section 5.0 will make it unlikely that the project will adversely affect the habitat critical to the survival of the species.

Disrupt the breeding cycle of a population**No**

Typhonium spp. subpopulation are defined as a group of plants with a minimum distance of 5 km between records (DENR, 2018). This is thought to be the distance that pollinators can travel between plants and maintain genetic diversity within the subpopulation. The results of the *Typhonium spp.* survey shows that *Typhonium mirabile* records are concentrated within the high density *Typhonium mirabile* patch (Gravel Pit 1 Road Alignment) and 2.3km away within the Creek Road Alignment. The project development is unlikely to have a significant impact on either of these populations (refer Section 5.4).

Modify, destroy, remove, isolate or decrease the availability or quality of the habitat to the extent that the species is likely to decline**No**

The *Typhonium spp.* survey has identified a significant patch of *Typhonium mirabile* and allowed for appropriate development placement and design (refer Section 5.0) to minimise impacts on the population within the project area.

Further *Typhonium spp.* surveys will take place within unsurveyed areas of GP1-2, prior to the site undergoing development, to determine the significance of impact.

Result in invasive species that are harmful to the species becoming established in the species' habitat**No**

Typhonium mirabile populations can be majorly impacted by the spread of weed grasses including Gamba Grass and Perennial Mission Grass. These grasses are responsible for an increase in fire frequency and intensity within Eucalypt open forest and woodlands which result impacts to the species. There are a number of records of both of these grasses on the Island and quarantine measures and management plans are in place to prevent the grassy weeds along roadsides on Melville Island. The proposed development will put in place an integrated weed management plan which enforces weed hygiene protocols for all plant and equipment associated with the proposed development. Follow up weed survey and monitoring should be put in place upon completion of the project to ensure weed populations do not impact on the species.

Assuming that this occurs the project is unlikely to result in invasive species becoming established within *Typhonium mirabile* habitat.

Introduce disease that may cause the species to decline**No**

There are no known diseases that affect the species.

Interfere with the recovery of the species**No**

The project is not considered to be interfering with the recovery of the species.

7.0 Summary and recommendations

7.1 Significant Impact Assessment

Following and an analysis of desktop records, field survey results and the project footprint it has been determined that the project is unlikely to have a significant impact to threatened species. In accordance with *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DEWHA, 2013) the project does not require a referral under the EPBC Act.

7.2 Recommended project placement and design

Development options have been designed to minimise impacts to *Typhonium jonesii* and *T. mirabile*. The following options are recommended:

- Paru Road preferred alignment
- Gravel Pits:
 - GP1-1
 - GP1-2 (within areas currently surveyed for *Typhonium spp.*)
 - GP1-3
 - GP2-1
 - GP2-2.

The location of the recommended Paru Road alignment is shown in Figure 12. Recommended gravel pit locations are shown in Figure 13 for Gravel Pit 1 and Figure 14 for Gravel Pit 2.

The implementation of these recommended options proposes to impact a total of 24 *Typhonium jonesii* and 20 *T. mirabile*. This equates to approximately 3.6% of the known *Typhonium jonesii* population and 2.9% of the known *T. mirabile* population. Proposed population impacts in relation to the current AOO cell records show that there is a maximum of 13% impact on *Typhonium jonesii* AOO cells and 11.9% impact on *T. mirabile* AOO cells. Given the proposed project placement and design outlined above, the project has a low likelihood of resulting in a significant impact on the target *Typhonium spp.*

7.3 Potential Red Goshawk nest

The recommended gravel pit location within Gravel Pit 1 (GP1-1) is close to where a potential Red Goshawk nest was detected during the January 2021 survey. Monitoring undertaken on the Tiwi Islands suggests that although Red Goshawks are able to nest and hatch chicks within roadside remnant forest and plantation buffers, breeding success declines when a threshold level of >25% of forest is cleared within 4 km of a pair's nest (Baker-Gabb 2013).

The nest is surrounded by approximately 50 ha of suitable habitat. Assuming that the gravel pit clears 6.6 ha of habitat this represents approximately 13% of suitable habitat close to the nest, less than the threshold described by Baker-Gabb (2013).

The area suitable for gravel extraction is constrained by *Typhonium spp.* records and slope. AECOM has therefore recommended that an 80 m buffer be applied to this nest. A larger buffer would be preferable; however, such a buffer would make road access to the gravel extraction area impossible.

The disturbance of one pair of Red Goshawks would not comprise a significant impact; however, efforts should be made to minimise disturbance to a pair of breeding birds.

