Fauna Risk Assessment for Roy Hill Iron Ore Pty Ltd Proposed Hillside South Railway Corridor

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Executive Summary

Roy Hill Iron Ore Pty Ltd (RHIO) wishes to transport iron ore from its proposed Roy Hill mine near the Newman to Marble Bar Road to Port Hedland by rail. Terrestrial Ecosystems was subcontracted to undertake a Level 1 fauna risk assessment of the proposed 'Hillside South' route for the railway line. This assessment covers that section of the proposed railway line from where it crosses the BHP railway line, through the Chichester Range, north of the FORTESCUE METALS GROUP Cloud Break mine and along the northern border of the Fortescue Marsh to the proposed RHIO mine site.

Four species listed under either the *Environment Protection and Biodiversity Act (1999)* or the *Wildlife Conservation Act (1950)* of conservation significant fauna (Northern Quoll, Mulgara, Bilby and Pilbara Olive Pythons) could be impacted on by the construction and operation of the proposed Hillside South route for the railway line. Additional species listed by DEC as priority species could also be lost during the vegetation clearing and infrastructure development program.

With the exception of the Northern Quoll, Terrestrial Ecosystems believes that sufficient information has been collected or is known to assess the potential impact of the proposed rail corridor and associated infrastructure on fauna and fauna assemblages. Additional spatial movement and geographic distribution data for the Northern Quoll in the Pilbara region are required before more explicit recommendations can be made to protect this endangered species. Sufficient is known of the ecology of the other conservation significant species to develop and implement effective impact mitigation strategies.

Potential impacts on conservation significant species include mortality of animals during the clearing of vegetation and rock piles, a reduction in activity areas and home ranges due to the loss of habitat, habitat fragmentation by tracks and the railway line, dust from vehicle traffic, road deaths, altered fire regimes and the increase in feral species populations.

Implementation of the following recommendations will minimise the impact on fauna, in particular, conservation significant fauna during construction and operation of the railway line.

EPBC Act Referral

- RHIO refer the project to the Commonwealth DEWHA advising of the potential impact that the construction of the railway line and associated infrastructure might have on species of conservation significance.
- A fauna management plan for the railway corridor is developed with specific objectives, key performance indicators (KPIs) and management actions.

Fauna Management Plan

- The following management principles are adopted to guide the development and implementation of RHIO's fauna management plan for species of conservation significance:
    - where possible the destruction of habitat known to be used by Mulgara, Northern Quolls, Star Finches, Pilbara Leaf-nosed Bats and the Ghost Bats is avoided;

- where avoidance is not possible, then management actions will be implemented to minimise anthropogenic activity in habitat used by Mulgara, Northern Quolls, Ghost Bat and the Pilbara Leaf-nosed Bat;
- where possible, habitat containing Mulgara, Bilby and Northern Quolls should not be fragmented by land clearing;
- where a direct impact on Northern Quoll, Bilbies or Mulgara cannot be avoided, then a catch and translocation program will be implemented prior to vegetation clearing;
- the success of the translocation programs for Northern Quoll, Bilbies and Mulgara will be monitored to determine the success of the program; and
- should the monitoring program indicate a decline in the number of conservation significant species, then every effort will be made to determine the cause, and if related to RHIO's activities, remedial action taken immediately to address the problem(s).

Rehabilitation Plan

- A rehabilitation plan is prepared for all disturbed areas along the proposed railway corridor that includes specific objectives, KPIs and action plans.
- All areas disturbed during construction within the rail corridor are rehabilitated within six months after they are no longer required.

Conservation Significant Fauna Management

Northern Quolls

- A Standard Operating Procedures (SOP) manual is prepared for the trapping and translocation of Northern Quolls that are in the disturbance area.
- All habitats likely to support Northern Quolls are trapped prior to vegetation clearing and individuals translocated to a suitable location away from the disturbance area by suitably experienced and trained zoologist.
- Feeding Northern Quolls, as with any other native fauna, is prohibited.

Mulgara and Bilby

- A SOP manual is prepared for the search, trapping and translocation of Mulgara and Bilby.
- All suitable habitat for Mulgara and Bilby that is to be disturbed is searched for active burrows prior to vegetation clearing.
- Where feasible, a non-clearing buffer zone of 250m radius is established around every active Mulgara burrow.
- Where feasible, a non-clearing buffer zone of 1km radius is established around every active Bilby burrow.
- A translocation program is implemented as described in the SOP in areas where active Mulgara and Bilby burrows have been detected and the vegetation will be cleared.
- Speed restrictions of 20km/h between 7pm and 6am should be applied to areas that contain Bilby around infrastructure in operational areas.

Pilbara Olive Pythons

- A SOP manual is prepared for the translocation of Pilbara Olive Pythons.

Pilbara Leaf-nosed and Ghost Bats

- All caves that will be impacted on by construction activities should be searched and checked using an echolocation detector for Pilbara Leaf-nosed and Ghost Bats prior to disturbance.
- Caves providing maternal roosts for Pilbara Leaf-nosed and Ghost Bats should not be disturbed.

Staff and Contractor Inductions

- An induction program for staff and contractors that includes components on managing conservation significant species is a mandatory component of working on the RHIO rail corridor.

Site Management

- Access routes and construction areas are aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale vegetation associations in the area.
- Pets are not permitted on site.
- All waste and rubbish be contained in bins and regularly removed from site.
- Animals killed on the tracks and roads are recorded and removed.
- A maximum speed limit of 80km/h is imposed on all access tracks
- Signage is erected to indicate the possible presence of wildlife crossing.
- A dust suppression program is implemented for high traffic volume roads.
- A monitoring program is put in place to assess the impact of dust and the dust suppression program on the vegetation along high volume road verges.
- An effective dust management strategy is put in place, and the impact of dust on the adjacent vegetation and fauna habitats is systematically monitored with appropriate triggers that will initiate corrective actions; and
- The potential injury and death of cattle on the railway line should be discussed with the local pastoralists to develop an acceptable management strategy.

Infrastructure design

- The drainage design for the railway line minimises changes to the flow and maintains existing habitat so as to minimise the impact on conservation significant species living along the creek lines.
- Culverts under the railway line and access tracks have a fauna friendly flat bottom.
- Access tracks and roads with high vehicle traffic are designed to minimise ponding on the edges.
- Infrastructure is designed to minimise the size of the area that is cleared;
- Ground works are timed so that they do not occur when creeks are flowing;

- Changes to the creek bed profiles during construction are returned to pre-construction conditions;
- Sufficient culverts should be provided in appropriate places to minimise the impact of the linear barrier on sheet flow of water across the landscape;
- Creek crossings should be designed to minimise the pooling of water adjacent to the road to avoid attracting birds and mammals to the edge of the road;

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Introduction

Background

Roy Hill Iron Ore Pty Ltd (RHIO) has identified a large deposit of iron ore on Roy Hill station approximately 110km north of Newman. The deposit straddles the Newman to Marble Bar Road and RHIO is planning to develop a 55 Mtpa iron ore mine to exploit this deposit.

The RHIO project will require dedicated mine, rail and port infrastructure. It is proposed that a 300km railway line will be constructed to transfer ore from the mine to the port facilities in Port Hedland. Based on the present design and previous experience it is expected that 3,770ha of land will be cleared during the construction phase for the rail line, borrow pits, camps and associated construction infrastructure. During the operational phase, an area of 1,200ha is proposed to remain cleared, allowing for the rail corridor and maintenance road.

Terrestrial Ecosystems was subcontracted to undertake a Level 1 fauna risk assessment of the proposed 'Hillside South' route for the railway line (Figure 1). This assessment covers that section of the proposed railway line from where it crosses the BHP railway line, through the Chichester Range, north of the Fortescue Metals Group (FMG) Cloud Break mine and along the northern border of the Fortescue Marsh to the proposed RHIO mine site.

Objectives

The objectives of this assessment were to identify potential impacts on fauna and fauna assemblages, in particular those of conservation significance that will be affected by the proposed Hillside South railway line.

The methodology used by Terrestrial Ecosystems included:

- a search of the Department of Environment and Conservation's (DEC's) Threatened and Priority Species database via NatureMap to identify potential scheduled and threatened species in the bioregion;
- a search of the Department of the Environment, Water, Heritage and the Arts (DEWHA) on-line database to identify fauna species that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) potentially occurring in the area;
- a search of Terrestrial Ecosystems fauna survey database;
- a review of the literature to assess current knowledge of the biology and ecology of conservation significant species potentially found in the proposed rail corridor;
- an on-ground / aerial reconnaissance site assessment;
- a discussion of the potential impacts of the proposed disturbance on the fauna and fauna habitat; and
- management recommendations to minimise the potential impacts on fauna of conservation significance.

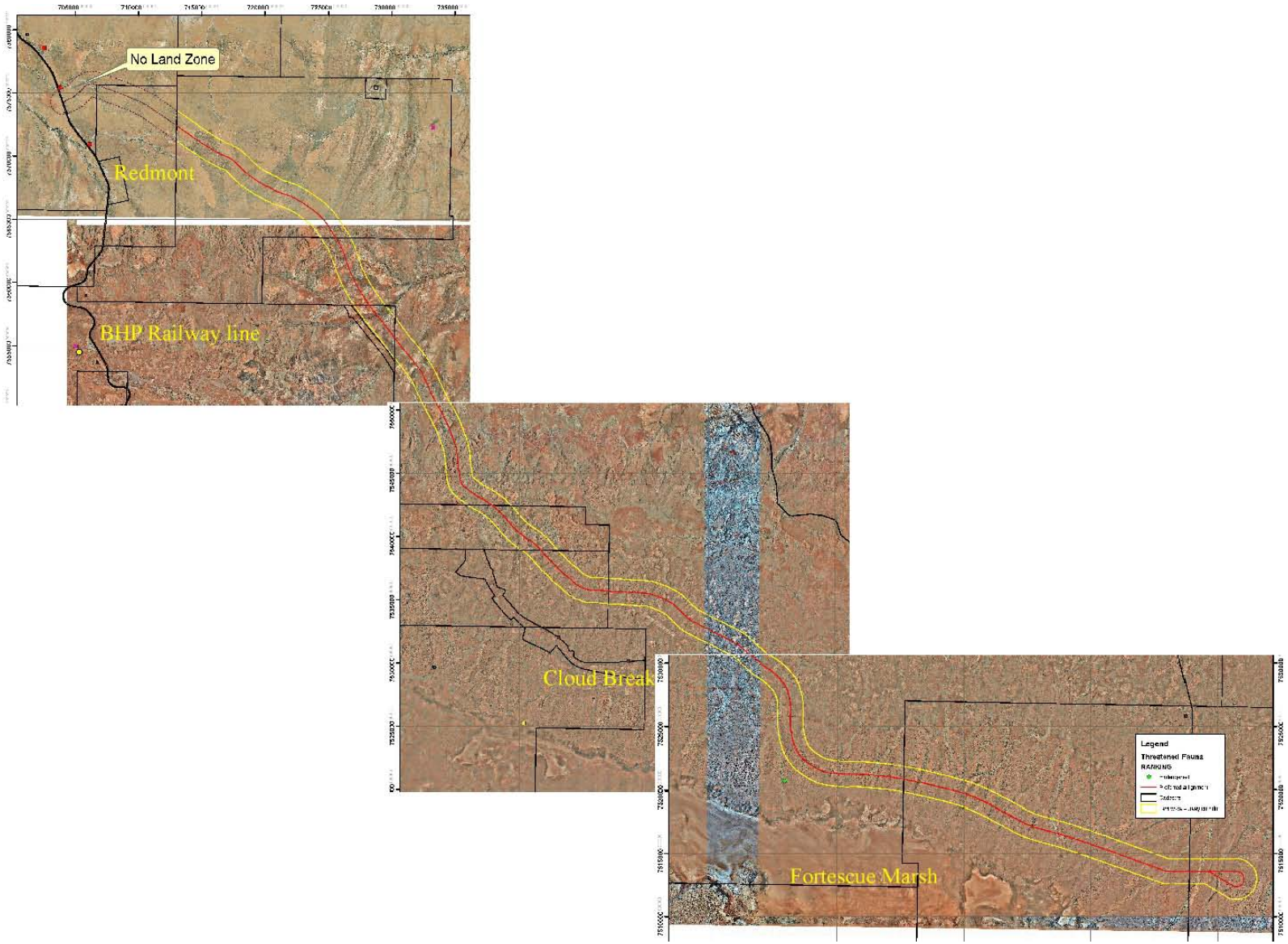

FIGURE 1
PROPOSED HILLSIDE SOUTH ROUTE FOR THE RHIO RAILWAY.

Existing Environment

The project area lies in the Pilbara biogeographic region of the Interim Biogeographic Regionalisation for Australia (IBRA; (Thackway and Cresswell, 1995). These bioregions are defined on the basis of geology, landform, vegetation, fauna and climate. The Pilbara biogeographic region is similar to that commonly recognised as the Pilbara region. With an area of 179,287km^2, the Pilbara bioregion includes four major subregions; Chichester, Fortescue Plains, Hamersley and Roebourne. The RHIO Hillside South Rail Project crosses two of these subregions; Chichester (9,044,560 ha) and Fortescue Plains (9,044,560 ha).

Topography and Landforms

The Pilbara region comprises a significant proportion of the ancient continental shield of Western Australia, consisting of both Proterozoic and Archaean rocks. The latter constitutes the Pilbara Block, overlain by Proterozoic rock deposited in the Hamersley and Bangemall Basins. The Hamersley Basin occupies most of the southern part of the Pilbara Block and can be divided into three stratigraphic groups; the Fortescue, Hamersley and Turee Creek (Beard, 1975, Jarvis, 1979). Two topographical units define the proposed rail corridor:

- *Chichester Plateau*: a plateau of mainly basalts, including siltstone, mudstone, shale, dolomite and jaspilite; forming a watershed between numerous rivers flowing north through the Abydos Plain to the coast, and the Fortescue's drainage on the southern side; and
- *Fortescue Valley*: occupying the lowland between the Chichester and Hamersley Plateaus; the eastern portion drains into the Fortescue Marsh.

The landform units typical of the Pilbara are:

- *Ridges and hills*: ridges and hills rising above the surrounding plains. The surface is largely covered with skeletal soils, with areas of exposed rock. Vegetation is dominated by *Eucalyptus kingsmilli* mallees, *E. leucophloia* woodlands, *Callitris columellaris* low forest, *Acacia* scrubs and hummock grasses (*Triodia* spp.);
- *Scree slopes*: Gravelly gibber loams with pockets of skeletal neutral soil on undulating slopes. Vegetation is dominated by *Acacia* and *Cassia* scrubs, *Eucalyptus gamophylla* mallees and hummock grasses (*Triodia* spp.);
- *Valley floor*s: Neutral to slightly acidic loams or sandy loams on flat or low slope valley floors. Vegetation is dominated by mixed woodlands over mixed hummock grasses;
- *Outwash plains*: Neutral to slightly acidic deep loams or clayey loams on flat plains. Vegetation is dominated by mixed woodlands over mixed hummock and tussock grasses;
- *Low hills of calcrete and dolomite outcrops*: Shallow loams of clays over stony pavements and screes. Vegetation is dominated by *Eucalyptus transcontinentalis* and *E. oleosa* mallees, *Acacia bivneosa* and *Cassia desolata* scrub over *Triodia* hummock grasses;
- *Minor drainage channels*: Shallow sandy soils and sandy loams. Vegetation is dominated by fringing mixed eucalypt woodlands over mixed scrubs and hummock grasses;

- *Major drainage channels*: Heavy gravels with sandy levee banks and islands. Vegetation is dominated by fringing *Eucalyptus camaldulensis* woodlands over *Acacia* scrubs and *Melaleuca glomerata* thickets; and
- *Gorges*: Exposed rock, gravel and sand. Vegetation is dominated by fringing *Melaleuca leucodendron* forests (Dawe and Dunlop, 1983).

Drainage

Major drainage associated with the RHIO Rail Project is divided by the Chichester Range. North of the Chichester Range surface water drains mostly into the tributaries of the Yule River, but the eastern section drains into tributaries of the De Grey River. South of the Chichester Range, surface water drains into the Fortescue Marsh which is part of the Fortescue River system.

Land Systems

In 2002, Payne *et al.* (2002) delineated the Pilbara region into a system of land units. These land units occur in association with characteristic physiographic features. A total of 11 land system units are traversed by the proposed railway corridor. These are described below shown the area within the proposed railway corridor:

- *Cowra* Plains fringing the Marsh land system (524ha)
- *Granitic* Rugged granitic hills supporting shrubby hard and soft spinifex grasslands (1772ha)
- *Jamindie* Stony hardpan plains and rises supporting groved mulga shrublands occasionally with spinifex understorey (1908ha)
- *Macroy* Gently undulating stony plains; generally not degraded or eroded (5047ha)
- *McKay* Hills, ridges plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands (6069ha)
- *Newman* Rugged jaspellite plateaux, ridges and mountains supporting hard spinifex grassland (706ha)
- *Robe* Low limonite mesas and buttes (303ha)
- *Rocklea* Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands (1505ha)
- *Talga* Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands (715ha)
- *Turee* Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy Shrubland (6286ha)
- *White Springs* Stony gilgai plains (85ha).

Vegetation

The eastern portion of the Pilbara region in particular is located in a transitional zone between the floras of the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions, and contains elements of both floras. In recognition of the high species diversity and the high levels of endemism in the region, the Hamersley/Pilbara region has been designated one of 15 national biodiversity "hotspots" by DEWHA.

The vegetation of the Chichester (PIL 1) subregion was described as plains supporting a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges (Kendrick and McKenzie, 2002).

The vegetation of the Fortescue subregion (PIL 2) was described as extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains in the east. River Gum woodlands fringe the drainage lines. It is the northern limit of Mulga (*Acacia aneura*). An extensive calcrete aquifer (originating within a palaeo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of River Gum and Cadjeput *Melaleuca* woodlands (Kendrick, 2002).

Climate

The Pilbara bioregion experiences an arid-tropical climate with hot summers from October to April and mild winters from May to September (Gentilli, 1972). Rainfall in the Pilbara is highly unpredictable and recordings are highest at stations around the Hamersley Range, which lie at altitudes of up to 900m (Beard, 1975).

The Pilbara receives the majority of its annual rainfall between December and March. This rain is usually the result of moist tropical storms and cyclones originating in the north-west, producing sporadic and drenching thunderstorms. Winter rain is generated by extensive cold fronts moving east across the state, which occasionally reach the Pilbara, although these are less frequent further to the north. These fronts produce only light winter rains that are mostly ineffective for plant growth other than herbs and grasses. Larger perennial species require the intense and prolonged summer storms. Surface water can be found in some pools and springs in the Pilbara all year round, although most watercourses only flow briefly due to the short summer wet season. Annual evaporation exceeds rainfall by as much as 2,500mm per year.

The closest Bureau of Meteorology (BOM) weather stations to the study area that maintain long term dataset are at Redmont and Nullagine. Weather data for Redmont (21.99°S, 119.01°E) which is just south of the northern section of the Hillside South the railway corridor and Nullagine (21.89°S 120.11°E), which is north of the eastern end of the proposed railway corridor, are shown in Charts 1 and 2.

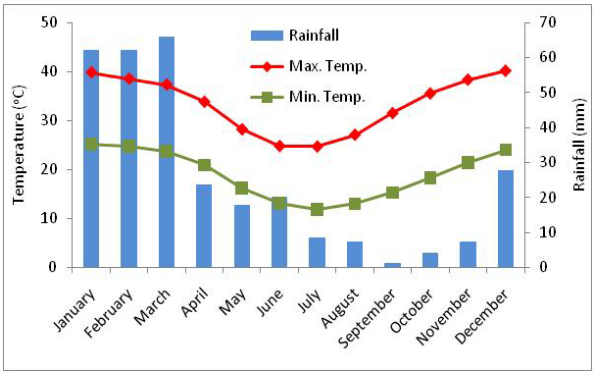

Chart 1.
Climate averages for Redmont

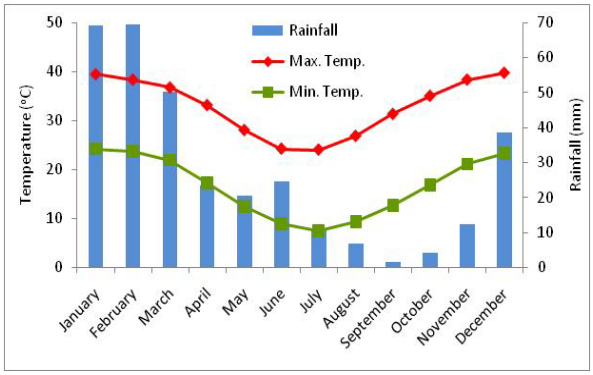

Chart 2.
Climate averages for Nullagine

Conservation Significant Fauna

Conservation significant fauna are protected by the *EPBC Act*, which includes species covered by international treaties such as the Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA) and by the Western Australia (WA) *Wildlife Conservation Act 1950*. The WA legislation enables the publishing of the *Wildlife Conservation (Specially Protected Fauna) Notice* that lists species under multiple categories. In addition, the Department of Environment and Conservation (DEC) maintains a list of fauna that require monitoring under five priorities based on the current knowledge of their distribution, abundance and threatening processes. The *EPBC Act 1999* and *Wildlife Conservation Act 1950* imply legislative requirements for the management of anthropogenic impacts to minimise the effects of disturbances on species and their habitats. Priority species have no statutory protection, other than the DEC wishes to monitor potential impacts on these species. Environmental consultants and proponents of developments are encouraged to avoid and minimise impacts on these species.

Significant Fauna Species Recorded or Predicted for the Project Area

The fauna species that have special status in either State or Commonwealth government legislation or are on the DEC Priority species list, and are potentially present in the rail corridor are listed in Table 1. Migratory marine species have been excluded from this list as they are unlikely to be affected by the rail proposed development. Twelve species listed under the *EPBC Act* and eight species listed under the *WA Wildlife Conservation Act* potentially occur within the vicinity of the project area. In addition, another 15 are listed as Priority species requiring further monitoring may occur in the vicinity of the rail corridor. These species are discussed below.

TABLE 1
CONSERVATION SIGNIFICANT FAUNA THAT COULD POSSIBLY OCCUR IN THE VICINITY OF THE PROPOSED RAIL CORRIDOR

Species		Status under Wildlife Conserv. Act	Status under Cwth EPBC Act	Potential to be found in the project area
Night Parrot	(*Pezoporus occidentalis*)	Schedule 1	Endangered	Moderate
Northern Quoll	(*Dasyurus hallucatus*)	Schedule 1	Endangered	High
Pilbara Olive Python	(*Liasis olivaceus barroni*)	Schedule 1	Vulnerable	High
Crest-tailed Mulgara	(*Dasycercus cristicauda*)	Schedule 1	Vulnerable	Moderate
Bilby	(*Macrotis lagotis*)	Schedule 1	Vulnerable	Low
Pilbara Leaf-nosed Bat	(*Rhinonicteris aurantia*)	Schedule 1	Vulnerable	High
Black-footed Rock-wallaby	(*Petrogale lateralis lateralis*)	Schedule 1	Vulnerable	Low
Princess Parrot	(*Polytelis alexandrae*)	Priority 4	Vulnerable	Low
Peregrine Falcon	(*Falco peregrinus*)	Schedule 4		High
Fork-tailed Swift	(*Apus pacificus*)		EPBC (Migratory)	Low
Rainbow Bee-eater	(*Merops ornatus*)		EPBC (Migratory)	Present
Great Egret	(*Ardea alba*)		EPBC (Migratory)	Moderate
Cattle Egret	(*Ardea ibis*)		EPBC (Migratory)	Moderate
	(*Ramphotyphlops ganei*)	Priority 1		Moderate
	(*Ctenotus nigrilineatus*)	Priority 1		Moderate
	(*Ctenotus uber johnstonei*)	Priority 2		Low
Spectacled Hare-wallaby	(*Lagorchestes conspicillatus*	Priority 3		Low

Species	Status under Wildlife Conserv. Act	Status under Cwth EPBC Act	Potential to be found in the project area
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Grey Falcon (*Falco hypoleucos*)	Priority 4		High
Australian Bustard (*Ardeotis australis*)	Priority 4		Present
Bush Stone-curlew (*Burhinus grallarius*)	Priority 4		High
Star Finch (*Neochmia ruficauda subclarescens*)	Priority 4		Moderate
Long-tailed Dunnart (*Sminthopsis longicaudata*)	Priority 4		Moderate
Pebble-mound Mouse (*Pseudomys chapmani*)	Priority 4		Present
Northern Short-tailed Mouse (*Leggadina lakedownensis*)	Priority 4		High
Ghost Bat (*Macroderma gigas*)	Priority 4		High
Fortescue Grunter (*Leioptherapon ahenius*)	Priority 4		Moderate
Brush-tailed Mulgara (*Dasycercus blythi*)	Priority 4		Moderate

The following is an assessment of the likelihood of each of the species listed in Table 1 being found in the project area.

Night Parrot (*Pezoporus occidentalis*) - Endangered under the *EPBC Act* and Schedule 1 under the WA *Wildlife Conservation Act*

The most recently published sighting of the Night Parrot was on the northern side of the Fortescue Marsh approximately 12km to the west of the Cloud Break mine site (Davis and Metcalf, 2008). The FMG Management Plan for the Night Parrot (Fortescue Metals Group, 2005) reported only two specimens being collected for Australian museums during the 20th century; one from the Gascoyne in 1912 and one from south-western Queensland in 1990. There have been numerous investigations to determine the existence and location of this little-known species (Davies et al., 1988, Garnett et al., 1993, Blyth and Boles, 1997, Blyth et al., 1996). As its name suggests, the Night Parrot is thought to be either nocturnal or crepuscular, drinking after dark then dispersing to forage. Little is known of its foraging habitat but the summary of the information provided by FMG (2005) suggested that it might forage in spinifex where it probably eats seeds. Subsequent species-specific searches in the vicinity of the FMG Cloud Break mine have failed to detect its presence. The species is thought to be very shy, typically depending upon camouflage to protect them from predation, and only flushing from roosts if disturbance affects the actual shelter they are hiding in. Almost all sightings have occurred at sunset or after dark (Johnstone and Storr, 1998).

Although its patterns of movement are unknown, the Night Parrot is presumed to be nomadic. Several reasons have been suggested for its decline, including habitat loss and degradation through clearing, grazing and altered fire regimes, reduced availability or quality of watering points and predation from feral species. There is no evidence to suggest that habitat destruction has been a major contributor to the decline of this species. The most significant potential impact on this species in the RHIO project area is that nests containing eggs are destroyed during the clearing process, as adult birds are likely to move away from the disturbance into adjacent areas unhurt.

The recent sighting near Minga Well, which is in a Mulga woodland, is west of the proposed Hillside South railway corridor, but there is similar habitat along the proposed RHIO railway corridor. These parrots were drinking at the Minga Well but it was thought they foraged in the hummock grassland in adjacent areas, and the Mulga woodland was not its preferred foraging habitat type. The proposed rail alignment represents a small fraction of similar habitat in the Pilbara bioregion and there is no evidence to indicate that this particular area is important habitat for the Night Parrot. It is therefore Terrestrial Ecosystems' assessment is that this

species may infrequently be seen in the general area, but the proposed vegetation clearing and development is unlikely to have a significant impact on this species.

Northern Quoll (*Dasyurus hallucatus*) - Endangered under the *EPBC Act* and Schedule 1 under the *WA Wildlife Conservation Act*

The Northern Quoll is found in east and north Queensland, northern parts of the Northern Territory, the Kimberley and the Pilbara. In the Northern Territory, and to a lesser extent in north-eastern Australia, Northern Quoll populations have declined significantly due to their predation on Cane Toads. Van Dyck and Strahan (2008) suggested that they were most abundant in broken country, rocky areas and open eucalypt forest within 150km of the coast. Terrestrial Ecosystems and other consultant records indicate that Northern Quoll are present in a variety of habitats in the Pilbara including rocky gorges and scree slopes, creek lines, open spinifex sand plains, near permanent water and spinifex and acacia shrubland. They are reported to den in hollow tree trunks, but will use other spaces such as rock crevices and openings in old termite mounds.

It is thought that most males in savannah areas die after breeding (Braithwaite and Griffiths, 1994; Oakwood, 2000), but in captivity, if breeding activity is restricted, then males will live to breed in subsequent years. In rocky areas, Braithwaite and Griffiths (1994) reported Northern Quolls living for 2-3 years, whereas in savannah areas they rarely live beyond the first mating. Many females also die after raising their first litter, but about a quarter survive to produce a second litter. Mating occurs in winter, with young being carried by the female for 8-10 weeks after birth, and they then stay with their mother until they are able to fend for themselves.

Home ranges for females in the savannah areas of Kakadu National Park are about 35ha, with some overlap in foraging areas when population densities are 3-4 females/km^2, but at 1-2 females/km^2 there is no overlap (Oakwood, 2002). Male home ranges are similar to females before the breeding season, but increase to in excess of 100ha when they are searching for females.

There is little known of the spatial ecology of Northern Quolls in the Pilbara. It is thought that they are likely to have a relatively large geographic distribution in the Pilbara, and are possibly more abundant and wide-spread than is currently reported. Being nocturnal, secretive, having large home ranges, and living in rocky areas where tracks are difficult to detect and not being caught in pit- and funnel traps could easily result in a significant under-estimation of their abundance and distribution.

