ROY HILL INFRASTRUCTURE PTY LTD

Roy Hill Infrastructure Railway

Environmental Referral Document

RHI-001-30-EN-REP-0564

30 July 2010

SYNOPSIS

As part of the Roy Hill 1 Iron Ore project, Roy Hill Infrastructure Pty Ltd is proposing to construct a 300km (approximate) railway and associated infrastructure to transport iron ore from its proposed Roy Hill 1 mine to a port infrastructure facility at Port Hedland. This document is part of the formal referral of the railway to the Environmental Protection Authority for assessment under Section 38 of the *Environmental Protection Act 1986* and for assessment of the proposal by the Department of Environment, Water, Heritage and the Arts under section 95A of the *Environmental Protection and Biodiversity Conservation Act 1999*.

Rev	Description	ORIG	REVIEW	APPROVAL	Date
1	Final	A Tran	T Crossley	T Crossley	9 July 2010
2	Revised Referral	I Pound	A Tran	T Crossley	30 July 2010

VOLUME I – ENVIRONMENTAL REFERRAL DOCUMENT

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List of acronyms and abbreviations

26D	Licence to construct or alter wells under the *Rights in Water and Irrigation Act 1914* (WA)
5C	Licence to abstract water under the *Rights in Water and Irrigation Act 1914* (WA)
AH Act	*Aboriginal Heritage Act 1972* (WA)
AHD	Australian Height Datum
ARI	Assessment on Referral Information
BHPB	BHP Billiton
BHPBIO	BHP Billiton Iron Ore
Ch	Chainage in kilometres from 0km at Port Hedland
DEC	Department of Environment and Conservation (WA)
DEWHA	Department of the Environment, Water, Heritage and the Arts (Commonwealth)
DIA	Department of Indigenous Affairs (WA)
DoW	Department of Water (WA)
DSD	Department of State Development (WA)
DRDL	Department of Regional Development and Lands
DRF	Declared Rare Flora
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environmental Protection Authority (WA)
EP Act	*Environmental Protection Act 1986* (WA)
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESA	Environmentally Sensitive Area
FBW	Flash Butt Welding
FMG	Fortescue Metals Group Ltd
GL	Gigalitres
HPPL	Hancock Prospecting Pty Ltd

km	kilometres
km^2	square kilometres
km/h	kilometres per hour
m	metres
m^3/s	cubic metres per second
MCA	Multi-Criteria Analysis
mg/L	milligrams per litre
MLpa	million litres per annum
mm	millimetres
Mm^3	million cubic metres
Mtpa	million tonnes per annum
NT Act	*Native Title Act 1993* (Commonwealth)
NWIOA	North West Iron Ore Alliance
PEC	Priority Ecological Community
PHPA	Port Hedland Port Authority
RHI	Roy Hill Infrastructure Pty Ltd
RHIO	Roy Hill Iron Ore Pty Ltd
RIWI Act	*Rights in Water and Irrigation Act 1914* (WA)
TEC	Threatened Ecological Community
TOR	Top of Rail
tph	Tonnes per hour
TPI	The Pilbara Infrastructure Pty Ltd
WC Act	*Wildlife Conservation Act 1950* (WA)

1 EXECUTIVE SUMMARY

The purpose of this environmental impact assessment document is to provide sufficient information regarding the proposed Roy Hill Infrastructure Railway (RHI Railway):

- to the Western Australian Environmental Protection Authority (EPA) to allow it to decide whether it should formally assess the proposal under Part IV of the Environmental Protection Act 1986 (WA) (EP Act), and if so, complete an Assessment on Referral Information (ARI); and
- to the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) to permit it to assess the proposed action by Preliminary Documentation (decision of 4 May 2010, EPBC Ref 2010/5424).

Roy Hill Infrastructure Pty Ltd (RHI) (the Proponent) is proposing to develop a railway of approximately 300 km length to transport iron ore from the Roy Hill 1 mine to facilities at Port Hedland within the lease area of the Port Hedland Port Authority (PHPA) and the proposed Boodarie multi-user stockyard area which is to be vested in the PHPA. The railway proposal includes a marshalling yard (with associated workshops and maintenance facilities, storage and laydown areas; rail welding yard); passing sidings; construction water bores and 'turkeys nest' dams; borrow and ballast areas for construction material; communications cable, towers and signalling system; construction workers accommodation camps and amenities for workers; access roads; and construction power supplies. Figure 2-1 provides an overview of the area and the proposed railway route. The key characteristics of the RHI Railway are listed in Table E1.

This referral is the culmination of engineering and environmental investigations, engagement with recognised technical specialists and consultation with the Department of Environment and Conservation (DEC) and other stakeholders. The information contained within the referral describes:

- the environmental context and values of the project area and its surroundings;
- methodology for how potential impacts of the project were identified and evaluated;
- the possible extent and predicted nature of the biophysical consequences of project implementation;
- the potential for the project to significantly and adversely change people's social surroundings or to unreasonably interfere with the health, welfare, convenience, comfort or amenity of people;
- how sustainability principles will be incorporated in project design and implementation;
- the legislative and policy context within which the proposal will be assessed and regulated;
- the predicted environmental outcomes that will result from project implementation and the management actions required to ensure attainment of the outcomes; and
- the extent to which the Proponent has consulted with interested and affected parties and responded to issues raised by them.

Table E1: Key characteristics of the RHI Railway

Element	Description
General	
Construction period	24 months (approximate)
Operating life	20+ years
Export tonnage	55 Mtpa (minimum)
Overall characteristics	
Main line length of railway	300 km (approximate)
Permanent disturbance area	2,095ha (approximate ± 5%)
Construction disturbance area	4,460ha (approximate ±10%)
Support Infrastructure	Passing sidings, marshalling yard, maintenance facilities, fuel storage, washdown, administration, workshops, welding yard, communication cable, towers and signalling system, water bores and 'turkeys nest' dams, borrow and ballast areas, lay-down yards.
Bridges	Great Northern Highway, BHPB and TPI railways, rivers and creeks.
Access and construction roads	An access road for construction and maintenance will follow the railway for its entire length. Additional construction roads will be built within the RHI Railway corridor.
Construction Workforce Accommodation	Five rail camps within the RHI Railway corridor.
Groundwater supply for construction	5GL (approximate total)

RHI has negotiated a State Agreement for the railway with the Government of Western Australia. The *Railway (Roy Hill Infrastructure Pty Ltd) Agreement Bill* was introduced to Parliament on 24 June 2010. The State Agreement is expected to be ratified by October 2010. The agreement will provide tenure and approval to construct and operate the railway and associated infrastructure.

Extensive stakeholder consultation has been undertaken and the input of interested parties incorporated within this document. It has been determined that interest in the project is limited locally and to those directly associated with the project.

RHI has adopted a semi-quantitative risk-based approach to its assessment of potential environmental impacts of the railway proposal. The approach follows the established methods and definitions of AS/NZS4360:2004 Risk assessment to systematically define and categorise the potential environmental impacts, having regard to HB203:2006 Environmental risk assessment – principles and processes in applying the standard to assessment of the environment.

The regional environmental factors to be assessed have been identified through a combination of advice secured by RHI from environmental specialists; reference to existing studies and approvals for other developments in the central Pilbara, such as the Fortescue Metals Group (FMG) mine and the The Pilbara Infrastructure Pty Ltd (TPI) and BHP Billiton (BHPB) rail projects; consultation with DEC, EPA, Department of Water (DoW), Department of Indigenous Affairs (DIA), Department of State Development (DSD), DEWHA and other stakeholders; and other published and unpublished information. This included risk workshops in November 2009 and May 2010 with officers from the Office of the EPA (OEPA) and DEC and a site visit on the southern section of the rail with officers from DEC and DEWHA in May 2010.

The preliminary risk assessment process resulted in the identification of three key environmental factors that required more detailed assessments and/or increased levels of management at the time. These include:

- flora and vegetation (Section 8.3.1);
- fauna (Section 8.3.2); and
- surface water (Section 8.3.3).

For these three factors, draft environmental management plans are presented in the Appendices.

Following further investigation and after the identification of effective management measures it was determined that for each key environmental factor:

- the residual risk rating is medium or lower and hence has an acceptable level of risk with appropriate management measures in place;
- the project does not pose a significant impact to the environment; and
- EPA objectives can be met.

As a result, the project overall:

- raises a limited number of key environmental factors that can be readily managed;
- is consistent with established environmental policy frameworks, guidelines and standards; and
- has been developed after comprehensive consultation with the key stakeholders.

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2 INTRODUCTION

2.1 Background

Roy Hill Iron Ore Pty Ltd (RHIO) has identified a large deposit of iron ore (1 billion tonnes of bedded iron ore and 1.4 billion tonnes of detritals) on Roy Hill Station approximately 110 km north of Newman, Western Australia. RHIO is planning to develop a 55 million tonnes per annum (Mtpa) of shippable iron ore (lump and fine) mine - the Roy Hill 1 Iron Ore project - based on this deposit, which straddles the Newman to Marble Bar Road. Approval under the *Environmental Protection Act 1986* was obtained in two stages. Ministerial Statement 824 covering Stage 1 was published on 23 December 2009 and Ministerial Statement 829 (Stage 2) on 31 March 2010.

Roy Hill Infrastructure Pty Ltd (RHI) is proposing to develop a dedicated heavy-haul standard-gauge railway to transport ore from the Roy Hill 1 mine approximately 300 km to facilities at Port Hedland within the lease area of the Port Hedland Port Authority (PHPA) and the proposed Boodarie multi-user stockyard area which is to be vested in the PHPA. The proposed RHI Railway is the subject of this environmental impact assessment. The reffered proposal does not include those parts of the railway and the railway loops that are within the Roy Hill 1 Mine lease and within the proposed Boodarie multi-user stockyard area which is to be vested in the PHPA. Figure 2-1 gives an overview of the area and the proposed railway route.

The railway will be constructed and operated pursuant to the *Railway (Roy Hill Infrastructure Pty Ltd) Agreement*. A bill to ratify this agreement was introduced into Parliament on 24 June 2010.

The railway proposal was referred to the Department of Environment, Water, Heritage and the Arts (DEWHA) in March 2010 under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and was determined to be a ‘controlled action’ on 4 May 2010, with an assessment on preliminary information. This document provides information relating to the railway route as it is defined at July 2010. DEWHA has advised that the changes in route alignment arising as project design has progressed since March 2010 are considered minor and do not require a variation to the referred project.

To meet the proposed project schedule Federal and State Ministerial approvals for the railway proposal are required before the end of 2010.

2.2 Purpose of This Document

This document has been prepared as part of the railway proposal’s formal referral to the Environmental Protection Authority (EPA) for assessment under Section 38 of the *Environmental Protection Act 1986* (EP Act) and to inform the DEWHA assessment process of the current railway route and related environmental infromation. This document has been prepared in accordance with EPA referral guidelines and provides the key environmental information in relation to the railway proposal. A separate EPA referral form has been completed for the proposal in which it is suggested that the appropriate level of assessment is an Assessment on Referral Information (ARI).

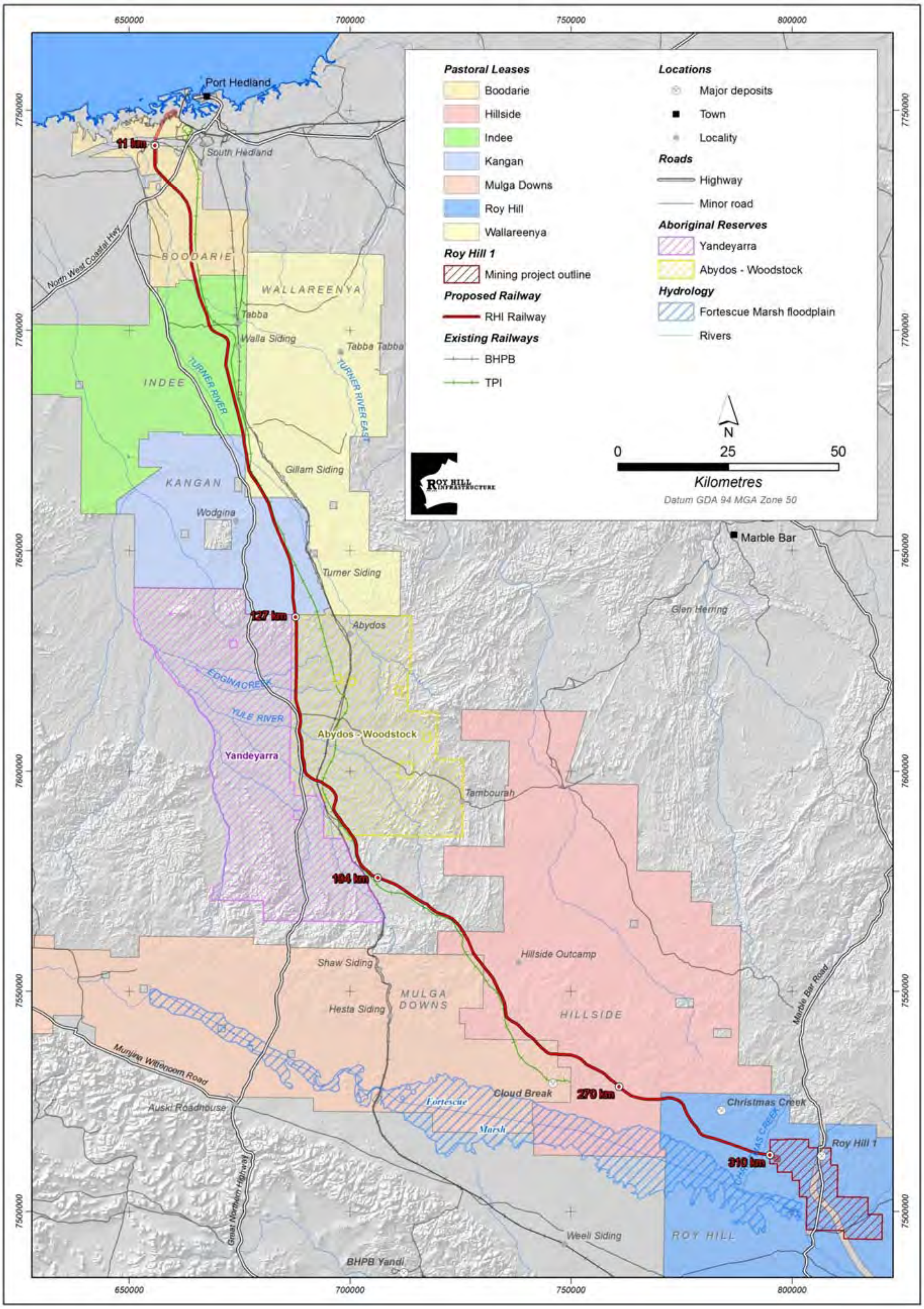

Figure 2-1: RHI Railway Project area overview

The purpose of this document is to:

a) demonstrate that the railway proposal is unlikely have a significant impact on the environment;

b) demonstrate that the railway proposal's potential environmental impacts—during both construction and operation—can be effectively managed to meet the EPA's environmental objectives;

c) demonstrate how RHI will manage the proposed railway project in an environmentally acceptable manner; and

d) demonstrate that the rail project meets the EPA criteria for an Assessment on Proponent Information (API) level of assessment.

This document should be read in conjunction with the report in Appendix A *Ecological survey comparative analysis*, prepared by WorleyParsons. This document presents an assessment of flora and fauna surveys undertaken as part of the FMG, BHPBIO and Hope Downs approvals. The document compares and contrasts the relevant issues and presents a gap analysis of aspects for further assessment.

2.3 Scope

The scope of this document is to:

- describe the railway proposal;
- consider the best route option for the railway alignment;
- provide a summary description of the existing environment;
- identify potential impacts associated with the railway proposal;
- define a scope of works for any environmental work required before construction begins; and
- outline management strategies that will be applied to manage and mitigate identified impacts.

In preparing this document, the following information has been considered:

- relevant environmental documentation that has been compiled for railway and associated projects between East Pilbara iron ore mines and the coastal ports;
- previous EPA advice on relevant Pilbara proposals and the associated Ministerial conditions; and
- Environmental Management Plans (EMPs) that have been prepared, and specialist scientific investigations and environmental monitoring programmes that have been undertaken.

The entire railway project with its typically 200 m-wide construction zone within the 2 km-wide environmental approval corridor (as outlined in section 6.2) for the railway and associated infrastructure, marshalling and maintenance yard, access roads, camps, water bores and borrow pits from the Roy Hill 1 mine boundary to the port facility boundary is referred to collectively in this document as 'the railway proposal'.

2.4 Proponent Details

The proponent of the project is:

Roy Hill Infrastructure Pty Ltd
PO Locked Bag No 2
WEST PERTH WA, 6872

The key contact for the project is:

Tim Crossley
Executive General Manager Carbon Steel Materials and Coal
Telephone: (08) 9429 8222
Facsimile: (08) 9429 8266
Email: mailto:tim_crossley@hancockexplorationhq.com.au

The key contact for information related to the environmental impact assessment is:

Ailan Tran
Environment Manager
Telephone: (08) 9429 8222
Email: ailan_tran@hancockexplorationhq.com.au

2.5 Related Proposals

RHI already holds approvals under the *Environmental Protection Act 1986* for the Roy Hill 1 Iron Ore Mining Project, Stages 1 and 2.

In addition to this referral, separate referrals under Section 38 of the *Environmental Protection Act 1986* have been or will also be made for the establishment of port infrastructure in Port Hedland, and dredging in the Port Hedland Inner Harbour to establish two shipping berths.

2.6 Timing

RHI proposes to commence construction of the RHI Railway project in Q1 2011.

2.7 Project Justification

The RHI project is a strategic development to bring iron ore to global markets. The development will help to meet the expected growth in demand for iron ore due to the rapid industrialisation of China and other Asian countries.

Increased demand from countries such as China, Korea and India for iron ore and other mineral resources will drive major growth in Western Australia's Pilbara region. The export of iron ore from the Roy Hill 1 Mine is proposed to commence in late 2013 to meet part of this demand. The project will contribute to the local, state and national economies though payment of royalties and taxes and the creation of employment and business opportunities in the Pilbara region, in Western Australia and nationally.

The RHIO mine development is based on a resource of 2.4 billion tonne and will produce 55 Mtpa for export.

It is estimated that the mine, port and rail projects will collectively contribute $296 million in royalties, $4.3 million in payroll tax and another $626 million in company tax. The construction workforce will be between 1,500 and 2,000. The operational workforce for the mine, port and rail operations will be between 1,000 and 1,200. Benefits to the Native Title claimant groups will include royalty payments and employment opportunities.

To ensure that benefits also flow to the local communities in the Town of Port Hedland, Shire of East Pilbara and the Shire of Ashburton, Community Development Plans will be developed in consultation with the local government authorities.

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3 EVALUATION OF RAILWAY ALTERNATIVES AND ROUTE SELECTION

A heavy-haul standard-gauge railway with associated railway infrastructure is proposed from the Roy Hill 1 Mine to Port Hedland (Figure 2-1). This referral includes the approximately 300 km of railway from the marshalling yard immediately outside the Port Hedland facility boundary to the point where it enters the Roy Hill 1 Mine lease. It does not include the railway line, loops and associated works within either the mine site lease or the Port Hedland port and proposed Boodarie multi-user stockyard area which is to be vested to the PHPA.

The mine and port facilities including the loops and rail within the mine and port lease areas have been or are the subject of separate referrals.

3.1 Transport alternatives

As part of RHI's planning and project feasibility studies a number of alternatives for the transport of iron ore from the Roy Hill 1 Mine to the port infrastructure facility at Port Hedland were considered.

Three transport options were identified, as follows:

- road haulage;
- access on existing railways; and
- construction of a new railway.

3.1.1 Road haulage

Road haulage was discounted due to environmental, safety, social and economic considerations. Rail is the most efficient and economic means to transport large quantities of material such as iron ore over long distances, for extended periods.

3.1.2 Use of existing railways

Sharing of either the existing BHPB Newman Railway or The Pilbara Infrastructure (TPI) Railway was considered as alternatives to developing a new dedicated RHI railway.

The BHPB railway is currently fully dedicated to BHPBIO mining operations. BHPB is looking to increase rail capacity and export tonnages by constructing a railway to connect to a new port infrastructure facility near the Boodarie Industrial Estate. However, no timeframe has been announced for any decision on the feasibility of that proposal and there is no indication that any spare capacity would be available to accommodate the 55 Mtpa that RHI is proposing to transport from the Roy Hill 1 Mine.