AECOM recommends that this nest be monitored during the dry season to determine whether it is an active Red Goshawk nest. If the recommended GP1-1 area is used for gravel extraction monitoring should continue to determine whether breeding is successful and if project activities may be impacting the nesting birds. Plantation Management Partners undertakes regular monitoring of Red Goshawk nests on Melville Island with the assistance of Tiwi Rangers. These entities should be engaged to undertake monitoring of the nest during the following periods:

- nesting (late July),
- fledging of juveniles (September/ early October)
- dependant juveniles hanging near the nest (November/ December).

7.4 Mitigation Measures

Under the NT *Land Clearing Guidelines* (DLRM, 2020) the performance criteria in relation to clearing of native vegetation are to:

- Avoid impact to environmentally significant or sensitive vegetation
- Avoid impacts to drainage areas, wetlands and waterways; and
- Avoid habitat fragmentation and impacts to native wildlife corridors.

Environmentally significant and sensitive vegetation occurs within the Creek Road Alignment, where riparian habitat occurs (vegetation type 3a). Riparian vegetation within the Creek Road Alignment is likely to be of lower quality due to being located adjacent to the road and subsequent disturbance. There is no option to completely avoid this vegetation, as realignment of this section of road is an essential part of the project. Mitigation measures that will be implemented within the Creek Road Alignment include minimising vegetation clearance as much as practicable, flagging the outer extent of the alignment to be cleared and approved prior to clearing and the development and implementation of sediment and erosion controls integrated into the road design and as part of a Construction Environmental Management Plan.

Other sensitive vegetation likely to occur within the project area includes habitat that qualifies as old growth forest. The criteria by which such stands of vegetation are identified in *Eucalyptus miniata* and *E. tetradonta* communities is defined as a minimum of five or more stems greater than 50 cm diameter at breast height (DBH) per hectare and/or 30 or more stems greater than 40 cm DBH per hectare (DLRM, 2019).

This habitat is widely distributed across the Tiwi Islands, therefore stands of vegetation within the project area represents a small portion of the total area of old growth forest at Melville Island. However, such habitat may provide large hollows that support threatened species that may occur within the project area, such as Brush-tailed Rabbit-rat and Masked Owl. The project should therefore aim to minimise the clearance of large *Eucalyptus miniata*, *E. tetradonta* and *Corymbia nesophila* trees that contain large hollows (25 x 25 cm), noting that within the road alignment project areas, safety considerations to motorists may necessitate the removal of large trees with overhanging branches.

Other vegetation types that should be protected include areas with high shrub density that comprise suitable habitat for threatened small and medium sized mammals such as Brush-tailed Rabbit-rat and Black-footed Tree-rat. Shrubs can be defined as vegetation between 0.2 m and 1.3 m in height (Davies *et al.*, 2017). These areas should be exempt from removal within the gravel pits; however, if such habitat occurs within the road realignments then their protection is likely unfeasible.

The introduction of weeds to the project area represents an additional risk that has potential to degrade native vegetation communities and native fauna habitat. To mitigate the risk of weed introduction, all plant and machinery should be sourced from the Tiwi Islands where possible. Any plant and machinery required to be imported from the mainland will be cleaned and free from mud and plant material prior to transport. Vehicle wash-down facilities should be used, if possible, prior to the project being undertaken. A weed wash-down bay may be available at the Forestry facilities at Maxwell Creek. Weed -free declarations will be required for machinery being transported to the Tiwi Islands. Machinery already present on the islands will be cleaned and confirmed as weed-free prior to being mobilised to the project area.

To summarise AECOM recommends the following mitigation measures be implemented for the project:

- Avoid as far as practicable the removal of:
 - 3a - Riparian vegetation (Creek Road Alignment)

- large (diameter >30 cm) *Eucalyptus miniata*, *E. tetradonta* and *Corymbia nesophila* trees that contain large hollows
- Areas with high shrub density.
- Implement erosion and sediment controls at the Creek Road Alignment; and
- Implement weed hygiene methods to prevent the introduction of weeds to the project area.

