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EcoNomics

ROY HILL IRON ORE PTY LTD

Roy Hill Iron Ore (RHIO) Railway Corridor -

Ecological Survey Comparative Analysis

301012-00928-EN-REP-004

2-Oct-09

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SYNOPSIS

Roy Hill Iron Ore Pty Ltd (RHIO), a wholly owned subsidiary of Hancock Prospecting Pty Ltd (HPPL), is proposing to construct a heavy-haul railway and associated infrastructure to transport iron ore from its proposed Roy Hill 1 mine to a port infrastructure facility near to Port Hedland as part of the Roy Hill 1 Iron Ore project. WorleyParsons have been commissioned to undertake engineering and environmental services for the prefeasibility stage of the project.

The proposed railway corridor is 300km long. For much of this distance, the disturbance footprint will be adjacent or in close proximity to existing disturbance footprints. In recent years, there have been railway construction projects similar to the RHIO project. These areas have been thoroughly surveyed for environmental impacts and predicted impacts, and have been managed to mitigate the risks.

The aims of this report are;

- to provide a comprehensive summary of existing environmental data pertinent to the proposed rail development;
- to identify areas along the proposed rail corridor where little or insufficient is known about the environment and in so doing identify additional studies and / or investigations that may be required;
- to demonstrate environmental similarities between this proposal and other environmentally approved rail developments in terms of terrain traversed and environmental impacts;
- to demonstrate through the above that, with the exception of an isolated number of areas, the environment through which the proposed rail traverses and the impacts which result are well understood, easily managed and accepted for other existing or proposed rail developments in the same general Pilbara region; and
- on the basis of all of the above, to support an Environmental Protection Act Part IV Assessment on Referral Information (ARI) process.

PROJECT 301012-00928 - ROY HILL IRON ORE (RHIO) RAILWAY CORRIDOR -

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	B Cross	A Jacobs	N/A	22-Sept-09	N/A	
B	Issued for Client Review	B Cross	M Anderson	N/A	28-Sept-09		N/A
0	Issue to EPA	B Cross	P Mellor	R Earl	2-Oct-09		

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ABBREVIATIONS AND DEFINITIONS

Abbreviation	Definition
AHD	Australian Height Datum
DEC	Western Australian Department of Environment and Conservation
DEWHA	Commonwealth Department of Environment Water Heritage and the Arts
DMA	Decision Making Authority
EPA	Environmental Protection Authority
FMG	Fortescue Metals Group Ltd
MCA	Multi Criteria Analysis
HPPL	Hancock Prospecting Pty Ltd
PER	Public Environmental Review
RHIO	Roy Hill Iron Ore
EPA	Environmental Protection Authority, Western Australia
EPBC Act	Environment Protection and Biodiversity Conservation Act, 1999
RGP	Rapid Growth Project
WP	WorleyParsons Services Pty Ltd

1. INTRODUCTION

Roy Hill Iron Ore Pty Ltd (RHIO), a wholly owned subsidiary of Hancock Prospecting Pty Ltd (HPPL), is proposing to construct a heavy-haul railway and associated infrastructure to transport iron ore from its proposed Roy Hill 1 mine to a port infrastructure facility near to Port Hedland as part of the Roy Hill 1 Iron Ore project. WorleyParsons have been commissioned to undertake engineering and environmental services for the prefeasibility stage of the project.

WorleyParsons recently completed a Multi-Criteria Analysis of possible routes for the proposed railway. This analysis resulted in a preferred corridor being identified. The route selection process is discussed in this report. The preferred railway corridor extends from approximately 110km north of Newman townsite to Port Hedland, 300km to the north and is approximately 2km in width. Refinement of the corridor to a single alignment with a disturbance footprint of approximately 100m either side of the centerline is underway.. The narrower corridor is proposed to be surveyed during and immediately following the wet season in 2010. The information collected will be used to drive potential modifications to the rail alignment and in-situ management of the potential impacts.

Potential environmental and social impacts of railway construction and operation in the Pilbara region are well understood and their potential impacts are well documented. Effective management and mitigation measures have been developed and implemented by existing railway development proponents. There has also been extensive consultation with the community and stakeholders.

As such, it is the intention of RHIO to survey / investigate only those areas along the development corridor where “gaps” in the available literature are found. A targeted approach to investigations and studies based on “gaps” in the available literature was suggested by RHIO to the DEC at a meeting held on 6th August 2009 and was supported by the DEC. It represents an efficient use of resources considering the vast body of literature already available.

Additionally, because of the extensive information available and through comparison to approved existing or proposed railways of other proponents within the Pilbara, RHIO believes that the rail development warrants assessment under an “Assessment on Referral Information” (ARI) process, as defined within Part IV of Section 38 of the *Environmental Protection Act 1986*.

The aims of this report are;

- to provide a comprehensive summary of existing environmental data pertinent to the proposed rail development;
- to identify areas along the proposed rail corridor where little or insufficient is known about the environment and in so doing identify additional studies and / or investigations that may be required;

- to demonstrate environmental similarities between this proposal and other environmentally approved rail developments in terms of terrain traversed and environmental impacts;

- to demonstrate through the above that, with the exception of an isolated number of areas, the environment through which the proposed rail traverses and the impacts which result are well understood, easily managed and accepted for other existing or proposed rail developments in the same general Pilbara region; and

- on the basis of all of the above, to support an Environmental Protection Act Part IV Assessment on Referral Information (ARI) process.

1.1 Statutory Requirements

1.1.1 Western Australia Legislation

Environmental Protection Act 1986

The *Environmental Protection Act 1986* is the primary legislation that governs environmental impact assessment and protection in Western Australia. Approvals can be required under two parts of the Act: Part IV – Environmental Impact Assessment and Part V – Environmental Regulation.

It is the main WA law governing environmental protection, and with supporting laws and regulations, covering requirements for impact assessments, approvals, licensing, prevention and control of pollution, and conservation.

Wildlife Protection Act 1950

The *Wildlife Conservation Act 1950* is an act of the Western Australian Parliament that provides the statute relating to conservation and legal protection of flora and fauna.

The Act is supplemented periodically by Notices, which are lists of species subject to protection under the Act, eg. the Wildlife Conservation (Specially Protected Fauna) Notice 2008(2). The lists are arranged in Schedules according to level of vulnerability. Schedule 1 is "Fauna that is rare or is likely to become extinct" or "Extant [flora] taxa"; Schedule 2 is "Fauna presumed to be extinct" or [Flora] "Taxa presumed to be extinct"***.***

Environmental Protection (Clearing of Native Vegetation) Regulation 2004

Environmental Protection (Clearing of native vegetation) Regulation 2004 covers

1.1.2 Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act) applies to proposals that have, will have or would be likely to have a significant impact on one or more of the matters of national environmental significance specified in the EPBC Act. Proponents will be expected to consult with the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) as required to determine what action(s), if any, would be necessary to meet the requirements of the EPBC Act. The Environmental Protection Authority (EPA) of Western Australia and DEWHA may consider undertaking a joint environmental impact assessment (EIA) for some proposals. Proponents will be advised of decisions in this regard.

The objectives of the EPBC Act are:

a) to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance; and

b) to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and

c) to promote the conservation of biodiversity; and

d) to provide for the protection and conservation of heritage; and

e) to promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples; and

f) to assist in the co-operative implementation of australia's international environmental responsibilities; and

g) to recognise the role of indigenous people in the conservation and ecologically sustainable use of australia's biodiversity; and

h) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge.

1.2 Desktop Review

RHIO commissioned a combined desktop study and site reconnaissance visit (performed by *Animal Plant Mineral*) in May 2009 in order to;

- provide specific information on the potential flora, fauna and habitats of the route and region;

- assess the level of potential disturbance;
- assess the potential for protected, rare or species of conservation interest in the area;
- assess the potential for the occurrence of significant faunal assemblages; and
- assess the complexity of habitat or faunal assemblage.

A review of relevant studies conducted for the purpose of railway construction was completed. The studies are listed in Table 1 and form the basis of review of existing environmental information contained within this document.

Table 1 Key studies analysed in this comparative ecological assessment

Company	Purpose	Level of Survey	Date of Survey
WorleyParsons & RHIO	Railway construction pre-feasibility study	Multi Criteria Analysis (MCA) constraints and route selection	August 2009
RHIO (Animal Plant Mineral - APM)	Railway line construction	Desktop, 3 day aerial survey	23 - 25 May 2009
BHPBIO RPG	23km railway diversion (Chichester Ranges)	ARI	
FMG	Railway line construction	Public Environmental Review (PER) under Part IV of Western Australian Environmental Protection Act, 1986	March – April 2004
Hope Downs	Railway line construction	Public Environmental Review (PER) under Part IV of Western Australian Environmental Protection Act, 1986	February 2001

2. ENVIRONMENTAL REVIEW

The process for selecting the preferred railway alignment was based on a Multi Criteria Analysis (MCA), developed by WorleyParsons and RHIO personnel. The corridor alignment is illustrated in Figure 1.

Figure 1 The proposed corridor alignment - Oblique view of Proposed Railway Line from Roy Hill to Port Hedland Facilities

2.1 Pilbara Biogeographical Region

The Interim Biogeographic Regionalisation for Australia (IBRA) recognizes 85 bioregions. IBRA is the planning framework of the National Reserve System, the fundamental tool for identifying land for conservation (DEWHA 2009b). The FMG (2005), BHPBIO[1] and Hope Downs (2002) rail alignments also fall into this biogeographical region and so can be considered to have the same level of reserve constraints on a regional level (Figure 2).

[1] No EIA perfomed for the original BHPBIO rail alignment

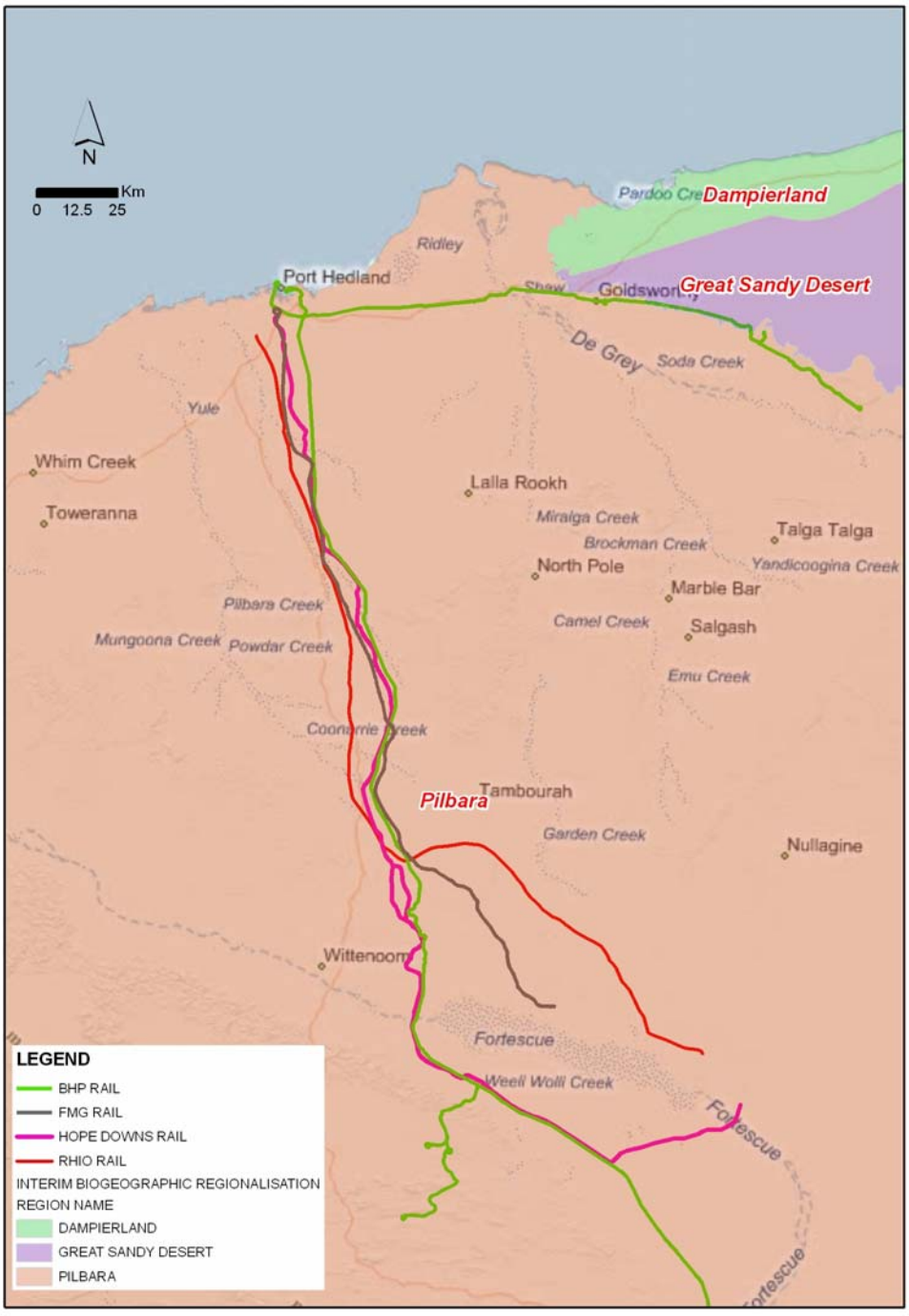

Figure 2 Interim Biogeographic Regionalisation for Australia

2.2 Biogeographical sub-regions

Within the Pilbara Biogeographical region, there are four sub-regions (Figure 3). IBRA sub-regions are more localised and homogenous geomorphological units that occur in each bioregion (DEWHA 2009a). With increasing survey work in the Pilbara, it is becoming apparent that this region is one of the centres of biodiversity in the state. All flora and fauna impacts have been managed by previous proponents who all traversed similar bioregions. These statistics are represented in Table 2.:

- Roebourne (PIL4)
- Chichester (PIL1)
- Fortescue (PIL2)

Table 2 Linear km of each alignment in each biogeographical sub-region

	RHIO Alignment (km)	FMG Alignment (km)	BHPBIO Alignment (km)	Hope Downs Alignment (km)
Roebourne (PIL4)	**22**	**33**	**122**	**18**
Chichester (PIL1)	**250**	**204**	**305**	**217**
Fortescue (PIL2)	**26**	**22**	**166**	**154**
Hamersley (PIL3)	**0**	**0**	**78**	**0**

As illustrated in Table 2, FMG (2005), BHPBIO[1] and Hope Downs (2002) rail alignments all traverse the same or similar biogeographical subregions. As such, environmental impacts from all of the railway developments / proposals can be expected to be similar. Further, the following descriptions can be considered common across all railway alignments.