Braithwaite and Griffiths (1994) reported their range reduction might be associated with cattle grazing and exotic disease. The Cane Toad may also contribute to their range reduction.

A search of Terrestrial Ecosystems' fauna survey database indicated that Northern Quoll have been caught in a variety of habitats across the Pilbara (Appendix A). How *et al*. (1991) and How and Cooper (2002) recorded this species at numerous locations on the Abydos Plains. Other recent records in the Pilbara include those by Biota Environmental Sciences (2002, 2004b, 2004c, 2007, 2008), Bamford Consulting Ecologists (2008, 2009) and Outback Ecology (2006). ATA Environmental's (2007) surveys along the FMG railway line corridor from Port Hedland to Cloud Break found evidence of Northern Quoll in the vicinity of rocky outcrops, escarpments and vegetated plains. Fresh scats and tracks and possible den sites were also recorded in numerous locations along the base of gorges and under rock overhangs. Bamford Consulting Ecologists (2009) reported catching Northern Quolls at the BC Iron Nullagine project area and Terrestrial Ecosystems recorded Northern Quoll tracks in the

sandy creek bed east of the proposed railway corridor north of the Redmont camp. Based on these data it is likely that they are present in the Chichester Range.

Suitable habitat for the Northern Quoll is present in many of the more vegetated areas of the proposed rail corridor and in the Chichester Range. Assessing the potential risk associated with clearing the vegetation in the corridor on the Northern Quoll is difficult, in the absence of any published data on the spatial ecology of this species in the Pilbara.

Given that populations of the Northern Quoll outside the Pilbara are at serious risk due to the Cane Toad, the Pilbara may constitute an important regional refuge population for the species. The proposed railway line and associated infrastructure will cross multiple areas that potentially support this species.

Terrestrial Ecosystems' considers it likely that vegetation clearing in the proposed rail alignment will result in a few individuals being killed, however, the overall impact on the species is likely to be low based on the available data, as the vegetation clearing is linear and limited in the context of the known Northern Quolls' Western Australian distribution.

Pilbara Olive Python (*Liasis olivaceus barroni*) - Vulnerable under the *EPBC Act* and Schedule 1 under the *WA Wildlife Conservation Act*

Pilbara Olive Pythons are found throughout the Pilbara and east to Mt Augustus and north to the Gregory Range. Pilbara Olive Pythons are most often seen at dusk or night and are generally found around rocky areas, rocky outcrops and cliffs, particularly in the vicinity of watercourses and water holes, but they also shelter in logs, flood debris, caves, tree hollows and thick vegetation (Burbidge 2004, Pearson 1993, 2007). They are generally opportunistically sighted and even species-specific searches in the right conditions often fail to detect their presence when they are in the area. Large specimens have been seen to feed on a variety of birds (e.g. corellas, pigeons and ducks) and mammals (e.g. fruit bats, small Euros and rock wallabies), with smaller snakes probably feeding mainly on reptiles and frogs (Pearson, 2003).

Kendrick (2002) reported this species as common and wide-spread in the Pilbara and one that should not be listed as threatened or declining. Studies (Pearson, 1993) indicated that *L. o. barroni* is widespread across the Pilbara, and that there are a number of sizeable populations. The Terrestrial Ecosystems' fauna survey database has records of the Pilbara Olive Python throughout the Pilbara but there are no records for the Chichester Range or around the Fortescue Marsh. This maybe because of a lack of survey effort in this area. It should be noted that most of the terrestrial fauna surveys for this area did not use funnel traps, and there is little possibility of them being caught in the other trap types.

Terrestrial Ecosystems' assessment is that Pilbara Olive Pythons are likely to be present in the proposed Hillside South rail alignment, particularly in well vegetated areas, around water holes and rocky outcrops and in the Chichester Range, and that vegetation clearing in the rail alignment will possibly result in individuals being killed. However, given their spatial distribution, their relatively low abundance and patchy distribution, the loss of a few individuals along the proposed rail corridor during the clearing process is unlikely to significantly impact on this species.

Crest-tailed Mulgara (*Dasycercus cristicauda*) - Vulnerable under the *EPBC Act* and Schedule 1 under the *WA Wildlife Conservation Act* and the **Brush-tailed Mulgara (*Dasycercus blythi*)** - Priority 4 with the DEC.

Woolley (2005) has recently recognised two species of 'Mulgara'; *Dasycercus blythi* and *D. cristicauda*. *Dasycercus blythi* has a non-crested tail, two upper premolars and six nipples; *D. cristicauda* has a crested tail, three upper premolars and eight nipples. Both species have a wide and overlapping distribution in arid Australia. Woolley (2005) suggested the common names for these two species be Brush-tailed Mulgara for *D. blythi* and Crest-tailed Mulgara for *D. cristicauda*. These two species can be sympatric in places, but probably utilise different parts of the habitat on a local scale when they are recorded in the same area. Currently, there are insufficient data to separate the spatial ecology, burrows and reproductive biology of these two species. Information that follows is based on what is known for 'Mulgara' without distinguishing between the species.

The EPBC website has not yet incorporated the change in Mulgara taxonomy. However, recent communications from an officer in the DEWHA suggested that *D. hillieri* (listed as Endangered under the *EPBC Act*) is now known as *D. cristicauda* (as per Woolley 2005) and *D. cristicauda* (listed as Vulnerable under the *EPBC Act*) is now *D. blythi* (as per Woolley 2005).

The reported distribution of Mulgara includes much of the inland spinifex covered sandy desert and spinifex vegetated areas in the Pilbara and northern goldfields. Within these areas their distribution is patchy and it is most frequently confined to mature spinifex dominated habitat (Gibson and Cole, 1992, Masters, 2003, Masters et al., 2003, Thompson and Thompson, 2008a). Active burrows of Mulgara were found at multiple locations along the FMG railway corridor. Subsequent trapping caught *D. cristicauda* about 89km south of Port Hedland, and *D. blythi* in the northern section of the FMG railway corridor.

In some areas, their relative abundance is positively associated with rainfall in the previous 12 to 24 months (Masters, 1998, Gibson and Cole, 1992, Dickman et al., 2001, Letnic and Dickman, 2005) and recent burning of the spinifex does not seem to be sufficient to shift Mulgara out of an area (Thompson and Thompson, 2007). Mulgara are generally sedentary in contrast with some other small dasyurids and have high site fidelity and a low propensity for dispersal once a home range has been established (Masters, 1998, Masters, 2003, Dickman et al., 2001). Thompson and Thompson (2008a) reported a relatively high density of *D. blythi* south of Port Hedland in a densely vegetated sand plain.

The loss of *D. blythi* is probably of less concern than the loss of *D. cristicauda* because of their relative conservation status, but the available information makes it difficult to predict which species might be present in the proposed rail corridor.

Terrestrial Ecosystems' assessment is that there is a moderate possibility of some Mulgara being killed in their burrows during the vegetation clearing process north of the Chichester Range in the sandy terrain vegetated with spinifex unless all suitable areas are searched prior to vegetation clearing and burrows dug out and / or Mulgara trapped and translocated.

Bilby (*Macrotis lagotis*) - Vulnerable under the *EPBC Act* and Schedule 1 under the WA *Wildlife Conservation Act*

This nocturnal, medium sized, omnivorous, burrow dwelling marsupial was once wide-spread in Australian arid and semi-arid areas. Its geographical distribution has now contracted to a few small populations in southern Northern Territory and south-eastern Queensland, and the Pilbara and Sandy Deserts of Western Australia. Bilby distribution is now largely restricted to

the inland sandy deserts in two broad habitat types; mulga woodlands with lateritic red earth and spinifex grassland with high fire frequency, again with the red earth (Johnson, 1989, Southgate, 1990).

Bilbies have a diet of insects, seeds, bulbs, fruit and fungi and often leave a characteristic excavation of up to 10cm deep with the soil scattered in all directions or a 'pot-hole' in the ground (Thompson and Thompson, 2008b). Bilbies intensively forage in an area of about 10ha around multiple burrows (Thompson and Thompson, 2008b). They will shift burrows and foraging areas when resources are depleted.

There exists a few known scattered populations of Bilby in the Pilbara, and their numbers are thought to be in significant decline. However, it is possible that they are more wide-spread and abundant in the Pilbara than the government conservation agencies believe [see Pavey (2006) for current geographic range] because of a lack of survey effort in the region. How *et al*. (1991) recorded this species at numerous locations on the Abydos Plains. ATA Environmental (2007) reported burrows and digging at numerous locations along the FMG rail corridor from Port Hedland to Cloud Break. These burrows and diggings were predominantly located on red sandy soils in a spinifex meadow with occasional trees; however, they have also recently been recorded in open burnt habitat (Thompson and Thompson, 2008b). An active Bilby burrow was located by Terrestrial Ecosystems about 15km north-east of the Redmont camp in a creek bed along with recent tracks. Davis et al. (2005) reported a Bilby had been seen on Mulga Downs Station near Kardarderrie Well on the northern border of the Fortescue Marsh by FMG staff and active burrows were found at Cockeye Bore. Davis et al. (2005) reported finding a number of active Bilby burrows on the northern fringes of the Fortescue Marsh in a spinifex meadow south of the Cloud Break mine. The RHIO proposed rail corridor is to the east of these records and does not traverse this type of habitat.

The Bilby is a critical weight-range mammal and is therefore at risk of predation by feral predators such as the cat, fox and dingo, but their presence is correlated with the absence of rabbits and pastoral activities (Bellchambers, 1993). Bilbies are susceptible, particularly juveniles, to predation in disturbed environments, and vulnerable to vehicle collisions at night. Because they live in small groups and their population is highly fragmented and dispersed in the Pilbara, the loss of a few individuals or localised population is of significance.

Terrestrial Ecosystems' assessment is that Bilbies could be present in a couple of sections of the proposed rail corridor, in the sandy habitat that is vegetated with spinifex. As the loss of any small population / colony of Bilbies in the Pilbara would be of conservation concern, appropriate management actions are recommended to protect these species during the vegetation clearing and construction process.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - Vulnerable under the *EPBC Act* and Schedule 1 under the *WA Wildlife Conservation Act*

Armstrong (2001) reported populations of *R. aurantia* around Marble Bar, Nullagine, Hillside station, Soansville, Tom Price, Paraburdoo, Red Hill, Millstream, Fortescue and the Barlee Range. Earlier reports suggested that its geographic distribution was divided into three distinct areas: mines of the eastern Pilbara – George Ranges, Hamersley Range in small colonies, and in the Gascoyne Range (Armstrong, 2001). More recently, McKenzie and Bullen (2009) commented that *R. aurantia* was widespread in the Pilbara, as it was recorded in 17 of their 24 survey areas.

The Pilbara Leaf-nosed Bat retreats to humid caves or mine shafts (Armstrong, 2001). Churchill (2008) reported the Pilbara Leaf-nosed Bat was rare because of the scarcity of caves and mines with suitable microclimate (i.e. 28-32^{o}C, 85-100% humidity). Colony sizes varied seasonally, with all colonies abandoning their cave roosts during the wet season in the wet-dry tropics. Colony size was correlated with mean minimum monthly temperature and rainfall, with populations being greatest during the coolest and driest period in the tropics. McKenzie and Bullen (2009) suggested that there were probably additional unrecorded roosts for this species in the Pilbara. These are likely to be in rocky and hilly areas that contain caves.

Given recent records in the Pilbara and habitat present in the rail corridor, Terrestrial Ecosystems' assessment is that the Pilbara Leaf-nosed Bat is probably in the project area and caves in the Chichester Range could support a colony of Pilbara Leaf-nosed Bats. If any of these caves are to be impacted, then they should be inspected prior to disturbance. Avoiding impacts on maternity caves and roosts is an important strategy for minimising impacts on this species.

Black-footed Rock-wallaby (*Petrogale lateralis lateralis*) - Vulnerable under the *EPBC Act* and Schedule 1 under the *WA Wildlife Conservation Act*

Petrogale lateralis is a diverse species, with three subspecies and two chromosomal races:

P. lateralis lateralis	Black-footed Rock Wallaby
P. lateralis hacketti	Recherché Rock Wallaby
P. lateralis pearsoni	Pearson Island Rock Wallaby
P. lateralis MacDonnell Ranges race	Black-footed (MacDonnell Ranges race)
P. lateralis West Kimberley race	Black-footed (West Kimberley race)

Eldridge and Close (1997) indicated that the Black-footed Rock-wallaby is potentially found in project area. Pearson and Kinnear (1997) reported *P. l. lateralis* had an unusual disjunct geographic distribution in Western Australia with individuals recorded in the Cape Range, with a small population east of the Fortescue River Roadhouse seen in 1985 and possibly another small population in the Barlee Range. Pearson (1992) reported the preferred habitat of the Macdonnell Ranges race around Warburton was rocky outliers and tumbled blocks on scree slopes rather than areas of steep cliffs or major ranges. The primary predators being Wedge-tailed Eagles, foxes, dingoes and perenties (Pearson, 1992).

Male Black-footed Rock-wallabies grow to about 4.5kg and females to about 3.5kg (Eldridge and Close, 1997), and they are seldom sympatric with any other rock-dwelling wallaby so they are relatively easily identified. However, Pearson and Kinnear (1997) suggested that *P. l. lateralis* could be sympatric or hybridise with *P. rothschildi* in the Pilbara.

There are no records of the Black-footed Rock-wallaby in or near the Chichester Range, so Terrestrial Ecosystems' assessment is that they are unlikely to be within the proposed RHIO rail corridor.

Princess Parrot (*Polytelis alexandrae*) - Vulnerable under the *EPBC Act* and Priority 4 with the DEC

Very little is known about the Princess Parrot, even its geographical distribution. It is thought to be nomadic within the central desert regions of Australia, occupying arid shrub lands, particularly those dominated by mulga, Desert Oak and spinifex.

The proposed rail corridor is probably too far west of its known distribution and it is generally not recorded in ranges (Johnstone and Storr, 1998). Due to the paucity of information for this

species, accurate estimates of its conservation significance are difficult to make; however, this species is probably threatened by habitat loss to agricultural practices and changes in fire regimes.

Terrestrial Ecosystems' assessment is that it is unlikely that the Princess Parrot would be seen and therefore impact by the clearing of vegetation in the project area.

Peregrine Falcon (*Falco peregrinus*) - Schedule 4 under the *WA Wildlife Conservation Act*

Johnstone and Storr (1998) reported the Peregrine Falcon as being widespread including some off-shore islands, but was absent from most deserts. They went on to suggest that it was mainly seen around cliffs, along coasts, rivers and ranges and wooded watercourses and lakes; however, Terrestrial Ecosystems fauna survey database has records of them in a variety of other habitats. Biota Environmental Sciences (2002, 2004a, 2005) recorded Peregrine Falcons during its FMG Stage A and B surveys and the Hope Downs railway corridor, Ecologia Environment (2009) reported one during its survey of Roy Hill mining operations and Terrestrial Ecosystems has seen one near the FMG Cloud Break camp.

Ground disturbance activities on a localised scale are unlikely to significantly impact on the Peregrine Falcon. Terrestrial Ecosystems' considers it unlikely that the construction of the rail corridor will significantly impact on this species because they will move to adjacent areas if disturbed.

Fork-tailed Swift (*Apus pacificus*) - Migratory under the *EPBC Act*

The Fork-tailed Swift breeds in north-east and mid-east Asia and winters in Australia and south New Guinea (Johnstone and Storr, 1998). They arrive in the Kimberley in late September and in the Pilbara in November and the south-west in December, leaving late in April. Johnstone and Storr (1998) reported them as common in the Kimberley and uncommon to moderately common along the north-west, west and south-east coasts and scarce elsewhere. They are infrequently seen in large flocks and can be attracted to thunderstorms or cyclonic events in the Pilbara.

Biota Environmental Sciences (2004a) described them as common but patchy and seen along the storm front associated with ex-tropical cyclone Fay, primarily south of the Fortescue Marshes. Terrestrial Ecosystems' considers it unlikely that the construction of the proposed rail corridor will significantly impact on this species as they can move to adjacent areas if disturbed.

Rainbow Bee-eater (*Merops ornatus*) - Migratory under the *EPBC Act*

Rainbow Bee-eaters are abundant in Australia, and found in many parts of Western Australia except the sandy deserts and dry arid interior. Johnstone and Storr (1998) described them as resident, breeding visitors and postnuptial nomads. They are generally migratory, moving south in late September and early October, having wintered from the Gascoyne to Indonesia.

The Rainbow Bee-eater is relatively abundant in the Pilbara and is likely to be seen in the flat and undulation plains along the proposed railway corridor, particularly around creek lines for most of the year. Terrestrial Ecosystems' considers it unlikely that the construction of proposed rail line and associated infrastructure will significantly impact on this species as they can move to adjacent areas if disturbed.

Great Egret (*Ardea alba*) - Migratory under the *EPBC Act 1999*.

Herons and egrets all depend to some extent upon surface water for hunting. The Great Egret is the largest of the Australian egrets, and is an elegant, white wader dependent upon floodwaters, rivers, shallow wetlands and intertidal mudflats. Its diet consists of a range of small, aquatic invertebrates and small vertebrates (Frith, 1976). It was recorded by Biota Environmental Sciences (2002, 2005) during its FMG Stage B survey and during the Hope Downs railway corridor during other fauna surveys in the vicinity of the proposed railway corridor (Appendix A).

Given the dependence of the Great Egret upon restricted habitats, impacts of land clearing and development of these habitats are likely to have a local impact on this species. The species is also likely to be susceptible to secondary impacts, particularly changes in local hydrology, where this changes the water levels in local wetlands.

Cattle Egret (*Ardea ibis*) - Migratory under the *EPBC Act 1999*.

The smallest of the Australian egrets, this species has undertaken an invasion of Australia from the north, where it was originally more common in the Indonesian archipelago than Australia. This invasion may have been assisted by the opening up of farming land and irrigation schemes, providing the pasturelands and shallow wetlands in which it prefers to forage. Johnstone and Storr (1998) noted the species distribution in Western Australia as being confined to the irrigation areas surrounding Kununurra, however, its migratory nature, and current invasive tendencies suggest that it may occur elsewhere in the state, and may still be expanding its distribution. It was not recorded during other fauna surveys in the vicinity of the proposed railway corridor.

This species is also likely to be susceptible to secondary impacts, particularly changes in local hydrology, where this changes the water levels in local wetlands or creeks. The widespread nature of the species, and the fact that it seems to represent an unassisted invasion of Australia suggests, that the loss of habitats in the region is not likely to greatly impact the species nationally.

Ramphotyphlops ganei - Priority 1 with DEC

NatureMap records this species near Newman, Millstream Road, Chichester Range and Pannawonica. Terrestrial Ecosystems' fauna survey database indicates that this blind snake has been caught south of Newman, north-west of the Fortescue Marsh and in the Hamersley Range.

Terrestrial Ecosystems' assessment is that it is possible that *R. ganei* are present in the proposed rail corridor in the Chichester Range, however, as the width of the vegetation clearing in the corridor will generally not exceed 100m and similar habitat is present in adjacent areas, the loss of these individuals is unlikely to be of long-term conservation significance.

Ctenotus nigrilineatus - Priority 1 with DEC

Two specimens of *C. nigrilineatus* were caught in the Abydos Plains survey by How and Dell (2004) but they were not caught in the Hope Downs survey or any of the FMG Stage A or B rail corridor assessments. Terrestrial Ecosystems has caught specimens in the Hamersley Range on a stony substrate and NatureMap records this species at Meetheena, which is north-east of Nullagine.

Terrestrial Ecosystems' assessment is that it is possible that *C. nigrilineatus* is present in the proposed rail corridor, however, as the width of the vegetation clearing in the corridor will generally not exceed 100m and similar habitat is present in adjacent areas, the loss of a few individuals of this species is unlikely to be of significance.

Ctenotus uber johnstonei - Priority 2 Species with DEC.

This subspecies of skink is currently known from a few localities on the western plains surrounding the Fortescue Marshes, and a particular area of chenopod shrubland near Balgo (Wilson and Swan, 2003). Very little is known of this subspecies, but it is presumed to be similar to other subspecies of *Ctenotus uber*. *Ctenotus uber* was caught by Biota Environmental Sciences (2004a) during its FMG Stage A surveys and by Ecologia Environment (2009) during its survey of Roy Hill infrastructure. It is not clear whether these records are the subspecies that is a Priority 2.

Its habitat preferences for mature, chenopod shrublands on alluvial plains and its restricted geographical distribution suggest that it is unlikely to be found within most of the rail corridor and therefore not likely to be significantly impacted by the proposed development.

Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*) – Priority 3 with DEC

Ingleby (1991) reported that this small (1-4.5kg) nocturnal macropod was rare in the Pilbara and Kimberley regions of Western Australia, although moderately common in the appropriate habitat in the Northern Territory and is still abundant on Barrow Island. The Spectacled Hare-wallaby is noted for its reliance upon specialised habitat of hummock grasses at a suitable seral stage (Van Dyck and Strahan, 2008).

How *et al*. (1991) reported anecdotal evidence of a small population at the Pilgangoora mining camp and between the airstrip and Chinnamon Creek on the Mt York Road. Terrestrial Ecosystems' fauna survey database records them on the Abydos-Woodstock Plain, and further to the north-east. All of these records are to the north of the proposed railway.

Terrestrial Ecosystems' assessment is that it is unlikely to be seen in the proposed rail corridor as the proposed corridor is too far south of its recently known geographic distribution in the Pilbara.

Grey Falcon (*Falco hypoleucos*) - Priority 4 with DEC

Johnstone and Storr (1998) recorded the geographic distribution of the Grey Falcon as the northern half of Western Australia, excluding the coastal area of the Pilbara. They went on to suggest that it is mostly found in lightly wooded coastal and riverine plains.

A pair of Grey Falcons was recorded in eucalypt woodland along Sandy Creek, near Cloud Break (Davis et al., 2005) and by Terrestrial Ecosystems on multiple occasions in the same area since July 2006. Biota Environmental Sciences (2004a) recorded three birds (one adult and two immature) over cracking clay adjacent to FMG20f along the Fortescue railway line corridor in March 2004.

Terrestrial Ecosystems' considers it is unlikely that the clearing of vegetation along the proposed rail corridor will significantly impact on this species as they will generally move to adjoining areas if disturbed.

Australian Bustard (*Ardeotis australis*) - Priority 4 with DEC

Johnstone and Storr (1998) reported the Australian Bustard as occurring in most parts of Western Australia, and was often found in lightly wooded grassland, sand plains vegetated with spinifex, chenopod flats, low heath and farming country. The Australian Bustard has been seen in various habitats, particularly flat plains vegetated with spinifex, grasses and low shrubs in most areas of the Pilbara. Terrestrial Ecosystems has observed the Australian Bustard at multiple locations along the existing FMG Port Hedland to Cloud Break and to Christmas Creek rail corridor between 2007 and 2009 and during the site investigation in March 2010.

Terrestrial Ecosystems' considers it is unlikely that the clearing of vegetation along the proposed rail corridor will significantly impact on this species as they will generally move to adjoining areas if disturbed.

Bush Stone-curlew (*Burhinus grallarius)* - Priority 4 with DEC

Johnstone and Storr (1998) reported the Bush Stone-curlew as being found in the western half of Western Australia and the Kimberley, but is absent from the sandy deserts and the interior east of Leonora and Southern Cross. Johnstone and Storr (1998) recorded their preferred habitat as lightly wooded areas. Biota Environmental Sciences (2004a) sighted one adult and a chick north of Redmont Camp along the BHP rail access road and one during the Hope Downs survey and Ecologia Environment (2009) recorded one in its survey of the Chichester Range. Terrestrial Ecosystems recorded two individuals north of the Cloud Break mine site in a creek bed.

Terrestrial Ecosystems' considers it is unlikely that the proposed rail corridor will significantly impact on this species as these birds will move to adjacent areas when vegetation clearing commences.

Star Finch (*Neochmia ruficauda subclarescens*) - Priority 4 with DEC

Johnstone and Storr (1998) recorded the Star Finch being found around the western end of the Ashburton, Fortescue and DeGrey Rivers in the Pilbara, and having a preference for long grass, rushes and shrubs around swamps, lagoons and permanent water bodies. Johnstone and Storr (1998) reported the Star Finch to be locally common in the Pilbara, but patchily distributed. Howard (1986) reported seeing a couple of birds around Wittenoom, Davis *et al*. (2005) recorded Star Finches at Minga Well near the FMG Cloud Break mine and Ecologia Environment (2009) recorded one during its survey of the Chichester deviation. They appear to be relatively rare and are almost always seen near water in the adjacent vegetation. If Star Finches are present in the proposed rail corridor they are most likely to be seen around the small semi-permanent ponds in the dense water side vegetation.

Clearing of relatively dense vegetation near permanent or semi-permanent water holes along the corridor could impact on this species. Although, they are likely to move if this vegetation is cleared, this loss of habitat could be important.

Long-tailed Dunnart (*Sminthopsis longicaudata*) - Priority 4 with DEC

Terrestrial Ecosystems' fauna survey database records Long-tailed Dunnarts being caught in the Hamersley Range, Abydos-Woodstock area and further to the east, and near Newman. Van Dyck and Strahan (2008) indicated that they have been caught in a variety of habitats including rocky areas, on scree slopes and sandy gravel soils vegetated by spinifex. As this habitat is present in the gorges and other areas along the proposed railway corridor, it is possible that the Long-tailed Dunnart is the project area.

Terrestrial Ecosystems' considers it is possible that Long-tailed Dunnarts are in the proposed rail corridor because it contains suitable habitat; however, as the width of the vegetation clearing in the corridor will generally not exceed 100m and similar habitat is present in adjacent areas, any loss of individuals of this species is unlikely to be of long-term conservation significance.

Pebble-mound Mouse (*Pseudomys chapmani*) - Priority 4 with DEC

Van Dyck and Strahan (2008) recorded the Pebble-mound Mouse as endemic to the Pilbara of Western Australia. Terrestrial Ecosystems' fauna survey database indicates that Pebble-mound Mice mounds are abundant in many sections of the Pilbara, including the Chichester Range between Cloud Break and Christmas Creek, and in the stony undulating terrain north of the Chichester Range. Only a small percentage of the mounds appear to be active. This might indicate that our assessment of what is an active mound is understating the number of 'active' mounds, or that mounds remain obvious for decades and it appears that the number of Pebble-mound Mice are in decline because of the high number of inactive mounds.

The Pebble-mound Mouse mounds were present in multiple locations along the rail corridor; however, given their abundance in the Pilbara, it is Terrestrial Ecosystems' view that the clearing of vegetation for the proposed rail corridor will not significantly impact on this species.

Northern Short-tailed Mouse (*Leggadina lakedownensis*) – Priority 4 with DEC

Van Dyck and Strahan (2008) indicated that the Northern Short-tailed Mouse predominantly occurs in the Pilbara, sandy deserts north of the Pilbara and the Kimberley. Van Dyck and Strahan (2008) reported that little is known of the biology and abundance of this species. Because of the paucity of data on this species' ecology and preferred habitat type, it is difficult to indicate areas where it might be significantly impacted on. As with all small mice, vegetation clearing, habitat fragmentation, changed fire regimes and introduced predators are the major threatening processes.

Terrestrial Ecosystems' fauna survey database records indicate that the Northern Short-tailed Mouse has been caught along the Fortescue River to the north and south of the Fortescue Marsh, east of the Abydos-Woodstock area and around the Wittenoom. Ecologia Environment (2009) recorded catching one in its survey of the Chichester Deviation. Terrestrial Ecosystems' considers it likely that the Northern Short-tailed Mouse could be within the proposed rail corridor, however, given the width of the corridor, clearing of vegetation is unlikely to significantly impact on this species.

Ghost Bat (*Macroderma gigas*) – Priority 4 with DEC

This is Australia's only carnivorous bat, eating large insects, frogs, lizards, small birds and mammals. Tideman *et al*. (1985) reported Ghost Bats in the Northern Territory foraged, on average, 1.9km from their day roost, with a mean size of foraging area of 61ha. Their hunting behaviour utilised vantage points to detect prey with their eyes and ears, rather than using echolocation. These vantage points were changed about every 15min during foraging periods, with a mean distance of 360m between them. The Ghost Bat is an obligate troglodyte, and its survival is dependent on finding natural roosts in caves, crevices, deep overhangs and artificial roosts such as abandoned mines. Each population appears to have a regionally centralised maternity site and a few sites were known to exist in the mid 1990s (Worthington-Wilmer et al., 1994). Populations are known to disperse in the non-breeding (dry) season in the wet-dry tropics (Toop, 1985).