8.0 References

- Aumann, T. & D. Baker-Gabb. 1991. *RAOU Report 75: A Management Plan for the Red Goshawk*. RAOU. Royal Australasian Ornithologists Union, Melbourne.
- Baker-Gabb, D. 1998. Red Goshawk Decline. *Wingspan*. Volume 8, issue 4, p 6.
- Baker-Gabb, D. 2007. *Recovery Plan for the Red Goshawk *Erythrotriorchis radiatus*, 2007-2011*. Elanus Pty Ltd. Melbourne, Victoria.
- Baker-Gabb, D. 2013. **Erythrotriorchis radiatus* surveys and monitoring on the Tiwi Islands, northern Australia during 2001-2011*. Program and Abstracts, Australasian Raptor Association conference, Adelaide 2013, p. 12.
- Brennan K., Cowie 1., Cuff N., Fegan M., Fisher A., Gillespie G., Griffiths T. and Liddle D. 2015. Biodiversity, in Tiwi Island economic development- Bio-physical resources of the North East Bathurst Island (Technical Report), pp 117-173. Technical Report No. 12/2014/D. Department of Land Resources Management, Darwin, Northern Territory.
<https://www.territorystories.nt.gov.au/handle/10070/257735>
- Braby, M. Wilson, C. and Ward, S. 2012. *Threatened Species of the Northern Territory: Atlas Moth *Attacus wardi**. Available online: <https://nt.gov.au/data/assets/pdf_file/0004/206518/atlas-moth.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.
- Brennan K., Cowie 1., Cuff N., Fegan M., Fisher A., Gillespie G., Griffiths T. and Liddle D. 2015. *Biodiversity, in Tiwi Island economic development- Bio-physical resources of the North East Bathurst Island (Technical Report)*. Technical Report No. 12/2014/D. Department of Land Resources Management, Darwin, Northern Territory.
- Brocklehurst, P. S. Lewis, D., Lynch, D., and Napier, D. 2007. *Northern Territory guidelines and field methodology for vegetation survey and mapping*. Northern Territory. Department of Natural Resources, Environment and the Arts, Palmerston, NT.
- Davies, H., McCarthy, M.A., Firth, R.C. Woinarski, J.C., Gillespie, G., Anderson, A.N., Geyle, H.M., Nicholson, E. and Murphy, B. 2017. Top-down control of species distributions: feral cats driving the regional extinction of a threatened rodent in northern Australia. *Diversity and Distributions*. Volume 23, pp. 272-283.
- Davies, H.F, McCarthy, M.A, Firth, R.S., Woinarski, J. C., Gillespie, G.R., Anderson, A.N., Rioli, W., Puruntatameri, J., Roberts, W., Kerinaiaua, C., Kerinaiaua, V., Womatakimi, K.B., and Murphy, B.P. 2018. Declining Populations in one of the last refuges for declining mammal species in the Northern Territory. *Austral Ecology*. March 2018.
- Debus, S. 2009. *The Owls of Australia: A field guide to Australian night birds*. Envirobook. Canterbury, NSW.
- Debus, S. 2019. *Birds of Prey of Australia, third edition*. CSIRO Publishing, Collingwood, Victoria.
- Debus, S. & G. Czechura. 1988. The Red Goshawk *Erythrotriorchis radiatus*: a review. *Australian Bird Watcher*. Volume 12, pp.175-199.
- Department of Agriculture, Water and the Environment (DAWE). 2017. Australian Vegetation Attribute Manual, version 7.0. Australian Government Department of Agriculture, Water and the Environment. Accessed 20/03/2020. <https://www.environment.gov.au/land/publications/australian-vegetation-attribute-manual-version-7>
- Department of Environment and Natural Resources (DENR). (2018). Melville Island Typhonium field survey: GridConnect Project. Prepared for Power and Water Corporation.
- Department of Environment and Natural Resources (DENR). 2019. *Land Clearing Guidelines*. Northern Territory Government. Available online: <https://nt.gov.au/data/assets/pdf_file/0007/236815/land-clearing-guidelines-2019.pdf>.
- Department of Environment and Natural Resources (DENR). 2020. Natural Resources Maps. Site accessed 09/04/2020. <https://nrmaps.nt.gov.au/nrmaps.html> Department of the Environment, Water, Heritage and the Arts. (DEWHA). 2013. *Significant Impact Guidelines regarding Matters of National*

Environmental Significance. Australian Government. Available online:

<<https://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance>>.

Department of Environment and Heritage (DEH). 2003. Threatened Species Fact Sheet: False Water Rat *Xeromys myoides*. Available online:

<<https://www.environment.gov.au/biodiversity/threatened/publications/false-water-rat-xeromys-myoides-2003>>. Australian Government, Canberra, ACT.

DigitalGlobe 2020. DigitalGlobe – Maxar base layers ArcGIS.