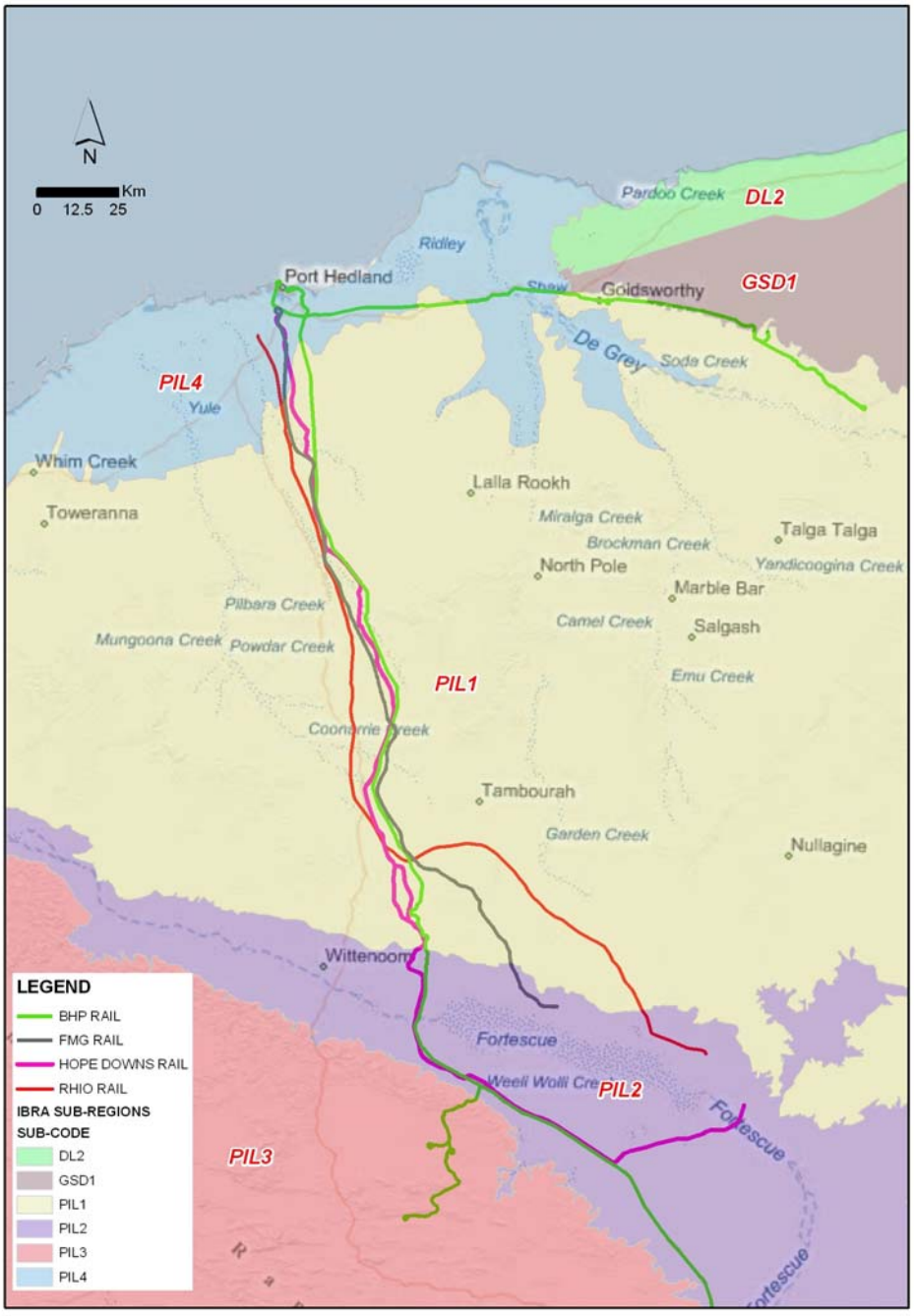

Figure 3 Interim Biogeographic Regionalisation for Australia - Sub-regions

2.2.1 Chichester (PIL1)

The Chichester subregion (PIL 1) comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is Semi-desert-tropical and receives 300mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock). The total area of the sub-region is 9,044,560ha (Kendrick & McKenzie 2001).

Biota's (2004d) study for the FMG rail alignment identified 4 vegetation types of highest conservation significance within this biogeographic subregion and can reasonably be expected to be found in future studies undertaken by RHIO. These Vegetation types include[2]:

- cracking clay vegetation types of the Chichester Range (Cx4 and Cx5);
- restricted sandplain and creekline vegetation of the Chichester Range (Cp1, Cc3, Cc17); and
- the northernmost limit of associations containing mulga in Chichester Range (Ch9 and Ch10).

2.2.2 Fortescue (PIL2)

The Fortescue Marsh is an extensive, episodically inundated samphire marsh, approximately 100km long and 10km wide, and is located on the Fortescue Valley floor. The Marsh has an elevation approximately 400m above sea level (Kendrick 2001).

Extensive salt marsh, mulga-bunch grass and short grass communities occur on alluvial plains in the east. Deeply incised gorge systems occur in the western (lower) part of the drainage. River gum woodlands fringe the drainage lines. The Fortescue Marsh marks the northern limit of Mulga (Acacia aneura) in Western Australia. 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. The Fortescue Marsh episodically supports immense water-bird breeding (Kendrick, 2002).

Impacts from the proposed railway upon the Fortescue Marsh are unlikely (WorleyParsons 2009). The rail alignment has been specifically designed to avoid the highly constrained area, as identified in Figure 4.

[2] For vegetation types see Beard J.S. 1975. Vegetation Survey of Western Australia. 1:100,000 Vegetation Series Mapsheet 5 - Pilbara.

Biota's (2004d) study for FMG rail alignment identified four vegetation types of highest conservation significance within this biogeographic subregion and these can reasonably be expected to be found in future studies undertaken by RHIO. These Vegetation types include[2]:

- vegetation of the cracking clays of the Fortescue Marsh and surrounding valley (Fx1 – Fx9);
- Mulga dominated vegetation types of the Fortescue Valley (Fa1-Fa7, Fa9) and isolated hills in the area (Fh1);
- unusual creek-line vegetation of the Fortescue Valley (Fc2); and
- shrublands restricted to isolated linear dunes at the junction of the Fortescue Valley and Hamersley Range (Hd1).

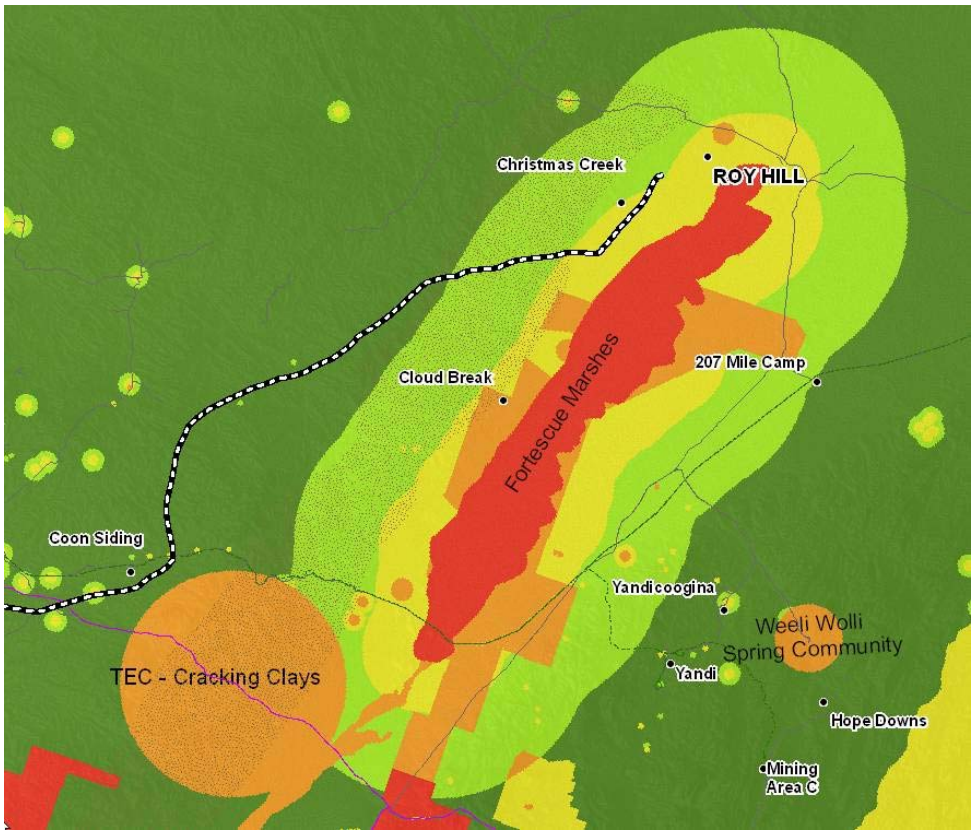

Figure 4 MCA environmental constraints map showing the highly constrained Fortescue Marsh (WorleyParsons 2009).

2.2.3 Roebourne (PIL4)

Roebourne Plains are described as quaternary alluvial and older colluvial coastal and sub-coastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of Acacia stellaticeps or A. pyrifolia and A. inaequilatera. Uplands are dominated by Triodia hummock grasslands. Ephemeral drainage lines support Eucalyptus victrix or Corymbia hamersleyana woodlands. Samphire, Sporobolus and mangal occur on marine alluvial flats and river deltas. Resistant linear ranges of basalts occur across the coastal plains, with minor exposures of granite. Climate is arid (semi-desert) tropical with highly variable rainfall, falling mainly in summer. Cyclonic activity is significant, with several systems affecting the coast and hinterland annually. The total area of the sub-region is 2,008,983ha (Kendrick & Stanley 2001).

Biota's (2004d) study for FMG rail alignment identified 4 vegetation types of highest conservation significance within this biogeographic subregion and these can reasonably be expected to be found in future studies undertaken by RHIO. These Vegetation types include[2]:

- restricted hummock grassland vegetation (Ah5a, Apt1, Apt2, Apt5,Apt8);
- granite, quartz and dolerite outcrop vegetation types (Ar4-7); and
- restricted soak and drainage vegetation (Ac21, Ac30);

2.2.4 Geology

The region may be divided broadly into three physiographic types: low ranges, wide floodplains and a coastal zone. The ranges form part of the Pilbara craton which has been emergent since the Palaeozoic. They comprise the Early Proterozoic - Archaean metasedimentary Hamersley Range in the central Pilbara, reaching around 900m AHD, with peaks around 1,250m AHD, and the predominantly volcanic Chichester Range to the north, with a more subdued topography of around 600m (Trendall 1990). These units overlie the Archaean greenstones and granites, which outcrop to the northeast of the region. The regolith comprises a fine red blanket over much of the region, resulting in a very thin vadose zone. The Fortescue and Ashburton Rivers form extensive floodplains, draining either side of the Hamersley Ranges. The Robe, Yule and De Grey Rivers extend as broad deltas from the highlands toward the Indian Ocean. Several other minor rivers also traverse this path. The coastal zone comprises broad, flat hummock and tussock grasslands, with scattered woodlands, on cracking clays or sandy soils.

The geology is evidently comparable between similar chainages of the already surveyed rail corridors (Figure 5). Features suitable for particular flora and fauna are common to all corridors. Associations exist between geology and species composition based on areas traversed (E. J. B. van Etten 2000).