Armstrong and Anstee (2000), in their summary of the geographic distribution of *M. gigas* in the Pilbara, reported that they had been present in the Abydos Plain, Chichester Plateau, Gascoyne Range, George Range, Hamersley Plateau and Oakover Valley. Terrestrial Ecosystems' fauna survey database records Ghost Bats in the Hamersley and Chichester Ranges, around Newman, Abydos-Woodstock and further to the east. Douglas (1967) examined 30 likely caves for *M. gigas* in cliffs and breakaways in the Hamersley Range on the northern section near Millstream Station and Tambrey Station and found them in seven. More recently McKenzie and Bullen (2009) recorded *M. gigas* in 21 of its 24 Pilbara survey sites, and suggested that it was more common than previously supposed. It therefore appears that they are relatively common and widespread in the Pilbara as they are in the Kimberley. A single individual was caught in a mist net south of the Cloud Break mine on the northern boundary of the Fortescue Marsh. It is presumed that this individual had a roost in the rocky gorges near the Cloud Break mine site. Its preferred habitat in the Hamersley Range is caves beneath bluffs of low rounded hills composed of Marra Mamba geology and granite rock piles in the eastern Pilbara (Armstrong and Anstee, 2000).

Given recent records in the Pilbara and habitat present in the rail corridor, Terrestrial Ecosystems' assessment is that the Ghost Bat is probably present along the proposed railway corridor.

Fortescue Grunter (*Leioptherapon ahenius*) – Priority 4 with DEC

Morgan and Gill (2004) reported the Fortescue Grunter being found in the Ashburton, Robe and Fortescue Rivers in reasonably high densities. This species is likely to be present in seasonally isolated pools that are linked to the Fortescue River during flood times. It is possibly found in any permanent or semi-permanent pools of tributaries of the Fortescue River.

The loss of a small number of Fortescue Grunter is unlikely to be of conservation significance as there are many locations within the Fortescue River system where they are known to exist, and they have a boom-bust population that is driven by seasonally heavy rainfall.

Aquatic Vertebrate Species

The proposed rail corridor is mostly drained by the Fortescue River, but north of the Chichester Range it is drained by the Yule River, with the eastern section draining into tributaries of the De Grey River.

Fish species likely to be found in the creeks and waterways of the Fortescue and Yule Rivers and their tributaries include the Short-finned Eel (*Anguilla bicolour*), Bony Bream (*Nematalosa erebi*), Salmon Catfish (*Arius graeffei*), Eel-tailed Catfish (*Neosilurus hyrtlii*, and *Neosilurus* sp.), Western Rainbowfish (*Melanotaenia australis*), Barred Grunter (*Amniataba percoides*), Spangled Perch (*Leiopotherapon unicolor*), Fortescue Grunter (*Leiopotherapon aheneus*), Empire Gudgeon (*Hypseleotris compressus*) and Flathead Gobies (*Glossogobius giurus*)(Morgan and Gill, 2004). Other than the Fortescue Grunter, none of these species are considered threatened.

The Dinner Plate Turtle (*Chelodina steindachneri*) is in the Fortescue and Yule Rivers and almost certainly in some of the large water holes in the general area. This species is known from many of the creeks and rivers in the Murchison and De Grey River catchments in the north to the Irwin River in the south and inland to Meekatharra and Paynes Find. After heavy rain it is occasionally seen walking over dry land many kilometres from surface water. The Dinner Plate Turtle is not of conservation significance.

Methodology

Introduction

The fauna assessment for the Hillside South rail corridor focussed on identifying habitat suitable for conservation significant fauna that could be impacted by the construction and operation of a railway. Terrestrial Ecosystems have used a risk assessment approach based on a habitat assessment to determine the potential of impacting on fauna or fauna assemblages of importance. The habitat assessment included a particular focus on identifying suitable habitat for the Star Finch given its conservation status.

Bats are likely to be impacted on if their roosts are disturbed. During the field assessment, areas likely to contain caves or retreats suitable for conservation significant bats (e.g. Pilbara Leaf-nosed Bat, Ghost Bat) were noted; but, no caves or overhangs were investigated to determine the presence or absence of bats due to anthropogenic or aboriginal heritage restrictions. No echolocation detection was conducted as part of the habitat assessments.

Database searches

A review of previous survey reports for the region and the DEC's Threatened and Priority Fauna database via information available in NatureMap was undertaken to identify potential threatened or priority species in the region. A search of the Commonwealth DEWHA on-line database was also undertaken to identify species of conservation interest to the Commonwealth Government.

Regional Comparisons

Mining developments in the Pilbara have resulted in numerous biological surveys being conducted in the region. The specific reports reviewed to obtain a regional overview of vertebrate fauna likely to be encountered along the proposed Hillside South railway corridor include Hope Downs, FMG and BHP Billiton Chichester Deviation rail corridors, FMG Cloud Break mine site, Roy Hill and BC Iron Nullagine fauna assessments. The specific reports reviewed included:

ATA Environmental (2007) *Assessment of the Conservation Significant Vertebrate Fauna for the Proposed Rail Corridor and Associated Borrow Pits*. Unpublished report for Fortescue Metals Group, Perth.

Bamford Consulting Ecologists (2009) *Fauna Assessment of the BC Iron Nullagine Iron Ore Project*. Unpublished report for Astron Environmental Services, Perth.

Biota Environmental Sciences (2002). *Proposed Hope Downs rail corridor from Weeli Wolli Siding to Port Hedland - vertebrate fauna survey*. Unpublished Report commissioned by Hope Downs Management Services.

Biota Environmental Sciences (2004a). *Fauna Habitats and Fauna Assemblage of the proposed FMG Stage A Rail Corridor*. Unpublished Report commissioned by Fortescue Metals Group Pty. Ltd.

Biota Environmental Sciences (2005). *Fauna Habitats and Fauna Assemblage of the proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas mine areas*. Unpublished Report commissioned by Fortescue Metals Group Pty. Ltd.

Davis, R.A., Wilcox, J.A., Metcalf, B.M. Bamford, M.J. (2005). *Fauna survey of proposed Iron Ore Mine, Cloud Break*. Unpublished report for Fortescue Metals Group, Perth.

Ecologia Environment (2008a) *RGP5 Level 2 Fauna Survey Chichester Deviation*. Unpublished report for BHPBIO; Perth.

Ecologia Environment (2008b) *Roy Hill Iron Ore Project - Proposed Infrastructure Supplementary Level 1 Terrestrial Vertebrate Fauna Survey*. Unpublished report for HPPL, Perth.

Ecologia Environment (2009) *Hancock Prospecting Ltd Roy Hill Ore Project Vertebrate Fauna Assessment*. Unpublished report for Hancock Prospecting Pty Ltd, Perth.

In addition, data from Terrestrial Ecosystems fauna survey database, including vouchered specimens in the Western Australian Museum (WAM) collection, have been included in this review. Plate 1 shows the distribution of biological survey data that are available for comparison in the vicinity of the proposed Hillside South railway corridor. Those sites inside the blue area were used in this assessment.

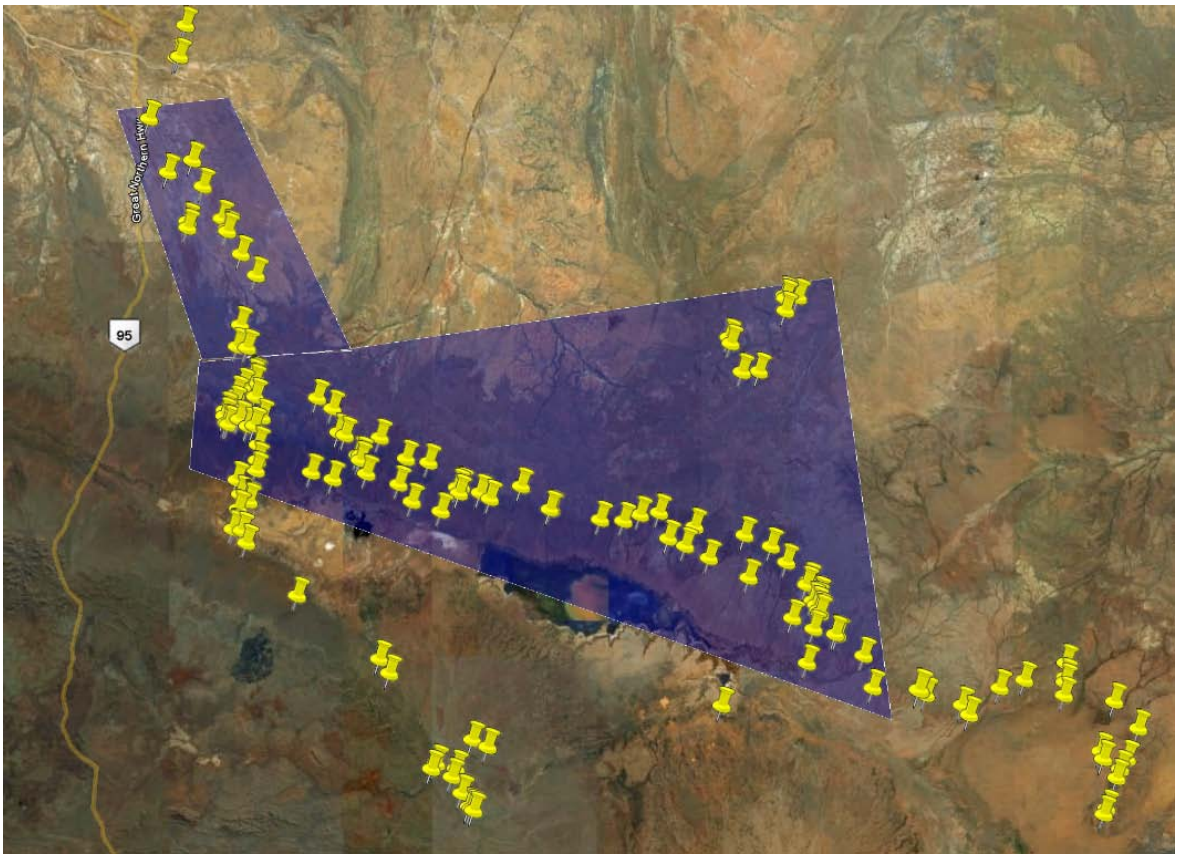

PLATE 1.

DISTRIBUTION OF FAUNA ASSESSMENTS IN THE VICINITY OF THE RHIO PROJECT AREA (DATA FROM THE TERRESTRIAL ECOSYSTEMS' DATABASE). YELLOW FLAGS INDICATE SURVEY SITES.

Nomenclature

Taxonomy and nomenclature for fauna species used in this report are mostly those used in the Australian Biological Resources Study (www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/ groups). Terrestrial Ecosystems acknowledges that the taxonomy of Western Australian vertebrates is continually being revised and the taxonomy of some of these species might have changed since publication by the authors. Where possible these records have been updated before they have been loaded in Terrestrial Ecosystems fauna survey database which is the source of all the data shown in Appendix A.

Site Visit

The majority of the proposed Hillside South rail corridor was traversed in a helicopter to identify and describe fauna habitat. These investigations were undertaken between 2-5 March, 2010. The field assessment comprised two aspects:

- a rapid fauna habitat assessment; and
- an assessment of the suitability of habitats to support conservation significant fauna.

Rapid Fauna Habitat Assessment

The risk of impacting on conservation significant fauna have been determined based on the habitat type, vegetation description, soil types, age since fire, landform and the biological and ecological knowledge for each species.

Custom written software on a PDA was used to record and describe fauna habitat along the proposed rail corridor during the field work component of this assessment. A field surveyor stopped at multiple locations along the proposed rail corridor to record a suite of data about the fauna habitat in that area. This information included a description of the habitat condition, landform, soils and vegetation. The details of the nature of this information recorded are provided in Appendix B.

Survey and Reporting Staff

Dr Scott Thompson undertook the field surveys and fauna habitat assessments. This fauna assessment report was prepared by Dr Graham Thompson, and reviewed by Dr Scott Thompson, both of whom are appropriately qualified and have experience (Table 3) in undertaking and reporting fauna surveys for various areas of Western Australia and are familiar with the fauna habitat in the vicinity of the proposed Hillside South railway corridor.

TABLE 3
PROJECT PERSONNEL AND QUALIFICATIONS

Name	Qualifications	Experience	Position
Dr Scott Thompson	BSc., MSc. (Env. Mngt), PhD (Env. Sc./Mngt).	> 10 years	Zoologist / Partner
Dr Graham Thompson	PhD (Zoology)	> 20 years	Zoologist / Partner

Limitations

The intensity of the field investigation was designed to provide a understanding of the fauna habitat at a landscape scale. It was not designed, for example, to locate burrows of Mulgara and Bilbies, Pebble-mound Mice mounds or to record the location of all conservation significant species in the proposed rail corridor.

Previous disturbances have been made to the proposed rail corridor as a result of mining infrastructure and pastoral activity. These disturbances have been factored into this assessment.

The helicopter that was used for the survey became unusable for the last of a planned three day site visit. A section of about 30km in the northern section of the proposed alignment was not visited as a consequence. This area has the potential to support Northern Quoll, Mulgara and possibly Bilbies; therefore this is a significant limitation.

This field investigation was undertaken in accordance with a Level 1 assessment as suggested in the Environmental Protection Authority (EPA) *Terrestrial Biological Surveys as an Element of Biodiversity Protection Position Statement No. 3* (2002). The EPA *Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56* (2004) suggests that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 4.

TABLE 4
FAUNA SURVEY LIMITATIONS AND CONSTRAINTS

Possible limitations	Constraint	Comment
Competency and experience of the consultants carrying out the survey	No	The two scientists that undertook and reported on this assessment have appropriate training and experience to undertake fauna assessment of this type.
Scope	No	Database reviews and a field visit were used to locate and identify evidence of conservation significant vertebrate species in the bioregion.
Proportion of fauna identified, recorded and/or collected	NA	Not applicable as no trapping surveys were undertaken.
Sources of information	Yes, negligible	Much of this area has been subject to fauna surveys in the past for either railway corridor developments or mining areas. The EPA has accepted these data as adequate to make an informed judgment about potential impacts on the vertebrate fauna.
Proportion of the task achieved	Yes, moderate	The conservation value of the area has been demonstrated by the results from other surveys conducted in the region. Further surveys at selected sites would assist in determining the fauna assemblage and quantifying relative abundance, but this was not required for this assessment.
Timing/weather/ season cycle	No	The field assessments were undertaken at an appropriate time.
Disturbances which affected results of the survey	Yes, negligible	The area has been partially disturbed by mining infrastructure and pastoral activity. This has been factored into the assessment.
Intensity of survey effort	Yes, moderate	The field investigations were adequate to describe the fauna habitat and to assess potential impacts on conservation significant species for that section of the corridor visited.
Completeness	Yes, moderate	The field work covered most of the proposed Hillside South rail corridor, except the northern most 30kms.
Resources	No	Resources were adequate, except a helicopter was not available as planned for the 3rd day in the field.
Remoteness and/or access problems	Yes, moderate	The use of a helicopter enabled most habitat types to be visited. The northerly section of the proposed railway corridor was not inspected.
Availability of contextual information on the region	Yes, moderate	Restrictions on accessing data in NatureMap meant most of these data could not be fully exploited in the assessment. Access to the DECs Pilbara biological survey data would have significantly enhanced this assessment. Terrestrial Ecosystems fauna survey database was therefore the primary

Possible limitations	Constraint	Comment
		source of bioregional data.

Negligible – less than 20%; Moderate – 20-60%; Significant – greater than 60%

Short Range Endemic Invertebrates

Harvey (2006), based on sampling undertaken in conjunction with ATA Environmental around the Cloud Break mine and infrastructure site, recorded the presence of the following invertebrates:

Dampetrus 'Pilbara 1' was found in two locations during the survey under rocks. As the assamiid fauna of the Pilbara region is so poorly known, it is uncertain the full distribution of the species. It is likely this is the only species that is considered a SRE species. Several specimens of the pseudoscorpion families Olpiidae and Atemnidae were found during the survey. None of these species are deemed to be short-range endemic taxa, and are likely to be moderately widespread across the Pilbara (Harvey, 2006).

Biota Environmental Sciences (2005) reported no live Camaenidae molluscs or dead shells being collected during its survey of the FMG Stage B project area, however, they did indicate that *Rhagada* had been collected from beneath *Triodia longiceps* on calcareous soils on the western side of the Fortescue Marsh. Biota Environmental Sciences (2005) reported vouchering the mygalomorph spiders: *Aganippe* sp. (site FMG08), *Synothele* sp. (site FMC01) and *Missulena occatoria* (*FML01*). Slack-Smith (2006), having surveyed 40 sites in the FMG Stage B railway corridor, reported non-marine molluscan species *Quistrachia* sp., *Pupoides* ?*beltianus*, *Gastrocopta* pilbarana, *Eremopeas interioris* and *Isidorella* ?*newcombi* were collected during the survey. Of these, only the new and undescribed camaenid species of *Quistrachia*, known only from this area and within a limited habitat range, appears to be a SRE species. Slack-Smith (2006) suggested that FMG should adopted procedures that would protect of cliff-based habitats, particularly those in which fig trees (*Ficus* sp.) are growing, as this would allow for the conservation of this camaenid species.

Stygofauna

Eberhard *et al*. (2005) indicated that the Pilbara contains a rich and diverse subterranean fauna. Mulga Downs Station has had a number of its bores sampled for stygofauna but the report is not available.

Knott and Goater (2004), after an investigation of potential stygofauna along the FMG Stage B railway corridor, recorded no stygofauna having sampled four sites at Christmas Creek, four sites at Mt Lewin and three sites at Mt Nicholas.

Results

Habitat within the Project Area

Fauna habitats along the proposed railway corridor have been classified as follows:

1) Flat plain on the northern fringe of the Fortescue Marsh with:
    a) Mostly bare ground;
    b) Mulga woodland; or
    c) Mulga woodland groves and creeklines in a sparsely vegetated plain;
2) Flat and slightly undulating plain vegetated with scattered trees and shrubs and spinifex often with a stony substrate;
3) Undulating hills vegetated with scattered trees and shrubs and spinifex often with a stony substrate;
4) Ephemeral creeklines in undulating hills that are vegetated with trees, shrubs, grasses and spinifex;
5) Mesas and stony ridges, often with scree slopes that are vegetated with scattered trees and shrubs and spinifex leading to ephemeral creeklines that are more densely treed;
6) Flat plains on a sandy substrate and vegetated with scattered trees and shrubs and spinifex; and
7) Creeklines on a flat plain on a sandy-clay substrate vegetated with trees and shrubs.

Plates 2a-ab provided a visual indication of the fauna habitat types along the proposed railway corridor commencing near the proposed mine and moving northward along the corridor. Ephemeral creeks generally support more dense vegetation and are often a focal point for fauna, particularly birds and larger mammals such as kangaroos during the heat of the day.

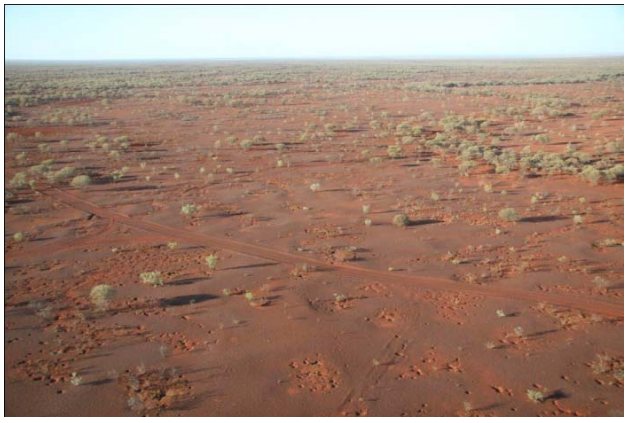

Plate 2a. Sparsely vegetated mulga woodland north of the Fortescue Marsh

Plate 2b. Sparsely vegetated mulga woodland north of the Fortescue Marsh

Plate 2c. Ephemeral creek leading into the Fortescue Marsh

Plate 2d. Open mulga woodland north of the Fortescue Marsh

Plate 2e. Open mulga woodland north of the Fortescue Marsh

Plate 2f. Mulga woodland on a sandy clay substrate

Plate 2g. Open mulga woodland

Plate 2h. Open mulga woodland

Plate 2i. Undulating rises vegetated with scattered trees and spinifex with an ephemeral creekline

Plate 2j. Undulating rises vegetated with scattered trees and spinifex with an ephemeral creekline

Plate 2k. Mesas and valley floors vegetated with scattered trees and shrubs and spinifex with an ephemeral creekline

Plate 2l. Low ranges vegetated with scattered trees and spinifex with an ephemeral creekline

Plate 2m. Sparsely vegetated spinifex plain

Plate 2n. Creekline in flat plain vegetated with scattered trees and shrubs and spinifex

Plate 2o. Undulating hills that was a recently burnt tussock grassland with scattered trees

Plate 2p. Undulating hills vegetated with a tussock grassland

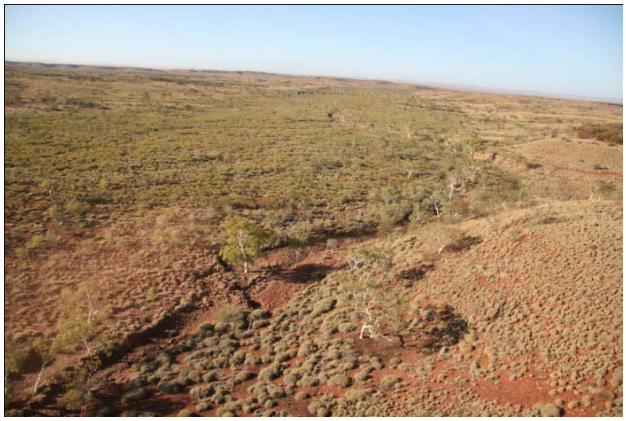

Plate 2q. Creekline in undulating hills vegetated with scattered trees and spinifex

Plate 2r. Creekline in undulating hills vegetated with scattered trees and spinifex

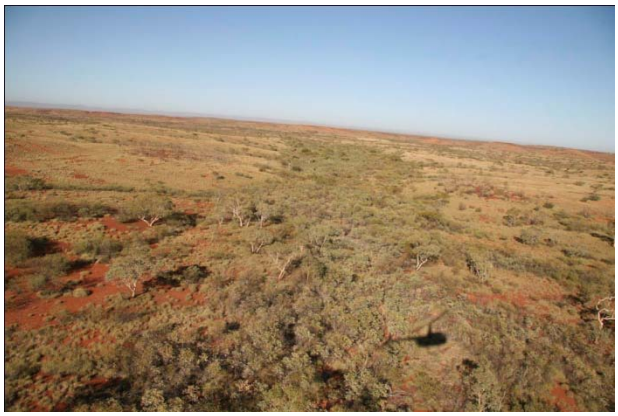

Plate 2s. Creekline on the Chichester plateau vegetated with scattered trees and spinifex

Plate 2t. Creekline in undulating hills vegetated with scattered trees and spinifex

Plate 2u. Creekline in the flat plain on the northern side of the Chichester Range

Plate 2v. Flat plain on the northern side of the Chichester Range vegetated with scattered trees and shrubs and mature spinifex

Plate 2w. Stony plain vegetated with spinifex and a treed creekline in the background

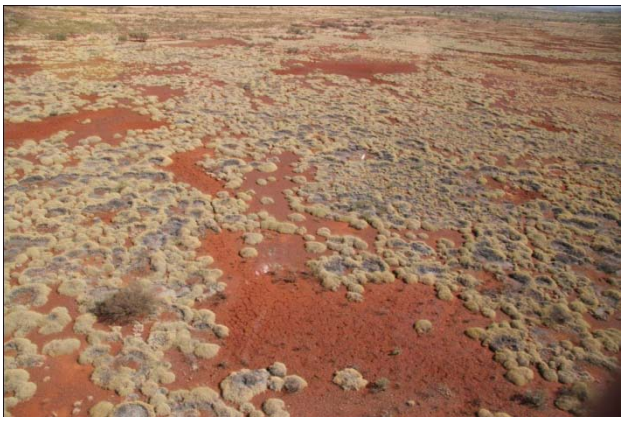

Plate 2x. Flat clay soil plain vegetated with spinifex

Plate 2y. Stony ridges in an undulating plain vegetated with spinifex and scattered tress

Plate 2z. Stony ridges containing caves and overhangs

Plate 2aa. Flat plain of sandy clay soils vegetated with spinifex and scattered trees and shrubs

Plate 2ab. Low granite outcrop in a flat plain vegetated with scattered trees and shrubs and spinifex

Rapid Habitat Assessment

Results from the rapid habitat assessment are shown in Appendix C. It is apparent from these data that the habitat along the corridor is variable but within the land systems described above.

Fauna Potentially Found in the Project Area

A composite list of the mammals, frogs, reptiles and bird species caught or seen in the various fauna surveys undertaken in the vicinity of the railway corridor is contained in Appendix A. Each of the columns in Appendix A represents the results of a fauna survey of a particular site and habitat type. Although the number of individuals caught in any one habitat type was generally low, and as a consequence sampling error would be high, it is apparent that the reptile, mammal and bird assemblages differ among sites and habitat types as would be expected (see Thompson *et al*., 2003). The list of species in Appendix A represents the species that might be found in the general vicinity of the project area.

Biodiversity Value

The EPA *Position Statement No. 3* indicates that an ecological assessment of a site must consider its biodiversity value at the genetic, species and ecosystem levels; and its ecological functional value at the ecosystem level (EPA, 2002).

Biodiversity Value of the Proposed Rail Corridor at the Genetic, Species and Ecosystem Levels

The habitat quality along the proposed railway line corridor varied from highly disturbed to high quality with areas around windmills being particularly degraded by cattle, and areas where the rail corridor crosses FMG's railway and access tracks also being highly disturbed.

The Northern Quoll, Mulgara, Bilbies, Pilbara Olive Python, Rainbow Bee-eater, Australian Bustard, Bush Stone-curlew, Pebble-mound Mice, Ghost Bat and the Pilbara Leaf-nosed Bat, which are listed as species of conservation significance under Commonwealth and State legislation, were assessed as possibly being present within the proposed Hillside South rail

corridor. The presence of a conservation significant species in the railway corridor should not be interpreted to indicate that the development of the railway line will have a significant impact on these species. The biodiversity value of conservation significant species and the potential impact on these species is discussed below.

Vegetation clearing for the purposes of constructing a railway line, lay down areas, water reserves, quarries, access roads, etc, will result in the destruction of habitat used by fauna. Clearing of the vegetation in the rail corridor will also result in the death of numerous reptiles, frogs and small mammals. Most of the larger mammals, such as kangaroos and some of the larger reptiles (e.g. goannas), will move out of the area and find new activity areas. Almost all the birds will move into adjacent areas. This will result in some short-term adjustment for many individuals, including those forced to move and those in areas with new migrants. For the more sedentary species this will mean shifting activity areas and competing for resources and some individuals may not survive. For those individuals that are nomadic, transient, migratory or without defined home ranges that are forced to shift into new areas the impact will generally not be significant.

The impacts of the clearing of sections of the proposed railway corridor will be localised when placed in a bioregional context. All fauna habitats in the rail corridor are abundant in the adjacent areas, so although the fauna in the areas to be cleared will be lost during the clearing process, the destruction of this habitat will generally not have a significant impact on the vertebrate fauna in a bioregional context. It is therefore Terrestrial Ecosystems' view that the scale of the proposed disturbance is unlikely to result in a significant loss of non-conservation significant fauna or fauna habitat when placed in a regional context.

Based on the information available it is not possible to assess the biodiversity value at a genetic level.

Ecological Functional Value at the Ecosystem Level

From a fauna perspective, some sections of the proposed railway line corridor have been degraded by existing access roads, pastoral and mining infrastructure. Evidence of cattle grazing and damage was most noticeable around water sources such as windmills and dams and temporary stock yards. The construction of linear infrastructure for other mines was also evident at some locations.

Many areas in the proposed rail corridor are of high quality and show little disturbance from cattle or other anthropogenic factors. From a fauna perspective, the primary issue is the quantity of vegetation that is being cleared for the construction and operation of a railway line and the linear barrier that the proposed development will create for fauna in the area. These issues are addressed below.

Potential Impact on Species of Conservation Significance

An assessment of the potential impact of the proposed Hillside South railway corridor on conservation significant vertebrates is provided below and summarised in Table 5.

Night Parrot (*Pezoporus occidentalis*)

Night parrots were recorded at Minga Well during the early stages of the fauna survey investigation for the FMG Cloud Break mine and associated infrastructure (Davis et al., 2005, Davis and Metcalf, 2008). Since then, further surveys for the Night Parrot have failed to record their presence in the area. Based on the information available, Terrestrial Ecosystems

believe that the proposed disturbances associated with the construction of the railway line and associated infrastructure are unlikely to have a significant impact on this species.

Northern Quoll (*Dasyurus hallucatus*)

Habitat for the Northern Quoll is located along the many sections of the rail corridor. Areas that have the highest potential to contain resident Northern Quolls are along the gullies and creek lines and around the rocky scree slopes, rocky boulder fields and rocky ranges. Northern Quoll are also likely to forage considerable distances away from these areas. If appropriate management strategies are put in place for the construction of the rail and associated infrastructure, Terrestrial Ecosystems' considers that it is unlikely that the railway development will have a significant long-term impact on the Northern Quoll.