Further the Australian Competition Tribunal determined on 30 June 2010 not to declare open access on the BHPB Newman railway.

The TPI railway is almost fully dedicated to FMG mining operations. FMG has announced plans to increase production and expand the rail line's capacity. However, any spare capacity after expansion of the rail line may not meet RHI's project requirements and FMG's plans do not provide certainty or bankability for the RHI project.

For the reasons explained above both TPI and BHPB options were discounted.

3.1.3 Development of new railway

Port Hedland is the preferred export location for the Roy Hill 1 Iron Ore project. The Port Hedland Port Authority (PHPA) released a draft *Ultimate Development Plan* in 2007 (Worley Parsons, 2007) that describes the capacity of the Port Hedland inner harbour for potential future development, including additional shipping berths in South West Creek. Subsequent discussions with PHPA confirmed the viability of exporting up to 55 Mtpa of ore from two berths in South West Creek. While other port locations were considered, including both new and existing ports, none was considered superior to Port Hedland as an export location.

Consultation with PHPA has determined that the stockpiles and material-handling equipment to receive, store and transport the ore will be located on land adjacent to the site of the now-closed BHP DRI plant at Boodarie, near Port Hedland. This is referred to in the State Agreement and this document, as the proposed Boodarie multi-user stockyard area. RHI is currently negotiating with the PHPA for a port lease and licence to enable rail transport and material handling of the iron ore to shiploading facilities in South West Creek.

As discussed above, the distance between Port Hedland and the Roy Hill 1 Mine site and the life of the extended life of the project dictates that rail is the only option for transporting ore from the mine to Port Hedland. RHI has investigated access to, or sharing of, existing rail and has concluded that the tonnages involved and difficulties in obtaining access for those tonnages on a long-term basis means that a dedicated RHI railway is the only viable project go-forward option.

The Government of Western Australia has agreed to the development of a dedicated RHI Railway and has concluded a State Agreement with RHI to facilitate its development. The *Railway (Roy Hill Infrastructure Pty Ltd) Agreement* Bill was introduced into the Parliament of Western Australia on 24 June 2010.

3.1.4 No development option

If RHI is unable to build a railway to transport mined ore to Port Hedland for export, the Roy Hill 1 Mine cannot proceed. A significant opportunity to increase export earnings will be lost unless and until an alternative transport means can be established. In this case the economic benefits from the mine would be lost to the region, the state and the nation.

3.2 Route selection

There are an almost infinite number of possible routes connecting two end points. From an engineering point of view, many are technically feasible, albeit they may be financially prohibitive. All projects set out to balance a large number of issues and constraints. In terms of cost, the final selection is generally neither the least nor the most expensive option, but a compromise between a number of factors.

A route screening and selection process considering environmental, social and engineering constraints was completed in 2009 to select the most appropriate route for the rail project from the Roy Hill 1 mine to Port Hedland (Appendix B Multi-Criteria Analysis). The selected route is referred to in this Section as the RHI Railway. The steps completed in the detailed route selection process are summarised below and illustrated in Figure 3-1.

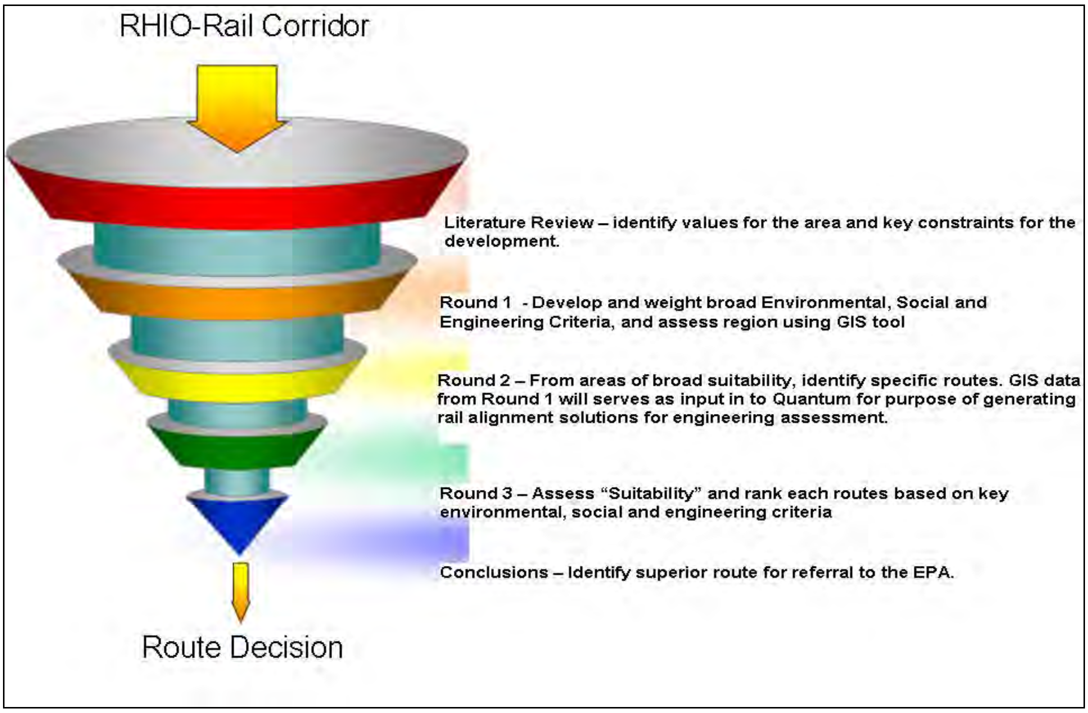

Figure 3-1: Rail route selection process

The method utilised for route selection involved a three-stage approach starting with coarse screening of the region of interest, subsequent identification of suitable routes, and then location-specific investigations as follows.

Round 1 of the Multi-Criteria Analysis (MCA) (Worley Parsons, 2009) route selection process identified broad areas suitable for development of a rail route based on 20 m by 20 m grids. The main result was the generation of a composite environmental, social and engineering constraints map by overlaying these constraints on each other to produce a combined weighted constraints map (Figure 3-2).

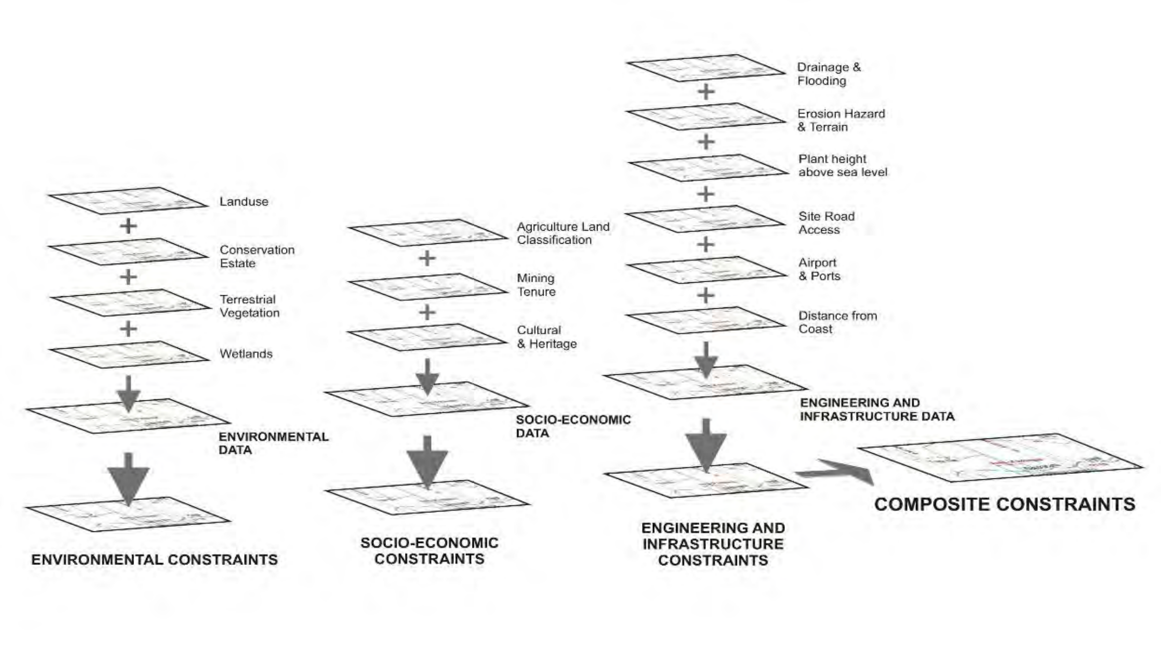

Figure 3-2: Example procedure for constructing environmental, social and engineering weighted overlay

This process identified areas with the greatest level of constraint as having the least suitability for development of a rail route. Such areas included cultural heritage, wetlands and conservation estate. The output of Round 1 showed a potentially suitable corridor for the rail route. Notable outcomes of this round of assessment included:

- environmental considerations producing substantial constraints such as numerous rivers and creeks;
- social constraints such as the Black Range Dyke Section and Yandeyarra Reserve;
- engineering constraints such as road, rail and pipeline crossings;
- identified indigenous sites along the rail routes; and
- registered native title claims.

A suitable corridor was identified in Round 1. This corridor became the basis for Round 2 of the MCA route selection process, the identification of specific routes within the study area used in Round 1, that were likely to permit the development of a railway line.

Geographic Information System (GIS) fatal-flaw data from Round 1 provided the input into engineering modelling (using 'Quantm' software) for the purpose of generating lowest-cost rail alignments. These alignments avoid areas graded as unfeasible in terms of environmental, social and economic/engineering impacts. Subsequently a more detailed assessment was undertaken of the short-listed routes. The goal was to review constraints along the proposed routes and to identify any required deviation to the modelled alignments. Route attributes were summarised and potential constraints for the positioning of a railway line were identified.

In Round 3, each route was ranked based on route feasibility, constructability, environmental and social constraints data. The resulting scores for each route provided a means of ranking the routes based on their satisfaction of the evaluation criteria. A capital cost for each route was then estimated to provide a financial measure against which the preferred routes could be compared. The outcome of the MCA selection process was the identification of the preferred route corridor for the rail alignment.

The MCA process incorporated stakeholder liaison and the feedback of interested parties on the numerous options before selecting the preferred alignment.

3.3 Alternative rail routes options

From the results of the MCA, RHI identified several possible railway routes from the Port to the Roy Hill mine. Stakeholders, both government and private, were consulted and involved in the development of the railway routes.

Five possible route options to Roy Hill are described below and compared in this report (Table 3-1 and Figure 3-3). All routes start at the boundary of the Boodarie multi-user stockyard area in Port Hedland. Routes 1 to 6 are similar from Port Hedland to the Northern side of the Abydos Woodstock reserve. The routes are as follows:

- Hillside Central Route: The Pre-Feasibility Study route option. From the Roy Hill mine this route passes over the Chichester Ranges, through the centre of Hillside Station, and then onwards, through the Yandeyarra Reserve, to Port Hedland, on the western side of the existing TPI and BHPB railways.
- BFS1: From the Roy Hill mine this route crosses the TPI rail west of Christmas Creek, and passes along the Chichester Ranges, through the southern side of Hillside Station, before crossing both the TPI and BHPB railways, and entering the Yandeyarra Reserve, and then on the western side of the existing TPI and BHPB railways to Port Hedland. (From the BHPB and TPI crossing south of the Yandeyarra Reserve, Hillside Central, BFS4 and BFS1 have the same alignment. BFS2 and BFS3 do not cross the TPI railway south of the Yandeyarra Reserve but do cross the BHPB railway.)
- BFS2. From the Roy Hill mine this route travels along the northern side of the Fortescue Marsh wetlands, before turning north at the BHPB railway heading north over the Chichester Ranges, and then passing through the Yandeyarra Reserve, on the western side of the existing TPI and BHPB railways on route to Port Hedland.
- BFS3: From the Roy Hill mine this route travels south to the BHPB railway, south of the Fortescue Marsh, before turning north over the Chichester Ranges, passing through the Yandeyarra Reserve, on the western side of the existing TPI and BHPB railways on route to Port Hedland.
- BFS4: From the Roy Hill mine this route travels east to the Marble Bar Road, before heading north to travel along the Chichester Ranges, and crossing the TPI and BHPB railways, before travelling to Port Hedland. (After crossing the TPI and BHPB railways BFS4 has the same alignment as BFS1.)

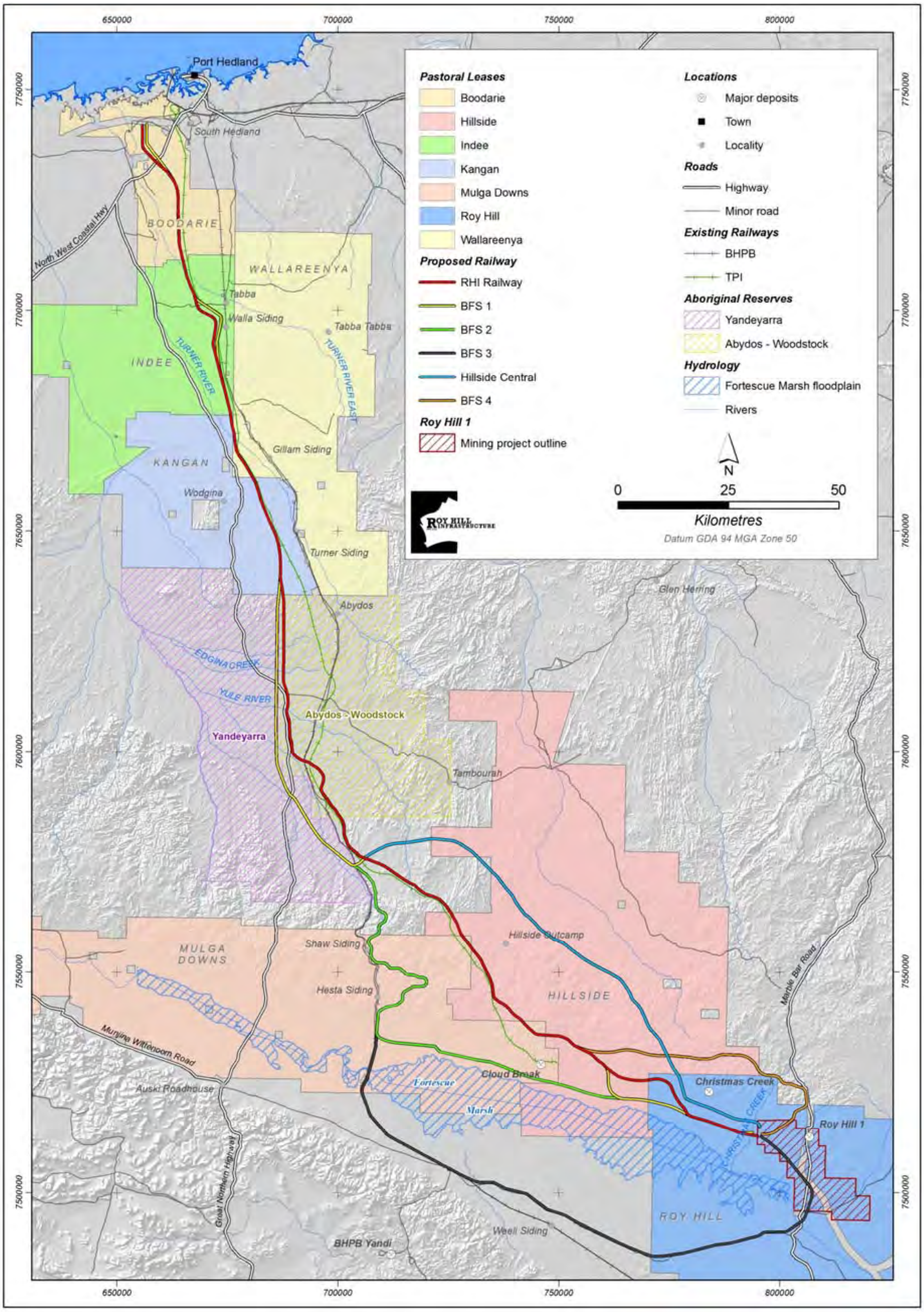

Figure 3-3: RHI Railway – route options considered.

Table 3-1: Alternative Rail Routes Options

	Alternative Rail Routes					
Route	**PFS Route**	**BFS 1**	**RHI Railway**	**BFS2**	**BFS 3**	**BFS 4**
Length (km)	**310**	**310**	**300**	**330**	**400**	**330**
Description	• Initial route concept at PFS stage • Bisects Hillside Station • Over the Chichester Ranges • Around the Abydos Woodstock Protected Area • Through Yandeyarra Reserve • On the western side of TPI and BHPB from south of Abydos Woodstock Protected Area	• PFS route modified to reduce impact of crossing miscellaneous and mining leases • Across the south of Hillside Station, rather than the centre • Along the top of the Chichester Ranges • Crosses Great Northern Highway twice in Yandeyarra • Around the Abydos Woodstock Protected Area • Through Yandeyarra Reserve • On the western side of TPI and BHPB from south of Abydos Woodstock Protected Area • Same length as PFS route	• Selected route • BFS1 route further modified to minimise impact on miscellaneous and mining leases • Crosses future TPI railway near Christmas Creek • Largely follows BFS1 to south of Abydos Woodstock Protected Area • Avoids Yandeyarra Reserve • Crosses Abydos Woodstock Protected Area • Crosses TPI and BHPB railways on Abydos Woodstock • Avoids double crossing of Great Northern Highway twice in Yandeyarra • On the western side of the TPI and BHPB railways from crossing points in the Abydos Woodstock Protected Area • Minimises impact on Domain Mining and Indee Station • Shorter length than BFS1	• PFS route modified to avoid crossing FMG's mining leases • Route is on the northern flank of the Fortescue Marsh wetland for approx 90 km • Crosses the Chichester Ranges • Crosses Great Northern Highway twice in Yandeyarra • Around the Abydos Woodstock Protected Area • Through Yandeyarra Reserve • On the western side of TPI and BHPB from south of Abydos Woodstock Protected Area	• Avoids crossing FMG's mining leases • Circles the Fortescue Marsh wetland to the east, south and west • Elimiates crossing TPI railway • Route is near and crosses the BHPB railway • Crosses the Chichester Ranges • Crosses Great Northern Highway twice in Yandeyarra • Avoids the Abydos Woodstock Protected Area • Crosses Yandeyarra Reserve • On the western side of TPI and BHPB from south of Abydos Woodstock Protected Area • Adds 85km Rail to the PFS route • Higher OPEX costs	• Minimises crossing FMG's mining leases • Route runs east from the Roy Hill mine to the Marble Bar Road • Along top of the Chichester Ranges • Avoids southern crossing of TPI railwayrequired by BFS1 & RHI Railway options • Most difficult terrain for construction • Indigneous heritage concerns • Steep terrain from the mine presents operational difficulties and costs • Crosses TPI and BHPB railways • Crosses Great Northern Highway twice in Yandeyarra Reserve • Avoids Abydos Woodstock Protected Area • Crosses Yandeyarra Reserve • On the western side of TPI and BHPB south of Abydos Woodstock Protected Area

- RHI Railway: a derivation of BFS1 to overcome some remaining issues, the RHI Railway route from the Roy Hill mine crosses the TPI Railway near Christmas Creek, and traverses along the Chichester Ranges through the southern side of Hillside Station, before entering the Abydos Woodstock Protected Area, and crossing both the TPI and BHPB railways, then heading north to Port Hedland on the western side of both the TPI and BHPB railways. (This route differs from BFS1 in that it deviates to avoid as much as practicable Domain Mining's mineral deposits on Indee Station and to move as far east as possible from the Indee Station homestead.)