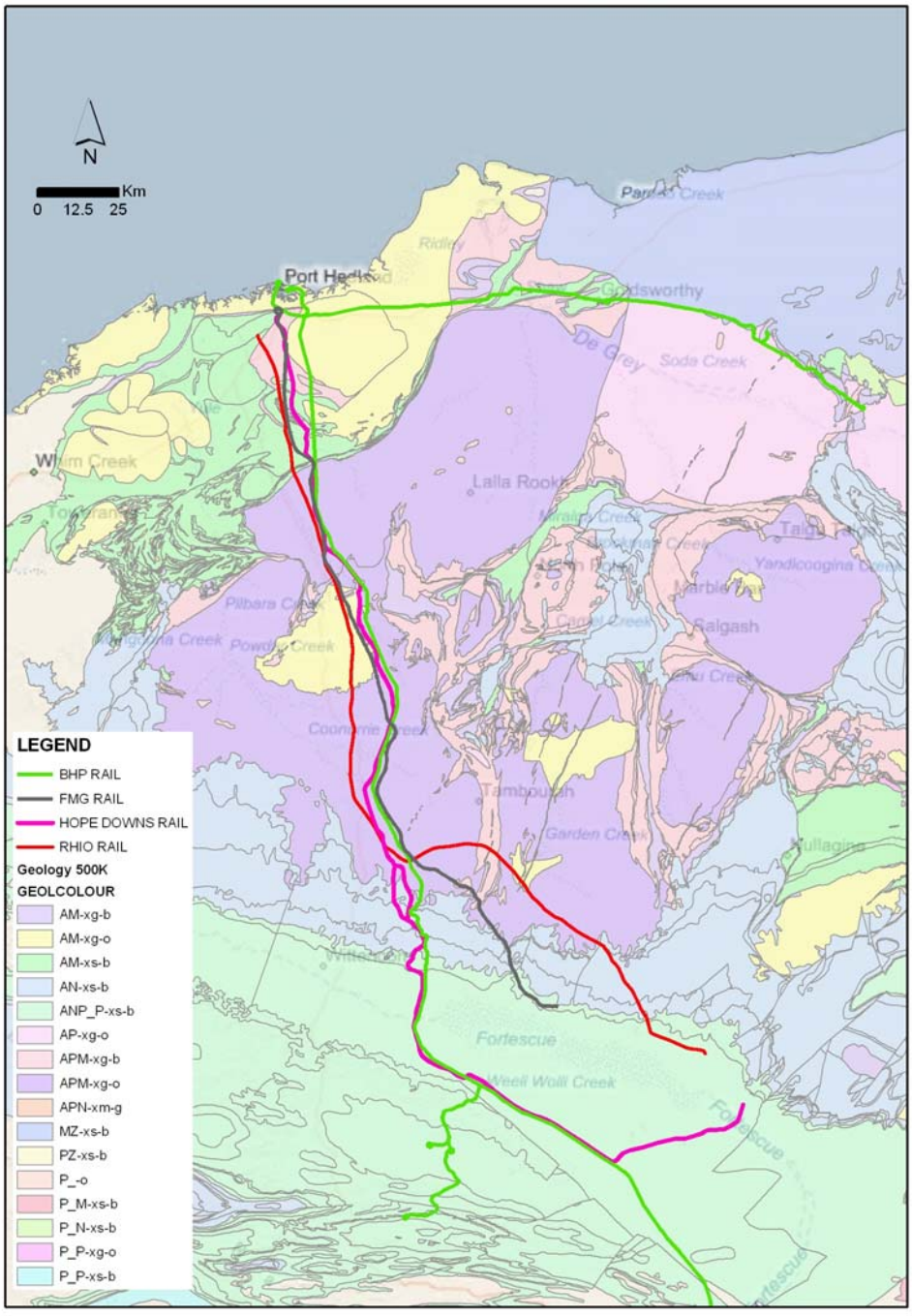

Figure 5 Geology comparison between rail alignments

2.2.5 Surface Water

All drainage channels in the area of investigation are ephemeral. Following significant rainfall, the channels carry large discharges for up to a few days then retreat back to isolated pools. In the main channels, smaller discharges may persist for a few weeks. During the large flood events, floodwater can overflow the main river channels into the surrounding floodplains. River pools are sustained by local bank storage or the local water table and springs are fed by local aquifers, particularly in the karstic areas.

The FMG (2005), BHPBIO[1] and Hope Downs (2002) corridors all traverse the same four water catchments, as will the proposed Roy Hill rail corridor. The catchments are listed below:

- Port Hedland Area (Abydos Plain);
- Turner and Yule River Catchments
- Chichester Plateau
- Fortescue Valley

Having similar catchments indicates that surface water will drain to a common point at similar chainages between the four alignments (proposed and existing). It is not anticipated that any new issues will arise as a result of the proposed rail. All four alignments cross the same major drainage lines in the area of investigation (Figure 6).

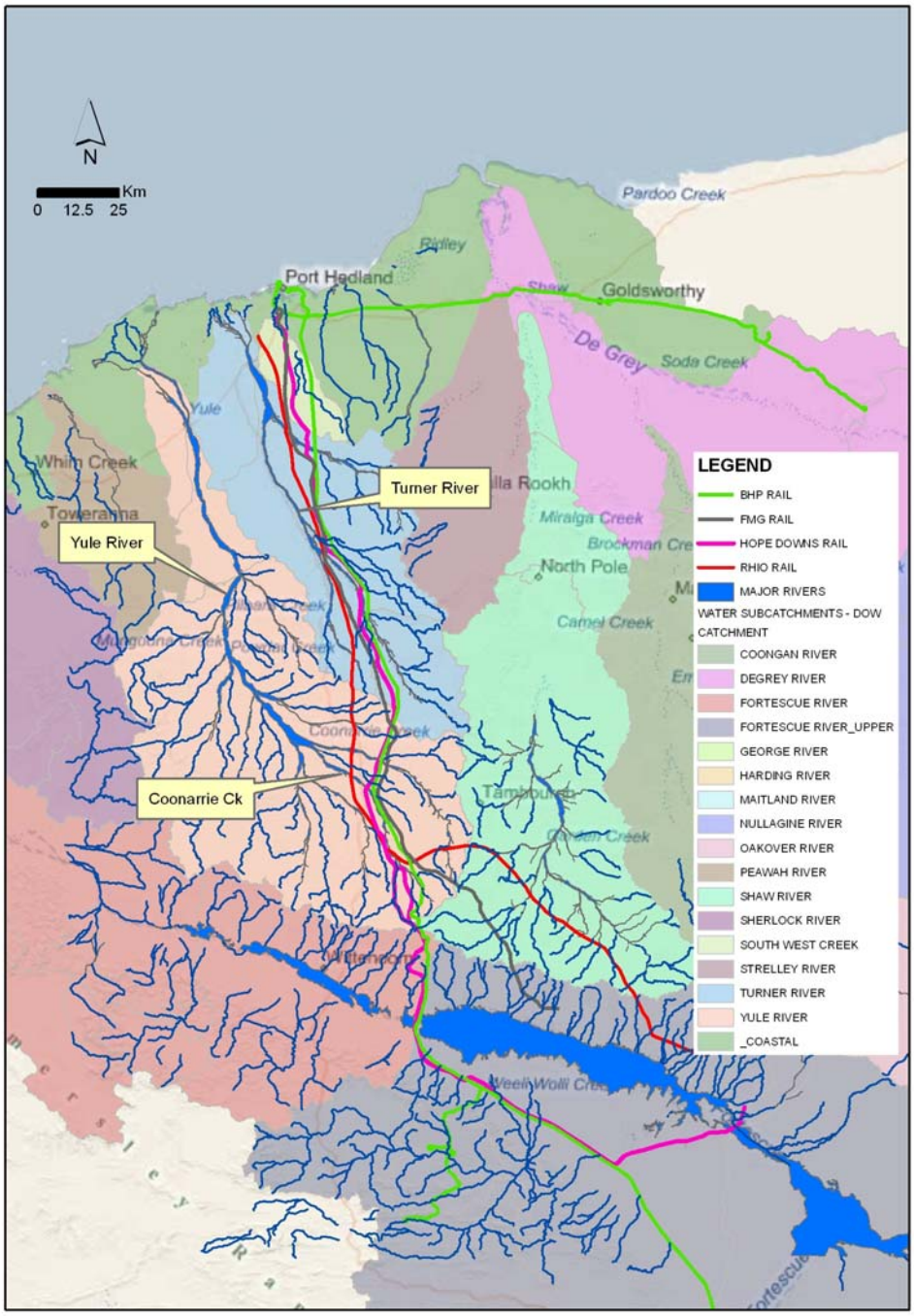

Figure 6 Catchments and major drainage lines in the area of interest

2.3 Fauna

2.3.1 Significant Fauna Habitats

None of the habitats along the rail corridor appear to be unique or significant at the bioregional level based on other results of studies conducted in the vicinity by other proponents (Halpern Glick Maunsell 2000, Biota Environmental Sciences 2002, Hope Downs Management Services 2002, Biota Environmental Sciences 2004d, Biota Environmental Sciences 2004c, Biota Environmental Sciences 2004b, Fortescue Metals Group Limited 2005, BHPBIO 2009). Eight significant habitats relevant to the proposed rail development have been identified in past studies. These habitats are;

- linear sand dune habitats adjacent to the Weeli Wolli Creek Delta;
- clay based habitats associated with the Fortescue Marsh;
- cracking clay habitats associated with the Chichester Range;
- granite rock piles on the Abydos Plain portion of the rail corridor;
- major drainage systems;
- black Range Dyke Section (the Route intersects 4km of this dyke); and
- Priority Ecological Community of the Wona Land System.

2.3.2 Important Bird Areas

Birds Australia maintains a database of important bird areas. An important bird area, as defined by Birds Australia must meet one of four global criteria to be included in the database. The criteria are;

- *globally threatened species:* the site must regularly support a Critical or Endangered species or at least 10 pairs of a vulnerable species, as categorised by the IUCN Red List;
- *restricted-range species:* the site forms one of a set protecting 'restricted-range species' (birds with a global range of <50,000 km2);
- *biome-restricted species:* the site forms one of a set protecting all species restricted to a given biome. For this purpose, Australia has been divided into seven biomes using the following paper, (Hutchinson. M. F et al. 2005); and
- *congregations: the site supports* > 1% of the world population of a waterbird (matching Ramsar Convention criteria).

Important Bird Areas was a constraint interrogated in the Multi-Criteria Analysis route selection study (WorleyParsons 2009). Only two areas were identified as illustrated in Figure 7.

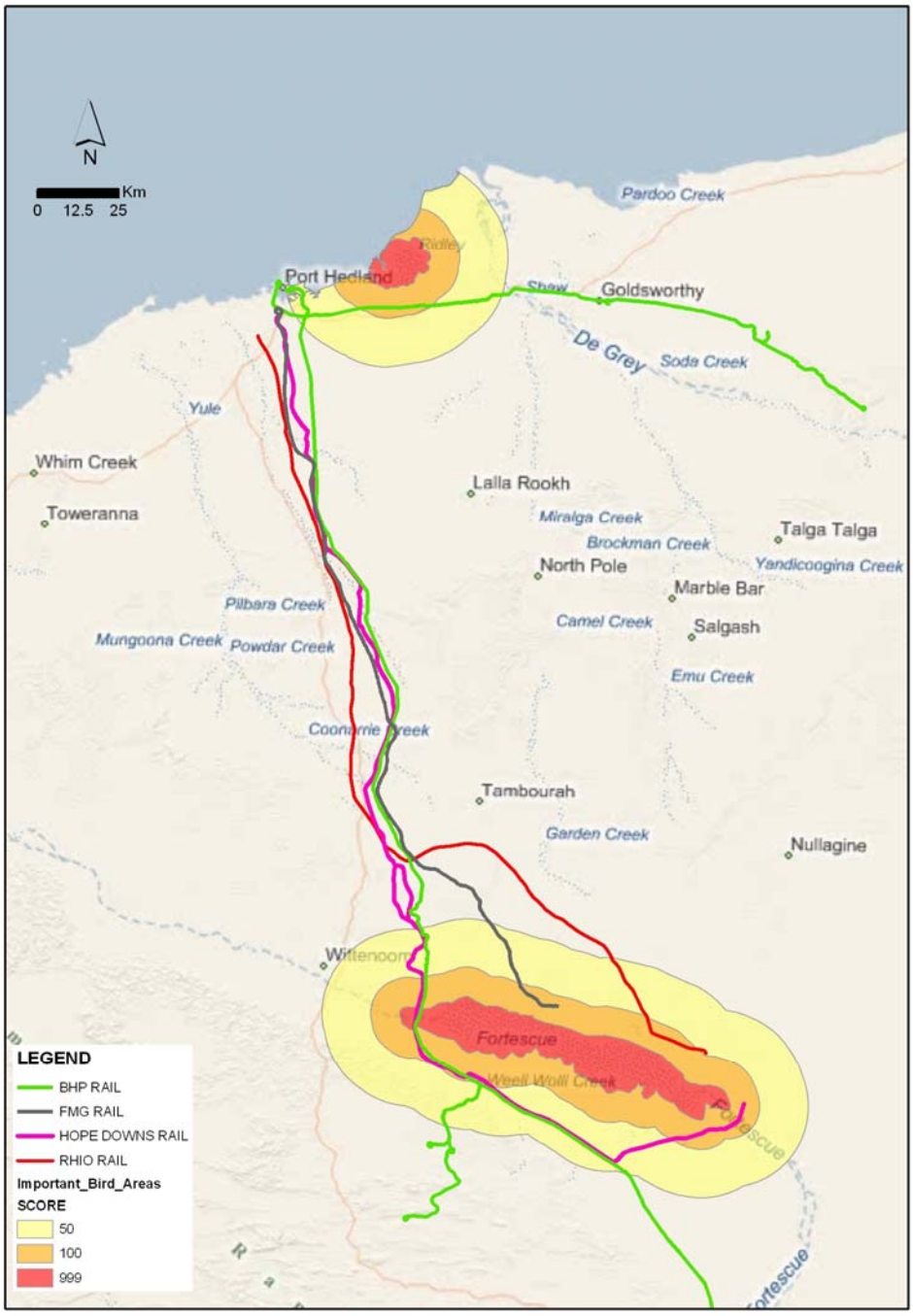

Figure 7 Areas of constraint for important bird areas

2.3.3 Subterranean Fauna

Stygofauna is a general term used to describe the subterranean fauna occurring in the groundwater of a given area (Humphreys 2000). The term is commonly used in reference to stygobites: obligate groundwater-dwelling, aquatic fauna. This fauna tend to be highly specialised inhabitants of subterranean groundwater habitats and may be restricted spatially in distribution (Watts & Humphreys 1999, Biota Environmental Sciences 2001). Stygofauna are known to be present in a variety of rock types, primarily karst (limestones, calcretes) and other porous stratigraphies (e.g. alluvium and gravels) (Marmonier et al. 1993)