Mulgara (*Dasycercus cristicauda, D. blythi*)

The Terrestrial Ecosystems' assessment indicates that the proposed rail corridor contains habitat suitable for Mulgara north of the Chichester Range in the sandy soil vegetated with relatively dense spinifex. No diggings, holes or individuals were recorded, however, many of the areas that supported mature spinifex on a sandy substrate could provide suitable habitat. Therefore, given the sedentary nature of Mulgara, the proposed vegetation clearing and associated disturbance could result in the loss of a number of individuals. If appropriate management strategies are put in place for the construction of the rail and associated infrastructure, Terrestrial Ecosystems' considers it unlikely that the railway development will have a significant long-term impact on the Mulgara.

Pilbara Leaf-nosed Bat (*Rhinonycteris aurantia*)

Terrestrial Ecosystems noted that McKenzie and Bullen (2009) recorded *R. aurantia* at 17 of their 24 survey sites and commented that this species was widespread. *Rhinonycteris aurantia* forages in cluttered airspace and roosts in caves and mine shafts. Data on the specific locations for the DEC Pilbara survey records for *R. aurantia* are not available, but this species is likely to occur at numerous locations along the corridor, particularly in the rocky areas that contain caves and those around water sources. Terrestrial Ecosystems' believes that the proposed disturbance is unlikely to have a significant impact on this species, unless roosts are disturbed. Potential roosts could be found in the caves in the some of the stony ridges. When the route of the railway line is finalised, any caves likely to be disturbed should be investigated by a suitably trained and experienced zoologist to see whether they provide a roost for Pilbara Leaf-nosed Bats.

Bilby (*Macrotis lagotis*)

The Terrestrial Ecosystems' assessment indicates that the rail corridor contains habitat suitable for Bilby north of the Chichester Range in the sandy soil vegetated with relatively dense spinifex. If appropriate management strategies are put in place for construction of the rail and associated infrastructure, Terrestrial Ecosystems' considers the proposed disturbance it is unlikely to be a significant impact on the Bilby.

Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python was not reported during surveys in the proposed Hillside South railway corridor or surrounding areas, however, its presence can be difficult to detect, particularly when most of these surveys did not utilise funnel traps and the trapping effort was very low for the area. It is probable that the home range of numerous individuals overlap the rail corridor. The areas that have the highest potential to contain resident Pilbara Olive Pythons are along the gullies and creeklines and around vegetated water sources.

This species maybe encountered infrequently by RHIO staff when travelling on access corridor roads at night. Some of these encounters will inevitably result in the death of Pilbara Olive Pythons. However, based on the available information, Terrestrial Ecosystems' believes that the proposed disturbances are unlikely to have a significant long-term impact on this species. Impacts on this species can be reduced by implementing an effective fauna management plan for the railway corridor.

Black-footed Rock Wallaby (*Petrogale lateralis*)

No records were evident for the Black-footed Rock Wallaby, either in consultant reports or in the Terrestrial Ecosystems' database for the proposed railway corridor alignment. There was very little habitat in the proposed railway corridor that might be suitable for this species. Based on the information available and the habitats proposed for disturbance, Terrestrial Ecosystems' assessment is that the proposed disturbances are unlikely to have a significant impact on this species.

Fork-tailed Swift (*Apus pacificus*)

A number of Fork-tailed Swifts were sighted by Biota Environmental Sciences (2004a, 2005). This species forages on the wing, and can readily move away from a disturbance. Based on the available information, Terrestrial Ecosystems' considers it is highly unlikely that construction in the rail corridor or associated infrastructure will significantly impact on this species.

Rainbow Bee-eater (*Merops ornatus*)

This species was recorded during the numerous fauna surveys in the area. It is able to move away from a disturbance to find new foraging and breeding sites, so adults are unlikely to be killed or injured in the clearing process. This species is migratory and wide-spread and as a consequence, Terrestrial Ecosystems' considers that the development of the rail corridor is unlikely to result in a significant long-term impact on this species.

Great Egret (*Ardea alba*)

It is Terrestrial Ecosystems' assessment that the Great Egret may infrequently utilise the ephemeral wetlands within the general area, however, the railway corridor does not contain habitat that is suitable for this species; therefore it is unlikely that the proposed railway development will significantly impact on this species.

Cattle Egret (*Ardea ibis*)

It is Terrestrial Ecosystems' assessment that the Cattle Egret may infrequently utilise the ephemeral wetlands within the general area, however, the railway corridor does not contain habitat that is suitable for this species; therefore it is unlikely that the proposed railway development will significantly impact on this species.

Peregrine Falcon (*Falco peregrinus*)

It is possible that the Peregrine Falcon will be seen in the vicinity of the proposed rail corridor on occasions; however, it is unlikely to depend on proposed disturbance areas for it survival and has the capacity to move away from a disturbance. It is therefore Terrestrial Ecosystems' assessment that the Peregrine Falcon will not be significantly impacted on by the proposed development.

Ramphotyphlops ganei

It is possible that this blind snake could be found in the vicinity of the proposed rail corridor and as a consequence, it is possible that some *R. ganei* could be killed during the clearing process. However, it is Terrestrial Ecosystems' assessment that these deaths will not significantly impact on the long-term survival of this species.

Ctenotus uber johnstonei

It is possible that this small skink could be found in the vicinity of the rail corridor and as a consequence it is possible that some *C. u. johnstonei* could be lost during the clearing process. However, it is Terrestrial Ecosystems' assessment that these deaths will not significantly impact on the long-term survival of this species.

Spectacled Hare-wallaby (*Lagorchestes conspicillatus*)

There is a very low probability that the Spectacled Hare-wallaby forage in the proposed railway corridor. If this were the case then it would be in the plains vegetated with dense spinifex on the northern side of the Chichester Range. If the Spectacled Hare-wallaby are in the proposed railway corridor, it is very likely that they will move into adjacent areas once vegetation clearing commenced. It is Terrestrial Ecosystems' assessment that the proposed development is unlikely to have a significant impact on the long-term survival of this species.

Pebble-mound Mouse (*Pseudomys chapmani*)

Given the abundance of Pebble-mound Mice in the Pilbara and the low success of relocations; Terrestrial Ecosystems can see little justification for relocating a small number of individuals from areas to be cleared when it is probable that the general area contains many social groups. It is almost certain that some Pebble-mound Mice will be killed during the clearing process, but this is unlikely to have a significant impact on the long-term survival of the species in the bioregion.

Ghost Bat (*Macroderma gigas*)

Terrestrial Ecosystems assessment is that Ghost Bats could be seen along the proposed rail corridor and may retreat to caves in the rocky ridges and ranges or boulder piles within the corridor. An impact would only be significant if the proposed development disturbed or destroyed a maternal colony or significant roost. This is unlikely, however, if construction activities are to impact on caves or large piles of boulders in the area, then these will need to be investigated by a suitably trained and experienced zoologist prior to the disturbance.

Australian Bustard (*Ardeotis australis*)

This large bird is present along the proposed rail corridor. However, the clearing of vegetation is unlikely to significantly impact on this species as it can readily move to other areas which have similar habitat.

Bush Stone-curlew (*Burhinus grallarius*)

Multiple records of the Bush Stone-curlew are available for the Pilbara. It is likely that some Bush Stone-curlews forage in proposed rail corridor, however, they will probably move to adjacent areas once construction commences. The Bush Stone-curlew demonstrates some site fidelity but its home range appears quite large relative to the size of areas to be cleared. Terrestrial Ecosystems' view is that the proposed vegetation clearing is unlikely to have a significant long-term impact on this species.

Grey Falcon (*Falco hypoleucos*)

Clearing of nests containing chicks is likely to be the most significant impact on Grey Falcon in the proposed railway corridor. The probability of that occurring is low. Terrestrial Ecosystems' assessment is that the Grey Falcon is unlikely to be significantly impacted on by the proposed development as adult birds can readily move to other areas once vegetation clearing commences.

Star Finch (*Neochmia ruficauda subclarescens*)

The Star Finch is only likely to reside around semi-permanent or permanent creeks and ponds that support a dense vegetation of reeds. The site visit found no suitable habitat for this species in the proposed railway corridor.

Lakeland Downs Mouse (*Leggadina lakedownensis*)

The Lakeland Downs Mouse is likely to be present in some sections of the proposed railway corridor. If present in areas to be cleared then it is likely to be lost. It is Terrestrial Ecosystems assessment that these deaths will not significantly impact on the long-term survival of this species as the cleared areas will represent only a small fraction of similar habitat in adjacent areas.

Long-tailed Dunnart (*Sminthopsis longicaudata*)

The Long-tailed Dunnart has a preference for stony and rocky areas and breakaways and it is possible that this Dunnart could be found in the proposed rail corridor. Therefore, it is possible that some Long-tailed Dunnarts could be lost during the clearing process. However, it is Terrestrial Ecosystems' assessment that these deaths will not significantly impact on the long-term survival of this species as the cleared areas will represent only a small fraction of similar habitat in adjacent areas.

Ctenotus nigrilineatus

This small dark striped skink is known only from limited areas in the Pilbara. A paucity of information on the spatial distribution of this species makes it difficult to speculate on potential impacts of vegetation clearing along the rail corridor. They have been recorded to the north of the northern section of the proposed railway corridor (Abydos), but not near the railway corridor. It is Terrestrial Ecosystems' assessment that the proposed disturbance is unlikely to have a significant impact on the long-term survival of this species.

Fortescue Grunter (*Leiopotherapon aheneus*)

It is likely that the Fortescue Grunter will be present in some semi-permanent or permanent ponds and creeks in the general area. However, as no permanent or semi-permanent water bodies were found in the proposed railway corridor, it is unlikely that the proposed disturbance will impact on this species.

Northern Short-tailed Mouse (*Leggadina lakedownesis*)

It is probable that the Northern Short-tailed Mouse is present in the proposed railway corridor, and therefore could be lost during the clearing process. However, it is Terrestrial Ecosystems assessment that these deaths will not significantly impact on the long-term survival of this species as the cleared areas will represent only a small fraction of similar habitat in adjacent areas.

TABLE 5
SUMMARY ASSESSMENT OF POTENTIAL IMPACTS ON CONSERVATION SIGNIFICANT FAUNA THAT COULD POSSIBLY OCCUR IN THE VICINITY OF THE PROPOSED RAIL CORRIDOR

Species	Status under Wildlife Conservation Act and with DEC	Status under Cwth EPBC Act	Potential Impact on conservation significant species
Night Parrot (*Pezoporus occidentalis*)	Schedule 1	Endangered	The disturbances associated with the construction of the proposed railway line and associated infrastructure are unlikely to have a significant impact on the long-term survival of this species.
Northern Quoll (*Dasyurus hallucatus*)	Schedule 1	Endangered	The proposed vegetation clearing and associated disturbance could result in the death of numerous Northern Quoll. If the recommended management strategies are put in place for construction of the proposed rail and associated infrastructure, there is unlikely to be a significant impact on the long-term survival of this species.
Pilbara Olive Python (*Liasis olivaceus barroni*)	Schedule 1	Vulnerable	The proposed disturbances associated with the construction of the proposed railway line and associated infrastructure are likely to kill some of these pythons, but these deaths are unlikely to have a significant impact on the long-term survival of this species.
Crest-tailed Mulgara (*Dasycercus cristicauda*)	Schedule 1	Vulnerable	The proposed vegetation clearing and associated disturbance could result in a loss of a number of Mulgara if they are in the rail corridor. If the recommended management strategies are put in place for the construction of the rail and associated infrastructure, there is unlikely to be a significant impact on the long-term survival of this species.
Bilby (*Macrotis lagotis*)	Schedule 1	Vulnerable	The proposed vegetation clearing and associated disturbance could result in a significant impact on a small number of Bilbies, if they are in the rail corridor. If the recommended management strategies are put in place for the construction of the proposed rail and associated infrastructure, there is unlikely to be a significant impact on the long-term survival of this species.
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Schedule 1	Vulnerable	The proposed disturbances are unlikely to have a significant impact on this species, unless roosts are disturbed. When the route of the proposed railway line is finalised, any caves likely to be disturbed should be investigated by a suitably trained and experienced zoologist to see whether they provide a roost for Pilbara Leaf-nosed Bats.
Black-footed Rock-wallaby (*Petrogale lateralis lateralis*)	Schedule 1	Vulnerable	The proposed disturbances are unlikely to have a significant impact on the long-term survival of this species.
Peregrine Falcon (*Falco peregrinus*)	Schedule 4		The proposed disturbances are unlikely to have a significant impact on the long-term survival of this species.
Fork-tailed Swift (*Apus pacificus*)		EPBC	The proposed disturbances are unlikely to have a significant impact on the long-term

Species	Status under Wildlife Conservation Act and with DEC	Status under Cwth EPBC Act	Potential Impact on conservation significant species
		(Migratory)	survival of this species.
Rainbow Bee-eater (*Merops ornatus*)		EPBC (Migratory)	The proposed disturbances are unlikely to have a significant impact on the long-term survival of this species.
Great Egret (*Ardea alba*)		EPBC (Migratory)	The proposed disturbances are unlikely to have a significant impact on the long-term survival of this species.
Cattle Egret (*Ardea ibis*)		EPBC (Migratory)	The proposed disturbances are unlikely to have a significant impact on the long-term survival of this species.
(*Ramphotyphlops ganei*)	Priority 1		Some individuals could be killed during the clearing process, however, these deaths are unlikely to significantly impact on the long-term survival of this species.
(*Ctenotus nigrilineatus*)	Priority 1		Some individuals could be killed during the clearing process, however, these deaths are unlikely to significantly impact on the long-term survival of this species.
(*Ctenotus uber johnstonei*)	Priority 2		Some individuals could be killed during the clearing process, however, these deaths are unlikely to significantly impact on the long-term survival of this species.
Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*)	Priority 3		The proposed disturbances are unlikely to have a significant impact on the long-term survival of this species.
Grey Falcon (*Falco hypoleucos*)	Priority 4		The proposed disturbances are unlikely to have a significant impact on the long-term survival of this species as it can readily move into adjacent areas.
Australian Bustard (*Ardeotis australis*)	Priority 4		The clearing of vegetation is unlikely to significantly impact on this species as it will readily move to other areas which have similar habitat.
Bush Stone-curlew (*Burhinus grallarius*)	Priority 4		The proposed vegetation clearing is unlikely to have a significant impact on the long-term survival of this species.
Star Finch (*Neochmia ruficauda subclarescens*)	Priority 4		The Star Finch is unlikely to be significantly impacted on by the proposed development as there are no semi-permanent or permanent water bodies in the proposed railway corridor surrounded by a dense vegetation of reeds that it could use a breeding site.
Long-tailed Dunnart (*Sminthopsis longicaudata*)	Priority 4		Some individuals could be killed during the clearing process, however, these deaths are unlikely to significantly impact on the long-term survival of this species.
Pebble-mound Mouse (*Pseudomys chapmani*)	Priority 4		Some individuals could be killed during the clearing process, however, these deaths are unlikely to significantly impact on the long-term survival of this species.
Northern Short-tailed Mouse (*Leggadina lakedownensis*)	Priority 4		Some individuals could be killed during the clearing process, however, these deaths are unlikely to significantly impact on the long-term survival of this species.
Ghost Bat (*Macroderma gigas*)	Priority 4		The proposed disturbances are unlikely to have a significant impact on this species, unless roosts are disturbed. When the route of the railway line is finalised, any caves likely to be disturbed should be investigated by a suitably trained and experienced zoologist to see whether they provide a roosts for Ghost Bats.

Species	Status under Wildlife Conservation Act and with DEC	Status under Cwth EPBC Act	Potential Impact on conservation significant species
Fortescue Grunter (*Leioptherapon ahenius*)	Priority 4		The Fortescue Grunter is unlikely to be significantly impacted on by the proposed development as there are no semi-permanent or permanent water bodies in the proposed railway corridor.
Brush-tailed Mulgara (*Dasycercus blythi*)	Priority 4		The proposed vegetation clearing and associated disturbance could result in a loss of some Mulgara if they are in the proposed rail corridor. If appropriate management strategies are put in place for construction of the rail and associated infrastructure, there is unlikely to be a significant impact on the species.

Discussion and Management Strategies to Minimise Potential Environmental Impacts

Adequacy of the available data

The EPA *Terrestrial Biological Surveys as an Element of Biodiversity Protection:* Position Statement No. 3 (EPA, 2002) and *Guidance Statement for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56* (EPA, 2004)are the two relevant documents to assess the adequacy of the available information and reporting for vertebrate fauna surveys in Western Australia. They indicate that for large scale developments with a potentially significant impact on the environment, and where there is likely to be alteration to, or clearing of large sections of the original vegetation, a 'comprehensive' survey of the terrestrial fauna for the project area is required.

The adequacy of the data provided and the resulting assessment of potential impacts of the proposed railway corridor on terrestrial vertebrate fauna should be judged in the context of whether additional fauna survey data would provide a better understanding of potential impacts, and as a consequence, improve how these impacts might be managed.

Given the site visit and the survey data reviewed in the desktop assessment, Terrestrial Ecosystems' view is that sufficient is known about the terrestrial fauna species and fauna assemblages likely to be present along the majority of the corridor to undertake an assessment of the potential impacts on the vertebrate fauna.

Defining significant impacts

The Commonwealth Government have provided *Significant Impact Guidelines* (Department of the Environment and Heritage, 2006) for conservation significance species listed under the *EPBC Act 1999*. These guidelines indicate a development is likely to have a significant impact on:

Critically endangered and endangered species, if it will:

- *lead to a long-term decrease in the size of a population;*
- *reduce the area of occupancy of the species;*
- *fragment an existing population into two or more populations;*
- *adversely affect habitat critical to the survival of a species;*
- *disrupt the breeding cycle or a population;*
- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*
- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;*
- *introduce disease that may cause the species to decline; or*
- *interfere with the recovery of the species.*

Vulnerable species, if it will:

- *lead to a long-term decrease in the size of an important population of a species;*
- *reduce the area of occupancy of an important population;*
- *fragment an existing important population into two or more populations;*
- *adversely affect habitat critical to the survival of a species;*
- *disrupt the breeding cycle of an important population;*
- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*
- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;*
- *introduce disease that may cause the species to decline; or*
- *interfere substantially with the recovery of the species.*

'Important population' in this context is defined as a population necessary for a species' long term survival and recovery.

The EPA and DEC do not provide similar guidelines against which to assess potential impacts of developments on listed species under the WA *Wildlife Conservation Act 1950*. The procedure is for the proponent to provide the appropriate information and the EPA will make a recommendation for Ministerial consideration based on the available information.

Potential Environmental Impacts on Conservation Significant Fauna

Given the length of the proposed corridor and based on the available data, it is likely that some Northern Quoll could be lost during the vegetation clearing program and development of the railway. It is also possible that Mulgara and Pilbara Olive Pythons are lost during the vegetation clearing program, and there is a low possibility that Bilby are in the railway corridor north of the Chichester Range and will be impacted by vegetation clearing. If caves that provide retreats for Pilbara Leaf-nosed Bats and Ghost Bats, particularly those that support maternal colonies, are impacted by the construction of the proposed railway, then this could significant disturb to these individuals. Some caves were located during Terrestrial Ecosystems site visit, but none were inspected. A thorough search of the caves in the Chichester Range section of the proposed railway line route should be undertaken when it is finalised. Adult conservation significant birds, such as the Night Parrot, Peregrine Falcon, Grey Falcon, Australian Bustard and Brush Stone-curlew, if they are in the proposed railway corridor, can and will also certainly move to adjacent areas once vegetation clearing commences. Damaging nests that contain chicks is the most significant impact on these species.

Given appropriate management, Terrestrial Ecosystems does not believe that the impact on Northern Quoll, Mulgara, Pilbara Leaf-nosed Bat or Ghost Bat will be judged as significant against the criteria outlined above, but this is a subjective judgement. However, if a small population of Bilby were killed during the clearing process, this could be deemed a significant impact. The suggested management program will reduce the possibility of Bilbies being lost in the vegetation clearing program. Terrestrial Ecosystems' recommends that the proposed Hillside South railway line proposal is referred to the DEWHA under the *EPBC Act*.

The following assessment of environmental impacts is based on clearing a proposed rail corridor that is approximately 100m wide with the associated access tracks, borrow pits, water reserves and lay down areas constructed adjacent to the proposed rail corridor. The assessment of other disturbances such as construction camps and quarrying activities has not been considered.

Potential Environmental Impacts of Fauna

Direct Impacts

The proposed development will result in the clearing of native vegetation and consequently a loss and alteration of fauna habitat. Besides the initial mortality of fauna during clearing, there will also be an ongoing indirect impact, largely consisting of the loss and degradation of habitat including feeding areas and shelter sites.

Linear corridors often result in the clearing of quite a narrow track of vegetation, but they can have an equally significant or greater impact in the adjacent areas because of 'edge effects'. Edge effects include disruption to ecological processes such as predation and dispersal, animal movements and can change fauna assemblage structures. The consequence is that the impact area will always be much larger than the cleared area. Transport corridors also have the propensity to develop weed infestations which can impact on natural fauna habitats. Cleared corridors can also provide improved predator access to areas, enhance the invasion of pest species into areas and may act as inhibitors or disrupt fauna migration and movement patterns.

Any removal of the vegetation from the study area will require all species that flee the area to find alternative suitable habitats. Some individuals will remain in any remnant vegetation, however, many will seek new areas during the clearing and development stages (or alternatively could perish) and some that move away may return to the area once the development and construction work has ceased and the area is rehabilitated.

Secondary Impacts

Increased human activity is often associated with a change in fire regimes, increased dust and fauna deaths on roads and railway lines, which lead to a degradation of natural ecosystems. Fire has been identified as one of the threatening processes for some conservation significant species in the Pilbara and a number of small mammal and bird species rely on long unburnt vegetation. Provided that fire management strategies are implemented, fires caused by the proposed development are unlikely to be a significant threat to native fauna species in the vicinity of the proposed rail corridor.

Introduced plant species can successfully and rapidly invade areas of cleared native vegetation or otherwise disturbed by humans. Introduced plant species may replace native species that provide shelter or foraging areas for native fauna. Major changes to the structure of vegetation will alter the fauna habitat and consequently may influence fauna species composition. Preparing and implementing a weed management plan will reduce their threat to native fauna species.

An increase in human activity is also associated with an increase in the abundance of introduced species, such as the cat and dog. Management strategies for addressing feral animals should be implemented.

Risk Assessment

Fauna surveys to support Environmental Impact Assessments (EIA) are part of the environmental risk assessment undertaken to consider what potential impacts a development might have on the biodiversity on a particular area and bioregion. Potential impacts on fauna from the proposed development are identified and briefly summarised below. Tables 6, 7 and 8 provide a summary of the risk assessment associated with this project.

TABLE 6
FAUNA IMPACT RISK ASSESSMENT DESCRIPTORS

An environmental risk assessment is a product of the likelihood of an *impact* occurring and the consequences of that *impact*. Likelihood and consequences are categorised and described below. The assessed risk level (likelihood x consequences) is then calculated as the overall risk for the development. This is followed by an assessment of the acceptability of the risk associated with each of the events or impacts. Disturbances and vegetation clearing have an impact on the fauna at multiple scales – site, local, landscape and regional. Each of these is considered in the risk assessment. This assessment should be considered in the context of the summary in Table 8.

Likelihood		
Level	Description	Criteria
A	Rare	The environmental event may rarely occur.
B	Unlikely	The environmental event is unlikely to occur.
C	Moderate	The environmental event could occur.
D	Likely	The environmental event should occur.
E	Almost certain	The environmental event will occur.
Consequences		
Level	Description	Criteria
1	Insignificant	No loss of conservation significant fauna or regional biodiversity and an insignificant impact on non-conservation significant fauna.
2	Minor	No loss of conservation significant fauna or the localised loss of individuals and species in a regional context.
3	Moderate	Loss of an individual from a conservation significant species or a moderate loss of non-conservation significant fauna in a regional context.
4	Major	Significant loss of conservation significant fauna as defined in the DEH (2006) publication or a loss of a significant number of non-conservation significant fauna at landscape scale.
5	Catastrophic	Loss of a population of conservation significant at a local scale or loss of a significant number of non-conservation significant fauna at regional scale.
Acceptability of Risk		
Level of risk	Management Action Required	
Low	No action required.	
Moderate	Avoid if possible, routine management with internal audit and review of monitoring results annually.	
High	Externally approved management plan to reduce risks, monitor major risks annually with external audit and review of management plan outcomes annually. Will require a referral to the Commonwealth under the *EPBC Act 1999*.	
Extreme	Unacceptable, project should be redesigned or not proceed.	

TABLE 7
LEVELS OF RISK

		Likelihood				
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)
Consequences	Insignificant (1)	Low	Low	Low	Low	Low
	Minor (2)	Low	Low	Low	Moderate	Moderate
	Moderate (3)	Low	Moderate	Moderate	High	High
	Major (4)	Moderate	Moderate	High	High	Extreme
	Catastrophic (5)	Moderate	High	High	Extreme	Extreme

TABLE 8
A RISK ASSESSMENT OF THE IMPACT OF GROUND DISTURBANCE ACTIVITY ON FAUNA

		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Manag't	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
Inadequate fauna survey data.	Unknown loss of fauna, fauna of conservation significance, fauna assemblage(s) in development site.	B	2	Low				
Inadequate knowledge of potential impacts.	Unknown or poorly assessed impact(s) on fauna assemblage and conservation significant species.	B	2	Low				
Inadequate bioregional data for contextual purposes.	Incomplete analysis of data and appreciation of impacts on biodiversity values in a regional context.	C	2	Low				
Removal of habitat – site scale.	Almost complete loss of terrestrial fauna in cleared areas, severe impact on local fauna assemblage.	E	2	Moderate	Minimise the extent of clearing and avoid clearing areas with a high probability of impacting on conservation significant species. Implement recommended fauna management procedures.	E	2	Moderate
Significant reduction of habitats – local scale.	Loss of fauna and fauna habitat and impacts on local fauna assemblage (excluding conservation significant species).	B	2	Low				

		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Manag't	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
Significant reduction of habitats – landscape scale.	Loss of fauna and fauna habitat and impacts on fauna in a landscape context (excluding conservation significant species).	A	1	Low				
Significant reduction of habitats – regional scale.	Loss of fauna and fauna habitat and impacts on fauna in a bioregional context (excluding conservation significant species).	A	1	Low				
Impact on resident conservation significant terrestrial species.	Loss of a localised population or a few individuals or eggs in a nest – *Pezoporus occidentalis*	A	4	Moderate				
	Loss of a localised population or a few individuals – *Dasyurus hallucatus*.	D	3	High	Implement management procedures detailed in RHIO's fauna management plan.	C	3	Moderate
	Loss of a localised population or a few individuals – *Liasis o. barroni*	D	2	Moderate	Avoid semi-permanent and permanent water and gullies which are preferred habitats for Pilbara Olive Pythons.	B	2	Low
	Loss of a localised population or a few	B	3	Moderate	Avoid known populations.	B	2	Low

		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Manag't	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
	individuals – *D. cristicauda.*				Implement management procedures detailed in RHIO's fauna management plan.			
	Loss of a localised population or a few individuals – *D. blythi*.	D	2	Moderate	Avoid known populations. Implement management procedures detailed in RHIO's fauna management plan.	B	2	Low
	Loss of a localised population or a few individuals – *M. lagotis.*	B	4	Moderate	Avoid known populations if they are located in the proposed rail corridor. Implement management procedures detailed in RHIO's fauna management plan.	B	2	Low
	Loss of a localised population or a few individuals – *Rhinonicteris aurantia*.	B	3	Moderate	Search any caves that might be impacted for Pilbara Leaf-nosed Bats. Avoid known population(s) by moving the proposed rail corridor.	B	2	Low
	Loss of a localised population or a few individuals – *Petrogale l. lateralis*.	A	2	Low				

		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Manag't	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
	Loss of a localised population or a few individuals – *Ramphotyphlops ganei*.	C	2	Low				
	Loss of a localised population or a few individuals – *Ctenotus nigrilineatus*.	C	2	Low				
	Loss of a localised population or a few individuals – *Lagorchestes conspicillatus*.	B	2	Low				
	Loss of a localised population or a few individuals – *Sminthopsis longicaudata*.	C	2	Low				
	Loss of a localised population or a few individuals – *Pseudomys chapmani*.	E	2	Moderate				
	Loss of a localised population or a few individuals – *Leggadina lakedownensis*.	D	2	Moderate				
	Loss of a localised population or a few individuals – *Macroderma gigas*.	B	3	Moderate	Search any caves that might be impacted for Ghost Bats. Avoid known population(s) by moving the proposed rail corridor.	B	2	Low
	Loss of a localised population or a few individuals – *Leioptherapon ahenius*.	A	2	Low				
Resident avian species.	Loss of a localised population or a few individuals – *Falco hypoleucos*.	A	2	Low				

		Before Management				With Management		
Factor	Potential Impact	Inherent Risk			Risk Controls / Manag't	Residual Risk		
		Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
	Loss of a localised population or a few individuals – *Burhinus grallarius*.	A	2	Low				
	Loss of a localised population or a few individuals – *Neochmia r. subclarescens*.	A	3	Low				
Nomadic avian species	Loss of a localised population or a few individuals – *Polytelis alexandrae*	A	2	Low				
	Loss of a localised population or a few individuals – *Ardeotis australis*.	A	2	Low				
Migratory avian species.	Loss of a localised population or a few individuals – *Merops ornatus*.	A	2	Low				
	Loss of a localised population or a few individuals – *Apus pacificus*	A	2	Low				
Anthropogenic activity	Altered fire regimes adversely affecting fauna assemblages	C	2	Low				
	Introduced fauna populations increasing	C	3	Moderate				
	Road kills	E	2	Moderate	Implement speed restrictions	E	1	Low
Loss of fauna corridors.	Loss of vegetation and corridors in valleys that are to be mined.	E	2	Moderate	Site redesigned to maintain important vegetation corridors.	E	1	Low

Factors likely to increase the impacts on vertebrate fauna

Animal Deaths during the Clearing Process and the Destruction of Burrows and Retreat Sites

Clearing vegetation and construction activities will result in the loss of most of the small fauna that retreat to burrows, such as reptiles and mammals, including Northern Quoll and Mulgara. Many of the nocturnal species that are unlikely to be active when most of the land clearing and construction work is taking place will inevitably be buried alive in their burrows, killed or injured when they attempt to escape.