Flora NT, 2020. Flora NT Northern Territory Flora Online. Available online:

<<http://eflora.nt.gov.au/home>>.

Fraser, F.J., 2001. The impacts of fire and grazing on the Partridge Pigeon: the ecological requirements of a tropical granivore. PhD Thesis, Australian National University, Canberra.

Garnett, S.T. and Crowley, G.M. 2000. *The Action Plan for Australian Birds 2000*. Canberra, ACT: Environment Australia and Birds Australia.

Garnett, S.T., Szabo, J. K. and Dutton, G. 2011. *The Action Plan for Australian Birds*. CSIRO Publishing / Birds Australia, Melbourne, Victoria.

Geocat 2020. Geocat website, Kew. Accessed 24/03/2020. <http://geocat.kew.org/editor>

Hamel, M., Bradshaw, C. and Garnett, S. 2008. *Population Viability Analysis for the Red Goshawk (Erythrotriorchis radiatus) on the Tiwi islands*. Unpublished report for Great Southern and Tiwi Land Council.

Hill, B. 2012. *Threatened Species of the Northern Territory: Black-footed Tree-rat Mesembriomys gouldii*. Available online: <https://nt.gov.au/data/assets/pdf_file/0018/205515/black-footed-tree-rat.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Indicus Biological Consultants. 2007. *Investigating the ecology of the Masked Owl on Melville Island – Report 3*. August 2007. Smith, J. and Brady, C. Unpublished report for Great Southern.

Indicus Biological Consultants. 2008. *Investigating the ecology of the Masked Owl on Melville Island – Report 7*. October 2008. Smith, J., Dudgeon, I. and Duncan, T. Unpublished report for Great Southern.

International Union for Conservation of Nature and Natural Resources (IUCN). 2011. *Red List of Threatened Species - Phascogale pirata*. Available online: <<https://www.iucnredlist.org/species/16889/21944455>>.

Kavanagh, R., and Murray, M. 1996. Home range, habitat and behaviour of the Masked Owl *Tyto novaehollandiae* near Newcastle, NSW. *Emu*. Volume 96, pp. 250-257.

Kerrigan, R., Cowie, I., 2006. *Typhonium jonesii*, Threatened Species of the Northern Territory. Available online: <https://nt.gov.au/data/assets/pdf_file/0015/208500/typhonium-jonesii.pdf>.

Kerrigan, R., Cowie, I., and Liddle, D. 2006. *Cycas armstrongii*, Threatened Species of the Northern Territory. Available online: <https://nt.gov.au/data/assets/pdf_file/0017/208430/cycas-armstrongii.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Kerrigan, R., Cowie, I., and Wonarski, J. 2007. *Typhonium mirabile*, Threatened Species of the Northern Territory. Available online: <https://nt.gov.au/data/assets/pdf_file/0016/208501/typhonium-mirabile.pdf>.

Liddle, D.T., Gibbons, A. and Taylor, R. 2008. *Recovery plan for the threatened plants of the Tiwi Islands in the Northern Territory of Australia 2008 - 2013*. Northern Territory Department of Natural Resources, Environment and the Arts, Darwin.

Northern Territory Environment Protection Authority (NT EPA). 2013. *Guidelines for Assessment of Impacts on Terrestrial Biodiversity, version 2.0*. The Northern Territory Environment Protection Authority. Available online:

<https://ntepa.nt.gov.au/data/assets/pdf_file/0004/287428/guideline_assessment_terrestrial_biodiversity.pdf>.

Parks and Wildlife Commission of the Northern Territory. 1998. *The History and Natural Resources of the Tiwi Island, Northern Territory*. Northern Territory Government.

Potter, L.C. 2017. *Camera trap constraints in focus: assessing detectability and identification of small mammals in camera trap studies*. Honours Thesis. School of Environment. Charles Darwin University. Darwin, NT.

Queensland Museum. 2020. *Pale Field Rat*. Available online: <<https://www.qm.qld.gov.au/Find+out+about/Animals+of+Queensland/Mammals/Common+mammals+of+south-east+Queensland/Rats+and+Mice/Pale+Field+Rat#.Xnv8OXmP6Uk>>. Brisbane, Queensland.

Rankmore, B.R. 2006. *Impacts of Habitat Fragmentation on the Vertebrate Fauna of the Tropical Savannas of Northern Australia; with special reference to medium-sized mammals*. PhD thesis submitted for the School of Environmental Research, Charles Darwin University. Darwin, NT.