An overview of the broad geology types traversed by the RHIO rail corridor is provided in Section 2.2.4. A review of potential stygofauna habitats was completed as part of the parallel Hope Downs rail corridor development (Hope Downs Management Services 2002), and indicated that no major calcretised areas are crossed by the proposed rail corridor. In past assessments, many of the diversity centres for stygofauna in the inland Pilbara appear to be associated with such calcretised formations in fluvial environments (Humphreys 2000, Biota Environmental Sciences 2001). It is possible that stygofauna occur in association with the major drainages crossed by the RHIO rail corridor and the alluvial aquifers associated with these. These are, however, unlikely to be affected by the RHIO railway if present.

2.3.4 Short Range Endemics

Generally, very little is known about Short Range Endemic (SRE) invertebrates in the Pilbara (Kendrick & McKenzie 2001). Investigations on SREs have generally been carried out on a project by project basis.

Previous studies have shown that the Pilbara region contains a large number of arid adapted invertebrate species such as Scorpions, Pseudoscorpions and Centipedes (BHPBIO 2009). Other SRE groups that are likely to be found in the proposal area in lesser numbers include Isopods, Mygalomorph spiders and snails. Evidence of SRE groups was found at the BHPBIO Chichester Deviation recently (Ecologia 2008).

It is recognised that SREs are moisture reliant and exist in specific niches that act as a suitable habitat. Generally, these can be described as being;

- southern slopes off breakaways;
- areas protected from fires that also hold moisture;
- granite outcrops;
- springs;
- southern aspects within the Chichester Ranges; and

- banks of creeklines that have not been disturbed by Buffel Grass (*Cenchrus ciliaris*) and cattle (van Leeuwen per. comm. 2009).

RHIO have identified likely habitats for SRE's within the proposed railway corridor and these areas will be surveyed during the 'wet' season, between two and five weeks after significant rain. Where SRE's, or their preferred habitat are identified within the proposed corridor (disturbance footprint), the following three options would be considered;

- investigate an appropriate distance outside the disturbance footprint to a similar habitat and identify if the same SRE's exist elsewhere; then
- if no SRE's have been found within the disturbance footprint, only suitable habitat, then search outside the disturbance footprint for suitable habitat; and then
- if no similar habitats are found outside the disturbance footprint, then the option of engineering to avoid that particular area would be taken into consideration.

2.4 Threatened Fauna and Flora

Native fauna species which are rare, threatened with extinction or have high conservation value are specially protected by law under the Western Australian *Wildlife Conservation Act 1950-1979*. In addition, many of these species are listed under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999)*. Extant species listed under the *EPBC Act 1999* may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent'. Migratory wader species are also protected under the *EPBC Act 1999*, and consist of those species identified under the following international conventions;

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals - (Bonn Convention).

Classification of rare and endangered fauna under the Wildlife Conservation (Specially Protected Fauna) Notice 1998 recognises four distinct schedules of taxa;

- Schedule 1 - taxa are fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;
- Schedule 2 - taxa are fauna which are presumed to be extinct;
- Schedule 3 - taxa are birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction which are declared to be fauna in need of special protection; and

- Schedule 4 - taxa are fauna that are in need of special protection, otherwise than for the reasons mentioned above.

In addition to the above classification, fauna are also recognised by CALM under four Priority levels:

- Priority One - Taxa with few, poorly known populations on threatened lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna;

- Priority Two - Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna;

- Priority Three - Taxa with several, poorly known populations, some on conservation lands. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna; and

- Priority Four - Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.

2.4.1 National Threatened Fauna Species

Eleven threatened fauna species were identified in a Protected Matters Search under the EPBC Act (DEC 2008). These threatened species are protected under the EPBC Act and are listed in Table 3.

2.4.2 National Threatened Flora Species

One flora species *Lepidum catapycnon* was recorded in the area of interest and was listed as being vulnerable. This threatened species is protected under the EPBC Act (Table 3). This species is also recorded as being Declared Rare flora (DRF) under the Wildlife Conservation Act 1950.

2.4.3 Migratory Species

Thirty five species were recorded from within the area of interest (Table 3). These species are listed as matters of NES and on a number of international agreements.

Table 3: Threatened Fauna and Flora Species of National or State Significance

	Federal Status	State Status	Comments
Birds			
Macronectes giganteus Southern Giant-Petrel	Endangered	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot	Endangered	Critically Endangered	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot	Vulnerable	Priority 4	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	-	Species or species habitat may occur within area
Mammals			
Dasycercus cristicauda Mulgara	Vulnerable	Schedule 1	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Endangered	Species or species habitat may occur within area
Macrotis lagotis Greater Bilby	Vulnerable	Schedule 1	Species or species habitat may occur within area
Notoryctes caurinus Karkarratul, Northern Marsupial Mole	Endangered	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Vulnerable	Community likely to occur within area
Reptiles			
Egernia kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Vulnerable	Species or species habitat may occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Schedule 1	Species or species habitat may occur within area
Plants			
Lepidium catapycnon Hamersley Lepidium, Hamersley Catapycnon	Vulnerable	Declared Rare	Species or species habitat likely to occur within area
Migratory Terrestrial Species - Birds			
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	-	Species or species habitat likely to occur within area
Hirundo rustica	Migratory	-	Species or species

	Federal Status	State Status	Comments
Barn Swallow			habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	-	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot	Migratory	Critically Endangered	Species or species habitat likely to occur within area
Migratory Wetland Species - Birds			
Ardea alba Great Egret, White Egret	Migratory	-	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	-	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Migratory	-	Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper	Migratory	-	Species or species habitat likely to occur within area
Calidris alba Sanderling	Migratory	-	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot	Migratory	-	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper	Migratory	-	Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint	Migratory	-	Species or species habitat likely to occur within area
Calidris tenuirostris Great Knot	Migratory	-	Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Migratory	-	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Migratory	-	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	-	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	-	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler	Migratory	-	Species or species habitat likely to

	Federal Status	State Status	Comments
			occur within area
Limicola falcinellus Broad-billed Sandpiper	Migratory	-	Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit	Migratory	-	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew	Migratory	Priority 4	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	-	Species or species habitat may occur within area
Numenius phaeopus Whimbrel	Migratory	-	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover	Migratory	-	Species or species habitat likely to occur within area
Pluvialis squatarola Grey Plover	Migratory	-	Species or species habitat likely to occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	-	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	-	Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Migratory	-	Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper	Migratory	-	Species or species habitat likely to occur within area
Migratory Marine Birds			
Apus pacificus Fork-tailed Swift	Migratory	-	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	-	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	-	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Migratory	Endangered	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Migratory	-	Breeding known to occur within area
Sterna albifrons	Migratory	-	Species or species

	Federal Status	State Status	Comments
Little Tern			habitat may occur within area

2.5 DEC Threatened and Priority Ecological Communities (TEC and PEC)

No TECs exist within the proposed corridor. However, the corridor does traverse the Wona Land System. This Land System is composed of basalt upland gilgai plains supporting tussock grasslands and minor hard Spinifex grasslands (van Vreeswyk et al. 2004). Of interest within this land system are the landforms of the stony gilgai upland plains. These are cracking clay, self mulching components that make up approximately 70% of the total system. Typically this community is expressed as tussock grasses (*Astrebela pectinata, Eragrostis xerophila* and *Eriachne spp.*) on stony gibber plains or simply bare stony gibber plains for most of the year. Characteristically they are devoid of perennial shrubs although small pockets of snakewood may persist and importantly they do not support hummock grasses (van Leeuwen pers. comm. 2009).

Within these gilgai plains there are at least four community types, all worthy of PEC status because of their vulnerability to grazing or rareness/restrictedness. Broadly these four community types are;

- annual Sorghum grasslands on self mulching clays (very rare: Pannawonica-Robe valley end of Chichesters);
- Mitchell grass plains (*Astrebela spp.*) on gilgai;
- Mitchell grass and Roebourne Plain Grass (*Eragrostis xerophila*) plain on gilgai (typical type, heavily grazed); and
- grassless plains of stony gibber covered by a very rich herbfield (mostly peas and *Convolvulaceae*) after rain (uncommon).

Each of these community types has differing conservation status. RHIO upon surveying the area for the rail alignment will identify the community type intersected by the rail corridor and thus its status. From there, appropriate management actions will need to be implemented (van Leeuwen pers. comm. 2009).

The Wona Land System is not susceptible to erosion except when the stony mantle is removed such as along tracks on sloping plains (van Vreeswyk et al. 2004).

The proposed corridor crosses the Wona Land System in two parts. The total length that it crosses is 1.87km that is, 0.006% of the entire length of the railway disturbance footprint.

A total of 21 declared Priority flora were recorded within the area of interest, being; six priority one flora species, four priority two flora species, and 11 priority three flora species. A summary of the

priority flora are presented below in Table 4. No DRF flora species were identified in the area of interest.

Table 4: Threatened Flora identified in the area of investigation

Species	Conservation Code
Eremophila spongiocarpa	P1
Acacia leeuweniana	P1
Acacia levata	P1
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	P1
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P1
Goodenia sp. Pilbara calcrete (A.A. Mitchell PRP 1436)	P1
Acacia effusa	P2
Ischaemum albovillosum	P2
Olearia fluvialis	P2
Gonocarpus ephemerus	P2
Bulbine pendula	P3
Bulbostylis burbidgeae	P3
Cynanchum sp. Hamersley (M. Trudgen 2302)	P3
Dampiera metallorum	P3
Acacia bromilowiana	P3
Goodenia nuda	P3
Goodenia pascua	P3
Gymnanthera cunninghamii	P3
Hibiscus brachysiphonius	P3
Indigofera gilesii subsp. gilesii	P3
Acacia subtiliformis	P3

N.B. Some species were identified in the area more than once.

2.6 Matters of National Environmental Significance

Nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined as matters of National Environmental Significance (NES), are protected and managed under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*).

Threatened ecological communities and flora/fauna conservation categories include endangered species, critically endangered species, conservation dependant species, vulnerable species and species that are extinct in the wild. Nominations for species and ecological communities are assessed by the Threatened Species Scientific Committee (TSSC) (DEWHA 2009a).

There were no listed world heritage properties, Commonwealth Heritage Places, or critical habitats identified in a search of Protected Matters under the EPBC Act for the area of investigation.

There were no threatened ecological communities identified in a Protected Matters Search under the *EPBC Act*. However, the Fortescue Marsh is under consideration for listing as a wetland of international importance under the *EPBC Act* and the RAMSAR convention of wetlands 1971. Although this wetland is not officially listed as a wetland of NES, any proposals likely to impact on this wetland will be assessed under the *EPBC Act*.

RHIO's efforts to avoid the area using the MCA study (WorleyParsons 2009) and the precedent of other railways in the area suggest that impacts from RHIO's rail will be minimal with appropriate management plans in place.

3. SUMMARY OF PAST STUDIES

The Pilbara represents one of the most comprehensively surveyed bio-regions in Australia, due to the number of surveys undertaken for other developments as part of the Environmental Impact Assessment process. As a result there is a wealth of existing baseline flora and fauna data. Therefore, any further survey work will focus only on investigating in detail issues relating to flora and vegetation communities that are of priority status, fauna of conservation significance (APM 2009) and communities for which existing literature is not available. This section provides an overview of studies that have been performed, the results of which have key importance to the proposed rail development.