Conservation significant fauna likely to be killed during the vegetation clearing process include the Northern Quoll, Pilbara Olive Python, Pebble-mound Mouse, Mulgara, Long-tailed Dunnart, Northern Short-tailed Mouse, *R. ganei and C. nigrilineatus*. If a small population of Bilbies is in the proposed railway line route, then these could be killed by vegetation clearing activities. Implementing the recommended management strategies will significantly reduce the impact on Northern Quoll and Mulgara, and Bilbies, if they are present in the proposed railway corridor.

Reduction or Loss of Activity Areas or Home Ranges, and Closure of Burrows

Clearing vegetation and associated construction activities are likely to destroy reptile and mammal burrows that are currently in use, or could be used again. Clearing vegetation that forms part of the activity area or home range of individuals has the potential to force these animals into adjacent areas. These areas may offer fewer resources placing individuals under survival pressure. It could also cause individuals to move into the territories of other individuals increasing competition for resources. Forced relocations could increase the possibility of predation.

Both Bilbies and Mulgara often re-use burrows that are recorded as 'inactive' during surveys. This re-use of existing burrows is both an energy saving strategy and may form part of the normal sequence of movements within a home range. Clearing and closing burrows that are currently not occupied may require individuals to dig new burrows.

Little is known of the spatial ecology of Northern Quoll in the Pilbara, with most of the information about its spatial ecology coming from woodlands or the wet-dry tropics. It is envisaged that Northern Quolls are using hollow logs, tree hollows and holes in the ground or in termite mounds as diurnal retreats in the Pilbara, but this needs to be confirmed with field data. In this context, preparing management plans for this species based on spatial ecology data collected elsewhere in Australia and in different habitats brings with it significant risks.

The proposed vegetation clearing and disturbance fall into two categories: a) the low impact habitat disturbance associated with water reserves, and b) a higher impact habitat loss associated with clearing borrow pits and the linear rail corridor footprint and the associated access tracks. Impacts in water reserves are considered to represent a minimal threat of habitat loss, as approximately only $100m^2$ needs to be cleared for each drill pad and minimal clearing is necessary for access tracks, so the surrounding habitat should be largely unaffected.

Impacts in borrow pits and lay down areas represent a higher threat of localised habitat loss as there is normally total removal of vegetation from the proposed borrow pit area and the areas are usually much larger than water reserves. There is also a greater risk of

secondary impacts including dust, noise and vibration from activities associated with these sites.

The potential vegetation clearing for the proposed railway line and the adjacent access track in most cases will result in a linear disturbance to a maximum of 100m wide. In the majority of the habitats found in the proposed rail corridor this loss of vegetation is unlikely to have a significant impact in any particular area, but the length of the proposed railway line and associated incremental effects could be substantial.

Where the proposed rail alignment crosses ephemeral water courses, it has the potential to change the hydrology of the area. This may have flow-on effects to nearby small wetlands by increasing or decreasing water levels or the duration of ephemeral pools. Since many groups, including migratory wading birds, rely on predictable levels of water being present, ongoing change to these habitats degrades their suitability as foraging or breeding sites.

Habitat Fragmentation

In addition to vegetation clearing, infrastructure including roads and the proposed rail line, have the potential to fragment habitat. Raised railway lines, linear bunds of blue metal, and cleared linear tracks of land are 'unnatural' in this habitat. These linear structures could partition existing activity areas and home ranges, isolate sections of established communities and may alter long and medium-term patterns of movement around established home ranges particularly for small mammals and reptiles. A reduction in the population as a result of this infrastructure would be difficult to detect given the current knowledge of the spatial ecology for most of the small conservation significant mammals known to be in the area.

Fragmented habitats and landscapes have increased habitat edges. Small mammals can respond both positively and negatively to edges depending on their ecological traits and the biotic and abiotic features of the edges. Edge and disturbance effects can lead to altered levels of predation, restricting or increasing fauna movements and altering assemblage structure.

Dust

Dust generated from construction activities (rail, road, camps, etc) can potentially degrade surrounding vegetation, reducing their ability to absorb sunlight and thus influencing photosynthetic rates. Degradation of these areas could make the habitat unsuitable for some fauna. The volume of traffic and speed of vehicles on access roads will largely determine the impact of dust in any area.

A dust monitoring program, including specific triggers, for corrective action, should be implemented.

Altered Fire Regimes

A change in fire regimes is often associated with increased human activity, leading to degradation of natural ecosystems. Linear infrastructure such as rail lines and roads provide barriers to naturally occurring fires and may alter the natural fire regimes that the fauna have evolved to accommodate. The risk of fire is likely to be higher during construction activities. The potential impact of fires on the native fauna should be addressed in RHIO's fire management plan for the proposed rail corridor.

Introduced Fauna

An increase in human activity is often associated with an increase in the abundance of introduced species such as the house mouse (*Mus musculus*), feral cat (*Felis catus*) and wild dogs (*Canis lupus*). This increase may be due to a decline in habitat health, increased road kills, poor disposal of waste and easier access to areas via tracks.

The house mouse, cat and wild dogs are known to be established in the area. In many situations they have become a 'naturalised' species in the Australian bush. Increases in dog or cat numbers can have a detrimental impact on native fauna because they predate on and compete with native species, severely disrupting the natural balance.

Infrastructure known to support feral species, such as rubbish disposal sites and bins, should be managed to minimise increases in these populations. Monitoring and recording feral numbers is an important component of the management of feral species.

Road and Rail Fauna Deaths

An increase in road fauna deaths is likely to occur where new roads are constructed or upgraded, in particular affecting kangaroos, nocturnal birds and ground dwelling large carnivorous predators. Most of the conservation significant vertebrate fauna in the area, such as Northern Quoll, Bilbies, Bush Stone-curlew and the Pilbara Olive Python can be causalities of night vehicle traffic. Species such as goannas and raptors and possibly Northern Quolls, are attracted to carrion on road verges. Therefore, there is an increased propensity for these species to be killed by vehicles.

Terrestrial Ecosystems has records of Northern Quoll, wallabies and kangaroos being killed on the Port Hedland to Cloud Break rail line and in equipment, so the same is possible for the RHIO railway.

Loss of Granite Rock Piles

The ecological significance and importance of isolated granite rock piles is largely unknown. These habitats form a series of 'islands' spread throughout the landscape. For many individuals their entire activity area is confined to a single or few rock piles (e.g. *Varanus pilbarensis*, *Egernia pilbarensis*). These individuals will be almost certainly lost with the destruction of these rock piles. The importance of these rock piles for the Northern Quoll and perhaps the Ghost Bat is unknown.

Anthropogenic Activity

Unnatural noises, vibrations, artificial light sources and vehicle and human movement in an area may be sufficient to force individuals or fauna species to move from an area, or alter their activity periods. This form of disturbance is likely to occur around quarries while the proposed railway line is under construction, but the impact will be short term. Once operational, continual train movements could force many individuals to move from areas adjacent to the proposed rail line and associated access track.

Impact of Creating a Linear Barrier

The proposed railway line and adjacent access track will form a significant barrier to the movement of terrestrial fauna in the area. Most other railway lines carrying iron ore in the Pilbara are placed on an elevated bed of coarse ballast. The same design is therefore likely to be used for RHIO railway line. Culverts constructed of circular corrugated pipe have been used along both BHP and FMG railway lines. These are not 'fauna friendly' (i.e.

vertebrate fauna are hesitant about moving through these culverts because of the corrugated iron base), so in many cases these types of culverts do not enable terrestrial fauna to move past the barrier. The railway line is also likely to act as a barrier for cattle movement, with the potential that some cattle will be killed or injured by trains unless the railway line is fenced.

In addition, roads can result in road kills, and destruction of habitat adjacent to the road due to dust or the impact of (saline) water used to consolidate the road and suppress dust during road construction.

Depending on the drainage design, the road and elevated railway line may act as a barrier to the flow of surface water across some areas. This could result in the progressive death of vegetation in some areas adjacent to the barrier and the loss of fauna habitat due to some areas being deprived of access to surface water during heavy rainfall events. Appropriately placed culverts can minimise this impact.

A linear barrier in association with poorly designed culverts will often result in the pooling of water adjacent to the barrier in ephemeral creek beds long after other pools have dried up. These pools attract birds and mammals during the dry season. If they are close to the road, then the propensity for birds and mammals drinking from these pools being killed on the road increases. Carcasses on the road verge attract raptors and large goannas which are then vulnerable to being killed. Creek crossings should be designed to minimise the long term pooling of water adjacent to the road to avoid attracting birds and mammals to the edge of the road and 'road and rail kills' should be removed as soon as possible.

Cumulative Effects of Vegetation Clearing

To date, a minimal quantity of vegetation has been cleared along the proposed railway corridor. While the clearing of native vegetation and fauna habitat for a single development will probably have a low overall impact on the fauna, the cumulative effect associated with the clearing multiple railway line corridors (e.g. BHP, FMG and RHIO) and mine sites in the Pilbara could have long term consequences for the fauna.

In addition, these types of developments increase the occurrence of 'edge-effects' and the associated change in assemblage structure and fragment the available fauna habitat. These potential impacts can also be cumulative and should be considerable when viewed in the context of the total number of hectares being cleared in the bioregion.

Construction of the Railway Line and Access Road

Construction and use of heavy vehicles and machinery, and if bridges are to be built to across the larger creeks, driving piles into the substrate will temporarily impact on the fauna in the area. The consequence will be that some fauna will be lost and others will shift in to neighbouring areas. Migrants increase competition for resources, which may result in the subsequent death of migrants or local individuals. Individuals shifted out of their established activity areas are also vulnerable to predation until they have become established in their new areas.

Rehabilitation of Cleared Areas

Eventually some of the access tracks, borrow pits, water reserves and lay down areas constructed adjacent to the proposed railway line will no longer be required. To minimise the long term potential impact, rehabilitation programs should be progressively implemented and evaluated. An emphasis should be placed on the establishment of near-

natural, self-sustaining, functional ecosystems in rehabilitation planning, and this should be one of the focal criteria for assessing the success of rehabilitation programs.

Fortescue Marsh and Adjacent Area

The proposed Hillside South railway corridor runs within 2km of the northern boundary of the Fortescue Marsh. Little is known of the vertebrate fauna ecology of the Marsh and the associated hinterland. FMG (2004) undertook an environmental risk assessment of potential impacts of FMG's operation on the Marsh. This assessment concluded their proposed mining and infrastructure developments, when control measures were considered, would be minimal on the ecosystems associated with the Marsh.

The three linear land systems found along the northern edges of the Fortescue Marsh are: Cowar (Plains fringing the Marsh land system and supporting snakewood and mulga shrublands with some halophytic under shrubs), Turee (Stony alluvial plains with gilgaied and non-galgaied surfaces supporting tussock grasslands and grassy shrublands) and Jamindie (Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey). Ephemeral creeks that move water after heavy rainfall from the Chichester Range and stony rises on the north side of the Marsh will be traversed by the proposed Hillside South railway corridor. These ephemeral creeks are mostly dry, but after heavy rain some can carry large volumes of water for a few hours or days. Water holes remain along some of these creeks for many months after heavy rain. These water holes are used by stock, birds and native mammals as watering holes.

The Dinner Plate Turtle (*Chelodina steindachneri*) is in the Fortescue River and almost certainly in some of the large water holes in the general area. This species is known from many of the creeks and rivers in the Murchison River and De Grey catchments in the north to the Irwin River in the south and inland to Meekatharra and Paynes Find and is not of conservation significance.

After heavy rain, frogs that have burrowed or have hidden in crevices emerge and congregate around these flooded waterways, often in large numbers. None of these frogs are threatened or of conservation significance.

Fish were not seen during the search of the corridor, but have been seen during previous visits in the creeks and remnant pools that flow into the northern edge of the Fortescue Marsh. None of these fish are of conservation significance, although a number are endemic to the bioregion.

Major ground disturbances in ephemeral water courses during periods when they are flowing can result in the displacement of large quantities of silt, which discolour the waterway downstream, and sediment can remain suspended for longer periods in the remnant pools. These high levels of silt can negatively impact on the habitat for aquatic invertebrates and vertebrates. Construction and disturbance should therefore be planned for periods when the creeks are unlikely to contain water to minimise this potential impact.

Terrestrial Ecosystems' assessment is that it is unlikely that the construction of a proposed railway line and associated infrastructure within the proposed corridor will significantly impact on any of these semi-aquatic and aquatic species associated with the Fortescue Marsh, as long as the flooding of these creeks is not impeded by the railway line and the adjacent access road.

Short Range Endemic Terrestrial Invertebrates and Stygofauna

There are few areas within the proposed railway corridor that are suitable to support short range endemics that are currently of conservation concern. Harvey (2006) reported *Dampetrus* 'Pilbara 1' and Slack-Smith (2006) undescribed camaenid species of *Quistrachia* as possible SRE in the east-west FMG railway corridor. Fauna habitat along the proposed corridor is similar to that in the many hectares in adjacent areas, so it is likely that any species found in the proposed railway corridor will be found in adjacent areas, but this would need to be verified by further field investigations. So any loss of a small number of individuals in the linear corridor is unlikely to have a significant long-term impact on the survival of that species. No stygofauna were reported from the field survey undertaken by FMG for the Stage B railway corridor.

Management Strategies

Referral under the EPBC Act

There is a potential to kill the conservation significant Northern Quoll, Pilbara Olive Python, Mulgara and Bilbies, if they are present in the corridor, during the clearing of vegetation and during railway line construction. Other conservation significant fauna that may be present in the area are unlikely to be significantly impacted on in the long-term. Although the potential deaths in any particular section of the corridor are likely to be low due to the width and linear nature of the proposed disturbance, the cumulative effects have the potential to be important, although none would probably trigger any one of the significant impact criteria of the *EPBC Act*. However, it is noted that the Commonwealth DEWHA has recently taken a particular interest in potential impacts on Northern Quolls in the Pilbara, possibly because of the likely destruction of the population in the Kimberley once the Cane Toad has become established.

Recommendation 1: RHIO refer the project to the Commonwealth DEWHA advising of the potential impact that the construction of the railway line and associated infrastructure might have on species of conservation significance.

Fauna Management Plan

If management procedures proposed below are adopted, the potential impacts on conservation significant vertebrate fauna will be minimised, but not ameliorated.

Recommendation 2: A fauna management plan for the railway corridor is developed with specific objectives, key performance indicators (KPIs) and management actions.

Recommendation 3: The following management principles are adopted to guide the development and implementation of RHIO's fauna management plan for species of conservation significance:

- where possible the destruction of habitat known to be used by Mulgara, Northern Quolls, Star Finches, Pilbara Leaf-nosed Bats and the Ghost Bats is avoided;
- where avoidance is not possible, then management actions will be implemented to minimise anthropogenic activity in habitat used by Mulgara, Northern Quolls, Ghost Bat and the Pilbara Leaf-nosed Bat;

- where possible, habitat containing Mulgara, Bilby and Northern Quolls should not be fragmented by land clearing;
- where a direct impact on Northern Quoll, Bilbies or Mulgara cannot be avoided, then a catch and translocation program will be implemented prior to vegetation clearing;
- the success of the translocation programs for Northern Quoll, Bilbies and Mulgara will be monitored to determine the success of the program; and
- should the monitoring program indicate a decline in the number of conservation significant species, then every effort will be made to determine the cause, and if related to RHIO's activities, remedial action taken immediately to address the problem(s).

Habitat loss and fragmentation

Loss of vegetation and habitat may contribute to the decline in the number of conservation significant fauna on and in the vicinity of the proposed railway corridor. A loss of connectivity among habitats restricts movements and isolates populations. Where possible, areas to be disturbed should be minimised, connectivity among natural vegetation maintained and high quality habitat preserved.

Recommendation 4: A rehabilitation plan is prepared for all disturbed areas along the proposed railway corridor that includes specific objectives, KPIs and action plans.

Management of Northern Quoll populations

The Northern Quoll is widespread throughout the Pilbara bioregion with records of the species in 26 land systems. However, six land systems comprise 74% of Northern Quoll records for the Pilbara region indicating that the species has a preferred habitat (Biota Environmental Sciences 2009). Populations of Northern Quoll may be located in the vicinity of the proposed railway corridor. Areas that could support Northern Quolls are the treed ephemeral creek and drainage lines, rocky hills with dense vegetation and granite outcrops.

Areas likely to support Northern Quolls that are to be disturbed should be trapped immediately prior to clearing and individuals translocated to a suitable location out of harms way. The trapping program should be undertaken by suitably experienced and trained zoologists and the success of the program monitored. A standard operating procedures manual should be prepared for the Northern Quoll trapping and translocation program.

A Standard Operating Procedures (SOP) manual should be prepared prior to any animals being caught. This SOP manual should be developed in accordance with acceptable animal welfare considerations and provide information on issues such as trapping, handling and the design of monitoring programs.

Feeding of Northern Quoll or leaving food scraps that Northern Quoll could access should be prohibited. Northern Quoll may infrequently retreat to the warmth of vehicles and human areas of habitation in winter. This should be discouraged.

Recommendation 5: A SOP manual is prepared for the trapping and translocation of Northern Quolls that are in the disturbance area.

Recommendation 6: All habitats likely to support Northern Quolls are trapped prior to vegetation clearing and individuals translocated to a suitable location away from the disturbance area by suitably experienced and trained zoologist.

Recommendation 7: Feeding Northern Quolls, as with any other native fauna, is prohibited.

Management of Mulgara populations

A Mulgara population may be present in the vicinity of proposed development in the railway corridor. Areas potentially supporting Mulgara include the sand plain vegetated with mature spinifex north of the Chichester Range. Areas potentially containing Mulgara should be searched prior to vegetation clearing. Those areas that contain active burrows should be trapped and the individuals translocated to a suitable adjacent location.

A SOP manual should be prepared for the relocation of Mulgara prior to any animals being caught. This SOP manual should be developed in accordance with acceptable animal welfare considerations and should provide information on issues such as trapping, handling and the design of monitoring programs.

Recommendation 8: A SOP manual is prepared for the search, trapping and translocation of Mulgara.

Recommendation 9: All suitable habitat for Mulgara that is to be disturbed is searched for active burrows prior to vegetation clearing.

Recommendation 10: Where feasible, a non-clearing buffer zone of 250m radius is established around every active Mulgara burrow.

Recommendation 11: A translocation program is implemented as described in the SOP in areas where active Mulgara burrows have been detected and the vegetation will be cleared.

Management of Bilby populations

There is a remote possibility that the proposed railway corridor in the sandy plain area north of the Chichester Range contains a population of Bilbies. Areas potentially containing Bilbies should be searched prior to vegetation clearing. Those areas that contain active burrows should be trapped and the individuals translocated to a suitable adjacent location.

A SOP manual should be prepared for the relocation of Bilbies prior to any animals being caught. This SOP manual should be developed in accordance with acceptable animal welfare considerations and should provide information on issues such as trapping, handling and the design of monitoring programs.

Recommendation 12: A SOP manual is prepared for the search, trapping and translocation of Bilbies program.

Recommendation 13: All suitable habitat for Bilbies that is to be disturbed is searched for active burrows prior to vegetation clearing. This search program should be undertaken simultaneously with the search for active Mulgara burrows.

Recommendation 14: Where feasible, a non-clearing buffer zone of 1km radius is established around every active Bilby burrow.

Recommendation 15: A translocation program is implemented as described in the SOP in areas where active Bilby burrows have been detected and the vegetation will be cleared.

Recommendation 16: Speed restrictions of 20km/h between 7pm and 6am should be applied to areas that contain Bilby around infrastructure in operational areas.

Pilbara Olive Python

Pilbara Olive Pythons are likely to be found in low abundance in rocky and vegetated areas along the rail corridor. Their presence is very difficult to detect which makes translocation programs difficult to implement. In this context, there is little justification in attempting to catch and translocate individuals. It is recommended that the loss of a few Pilbara Olive Pythons be noted and addressed through the EIA process. Where Pilbara Olive Pythons are seen by staff and contractors, and are likely to be in harms way, then they should be translocated. A SOP manual should be prepared for this procedure prior to any animals being caught.

Recommendation 17: A SOP manual is prepared for the translocation of Pilbara Olive Pythons.

Pilbara Leaf-nosed Bat

Pilbara Leaf-nosed Bats roost in humid caves and mine shafts. Disturbing a maternity roost could be a significant impact on this species. Terrestrial Ecosystems have no data to suggest that the proposed vegetation clearing and construction activity will impact on the Pilbara Leaf-nosed Bat. However, if construction activities will impact on caves in the proposed railway corridor, then these will need to be searched by a suitably experienced zoologist prior to disturbance.

Recommendation 18: All caves that will be impacted on by construction activities should be searched and checked using an echolocation detector for Pilbara Leaf-nosed Bats prior to disturbance.

Recommendation 19: Caves providing maternal roosts for Pilbara Leaf-nosed Bats should not be disturbed.

Ghost Bats

Armstrong and Anstee (2000) reported Ghost Bats in the Hamersley Range roost in caves beneath bluffs of low rounded hills composed of Marra Mamba geology and granite rock piles in the eastern Pilbara, but they have also been found in mine shafts and a variety of other caves. A single individual was caught on the northern fringe of the Fortescue Marsh south of the Cloud Break mine which probably has a roost in the caves behind the Cloud

Break mine. Disturbing a maternity roost could be a significant impact on this species. Terrestrial Ecosystems have no data to suggest that the proposed vegetation clearing and construction activity will impact on the Ghost Bat. However, if construction activities will impact on caves in the proposed railway corridor, then these will need to be searched by a suitably experienced zoologist prior to disturbance.

Recommendation 20: All caves that will be impacted on by construction activities should be searched and checked using an echolocation detector for Ghost Bats prior to disturbance.

Recommendation 21: Caves providing maternal roosts for Ghost Bats should not be disturbed.

Pebble-mound Mouse

Active Pebble-mound Mouse mounds are present within the proposed rail corridor, particularly on slopes and hilly areas with a uniform gravel surface substrate. Given the low success rate of translocation programs, there is little justification in attempting to translocate individuals when it is probable that the general area contains many social groups of Pebble-mound Mice. It is recommended that where possible, mounds are avoided.

The destruction of active Pebble-mound Mouse mounds should be addressed in the EIA process.

Long-tailed Dunnart and Northern Short-tailed Mouse

It is possible that the clearing of vegetation and development of the railway line will impact on a small number of Long-tailed Dunnarts and Northern Short-tailed Mice. It is not feasible to trap and translocate individuals that might be killed or injured by the proposed development.

The possible loss of Long-trailed Dunnarts and Northern Short-tailed Mice during the clearing and development program should be addressed in the EIA process.

Ramphotyphlops ganei *and* Ctenotus nigrilineatus

It is possible that the clearing of vegetation and development of the proposed railway line will impact on a small number of *R. ganei* and *C. nigrilineatus*. It is not feasible to trap and translocate individuals that might be killed or injured by the proposed development.

The possible loss of *R. ganei* and *C. nigrilineatus* during the clearing and development program should be addressed in the EIA process.

Conservation Significant Bird Species

The Rainbow Bee-eater, Australian Bustard, Bush Stone-curlew, Peregrine Falcon and Grey Falcon are present or potentially present in the railway corridor and adjacent areas. These species are capable of moving to adjacent areas once vegetation clearing commences and any impacts are unlikely to be significant. It is recommended that low potential impact that clearing might have on any of these species is addressed in the EIA process.

Induction and Awareness

All staff and clearing contractors and other people involved in clearing and quarrying activities on the proposed rail corridor should be made aware of the possible presence and issues associated with conservation significant species in the area through the induction process.

Recommendation 22: An induction program for staff and contractors that includes components on managing conservation significant species is a mandatory component of working on the RHIO rail corridor.

Minimising Habitat Fragmentation

Where possible, access routes should be aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale vegetation associations in the area. This will have less impact on the terrestrial fauna, which are often dependent upon specific habitat types. Clearing should be minimised wherever possible and remnant vegetation fragmentation should be avoided wherever possible. Once areas are no longer required then they should be rehabilitated.

Recommendation 23: All areas disturbed during construction within the rail corridor are rehabilitated within six months after they are no longer required.

Recommendation 24: Access routes and construction areas are aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale vegetation associations in the area.

Changes to Fire Regimes

Fauna habitat can be gradually degraded by ongoing changes to natural fire regimes. A fire management plan should be formulated to minimise and control accidental fires.

Recommendation 30: A fire management plan is prepared for the proposed railway corridor.

Secondary Impacts to the Habitat

Weed invasion and dust often impact upon vegetation immediately following disturbances. Both impacts reduce the ability of native vegetation to maintain ecological processes at their highest productivity, and may impact upon the ability of the local ecosystem to support conservation significant vertebrates. These issues should be addressed in the RHIO fauna management plan for the proposed railway corridor.

Pets and feral animals have the potential to impact on conservation significant species. Pets should not be permitted on site and feral animal numbers monitored and controlled.

Where the rail alignment and access road cross drainage lines, the rail line should be constructed so as to minimise impacts on flows in these water courses. This can be achieved through effective design such as bridging, use of pylons, and causeways over culverts beneath the rail line.

Recommendation 25: Pets are not permitted on site.

Recommendation 26: All waste and rubbish be contained in bins and regularly removed from site.

Recommendation 27: The drainage design for the railway line minimises changes to the flow and maintains existing habitat so as to minimise the impact on conservation significant species living along the creek lines.

Recommendation 28: Culverts under the railway line and access tracks have a fauna friendly flat bottom.

Road and Rail Fauna Deaths

Unsealed roads pose two major problems for fauna:

- road kills, and
- destruction of habitat adjacent to the road due to dust or the impact of (saline) water used to consolidate the road and suppress dust.

The proposed railway corridor and adjacent area access roads will cross numerous ephemeral creeks and flood ways. Road construction often results in shallow channels along road verges that accumulate run-off water. This water is often on the surface for longer periods than in the adjacent areas, and promotes grass and weed growth along the road verges and temporary ponds. Surface water and a high concentration of grasses attract large mammals to these areas, which increases the propensity for them to be killed on the road. This becomes a greater issue if the access road is used at night when kangaroos and cattle drink or feed near the road verges. Raptors and large goannas are often attracted to the carrion and are also killed by vehicles. Constructing the access roads to minimise the collection of run-off surface water along road verges can significantly reduce fauna deaths.

Some of the proposed access road corridors cross areas of fine, clay soils that form a plume of powdery dust when driven on by vehicles. This dust often settles some distance from the track where it can have a detrimental impact on vegetation. Uncontrolled dust generated from the road construction, and use of these roads is likely to have a negative impact on the fauna located within in the road corridor. A loss of vegetation rapidly leads to a loss of suitable habitat for invertebrate and vertebrate fauna.

Construction of roads across ephemeral creeks and flood ways is often achieved using a series of culverts, or flood ways that result in ponding of water adjacent to the road. This habitat has little free surface water for most of the year, and the availability of surface water attracts and concentrates birds and mammals in a particular area, and provides an unnatural habitat. This should be avoided.

To minimise the impact of vehicles and dust along the access road, it is recommended that tracks and roads likely to be used on a frequent basis (e.g. 20 or more vehicles per day):

- be designed to minimise the accumulation of ephemeral ponds along the road verges and in association with creeks, culverts and flood ways;
- a dust suppression program be implemented for high volume roads;
- a monitoring program is put in place to assess the impact of dust and the dust suppression program on the vegetation along the road verges; and
- a monitoring program is put in place to assess the number of animals killed by vehicle traffic along access roads.

A vehicle collision with large mammals is not only a safety issue for RHIO staff, but can result in large carcasses remaining adjacent to the road for weeks. These carcasses attract

raptors and in the warmer months, large goannas (e.g. *V. giganteus*, *V. panoptes*, *V. gouldii*). Often these predators are killed when they are frightened by an approaching vehicle and attempt to run or fly off. The death of these animals can be reduced by removing carcasses from the road verges. Terrestrial Ecosystems' recommends that a procedure be put in place so that when RHIO staff find dead animals adjacent to access roads, they report their presence to the environmental staff who will arrange for their removal and disposal.

If the number of animal deaths due to vehicles becomes excessive (e.g. more than 2-3 large mammals per week) then additional strategies will need to be explored to address this issue (e.g. restricting the time when the road is used, fencing the road, etc).