3.4 Description of selected route option

The RHI Railway corridor is shown in Figure 2-1. From the northern end, the referred railway proposal starts at the proposed PHPA port facility lease boundary, at approximate rail chainage (Ch) 11. The rail route crosses the Great Northern Highway (GNH) in a south easterly direction to lie close to and parallel with the TPI Special Railway Licence (SRL) boundary. The RHI Railway then follows the TPI SRL closely to approximate Ch 115 at which point it deviates in a southerly direction to follow the GNH on the eastern side from Ch 150 to Ch 162. From this point the route heads south-east crossing both the BHPB and TPI railways on rail-over-rail overpasses at approximate Ch 165. From the crossing the RHI Railway again closely follows the TPI SRL on the northern side to Ch 240 from which point it deviates in a south-easterly direction until it again meets the TPI SRL at about Ch 270 which it follows until a suitable point of crossing at a rail-over-rail overpass at approximate Ch 285. From this crossing point the RHI Railway follows the TPI SRL on the southern side until it reaches the FMG loadout loop at Christmas Creek, and then continues in an east-south-east deviation to the Roy Hill 1 mine's western lease boundary. The total length of railway from the port facility lease boundary to the Roy Hill Mine lease boundary will be approximately 300 km.

4 RAILWAY DESCRIPTION

4.1 Key Characteristics

The key characteristics of the RHI Railway are outlined in Table 4-1.

Table 4-1: Key characteristics of the RHI Railway

Element	Description	
Overall characteristics		
Main line length of railway (approximate)	300 km	
Area of permanent disturbance (approximate)	2,095 ha ±5%	
Area of construction disturbance (approximate)	4,460 ha ±10%	
Maximum disturbance footprint estimates (rounded to the nearest 5 ha)	**Construction** (ha) (±10%)	**Permanent** (ha) (±5%)
Rail mainline and passing loops (including bridges)	1945	950
Marshalling and construction/maintenance yards	405	405
Rail service tracks, communications cable corridor & towers	1360	635
Culverts / drainage structures, water bores and dams	180	100
Borrow / quarry areas (incl. investigations) and ballast stockpiles	520	5
Construction camps, site offices and laydown areas	50	0

4.2 Railway Corridor Configuration

RHI is in the process of progressing more detailed investigations to design the final alignment of the RHI Railway main line and the locations of associated infrastructure and construction facilites. Environmental approval is being sought for that alignment and associated works to be within a 2 km wide 'environmental approval corridor', as illustrated in Figure 2-1.

Construction of the linear elements of the RHI Railway will normally be restricted to within a corridor 200 m in width, referred to as the 'construction corridor' (refer to engineering drawing 3E0-32X1-RL-SKT-0003). For most of the length of the railway, direct disturbance within the construction corridor will be restricted to between 65 m and 100 m in total width. Exceptions to the 200 m construction width include the marshalling yard complex at the northern end of the railway and possibly the siting of individual communications towers, construction camps and access tracks where suitable locations cannot be identified or fully accommodated within the 200 m corridor width. It is intended that such circumstances be exceptions and that wherever practicable, normal railway works be restricted within the 200 m corridor.

The construction corridor will incorporate the main line rail embankment earthworks, passing-loop and back-track installations, railway access roads, longitudinal catch drains at the top of cut batters and on the toe of rail access road batters, spreader berms in sheet flow areas, bridges and engineering culvert installations, as well as providing for construction equipment to cross transversely between the various areas and to manoeuvre in order to achieve efficient construction methodologies. The construction corridor also incorporates the buried communications cable running the full length of the railway, along with transverse links from the backbone to railway signals, condition monitoring equipment and communications towers. Provision is also made for localised laydown areas, such as for sleepers, ballast and pipe culverts.

The direct disturbance footprint and infrastructure layout within the construction corridor will vary, predominantly due to the extent of earthworks required for the railway embankment, the configuration of the adjacent borrow areas and the need for the rail access road to, in places, deviate away from the main railway alignment to follow suitable natural gradients without introducing excessive earthworks for its installation. The footprint is wider where passing-loops and back-tracks are installed alongside the main line. In areas of deep cut or deep fill, or where guide banks extend well upstream from major bridge sites, necessary construction disturbance may vary up to 200m.

4.3 Rail Construction

All dimensions and volumes presented in this report relate to the RHI Railway between the boundary of the Roy Hill 1 mine site and the boundary of the RHI Port Hedland facility in the Boodarie Industrial Estate and port area, referred to in Table 4-2 as Sections 1 and 6.

Table 4-2: Railway sections

Section Number	Description	Start Chainage (km)	End Chainage (km)	Length of Section (km)
1	Port Rail Facility	0	11	11
2	Northern Section	11	127	116
3	Abydos-Woodstock	127	194	67
4	Southern Section	194	270	76
5	Sandy Creek to RHIO Mine	270	310	40
6	Mine Site Rail Facility	310	318	8

Note: Sections 1 and 6 are not part of the RHI Railway proposal for assessment, as they are part of the respective port and mine projects. They are included here for context.

For the purpose of the next stage of investigation and design the railway route has been divided into six sections (RCS) from the port to the mine site, as set out in Table 4-2. Section 1 is rail works within the port facility and section 6 is part of the mine site facility. The railway proposal referred for assessment and described in this document is limited to sections 2 to 5 inclusive.

4.3.1 Track

The track structure will be designed for loads of 40 tonne per axle, comparable to that adopted for other heavy haul railways in the Pilbara. The following is a summary of key criteria and materials anticipated for the railway. The information is preliminary, and may be revised during the next stage of project development based on economics, geotechnical information as it becomes available and other design requirements:

- track gauge 1,435 mm ± 2 mm;
- rail supplied in 25 m lengths at Port Hedland and transported to a rail welding yard for flash-butt welding (FBW) into 400 m-long strings;
- pre-stressed mono block concrete sleepers;
- 50 mm Class H ballast from quarries.

4.3.2 Earthworks

The total earthworks for the railway — including allowances for all associate dinfrastructre, such as the marshalling yard — is estimated to be approximately 5.56 million cubic metres (Mm^3) of fill, 5.03 Mm^3 of cut and 1.67 Mm^3 of borrow . At this stage of design the uncertainty in these estimates is in the order of 10-15%. The alignment is generally in cut-to-fill and borrow-to-fill. Cut-to-fill and borrow-to-fill haul distances vary from 1 km to 5 km. Drawing 1 provides a typical section of the railway mainline showing the cut and fill arrangements.

It is estimated that approximately 1.55 Mm^3 of cut material unsuitable for use on the railway will need to be replaced with materials from borrow pits. Unsuitable materials will be used for flattening embankment batter slopes and rehabilitating borrow areas.

Cutting-in of the rail line is anticipated to require explosive excavation into the basalt bedrock in the Chichester Range. The majority of the remaining rail line will require ‘common excavation’ utilising heavy earthmoving equipment to remove overburden materials (soil and weathered rock) as well as shale and fractured rocks.

A summary of estimate earthworks for each section is provided in Table 4-3

Table 4-3: Bulk earthworks for railway construction

Alignment Section	Fill (m^3)	Cut (m^3)	Borrow (m^3)	Spoil (m^3)
2	857,944	947,253	92,100	67,604
3	1,556,803	1,320,213	617,000	135,539
4	3,112,189	2,606,323	963,000	1,172,423
5	36,585	155,962	1,210	168,639
Totals	**5,563,521**	**5,029,751**	**1,673,310**	**1,544,206**

Asbestos-bearing formations were not indicated in the literature review of the geology during the pre-feasibility study. Should on-site geotechnical test work find the presence of asbestos a project-specific asbestos management plan will be developed and implemented.

Desktop investigation identified acid sulfate soils in areas near Boodarie Industrial Estate, but are not expected to be encountered in RCS 2. This will be further investigated and confirmed upon route and infrastructure finalisation. If required a project-specific acid sulfate soils management plan will be developed to guide the handling of such materials.

4.3.3 Rail ballast, embankment and foundations

Engineering studies will be undertaken during the next stage of the design to address in detail problematic soil foundations, surface water management, scour protection measures, borrow pit and quarry locations and groundwater bore locations for construction water supply.

Rail embankment foundations are expected to be generally acceptable across most of the proposed corridor, with the exception of areas of problematic soils including gilgai surfaces, red silty soils and collapsing silts. Local remediation measures will be required to deal with isolated patches of weaker materials.

Relatively low rail embankment will occur over topographically subdued areas, such as the Abydos Plain (RCS 3) and west of the mine site (RCS 5). Surface water management and scour protection measures will be adopted (where necessary) at all crossings and low-lying RCSs.

Excavated natural material, including cut material, will be used to form the embankment for the rail line. Excavated materials used for the rail embankment will be placed in a controlled manner and compacted in specified layers. The problematic soils discussed above will be removed and not be used to form the rail embankment.

For the Abydos Plain, coastal areas and other areas where unsuitable materials are found, borrow pits will be used as the main source of embankment fill. They will be located every few kilometres along, or close to, the selected alignment.

The preferred naturally occurring sources of sub-ballast or formation capping are laterite, calcrete and silcrete gravels. These materials will be supplemented with colluvial gravels from hill slopes or other consolidated materials where required.

Granite and basalt are the preferred materials for crushed ballast. Along certain parts of the alignment it will be necessary to ‘cut’ the rail into bedrock. Where possible, materials for ballast will be produced from cut materials using a mobile crushing and screening plant. For example, immediately north of Chichester Range, cutting-in of the rail line will be necessary. In this area there are known outcrops of whaleback granite that will be targeted as ballast supply.

Ballast will also be sourced from quarries, with existing commercial quarries preferred. Existing quarries have been identified and subject to commercial negotiations may include the Elazac Quarry, the Turner River-Boodarie/Semex Quarry, the BHPB Newman line quarry and the FMG quarry.

All supplies of water for construction of the rail ballast, embankment, foundation and for dust control will be from existing or new bores constructed along the rail route. Bores are expected to be required approximately every 8-15 km.

4.4 Rail operations

4.4.1 Rolling stock

Five train sets will be required to transport 55 Mtpa, with each train consisting of two diesel electric locomotives (EMD SD70Ace or similar) and 232 iron ore wagons. When spares are included, this will entail a fleet of 17 locomotives and 1790 wagons. Fuel supply trains will require one additional AC locomotive and 12 tanker cars.

4.4.2 Signals and communications

A communication-based signalling system will be used to control the railway. The system will use global positioning satellite (GPS) and locomotive odometers to position trains. Data radio links and a voice radio network will be used for communication with and between trains, key wayside infrastructure and a train control centre (TCC). The main TCC will be located in Perth in the Remote Operations Centre (ROC) with a standby TCC located within the maintenance workshop at the Marshalling Yard at the Port Hedland end of the railway.

Reliable data and voice mobile radio will be available 24 hours a day, seven days a week, over the entire length of the new rail line with base station towers located intermittently along the railway. Connection between the base stations will be via a combination of digital microwave radio and fibre-optic cable.

4.5 Rail infrastructure

4.5.1 Service road

An unsealed, at-grade access road will run adjacent to and generally parallel to the proposed railway for its entire length, for the purposes of railway access and maintenance. The road will be built to appropriate Australian standards and will be consistent, in terms of good practice design, with existing Pilbara railway access roads. The road pavement width will be approximately 9 m.

4.5.2 Passing sidings

It is anticipated that along the entire length of the railway, seven sidings will be installed to allow trains travelling in opposite directions to pass. Additional sidings called “back-tracks” will be provided on the back of the passing sidings along the alignment as required to allow removal of ‘bad-order’ wagons (e.g. a wagon with a mechanical fault). Drawing 2 presents a typical section of the passing sidings (loops).

4.5.3 Level crossings

Road crossings will be at grade or grade separated in accordance with the requirements of Main Roads of Western Australia (MRWA) in their publication *Railway crossing protection in Western Australia – policy and guidelines* (Main Roads, 2007).

Crossing controls will be in accordance with AS 1742.7-1993 *Manual of uniform traffic control devices – Railway crossings* (Standards Australia, 2007).

Level crossings on access roads will be protected with signs that comply with this standard.

- Occupational crossings will be protected by either locked or self-closing (bump) gates with warning signs, complying with AS1742.7-1993.
- The main crossing of the Great Northern Highway at approximate chainage (Ch) 20 is to be a grade-separated road-over-rail bridge. Details of the bridge crossing will be determined during the next stage of project development.

4.5.4 Fences and crossings

The proposed railway will cross four active pastoral leases from Ch 11 to Ch 194 and three between Ch 194 and Ch 310. To preserve current land uses in a way that is compatible with the proposed railway, fencing and/or controls will need to be installed at occupational rail crossings, vehicle access paths, livestock grids and in other areas where access requires controlling or restricting.

The fencing requirements will be determined after consideration has been given to safety, asset protection and operational practicalities, and after consultation with other rail operators, pastoralists and other stakeholders.

4.5.5 Culverts and surface drainage

Railway crossings of watercourses will be by culverts or bridges. Culverts will be used in preference to bridges.

Culverts and bridges will be designed with consideration of the ecological water requirements for sensitive areas, particularly mulga communities and the Fortescue Marsh. The results of vegetation, and flora and fauna surveys will be incorporated into engineering design finalisation.

Engineering Culverts

Engineering culverts are provided to transfer naturally occurring creek flows and floodwaters transversely beneath the rail embankment. The diameters of engineering culverts are expected to be in the range from 600 mm to 3,600 mm.

Environmental Culverts

A limited portion of the RHI Railway passes through areas of surface water sheetflow, largely in the section Ch 285 to Ch 315. Environmental culverts will be installed in these sheetflow areas to maintain continuity of sheetflow across the alignment. Environmental culverts are expected to be required at intervals typically of 50-100m in identified sheetflow area. The diameters of environmental culverts are expected to range from 300 mm to 600 mm and will be of similar construction to the engineering culverts.

Low earth guide banks protruding from the embankment will help to capture and direct sheetflows through the embankment, helping to prevent longitudinal flows and consequent scour of the embankment toe. In sheetflow areas where the railway alignment runs parallel to the ground contours, these guide banks are unlikely to be needed. Rock riprap aprons will be installed at culvert outlets to slow and spread flows and to reduce scour potential.

Following preliminary design based on topographic and environmental data, the final locations and designs of environmental culverts and other drainage control measures in these sensitive environments will be reviewed based on a field inspection and assessment of the vegetation, soils and drainage patterns at each culvert site. That process will incorporate further consultation and advice from DEC.

Fauna Culverts

Environmental and engineering culverts may also serve as fauna crossings, however where terrestrial fauna surveys identify a particular need for fauna crossings of the railway then specific culverts may be installed for this purpose and will be sized dependent on the nature of the wildlife to be accommodated.

Where ground water flows do not establish smooth culvert inverts by sedimentation build up in the pipe ribs, then additional consideration will be given to using smooth barrel pipes (such as High Density Poly-Ethylene) of a diameter suitable for the identified fauna.

It may be necessary to provide “lead in” fencing to direct wildlife to fauna culverts. The need for such fencing is to be determined from the advice of fauna experts obtained during the detailed design stage of the project.

4.5.6 Bridges

To provide a simple and efficient method of construction, the design of the rail bridges will be standardised for fast construction requiring a minimum quantity of *in situ* concrete. The span length proposed is 25 m.

The construction methodology will be to at 25 m intervals drive circular steel pier columns as a “trestle” consisting of three members with the two outer members raking and the central pier column vertical.

A heavy hardstand granular pavement is required for installation of piled substructure over the full length of each bridge primarily to provide safe, stable access for heavy plant and equipment. The width of the hardstand on both the upstream and downstream sides of the piers will be approximately 20 m, i.e. a total of 40 m wide. Hardstand will remain in service until superstructure units are placed by heavy cranage.

Prefabricated steel headstocks will be lifted into place by a crane and site welded to the pier columns. Decks will consist of prefabricated composite girders or steel through girder construction.

Due to the use of prefabrication, site construction time in the bridge crossing areas will be minimised and in the event of flash flooding, rapid vacation of the sites will be enabled. Flash flooding will have little impact on partially constructed works. Bridge locations and designs are still under investigation and Table 4-4 provides a preliminary list of the currently anticipated bridge requirements.

Table 4-4: Preliminary Assessment of Bridge Requirements

Crossing name	Estimated deck length (m)	Railway Section
GNH 1	64	2
East Turner River	200	2
Chinnamon Creek	100	2
Gillam Creek	75	2
Turner River	225	2
Edgina Creek	109	3
Yule River	175	3
Coonarie Creek 2	100	3
BHP Overpass Bridge	75	3
TPI Overpass Bridge 1	75	3
Western Shaw River	50	4
Sandy Creek	50	5
TPI Overpass Bridge 2	75	5

4.5.7 Mine rail plant

The rail loop and rail load-out station at the mine form part of the Roy Hill Stage 1 project and are described here only to give an overview of the entire rail operation. They do not form part of this railway proposal. The subject of this referral starts at the proposed Boodarie multi-user stockyard area PHPA lease boundary and ends where the rail crosses the Roy Hill mining lease boundary.

Ore trains will be loaded at the mine load-out station at an average rate of approximately 12,500 tonnes per hour (tph), with a peak loading rate of approximately 16,000 tph. The length of departure track at the mine will be sufficient to accommodate the required train length to enable the constant loading of ore. Sidings will be provided to allow mine fuel trains and mine cargo trains to be unloaded and to create an area for temporary storage of overloaded or bad-order ore cars. A vehicle access track will be provided around the mine loop and located adjacent to and approximately parallel to the rail line.

4.5.8 Port rail and other infrastructure

The port rail loop and infrastructure facilities are not part of this proposal for assessment and are described here only to give an overview of the entire rail operation.

Ore will be unloaded through a twin-cell train unloader on to conveyors for transport to the materials handling area for storage on the lump and fines stockpiles. Ore will be reclaimed, screened and transported (via overland conveyor) to a shiploader at the RHI berths in South West Creek and on to bulk ore transport ships for export.

4.5.9 Marshalling yard

At the northern end of the RHI Railway, and immediately adjacent to the RHI port facility, is the railway Marshalling Yard, located from Ch 11 to Ch 15 (chainages 0 to Ch 10 are within the port facility).

Adjacent to the main line the Marshalling Yard will incorporate 10 rail tracks for the purposes of storing rail car wagons; inspecting rail cars; servicing of rail cars; locomotives and track maintenance equipment; storage and dispensing of diesel fuel used for port, rail and mine operations; and administration of the port and rail operations. The site is expected to accommodate a rolling-stock workshop and washdown bay; locomotive provisioning hall; rail infrastructure yard; diesel fuel storage; electrical substation; communications tower; administration building; car parks; potable and wastewater treatment units and firewater storage; and access roads.

4.5.10 Rolling stock workshop and washdown bay

The rolling stock workshop will be a single-storey building with a heavy-duty concrete slab, overhead travelling cranes, high pressure water wash-down facilities and various pieces of maintenance equipment including a wheel lathe to service and maintain locomotives and wagons. The wash-down bay is washing locomotives prior to entering the rolling stock workshop for services or maintenance. It is an enclosed building with a covered roof with plant and equipment area to one side and incorporates a pit section containing equipment for washing the under-carriage of locomotives. The facility houses a foam and rinse wash system that recycles more than 90% of its water, and incorporates a sludge removal and water treatment system for solids and hydrocarbons.

4.5.11 Locomotive provisioning hall

This facility provides for the provisioning of locomotives prior to departure to the mine. It is a covered roof structure, with open sides, over the provisioning road adjacent to the main line. Facilities are provided for the dispensing and recovery of lubricating grease, lubricating oil, demineralised water, radiator coolant and locomotive sand.

4.5.12 Diesel fuel storage

A pair of bulk storage tanks, with an estimated total stored capacity of 4ML, is envisaged for providing storage and dispensing of diesel fuel to the locomotive provisioning hall, marina, port stockyard and inland mine site. This facility, designed and constructed in accordance with AS 1940-2004, will include bunded concrete-walled spill containment, storage, receival and unloading facilities for single, double and triple road tankers, rail loading facilities for filling up to 18 x 100 kL rail tanker cars for transfer of fuel to a mine storage facility, a pipeline for supply of diesel fuel to the 110 kL double-skin diesel storage tank in the locomotive provisioning hall, road tanker filling facilities for dispensing fuel to storage facilities at the marina and port stockyards for daily operational use and refuelling bowsers for light and medium vehicle fuelling.

4.5.13 Administration building

A separate freestanding single storey building will be provided as the rail communications control room and offices for operations staff. This building will house the standby train control centre and standby port and stockyard control centres.

4.5.14 Infrastructure yard

The rail infrastructure yard will be constructed as a spur line, accommodating three rail loops running off the main line, for the purposes of housing below-rail maintenance equipment and rolling stock, rail construction and maintenance materials; and will have a local office and amenities for the rail maintenance personnel. The site is expected to accommodate a flash-butt welding line; ballast stockpile; ballast wetting gantry; sleeper storage yard; local service canopy; infrastructure building; car park; wastewater storage; and access roads. During the construction stage, the yard will provide a storage area for construction materials as well as a maintenance facility.