Schoenjahn, J. 2013. A hot environment and one type of prey: investigating why the Grey Falcon (*Falco hypoleucos*) is Australia's rarest falcon. *Emu Austral Ornithology*. Volume 113, pp 19-25.

Ward, S. 2012a. *Threatened Species of the Northern Territory: Grey Falcon Falco hypoleucos*. Available online: <https://nt.gov.au/_data/assets/pdf_file/0020/206354/grey-falcon.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Ward, S. 2012b. *Threatened Species of the Northern Territory: Horsfield's Bushlark (Tiwi Island subspecies) Singing Bushlark *Mirafra javanica melvillensis**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0006/373551/horsfields-bushlark.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Ward, S. and Phillips, B. 2012. *Threatened Species of the Northern Territory: Plains Death Adder *Acanthopsis hawkei**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0014/206402/plains-death-adder.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Ward, S., Woinarski, J., Griffiths, T. and McKay, L. 2012. *Threatened Species of the Northern Territory Yellow-spotted Monitor Northern Sand Goanna, Floodplain Monitor *Varanus panoptes**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0006/206466/floodplain-monitor.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Wilson, C., Woinarski, J., Kessner, V., and Braby, M. 2006. *Threatened Species of the Northern Territory: Cognate Land Snail *Amphidromus cognatus**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0003/206517/amphidromus-cognatus.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Woinarski, J.C. 2006. *Threatened Species of the Northern Territory: False Water Rat Water Mouse *Xeromys myoides**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0008/376136/false-water-rat.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Woinarski, J and Hill, B. 2012. *Threatened Species of the Northern Territory: Brush-tailed Rabbit-rat *Conilurus penicillatus**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0016/205504/brush-tailed-rabbit-rat.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Woinarski, J. and Ward, S. 2012a. *Threatened Species of the Northern Territory: Masked Owl (Tiwi subspecies) *Tyto novaehollandiae melvillensis**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0020/206345/masked-owl-tiwi.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Woinarski, J.C. and Ward, S. 2012b. *Threatened Species of the Northern Territory: Northern Brush-tailed Phascogale *Phascogale pirata**. Available online: <https://nt.gov.au/_data/assets/pdf_file/0003/205509/brush-tailed-phascogale.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.

Woinarski, J., Brennan, K., Hempel, C., Firth, R. and Watt, F. 2000. *Biodiversity Conservation on the Tiwi Islands: vegetation types and terrestrial vertebrates on Melville Island*. Report to the Tiwi Land Council. Parks and Wildlife Commission of the Northern Territory, Darwin.

- Woinarski, J., Brennan, K., Hempel, K., Armstrong, C. Milne, D. and Chatto, R. 2003a. Biodiversity Conservation on the Tiwi Islands. Part 2, Fauna. 127 pp. Department of Planning and Environment, NT.
- Woinarski, J., Hadden, K., Hicks, J. and McLeod, D. 2003b. *Biodiversity Conservation on the Tiwi Islands, Northern Territory: Part 3 Management and Planning for Biodiversity Conservation*. Report commissioned by the Natural Heritage Trust, Tiwi Land Council and the Northern Territory Government. Darwin, NT.
- Woinarski, J.C., Burbidge, A.A., and Harrison, P.L. 2014. *The action plan for Australian mammals 2012*. CSIRO Publishing, Collingwood, Australia.
- Woinarski, J.C, Hill, B. and Ward, S. 2017. *Recovery, Monitoring and Management Plan: Brush-tailed Rabbit-rat Conilurus penicillatus*. Published by the Northern Territory Department of Environment and Natural Resources, Darwin, NT.
- Wuster, W., Dumbrell, A.J., Hay, C., Pook, C., William, D.J and Fry, B.G. 2005. Snakes across the Strait: trans-torresian phylogeographic relationships in three genera of Australasian snakes (Serpentes: Elapidae: Acanthophis, Oxyuranus, and Pseudechis). *Molecular Phylogeny and Evolution*. Volume 34, pp 1-14.
- Young, S. 2012. Threatened Species of the Northern Territory: Fawn Antechinus *Antechinus bellus*. Available online: <https://nt.gov.au/_data/assets/pdf_file/0015/205503/fawn-antechinus.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.
- Young, S & Hill, B. 2012. Threatened Species of the Northern Territory: Pale Field Rat *Rattus tunneyi*. Available online: <https://nt.gov.au/_data/assets/pdf_file/0020/205517/pale-field-rat.pdf>. Northern Territory Department of Environment and Natural Resources, Darwin, NT.