Signage should be erected to indicate appropriate travelling speeds, and should also indicate the possible presence of wildlife in the area. These problems are particularly acute at dusk when many of the species of conservation significance emerge to forage and in low light conditions when observer vision is reduced.

A small number of terrestrial vertebrates will be killed on the railway line once it becomes operational. This is unavoidable.

Recommendation 29: Access tracks and roads with high vehicle traffic are designed to minimise ponding on the edges.

Recommendation 30: Animals killed on the tracks and roads are recorded and removed.

Recommendation 31: A maximum speed limit of 80km/h is imposed on all access tracks

Recommendation 32: Signage is erected to indicate the possible presence of wildlife crossing.

Recommendation 33: A dust suppression program is implemented for high traffic volume roads.

Recommendation 34: A monitoring program is put in place to assess the impact of dust and the dust suppression program on the vegetation along high volume road verges.

Railway and Access Road Design

The construction of access tracks and the railway line, location and construction of lay down areas, water reserves, quarries and access roads can be done in an environmentally sensitive way so as to minimise potential impacts.

To minimise the impact of this proposed development and vegetation clearing, it is recommended that:

- infrastructure is designed to minimise the size of the area that is cleared;
- ground works are timed so that they do not occur when creeks are flowing;
- changes to the creek bed profiles during construction are returned to pre-construction conditions;
- sufficient culverts should be provided in appropriate places to minimise the impact of the linear barrier on sheet flow of water across the landscape;
- creek crossings are designed to minimise the pooling of water adjacent to the road to avoid attracting birds and mammals to the edge of the road;

- an effective dust management strategy is put in place, and the impact of dust on the adjacent vegetation and fauna habitats is systematically monitored with appropriate triggers that will initiate corrective actions; and
- the potential injury and death of cattle on the railway line should be discussed with the local pastoralists to develop an acceptable management strategy.

Conclusion

RHIO propose to transport iron ore from its proposed Roy Hill mine to the Port Hedland port via a railway. The Hillside South railway corridor is an alternative route for the proposed railway.

Four species listed under either the *EPBC Act* or the *Wildlife Conservation Act* (Northern Quoll, Mulgara, Bilby and Pilbara Olive Pythons) could be impacted on by the construction and operation of the proposed Hillside South route for the railway line. Additional species listed by DEC as priority species could also be lost during the vegetation clearing and infrastructure development program.

Terrestrial Ecosystems believes that sufficient information has been collected or is known to assess the potential impact of the proposed rail corridor and associated infrastructure on fauna and fauna assemblages. Additional spatial movement and geographic distribution data for the Northern Quoll in the Pilbara region would be useful to develop more explicit recommendations on protecting this endangered species. Sufficient is known of the ecology of the other conservation significant species to develop and implement effective impact minimisation strategies.

Potential impacts on conservation significant species include mortality of animals during the clearing of vegetation and rock piles, a reduction in activity areas and home ranges due to the loss of habitat, habitat fragmentation by tracks and the railway line, dust from vehicle traffic, road deaths, altered fire regimes and the increase in feral species populations.

Fauna management recommendations have been provided will reduce the potential impact of fauna, in particularly conservation significant fauna, in the proposed railway line corridor.

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APPENDIX A1
VERTEBRATE FAUNA CAUGHT OR OBSERVED IN OTHER FAUNA SURVEYS UNDERTAKEN IN THE VICINITY OF THE PROPOSED PROJECT AREA

		Fauna Surveys	A									B								C																		
Family	**Species**	**Common Name**	**Camp**	**Coongan north**	**Coongan south**	**Haul road**	**Outcamp creek**	**Outcamp east**	**Outcamp west**	**Plant**	**PMM**	**CH01**	**CH02**	**CH03**	**CH04**	**CH05**	**CH06**	**CH07**	**Opportunistic**	**Minga Well**	**Moojarri Well**	**OB1**	**OB1A**	**OB2**	**OB3**	**OB4**	**OB5**	**Site A**	**Site B**	**Site C**	**Site D**	**Site E**	**Site G**	**Site H**
Birds																																						
Accipitridae	*Elanus axillaris*	Black-shouldered Kite																8	2																			
	Lophoictinia isura	Square-tailed Kite												1					1																			
	Haliastur sphenurus	Whistling Kite																	2	X		X																
	Accipiter fasciatus	Brown Goshawk																	1																			
	Circus assimilis	Spotted Harrier																	1																			
	Aquila audax	Wedge-tailed Eagle																	3																			
	Hieraaetus morphnoides	Little Eagle													1				2																			
Anatidae	*Anas gracilis*	Grey Teal																		X																		
	Anas superciliosa	Pacific Black Duck																	6																			
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar					1					1	1						2																			
Apodidae	*Apus pacificus*	Fork-tailed Swift																	2																			
Podargidae	*Podargus strigoides*	Tawny Frogmouth												1																								
Casuariidae	*Dromaius novaehollandiae*	Emu		1												5				X	X																	
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew																	1																			
Charadriidae	*Charadrius ruficapillus*	Red-capped Plover																		X																		
	Elseyornis melanops	Black-fronted Dotterel																	3	X	X																	
	Erythrogonys cinctus	Red-kneed Dotterel																		X																		
Scolopacidae	*Tringa glareola*	Wood Sandpiper																	2																			
Turnicidae	*Turnix velox*	Little Button-quail										1		1	1	3		1	1								X										
Ardeidae	*Ardea pacifica*	White-necked Heron																	1																			
	Egretta novaehollandiae	White-faced Heron																	1	X	X																	
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis																		X																		
Columbidae	*Phaps chalcoptera*	Common Bronzewing		1								7	8	1	1	1		3	5	X																		
	Ocyphaps lophotes	Crested Pigeon	2	4					1			16	12	13	31	8	22	27	5	X	X	X					X											
	Geophaps plumifera	Spinifex Pigeon	2		1		25	10	2			1	2	15			17		42																			
	Geopelia cuneata	Diamond Dove				4						20	3	17	1	15	10	4	20																			
	Geopelia striata	Peaceful Dove																1																				
Alcedinidae	*Dacelo leachii*	Blue-winged Kookaburra	1	1			2											7	2	X																		
	Todiramphus pyrrhopygius	Red-backed Kingfisher												3	1	2		20																				
	Todiramphus sanctus	Sacred Kingfisher					5			1								2	2																			
Meropidae	*Merops ornatus*	Rainbow Bee-eater		4	2		11					2	1	15		3	4	10	9	X		X				X											
Cuculidae	*Centropus phasianinus*	Pheasant Coucal										1						1	2																			
	Chalcites basalis	Horsfield's Bronze-Cuckoo										1					1																					
	Chalcites osculans	Black-eared Cuckoo			1																																	

		Fauna Surveys	A									B								C																				
Family	Species	Common Name	Camp	Coongan north	Coongan south	Haul road	Outcamp creek	Outcamp east	Outcamp west	Plant	PMM	CH01	CH02	CH03	CH04	CH05	CH06	CH07	Opportunistic	Minga Well	Moojarri Well	OB1	OB1A	OB2	OB3	OB4	OB5	Site A	Site B	Site C	Site D	Site E	Site G	Site H
	Cacomantis pallidus	Pallid Cuckoo	1	1	1		1	2				4	2	3				5																	
Caprimulgidae	*Eurostopodus argus*	Spotted Nightjar																	2	X														
Falconidae	*Falco cenchroides*	Nankeen Kestrel				1	1						2	1					2															
	Falco berigora	Brown Falcon			1									3			1	1																
	Falco hypoleucos	Grey Falcon																	2 1															
Phasianidae	*Coturnix ypsilophora*	Brown Quail																	2															
Otididae	*Ardeotis australis*	Australian Bustard										2			3	1	2		3	X							X							
Rallidae	*Porzana tabuensis*	Spotless Crake																	6															
	Tribonyx ventralis	Black-tailed Native-hen																		X														
Acanthizidae	*Calamanthus campestris*	Rufous Fieldwren						2																										
	Smicrornis brevirostris	Weebill			2		9	32	1			1 2	2	13	12		5		2															
	Gerygone fusca	Western Gerygone														4						X												
	Acanthiza robustirostris	Slaty-backed Thornbill														2				X		X												
	Acanthiza apicalis	Inland Thornbill										4	2			1	13																	
	Acanthiza uropygialis	Chestnut-rumped Thornbill											3		4	1	5	1	1 4															
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Wabler																	7															
	Cincloramphus mathewsi	Rufous Songlark																1	2															
	Eremiornis carteri	Spinifexbird										6	21	5				25	3															
Alaudidae	*Mirafra javanica*	Horsfield's Bushlark	2					1											4															
Artamidae	*Artamus cinereus*	Black-faced Woodswallow	4			8	4					1 9	18	37	35	5	16	19	1 3			X	X											
	Artamus minor	Little Woodswallow										6	8	6					1															
	Cracticus torquatus	Grey Butcherbird										6	6	5	15	11	10	21	2		X	X					X							
	Cracticus nigrogularis	Pied Butcherbird		1	2		1	4	7			4	18	21	13	10	10	10	2		X													
	Cracticus tibicen	Australian Magpie	1				2						1	10				1																
Campephagidae	*Coracina maxima*	Ground Cuckoo-Shrike											2	3					2															
	Coracina novaehollandiae	Black-faced Cuckoo-Shrike	1	3	2		1	2	3	1		2	11	4	9	8	2	3	6	X		X					X							
	Lalage sueurii	White-winged Triller										3		3		1		1	2															
Corvidae	*Corvus bennetti*	Little Crow																1			X													
	Corvus orru	Torresian Crow			1		3					2	1	9	1	1	6	4	2		X	X												
Estrildidae	*Taeniopygia guttata*	Zebra Finch	1 6	6	13	3	11	11				1 2	6	22	14	118	251	208	1 7 8	X	X	X					X							
	Neochmia ruficauda	Star Finch																	2	X														
	Emblema pictum	Painted Finch	1 5		2	3	2	4	3			3 0	2					2	7 2 7															
Hirundinidae	*Hirundo neoxena*	Welcome Swallow																	1															
	Petrochelidon nigricans	Tree Martin																	4															
	Petrochelidon ariel	Fairy Martin																	6															
Maluridae	*Malurus leucopterus*	White-winged Fairy-wren												7	14			30	8			X	X											
	Malurus lamberti	Variegated Fairy-wren		10				4				2 6	35	26	1	2	40	23	9			X				X								
Meliphagidae	*Lichenostomus virescens*	Singing Honeyeater		3	6	10						3 3	12	44	37	54	37	47	2 3	X		X		X			X							
	Lichenostomus keartlandi	Grey-headed Honeyeater				1				7			13	23	3	14	5		2 5							X	X							

		Fauna Surveys	A								B								C																	
Family	Species	Common Name	Camp	Coongan north	Coongan south	Haul road	Outcamp creek	Outcamp east	Outcamp west	Plant	PMM	CH01	CH02	CH03	CH04	CH05	CH06	CH07	Opportunistic	Minga Well	Moojarri Well	OB1	OB1A	OB2	OB3	OB4	OB5	Site A	Site B	Site C	Site D	Site E	Site G	Site H
	Lichenostomus penicillatus	White-plumed Honeyeater			4		2	34		2								26	26	X															
	Manorina flavigula	Yellow-throated Miner		4		4	3			6		20	15	8	20	5	14		7								X							
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater		1								2		1	13	21	16	39	5	X		X												
	Conopophila whitei	Grey Honeyeater										1																						
	Epthianura tricolor	Crimson Chat										3																						
	Epthianura aurifrons	Orange Chat																		X														
	Lichmera indistincta	Brown Honeyeater		28		3	5	5	14					5	1	3	7	2	13															
	Melithreptus gularis	Black-chinned Honeyeater												10													X							
Monarchidae	*Grallina cyanoleuca*	Magpie-Lark			1		6		1				4	1					5	X	X						X							
Motacilidae	*Anthus novaeseelandiae*	Australasian Pipit										1							1															
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler		2			2	1				33	21	13	9	49	38	29	4	X		X					X							
	Colluricincla harmonica	Grey Shrike-thrush		4			6					12	15	30		11	14	8	2			X												
	Oreoica gutturalis	Crested Bellbird		1		2			1			3	8	20	17	26	16	7	1			X	X				X							
Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote		2		1	2							4		4	1		3															
	Pardalotus striatus	Striated Pardalote										1	2	8																				
Petroicidae	*Petroica goodenovii*	Red-capped Robin														4	3	2				X												
	Melanodryas cucullata	Hooded Robin										6	10	3	5	3	6	1	1			X												
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler			5		28	2	3									4		X														
	Pomatostomus superciliosus	White-browed Babbler										4	2		10	8	42		1															
Ptilonorhynchidae	*Ptilonorhynchus guttatus*	Western Bowerbird										2		6	1	2	1		3															
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	1			3	15	1				8	18	9	8	17	11	6	6	X		X					X							
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe																	2															
Cacatuidae	*Eolophus roseicapillus*	Galah					3		5	2		25	16	23	16			18	55	X	X	X												
	Cacatua sanguinea	Little Corella			14		24	5						25				4	72	X	X													
	Nymphicus hollandicus	Cockatiel										6	4	15				2	16	X														
Psittacidae	*Barnardius zonarius*	Australian Ringneck					5		1				12	8	11	2	7	21		X	X													
	Melopsittacus undulatus	Budgerigar										1		5				3	20															
	Neopsephotus bourkii	Bourke's Parrot																		X	X													
	Pezoporus occidentalis	Night Parrot																		X														
Strigidae	*Ninox novaeseelandiae*	Southern Boobook																	1															
Tytonidae	*Tyto javanica*	Eastern Barn Owl																	3															
Mammals																																		
Bovidae	*Bos taurus*																	10	41															
Canidae	*Canis lupus familiaris*											1				1																		
Felidae	*Felis catus*												1																					
Emballonuridae	*Saccolaimus flaviventris*													X																				
	Taphozous georgianus														X	X			X															
Megadermatidae	*Macroderma gigas*												X																					
Molossidae	*Chaerephon jobensis*													X	X			X																

		Fauna Surveys	A									B								C																			
Family	Species	Common Name	Camp	Coongan north	Coongan south	Haul road	Outcamp creek	Outcamp east	Outcamp west	Plant	PMM	CH01	CH02	CH03	CH04	CH05	CH06	CH07	Opportunistic	Minga Well	Moojarri Well	OB1	OB1A	OB2	OB3	OB4	OB5	Site A	Site B	Site C	Site D	Site E	Site G	Site H					
	Mormopterus beccarii											X			X																								
Vespertilionidae	*Chalinolobus gouldii*											X	X	X	X	X	X	X	X																				
	Nyctophilus geoffroyi													X	X		X	X		1																		
	Scotorepens greyii											X	X	X	X	X	X	X	X	3																		
	Vespadelus finlaysoni											X	X	X	X		X	X	X																			
Dasyuridae	*Dasykaluta rosamondae*			1	1					1					3	6	2	26														1					
	Dasyurus hallucatus			4			4	3	1																													
	Ningaui timealeyi											1	6					10												1			1					
	Planigale sp.		1		2	2							1																	1								
	Sminthopsis macroura				1	4								2			2											1										
Macropodidae	*Macropus robustus*														1	1			3																			
Leporidae	*Oryctolagus cuniculus*											1	1																									
Muridae	*Leggadina lakedownensis*																		2																			
	Mus musculus								1				5		1			3																				
	Notomys alexis														1																							
	Pseudomys chapmani										73	X				X		X	X																			
	Pseudomys desertor				3	1			2			3	3	2	2	2	3	15										1		3							
	Pseudomys hermannsburgensis											3		9	8	8	5	11																			
	Zyzomys argurus						1						8						1																			1
Amphibians																																						
Hylidae	*Litoria rubella*																	1	1	1																		
Limnodynastidae	*Neobatrachus aquilonius*					1																																
Reptiles																																						
Agamidae	*Amphibolurus longirostris*			4			1						1	5	1		1		2											1		2					
	Ctenophorus caudicinctus		2	2	1		2	2				6	1	17	5	26	23		1 2							1					2	10		2		
	Ctenophorus isolepis											2							2																		
	Ctenophorus nuchalis															1																					
	Ctenophorus reticulatus													1			1											1									
	Pogona minor											1				1		2																			
Boidae	*Antaresia stimsoni*																1		2																		
	Aspidites melanocephalus																		1	1																	
Carphodactylidae	*Nephrurus wheeleri*											2		1	1																						
Diplodactylidae	*Diplodactylus savagei*				1								3																								
	Lucasium stenodactylus													1		4																					
	Lucasium wombeyi				1											1	2																				
	Oedura marmorata																		1																		
	Strophurus elderi												2																								
	Strophurus wellingtonae													1	1	1	1																				
Elapidae	*Acanthophis wellsi*												3	1																							

		Fauna Surveys	A									B								C																				
Family	Species	Common Name	Camp	Coongan north	Coongan south	Haul road	Outcamp creek	Outcamp east	Outcamp west	Plant	PMM	CH01	CH02	CH03	CH04	CH05	CH06	CH07	Opportunistic	Minga Well	Moojarri Well	OB1	OB1A	OB2	OB3	OB4	OB5	Site A	Site B	Site C	Site D	Site E	Site G	Site H
	Brachyurophis approximans											1	1		1	1																		
	Demansia psammophis													2		3																		
	Demansia rufescens											1		1		1	1	1																
	Furina ornata			1			1																											
	Pseudechis australis																	2	6															
	Pseudonaja modesta																	1																
	Pseudonaja nuchalis													1		1																		
Gekkonidae	*Gehyra pilbara*			1					1																									
	Gehyra punctata												10																					
	Gehyra variegata							2				20	2	2	2	21	7	4	3			1		1			1		2		2			
	Heteronotia binoei				1	1	1			1		9	15	3	1	2		4											1	4	3			
	Heteronotia spelea																		1															1
	Rhynchoedura ornata													1	1	2		1																
Pygopodidae	*Delma elegans*												3																					
	Delma nasuta						2			1		1	1					1																
	Delma pax				1		2					1	1	1				1																
	Delma tincta											1						1																
	Lialis burtonis											2				1			1															
	Pygopus nigriceps														1			1																
Scincidae	*Carlia munda*						1			1		8		4	1	8	3	8	3											1		2	1	
	Carlia triacantha																																	
	Cryptoblepharus buchananii															1																	1	
	Ctenotus duricola														1																			
	Ctenotus grandis														5			8																
	Ctenotus helenae											4		4		1		1																
	Ctenotus pantherinus													2	1	2	6	10														3		
	Ctenotus piankai				1																													
	Ctenotus rubicundus												4	1																				1
	Ctenotus saxatilis			2		4	2	3	6	1		4	22	53	28	20	11	16												1				1
	Ctenotus uber											3																						
	Cyclodomorphus melanops					1						1	1				1													2				
	Lerista muelleri	1										1	2	1	1	1	1															4		
	Menetia greyii											1	2															1	1					
	Morethia ruficauda				2			2					2																					2
	Proablepharus reginae												1	2																				
	Tiliqua multifasciata		1	2											1	1	1	4										1		1	1		
Typhlopidae	*Ramphotyphlops ammodytes*												1																		1		
	Ramphotyphlops grypus	1													1			1												1			
Varanidae	*Varanus acanthurus*					1		1				1	2	4	4	3	14	3													2		1

		Fauna Surveys	A									B								C																			
Family	Species	Common Name	Camp	Coongan north	Coongan south	Haul road	Outcamp creek	Outcamp east	Outcamp west	Plant	PMM	CH01	CH02	CH03	CH04	CH05	CH06	CH07	Opportunistic	Minga Well	Moojarri Well	OB1	OB1A	OB2	OB3	OB4	OB5	Site A	Site B	Site C	Site D	Site E	Site G	Site H					
	Varanus brevicauda																												1		1							
	Varanus bushi											1					1								1		2						1						
	Varanus caudolineatus											2							1																				
	Varanus eremius																	1																				
	Varanus panoptes																		1																				
	Varanus tristis											1	2		2				2											1									

A = Bamford Consulting Ecologists (2009) *Fauna Assessment of the BC Iron Nullagine Iron Ore Project*. Unpublished report for Astron Environmental Services, Perth.
B = ecologia Environment (2008) RGP5 Level 2 Fauna Survey Chichester Deviation. Unpublished report for BHPBIO; Perth.
C = Davis, R.A., Wilcox, J.A., Metcalf, B.M. Bamford, M.J. (2005) *Fauna survey of proposed Iron Ore Mine, Cloud Break.* Unpublished report for Fortescue Metals Group, Perth.
PMM = Pebble-mound Mouse mounds.
X = presence only recorded.

APPENDIX A2
VERTEBRATE FAUNA CAUGHT OR OBSERVED IN OTHER FAUNA SURVEYS UNDERTAKEN IN THE VICINITY OF THE PROPOSED PROJECT AREA

		Fauna Surveys	A												B																									
Family	**Species**	**Common Name**	**FMG12**	**FMG17**	**FMG18**	**FMG19**	**FMG20f**	**FMG21**	**FMG22**	**FMG23**	**FMG24**	**FMG25**	**FMG25f**	**FMG26f**	**Opportunistic**	**FMC01**	**FMC02**	**FMC03**	**FMC04**	**FMC05**	**FMR01**	**FMR14**	**FMR15**	**FMR16**	**FMR17**	**FMR18**	**FMR57**	**FMR58**	**FMR59**	**FMR60**	**FMR61**	**FMR63**	**FMR67**	**FMR69**	**FMR71**	**FMR73**	**FMR75**
Birds																																								
Accipitridae	*Elanus axillaris*	Black-shouldered Kite																			1																		
	Haliastur sphenurus	Whistling Kite		1			1						2			1			1			1																	
	Accipiter fasciatus	Brown Goshawk															5																		3			
	Accipiter cirrocephalus	Collared Sparrowhawk																							1													
	Circus assimilis	Spotted Harrier							1							1			1	1	1	3		1														
	Aquila audax	Wedge-tailed Eagle																					1	1		2												
	Hieraaetus morphnoides	Little Eagle	1																																			
Anatidae	*Anas superciliosa*	Pacific Black Duck								6					6																							
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar		1											1																							
Apodidae	*Apus pacificus*	Fork-tailed Swift	10				7			1																												
Podargidae	*Podargus strigoides*	Tawny Frogmouth								2					1																							
Casuariidae	*Dromaius novaehollandiae*	Emu					1				1			1		3																						
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew													2																							
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel								2	5																											
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt													1																							
Turnicidae	*Turnix velox*	Little Button-quail					2									1	2	8				1		1	2	4						1	1					
Ardeidae	*Ardea alba*	Great Egret															1																					
	Egretta novaehollandiae	White-faced Heron									1																											
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork			1					1																											
Columbidae	*Phaps chalcoptera*	Common Bronzewing																															1				
	Ocyphaps lophotes	Crested Pigeon							5		2		1					1	9		1	6		1	6	1					1		1	2			
	Geophaps plumifera	Spinifex Pigeon			5	6			3		3		1																								
	Geopelia cuneata	Diamond Dove		1		1				6						1			1	1		9												2	5		
	Geopelia striata	Peaceful Dove																	2		9																
Alcedinidae	*Dacelo leachii*	Blue-winged Kookaburra													1						1	2															
	Todiramphus pyrrhopygius	Red-backed Kingfisher						1			2								1		1		1			2												
	Todiramphus sanctus	Sacred Kingfisher								1	3																											
Meropidae	*Merops ornatus*	Rainbow Bee-eater								4	7					3	2	6			8			1	3		2			4	5	1					
Cuculidae	*Centropus phasianinus*	Pheasant Coucal																				2															
	Chalcites basalis	Horsfield's Bronze-Cuckoo					1	1	1							1	2		2			3	1	1	1	3					1						
	Cacomantis pallidus	Pallid Cuckoo		1							1								2	1		2		1	3												
Caprimulgidae	*Eurostopodus argus*	Spotted Nightjar													2																						
Falconidae	*Falco cenchroides*	Nankeen Kestrel		1									1	1				1	2			1	4				1					4					
	Falco berigora	Brown Falcon					3	2	1		1								2														1				

		Fauna Surveys	A													B																					
Family	**Species**	**Common Name**	**FMG12**	**FMG17**	**FMG18**	**FMG19**	**FMG20f**	**FMG21**	**FMG22**	**FMG23**	**FMG24**	**FMG25**	**FMG25f**	**FMG26f**	**Opportunistic**	**FMC01**	**FMC02**	**FMC03**	**FMC04**	**FMC05**	**FMR01**	**FMR14**	**FMR15**	**FMR16**	**FMR17**	**FMR18**	**FMR57**	**FMR58**	**FMR59**	**FMR60**	**FMR61**	**FMR63**	**FMR67**	**FMR69**	**FMR71**	**FMR73**	**FMR75**
	Falco berigora berigora	Brown Falcon																					2														
	Falco longipennis	Australian Hobby																												1		2					
	Falco hypoleucos	Grey Falcon													3																						
	Falco peregrinus	Peregrine Falcon			1																	1															
Phasianidae	*Coturnix ypsilophora*	Brown Quail																			15				6												
Otididae	*Ardeotis australis*	Australian Bustard	1											1		1	2					3	8		1	1						1					
Acanthizidae	*Pyrrholaemus brunneus*	Redthroat															1	2		2																	
	Smicrornis brevirostris	Weebill									10						4		2	10							1			3		1		3	4	1	4
	Gerygone fusca	Western Gerygone															2	1		4				1	7									1	1		
	Acanthiza robustirostris	Slaty-backed Thornbill		9												2				4																	
	Acanthiza apicalis	Inland Thornbill														2																					
	Acanthiza uropygialis	Chestnut-rumped Thornbill		24			1									31	2	13		19				15		10		6			6	5	3				
Acrocephalidae	*Cincloramphus mathewsi*	Rufous Songlark	1				1		1					1		1	1	2	1		1	18	2	1	3	1											
	Cincloramphus cruralis	Brown Songlark					11															9	2		2												
	Eremiornis carteri	Spinifexbird				6			1				2	6			1																2	2			
Alaudidae	*Mirafra javanica*	Horsfield's Bushlark			9		1	3										1				104	7	5	7	8											
Artamidae	*Artamus personatus*	Masked Woodswallow																							14												
	Artamus cinereus	Black-faced Woodswallow	2	1		5	20	3	2					3		8	2		4		3	11	2		33	24	4					1					
	Cracticus torquatus	Grey Butcherbird	1	6												4	2	1		2		1		1		4		1				3	3	3			
	Cracticus nigrogularis	Pied Butcherbird				3	1		1	3	1			3			1		2		1	2	3	1	3	1	4		2	1			1	1			
	Cracticus tibicen	Australian Magpie									1											3															
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-Shrike	2			1				4	6			1		1	2				3	8		1	3					2	1	1			1		
	Lalage sueurii	White-winged Triller					1															10	7		5	2											
Corvidae	*Corvus bennetti*	Little Crow																																	11		
	Corvus orru	Torresian Crow	1	1	2		1	1	1	3	3		1	2			4		1		1	1	2		2					1				1			
Estrildidae	*Taeniopygia guttata*	Zebra Finch	14	8		4	218	27	8	6	12		5	11		43	137	86	25	47	56	378	31	10	133	117	14	1		26	3	22	5	2	18	3	
	Emblema pictum	Painted Finch				10			7	2	1			10																				8	10		4
Eupetidae	*Cinclosoma castaneothorax*	Chestnut-breasted Quail-thrush																	2																		
Hirundinidae	*Petrochelidon ariel*	Fairy Martin													1																						
Maluridae	*Malurus leucopterus*	White-winged Fairy-wren	2				28	1	2				3	2			3	11	15	8		20	18	4	8	25	5				9		9			1	
Maluridae	*Malurus lamberti*	Variegated Fairy-wren		8	4					4	5					42	23	36	5	31		5		11	5	44		4		2		3	2	4	3		
	Amytornis striatus	Striated Grasswren								2	3			1																							
Meliphagidae	*Lichenostomus virescens*	Singing Honeyeater	1	10	4	5	4	1	2				2	2		3	7	30	17	17		21	9	9	12	6	6				2	2	1	5	1	3	
	Lichenostomus keartlandi	Grey-headed Honeyeater																											3						3		3
	Lichenostomus penicillatus	White-plumed Honeyeater								12	8					23	11				26									3							
	Manorina flavigula	Yellow-throated Miner		3		2			2				5					3	9	28	1	1			2	3	9		2					3	8		
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater	3	12				1								5	5	79	8	7		4	6	3		6	4	3		1	2	1	2	4			
	Epthianura tricolor	Crimson Chat					113	19																													
	Lichmera indistincta	Brown Honeyeater							1	4	4						2	28	5	7							11	2	3					2	6		1