4.5.15 Temporary Camps

During construction of the proposed railway, temporary camps will be required to accommodate workers. The location of the camps will be determined by balancing the requirements of construction (such as water, proximity to the rail and suitable materials) with the requirements of minimising social and environmental impacts to the extent practicable.

Housing, offices and amenities within the camps will consist typically of transportable structures. Potable water will be sourced from local aquifers or other sources, and electricity will be provided by diesel generators. A microwave communications system will form the primary communication link between Roy Hill, Port Hedland and the camps.

All camp wastes will be managed under a waste management plan. All construction rubbish, packing material, timber, sewage, plastic and waste hydrocarbons will be collected and stored within the site prior to removal and/or treatment. Solid waste will be trucked to approved and licensed refuse disposal locations. All rubbish will be contained and prevented from blowing away while being stored or during transportation for proper disposal. The camp areas will be rehabilitated as part of decommissioning.

Fixed construction camps will be established in Port Hedland and at the Roy Hill mine for the duration of construction and will respectively service both the rail construction works as well as the port and mine construction. The Port Hedland camp will cater for up to 1,200 persons and may either be a commercial independently operated facility at Port Hedland or an RHI established camp within the rail corridor, for which provision has been made in the referred proposal. A further four camps will be established and maintained along the length of the railway for the period of construction along each section. Indicative construction camp locations along the RHI railway route are listed in Table 4-5. Note that the camp to be located at the mine site is not part of this referral as it has previously been assessed as part of the mining project.

Table 4-5: Construction Camps and Locations

Camp Name	Location	Approximate Rail Chainage
Port Hedland	South West of Great Northern Highway crossing	22 km
Rail Camp 1	Indee Station	50 km
Rail Camp 2	Wodgina area	100 km
Rail Camp 3	Abydos Woodstock	160 km
Rail Camp 4	Mulga Downs Station	230 km
Roy Hill Mine	Roy Hill Mine Site	315 km

Note: The Roy Hill mine site camp is part of the mining project and not this RHI Railway referral.

The rail camps (1 to 4) are expected to temporarily house around 350 – 500 persons. A standardised design will be adopted for each of the camps.

At the camp locations fuel for construction works will be stored in self-bunded (doubled-skinned) portable steel tanks (probably 100 kL) located to meet construction demand. Fuel will either be dispensed directly at these locations to mobile plant or transported to the plant locations by mini-tankers. Hazardous waste and oils will be removed from the camps for disposal at approved off-site disposal locations.

4.6 Project implementation

It is proposed that construction of the railway will commence in the following order, from the northern end of the railway:

- infrastructure yard, specifically the sleeper factory, storage areas and rail welding depot, and the required access track from the Great Northern Highway;
- construction camps and water supplies (preceeding construction works along the length of the rail);
- bridge works;
- earthworks, including cut-to-fill, cut-to-waste and borrow-to-fill;
- embankment construction;
- communications cable, towers and systems;
- track-laying, including placement of ballast and tamping; and
- progressive rehabilitation activities.

Construction activities will progress from the northern end of the railway in an orderly manner towards the Roy Hill 1 Mine. It is currently proposed that restoration and rehabilitation activities will follow directly behind construction activities, the separation distance being determined by logistical efficiency.

5 APPLICABLE LEGISLATION AND STANDARDS

5.1 State legislation

RHI has negotiated a State Agreement for the railway with the Government of Western Australia. The *Railway (Roy Hill Infrastructure Pty Ltd) Agreement* Bill was introduced to Parliament on 24 June 2010. The State Agreement is expected to be ratified by October 2010. The agreement will provide tenure and approvals to construct and operate the railway and associated facilities.

The *Environmental Protection Act 1986* is the principal statute relevant to environmental protection in Western Australia as the Act under which the State environmental approvals process operates.

The following state legislation is also relevant to the railway proposal:

- *Aboriginal Heritage Act 1972;*
- *Agriculture and Related Resources Protection Act 1976*
- *Bush Fires Act 1954;*
- *Conservation and Land Management Act 1984;*
- *Contaminated Sites Act 2003;*
- *Dangerous Goods (Transport) Act 1998;*
- *Explosives and Dangerous Goods Act 1961;*
- *Health Act 1911;*
- *Heritage of Western Australia Act 1990;*
- *Land Administration Act 1997;*
- *Mining Act 1978;*
- *Occupational Safety and Health Act 1984;*
- *Private railways (level Crossings) Act 1966;*
- *Rail Safety Act 1998;*
- *Rights in Water and Irrigation Act 1914;*
- *Soil and Land Conservation Act 1945;*
- *Town Planning and Development Act 1928; and*
- *Wildlife Conservation Act 1950.*

Regulations that apply to the proposal include:

- Environmental Protection (Controlled Waste) Regulations 2004;
- Environmental Protection (Noise) Regulations 1997;
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004;

- Environmental Protection Regulations 1987; and
- Soil and Land Conservation Regulations 1992.

5.2 Commonwealth legislation

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) provides a framework to protect matters of national environmental significance (MNES). There are eight MNES as follows:

- world heritage sites;
- national heritage sites;
- wetlands of international importance;
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park; and
- nuclear actions.

The Act is administered by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA).

The railway proposal was referred to DEWHA in March 2010 under the EPBC Act and was determined to be a 'controlled action' on 4 May 2010, with an assessment on preliminary information. This document provides information relating to the railway route as it is defined at July 2010. DEWHA has advised (email Dunstan 21 July 2010) that the changes in route alignment arising as project design has progressed since March 2010 are considered 'minor' and do not require a variation to the referred project.

RHI is targeting to achieve an approval for the railway under the EPBC Act by the end of 2010.

The following Commonwealth legislation is also relevant to the railway proposal:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *Australian Heritage Council Act 2003*
- *Native Title Act 1993.*
- *National Greenhouse and Energy Reporting Act 2007*

The *National Greenhouse and Energy Reporting Act 2007* could potentially be relevant if RHI's company-wide greenhouse gas emissions require reporting to DEWHA.

5.3 International agreements

The following international agreements are relevant to the railway proposal:

- *Japan-Australia Migratory Bird Agreement (1974);*
- *China-Australia Migratory Bird Agreement (1986);*
- *Republic of Korea-Australia Migratory Bird Agreement (2007); and*
- *Convention on the Conservation of Migratory Species of Wild Animals (The Bonn Convention) (1979).*

These are assessed as part of the EPBC Act requirements.

5.4 Local government

The building of construction camps will be subject to conditions and approvals in accordance with the regulations of the following local governments (Figure 8-5):

- Town of Port Hedland;
- Shire of East Pilbara; and
- Shire of Ashburton.

5.5 Guidelines and statements

The EPA and DEC provide direction for environmental protection and impact assessment through published guidelines and position statements. RHI has referred to these publications in the preparation of this document.

The key EPA position statements and guidelines that are relevant to the railway proposal are as follows:

- EPA position statement no. 5: Environmental and ecological sustainability of the rangelands of WA (November 2004);
- EPA position statement no. 6: Towards sustainability (2004);
- EPA position statement no. 7: Principles of environmental protection (2004);
- EPA draft guidance statement no. 8: Environmental noise (2007);
- EPA guidance statement no. 12: Minimising greenhouse gases (2002);
- EPA guidance statement no. 33: Environmental guidance for planning and development (2008)
- EPA guidance statement no. 41: Assessment of Aboriginal heritage (2004);
- EPA guidance statement no. 51: Terrestrial fauna surveys for environmental impact assessment (2004);

- EPA guidance statement no. 55: Implementing best practice in proposals submitted to the environmental impact assessment process (2003);
- EPA guidance statement no. 56: Terrestrial flora and vegetation surveys for environmental impact assessment (2004); and
- EPA interim industry consultation guide to community consultation (2003).

6 STAKEHOLDER CONSULTATION

The stakeholder consultation process for the railway proposal began with discussions with the OEPA and the DSD during the initial stages of project definition. Initial contact with pastoral lessees occurred in April and May 2009 and was focussed on preliminary environmental surveys. Subsequently, an application was made to the Department of Regional Development and Lands (DRDL) for a Section 91 Investigation Licence under the *Land Administration Act 1997*. The DRDL process of obtaining agreement from landowners for the allocation of a Section 91 Licence requires a comprehensive stakeholder consultation program; commencing with the preparation of a stakeholder list to facilitate effective communication with stakeholders. This stakeholder consultation program has also been used to raise and address specific environmental issues. Wider consultation will continue as the project proceeds further towards construction.

All contact, communication and issues raised during consultation are captured in a database. The issues raised during the consultation process have been taken into consideration in preparing this environmental referral document.

RHI will to continue to keep stakeholders informed about the development and progress of the project and to seek feedback. As the project develops further, a wider range of stakeholders and consultation activities will need to be added to the consultation programme to address the environmental and social issues for the Roy Hill 1 project from mine to port. RHI will continue to maintain a register of all consultation with stakeholders and concerns raised by them. This register will form part of the 'monthly report to the project manager' and the RHI Board.

In general, interest in the project from stakeholders is limited locally and to those directly affected.

Table 6-1 provides a summary of the key consultation events.

Table 6-1: Summary of key consultation events

Stakeholder	Event	Summary of main points
Tenement holders along corridor	Formal letters, face-to-face meetings and follow up calls	Formal request letter for agreement of Railway Investigation Licence sent in November 2009. Consent granted by AMCI (IO) Pty Ltd, Atlas Iron Ltd, Atlas Operations Pty Ltd, BGC Contracting Pty Ltd, BHP Billiton Direct Reduced Iron Pty Ltd, Young, Bradford John. Chichester Metals Pty Ltd, FMG Pilbara Pty Ltd, Fortescue Metals Group Ltd and The Pilbara Infrastructure Pty Ltd declined pending further discussions. As pending tenements are granted, additional stakeholders will be included in the consultation process.

Stakeholder	Event	Summary of main points
Pastoral lease holders along corridor	Telephone call and follow up letter	Access to land within corridor for reconnaissance biological survey carried out in May 2009 agreed other than by Indee Station. Permission to enter Kangan and Yandeyarra Stations (Part III Lands) was also subject to consultation with, and issuing of a permit by, the Department of Indigenous Affairs. Formal request letter for agreement of Railway Investigation Licence sent in November 2009. Consent granted by Boodarie and Mulga Downs Stations. Consultations leading to interim access agreements concluded with Hillside and Roy Hill Stations. Discussions continuing with Indee Station regarding interim access agreement. Negotiations continuing with Yandeyarra/Kangan regarding ongoing access to Part III lands. Issues raised in consultations with all pastoral stakeholders include: notice in advance of entry, use and maintenance of pastoral tracks, management of activities to prevent conflict with pastoral business, protection of pastoral land values.
Native title claimants – Nyiyaparli	Face to face Formal letter	Consultation with Nyiyaparli initiated in 1994 on commencement of mineral exploration. Numerous meetings have been held since to discuss project and other activities in claim area. Nyiyaparli people are involved in heritage surveys at minesite (minimum of 10 days per month) and heritage monitors are employed. Negotiations on comprehensive project (including rail) Land Access Agreement commenced in 2005 and concluded in February 2009. Formal request letter for agreement of Railway Investigation Licence sent in November 2009. Consent to be given under terms of the LAA. Issues encompassed in the negotiation process include: establishment of a life-of-project liaison committee, heritage management and information exchange regarding environmental management issues.
Native title claimants – Palyku	Face to face Formal letter	Meetings held with claimants and legal representatives to discuss the rail project (negotiation funding and timetable. Formal request letter for agreement of Railway Investigation Licence sent in November 2009.
Native title claimants – Kariyarra	Face to face Letter	Meetings held with claimants and legal representatives to discuss the rail project, negotiation funding and timetable. Formal request letter for agreement of Railway Investigation Licence sent in November 2009.

Stakeholder	Event	Summary of main points
DSD	Face to face	Numerous meetings within negotiations for State Agreement for rail. No environmental or other concerns raised over a third railway to Port Hedland.
DEC (Environmental Management Branch) 27/08/09	Face to face meeting at Environmental Management Branch office in South Perth with follow-up correspondence.	Main issues raised: Currency of status for conservation significance of flora species e.g. DEC DRF and Priority species listings. Wona Land System needs to be considered. This has since been discussed further with DEC's EMB and the Department of Agriculture and Food WA. SREs need to be considered in surveys which should be conducted in the wet season. Lessons learned from other construction projects, such as ensuring borrow pits are self-draining. Where the RHI proposed disturbance footprint is closely aligned with previously surveyed areas, the existing data can be used.
DMP 08/09/09	Face to face meeting in DMP office in East Perth with follow-up correspondence	Main concern was surface water flow which should be addressed through engineering design. 91(5) agreed 15/2/10
DoW 14/09/09	Face to face meeting at DoW (Perth) office with follow-up correspondence	Main concern was sourcing of water for rail construction.
PHPA	Face to face and telephone	Numerous to discuss infrastructure and berth issues in Port Hedland harbour. Aware of railway. No concerns raised.
Fortescue Metal Group Pty Ltd (FMG)	Face-to-face meetings and formal correspondence during Q1 2010.	Unwilling to grant access across FMG State Agreement granted mining leases. The Roy Hill project railway must not interfere with FMG operations or impact FMG mining leases. RHI to investigate alternative alignments for the railway.
Environmental Protection Authority (EPA)	Face-to-face meeting 16 March 2010	Present the BFS2 option to the OEPA and the requirement to achieve approvals by Q4 2010. EPA requires guidance from Department of Environment and Conservation (DEC) and would consider an ARI level of assessment if supported by DEC.

Stakeholder	Event	Summary of main points
Department of Environment and Conservation, Environmental Management Branch (DEC EMB)	Face-to-face meeting 26 March 2010	Present the BFS2 option to the DEC EMB and the requirement to achieve approvals by Q4 2010. The BFS 2 option traverses a section of the northern side of the future (2015) Fortescue Marsh conservation area. Existing mining operations and existing infrastructure already impinge on this area. DEC EMB to present its position on BFS2 and the impact on the environmental values of the Fortescue Marsh to the DSD.
Conservation Council	Telephone conversation 9 April 2010	Discussion of overall project and seeking feedback on key issues of concern.
Western Australian Museum	Telephone conversation 8 April 2010	Discussion with Curator Ornithology, Terrestrial Vertebrates about the Night Parrot. Considerable survey effort by various parties, but physical evidence of Night Parrot occurrence in this area has not yet been found.
Department of Environment, Water, Heritage and the Arts (DEWHA)	Face-to-face meeting 20 April 2010	Present the BFS2 option to DEWHA and the requirement to achieve approvals by Q4 2010. DEWHA considers likely to be a 'controlled action' due to impacts on listed fauna species. DEWHA is willing to assess proposal on the basis of the information provided, a statement of environmental performance commitments and an offsets package.
Office of Major Projects (Canberra)	Face to Face meeting 20 April 2010	Briefing on railway project and route options
Office of the EP(OEPA)	Face-to-face meeting 21 April 2010	Present the BFS2 option to the OEPA and the requirement to achieve approvals by Q4 2010. EPA to will meet with DSD to present its position on BFS2.
Department of Environment and Conservation Conservation Commission	Face-to-face meeting 27 April 2010	DEC requires a scoping document that describes what RHI has identified as the key issues, what studies are being undertaken and the proposed long-term management strategies, and residual impacts.

Stakeholder	Event	Summary of main points
Office of the Appeals Convenor	Face-to-face meeting 28 April 2010	Provide an update of the Roy Hill Iron Ore Project as a whole and present the BFS2 railway. Appeals Convenor advised that the likely opportunities for appeal during the approval process are: on EPA setting the level of assessment on the EPA publishing its report and recommendations on the draft Ministerial conditions. The likely appellants are the indigenous groups, environmental groups and other project proponents.
DEWHA	Correspondence 4 May 2010	The BFS1 railway project is a controlled action, assessment on preliminary information.
Office of the Minister for Environment, Youth	Face-to-face meeting 7 May 2010	Provide an update of the Roy Hill Iron Ore Project as a whole and present the BFS2 railway. Minister to be briefed on the likely environmental issues and possible grounds for appeals.
DEC and DEWHA Site Visit	Site Visit including helicopter reconnaissance of BFS2 13 May 2010	Site visit to provide the DEC and DEWHA assessing officers with the environmental context for the BFS2 railway project. There is a lot of environmental information available in the public domain in the area of interest and no need to complete additional surveys, except for targeted fauna species.
DEWHA	Face-to-face meeting 14 May 2010	Meeting to seek DEWHA feedback on BFS2 following the site visit. RHI needs to provide the regional context for the impacts on the Night Parrot, Northern Quoll, Bilbies, Mulgara and other listed species. Mitigation and offsets package needs to demonstrate how RHI will contribute to the status of the species in the region and will be discussed further.
DEC, EPA, DSD, FMG, RHI	Face-to-face meeting 14 May 2010	Meeting between government agencies and FMG and RHI to discuss the constraints impacting on the Roy Hill to Port Hedland railway options. RHI seeking to find an option that will address FMG tenure constraints, minimise the impact on the Fortescue Marsh and allow for an approval process to delivery Ministerial Approval by end 2010.

Stakeholder	Event	Summary of main points
DEC, EPA, DSD, FMG, RHI	Face-to-face meeting 21 May 2010	Follow up meeting to 14 May meeting. Investigate any opportunities for RHI to use FMG corridor or cross proposed railway between Cloud Break and Christmas Creek mines.
DEC and EPA BFS2 workshop	Post-site visit 26 May 2010	Workshop identified the key environmental aspects and proposed management measures. OEPA and DEC stated that their participation was only to assist RHI on the identification of technical issues.
RHI internal Stakeholders	Meeting 21 June 2010	The BFS2 option is not a preferred option as an alternative for the RHI Railway. Progress has been made on a variation to BFS1.
Pastoral lease holders along corridor (Roy Hill, Hillside, Mulga Downs)	Telephone calls and formal correspondence	Permission to access land for the purposes of biological surveys for the railway corridor and potential borrow pit locations. Formal consent letter to be sent week ending 6 May.
FMG	Face to face meetings	Meetings with FMG to discuss railway options in the Christmas Creek/Cloud Break areas and areas of interface between FMG/RHI railways.
BHPB	Face to face meetings	A series of meetings with BHPB to investigate interface issues between BHPB/RHI rail and port
DSD	Face to face meetings	Meetings to examine possible alignments for the RHI rail
Office of Rail Regulator	Face to Face meetings	Meetings to clarify rail safety process and approval phases
DRDL	Face to face meetings	Meetings to progress applications for investigation licences for the rail project
DIA	Face to Face meeting 15 June 2010	Meeting to discuss investigation licence and railway alignment through Woodstock Abydos reserves
Office of Native Title	Face to Face Meeting 19 April 2010	Meeting to discuss Native Title and the railway
Office of Minister for Indigenous Affairs	Face to Face meeting	Meeting to brief Minister’s office on the RHI railway project

7 APPROACH TO ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Introduction

RHI has adopted a semi-quantitative risk-based approach to its assessment of potential environmental impacts of the railway proposal. The assessment follows the approach of AS/NZS ISO 31000:2009 *Risk Management – Principles and guidelines* (Standards Australia, 2009) (previously AS/NZS ISO 4360:2004) to systematically identify, analyse, evaluate and determine appropriate management measures for the environmental impacts potentially resulting from the proposal, having regard to HB203:2006 *Environmental risk assessment – principles and processes* in applying the standard to assessment of the environment.

The regional environmental factors to be assessed have been identified through a combination of advice secured by RHI from environmental specialists; reference to studies and approvals for other developments in the central Pilbara, such as the FMG mine and TPI and BHPB rail projects; consultation with DEC, EPA, DoW, DIA, DSD, DEWHA and other stakeholders; and other published and unpublished information. This included risk workshops in November 2009 and May 2010 with officers from the Office of the EPA and DEC and a field visit on the southern section of the rail with officers from DEC and DEWHA in May 2010.