3.1 Multi Criteria Analysis (MCA) Constraints and Route Selection

An integrated, Multi Criteria Analysis approach (MCA) was adopted to identify suitable routes for the RHIO rail. The MCA involved consideration of environmental, social and engineering constraints in the decision-making process. Criteria for the route selection were developed by WorleyParsons and RHIO personnel.

The MCA consisted of three distinct assessments. In the first assessment, performance ratings were assigned to each criterion to identify routing preferences, as well as fatal flaws. Unsuitable areas were subsequently screened out using a geographic information system (GIS) database that allowed the multiple layers of environmental, social and engineering information to be mapped and analysed against the selection criteria.

The second assessment utilised the GIS fatal flaw data from Round 1 as the input into Quantm (a proprietary software system utilised for optimising rail alignments based on information and constraints input by the user) for the purpose of generating low cost rail alignments. These alignments avoid areas graded as environmentally, socially or engineering unfeasible (from Round 1). The termini for the Quantm model were the Roy Hill Mine and the Port rail infrastructure facility, close to Boodarie Estate. Subsequently a more detailed assessment was undertaken of the short listed routes. The goal was to review constraints in the proposed infrastructure corridors and identify any required deviation outside the proposed alignments. Route attributes were summarised and potential constraints for the positioning of a rail route were identified.

During the third assessment, routes were ascribed a ‘Sustainability Index’ value. The dominance of each route was ranked based on the route feasibility, constructability, environmental and social constraint data. The resulting score for each route allowed a ranking of all routes to be developed.

A comparative Capital Cost (CAPEX) for each route was then determined to provide a financial measure against which the preferred route could be assessed. The CAPEX values for the routes were based on prices detailed in the Estimate Basis Report.

The result from this study identified Route 6 as being the most suitable. Cost aside, Routes 4, 5 and 7 would be suitable candidates as backup routes.

At the conclusion of the third assessment, a review of the outcomes was undertaken to confirm sensibility. Based on the analysis Route 6 was confirmed as the preferred alignment.

3.1.1 Proposed Corridor Statistics

Within and adjacent to the corridor	Description
Total Route length	300km
Indigenous and Cultural Heritage Includes European heritage	Passes through 6 Aboriginal sites Dambara Yambara (approx. 10km) Kulkakutjarra pool. (approx. 6km) Turner river (Tjirrlil) (approx. 1km) Yule river (Kakurka) (approx. 1km) Redmont access 1 (approx. 1km) Tjilling creek (approx. 2km) Route 6 passes through the Black Range Dyke Section (4km) listed on the Register of the National Estate
Aboriginal Communities	The route is approximately 3.5km from the nearest Aboriginal community (Abydos Woodstock Group)
Native Title	Native Title claims along Route length: • Kariyarra; • Palyku; and • Nyiyaparli.
Local Government Areas	• Shire of East Pilbara; and • Town of Port Hedland.
Environmentally Sensitive Area	No ESA within 5km of the route
Aesthetics/Homesteads	One homestead (Indee) is within 5km of the route
Important Bird Areas	The Fortescue Marshes are approximately 6.2km from the southern most part of the route
Important Wetlands	The only important wetland near to the route is the Fortescue Marshes
Direct disturbance to other areas of conservation significance.	No Threatened Ecological Community (TEC) within 1km of the route
Land Tenure	Crosses mining areas and railway leases under the following State Agreements: • Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006; • Iron Ore (Mount Newman) Agreement Act 1964; and • Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Act 2004.

Within and adjacent to Route	Description
Land Use	• Freehold Land (1.6km); • Leasehold Land (208km); • Reserve (89.4km); and • Road Reserve (0.4km).
Rivers and Creeks	The following rivers and creeks are within 500m of the route: • Haunted Hole Creek; • Big Creek; • Garden Creek; • Christmas Creek; • Cutinduna Creek; • Gillam Creek; • Yule River; and • Western Shaw River.
Mining Activities	Intersects mining leases held by: • FMG Chichester Pty Ltd; • Roy Hill Iron Ore Pty Ltd; and • Domain Mining Pty Ltd. Also intersects with exploration licences, miscellaneous licences and general purpose leases.
Road	The route crosses the Great Northern Highway at three points
Rail	The route crosses the FMG and BHPBIO rail lines
Gas Pipeline	The route crosses the Epic Energy pipeline.

In summary, the preferred alignment, Route 6, passes through the following;

- a Schedule 1 area (19km). Under Schedule 1 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 these areas may be exempt from the usual requirement for a vegetation clearing permit for defined 'low impact' mineral or petroleum-related activities;
- the Black Range Dyke Section (4km). This site is listed on the Register of the National Estate for its heritage significance;
- six registered Aboriginal sites; and

- Native Title claim areas of the *Kariyarra, Palyku* and *Nyiyaparli* claimants.

In addition,

- six “Priority four” fauna species (as listed in the DEC database) including birds and mammal species, have been identified within two kilometres of the route; and
- two “Priority four” threatened fauna species (as listed in the DEC database) including birds, as listed in the DEC database, have been identified within one kilometre of the route.

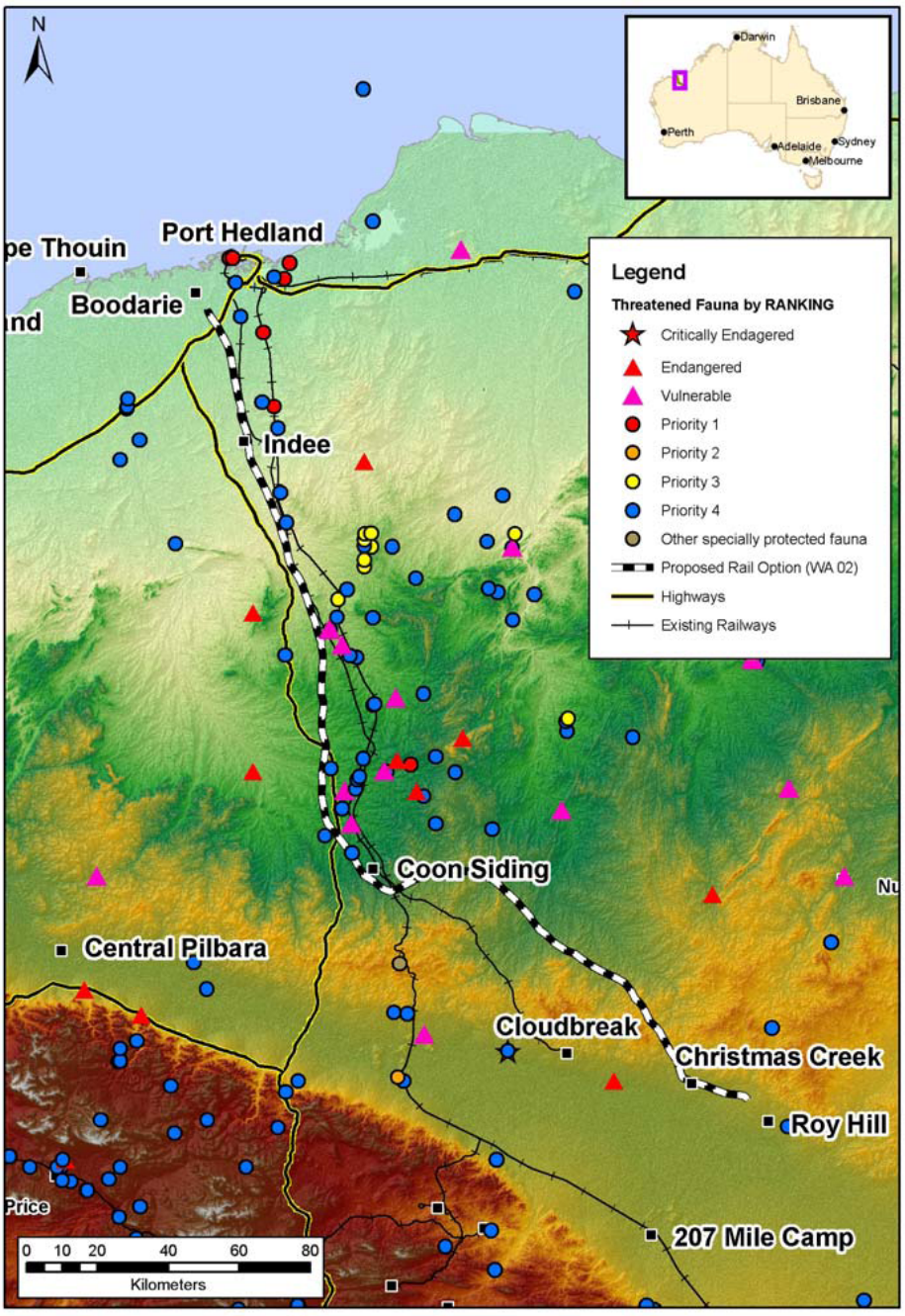

Figure 8 Location of Threatened Fauna along the length of the Proposed Corridor

3.2 Animal Plant Mineral (APM)

3.2.1 Overview of the Study

This study involved a site reconnaissance of the proposed Roy Hill mine to Port Hedland railway corridor to identify any fatal flaws associated with the preliminary route. The length of survey was approximately 290km and took in Fortescue Plains, Chichester and Roebourne biogeographic sub-regions (APM, 2009).

APM assessed the detailed attributes of the biogeographic sub-regions using information published in the Biodiversity Audit of Western Australia (2002). APM referred to the Fortescue Plains, Chichester and Roebourne subregions. Synopsises of each of the relevant Pilbara subregions were assessed in relation to fauna of conservation significance. These included Schedule fauna (listed under the Wildlife Protection Act 1950 Cth), Priority Fauna (as defined by the DEC nature protection branch) and endemic fauna as defined by Kendrick and McKenzie (2002),.

APM also used the online database search tool, Naturemap, produced by the Western Australian Museum and the Western Australian Herbarium. Naturemap details fauna recorded as occurring in the biogeographic sub-regions. This is a broad brush-stroke tool, giving a macro overview of the region. Bearing in mind this limitation when concerned with what may occur in a more defined area, it is useful in an initial investigation stage.

3.2.2 Flora

The report discussed in broad terms, possible impacts on flora due to impacts on habitats such as Mulga groves. It was stated that considerations of the impacts on flora will need to be made when the final alignment is selected based on the relevant constraints. The presence/absence and population boundaries of DRFs and Priority taxa flora will need to be determined in surveys of habitats in which they may occur.

Section 4 presents the results of the APM study as they relate to other projects.

3.2.3 Fauna

APM (2009) conducted a search on the EPBC database for threatened fauna species. Records returned were:

- Night Parrot *Pezoporus occidentalis*
- Princess Parrot, Alexandra's Parrot *Polytelis alexandrae*
- Mulgara *Dasycercus cristicauda*
- Northern Quoll *Dasyurus hallucatus*

- Greater Bilby *Macrotis lagotis*
- Northern Marsupial Mole *Notoryctes caurinus*
- Great Desert Skink
- Olive Python (Pilbara subspecies) *Liasis olivaceus barroni*

APM (2009) consider that the Western Pebble-mound mouse and the Short-tailed Mouse are two species likely to suffer some impact from the project. The Western Pebble-mound mouse typically occupies areas that have suitable borrow material for rail foundations (APM 2009). The Short-tailed mouse occupies stony hummock grasslands in Pilbara which are well represented. However, like most small ground dwelling fauna it is relatively sedentary, and individuals can be lost during ground clearing. Records of *Dasyurus hallucatus* in the area are scarce (APM 2009). Both of these species have been noted in Section 4.

Suitable habitat for both Woma and Mulgara, and secondary evidence of Mulgara (disused burrows) were noted near to the corridor but not along the corridor (APM 2009). Some of the most recent evidence of the presence of the Night Parrot has been at the nearby FMG Cloudbreak mine (Bamford. M. J 2005). As it is considered that there is suitable habitat for these species and that there has either been evidence of them occurring or confirmed sightings (Night Parrot), they should be considered in RHIO surveys.

The report states that passing of the RHIO corridor through the Fortescue Plains sub-region would not threaten the presence of any of the aforementioned fauna to the extent that the corridor should be realigned.

3.2.4 Significant Habitats

APM conducted a search for TECs and PECs on the DEC database. The search found that there were not any TECs within the proposed corridor. Two PECs were identified as being within the proposed rail corridor; these were the West Angelas Cracking-clays, otherwise known as the Cracking Clays of the Chichester Ranges, and the plant assemblages of the Wona Land System (APM 2009).

APM note that the WA Biodiversity Audit identifies the Fortescue Marsh saltbush community and the perennial grassland communities as ecosystems at risk. However, it is considered that the proposed corridor is unlikely to threaten these communities as the corridor skirts the north-eastern periphery of the Fortescue Marsh and runs on a diagonal away from the marsh minimising the potential secondary impacts of impeded surface water flow (APM 2009).

It was also noted in the report that mulga tree communities occur in the region and their boundaries are well defined. These communities can be affected by changes to surface sheet flows. However it was reported that whilst these communities do occur to the south west of Roy Hill, on the south side of the Fortescue Marsh, and in other areas west of Roy Hill along the northern boundary of the

Fortescue Marsh, none were observed on the northern rail corridor in the Fortescue Plains sub-region (APM 2009). RHIO recognises that communities reliant on sheet flow regimes require management through engineering and design of the railway to allow for the persistence of natural drainage patterns.