		Fauna Surveys	A													B																					
Family	**Species**	**Common Name**	**FMG12**	**FMG17**	**FMG18**	**FMG19**	**FMG20f**	**FMG21**	**FMG22**	**FMG23**	**FMG24**	**FMG25**	**FMG25f**	**FMG26f**	**Opportunistic**	**FMC01**	**FMC02**	**FMC03**	**FMC04**	**FMC05**	**FMR01**	**FMR14**	**FMR15**	**FMR16**	**FMR17**	**FMR18**	**FMR57**	**FMR58**	**FMR59**	**FMR60**	**FMR61**	**FMR63**	**FMR67**	**FMR69**	**FMR71**	**FMR73**	**FMR75**
Monarchidae	*Grallina cyanoleuca*	Magpie-Lark		1				1		3	5					3							1							1							
Motacilidae	*Anthus novaeseelandiae*	Australasian Pipit	1		2											1			1																		
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird							1		1					1	7				3	5				1											
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella																							3												
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler		10						1						17	10	2	1	9	2	5		10	10	10		2			4	1	3	3	4	1	
	Colluricincla harmonica	Grey Shrike-thrush														5						1															
	Oreoica gutturalis	Crested Bellbird		7		2										4	1	1	1	2		6		6	3	3		2	1			2	1	2			
Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote															2	3									1					1			1		
Petroicidae	*Petroica goodenovii*	Red-capped Robin		3												1				1				5								1					
	Melanodryas cucullata	Hooded Robin		2																					2	1											
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler														4				2																	
	Pomatostomus superciliosus	White-browed Babbler														8	4	8		11				5		9		1			8						
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	3	6			1	1		2	1					4	1	1	1			4	6		6	4	1				1	1	1	2	1	2	
Anhingidae	*Anhinga melanogaster*	Australasian Darter													1																						
Cacatuidae	*Eolophus roseicapillus*	Galah	2		20		2						6			1		4			9	14	16		4		2	2				1	1	2			
	Cacatua sanguinea	Little Corella	6								39											8															
	Nymphicus hollandicus	Cockatiel					2		3																					9	9						
Psittacidae	*Barnardius zonarius*	Australian Ringneck														3	1		1	1	14						1			3		1		1			
	Psephotus varius	Mulga Parrot																																			
	Melopsittacus undulatus	Budgerigar	5	11	7	10	4	15		6	24		11	13		12		5	26			20		7				1						1			
Strigidae	*Ninox novaeseelandiae*	Southern Boobook													1					1																	
Mammals																																					
Camelidae	*Camelus dromedarius*													1																							
Canidae	*Canis lupus*													5								1	2														
Felidae	*Felis catus*		1																						1												
Molossidae	*Chaerephon jobensis*					X																															
Vespertilionidae	*Chalinolobus gouldii*					X						X																									
	Scotorepens greyii					X						X																									
	Vespadelus finlaysoni											X																									
Dasyuridae	*Dasycercus cristicauda*														1																						
	Dasykaluta rosamondae												2																								
	Dasyurus hallucatus														1																						
	Ningaui timealeyi					1		3	2					1																							
	Planigale sp.			2			1		1													3	2	4		1											
	Sminthopsis macroura		1					3										2			5	2	2	4	3												
	Sminthopsis youngsoni																																				
Macropodidae	*Macropus robustus*							8																													
	Macropus rufus																					1															
Tachyglossidae	*Tachyglossus aculeatus*														1																						

		Fauna Surveys	A													B																					
Family	**Species**	**Common Name**	**FMG12**	**FMG17**	**FMG18**	**FMG19**	**FMG20f**	**FMG21**	**FMG22**	**FMG23**	**FMG24**	**FMG25**	**FMG25f**	**FMG26f**	**Opportunistic**	**FMC01**	**FMC02**	**FMC03**	**FMC04**	**FMC05**	**FMR01**	**FMR14**	**FMR15**	**FMR16**	**FMR17**	**FMR18**	**FMR57**	**FMR58**	**FMR59**	**FMR60**	**FMR61**	**FMR63**	**FMR67**	**FMR69**	**FMR71**	**FMR73**	**FMR75**
Thylacomyidae	*Macrotis lagotis*																								2												
Equidae	*Equus asinus*																				4					1											
	Equus caballus																					5															
Muridae	*Leggadina lakedownensis*						2									1					1			2	1												
	Mus musculus																1	5		1	1	1			1	1											
	Pseudomys delicatulus									1																											
	Pseudomys desertor							1									3																				
	Pseudomys hermannsburgensis		10					1										1	1	3																	
	Zyzomys argurus		1																																		
Amphibians																																					
Hylidae	*Cyclorana australis*														2																						
	Cyclorana maini		10	6				9		16	74		6	148																							
	Litoria rubella							2		25	1			3																							
Limnodynastidae	*Notaden nichollsi*									3	1			4																							
	Opisthodon spenceri									6	39		4	77																							
Myobatrachidae	*Uperoleia russelli*									14	26			3																							
Reptiles																																					
Agamidae	*Amphibolurus longirostris*									1							5				5			1													
	Caimanops amphiboluroides				1			2	3	1						8	6	4	9	6					2	1											
	Ctenophorus isolepis		5											1																							
	Ctenophorus reticulatus															1																					
	Pogona minor																								1												
	Tympanocryptis cephalus						1																														
Boidae	*Antaresia perthensis*				1										1																						
	Antaresia stimsoni														10																						
	Aspidites melanocephalus														4																						
Carphodactylidae	*Nephrurus levis pilbarensis*												1		1																						
Diplodactylidae	*Diplodactylus conspicillatus*		6						1																												
	Lucasium stenodactylus		1	2	4				1				1		1																						
	Lucasium wombeyi							3											6																		
	Strophurus elderi								1				3																								
	Strophurus jeanae		4																																		
	Strophurus wellingtonae		1		1	2		1									3	2	1	2																	
Elapidae	*Brachyurophis approximans*										1																										
	Demansia psammophis		1	3	2		1																		2												
	Demansia rufescens														1																						
	Furina ornata										1																										
	Pseudechis australis						1								6																						
	Suta fasciata								1																												

		Fauna Surveys	A													B																												
Family	Species	Common Name	FMG12	FMG17	FMG18	FMG19	FMG20f	FMG21	FMG22	FMG23	FMG24	FMG25	FMG25f	FMG26f	Opportunistic	FMC01	FMC02	FMC03	FMC04	FMC05	FMR01	FMR14	FMR15	FMR16	FMR17	FMR18	FMR57	FMR58	FMR59	FMR60	FMR61	FMR63	FMR67	FMR69	FMR71	FMR73	FMR75
	Suta punctata														1																												
Gekkonidae	*Gehyra variegata*					5										5	2	12		3				4	3	1																	
	Heteronotia binoei			1				3	1				1				1																										
	Heteronotia spelea																																										
Pygopodidae	*Delma nasuta*									2				1																													
	Delma pax							2		1			2	1		2	1	2		1	2																						
	Delma tincta			1		1		3	2	2	1			1																													
	Lialis burtonis		1					1		1			1																														
Scincidae	*Carlia munda*			6				1			4					5	1			3					1																	
	Carlia triacantha		1				1																																			
	Ctenotus duricola							2	1				2																														
	Ctenotus grandis titan		2							1	2		1																														
	Ctenotus helenae					1		1	2																																		
	Ctenotus pantherinus		1					2					1			5			1																								
	Ctenotus rubicundus							1																																		
	Ctenotus saxatilis							1	1		3						5	3	1																							
	Ctenotus uber							1																																		
	Cyclodomorphus melanops							4	3								2																									
	Lerista bipes								2	1				2																													
	Lerista muelleri			1	3	2										3		2		2			1	8	2	1																
	Menetia greyii			3	1	1								1		2		2						3	1	1																
	Proablepharus reginae							2																																		
	Tiliqua multifasciata							1		1				1																													
Typhlopidae	*Ramphotyphlops ammodytes*		3	3	1	3			2	1								1																								
	Ramphotyphlops ganei																																									
	Ramphotyphlops grypus								1																																	
Varanidae	*Varanus acanthurus*							1	1																																	
	Varanus brevicauda										2																															
	Varanus eremius		1								1																															
	Varanus panoptes rubidus														1																											
Cheluidae	*Chelodina steindachneri*													1																												

A = Biota Environmental Services (2004) *Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor*. Unpublished report to the Fortescue Metals Group Ltd, Perth.

B = Biota Environmental Sciences (2005) *Fauna Habitats and Fauna Assemblages of the Proposed FMG Stage B Rail Corridor and Mindy Mindy; Christmas Creek; Mt Lewin and Mt Nicholas Mines Areas*. Unpublished report for Fortescue Metals Group, Perth.

X = presence only recorded.

APPENDIX A3
VERTEBRATE FAUNA CAUGHT OR OBSERVED IN OTHER FAUNA SURVEYS UNDERTAKEN IN THE VICINITY OF THE PROPOSED PROJECT AREA

		Fauna Surveys	A																	B	C														
Family	**Species**	**Common Name**	**D2**	**D3**	**D4**	**D5**	**E1e**	**E2**	**E3**	**HAD1**	**HAD2**	**HAD3**	**HAD4**	**HAD5**	**HAD6**	**HAE1**	**HAE2**	**HAE3**	**Opportunistic**		**Opportunistic**	**Site 1**	**Site 10**	**Site 11**	**Site 12**	**Site 13**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Birds																																			
Accipitridae	*Elanus axillaris*	Black-shouldered Kite										1	1		2			1	9							2									
	Hamirostra melanosternon	Black-breasted Buzzard																	2																
	Haliastur sphenurus	Whistling Kite								1		1							21		6					12				1					
	Haliastur indus	Brahminy Kite																	13																
	Milvus migrans	Black Kite																	3																
	Accipiter fasciatus	Brown Goshawk								1									7											1	2				
	Accipiter cirrocephalus	Collared Sparrowhawk																												1					
	Accipiter novaehollandiae	Grey Goshawk																						1		1				1	6	4		2
	Circus assimilis	Spotted Harrier																	4																
	Aquila audax	Wedge-tailed Eagle											2						3																
	Hieraaetus morphnoides	Little Eagle																	6		1														
Anatidae	*Chenonetta jubata*	Australian Wood Duck																	3																
	Anas gracilis	Grey Teal																	11																
	Anas superciliosa	Pacific Black Duck																	96																
	Aythya australis	Hardhead																			3														
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar																	1		1														
Apodidae	*Apus pacificus*	Fork-tailed Swift																																	
Podargidae	*Podargus strigoides*	Tawny Frogmouth																	15		4														
Casuariidae	*Dromaius novaehollandiae*	Emu									1						1		5													1			
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew																	5		2														
Charadriidae	*Charadrius ruficapillus*	Red-capped Plover																	5																
	Elseyornis melanops	Black-fronted Dotterel																	76																
	Erythrogonys cinctus	Red-kneed Dotterel																			1														
Haematopodidae	*Oystercatcher haematopus*	South Island Pied Oystercatcher																	5																
Laridae	*Gelochelidon nilotica*	Gull-billed Tern																	25																
	Hydroprogne caspia	Caspian Tern																	3																
	Thalasseus bergii	Crested Tern																	2																
	Chroicocephalus novaehollandiae	Silver Gull																	38																
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt																	53																
Scolopacidae	*Numenius phaeopus*	Whimbrel																	97																
	Numenius madagascariensis	Eastern Curlew																	1																
	Actitis hypoleucos	Common Sandpiper																	10																
	Tringa brevipes	Grey-tailed Tattler																	4																
	Tringa glareola	Wood Sandpiper																			1														

		Fauna Surveys	A																	B	C																
Family	Species	Common Name	D2	D3	D4	D5	E1e	E2	E3	HAD1	HAD2	HAD3	HAD4	HAD5	HAD6	HAE1	HAE2	HAE3	Opportunistic		Opportunistic	Site 1	Site 10	Site 11	Site 12	Site 13	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Turnicidae	*Turnix velox*	Little Button-quail									1	1	2		1		1	2	6				4	1		9			3	1	1	4	1	1
Ardeidae	*Ardea alba*	Great Egret																	11															
	Ardea pacifica	White-necked Heron																	6		2					1								
	Ardea modesta	Eastern Great Egret																								7								
	Butorides striatus	Striated Heron																	5															
	Egretta novaehollandiae	White-faced Heron										1	1						87															
	Egretta garzetta	Little Egret																	18															
	Nycticorax caledonicus	Nankeen Night Heron																	13															
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork																	5															
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican											5						14															
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis																	7															
	Threskiornis spinicollis	Straw-necked Ibis																	1															
	Platalea regia	Royal Spoonbill																								6								
Columbidae	*Phaps chalcoptera*	Common Bronzewing								3		1							2		1					2					1	1		1
	Ocyphaps lophotes	Crested Pigeon								3		15			1		1	1	38		15	2	1	4	6	28		26	14	26	9	4	4	
	Geophaps plumifera	Spinifex Pigeon											6	6			7		47		3	1												
	Geopelia cuneata	Diamond Dove								22	1	23					2		84		15		6	1	1	4	1		15	4	7	5	34	6
	Geopelia striata	Peaceful Dove																	1		14					7					3			
	Geopelia humeralis	Bar-shouldered Dove																	1															
Alcedinidae	*Dacelo leachii*	Blue-winged Kookaburra																	10		1			2		1						4		
	Todiramphus pyrrhopygius	Red-backed Kingfisher											1						11		18			1	2						1	1		1
	Todiramphus sanctus	Sacred Kingfisher																	2															
Meropidae	*Merops ornatus*	Rainbow Bee-eater								7	7	10	14						20		9			2		11			2		15			
Cuculidae	*Centropus phasianinus*	Pheasant Coucal																	1															
	Chalcites basalis	Horsfield's Bronze-Cuckoo								1	1						3	1	2			1	1			1			2	3	3		2	1
	Chalcites osculans	Black-eared Cuckoo								2	1						1		2													1		
	Cacomantis pallidus	Pallid Cuckoo								1				1			2		3			4	4	2	1	2			2	1		4	4	
Caprimulgidae	*Eurostopodus argus*	Spotted Nightjar																	53		6													
Falconidae	*Falco cenchroides*	Nankeen Kestrel								2		1			1			4	20		2	1			1									
	Falco berigora	Brown Falcon								1								1	41		2	5	1	2	5	2				1	4			
	Falco berigora berigora	Brown Falcon																																
	Falco longipennis	Australian Hobby																	4					1		1							1	
	Falco hypoleucos	Grey Falcon																								2								
	Falco peregrinus	Peregrine Falcon													1				1							1								
Otididae	*Ardeotis australis*	Australian Bustard								1	1						2		11		2												1	
Acanthizidae	*Smicrornis brevirostris*	Weebill								2	23	7	15	10					1		1	1				1			1		2		3	2
	Gerygone fusca	Western Gerygone								10	1																				3			
	Gerygone tenebrosa	Dusky Gerygone																	10															
	Acanthiza robustirostris	Slaty-backed Thornbill																			1													

		Fauna Surveys	A																	B	C															
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	Acanthiza uropygialis	Chestnut-rumped Thornbill								42	30			1							22		17	5					25	1		2		
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Wabler											5						5															
	Cincloramphus mathewsi	Rufous Songlark											1						2		1		1	3		17			1		13	6		
	Cincloramphus cruralis	Brown Songlark																	4															
	Eremiornis carteri	Spinifexbird									3						2	5	1		2				3								12	7
Alaudidae	*Mirafra javanica*	Horsfield's Bushlark													24	8			10										5	1				
Artamidae	*Artamus personatus*	Masked Woodswallow										10											1	1	4	331							17	1
	Artamus superciliosus	White-browed Woodswallow																	11															
	Artamus cinereus	Black-faced Woodswallow									7								107		16	6	5	4	22	3		5	17	24	15	20	4	2
	Artamus minor	Little Woodswallow									6	11	4		4		22				1													
	Cracticus torquatus	Grey Butcherbird								8	6	3							4		2			2				3	11	10	4	1	3	
	Cracticus nigrogularis	Pied Butcherbird								1	1	1	2	1			1		17		3	11	7	13	6	15	3	5	12	8	12	14	8	9
	Cracticus tibicen	Australian Magpie										1							10							1			1					
Campephagidae	*Coracina maxima*	Ground Cuckoo-Shrike																								1								
	Coracina novaehollandiae	Black-faced Cuckoo-Shrike								2		3	3						26		13	6		4	10	10			6	5	7	3	4	2
	Lalage sueurii	White-winged Triller										1							8		3	2		1		22			2		6	7	2	
Corvidae	*Corvus bennetti*	Little Crow																	8		8							4	4		6			
	Corvus orru	Torresian Crow											2		2				1		1		1	3		3			2			2	1	
Estrildidae	*Taeniopygia guttata*	Zebra Finch									4	99	67		7	88	22	5	401		52	2	45	78	37	66		141	39	12	228	63	33	17
	Neochmia ruficauda	Star Finch																								14								
	Emblema pictum	Painted Finch										14	33	2	2	2		2	53	1	9			1	5								4	39
Eupetidae	*Cinclosoma castanotum*	Chestnut Quail-thrush																						4									1	
Hirundinidae	*Petrochelidon nigricans*	Tree Martin								2			3						8		1													
	Petrochelidon ariel	Fairy Martin														4			1															
Maluridae	*Malurus leucopterus*	White-winged Fairy-wren										1					4	6	27		1				14						4			
	Malurus lamberti	Variegated Fairy-wren								24	21	14	3				2	2	34		10		6		3			9	25	21	17	1		2
	Stipiturus ruficeps	Rufous-crowned Emu-wren														6		4	3															
	Amytornis striatus	Striated Grasswren																																2
Meliphagidae	*Certhionyx variegatus*	Pied Honeyeater																							9									
	Lichenostomus virescens	Singing Honeyeater								20	23	9	1	1	5	3	7	11	44		41	7	23	19	39	1	14	30	57	28	43	41	17	37
	Lichenostomus keartlandi	Grey-headed Honeyeater															2		13					8						6	2		2	6
	Lichenostomus penicillatus	White-plumed Honeyeater										9	20						27		25	1		16	34	46		2			72	5		
	Manorina flavigula	Yellow-throated Miner								1		5	5		4				36		13	6	2		4	2		4	10	28	15	4		4
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater								13	10	4	1						4		4	4	1	12	15				22	10	9	1	7	9
	Epthianura tricolor	Crimson Chat																	21		1		5		2				2	8	2	6	1	
	Sugomel niger	Black Honeyeater																	14		2	15		3	10								25	30
	Lichmera indistincta	Brown Honeyeater										8					2	1	30		4	32	1	26	56			2		13	32		43	51
Monarchidae	*Grallina cyanoleuca*	Magpie-Lark										4	2						41		7					23		1	1	1		2		
Motacilidae	*Anthus novaeseelandiae*	Australasian Pipit																	1		1	1												

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Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird										2							1												3			
Pachycephalidae	*Pachycephala melanura*	Mangrove Golden Whistler																	11															
	Pachycephala rufiventris	Rufous Whistler								8	6		2	3					12		30		22	17		5		9	18		29	4		2
	Colluricincla harmonica	Grey Shrike-thrush								3	8	2	3	4							3	1							4		10		3	3
	Oreoica gutturalis	Crested Bellbird								6	6		2				2		3		3	2	11	8	4	4	1	8	13	12	6	7	8	1
Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote										1	1						3					2		8					1	2		
Petroicidae	*Petroica goodenovii*	Red-capped Robin									4								2		2		4						1					
	Melanodryas cucullata	Hooded Robin										1			2									2					3					4
	Peneonanthe pulverulenta	Mangrove Robin																	6															
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler								6									1		6			7		17		12	2	11	15	7		
	Pomatostomus superciliosus	White-browed Babbler								19	10												6						17	14	4			
Ptilonorhynchidae	*Ptilonorhynchus guttatus*	Western Bowerbird																	2															
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail								2													1											
	Rhipidura phasiana	Mangrove Grey Fantail																	10															
	Rhipidura leucophrys	Willie Wagtail								5	4	6	6	3	2		1	1	43		15	1	5	14	3	6			2	8	9	6	10	4
Timaliidae	*Zosterops lutea*	Yellow White-eye																	95															
Anhingidae	*Anhinga melanogaster*	Australasian Darter																	12															
Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant																	13															
	Phalacrocorax sulcirostris	Little Black Cormorant											30		40				357		1													
	Phalacrocorax varius	Pied Cormorant																	4															
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe																	11															
Cacatuidae	*Eolophus roseicapillus*	Galah											14						59															
	Cacatua sanguinea	Little Corella																	528		28	2	2	5	3	17		6	10	36		2	14	
	Nymphicus hollandicus	Cockatiel								6	11	11	7				4		201		401		14	11	8	46				7	15	2	9	8
Psittacidae	*Barnardius zonarius*	Australian Ringneck								8	2	1	6			3	4		8		14		1	9	2	10		2			27	3		
	Psephotus varius	Mulga Parrot																	1															
	Melopsittacus undulatus	Budgerigar								1				1					15		157	162	83	20	3	549		1	38	5	35	61	16	9
Strigidae	*Ninox novaeseelandiae*	Southern Boobook																	6		1													
Mammals																																		
Bovidae	*Bos taurus*																				X		X	X		X			X	X	X	X		
Canidae	*Canis lupus*									1	3		2	2		2	1	1	3															
	Vulpes vulpes																		1															
Felidae	*Felis catus*										1								3															
Megadermatidae	*Macroderma gigas*						X																											
Molossidae	*Austronomus australis*			X	X	X																												
	Chaerephon jobensis							X																										
	Mormopterus beccarii																				X													
Vespertilionidae	*Chalinolobus gouldii*		X					X	X												X	X								X	X		X	
	Nyctophilus bifax																				X										X			

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	Nyctophilus geoffroyi																				X				X	X					X						
	Scotorepens greyii				X	X															X				X	X			X	X							
	Vespadelus finlaysoni		X		X	X	1														X	X			X					X	X	X	X				
Dasyuridae	*Dasycercus cristicauda*																		1																		
	Dasykaluta rosamondae									2				1			2	3																			
	Dasyurus hallucatus																		3	1																	
	Ningaui timealeyi									6			1	2		2	1	3																			
	Planigale sp.																					1			3							1		1			
	Sminthopsis macroura															1							1	1		2				2	2	2					
	Sminthopsis youngsoni																	1																			
Macropodidae	*Macropus robustus*														1				13																		X
	Macropus rufus									1		2			20	1			3										X		X						
	Petrogale rothschildi																		3																		
Tachyglossidae	*Tachyglossus aculeatus*																		1																		
	Macrotis lagotis																		3																		
Equidae	*Equus asinus*									1	1							2			X	X							X								
Equidae	*Equus caballus*																				X																
Muridae	*Leggadina lakedownensis*												2		10	4																					
	Mus musculus										1	1											2			2		2	2		5					
	Pseudomys chapmani																		7	X																
	Pseudomys desertor										1	2																			1					
	Pseudomys hermannsburgensis									1	7		1				5	2						1		1				1						
	Zyzomys argurus													2																						
Amphibians																																					
Hylidae	*Cyclorana australis*																		2																		
	Litoria rubella																				5																
Myobatrachidae	*Uperoleia russelli*											1																									
Reptiles																																					
Agamidae	*Amphibolurus longirostris*											15							1		16		4	2		2		1	3	3	7	1				
	Caimanops amphiboluroides																												2		4	4				
	Ctenophorus caudicinctus									2			1						11		15	5	6	12	15	2	4		3	7			3	10			
	Ctenophorus isolepis																		2																		
	Ctenophorus nuchalis																		3																		
	Ctenophorus reticulatus																			2																	
	Pogona minor										1		1						1											1							1
Boidae	*Antaresia stimsoni*																		4																		
	Aspidites melanocephalus																		1																		
	Aspidites ramsayi																		2																		
Carphodactylidae	*Nephrurus wheeleri*																		1		1			1													

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Diplodactylidae	*Lucasium stenodactylus*																		1									1			2				
	Lucasium wombeyi																								1					2					
	Oedura marmorata													2																					
	Strophurus wellingtonae																		1											3					
Elapidae	*Brachyurophis approximans*																													2					
	Demansia psammophis												1								1			1											
	Furina ornata																		1		2														
	Pseudechis australis																									1									
	Pseudonaja nuchalis																														1				
	Suta fasciata																		1																
	Suta punctata																		3																
Gekkonidae	*Gehyra punctata*											1							3			5					1								
	Gehyra variegata											1							5		9	1	5	2	2	2		9	7	8	23	5		7	
	Heteronotia binoei										1	1							8		4					1	1	3			1				
	Heteronotia spelea																		1																
Pygopodidae	*Delma nasuta*																		4								1								
	Delma pax																								2	2		1	5	5	2				
	Delma tincta																	2									1								
	Lialis burtonis																		2																1
	Pygopus nigriceps																													1					
Scincidae	*Carlia munda*											1							2		6			1	1			5		15	11			2
	Carlia triacantha													1																					
	Cryptoblepharus buchananii														1																				
	Ctenotus duricola																	1							2								1	
	Ctenotus pantherinus										1		1	1				1	3					1	10				2		1		2	3
	Ctenotus robustus														4																				
	Ctenotus rubicundus																					2													
	Ctenotus rutilans																						1	7											2
	Ctenotus saxatilis										1								4		3	12		9	5	1	7	8	1	14	2		16	9
	Cyclodomorphus melanops																		21							1		1					1	
	Egernia depressa																		1																
	Eremiascincus richardsonii																											1		2					
	Lerista flammicauda																					2													
	Lerista muelleri										2								7							1		3	2	4	1				
	Menetia greyii										1					2			2											1	1				
	Morethia ruficauda																					1						1						1	1
	Morethia ruficauda exquisita												1						1																
	Proablepharus reginae																2																		
	Tiliqua multifasciata										1																								

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Family	**Species**	**Common Name**	**D2**	**D3**	**D4**	**D5**	**E1e**	**E2**	**E3**	**HAD1**	**HAD2**	**HAD3**	**HAD4**	**HAD5**	**HAD6**	**HAE1**	**HAE2**	**HAE3**	**Opportunistic**		**Opportunistic**	**Site 1**	**Site 10**	**Site 11**	**Site 12**	**Site 13**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Typhlopidae	*Ramphotyphlops ammodytes*																					2							1		3			
	Ramphotyphlops grypus																							1				1	3		1			
	Ramphotyphlops hamatus																															1		
Varanidae	*Varanus acanthurus*																		1			3			1		1					2	2
	Varanus bushi																		1															
	Varanus caudolineatus																						1				1		3			1		
	Varanus eremius																		1															
	Varanus giganteus																			1														
	Varanus panoptes																				7		1					1		1				
	Varanus tristis										1										4							2						

A = Biota Environmental Sciences (2002) *Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate Fauna Survey*. Unpublished report for Hope Downs Management Services.
B = Incidental records in Terrestrial Ecosystems database
C = Ecologia Environment (2009) *Hancock Prospecting Ltd Roy Hill Ore Project Vertebrate Fauna Assessment*. Unpublished report for Hancock Prospecting Pty Ltd, Perth.
X = presence only recorded.