7.2 Approval and reference areas

A base-case railway route has been chosen for the RHI Railway, as shown on Figure 2-1 and described in Section 2.4. This base-case route was used to define the existing environment (see Section 7) and in assessing the environmental risks, impacts and management strategies (Section 8). To ensure the data, discussion and impact calculations remain relevant to RHI Railway, RHI has used several reference areas (as shown in Figure 7-1).

As described in section 4.2, the route of the railway for which RHI is seeking environmental approval is a corridor mostly 2 km wide. The environmental approval corridor consists of a 1 km buffer on either side of the centre-line of the base-case alignment. A few sections of the corridor are wider than 2 km, for example the location of the marshalling yard and severeal camps. Information from additional geotechnical, engineering and environmental surveys and progress of the project design process will define the final main line alignment of the RHI Railway and locations of associated infrastructure within this ‘environmental approval corridor’. This provides the flexibility required for the final railway alignment to be selected based on the results of future investigations of geotechnical conditions, topography, resolving remaining issues of land access and to avoid or mitigate impacts on significant environmental values.

Within the 2 km environmental approval corridor, a 200 m construction corridor will in future be defined. In advance of the final definition of that construction corridor, and for the purpose of establishing indicative environmental impacts a surrogate construction corridor has been used by placing a 100 m buffer on either side of the centre-line of the base-case alignment. Based on a railway length of 300 km, the area of a 200 m wide corridor is 6,000 ha.

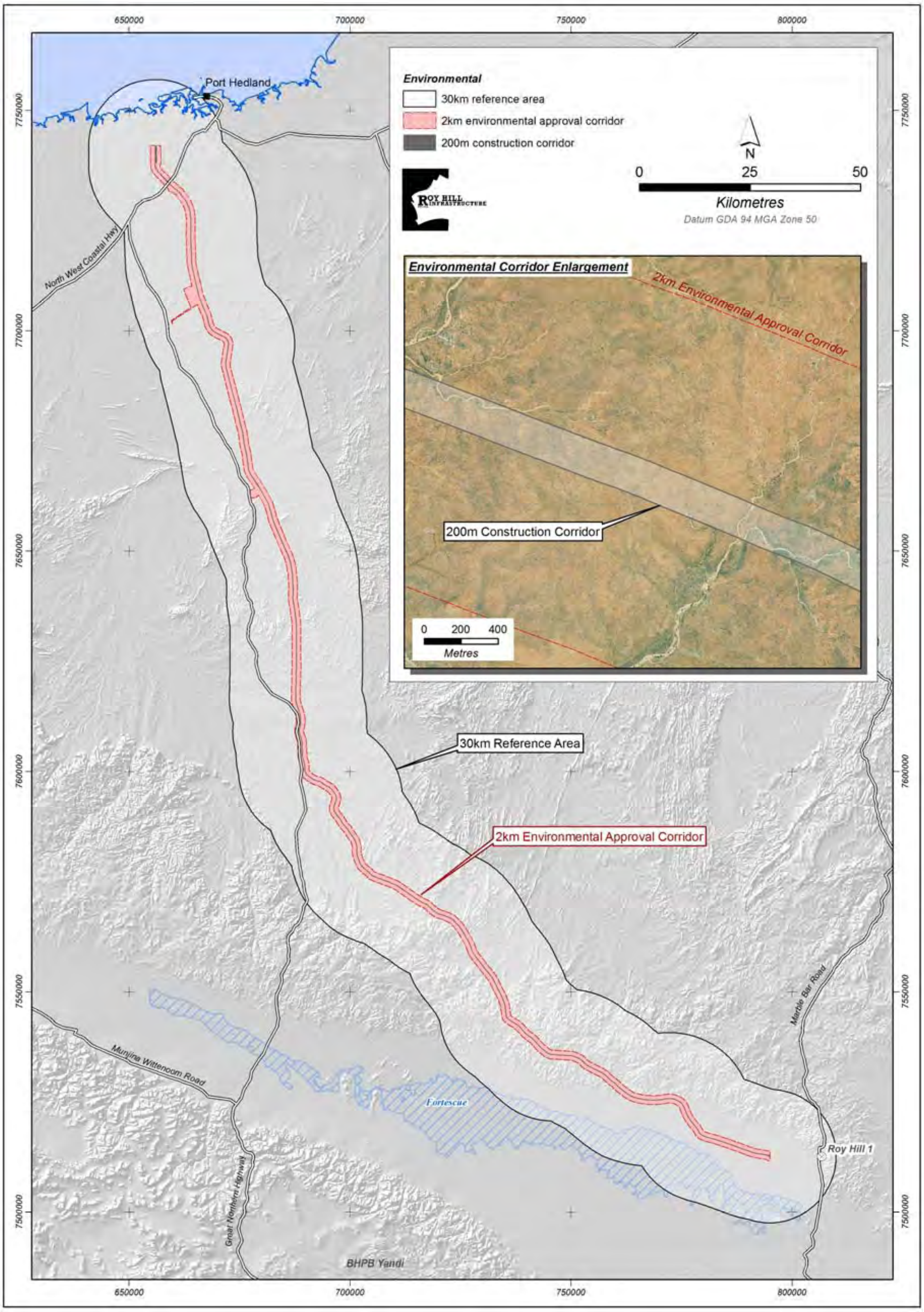

Figure 7-1: Definition of reference areas used in this assessment

As described in section 4, engineering design has estimated the railway construction direct disturbance footprint to be approximately 4,460 ha (±10%). Over half this area will be rehabilitated at the completion of construction, the estimated permanent footprint of the RHI Railway being approximately 2,095 ha (±5%). Therefore, for both construction and operation impact assessment, the 200 m disturbance corridor provides a conservative estimate of the potential impacts. Drawing 3 provides an illustration of a typical section through the railway corridor.

In order to establish the local context and significance of the environmental impacts of the RHI Railway, a 30 km wide local reference area corridor was created based on a 15 km buffer on either side of the centre-line of the base case alignment. The 15 km distance was adopted based on EPA Guidance Statements 51 and 56 for surveys of terrestrial flora, vegetation and fauna. The 30 km local reference corridor was used to complete a conservative assessment of the land systems and flora and fauna species that may potentially be encountered and impacted during the construction and operation of the RHI Railway.

The final alignment and location of the RHI Railway and associated infrastructure may be varied from the base-case alignment used to develop this referral document to take into consideration social, engineering and environmental constraints identified during field surveys. However, it will remain within the 2 km environmental approval corridor and RHI considers the base-case alignment used provides a confident indication of the potential and likely impacts and risks and can be used to develop the management strategies for construction and operation of the RHI Railway.

7.3 Risk assessment method

The following terms are used in the risk assessment:

- *Risk* is the chance that an intended objective (in this case protection of a particular environmental factor) may not be achieved, and is expressed as a combination of the likelihood and severity of a particular outcome.
- *Inherent risk* is that predicted to result from implementation of the project applying impact management controls normal to that activity and environment (e.g. dust control measures).
- *Residual risk* is that predicted to result after additional impact management measures are applied (e.g. relocation of animals prior to construction disturbance).
- *Environment* means the surroundings in which RHI operates, including air, water, land, natural resources, flora, fauna and humans, and their interrelations and interactions.
- *Environmental aspects* are elements of the rail project that can interact with the environment.
- *Environmental factor* is the receptor of the project's environmental impacts; for example, conservation significant flora and fauna.
- *Environmental impact* is any change to the environment, whether adverse or beneficial, wholly or partially resulting from the environmental aspects of the rail project.

- *Consequence* is the outcome or impact of an event. There can be more than one consequence from one event and consequences can range from positive to negative and can be expressed qualitatively or quantitatively.
- *Likelihood* is a general description of the extent to which an event is likely to occur.
- The risk assessment process is outlined in Figure 7-2. The guide to determining risk levels is shown in Table 7-1.

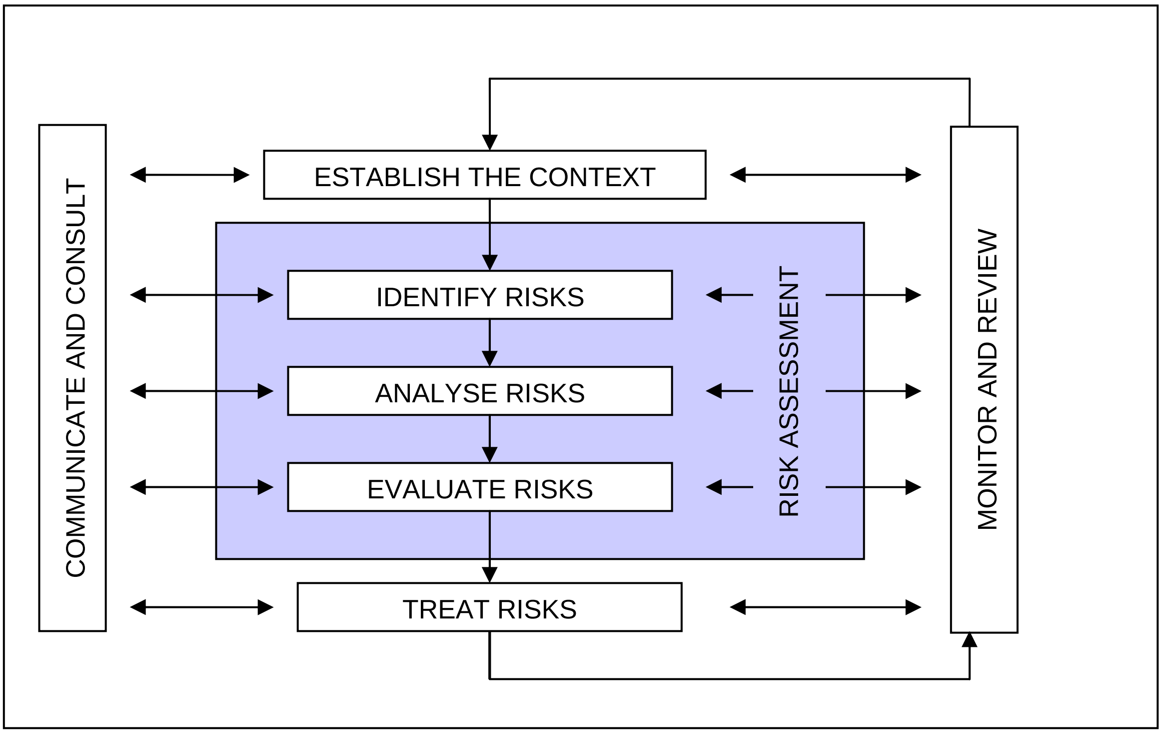

Figure 7-2: Overview of the risk assessment and management process (AS/NZS ISO 31000)

7.4 Preliminary identification of environmental factors and risks

In order to focus environmental investigations and the examination of potential impacts during the evaluation of railway route options and the selection of a proposed alignment, a preliminary risk assessment was conducted, having regard to environmental, social and engineering criteria (Appendix C Preliminary Risk Assessment). The environmental aspects, factors and impacts were further examined at a November 2009 workshop involving RHI, environmental specialists and officers of the Office of the EPA and DEC (Appendix D Addendum to Environmental Referral November 2009).

The outcomes of that process were used to identify the 'key' and 'other' relevant environmental factors and to gain an appreciation of the inherent risk of each factor, which were rated as 'critical', 'high', 'moderate' or 'low'. The attributes of 'key' environmental factors were defined as:

- having an inherent 'critical' risk;

- requiring a more detailed assessment in order to understand the risk to the particular environmental factor; or
- requiring a high level of management control in order to ensure potential impacts are acceptable.
- Those factors not considered 'key' were referred to as 'other' environmental factors. These environmental factors were defined as:
- having an inherent high, moderate or low risk;
- requiring less detailed assessment; or
- requiring a lower level of control to manage impacts and, in general, can confidently be acceptably managed using well established practices and procedures.

7.5 Characterising environmental risk

The next stage of the risk assessment focussed on the 'key' environmental factors identified by the preliminary risk assessment.

Having sourced additional information regarding the environment in which the project is to be undertaken and establishing the sensitivity of the environment to being impacted by the project development, the next stage was to assess the level of risk to the key environmental factors potentially resulting from the railway project. This involved considering the consequence and likelihood of potential impacts on the identified environmental factors. The descriptors of consequence and likelihood used to assess each factor and the matrix for assigning risk severity are presented in Table 7-1. Table 7-2 presents elaboration as to acceptability of the various risk levels and identifies the level of project management intervention and control appropriate to each level.

Section 8 reports the results of the risk assessment applied to environmental factors related to land systems, flora, vegetation associations and fauna. It is noted that the risk assessment adopted a precautionary approach, such that where uncertainty existed as to the nature or sensitivity of the environmental factor being assessed or as to the confidence in the effectiveness of identified management controls, the risk was rated higher than otherwise may have been the case.

Table 7-1: Measures of impact likelihood

RISK ASSESSMENT RATING		LIKELIHOOD				
		A – Certain Will occur under the circumstance	**B – Likely** Will probably occur under the circumstances	**C – Possible** May occur under the circumstances	**D – Unlikely** Could occur, but not expected to under the circumstances	**E – Rare** Conceivably could, but not expected to under the circumstances
CONSEQUENCE	**5 – Severe** Taxon extinction, community or ecosystem destruction, significant loss of biodiversity	Very High	Very High	High	Medium	Low
	4 – Major Permanent population decline resulting in change in viability or conservation status of population	Very High	High	High	Medium	Low
	3 – Moderate Significant local impacts. Permanent population decline, but no change in viability or conservation status of population	Very High	High	Medium	Medium	Low
	2 – Minor Limited local impacts. Short-term population decline (recovery after end of project), no change in viability or conservation status of population	High	Medium	Low	Low	Very Low
	1 – Negligible No discernable impact beyond intended work area. Little or no population decline	Medium	Medium	Low	Very Low	Very Low

Table 7-2: Descriptors of risk and control

Risk Level	Description	Responsibility
Very High	Generally an unacceptable risk. All feasible alternatives to have been considered. Acceptance of risk by highest level of management to be documented.	Executive Management / Board
High	Potentially tolerable risk. All practicable control measures to be employed. Formal management procedures, monitoring and review for key risks	Senior Management
Medium	Acceptable risk. Measures documented and employed to minimise risk as low as reasonably practicable.	Line Management
Low	Acceptable risk. Normal management measures sufficient.	All personnel
Very Low	Negligible risk. Normal operating practices.	All personnel

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8 EXISTING ENVIRONMENT

8.1 Climate

The Pilbara region falls within two bioclimatic regions (Beard 1990): semi-desert tropical and desert summer-rain. The semi-desert tropical region is characterised by nine to 11 months of dry weather: only the inland higher-rainfall areas and cooler areas nearer the coast fall into this category. The region is influenced both by tropical maritime air from the Indian Ocean and continental air from the interior. These influences result in a climate of extremes, with severe droughts and major floods occurring at close intervals (Haig 2009). The desert summer-rain region is characterised by up to 12 months of dry weather: higher-temperature and lower-rainfall areas are in this category (Leighton 2004).

During the warmer part of the year, there is a hot low-pressure system over the region resulting in clear skies and very high temperatures from November to February, with average maximum temperatures often over 40°C. During the winter months the average maximum temperature falls to about 25°C. Temperature ranges are generally greater in inland areas away from the moderating effects of onshore winds common in coastal areas (Department of the Environment, Water, Heritage and the Arts, 2002).

Rainfall is low throughout the Pilbara and quite variable. Rainfall activity can be very localised, meaning that measurements from a single monitoring site are seldom representative of an entire catchment (Haig 2009). Annual totals vary from 250 mm to 450 mm and there are many years without significant rainfall. The lower totals are typical of the south where tropical cyclone effects are less frequent. Most of the summer rain comes from scattered thunderstorms and the occasional tropical cyclone. A secondary peak in the monthly rainfall occurs in May as a result of rainfall from tropical cloud bands that intermittently affect the area, mostly in May and June. These events can also produce low maximum temperatures, particularly away from the coast. On average there are 20 to 30 thunderstorms each year over most of the area, although 15 to 20 each year is more common near the coast. Almost all storms occur in the summer (Australian Bureau of Meteorology, 2009).

The stretch of coast from Port Hedland to Exmouth Gulf is the most cyclone-prone area in Australia. The maximum wind speed recorded at Port Hedland airport between 1954 and 2008 is 208 km/h (reached during a cyclone). The mean annual wind speed over the same period is 17.4 km/h and varies between 14.3 km/h in January to 20.7 km/h in June and July. The average maximum wind speed is 69 km/h and the area falls into building Category A (Australian Bureau of Meteorology, 2008). Therefore construction, engineering and infrastructure developments in the Port Hedland area need to take into account the potential for possible periodic destruction or damage.

8.2 Geomorphology and Soils

The project area traverses the following main physiographic systems:

- Coastal Plain: a narrow strip along the present-day shoreline including calcareous beach/dune sands and cemented limestone ridges backed by tidal mud flats (including mangrove swamps and samphire marshes);
- Lowlands Plain: areas of low, rounded hills with strike-controlled 'razorback' ridges separated by sandplain deposits incised by major watercourses (e.g. Yule and Turner rivers). Domes of granite outcrop or 'whalebacks' form a distinctive feature on the plain;
- Chichester Range: a narrow plateau extending some 550 m above sea level with a north-facing scarp that drains southward. This range is composed mainly of basalt and interbedded sandstone with lesser banded iron-formation (BIF) along its southern margin. The main scarp is developed in the sandstone beds;
- Fortescue River Basin: a broad valley separating the two ranges with gently sloping plains. This valley is underlain by calcareous rock (dolomite) which weathers preferentially compared with the more resistant iron-bearing rocks in the respective ranges, resulting in a depression; and
- Hamersley Range: a large plateau extending some 1,000 m above sea level. This range is largely composed of BIF which is less susceptible to weathering than basalt (Chichester Range) resulting in more prominent terrain. Spectacular steep-sided gorges have formed along persistent fractures/joints in the BIF or shale beds.

The above rocks are variably covered by soils derived as the products of *in situ* weathering and subsequent mass wasting, erosion and transport.

The proposed RHI Railway will cross areas of expansive clay with gilgai surfaces ('crabholes') northwest of the Fortescue Marsh. These soils have high plasticity and are prone to shrink/swell processes or heaving in the upper few metres, resulting in hummocky ground. These red-brown clays are mostly derived from intense weathering of underlying basaltic rocks. Pockets can also be expected in the Fortescue River Basin alluvium.

Red silty soils or areas of 'pindan sand' occur in the sandplain deposits. These soils can also be problematic as they can be susceptible to collapsing. This process occurs where binding fines become saturated—when the material is loaded the particle framework can consolidate causing collapse. These soils have a mixed wind-blown and alluvial origin resulting in the fines content being highly variable. Collapse potential usually exists in the upper few metres of the profile. This geohazard cannot be avoided and, while considered to represent a low risk, will require management. A common feature associated with pindan sand is its susceptibility to erosion, necessitating proper drainage control.

Similar 'collapsing' silts are more widespread within the upper metre or so of the alluvium in the Fortescue River Basin. The mechanism here is likely to be driven by piping of fines into small cavities developed in the underlying calcareous rocks. The central part of this depression is also subject to seasonal flooding and the marsh area should also be avoided where possible. Only a small part of the railway proposal is located where these silts may be present.

With regard to acid sulfate soils, data from the DEC suggests that these soils are not present along the railway. However, there are unconfirmed reports that acid sulfate soils may be present in areas intersected by the railway proposal near the Boodarie multi-user stockyard.

8.3 Geology

The Chichester and Hamersley Ranges form part of the Pilbara Craton which has been emergent since the Palaeozoic. The Hamersley Range in the central Pilbara is Early Proterozoic to Archaean metasedimentary, reaching around 900 m Australian Height Datum (AHD) (with peaks around 1250 m AHD) and the predominantly volcanic Chichester Range to the north, with a more subdued topography of around 600 m AHD (Trendall 1990). These units overlie Archaean greenstones and granites, which outcrop to the north-east 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 Range. 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. Minor Tertiary limestone outcrops occur across the plain (Beard 1973; 1998).

The geological setting of the project area is summarised in Table 8-1.