APM (2009) recommended impacts on the Spectacled Hare-wallaby *Lagorchestes conspicillatus leichardti* and the Pilbara Olive Python *Liasis olivaceus barroni* should be considered as the habitats they occupy are not well represented and both are vulnerable to human and feral impacts.

With regard to habitat, the Pilbara Olive Python occupies rocky gullies and major drainage lines. The proposed corridor will impact very few drainage gullies but will cross several major drainage lines. Where mature eucalypts are lost there could be a loss of individuals and a loss of refuge (APM 2009). Habitats such as large permanent or semi permanent water holes with large fringing *Eucalyptus* and *Melaleuca* species and steep dissected cliff faces on the outer margins are important to this species for feeding and refuge. This is also noted as being an important habitat resource for the western race of the Star Finch *Neochima ruficauda subclarescens*.

The Spectacled Hare-wallaby relies on dense shrub vegetation for refuge overnight and during foraging. Typical sub tropical woodland over tussock or hummock grasses does not offer this species appropriate refuge from feral predators. Dense shrublands of *Acacia*, *Grevillia* and other similar species offer much better refuge and such vegetation can be found in minor drainage lines that dissect the low to medium hills. The proposed corridor appears to favour this level topology and so construction of the railway corridor has the potential to disturb significant tracts of suitable habitat (APM 2009).

The Mulgara *Dasycercus cristicauda* is recorded by Naturemap and also mentioned in the Biodiversity Audit for Chichester sub-region. However no suitable habitat was noted for this species. Thompson and Thompson (2007) recorded mulga on the adjacent FMG rail corridor on the northern fringe of the Chichesters during surveys for FMG. The *Planingale* sp. and the Pilbara endemic *Ningaui timealeyi* may utilise the elevated cracking clay in this sub region.

3.2.5 Study Conclusions

The aerial survey and associated desktop study performed by APM were commissioned as an initial ‘fatal flaws’ assessment to allow the proposed corridor to be assessed based on flora and fauna conservation values. The proposed rail corridor represents a large scale development that will cause minimal disturbance along its 300km extent.

This study focused on a corridor approximately 2.5km wide. The final construction corridor is likely to be less than 100 m wide either side of the centre line. APM note that approximately 170km of the route, from Port Hedland south to the northern apron of the Chichester Range, has already suffered some disturbance through the construction of the Great Northern Highway and the FMG and BHPBIO corridors. The remaining 120 km to Roy Hill mine is undisturbed (APM 2009).

APM made note in their report of a number of flora and fauna issues, however, few of these should be considered significant enough to influence the design and construction of the corridor. Those issues that may require further consideration are summarised below.

- The Chichester Cracking Clay communities should be avoided wherever possible. This is a unique biological community that is isolated and poorly represented in the Pilbara. It only occurs in specific landscapes, where its formation is dependant upon specific geological/geomorphological criteria. It is recognised as a Priority Ecological Community;
- The permanent or semi-permanent pool at the Yule and Turner rivers should be avoided in the final alignment and caution must be taken not to impact surface and sub-surface hydrology that may influence the persistence of the pool. Loss or impact of this pool would result in a loss of a limited habitat resource for the fauna of conservation significance.
- The final centreline of the railway should be located as far east and north of the Fortescue Marsh as possible. Significant effort will need to be invested into mitigating the secondary impacts of drainage shadows created by the obstruction of sheet water flow. Van Vreeswyk et al., (2004) states that for 'sheet wash plains' that: 'surface hydrology processes are extremely important in maintaining the ecological integrity of these systems. Any disturbance that restricts, diverts or concentrates surface sheet flows will effect (often adversely) vegetation communities. For example, these plains are susceptible to water starvation caused by inappropriately located or constructed tracks and roads. In such cases vegetation may decline down slope the impedance to flow and expose the soil to wind erosion' (van Vreeswyk et al. 2004).
- Developments such as the proposed railway corridor pose only a minor threat due to the small area and linear nature of the disturbance corridor. This is in relation to potential threats to lowland plant communities reliant on sheet flow regimes.
- The proposed corridor is not likely to impact any of the Biodiversity Audit's endemic taxa due to the small amount of habitat lost during the development relative to the amount of similar adjacent habitat. However, microhabitat is present for endemic taxa and other species of conservation significance. These include
  - scree and Spinifex steppe for pygopods (legless lizards), the Short-tailed Mouse *Leggadina lakedownensis* and the Pilbara Death Adder *Acanthophis wells* ; and
  - sandy alluvial/colluvial outwash plains supporting shrublands for mammals such as the Bilby *Macrotis lagotis* and heavily wooded drainage lines for the Northern Quoll *Dasyurus hallucatus* and nesting Grey Falcons *Falco hypoleucos*.

3.3 Hope Downs

Hope Downs is a Hancock Prospecting venture to mine, rail and ship Iron Ore from 3 large deposits namely Hope 1, Hope 2 and Hope 3. The rail and port part of the project have not progressed,

however the environmental surveys undertaken as part of the EIA are particularly relevant to this study.

A preferred rail alignment had been selected for the full length of the track between the mine site and the port. The proposed railway, approximately 324km long was designed for the transport of ore from the Hope Downs mine to the Port Hedland port facilities. The railway was designed to be capable of an independent operation of 25Mtpa. The railway line followed BHPBIO rail line where possible to minimise the construction footprint.

3.3.1 Flora

Biota were commissioned to carry out flora and vegetation surveys. These were conducted over two periods. The initial survey was conducted two months after sustained and heavy rainfall events in February 2001 when conditions were extremely favourable for the collection of ephemeral flora. The second survey was conducted slightly later in the season however annual species were still present and specimens were readily identifiable.

No Declared Rare Flora (DRF) were located during the field surveys and Biota reported that none were expected to occur in the habitats present along the rail corridor (Biota Environmental Sciences 2002). Priority species recorded during the surveys are detailed in Section 4. During the time of the survey 14 priority species were identified. Since that time the status of some of these species have changed. There are now two Priority 2 species (previously five), five Priority 3 species (previously eight; one has changed to Priority 4 and another previously not threatened now listed as a Priority 3). Section 4 lists priority species found at the time of the surveys as they are currently listed on the DEC threatened flora database.

Eighteen weed species were found over the course of the surveys. One of these species is the Prickly Pear *Opuntia stricta*, a Declared Plant under the *Agriculture and Related Resources Protection Act 1979*. A single individual of this species was recorded from the Turner River. Under the *ARRP Act*, this species is classified as P1 for all municipal districts in the State north of the 26th parallel of latitude, prohibiting movement of plants and their seeds within the state. The remaining species were largely common and widespread in the Pilbara region (Biota Environmental Sciences 2002).

3.3.2 Fauna

Systematic fauna surveying was undertaken in stages. The first stage consisted of the Fortescue Basin and Coastal Plain (sections C, F and G), surveyed in late April and early May 2001. The Chichester Range and Abydos Plain (sections D and E) were surveyed in late June and early July 2001. Systematic sampling was undertaken in areas of potentially high biodiversity indicated by topographical and vegetation complexity, and in restricted habitats or habitats thought likely to support rare species (Hope Downs Management Services 2002). Further season trapping was completed during mid November 2001, with additional surveys targeting the Mulgara and Bilby carried

out during October 2001. Overall, the surveys accounted for 33 survey grids over 324km with a total of 2900 trapping nights (Hope Downs Management Services 2002).

Results of survey findings are detailed in Section 4. Note in the table that most of the fauna recordings were reported as being opportunistic, i.e. not recorded through targeted trapping. Aside from trapping, fauna was recorded through:

- systematic transects at over 30 sites (between 15 and 130 minutes) to survey bird species;
- searching of burrows and microhabitats for reptiles and small mammals;
- spotlighting for nocturnal species;
- recording of opportunistic vertebrate sightings;
- identification of road kills etc; and
- recording of secondary signs such as burrows, tracks and scats.

The field surveys recorded no schedule listed fauna species but recorded three priority listed fauna taxa; the Western Pebble-mound Mouse *Pseudomys chapmani*, the Grey Honeyeater *Conopophila whitei* and the Ghost Bat *Macroderma gigas*.

3.3.3 Significant Habitats

Fourteen fauna habitats were identified in the project area:

- ridges or hills: (i) plateaux, ridges, mountains, hills; (ii) lower slopes;
- scree slopes;
- calcrete low Hills and dissected flats;
- gorges;
- minor drainages: (i) channels, (ii)
- minor outwash;
- outwash plains: (i) Lake Robinson; (ii) mulga woodland;
- washplains;
- gilgai plains;
- sandplain;
- alluvial plains; and
- creeklines.

These are the same significant habitats that RHIO have identified for surveying in the proposed corridor.

3.4 FMG

Fortescue Metals Group Limited (FMG) proposed to construct a port facility at Port Hedland and a connecting railway to the location of its proposed Mindy Mindy iron ore mining operation, approximately 345 km to the south-southeast. The majority of the disturbance corridor runs parallel and in close proximity to the existing BHP Billiton Newman to Port Hedland Railway and the proposed Hope Downs rail corridor.

3.4.1 Flora

Biota environmental consultants were commissioned to carry out a flora and vegetation survey for the project (Biota Environmental Sciences 2004d, Biota Environmental Sciences 2004a). A systematic flora and vegetation survey was completed of the proposed rail corridor. The approach and methodology adopted was consistent with the guidance provided in EPA Guidance Statement No. 51: Terrestrial flora and vegetation surveys for Environmental Impact Assessment in Western Australia (Environmental Protection Authority 2004).

In order to determine the overall value of the vegetation and flora of the study area, data was collected during a field survey to assess two different botanical attributes, namely;

- the vegetation types occurring within the rail corridor: these were described and mapped during a vegetation survey. The mapping indicated the distribution and relative abundance of each vegetation unit, which helped to define units of particular conservation value; and
- the overall flora occurring in the study area. this was determined through a flora survey that focused on sampling of quadrats. This survey provided a measure of the overall floristic richness of the area, and identified the individual species present. It also identified species of particular conservation significance.

The data collected during the field survey was then compared with other data from the region. The most recent and directly relevant studies were the systematic biological surveys of the proposed Hope Downs port facility and rail corridor between Port Hedland and Weeli Wolli Creek (Halpern Glick Maunsell 2000, Biota Environmental Sciences 2002, Biota Environmental Sciences 2004c, Biota Environmental Sciences 2004b). Data from these earlier surveys was found to be of direct relevance to the FMG assessment.

The terrestrial flora survey was perfomed approximately 6 weeks after sustained and heavy rainfall in the area in February and this timing was extremely favourable for the collection of ephemeral flora and flowering grasses. The vegetation was described at 97 quadrats, with the flora at each of these quadrats recorded in detail.

Given the similarities between the FMG rail corridor and the previously surveyed Hope Downs rail corridor, the impacts associated with the FMG proposal were considered to be essentially the same in nature as those presented by the earlier proposal (Halpern Glick Maunsell 2000, Biota Environmental Sciences 2002). A logical progression from this conclusion is to suggest that similarly, the impacts associated with the RHIO proposal will be essentially the same in nature as those presented by both the FMG and Hope Downs proposals.

At the time of survey, no DRF species were recorded in the railway corridor. This is still the case.

3.4.2 Fauna

The most recent and directly relevant studies to the FMG rail corridor assessment were the systematic fauna surveys completed for the proposed Hope Downs mine, port and rail developments (Hope Downs Management Services 2002), as these sites are in close proximity to the proposed FMG port and rail corridor. The data arising from the earlier surveys was found to be of direct relevance to the FMG assessment.

The Hope Downs work comprised detailed seasonal sampling of fauna. Forty-four systematic fauna trapping sites were established as part of the baseline fauna survey (Biota Environmental Sciences 2002). Additional work was also subsequently completed in areas where the Hope Downs rail corridor was realigned parallel to Weeli Wolli Creek (Biota Environmental Sciences 2004c) and in the Chichester Range (Biota Environmental Sciences 2004b). These studies added a further 18 systematic fauna survey grids.

In addition, work had been previously undertaken to assess potential links from the Hope Downs Mine to Weeli Wolli Siding of the BHPBIO line to the east and to Coondewanna Flats to the west; this study added an additional 12 systematic fauna sites (Halpern Glick Maunsell 2000). This work provided systematic contextual sampling along the same general corridor as the FMG Stage A rail proposal, amounting to 74 fauna trapping grids.

Two species of Schedule fauna and four priority listed species were recorded from the FMG rail corridor during the FMG survey. A further three Schedule species and five Priority species were recorded within the corridor during surveys for the Hope Downs project, or were considered likely to occur in the area. Threatened fauna that were recorded withing the FMG rail corridor, or which were considered likely to occur, are shown in Table 3 and include;

- Mulgara *Dasycercus cristicauda*;
- Bilby *Macrotis lagotis*;
- Pilbara Olive Python *Liasis olivaceus barroni*;
- Woma *Aspidites ramsayi*;
- Peregrine Falcon *Falco peregrinus*;

- *Ramphotyphlops ganei*;
- Spectacled Hare-wallaby *Lagorchestes conspicillatus*;
- Grey Falcon *Falco hypoleucos*;
- Bush Stone-curlew *Burhinus grallarius*;
- Australian Bustard *Ardeotis australis*;
- Star Finch *Neochmia ruficauda subclarescens*;
- Short-tailed Mouse *Leggadina lakedownensis*;
- Western Pebble-mound Mouse *Pseudomys chapmani*; and
- Ghost Bat Macroderma gigas.