APPENDIX A4

VERTEBRATE FAUNA CAUGHT OR OBSERVED IN OTHER FAUNA SURVEYS UNDERTAKEN IN THE VICINITY OF THE PROPOSED PROJECT AREA

		Fauna Surveys	A		B	C
Family	**Species**	**Common Name**	**Borefield**	**Infra. corridor**		
Birds						
Accipitridae	*Hamirostra melanosternon*	Black-breasted Buzzard	X			
	Haliastur sphenurus	Whistling Kite		X		
	Accipiter fasciatus	Brown Goshawk	X			
	Aquila audax	Wedge-tailed Eagle	X	X		
Podargidae	*Podargus strigoides*	Tawny Frogmouth		X		
Glareolidae	*Stiltia isabella*	Australian Pratincole	X			
Columbidae	*Phaps chalcoptera*	Common Bronzewing		X		
	Ocyphaps lophotes	Crested Pigeon	X	X		
	Geophaps plumifera	Spinifex Pigeon		X		
Alcedinidae	*Dacelo leachii*	Blue-winged Kookaburra		X		
	Todiramphus pyrrhopygius	Red-backed Kingfisher		X		
Meropidae	*Merops ornatus*	Rainbow Bee-eater	X	X		
Cuculidae	*Chalcites basalis*	Horsfield's Bronze-Cuckoo		X		
	Cacomantis pallidus	Pallid Cuckoo		X		
Falconidae	*Falco cenchroides*	Nankeen Kestrel		X		
	Falco berigora	Brown Falcon	X			
	Falco peregrinus	Peregrine Falcon		X		
Otididae	*Ardeotis australis*	Australian Bustard	X	X		
Acanthizidae	*Acanthiza robustirostris*	Slaty-backed Thornbill		X		
	Acanthiza uropygialis	Chestnut-rumped Thornbill	X	X		
Acrocephalidae	*Cincloramphus mathewsi*	Rufous Songlark	X			
Alaudidae	*Mirafra javanica*	Horsfield's Bushlark	X	X		
	Artamus cinereus	Black-faced Woodswallow	X	X		
	Cracticus torquatus	Grey Butcherbird		X		
	Cracticus nigrogularis	Pied Butcherbird	X	X		
	Cracticus tibicen	Australian Magpie		X		
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-Shrike	X	X		
	Lalage sueurii	White-winged Triller	X	X		
Corvidae	*Corvus orru*	Torresian Crow	X	X		
Estrildidae	*Taeniopygia guttata*	Zebra Finch	X	X		
	Emblema pictum	Painted Finch		X		
Maluridae	*Malurus leucopterus*	White-winged Fairy-wren	X	X		
	Malurus lamberti	Variegated Fairy-wren	X	X		
Meliphagidae	*Lichenostomus virescens*	Singing Honeyeater	X	X		
	Lichenostomus keartlandi	Grey-headed Honeyeater		X		
	Lichenostomus penicillatus	White-plumed Honeyeater	X	X		
	Purnella albifrons	White-fronted Honeyeater	X			
	Manorina flavigula	Yellow-throated Miner	X	X		
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater	X	X		
	Conopophila whitei	Grey Honeyeater		X		
	Lichmera indistincta	Brown Honeyeater		X		
Monarchidae	*Grallina cyanoleuca*	Magpie-Lark	X			
Motacilidae	*Anthus novaeseelandiae*	Australasian Pipit	X	X		
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird		X		
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella		X		
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	X	X		
	Colluricincla harmonica	Grey Shrike-thrush		X		
	Oreoica gutturalis	Crested Bellbird	X	X		
Petroicidae	*Petroica goodenovii*	Red-capped Robin		X		
	Melanodryas cucullata	Hooded Robin	X	X		
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	X	X		
	Pomatostomus superciliosus	White-browed Babbler		X		
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	X	X		
Cacatuidae	*Eolophus roseicapillus*	Galah	X	X		
	Cacatua sanguinea	Little Corella		X		
	Nymphicus hollandicus	Cockatiel		X		
Psittacidae	*Barnardius zonarius*	Australian Ringneck	X	X		
	Melopsittacus undulatus	Budgerigar	X	X		
Strigidae	*Ninox novaeseelandiae*	Southern Boobook	X	X		

		Fauna Surveys	A		B	C
Family	Species	Common Name	Borefield	Infra. corridor		
Mammals						
Bovidae	*Bos taurus*			X		
Emballonuridae	*Saccolaimus flaviventris*			X		
Megadermatidae	*Macroderma gigas*			X		
Molossidae	*Chaerephon jobensis*		X			
Vespertilionidae	*Chalinolobus gouldii*		X	X		
	Nyctophilus daedalus		X			
	Nyctophilus geoffroyi		X	X		
	Scotorepens greyii		X	X		
	Vespadelus finlaysoni			X	1	
Dasyuridae	*Dasykaluta rosamondae*				4	
	Dasyurus hallucatus				1	
	Ningaui timealeyi				9	
	Sminthopsis macroura			X	5	
	Sminthopsis youngsoni				4	
Macropodidae	*Macropus robustus*		X	X		
	Macropus rufus		X	X		
	Petrogale rothschildi				1	
Phalangeridae	*Trichosurus vulpecula*				1	
Thylacomyidae	*Macrotis lagotis*				1	
Equidae	*Equus caballus*			X		
Muridae	*Leggadina lakedownensis*				9	
	Pseudomys chapmani			X	7	15
	Pseudomys delicatulus				2	
	Pseudomys desertor				5	
	Pseudomys hermannsburgensis				16	
	Zyzomys argurus				3	
Amphibians						
Hylidae	*Cyclorana maini*				2	
Limnodynastidae	*Notaden nichollsi*				3	
	Opisthodon spenceri				1	
Myobatrachidae	*Uperoleia russelli*				3	
Reptiles						
Agamidae	*Amphibolurus longirostris*		X	X		
	Caimanops amphiboluroides			X	1	
	Ctenophorus caudicinctus		X	X	15	
	Ctenophorus nuchalis			X	1	
	Ctenophorus reticulatus				2	
	Pogona minor minor				3	
	Tympanocryptis cephalus			X		
Boidae	*Antaresia perthensis*			X		
	Antaresia stimsoni				1	
Carphodactylidae	*Nephrurus levis pilbarensis*				1	
	Nephrurus wheeleri				3	
Diplodactylidae	*Diplodactylus mitchelli*				7	
	Diplodactylus savagei				6	
	Lucasium stenodactylus				10	
	Lucasium wombeyi				3	
	Oedura marmorata				2	
	Strophurus elderi				5	
	Strophurus wellingtonae			X	5	
Elapidae	*Acanthophis wellsi*				1	
	Brachyurophis approximans				2	
	Demansia psammophis				9	
	Furina ornata				1	
	Pseudechis australis			X	2	
	Pseudonaja modesta				1	
	Pseudonaja nuchalis				3	
	Suta fasciata				3	
	Suta punctata				3	
Gekkonidae	*Gehyra pilbara*			X		
	Gehyra punctata			X	6	
	Gehyra variegata		X	X	21	
	Heteronotia binoei			X	7	
	Heteronotia spelea			X	4	

		Fauna Surveys	A		B	C
Family	Species	Common Name	Borefield	Infra. corridor		
	Rhynchoedura ornata				1	

A = ecologia Environment (2008) *Roy Hill Iron Ore Project - Proposed Infrastructure Supplementary Level 1 Terrestrial Vertebrate Fauna Survey*. Unpublished report for HPPL, Perth.

B = Western Australian Museum and other records.

C = Coffey Environments (2009) FMG Solomon railway spur line to Firetail.

X = presence only recorded.

APPENDIX B
RAPID HABITAT ASSESSMENT VARIABLES

Fauna habitat condition:

Fauna habitat within the proposed rail corridor was classified into one of five conditions as described below.

High quality fauna habitat – These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.

Very good fauna habitat - These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be minimally effected by disturbance.

Good fauna habitat – These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.

Disturbed fauna habitat– These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain weeds or have been damaged by vehicle or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.

Highly degraded fauna habitat – These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. Limited or no fauna habitat connectivity. Faunal assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance.

Fauna habitat type

Land forms at each survey site within the project area were categorised as:

- Ridge
- Upper slope
- Mid slope
- Water
- Undulating
- Flat
- Creekline
- Beach
- Wetland
- Water
- River
- Drainage line
- River
- Drainage line
- Dune Swale
- Rock Outcrop / Breakaway
- Intertidal / Mangrove

Fauna habitat soils

Soils at each survey site within the project area were categorised as:

- Yellow
- Black
- Red
- Grey
- Brown
- White

Soil horizons A and B, where they were known, were described as:

- Clay
- Sandy / Loam
- Gravel
- Peat / Organic
- Clay / Loam
- Sand
- Rock
- Stony

Fauna habitat vegetation

The vegetation was recorded for the upper, middle and lower stratums using the information contained in Table. B1.

TABLE B1.
VEGETATION STRUCTURE

Stratum	Canopy Cover				
	70%-100%	30%-70%	10%-30%	2%-10%	<2%
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland	Scattered Tall Trees
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Trees
Trees under 10m	Low Closed Forest	Open Forest	Low Woodland	Low Open Woodland	Scattered Low Trees
Shrubs over 2m	Tall Closed Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland	Scattered Tall Trees
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland	Scattered Shrubs
Shrubs under 1m	Low Closed Heath	Low Open Heath	Low Shrubland	Low Open Shrubland	Scattered Low Shrubs
Hummock Grasses	Closed Hummock Grassland	Mid-dense Hummock Grassland	Hummock Grassland	Open Hummock Grassland	Scattered Hummock Grasses
Grasses, Sedges and Herbs	Closed Tussock Grassland/ Sedgeland/ Herbland	Tussock Grassland/ Sedgeland/ Herbland	Open Tussock Grassland/ Sedgeland/ Herbland	Very Open Tussock Grassland/ Sedgeland/ Herbland	Scattered Tussock Grasses/ Sedges/ Herbs

In addition, an estimate of the time since the last fire was made. Fire age was categorised as over 5 years, between 1-5 years and less than 1 year.

Based on the vegetation description, soil types, age since fire and landform the fauna habitats were consolidated a fauna habitat type.

APPENDIX C
RESULTS OF THE RAPID HABITAT ASSESSMENT FOR THE HILLSIDE SOUTH RAILWAY CORRIDOR

Observer: ST Date: 3/3/2010 Habitat Assessment #: 1

Latitude: -22.4584 Longitude: 119.8414

Fire History: > 5 years Soil Colour: Brown

Landform: Flat Soil Type: Gravel and Clay

Habitat Description: Scattered Low Trees over Scattered Low Shrubs over Scattered Tussock Grasses

Habitat Quality: Disturbed

Observer: ST Date: 3/3/2010 Habitat Assessment #: 2

Latitude: -22.4442 Longitude: 119.7889

Fire History: > 5 years Soil Colour: Brown

Landform: Flat Soil Type: Gravel and Clay

Habitat Description: Scattered Low Trees over Scattered Low Shrubs over Scattered Tussock Grasses

Habitat Quality: Disturbed

Observer: ST Date: 3/3/2010 Habitat Assessment #: 3

Latitude: -22.4435 Longitude: 119.7888

Fire History: > 5 years Soil Colour: Brown

Landform: Flat Soil Type: Rock and Clay

Habitat Description: Open Forest over Shrubland over Scattered Tussock Grasses

Habitat Quality: Disturbed

Observer: ST Date: 3/3/2010 Habitat Assessment #: 4

Latitude: -22.3739 Longitude: 119.5385

Fire History: > 5 years Soil Colour: Brown

Landform: Flat Soil Type: Gravel and Clay

Habitat Description: Scattered Low Trees over Scattered Low Shrubs over Open Tussock Grassland

Habitat Quality: Disturbed

Observer: ST Date: 3/3/2010 Habitat Assessment #: 5

Latitude: -22.3305 Longitude: 119.5292

Fire History: > 5 years Soil Colour: Red

Landform: Ridge Soil Type: Gravel and Rock

Habitat Description: Scattered Low Trees over Scattered Low Shrubs over Scattered Hummock Grassland

Habitat Quality: Very Good

Observer: ST Date: 4/3/2010 Habitat Assessment #: 6

Latitude: -22.30858 Longitude: 119.5077

Fire History: > 5 years Soil Colour: Red

Landform: Ridge Soil Type: Rock and Gravel

Habitat Description: Scattered Low Trees over Low Shrubland over Open Hummock Grassland

Habitat Quality: High Quality

Observer: ST Date: 3/3/2010 Habitat Assessment #: 7

Latitude: -22.29855 Longitude: 119.4820

Fire History: > 5 years Soil Colour: Red

Landform: Lower Slope Soil Type: Gravel and Sand

Habitat Description: Open Woodland over Scattered Low Shrubs over Scattered Hummock Grassland

Habitat Quality: High Quality

Observer: ST Date: 4/3/2010 Habitat Assessment #: 8

Latitude: -22.2773 Longitude: 119.4442

Fire History: > 5 years Soil Colour: Brown

Landform: Creekline Soil Type: Gravel and Sand

Habitat Description: Scattered Trees over Low Open Shrubland over Scattered Tussock Grasses

Habitat Quality: Very Good

Observer: ST Date: 4/3/2010 Habitat Assessment #: 9

Latitude: -22.2584 Longitude: 119.3672

Fire History: > 5 years Soil Colour: Red

Landform: Drainage Line Soil Type: Gravel and Sand

Habitat Description: Open Woodland over Open Heath over Mid-dense Hummock Grassland

Habitat Quality: High Quality

Observer: ST Date: 4/3/2010 Habitat Assessment #: 10

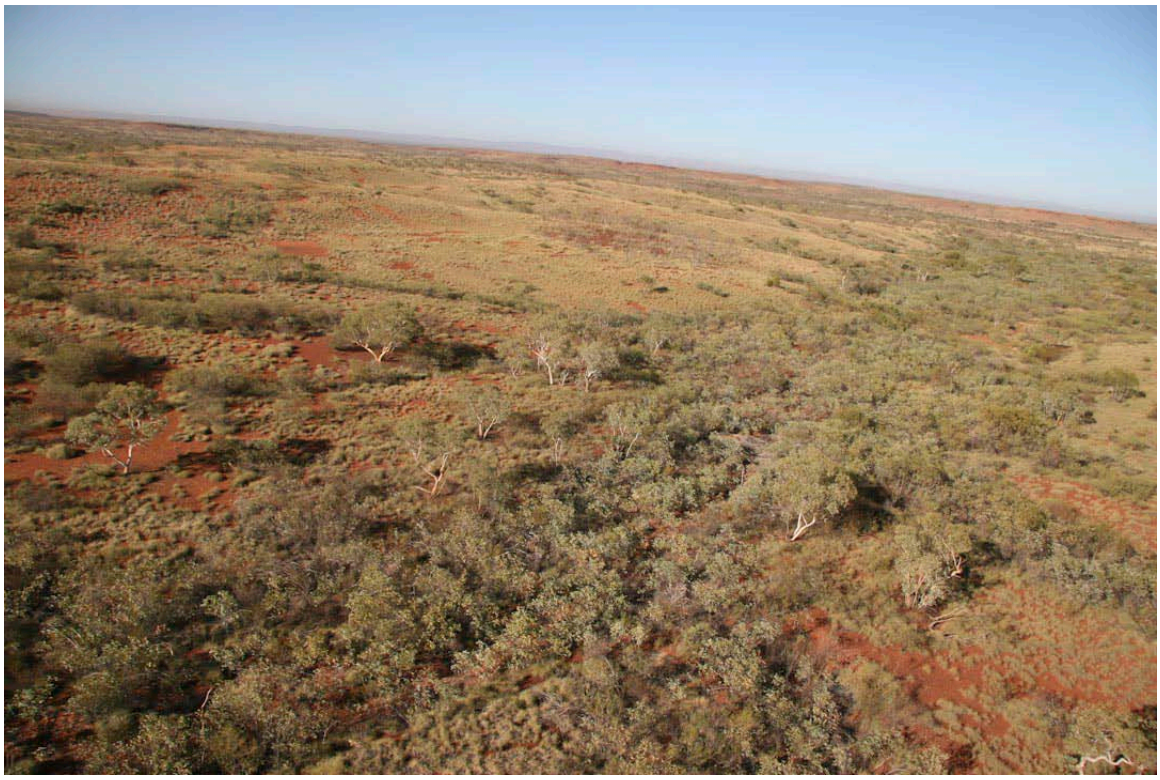
Latitude: -22.2492 Longitude: 119.3563

Fire History: > 5 years Soil Colour: Red

Landform: Drainage Line Soil Type: Gravel and Sand

Habitat Description: Woodland over Shrubland over Hummock Grassland

Habitat Quality: Very Good



Observer: ST Date: 4/3/2010 Habitat Assessment #: 11

Latitude: -22.1823 Longitude: 119.2806

Fire History: > 5 years Soil Colour: Red

Landform: Ridge Soil Type: Rock and Gravel

Habitat Description: Low Open Shrubland over Open Hummock Grassland

Habitat Quality: High Quality

Observer: ST Date: 4/3/2010 Habitat Assessment #: 12

Latitude: -22.1514 Longitude: 119.2727

Fire History: > 5 years Soil Colour: Brown

Landform: Lower Slope Soil Type: Rock and Gravel

Habitat Description: Scattered Low Trees over Scattered Low Shrubs over Mid-dense Hummock Grassland

Habitat Quality: Very Good

Observer: ST Date: 4/3/2010 Habitat Assessment #: 13

Latitude: -22.1511 Longitude: 119.2726

Fire History: > 5 years Soil Colour: White

Landform: Lower Slope Soil Type: Gravel and Sand

Habitat Description: Scattered Trees over Low Open Shrubland over Mid-dense Hummock Grassland

Habitat Quality: Very Good

Observer: ST Date: 4/3/2010 Habitat Assessment #: 14

Latitude: -22.1229 Longitude: 119.2578

Fire History: > 5 years Soil Colour: Red

Landform: Creekline Soil Type: Gravel and Sand

Habitat Description: Open Woodland over Shrubland over Tussock Grassland

Habitat Quality: Very Good

Observer: ST Date: 4/3/2010 Habitat Assessment #: 15

Latitude: -22.1222 Longitude: 119.2578

Fire History: > 5 years Soil Colour: White

Landform: Undulating Soil Type: Gravel and Sand

Habitat Description: Scattered Low Trees over Scattered Low Shrubs over Scattered Hummock Grassland

Habitat Quality: Very Good

Observer: ST Date: 4/3/2010 Habitat Assessment #: 16

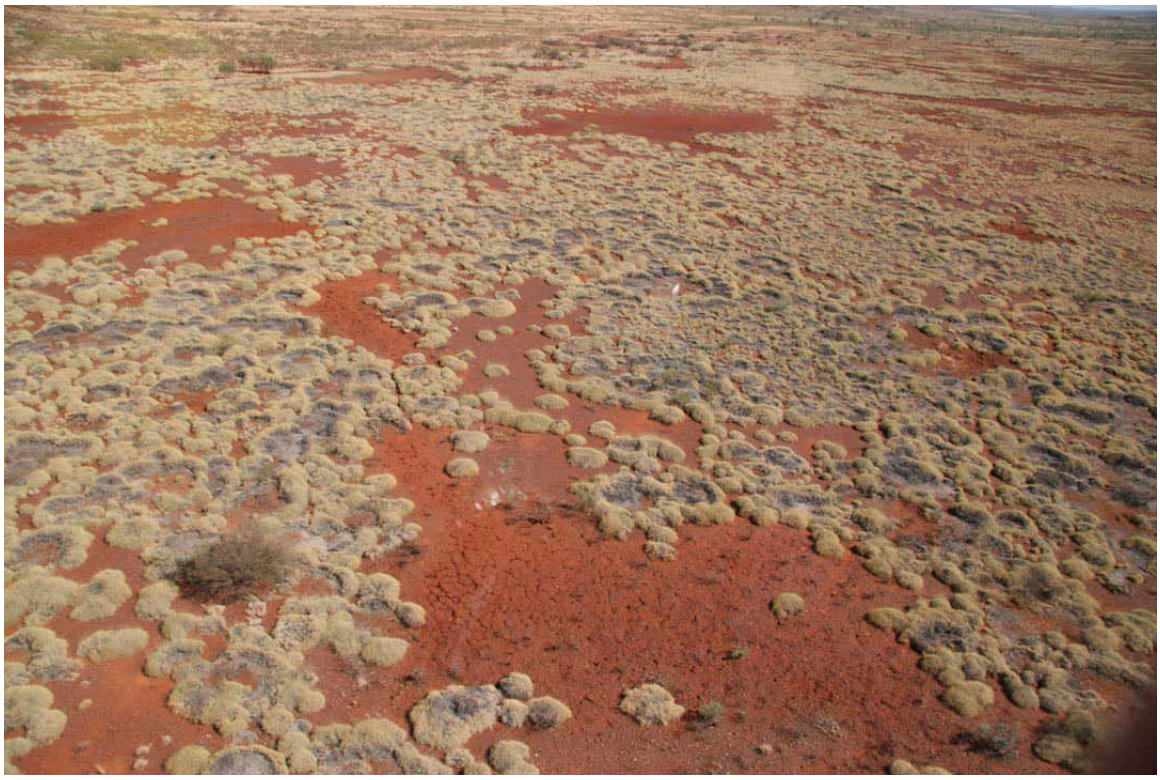
Latitude: -22.1214 Longitude: 119.2577

Fire History: > 5 years Soil Colour: Red

Landform: Flat Soil Type: Clay and Loam

Habitat Description: Scattered Low Shrubs over Scattered Hummock Grassland

Habitat Quality: Very Good



Observer: ST Date: 4/3/2010 Habitat Assessment #: 17

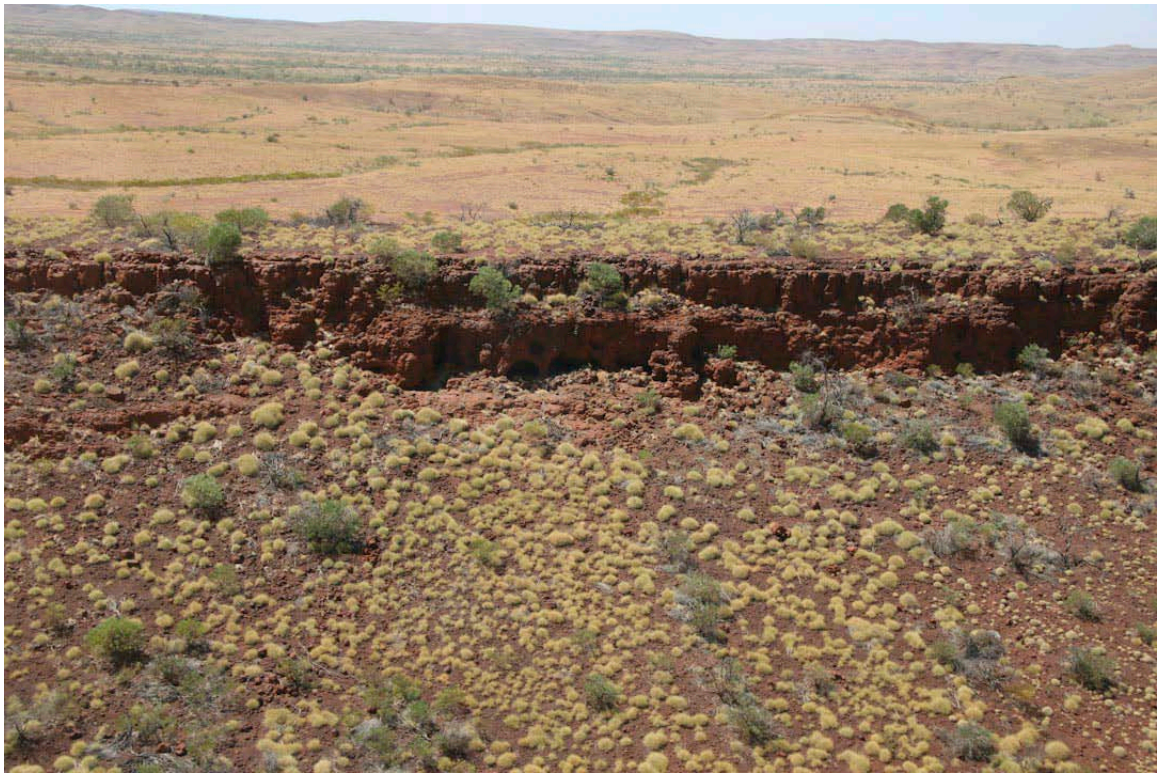
Latitude: -22.1153 Longitude: 119.2455

Fire History: > 5 years Soil Colour: Red

Landform: Ridge Soil Type: Rock and Gravel

Habitat Description: Scattered Low Trees over Low Open Shrubland over Open Tussock Grassland

Habitat Quality: High Quality



Observer: ST Date: 4/3/2010 Habitat Assessment #: 18

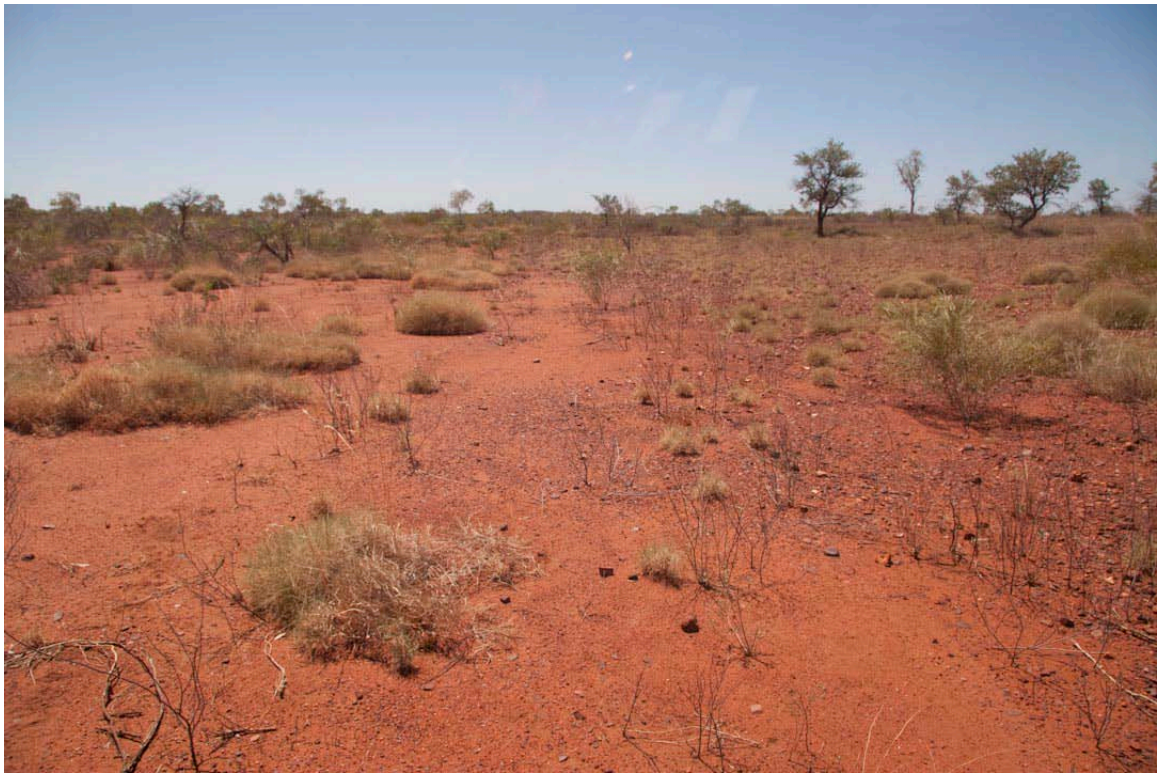
Latitude: -22.0488 Longitude: 119.2073

Fire History: 1-5 years Soil Colour: Red

Landform: Undulating Soil Type: Gravel and Sand

Habitat Description: Scattered Trees over Low Open Shrubland over Open Hummock Grassland

Habitat Quality: Good



Observer: ST Date: 4/3/2010 Habitat Assessment #: 19

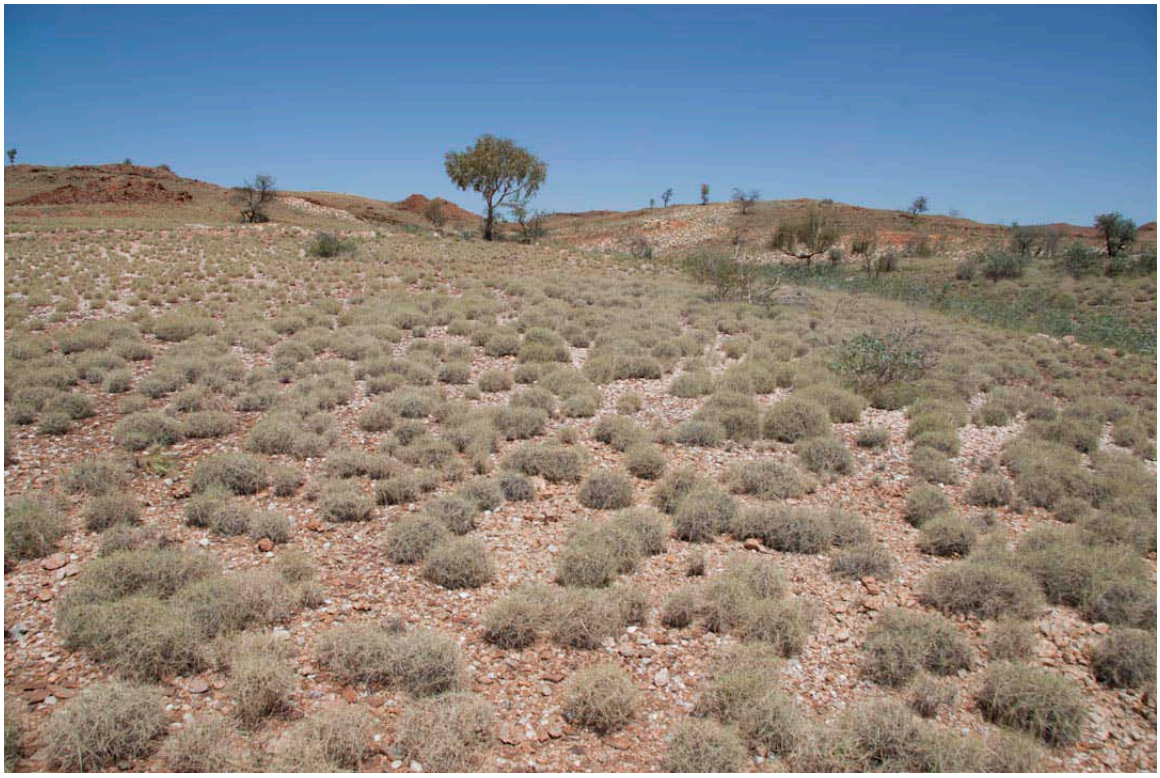
Latitude: -22.0119 Longitude: 119.1811

Fire History: 1-5 years Soil Colour: White

Landform: Undulating Soil Type: Gravel and Sand

Habitat Description: Scattered Low Trees over Low Shrubland over Mid-dense Hummock Grassland

Habitat Quality: Very Good



Observer: ST Date: 4/3/2010 Habitat Assessment #: 20

Latitude: -21.9923 Longitude: 119.1622

Fire History: > 5 years Soil Colour: Red

Landform: Undulating Soil Type: Gravel and Sand

Habitat Description: Scattered Trees over Scattered Low Shrubs over Hummock Grassland

Habitat Quality: Very Good

Observer: ST Date: 4/3/2010 Habitat Assessment #: 21

Latitude: -21.9923 Longitude: 119.1627

Fire History: > 5 years Soil Colour: Red

Landform: Undulating Soil Type: Rock and Gravel

Habitat Description: Scattered Trees over Scattered Low Shrubs over Hummock Grassland

Habitat Quality: High Quality