Table 8-1: Simplified geological model for Roy Hill 1 railway proposal route

Interval	Approximate age (million years)	Geological event	Comments
Archaean	3600 to 2800	Granite-greenstone basement	Volcanic and sedimentary rocks (greenstone) intruded by granite domes
	2775 to 2630	Fortescue Group	Initially comprised sandstone deposited along rivers eroded into basement. Followed by extensive subaerial volcanic activity, with basalt flooding the valleys and covering the sandstone and basement rocks

Interval	Approximate age (million years)	Geological event	Comments
	2595 to 2400	Hamersley Group	A period of rapid erosion levelling the landmass allowing invasion of the sea. Banded iron-formation (BIF) deposited in calm sea with the iron and silica being sourced from deep-sea volcanic fallout, aided by bacterial activity. Lesser deposition of calcareous rock (dolomite) and shale
Proterozoic	2200 to 1800	Capricon Orogeny/ Ophthalmia Fold Belt (including Hamersley Range Syncline)	Continental collision of Pilbara Craton and Yilgarn Craton (south) produced mountain ranges accompanied by periods of folding and faulting. Intrusion of quartz veins and dolerite dykes along the more prominent fractures in the rock mass
	1750	Ashburton Basin and major ore deposits	Trough south-southwest of Hamersley Basin filled with sediments. Supergene enrichment of iron with groundwater leaching the BIF and redepositing along structural pathways e.g. faults and base of synclines
	1600 to 800	Bangemall and Savoury Basins	Continued uplift and erosion of elevated ranges provided further sediment sources that filled the basins to the southeast of the Hamersley Basin
Phanerozoic	less than 500	Canning Basin	Extensive trough filled with terrestrial and marine sediments. Subsequent burial and compression produced a variety of sedimentary rocks
	150	Fortescue River Basin	Developed over dolomite susceptible to preferential weathering. Major aquifer associated with karstic features

Interval	Approximate age (million years)	Geological event	Comments
	100	Hamersley Surface	Period of warm and humid climate led to deep weathering and formation of elevated laterite duricrust (cemented caprock)
	65	Tertiary deposits	Dissection of the Hamersley Surface produced transported soils (older colluvium and alluvium), residual soils and chemically indurated deposits (calcrete). Gorges were also incised into the plateau along persistent joints
	30	Robe Pisolite	Ancient river/swamp deposit, also secondary source of iron ore
	2	Quaternary deposits	Younger colluvium, alluvium and eluvium (dunefields) over recent land surface with calcareous sediments along the coastal belt

8.4 Land systems

The land systems of the Pilbara region have been described and mapped by van Vreeswyk et al. (2004). Taking into account the 30 km wide local reference corridor, a total of 33 land systems coincide with the RHI Railway. These land systems are listed in Table 8-2.

Table 8-2: Land systems occurring within 15 km of the proposed RHI railway.

Land system	Land system code	Habitat
Black	BLK	Linear ridges of dolerite or basalt supporting hard spinifex grasslands, with unvegetated boulder slopes and rock piles along summits
Bonney	BNY	Low rounded hills and undulating stony plains supporting soft spinifex grasslands
Boolaloo	BOO	Granite hills, domes and tor fields and sandy plains with shrubby spinifex grasslands.
Boolgeeda	BGD	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.

Land system	Land system code	Habitat
Calcrete	CAL	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.
Capricorn	CPN	Hills and ridges of sandstone and dolomite supporting low shrublands or shrubby spinifex grasslands.
Cheerawarra	CHE	Sandy coastal plains and saline clay plains supporting soft and hard Spinifex grasslands and minor tussock grasslands
Coolibah	COB	Flood plains with weakly gilgaied clay soils supporting coolabah woodlands with tussock grass understorey
Cowra	CWA	Plains fringing the Marsh land system and supporting snakewood and mulga shrublands with some halophytic undershrubs
Granitic	GRC	Rugged granitic hills supporting shrubby hard and soft spinifex grasslands.
Gregory	GRG	Linear dunes and restricted sandplains supporting shrubby hard Spinifex (and occasionally soft spinifex) grasslands
Jamindie	JAM	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey
Littoral	LIT	Bare coastal mudflats with mangroves on seaward fringes, samphire flats, sandy islands, coastal dunes and beaches.
Macroy	MAC	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands.
Mallina	MAL	Sandy surfaced alluvial plains supporting soft spinifex (and occasionally hard spinifex) grasslands.
Marsh	MSH	Lakebeds and floodplains subject to regular inundation, supporting samphire shrublands, salt water couch grasslands and halophytic shrublands
McKay	MCK	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands
Newman	NEW	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands
Oakover	OAK	Breakaways, mesas, plateaux and stony plains of calcrete supporting hard spinifex grasslands.
Paradise	PDS	Alluvial plains supporting soft spinifex grasslands and tussock grasslands.

Land system	Land system code	Habitat
Platform	PLA	Dissected slopes and raised plains supporting hard spinifex grasslands.
River	RIV	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.
Robe	ROB	Low plateaux, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.
Rocklea	ROC	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.
Ruth	RUT	Hills and ridges of volcanic and other rocks supporting hard spinifex (occasionally soft spinifex) grasslands.
Satirist	SAT	Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands.
Talga	TLG	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.
Turee	TUR	Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands
Uaroo	UAR	Broad sandy plains supporting shrubby hard and soft spinifex grasslands.
Warri	WAI	Low calcrete platforms and plains supporting mulga and cassia shrublands
White Springs	WHS	Stony gilgai plains supporting tussock grasslands and hard spinifex grasslands.
Wona	WON	Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands.
Yamerina	YAM	Flood plains and deltaic deposits supporting tussock grasslands, grassy woodlands and minor halophytic low shrublands.

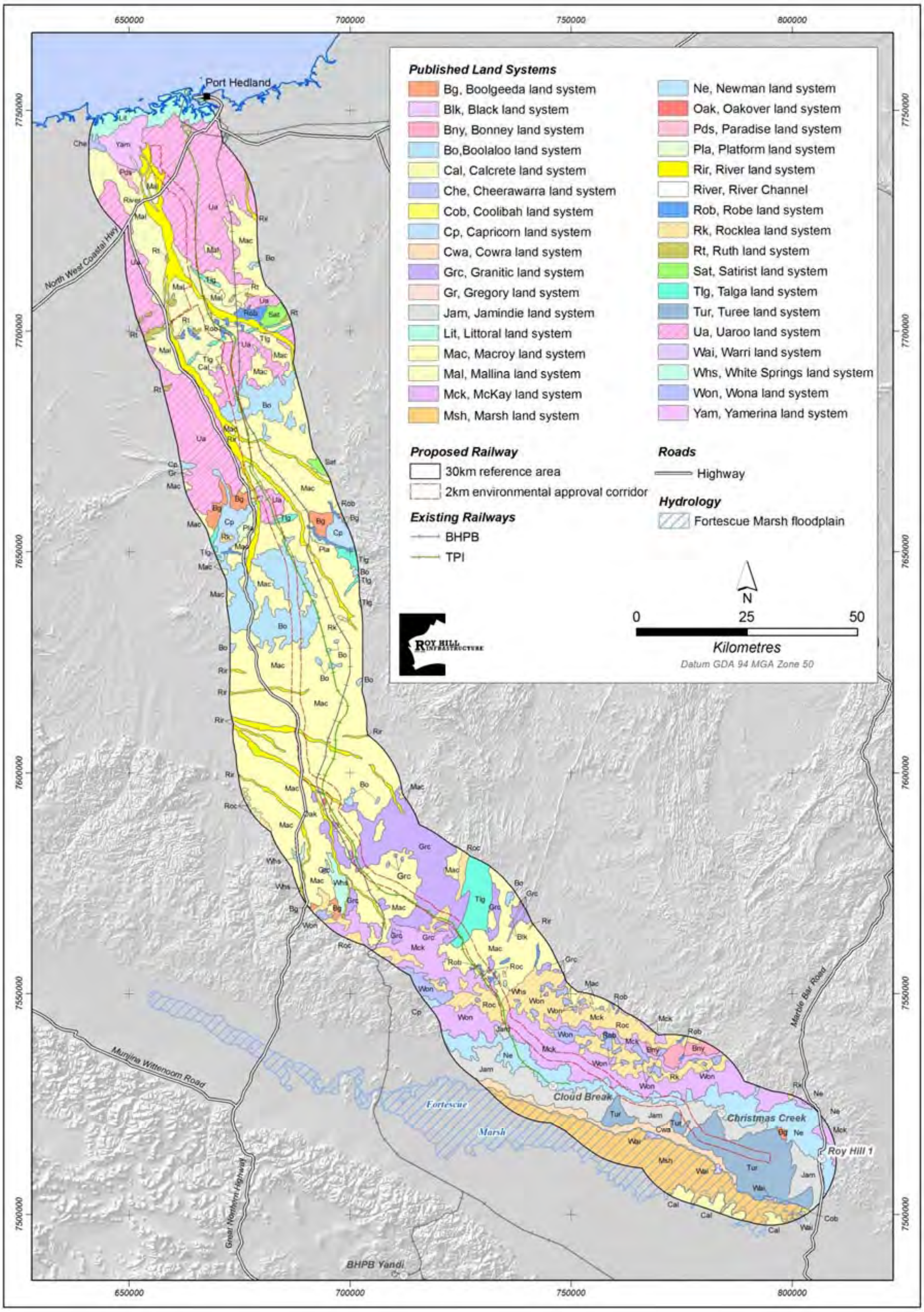

Figure 8-1: Land Systems within 30 km Reference Area

8.5 Surface water

8.5.1 Overview

Several major drainage lines occur in this area north of the Chichester Range, including the Turner, Yule and Shaw rivers, all of which drain northwards to the coast. The area of investigation also includes the drainage basin for the Fortescue Marsh.

All drainage channels 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, small discharges may persist for a few weeks. During large flood events floodwater can overflow from the main river channels into the surrounding floodplains. River pools are sustained by local bank storage or the local watertable and springs are fed by local aquifers, particularly in the karstic areas.

On the lower less-steep valley flanks, rainfall runoff tends to flow overland rather than along defined creek courses. These sheetflow areas frequently support scrub and mulga (*Acacia aneura*) communities, particularly in the areas of the Fortescue Valley adjacent to the Fortescue Marsh.

8.5.2 Port Hedland area catchment

The first approximately 25 km of the proposed route passes through the Port Hedland area catchment, where several creeks drain to the coast between the Turner River catchment and the De Grey River catchment. From west to east, these are South West Creek, South Creek, Beebingarra Creek, Petermarer Creek and Tabba Creek (Aquaterra Consulting 2004). The proposed RHI Railway will be aligned parallel to and away from the main surface drainages of this catchment.

Flooding of low-lying areas is common at the mouths of the major rivers on the Port Hedland coast, due to the low topography on the coastal dunes and the potentially high peak flows. RHI has committed to undertaking a flood study analysis of the proposed route before the railway is constructed.

8.5.3 Turner River and Yule River catchments

The proposed RHI Railway passes through the Turner River and Yule River catchments and crosses several major rivers and creeks including Turner River East, Turner River West, Coonarrie Creek and upper portions of the Yule River.

All drainage channels are ephemeral, responding only to major rainfall events. The drainage lines in these catchments support eucalypt woodland on their banks and floodplains, and have alluvial gravel/sand beds that may become mobile during flood events (Aquaterra Consulting 2004).

For the purpose of conducting a flood study analysis, records are available from gauging stations on the Yule and Turner rivers. MRWA has estimated the average recurrence interval of the 1975 Yule River flood event to be 80 years. Based on this assumption, the general extreme value (GEV) distribution appears to best represent the flow/recurrence relationship. The 100-year average recurrence interval discharge was estimated to be 19,002 m^3/s.

8.5.4 Upper Shaw River catchment

The proposed RHI Railway intersects a small portion of the southwest corner of the Upper Shaw River catchment, and runs perpendicular to the surface water direction. The proposed railway route crosses upper drainage lines of the Western Shaw River, which discharges north to the coast.

8.5.5 Upper Fortescue River catchment

The proposed route then crosses the Chichester Range and runs along the lower slopes of the Chichester Plateau through the Upper Fortescue River catchment to the north of the Fortescue Marsh. The natural drainage features along this route include creeks, floodplains and sheetflow areas (Aquaterra Consulting 2005).

The proposed RHI Railway is perpendicular to the surface water flow direction along this section and crosses several small creeks including Goman Creek, Sandy Creek and Christmas Creek, all of which drain south to the Fortescue Marsh. The largest is Christmas Creek, which has a catchment area of 250 km^2 (Aquaterra Consulting 2005).

8.5.6 Fortescue Marsh

At its closest point the southern boundary of the RHI Railway 2 km environmental approval corridor is approximately 2.5 km from Geoscience Australia's boundary of the Marsh.

The Fortescue Marsh is an extensive, intermittent wetland, bound by the Chichester Range to the north and the Hamersley Range to the south. The Marsh occupies an area of approximately 1,000 km^2 when in flood (Department of Environment, Heritage, Water and the Arts (DEHWA) 2008).

The Goodiadarrie Hills, located on the valley floor around 60 km east from the town of Wittenoom, effectively cut the Fortescue River into two separate river systems. West of the Goodiadarrie Hills, the Lower Fortescue River catchment drains to the coast, whereas east of the hills the Fortescue Marsh receives drainage from the Upper Fortescue River catchment.

Smaller runoff events result in isolated pools forming opposite the main drainage inlets of the Fortescue Marsh; while larger events may result in flooding of the whole marsh area. On the southern and northern flanks of the Fortescue Valley, numerous creeks discharge to the marsh.

Previous studies have established that the Marsh is predominantly a surface water fed feature, rather than ground water fed, on the basis that water levels in the uppermost (alluvium) aquifer within the surrounding plain are below the bed of the Marsh and the marsh water is hypersaline (Environ Australia, 2005).

8.6 Groundwater

There are three minor aquifer-types present in the project area:

- unconsolidated sedimentary aquifers, including recent valley-fill alluvium and colluvium;
- chemically-deposited calcrete and pisolite within Tertiary drainage channels; and
- fractured rock, which form local aquifers.

Unconsolidated sedimentary aquifers are located predominately along the coastal plain and creek and drainage channels further inland. Typically these aquifers are present across the project area at the Turner, Yule and Fortescue rivers, with more minor aquifers present along unnamed drainage channels. Groundwater quality typically ranges between 200 mg/L and 2,500 mg/L total dissolved solids. A saline interface is present along the coastal plain and at the Fortescue Marsh.

Chemically-deposited aquifers can form within unconsolidated sediments at the zone of fluctuation of the watertable and enhance porosity through deposition of carbonates creating a secondary porosity. These aquifers are generally located across the coastal plain and creek lines and drainage channels inland. Typically groundwater quality is good, and can range between 200 mg/L and 1,500 mg/L TDS (DoW 2006).

Fractured rock aquifers are present within bedrock that has been subject to lithostatic stresses creating faults and/or jointing. These aquifers are present in areas of regional faulting, igneous intrusions and granite terrain across the project area. Groundwater quality is generally poor, ranging from 1,000 mg/L to 5,000 mg/L TDS (DoW 2006).

Recharge to each of these aquifers is generally associated with occasional cyclonic high-rainfall events and can occur through direct recharge at outcrop, infiltration recharge and streamflow. Groundwater levels are controlled by a combination of discharge along creek lines, seepage at the Fortescue Marsh, surface evaporation and evapotranspiration from vegetation.

The southern section of RHI Railway is located on the southern side of the Fortescue Metals Group Pty Ltd (FMG) Christmas Creek mining operations. Groundwater is being managed on a large scale in these areas where extensive dewatering and injection occurs. Groundwater levels will have been depressed around dewatered pit areas and increased adjacent to injection wells and infiltration areas.

8.7 Biogeography

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions. IBRA is the National Reserve System's planning framework and the fundamental tool for identifying land for conservation. The current version is IBRA 6.1. This is updated from version 5.1 and has additional landscape data from states including Western Australia (DEWHA 2009).

IBRA sub-regions are more localised, homogenous geomorphological units in each bioregion (Department of the Environment, Water, Heritage and the Arts, 2009). Four sub-regions exist within the Pilbara bioregion and the RHI Railway traverses three of these sub-regions (Figure 8-2):

- Chichester (PIL1);
- Fortescue Plains (PIL2); and
- Roebourne Plains (PIL4).

The Chichester sub-region (PIL1) 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 on average 300 mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule and Sherlock). The sub-region’s total area is 9,044,560 ha (Kendrick & McKenzie 2001).

The Fortescue Marsh, within the Fortescue Plains sub-region (PIL2), comprises an extensive, episodically inundated samphire marsh system, approximately 100 km long and 10 km wide and located on the Fortescue Valley floor. The Fortescue Marsh is located approximately 400 m above sea level (Kendrick 2001). 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. It marks the northern limit of mulga (Acacia aneura) in Western Australia (Kendrick & McKenzie 2001).

The Fortescue Marsh is dry for extended periods, but episodically supports water-bird breeding when holding extensive areas of open water. The Fortescue Marsh is currently listed as a Wetland of National Importance under the *Directory of Important Wetlands of Australia* (DIWA) (Kendrick & McKenzie N.L. 2002).

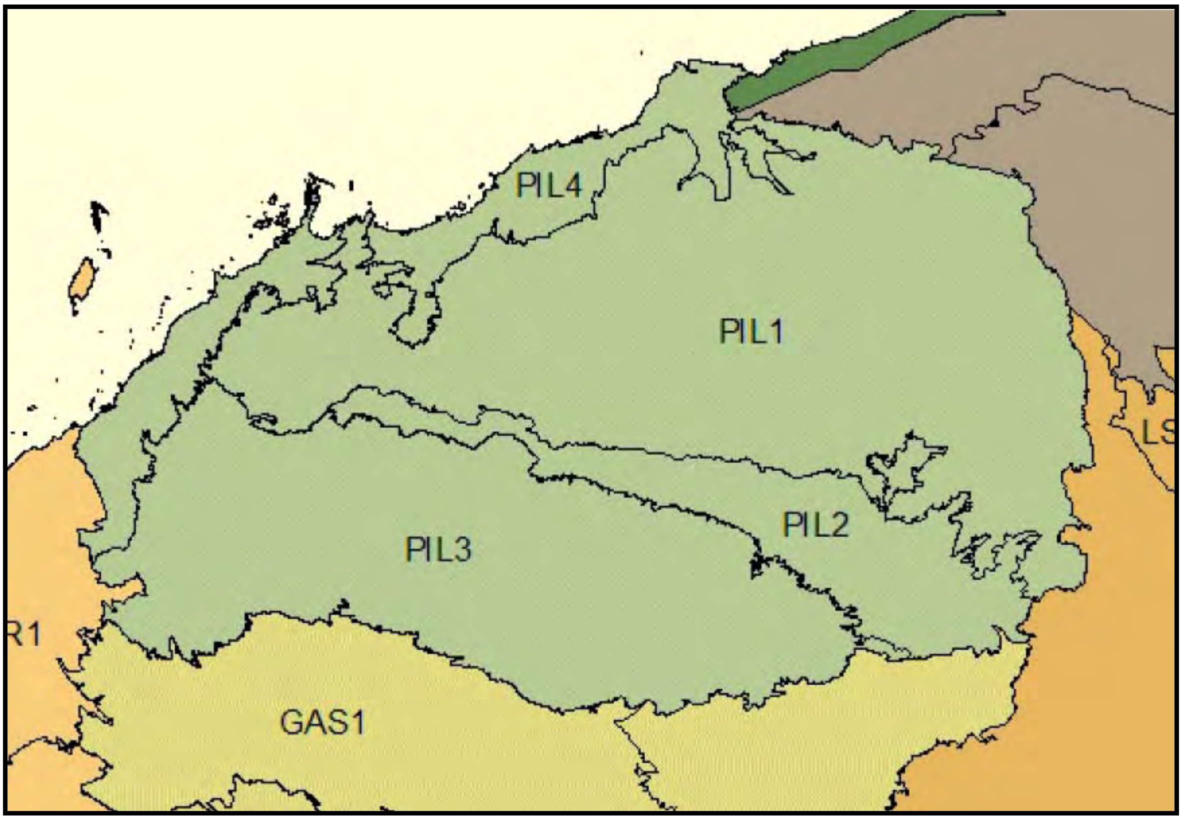

Figure 8-2: The IBRA sub-regions of the Pilbara showing PIL1 (Chichester) and PIL2 (Fortescue Plains)

Source: Adapted from Department of the Environment, Water, Heritage and the Arts, 2009

8.8 Flora and vegetation

8.8.1 Previous surveys

The area covered by the rail corridor has been the subject of a number of surveys for previous projects. Table 8-3 summarises recent flora and vegetation surveys conducted along or in the vicinity of the proposed rail corridor. Information from some of these surveys has been used to characterise the flora and vegetation of the 2 km wide environmental approval corridor and to discuss impacts.