The similarities between the proposed FMG rail corridor and the previously surveyed Hope Downs rail corridor were noted (Hope Downs Management Services 2002) and it was suggested that the impacts from both rails developments would therefore be comparable. The same can logically be deduced for the case of the RHIO rail development in comparison with the FMG and Hope Downs alignments and referrals.

Several fauna habitats along the rail corridor were identified as either spatially restricted or supporting populations of significant species or fauna communities. In summary these comprised:

- linear sand dune habitats adjacent to the Weeli Wolli Creek delta;
- clay-based habitats associated with the Fortescue Marsh;
- cracking clay habitats associated with the Chichester Range;
- granite rockpiles on the Abydos plain portion of the rail corridor; and
- major drainage systems.

All fauna habitats along the rail corridor were noted to be subject to impact from clearing activities, but it was further noted that the significance of the impact would be greater if any of the units above were disturbed. It was suggested that additional disturbance to vegetation from other project-related activities including off-road driving may occur.

Indirect modifications to the environment from construction and operation of the rail that may affect fauna habitat adjacent to the railway were reviewed. These were generally processes that would be initiated by the construction of the rail that have the potential to then continue to operate for the life of the railway, including:

- changes to surface hydrology;
- increased erosion;

- weed introduction/spread; and
- changes to fire regimes (principally in respect of increased frequency).

Biota noted that whilst the FMG development would inevitably cause some localised loss of individual fauna due to direct mortality arising from construction activities, it was unlikely that the loss of individuals would be significant enough to affect the conservation status of any of the species recorded from the corridor.

It was noted that the construction of the railway would result in a barrier to the movement of some fauna species and potential subdivision of populations situated along the rail alignment. The extent to which this would affect the various fauna occurring along the corridor would be dependent on the range, dispersal and effective population size of the various terrestrial species involved. Further, it was noted that habitat isolation may occur between the FMG and BHPB lines, and that the significance of this would depend on the distance between the lines, the population size and the dispersal of fauna species utilising the isolated habitat.

3.5 BHPIO Railway Diversion ARI

This corridor was surveyed for BHPBIOs construction of a new 23 km section of rail line (Chichester Deviation) through the southern slope of the Chichester Range adjacent to BHPBIO's existing Newman to Port Hedland rail line.

The project area is located approximately 210 km south of Port Hedland and 150 km northwest of Newman in the Pilbara. The proposed Chichester Deviation is approximately 23 km long and 1 km wide and deviates up to 6 km west of the existing line between chainage 220, just south of Shaw Siding, and chainage 237, just south of Hesta Siding.

3.5.1 Flora

Following appropriate consultation with relevant stakeholders, BHPBIO and Calibre Engenium commissioned *ecologia* Environment to undertake a two-phase biological survey of the vegetation and flora of the project area.

The first phase of the survey was carried out in October 2007 and the second in May 2008. Systematic and opportunistic sampling methods were used to assess the flora and vegetation.

In addition to pre-determined survey sites, opportunistic samples of plants not recorded in the quadrats were taken while traversing from site to site.

The Chichester Deviation crosses six of the land systems that have been mapped in the Pilbara - the Christmas (1.8 km), Jamindie (4.3 km), Newman (6.2 km), McKay (6.8 km), Capricorn (0.9 km) and Wona (2.9 km) Land Systems.

The vegetation of the Chichester Deviation survey area was mapped using the data recorded during the phase one survey, as a bush fire, caused by lightning, affected approximately 50- 60% of the area in November 2007.

The vegetation of the survey area was mapped into nine vegetation types, with some types further classified into subtypes on the basis of structure and species composition of the dominant strata and on landform. The vegetation types mapped were associated with the following landforms: rocky hill slopes, minor drainage channels on the hill slopes, creeklines, floodplains, gilgai plains and hard clay plains.

No Declared Rare Flora taxa were recorded in the area surveyed. One Priority Flora species was recorded during the survey, *Goodenia nuda* (Priority Three), at five of the sites surveyed. Results of database searches carried out indicate that no Declared Rare Flora taxa have been collected within 20 km of the survey area.

Ten Priority Flora taxa have been recorded within 20 km of the survey area and these are: *Eremophila spongiocarpa* and *Josephinia* sp. Marandoo (Priority One), *Ischaemum albovillosum*, *Paspalidium retiglume* and *Scaevola* sp. Hamersley Range Basalts (Priority Two), *Goodenia nuda, Hibiscus brachysiphonius, Polymeria* sp. Hamersley and *Themeda* sp. Hamersley Station (Priority Three), and *Eremophila youngii* subsp. *lepidota* (Priority Four). Refer to Section 4 for a comparison with other survey results.

Database searches indicate that no threatened ecological communities occur within 20 km of the Chichester Deviation survey area. However, the recently listed Priority 3 priority ecological community - “Plant assemblages of the Wona Land System.” - occurs in the survey area.

No declared weeds were recorded during the survey. A combined total of six general weed species was recorded over the two phases of the survey: *Aerva javanica*, *Bidens bipinnata*, *Cenchrus ciliaris*, *Cucumis melo* subsp. *agrestis, Malvastrum americanum* and *Vachellia farnesiana.*

3.5.2 Fauna

Three mammal species of conservational significance (Ghost Bat, Northern Short-tailed Mouse and Western Pebble-mouse) and seven bird species of conservational significance (Australian Bustard, Bush Stone-curlew, Star Finch (Western), Grey Falcon, Rainbow Bee-eater, Fork-tailed Swift and Wood Sandpiper) were recorded within the rail corridor. These species were either found through surveys or were considered likely to occur in the disturbance corridors.

Overall, the study considered that the development of the rail deviation through the Chichester Range was not expected to significantly impact on species of conservational significance primarily due to the relatively small width of the proposed disturbance area and the large areas of similar habitat adjacent to the project area.

4. COMPARITIVE RESULTS OF PAST SURVEYS

4.1 Flora and Vegetation

The table below lists flora that was either found within the DEC threatened flora database or was recorded during field surveys.

	Proposed Route 6 (MCA)	Proposed Route 6 (APM)	BHPBIO RGP5 (Chichester Deviation)	Hope Downs	FMG
DEC DRF	0	0	0	0	0
Priority Flora (see below)	0	0 (no priority flora were listed in the report)	10 (recorded within 20km of survey area)	7	13
Priority 1	0	0	*Eremophila spongiocarpa* *Josephinia* sp.	*0*	*Eremophila spongiocarpa* *Josephinia* sp. *O'Meara's Goodenia*
Priority 2	0	0	*Paspalidium retiglume* *Ischaemum albovillosum* *Scaevola* sp.	*Euphorbia clementii* *Indigofera ixocarpa* ms.	*Paspalidium retiglume* *Euphorbia clementii* *Indigofera ixocarpa* *Stylidium weeliwolli*

	Proposed Route 6 (MCA)	Proposed Route 6 (APM)	BHPBIO RGP5 (Chichester Deviation)	Hope Downs	FMG
Priority 3	0	0	*Goodenia nuda* *Themeda* sp. Hamersley Station (M.E. Trudgen 11,431) *Polymeria* sp. Hamersley (M.E . Trudgen 11353) *Hibiscus brachysiphonius*	*Goodenia nuda* *Themeda* sp. Hamersley Station (M.E. Trudgen 11,431) *Nicotiana umbratica* *Gymnanthera cunninghamii* *Phyllanthus aridus*	*Goodenia nuda* *Themeda* sp. Hamersley Station (M.E. Trudgen 11,431) *Polymeria* sp. Hamersley (M.E . Trudgen 11353) *Gymnanthera cunninghamii* *Phyllanthus aridus*
Priority 4	0	0	*Eremophila youngii* ssp. *lepidota*	*Bulbostylis burbidgeae*	*Bulbostylis burbidgeae*
Flora of interest	0 (none mentioned)	0 (none mentioned)	Unknown	19 species (3 new species, 10 species not recognized as distinct before the West Angeles survey and 6 species poorly collected or uncommon taxa)	Unknown

	Proposed Route 6 (MCA)	Proposed Route 6 (APM)	BHPBIO RGP5 (Chichester Deviation)	Hope Downs	FMG
Introduced	0	0 (none mentioned)	6 species	18 species	11 species

* *Declared Plants under Agriculture and Related Resources Protection Act 1976.*

*X = species recorded from or likely to occur within survey areas

The table on the following pages lists threatened fauna species that have either been recorded in particular surveys, or a likely to inhabit the areas that have been surveyed.

From the above table, it is expected that there are no DRF expected to occur in the proposed corridor. As indicated above, priority species may occur along the proposed corridor and in habitats where this is likely, surveys should be carried out.

4.2 Fauna

The table below shows a comparative analysis of fauna results.

Threatened Species S = Schedule P = Priority End = Endangered Vul = Vulnerable	Priority/Schedule	Proposed Route 6 (MCA) 4 Priority 4 species are located within 1km of the corridor. These are not specified	BHPBIO RGP 5	Proposed Route 6 (APM)	Hope Downs						FMG
					Opportunistic	Transects					
						C	D	E	F	G	
Mulgara *Dasycercus cristicauda*	S1 Vul		No records but some suitable habitat	X	1			14			1 observed
Black-footed Rock-wallaby *Petrogale lateralis*	S1 Vul										
Northern Quoll *Dasyurus hallucatus*	S1 End		X	X							
Greater Bilby *Macrotis lagotis*	S1 Vul		X (DEC threatened fauna	X	3						X

Threatened Species **S = Schedule** **P = Priority** **End = Endangered** **Vul = Vulnerable**	**Priority/Schedule**	**Proposed Route 6 (MCA)** **4 Priority 4 species are located within 1km of the corridor. These are not specified**	**BHPBIO RGP 5**	**Proposed Route 6 (APM)**	**Hope Downs**						**FMG**
					Opportunistic	**Transects**					
						C	**D**	**E**	**F**	**G**	
			records)								
Northern Marsupial Mole, Karkarratul *Nortoryctes caurinus*				**X**							
Pilbara Olive Python *Liasis olivaceous barroni*	**S1 Vul**		**X no records in region. Limited suitable habitat in survey area.**	**X**							**X**
Great Desert Skink, Tjakura, Warrarna *Egernia kintorei*				**X**							
Peregrine Falcon *Falco peregrinus*	**S4**		**X DEC records within area**		**2**						**X**
Woma *Aspidites ramsayi*	**S4**				**2**						**X**
Ghost Bat *Macroderma gigas*	**P1**		**X**								**X**

Threatened Species S = Schedule P = Priority End = Endangered Vul = Vulnerable	Priority/Schedule	Proposed Route 6 (MCA) 4 Priority 4 species are located within 1km of the corridor. These are not specified	BHPBIO RGP 5	Proposed Route 6 (APM)	Hope Downs							FMG
					Opportunistic	Transects						
						C	D	E	F	G		
Ramphotyphlops ganei	P1		X (Ecologia 2005)									X
Pilbara Leaf-nosed Bat *Rhinonicteris aurantius* (Pilbara form)	Vul											
Spectacled Hare-wallaby *Lagorchestes conspicillatus*	P3											X
Long-tailed Dunnart, *Sminthopsis longicaudata*	P3		No records but suitable habitat									
Little Western Free-tail Bat *Mormepterus loridae*	P1											
Short-tailed Mouse *Leggadina lakedownensis*	P4	X										X

Threatened Species S = Schedule P = Priority End = Endangered Vul = Vulnerable	Priority/Schedule	Proposed Route 6 (MCA) 4 Priority 4 species are located within 1km of the corridor. These are not specified	BHPBIO RGP 5	Proposed Route 6 (APM)	Hope Downs						FMG
					Opportunistic	Transects					
						C	D	E	F	G	
Western Pebble-mound Mouse *Pseudomys chapmani*	P4		X								X
Grey Falcon *Falco hypoleucos*	P4		X recorded outside survey								X
Australian Bustard *Ardeotis asutralis*	P4		X		X	X	X	X	X	X	X
Bush Stone-curlew *Burcinus grallarius*	P4		X opportunistic sightings							X	X
Eastern Curtlew *Mumenius madagascariensis*	P4										
Ctenotis nigrillineatus	P4										

Threatened Species S = Schedule P = Priority End = Endangered Vul = Vulnerable	Priority/Schedule	Proposed Route 6 (MCA) 4 Priority 4 species are located within 1km of the corridor. These are not specified	BHPBIO RGP 5	Proposed Route 6 (APM)	Hope Downs						FMG
					Opportunistic	Transects					
						C	D	E	F	G	
Star Finch *Neochmia ruficauda subclarescens*	P4		X Bamboo Spring								X
Princess Parrot *Polytelis alexandrae*	IUCN (Critically Endangered)			X							
Night Parrot *Pezoporus occidentalis*	IUCN (Near Threatened)		X (Bamford and Mahony)	X							
White-bellied Sea Eagle *Haliaeetus leucogaster*				X							
Rainbow Bee-eater *Merops ornatus*			X open country, most vegetation types, dunes, banks	X							
Great Egret, White Egret *Ardea*				X							