8.8.2 Vegetation communities and condition

Based on the surveys in Table 8-3; this section describes vegetation communities in the project area at a broad level. Vegetation descriptions were based on the structure classes, as defined by the Government of Western Australia (2000) (Table 8-4). Limited assessments of vegetation condition were completed and the vegetation condition scale (Government of Western Australia 2000) shown in

Table 8-5 has been used to rank condition within the various communities.

Table 8-3: Flora surveys to date along or in the vicinity of the proposed railway route

Survey	Date	Project	Summary
Biota (2002a)	April–May & May–June 2001	Hope Downs Railway	Surveys, description and assessment of vegetation and flora along the length of the proposed Hope Downs rail corridor from Port Hedland to Weeli Wolli Creek.
Biota (2004a)	March–April 2004	FMG Stage A Rail Corridor	Surveys, description and assessment of vegetation and flora along the length of the FMG Stage A Railway using results from the Hope Downs rail corridor and additional new surveys.
Biota (2004b)	June-October 2004	FMG Stage B Rail Corridor	Surveys, description and assessment of vegetation and flora along the length of the Stage B Corridor, Christmas Creek, Mt Lewin, Mt Nicholas and Mindy Mindy Mine areas.
Mattiske Consulting (2005)	October-November 2005	FMG Cloudbreak Mine	A survey of the project area to define plant communities and search for DRF and Priority Flora. Additional opportunistic sampling was undertaken in May 2005.
APM (2010)	March 2010	RHIO Hillside South Rail Option	Survey, description and assessment of vegetation and flora along the length of the RHIO Hillside South Rail Corridor.

Table 8-4: Plant community (vegetation) structural descriptions

Life form height class	Canopy cover (%)			
	70–100%	30–70%	10–30%	2–10%
Trees >30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees <10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Shrub Mallee	Closed Shrub	Shrub Mallee	Open Shrub	Very Open Shrub
Shrubs >2m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs <1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Tussock Grasses	Closed Tussock Grassland	Tussock Grassland	Open Tussock Grassland	Very Open Tussock Grassland
Hummock Grasses	Closed Hummock Grassland	Hummock Grassland	Open Hummock Grassland	Very Open Hummock Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Modified from Government of WA, 2000 (which is itself modified from multiple sources - originally Specht 1970)

Table 8-5: Vegetation condition scale (Government of Western Australia 2000)

Condition	Definition
Pristine	No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species; weeds are non-aggressive species.
Very Good	Vegetation structure altered; obvious signs of disturbance.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances; basic vegetation structure or ability to regenerate is retained.
Degraded	Basic vegetation structure severely impacted by disturbance; scope for regeneration but not to a state approaching good condition without intensive management.
Completely Degraded	Vegetation structure not intact; the area is completely or almost completely without native species. Often described as 'parkland cleared'.

The 2 km environmental approval corridor traverses 16 land systems and vegetation units that have been recorded in these land systems are described below. The land systems are discussed as they occur, from north to south, along the 2 km environmental approval corridor.

A: Uaroo Land System

A1 Hummock grasslands of *Triodia* (spinifex) species on sandy areas. The vegetation on low sandy islands within the coastal mudflats on sodic soils in low-lying seasonally inundated areas within the Abydos Plain. Mid-dense hummock grasslands of soft spinifex *Triodia epactia* and leaping spinifex *T. secunda*. *Triodia epactia* hummock grasslands with a few scattered shrubs of *Pluchae tetranthera*. Areas occurred on calcareous alkaline soils on orange brown coarse sands with algal crusts on surface with moderately dense hummock grassland *Triodia longiceps*. The vegetation varies in condition from Poor to Moderate in the region. There was evidence of cattle.

A2 Scattered shrubs over *Triodia* hummock grasslands with mid-dense hummock grassland *T. epactia* and *T. schinzii* influenced by tidal creek. Areas of high open shrubland to scattered tall shrubs dominated by *Acacia colei* and *A. tumida* over a *T. epactia* hummock grassland. Areas consist of scattered tall shrubs of *A. colei* over a shrubland of Cajanus cinereus over a mid-dense hummock grassland of *T. epactia*. Occasional tall shrubs of *A. inaeqilatera* and *A. ancistrocarpa* over a closed hummock grassland of *T. basedowii*. The vegetation in the region was in Good to Very Good condition with some areas in excellent condition. There was evidence of cattle.

A3 Vegetation occurring on stony plains and low ridges probably overlying calcareous soils. Scattered shrubs to shrublands over *Triodia* hummock grasslands. The vegetation in this region has been reported to be in excellent condition.

A4 Vegetation of minor creeklines and floodplains supporting Eucalyptus victrix, *Corymbia* spp. scattered trees to low open woodland over *Acacia colei* open scrub over *Triodia epactia* dense hummock grassland. *E. victrix* low open woodland to woodland over *A. collie* scattered tall shrubs to high open shrubland over *Triodia epactia* scattered hummock grasses and *Eriachne spp*.; tussock grasses. *A. colei*, *A. trachycarpa*, *A inaequilatera* high shrubland over *T. lanigera* mid-dense hummock grassland. Vegetation recorded as Good to Very Good.

A5 Shrublands over *Triodia* hummock grasslands *Corymbia hamersleyana* scattered low trees over *Acacia colei* shrubland over *Triodia langera* hummock grassland. *A. tumida* open shrubland to shrubland over *T. schinzii* hummock grassland. *Cullen leucochaites*, *Cajanus cinereus* shrubland over *T. epactia* mid-dense hummock grassland. Vegetation recorded as Good to Excellent.

A6 Quartz ridge vegetation *Acacia tumida*, *Grevillea wickhamii* subsp. *aprica* scattered shrubs to open shrubland over *Triodia epactia* open hummock grassland to hummock grassland. Vegetation recorded as Good condition.

A7 Dolerite dyke vegetation *Cajanus cinerius* shrubland over *Triodia epactia* hummock grassland. Vegetation recorded as Very Good condition.

B: Talga Land System

B1 Shrublands over *Triodia* hummock grasslands occurring on calcareous soils, supporting *Acacia orthocarpa* high open shrubland to high shrubland over *T. wiseana* mid-dense hummock grassland. Vegetation in Very Good to Excellent condition.

B2 Vegetation of major creek lines, *Eucalyptus camaldulensis* low open woodland over *Acacia trachycarpa* high shrubland over *Triodia epactia* mid-dense hummock grassland and *1*Cenchrus ciliaris* very open tussock grassland. Vegetation in Moderate to Very Good condition, evidence of buffel grass.

B3 Vegetation of stony plains and hills with scattered shrubs to shrublands over *Triodia* hummock grasslands. *Acacia inaquilatera* scattered tall shrubs over *T. wiseana* hummock grassland to mid-dense hummock grassland. Vegetation in Good to Excellent condition.

B4: Hills with shale and quartz with shallow stony soil. The vegetation was typically scattered bloodwood *Corymbia hamersleyana* over scattered *Acacia inaequilatera*, *Hakea chordophylla*, *Acacia bivenosa* and occasional *Grevillea pyramidalis* over Hummock Grassland *Triodia wiseana* (hard spinifex). The vegetation was in Excellent to Pristine condition.

B5: Major creek with clay bank and sandy, pebbly river bed. The vegetation was a Low Open Woodland Eucalyptus victrix and scattered *Acacia coriacea* subsp. *pendens* over Open Shrubland including *Acacia tumida*, *A. bivenosa* and *Melaleuca glomerata* over Very Open Hummock Grassland *Triodia epactia* (soft spinifex) with some *T. longiceps* (hard spinifex). The condition was difficult to assess as the groundcover was largely dormant at the time of the survey. There was little evidence of disturbance by cattle.

B6: Minor stony creek with clay loam banks and sandy pebbly bed. The vegetation was scattered bloodwood *Corymbia hamersleyana* over Tall Open Shrubland *Acacia tumida* over *A.*

[1] Denotes exotic species.

bivenosa and *A. pyrifolia* over Open Hummock Grassland *Triodia epactia* (soft spinifex) with some *T. longiceps* and *T. wiseana.*. The vegetation was in Excellent to Pristine condition.

B4 Talga LS shale and quartz with Bloodwood *Corymbia hamersleyana* over scattered *Acacia inaequilatera*, *Hakea chordophylla*, *Acacia bivenosa* and occasional *Grevillea pyramidalis* over Hummock Grassland *Triodia wiseana*

B5 Major creek with Low Open Woodland *Eucalyptus victrix* and *Acacia coriacea* subsp. *pendens*, *A. tumida*, *A. bivenosa* and *Melaleuca glomerata* over Very Open Hummock Grassland *Triodia epactia* and *T. longiceps*.

B6 Talga LS Minor stony creek with scattered Bloodwood *Corymbia hamersleyana* over Tall Open Shrubs *Acacia tumida* over *Acacia bivenosa* and *A. pyrifolia* over Open Hummock Grassland *Triodia epactia*.

C: Mallina Land System

C1 Scattered shrubs over *Triodia* hummock grasslands, *Acacia stellaticeps*, *Pluchea ferdinandi-muelleri* low open shrubland over *T. lanigera* mid-dense hummock grassland. Vegetation condition Good (with obvious signs of cattle grazing) to Excellent.

C2 Vegetation of major creek lines, *Eucalyptus camaldulensis* woodland over *Melaleuca* spp. high shrubland to open scrub over *Triodia epactia*, tussock grasses and patches of sedges. Vegetation Poor with considerable buffel grass infestation to Good and Very Good.

C3 Vegetation of minor creek lines and floodplains, *Corymbia hamersleyana* scattered low trees over *Acacia ampliceps*, *A. tumida* high shrubland over *Triodia lanigera*, *T. epactia* mid-dense hummock grassland. *A. acradenia*, open scrub to high shrubland over *T. lanigera* mid-dense hummock grassland. Vegetation condition is Very Good.

C4 Shrublands over *Triodia* hummock grasslands, Acacia colei high shrubland over *T. epactia, T. lanigera* mid-dense hummock grassland. Vegetation recorded as Good.

D: River Land System

D1 Hummock grasslands of *Triodia* (spinifex) species on sandy areas. Calcareous alkaline soils on orange brown coarse sands with algal crusts on surface with moderately dense hummock grassland *T. longiceps*. Vegetation in Excellent condition.

D2 Vegetation occurring on stony plains and low ridges probably overlying calcareous soils. Scattered shrubs to shrublands over *Triodia* hummock grasslands. The vegetation in this region has been reported to be in Excellent condition.

D3 Vegetation of creeklines and floodplains. *Eucalyptus victrix*, *Melaleuca argentea* low woodland to low open woodland. Vegetation in Good to Very Good condition.

D4 *Eucalyptus camaldulensis* woodland over *Melaleuca* spp. high shrubland to open scrub over *Triodia epactia*, tussock grasses and patches of sedges. Vegetation in Very Good condition with evidence of cattle.

D5 *Eucalyptus victrix* scattered low trees to low open woodland over *Melaleuca glomerata* high shrubland to open scrub over *Triodia epactia*, tussock grasses and patches of sedges. Vegetation in Good to Moderate condition with invasion of buffel grass.

D6 *Eucalyptus victrix* scattered trees over *Acacia coriacea* subsp. *pendens*, *Atalaya hemiglauca*, *Hakea lorea* subsp. *lorea* high open shrubland over **Cenchrus ciliaris* tussock grassland. Vegetation in Very Poor condition.

D7 *Eucalyptus victrix* scattered low trees over *Acacia trachycarpa* open scrub over *Triodia epactia* mid-dense hummock grassland or **Cenchrus ciliaris* open to closed tussock grassland. Vegetation in Good condition; grazing and weeds evident.

D8 *Acacia hemiglauca* low woodland over **Cenchrus ciliaris* open tussock grassland. Vegetation in Very Good condition with buffel grass.

D9 Scoured creek bed.

E: Robe Land System

E1 Hummock grasslands of *Triodia* (spinifex) species on sandy areas. Calcareous alkaline soils on orange brown coarse sands with algal crusts on surface with moderately dense hummock grassland *Triodia longiceps*. Vegetation in Excellent condition.

E2 Vegetation occurring on stony plains and low ridges probably overlying calcareous soils. Scattered shrubs to shrublands over *Triodia* hummock grasslands. The vegetation in this region has been reported to be in Excellent condition.

E3: Narrow, long ridgelines with shallow stony soil. The vegetation consisted of occasional snappy gum *Eucalyptus leucophloia* over Tall Open Shrubland of *Acacia pruinocarpa* over Hummock Grassland *Triodia epactia* (soft spinifex) . The vegetation was in Excellent to Pristine condition.

E3 Robe LS narrow, long ridgelines with occasional Snappy Gum *Eucalyptus leucophloia* over Tall Open Shrubland of *Acacia pruinocarpa* over Hummock Grassland *Triodia epactia*.

F: Calcrete Land System

F1 Calcrete plains, platforms and low rises. Hummock grasslands of *Triodia wiseana*, *T. plurinervata* or, less frequently, *T. pungens* with *Acacia bivenosa* and other acacia shrubs and occasional *Corymbia hamersleyana* trees

F2: Drainage foci. Similar to F1 with some additional grasses and/or low shrubs. Scattered to moderately close tall shrublands/woodlands with *Acacia aneura* (mulga) or *Eucalyptus victrix* (coolabah), sparse variable undershrubs and grasses such as *Eriachne benthamii*.

F3: Sandy plains / sandplains. Hummock grasslands of Triodia spp. with scattered *Acacia* spp. shrubs.

F4: Drainage tracts. Variable scattered to moderately close shrublands with numerous *Acacia* spp. occasional eucalypts, *Hakea suberea* (now *H. lorea* subsp. *lorea*) and scattered hummock and tussock grasses.

F5: Scattered to moderately close tall shrublands with *Corymbia hamersleyana*, *Acacia halosericea*, *A. trachycarpa*, *A. tumida* and *Triodia pungens*.

As described by Van Vreeswyk et al. (2004), who noted that the vegetation condition in most of the land system was good to very good.

G: Boolaloo Land System

G1 Vegetation of sandy areas: *Triodia longiceps*, *T. epactia* mid-dense hummock grassland. Vegetation in good condition.

G2 Vegetation of creek lines and floodplains: *Corymbia* spp. scattered low trees over *Acacia tumida*, *A. colei* open scrub over *Triodia epactia* hummock grassland. Vegetation in Excellent condition.

G3 Vegetation of rocky outcrops and rocky ridges. *Acacia tumida* high shrubland to open scrub over *Triodia epactia* hummock grassland. *Tripogon loliiformis* dwarf open grassland. Vegetation in Very Good condition with buffel grass in some pockets.

H: Macroy Land System

H1 Vegetation of sandy areas: *Triodia longiceps*, *T. epactia* mid-dense hummock grassland. Vegetation in Good condition.

H2 Scattered shrubs over *Triodia* hummock grasslands. *Acacia* spp., *Pluchea ferdinandi-muelleri* low open shrubland over *T. lanigera* mid-dense hummock grassland. Vegetation in good condition. *A. stellaticeps*, *P. ferdinandi-muelleri* scattered shrubs over *T. angusta*, *T. lanigera* mid-dense hummock grassland. Vegetation in Moderate to Poor condition grazed. *A. inaequilatera* scattered tall shrubs over *T. lanigera* mid-dense hummock grassland. Vegetation in Very Good to Excellent condition.

H3 Vegetation of stony plains and hills with scattered shrubs to shrublands over *Triodia* hummock grasslands. *Acacia inaequilatera* scattered tall shrubs over *T. wiseana* hummock grassland to mid-dense hummock grassland. *A. bivenosa*, *A. ancistrocarpa* open shrubland over *T. wiseana, T. lanigera* mid-dense hummock grassland. *Acacia ancistrocarpa*, *A. inaequilatera* scattered tall shrubs over *T. brizoides* mid-dense hummock grassland. Vegetation in Very Good to Excellent condition.

H4 Vegetation of major creek lines: *Eucalyptus victrix*, *Melaleuca argentea* low woodland to low open woodland. *E. victrix* scattered low trees over *Acacia trachycarpa* open scrub over *Triodia epactia* mid-dense hummock grassland or **Cenchrus ciliaris* open to closed tussock grassland. Vegetation in Good to Very Good condition.

H5 Vegetation of minor creek lines and floodplains: *Eucalyptus victrix* scattered low trees over *Acacia trachycarpa* open scrub over *Triodia epactia* mid-dense hummock grassland or **Cenchrus ciliaris* open to closed tussock grassland. Vegetation is Moderate to Poor, weedy and invaded by buffel grass.

Corymbia spp. scattered low trees over *Acacia trachycarpa* open scrub over *Triodia lanigera* mid-dense hummock grassland and **Cenchrus ciliaris* open to closed tussock grassland. *C. hamersleyana* scattered low trees over *Acacia tumida* high shrubland over *T. langera*, *T. epactia* mid-dense hummock grassland. Vegetation is Good to Very Good; signs of cattle.

Corymbia hamersleyana scattered low trees over *Acacia colei* open scrub over *A. stellaticeps* low open shrubland over *Triodia lanigera* hummock grassland and *Chrysopogon fallax*, *Eriachne obtusa* open tussock grassland. *A. tumida*, *A. colei* open scrub over mixed tussock grassland. Vegetation in Good to Very Good condition.

Acacia ampliceps open scrub over *A. trachycarpa* shrubland over **Cenchrus ciliaris*, *Diplanchne fusca* closed tussock grassland. *Corymbia* spp. low open woodland over *Acacia acradenia*, *A. ancistrocarpa* open scrub over *Triodia epactia* open hummock grassland and *Chrysopogon fallax*, *Themeda triandra* tussock grassland. *Corymbia hamersleyana* scattered low trees over *A. acradenia, A ancistrocarpa, A. bivenosa* high open shrubland *over Acacia stellaticeps* low open shrubland over *Triodia longiceps* mid-dense hummock grassland. Vegetation in Moderate to Excellent condition; evidence of grazing and weed invasion.

Acacia ancistrocarpa open scrub over *Triodia epactia* mid-dense hummock grassland. *Acacia bivenosa* open heath over *T. lanigera* hummock grassland. Vegetation in Good condition; grazing.

H6 Shrublands over *Triodia* hummock grasslands. *Acacia orthocarpa* high open shrubland to open scrub over *Triodia epactia* or *T. lanigera* or *T. wiseana* mid-dense hummock grassland. *Corymbia hamersleyana* scattered low trees over *A. adsu*rgens high shrubland to open scrubland to open scrub over *Triodia epactia* mid-dense hummock grassland. *A. maitlandii* open scrub over *Triodia lanigera* mid-dense hummock grassland. Vegetation in Very Good to Excellent condition.

H7 Vegetation of rocky outcrops and rocky ridges: *Ficus brachypoda*, *Flueggea virosa* subsp. *melanthesoides*, *Terminellia canescens*, *Clerodendrum* spp. Scattered shrubs over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock grassland. *Tripogon loliiformis* dwarf open grassland. Vegetation in mostly Good to Very Good condition.

H8 Granite ridge vegetation: *Acacia inaequilatera* scattered tall shrubs over *Gossypium australe* (Whim creek form) open shrubland over *Triodia epactia* hummock grassland. Vegetation in Good condition.

H9 Vegetation of stony plains and hills, scattered shrubs over *Triodia* hummock grasslands. *Acacia inaequilatera*, *Cassia* spp. scattered tall shrubs over *Triodia epactia* mid-dense hummock grassland. *T. wiseana, T longiceps* mid-dense grassland. Vegetation in Very Good to Excellent condition.

H10 Vegetation of minor creeklines and floodplains. *Corymbia hamersleyana* low trees over *Acacia acradenia* open scrub over *T. longiceps*, *T. lanigera* mid-dense hummock grassland and *Paraneurache muelleri* grassland. Vegetation in Very Good condition.

H11: Plains and hills of decomposed or massive granite with areas of quartz and calcrete and pale stony soils. The vegetation was similar to F1: Rocklea Land System and consisted of Tall Open Shrubland of kanji -*Acacia inaequilatera* - over Hummock Grassland *Triodia wiseana* (hard spinifex) with scattered bloodwood *Corymbia hamersleyana*. The vegetation was in Excellent to Pristine condition.