Threatened Species S = Schedule P = Priority End = Endangered Vul = Vulnerable	Priority/Schedule	Proposed Route 6 (MCA) 4 Priority 4 species are located within 1km of the corridor. These are not specified	BHPBIO RGP 5	Proposed Route 6 (APM)	Hope Downs						FMG
					Opportunistic	Transects					
						C	D	E	F	G	
ibis											
Sharp-tailed Sandpiper *Calidris ferruginea*				X							
Curlew Sandpiper*Calidris ferruginea*				X							
Red-necked Stint *Calidris ruficollis*											
Lesser Sand Plover, Mongolian Sand Plover *Charidrius monolus*				X							
Oriental Plover, Oriental Dotterel *Charadrius veredus*				X							
Oriental Pratincole *Glareola maldivarum*				X							

Threatened Species **S = Schedule** **P = Priority** **End = Endangered** **Vul = Vulnerable**	**Priority/Schedule**	**Proposed Route 6 (MCA)** **4 Priority 4 species are located within 1km of the corridor. These are not specified**	**BHPBIO RGP 5**	**Proposed Route 6 (APM)**	**Hope Downs**						**FMG**
					Opportunistic	**Transects**					
						C	**D**	**E**	**F**	**G**	
Broad-billed Sandpiper *Limicola falinellus*				**X**							
Little Curlew, Little Whimbrel *Numenius minutus*				**X**							
Painted Snipe *Rostratula benghalensis lat.*				**X**							
Marsh Sandpiper, Little Greenshank *Tringa stgnatilis*				**X**							
Common Sandpiper, *Actitis hypoleucus*											
Fork-tailed Swift *Apus pacificaus*			**X almost entirely aerial lifestyle**								

Threatened Species S = Schedule P = Priority End = Endangered Vul = Vulnerable	Priority/Schedule	Proposed Route 6 (MCA) 4 Priority 4 species are located within 1km of the corridor. These are not specified	BHPBIO RGP 5	Proposed Route 6 (APM)	Hope Downs						FMG
					Opportunistic	Transects					
						C	D	E	F	G	
Undescribed Taxa											
Ctenotus aff. *helenae*					Collected over wide area in Pilbara over the past decades						
Varanus aff. *Gilleni*					Much of the Hamersley's						
Ctenotus aff. *Robustus*					Cracking clays near Mt Brockman						
Diplodactylus stenodactylus					Wideley Distributed			X		X	
Lerista muelleri					Found but numbers not described						
Ramphotyphlops ammodytes					Found south of						

Threatened Species S = Schedule P = Priority End = Endangered Vul = Vulnerable	Priority/Schedule	Proposed Route 6 (MCA) 4 Priority 4 species are located within 1km of the corridor. These are not specified	BHPBIO RGP 5	Proposed Route 6 (APM)	Hope Downs						FMG
					Opportunistic	Transects					
						C	D	E	F	G	
					Chichesters to PH						
Cenotus aff. *Uber johnstonei*					1						
Lerista aff. *Bipes*					Along north Chichester						
Vermicella snelli					Poorly collected						
Lerist macropisthopus remota											

*X = species recorded from or likely to occur within survey areas

5. IMPACTS, RISKS AND MITIGATION STRATEGIES

Given the similarities between the FMG, BHP and Hope Down rail corridors that have been identified in previous studies and surveys, the impacts associated with the current proposal are essentially the same in nature as those presented by the earlier proposals, and have been demonstrated by others to be readily manageable during construction and operation of the rail development.

Impact mechanisms that may affect terrestrial flora, vegetation and habitat for fauna during the construction and operation of the proposed railway include;

- vegetation clearing;
- introduction and/or spread of weeds;
- disturbance of surface hydrology; and
- fire.

A variety of management measures exist to address the potential impacts presented by the proposed railway. These will be implemented as part of the design, construction and operation of the proposed railway to reduce the potential impacts to terrestrial vegetation and flora. Management measures anticipated to be employed for the proposal are listed below.

a) The design of the rail alignment will be refined, taking into account the locations of significant vegetation types and populations of priority flora and potentially significant fauna habitats with the objective of avoiding these through final design.

b) The drainage design for the railway will take into account local hydrological patterns that may have ecological significance. This includes adequate provision for drainage line habitats to ensure that back-water or flow restriction does not occur. In most areas this will probably be met by mirroring the drainage design of the existing railways (when adjacent), and following best practice drainage design in other areas.

c) The rail alignment and drainage design must and will ensure that interruption to existing sheet flow is kept to a minimum. This is required to ensure that sensitive vegetation both upstream and downstream (primarily mulga) is not adversely affected. This will be a consideration south of the Chichester Range, particularly where the rail passes through mulga vegetation in the Fortescue basin.

d) Vegetation clearing will be kept to the minimum necessary for safe construction and operation of the railway, particularly in areas adjacent to vegetation of higher conservation significance.

e) Off-road driving will be strictly prohibited, with all staff to be informed of this (and significant environmental issues generally) as part of an on-site induction programme;

f) Weed control measures will be developed and implemented to ensure that exotic flora species identified within the rail corridor are not spread as part of the construction of the railway.

g) Fire management will be addressed as part of the Environmental Management Plans (EMPs) prepared for construction, operation and maintenance of the railway. A key objective of these management measures will be to reduce the risk of unplanned fires and provide contingency measures to minimise any impacts in the event that a fire is started.

h) A Topsoil Management and Rehabilitation Plan will be prepared for all non-permanent cleared areas.

i) Standard dust suppression measures will be implemented across the project area during construction to minimise effects on surrounding vegetation.

j) The location of borrow pits and other materials sourcing sites will be appropriately located in the landscape and have features such as being self-draining. Once pit locations are identified, the location of these sites will be subject to targeted surveys for any threatened flora species or vegetation types of conservational significance prior to clearing commencing.

k) As part of the environmental induction, staff will be made aware that all native fauna are protected and that there are substantial penalties associated with disturbance to flora and fauna. Firearms, traps and domestic pets will be prohibited onsite.

6. CONCLUSIONS

Potential environmental and social impacts of railway construction and operation in the Pilbara region are well understood and their potential impacts are well documented. Effective management and mitigation measures have been developed and implemented with success by existing railway development proponents.

This comparative study and literature review has demonstrated that, in general, the proposed rail line traverses the same type of terrain, and will produce the same known low risk environmental impacts as other approved railways, existing and proposed, that traverse the Pilbara.

The vast body of literature reviewed as part of this study confirms that:

- there are no Declared Rare Flora within the proposed corridor, though there are a number of Priority Flora at differing categories of conservation significance;
- there are a number of Threatened Fauna that may be expected to inhabit the area;
- there are no Threatened Ecological Communities in close proximity to the proposed corridor;
- there is small area (1.87km) of a Priority Ecological Community, the Wona Land System, that the proposed corridor crosses;
- there are known habitats where Short-range Endemics may occur, which will be appropriately surveyed and impacts managed;
- there is an Important Bird Area, the Fortescue Marshes, within 6.2km of the proposed corridor, which will be appropriately surveyed and impacts managed; and
- there are areas where surface hydrology processes play an important role in maintaining ecological integrity.

Based on investigations and assessments made as part of the environmental approvals process for other developments, existing and proposed, the following is true;

- substantial data exists for the region traversed by the rail alignment, and no ‘fatal flaws’ have been identified;
- aside from a few, manageable environmental attributes unique to the Roy Hill rail alignment, the proposed alignment has very similar environmental impacts to a number of other rail alignments that have been approved from an environmental standpoint; and
- the scale of the potential impact is relatively insignificant in the context of the available habitat and faunal assemblages, however some planned targeted surveys will continue into the next stages of the project to ensure environmental attributes unique to the proposed alignment and of moderate environmental risk are effectively managed and mitigated. Studies and

investigations will be undertaken where sufficient information is not available from existing literature, as identified within this document.

On this basis, it is believed that the rail development warrants assessment under an “Assessment on Referral Information” (ARI) process, as defined within Part IV of Section 38 of the *Environmental Protection Act 1986*.

7. REFERENCES

Anon. 2002. A Biodiversity Audit of Western Australia. *In:* Department of Conservation and Land Management (ed.).

APM. 2009. HPPL - Roy Hill Iron Ore Pty Ltd: Mine to Port Northern Rail Corridor Fatal Flaws Assessment.

Bamford. M. J. 2005. Survey for the Night Parrot Pezoporus occidentalis in the Cloud Break Project Area, Fortescue Metals Group.

Beard J.S. 1975. Vegetation Survey of Western Australia. 1:100,000 Vegetation Series Mapsheet 5 - Pilbara.

BHPBIO. 2009. NEWMAN – PORT HEDLAND RAILWAY - CHICHESTER DEVIATION - ENVIRONMENTAL REFERRAL DOCUMENT.

Biota Environmental Sciences. 2001. Resources Development and Subterranean Biota in the Pilbara Region - Management and Approval Processes. EPA Submission prepared for BHP Iron Ore Pty Ltd, Perth.

Biota Environmental Sciences. 2002. Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate Fauna Survey Hope Downs Management Services.

Biota Environmental Sciences. 2004a. Fortescue Metals Group Rail Corridor and Mindy Mindy Mine: Vertebrate Fauna Survey.

Biota Environmental Sciences. 2004b. Hope Downs Rail Corridor, Chichester Range Additional Corridor - Vertebrate Fauna Survey. Hope Downs Management Services.

Biota Environmental Sciences. 2004c. Hope Downs Rail Corridor, Hamersley Ranges Extension - Vertebrate Fauna Survey. Hope Downs Management Services.

Biota Environmental Sciences. 2004d. Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor.

DEWHA. 2009a. Department of the Environment, Water, Heritage and the Arts.

DEWHA. 2009b. Interim Biogeographic Regionalisation for Australia.

E. J. B. van Etten. 2000. VEGETATION OF THE HAMERSLEY RANGES, NORTH-WEST AUSTRALIA - CHARACTERISTICS AND COMPARISONS, Curtin University of Technology.

Ecologia. 2008. Rapid Growth Project 5 (RGP5) Rail Duplication: Short Range Invertebrate Survey and a Targeted Survey for the Trapdoor Spider, *Aurecocrypa sp*.

Environmental Protection Authority. 2004. Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, Environmental Protection Authority, Perth, WA.

Fortescue Metals Group Limited. 2005. Pilbara Iron Ore and Infrastructure Project: E-W Railway and Mine Sites (Stage B)

Halpern Glick Maunsell. 2000. Hope Downs Rail Corridors Biological Surveys. *In:* H.D.M. Services (ed.) Report no.ES9779C.

Hope Downs Management Services. 2002. Hope Downs Iron Ore Project - Port and Rail - Public Environmental Review.

Humphreys, W.F. 2000. The Pilbara stygofauna: a synopsis. Unpublished report to the Waters and Rivers Commission.

Hutchinson. M. F, McIntyre. S, Hobbs. R. J, Stein. J. L, Garnett. S & Kinloch. J. 2005. Integrating a global agro-climatic classification with bioregional boundaries in Australia. Global Ecology and Biogeography 14: 197-212.

Kendrick, P. 2001. A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002: Pilbara 2 (PIL - Fortescue Plains subregion).

Kendrick, P. & N. McKenzie. 2001. A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002: Pilbara 1 (PIL - Chichester subregion).

Kendrick, P. & McKenzie N.L. 2002. Pilbara 1 (PIL 1 - Chichester Sub-region): A Biodiversity Audit of Western Australia's 53 Biogeographical Sub-regions in 2002.

Kendrick, P. & F. Stanley. 2001. A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002: Pilbara 4 (PIL - Roebourne synopsis).

Marmonier, P., P. Vervier, J. Gibert & M.J. Dole-Olivier. 1993. Biodiversity in groundwaters. TREE 8: 392-395.

Thompson, G.G. & Thompson S.A. 2007. Shape and spatial distribution of Mulgara (*Dasycercus cristicauda*) burrows, with comments on their presence in a burnt habitat and a translocation protocol. Journal of the Royal Society of Western Australia 90: 195 - 202.

Trendall, A.F. 1990. Hamersley Basin. *In:* Western Australia Geological Survey (ed.) Geology and Mineral Resources of Western Australia.

van Vreeswyk, A.M.E., A. L. Payne, K. A. Leighton & P. Hennig. 2004. In Technical Bulletin No. 92: An Inventory and Condition Survey of the Pilbara Region, Western Australia.

Watts, C.H.S. & W.F. Humphreys. 1999. Three new genera and five species of Dytiscidae (Coleoptera) from underground waters in Australia. Records of the South Australian Museum 32: 121-142.

WorleyParsons. 2009. Roy Hill Iron Ore Rail Route Selection Study MCA Constraints and Route Selection.