H12: Major creek lines with clay loam flood banks and a sandy, stony riverbed. The vegetation was typically a Low, to Low Open Woodland of *Eucalyptus victrix* in the riverbed with occasional *E. camaldulensis* var. *obtusa, Atalaya hemiglauca* and *Acacia coriacea* subsp. *pendens*. Bloodwood *Corymbia hamersleyana* gradually became more dominant in the upper reaches. There was a Shrubland of *Acacia pyrifolia* and *A. bivenosa* over tussock grasses, which were mainly dormant but included *Chrysopogon fallax* and buffel grass **Cenchrus ciliaris* and scattered hummock grasses *Triodia epactia* (soft spinifex). Condition was difficult to assess, as the herbaceous groundcover was mainly dormant at the time of the survey. There was evidence of cattle.

H13: Broad floodplains from major creeks (G2) with sandy loam soils. The vegetation was a Low Open Woodland of bloodwood *Corymbia hamersleyana* over scattered shrubs including *Acacia ancistrocarpa, A. pyrifolia, Atalaya hemiglauca* and *Senna glutinosa* subsp. *glutinosa* over Open Hummock Grassland *Triodia longiceps* (hard spinifex). Condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. There was little evidence of cattle.

H11 Macroy LS granite derived soil with Tall Open Shrubland of Kanji *Acacia inaequilatera* over *Triodia wiseana* and scattered Bloodwood *Corymbia hamersleyana*.

H12 Macroy LS major creek with a Low Open Woodland *Eucalyptus victrix* over shrubs and Open Hummock Grassland *Triodia epactia*.

H13 Macroy LS broad floodplains with Low Open Woodland Bloodwood *Corymbia hamersleyana* over scattered shrubs and Open Hummock Grassland *Triodia longiceps*.

I: Capricorn Land System

I1 Vegetation of stony plains and hills: *Cassia glutinosa* scattered shrubs over *Triodia brizoides*, *T. epactia* mid-dense hummock grassland. Vegetation in Excellent condition.

J: Granitic Land System

J1 Scattered shrubs over Triodia hummock grasslands. *Acacia inaequilatera, A. ancistrocarpa* scattered tall shrubs over *T. basedowii* closed hummock grassland. Vegetation in Very Good condition; signs of cattle present.

J2 Vegetation of major creeklines: *Eucalyptus camaldulensis* woodland over *Melaleuca* spp. high shrubland to open scrub over *Triodia epactia*, tussock grasses and patches of sedges. Vegetation in Good condition; grazing.

J3: Numerous outcroppings of granite interspersed by stony shallow orange soils. The vegetation typically included scattered snappy gum *Eucalyptus leucophloia* and/or bloodwood *Corymbia hamersleyana* over Shrubland to Open Shrubland including *Grevillea wickhamii* and *Acacia* spp. over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) (hard spinifex) and *T. epactia* (soft spinifex). The vegetation was in Excellent to Pristine condition.

J3 Granitic LS granite and shallow orange soils with scattered Snappy Gum *Eucalyptus leucophloia* and/or Bloodwood *Corymbia hamersleyana* over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and *T. epactia.*

K: White Springs Land System

K1 Vegetation of stony plains and hills, scattered shrubs over *Triodia* hummock grasslands. *Acacia inaequilatera* and *Cassia* spp. Scattered tall shrubs over *Triodia epactia* mid-dense hummock grassland. Vegetation in Very Good condition.

Triodia wiseana, T. longiceps mid-dense hummock grassland. Vegetation in Good condition; occasional weeds and some grazing.

K2 Shrublands over *Triodia* hummock grasslands. *Acacia inaequilatera* scattered tall shrubs over Indigofera rugosa low open heath over *T. epactia* closed hummock grassland. Vegetation in Very Good condition; signs of grazing.

K3 Vegetation of minor creek lines and floodplains: *Acacia coriacea* open woodland over *Petalostylis labicheoides*, *A. acradenia*, *A.bivenosa* high open shrubland over *Triodia epactia* mid-dense hummock grassland. Vegetation is in Good condition; some weed invasion.

Corymbia hamersleyana scattered trees over *Acacia bivenosa* high open shrubland over *Triodia epactia*, *T longiceps* open hummock grassland. Vegetation in Very Good condition.

Petalostylis labicheoides, *Acacia bivenosa* open scrub over *Triodia wiseana* mid-dense hummock grassland. *Acacia acradenia* open scrub over *T. wiseana* mid-dense hummock grassland. Vegetation in Very Good to Excellent condition.

K4 Vegetation of cracking clays: *Acacia victoriae* open shrubland to high shrubland over *Cassia oligophylla* scattered shrubs over *Sida* aff. *fibulifera* low open shrubland. *Cassia oligophylla* scattered shrubs over *Sida* aff. *fibulifera* low open shrubland over *Streptoglossa bubakii* open to very open herbland. Vegetation in Moderate to Good condition; grazed.

K5: Stony plain with patches of gilgai with cracking and non-cracking red clays. The vegetation consisted of scattered shrubs including *Solanum lasiophyllum*, *Tephrosia* sp. and *Sida* aff. *fibulifera* over tussock grasses (dormant) and Open Hummock Grassland of *Triodia wiseana* and *T. longiceps*. The condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. There was little evidence of cattle.

K5 White Springs LS stony plain with patches of gilgai with scattered shrubs, tussock grasses (dormant) and Open Hummock Grassland of *Triodia wiseana* and *T. longiceps*

L: Turee Land System

L1: Stony plain interspersed with shallow drainage channels and gilgai (Plates 10 and 11). There was a Tall Open Shrubland Acacia victoriae over tussock grasses (dormant). The condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. There was some evidence of disturbance by cattle.

L2: Shallow undefined drainage lines on clay with Low Open Forest mulga *Acacia aneura* and *A. pruinocarpa* over Low Open Shrubland of *Eremophila forrestii* with occasional patches of snakewood *Acacia xiphophylla* or scattered *Eucalyptus victrix*. The condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. There was some evidence of disturbance by cattle.

L3: Stony plain with scattered to Low Open Woodland mulga *Acacia aneura* and *A. pruinocarpa* over Tall Open Shrubland *A. tetragonophylla* and *A. victoriae* over scattered *Eremophila forrestii*. The condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. There was some evidence of disturbance by cattle.

L4: Stony plain with gilgai in patches with Tall Open Shrubland snakewood *Acacia xiphophylla* over Low Shrubland including *Sclerolaena bicornis*, *Maireana* sp., *Senna artemisioides* subsp. *oligophylla* and *S. artemisioides* subsp. *helmsii*. Tussock grasses on gilgai (dormant). The condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. There was some evidence of disturbance by cattle.

L5: Creek lines, well defined with clay banks and sandy riverbeds. Low Open Forest to Low Woodland *Eucalyptus victrix* and *Acacia coriacea* subsp. *pendens* with *Atalaya hemiglauca*, Mulga *Acacia aneura*, *A. pruinocarpa* and occasional *Corymbia flavescens*. The condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. There was widespread evidence of disturbance by cattle.

L1: Turee LS with stony plains interspersed with gilgai.

L1: Turee LS with patches of gilgai with tussock grasses (dormant).

L2 Turee LS with Low Open Forest Mulga *Acacia aneura* along poorly defined and often broad drainage lines.

L3 Turee LS on stony plains with scattered to Low Open Woodland Mulga *Acacia aneura*.

L4 Turee LS stony plains with Snakewood *Acacia xiphophylla*.

L4 Turee LS Tall Open Shrubland Snakewood *Acacia xiphophylla* with patches of gilgai and tussock grasses.

L5 Turee LS creeks with defined drainage tracts and sandy, cobbly riverbed soils with *Eucalyptus victrix* and *Acacia coriacea* subsp. *pendens*.

M: Jamindie Land System

M1: Plains with non-cracking clay and groves and inter-groves of mulga *Acacia aneura*. Groves irregular or arranged perpendicular to sheetflow in small regular foci. Groves with clay soil surface and a Low Open Forest of mulga *Acacia aneura* over tussock grasses (dormant). Inter-groves have clay soil with a stony mantle and a scattered to Low Open Woodland of mulga *A. aneura* and *A. pruinocarpa* over scattered low shrubs. Associated species include *Psydrax latifolia* and *Senna glutinosa* subsp. *glutinosa*. Condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey. Minimal disturbance was observed.

M2: Creek line, well-defined flow line with clay soil on banks and bed. The vegetation was a Low Open Forest *Eucalyptus victrix*, *Acacia aneura*, *A. pruinocarpa* and *Atalaya hemiglauca* over mixed shrubs typically of *Grevillea wickhamii*, *Psydrax latifolia*, *Acacia pyrifolia, A. tetragonophylla*, *Tephrosia rosea*, *Indigofera monophylla* and *Hybanthus aurantiacus* and scattered hummock grass *Triodia epactia* (soft spinifex). Condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey.

M3: Creek line, minor often with poorly defined flow line and clay soil. The vegetation was a Low Open Forest of mulga *Acacia aneura* and *A. pruinocarpa* over Low Open Shrubland of *Eremophila forrestii* and *Senna glutinosa* subsp. *glutinosa*. Condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey.

M1 Jamindie LS plains with Mulga *Acacia aneura* showing groves (areas with clay surface) and intergroves (stony mantle).

M1 Jamindie LS Mulga intergroves with clay soils and a stony mantle scattered to Low Open Woodland of Mulga *A. aneura* and *A. pruinocarpa* over scattered low shrubs.

M2 Jamindie LS moderately well defined flow line with clay banks and bed with Low Open Forest *Eucalyptus victrix*, *Acacia aneura*, *A. pruinocarpa* and *Atalaya hemiglauca* over mixed shrubs.

M3 Jamindie LS Creek line, minor often with poorly defined flow line and clay soil with a Low Open Forest of Mulga *Acacia aneura* and *A. pruinocarpa* over Low Open Shrubland of *Eremophila forrestii*.

N: Newman Land System

N1: Ironstone ranges crests, breakaways and scree slopes with shallow or stony soil and outcroppings. Vegetation Low Open Woodland snappy gum *Eucalyptus leucophloia* over scattered *Hakea chordophylla* and *Grevillea wickhamii*, *Acacia* spp. and *Senna glutinosa* subsp. *glutinosa* and *Corchorus* sp. over Hummock Grassland *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) (hard spinifex). Very Open Tussock Grassland of *Cymbopogon ambiguus* on breakaways and Hummock Grassland *Triodia epactia* in patches and below breakaways (Plates 21 and 22). This vegetation was in Excellent to Pristine condition.

N2: Major creek with clay banks and sandy and pebbly river bed soils. The vegetation typically consisted of a Low Open Woodland *Eucalyptus victrix* over shrubs typically *Petalostylis labichioides* and *Grevillea wickhamii* over Open Hummock Grassland *Triodia epactia* (soft spinifex). Condition was difficult to assess, as the herbaceous groundcover was dormant at the time of the survey.

O: McKay Land System

O1: Mosaic of mesas, hills, plains and minor drainage on a plateau, ironstone with skeletal, stony soils. The vegetation was typically scattered snappy gum *Eucalyptus leucophloia* and patches of mulga *Acacia aneura* over scattered shrubs typically of *Hakea chordophylla*, *Acacia* spp., *Tribulus suberosus*, *Ptilotus calostachyus* and *Goodenia stobbsiana* over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) and some *T. wiseana* on slopes (hard spinifex). Gentle, low hills often have *Triodia epactia* (soft spinifex), particularly towards the western extent of this land system. Minor drainage channels were similar in vegetation composition but with shrub strata typically of *Petalostylis labichioides*, *Corchorus* sp. and *Santalum lanceolatum*. This vegetation was in Excellent to Pristine condition.

O2: Major creek lines with clay loam flood banks and a sandy and pebbly river bed. The vegetation was typically a Low, to Low Open Woodland of *Eucalyptus victrix* in the riverbed and bloodwood *Corymbia hamersleyana* on the flood-out areas. There was a Shrubland including *Petalostylis labichioides*, *Grevillea wickhamii*, *Acacia pyrifolia*, *A. tumida*, *A. maitlandii* and *Acacia* spp. over tussock grasses, which were mainly dormant but included *Chrysopogon fallax*, *Cymbopogon ambiguus* and *Eriachne tenuiculmis* and scattered hummock grasses *Triodia epactia* (soft spinifex) or *T. longiceps* (hard spinifex). Similar to major creeks in D: Newman Land System. Condition was difficult to assess as herbaceous groundcover was dormant at the time of the survey. There was little evidence of cattle.

N1 Newman LS Ironstone hill crest with Low Open Woodland Snappy Gum *Eucalyptus leucophloia* over Hummock Grassland *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835).

N1 Newman LS breakaway with Low Open Woodland of Snappy Gum *Eucalyptus leucophloia* over Very open Tussock Grassland of *Cymbopogon ambiguus* and Hummock Grassland of *Triodia epactia*.

N2 Newman LS Major creek with a Low Open Woodland *Eucalyptus victrix* over shrubs and Open Hummock Grassland *Triodia epactia*.

O1 McKay LS mesas, hills, plains and minor drainage on a plateau. Snappy Gum *Eucalyptus leucophloia* over *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) in the east and *T. epactia* in the west.

O1 McKay LS mesa with scattered Snappy Gum and patches of Mulga *Acacia aneura* over Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835)

O2 McKay LS major creekline with *Eucalyptus victrix* in the river bed and Bloodwood *Corymbia hamersleyana* on the flood out areas over mixed shrublands and hummock and tussock grasslands.

P: Rocklea Land System

P1: Basalt hills and outcrops with stony soils. The vegetation consisted of Tall Open Shrubland of kanji *Acacia inaequilatera* over Hummock Grassland *Triodia wiseana* (hard spinifex) and Open Tussock Grassland *Cymbopogon ambiguus*. Bloodwood *Corymbia hamersleyana* occurred in minor, stony drainage lines and lower in the landscape. The vegetation was in Excellent to Pristine condition.

P1 Rocklea LS Basalt hills with Tall Open Shrubland of Kanji *Acacia inaequilatera* over Hummock Grassland *Triodia wiseana*.

With regard to vegetation condition in the areas described above, condition generally reflects the degree of grazing and weed invasion in an area and lower areas tend to be in poorer condition than higher areas in the landscape. While the condition of the vegetation has been noted for most land systems, a limited condition assessment only was possible during the most recent APM (2010) survey of the more southerly land systems, due to the extremely dry conditions leading up to the time of the survey. Herbaceous species were dormant, including buffel grass **Cenchrus ciliaris*. The extent of this species is one of the most significant factors in determining the condition of creeks and other low-lying areas in the Pilbara. Its dormancy made an assessment of the condition of low-lying areas difficult. However, upland areas were generally in Excellent to Pristine condition, with very localised areas of disturbance.

8.8.3 Flora and vegetation of conservation significance

Threatened and priority ecological communities

Two Threatened Ecological Communities (TECs) listed under the Western Australian *Wildlife Conservation Act 1950* (DEC 2006) and 29 Priority Ecological Communities (PECs) (DEC, 2010) May 2010) are known from the Pilbara region. No Commonwealth TECs are listed for the Pilbara under the EPBC Act (DEWHA 2010).

A search of DEC TEC database revealed that no known occurrences of TECs were within or immediately adjacent to the 2km rail environmental approval corridor. A search of the DEC PEC database indicated that a section of PEC 17: Fortescue Marsh occurs within the 30 km local reference corridor but not within the 2km environmental approval corridor or the 200 m disturbance corridor. PEC 21: Five plant assemblages of the Wona Land System occur as a mosaic with the Rocklea Land System (Figure 8-1) in the Chichester Range. These occurrences are arranged in an intermittent, linear east to west band. The 30 km local reference corridor intersects a small area of the Wona Land System, however the 2 km environmental approval and the 200 m construction disturbance corridor do not intersect any of the mapped areas of the Wona Land System.

The Wona Land System is composed of basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands (Payne 2004). Of concern 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).

The Wona Land System is not susceptible to erosion except if the stony mantle is removed, such as along tracks on sloping plains (Payne 2004).

Within the gilgai plains there are at least four community types:

- annual sorghum grasslands on self-mulching clays (very rare: Pannawonica-Robe valley end of Chichester Range);
- 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* sp.) after rain (uncommon).

As the Wona Land System and associated PEC do not occur within or close to the 2 km environmental approval corridor it will not be disturbed by the project.

Vegetation communities

Biota (2004a) defined and classified the terrestrial vegetation of the Hope Downs and FMG rail corridors into distinct types. Those distinct types were then further classified into subtypes on the basis of structure and species composition of the dominant strata and landform. These rail corridors are sometimes close to or even coincident with the northern section (to Ch 195) of the 2 km environmental approval corridor.

Vegetation types of conservation significance that potentially occur within the northern section of the 2 km environmental approval corridor, and which were considered by Biota (2004a) to be of highest conservation significance, are listed in Table 8-6.

This is a preliminary assessment of the significance of the vegetation of northern section of the 2 km environmental approval corridor that cross the areas previously mapped by Biota. It is probable that at least some of these units occur in the areas of the 2 km environmental approval corridor that are adjacent to but not coincident with the corridors mapped by Biota.

The cracking clays associated with the Wona Land System support mixed tussock Grassland on the low-lying flats/plains. Biota (2002a) identified two unusual cracking clay vegetation types that it considered to be conservation significant and probably uncommon in the region. These were *Acacia victoriae* Shrubland over *Aristida latifolia*, *Cymbopogon ambiguous* Grassland on hillcrest and *Astrebla pectinata*, *Aristida latifolia* Grassland. As the Wona Land System does not occur within the 2 km environmental approval corridor or the 200 m disturbance corridor these vegetation units will not be impacted.

Biota (2004b) mapped FMG Stage B Rail Corridor, Christmas Creek, Mt Lewin, Mt Nicholas and Mindy Mindy Mine areas. A small section of the corridor Biota mapped coincides with the 2 km wide environmental approval corridor. Biota (2004b) identified eight vegetation units as having very high or high conservation significance following analysis of the results of its survey of this corridor and these are detailed in Table 8-7.

Mulga community distribution through the Pilbara land systems has been well defined by Payne (2004). The mulga communities of the Chichester Range represent the northern limit of mulga in Western Australia. Mulga dominated land systems that are crossed by the rail corridor are the Jamindie and Turee Land Systems.

‘Mulga’ can refer to the large shrub Acacia aneura and its variants, or vegetation communities where A. aneura is the dominant overstorey species (‘mulga’ communities). Mulga communities tend to develop complex genetic variations that occur within and between populations (Miller, Andrew & Maslin 2002). Mulga can form groves across hill slopes, forming intergroves that trap overland flow and leaf litter and creating a more hospitable environment for seed germination and seedling establishment (Burnside et al. 1995). Groves typically develop higher plant and animal diversity and accumulate higher levels of organic carbon and nitrogen than the intergroves (Tongway & Ludwig 1989). Mulga is also drought-resistant and can aestivate (remain dormant) during long periods of low rainfall and resume growth four days after water becomes available (Miller, Andrew & Maslin 2002).

Biota (2004b) indicate that many of the mulga vegetation units in the area could be viewed as conservation significant because they appear to be restricted to that section of the Fortescue Valley.

Table 8-6: Vegetation types of highest conservation significance occurring within the northern section of the 2 km environmental approval corridor

Significance	Vegetation	Vegetation mapping code	Location	Location within 2 km environmental approval corridor
Highest	Vegetation dominated by *Triodia* aff. *lanigera* (dwarf form) on the Abydos Plain	Ah5a[b]	Abydos Plain	A polygon of this vegetation unit was mapped by Biota on the eastern edge of the corridor close to Ch 40, north of the Turner River
Highest	*Tripogon loliiformis* grasslands and *Bulbostylis burbidgeae* sedgelands of granite outcrops	Ar3[b] and Ar4[b]	Abydos Plain	Areas of vegetation units Ar3 and Ar4 have been mapped within the 2 km environmental approval corridor close to Ch 76 (in the vicinity of Chinnamon Creek), Ch 109, Ch 115 and Ch 188
Highest	Three vegetation types of granite ridges, quartz ridges and dolerite dykes	Ar5[b], Ar6[a] and Ar7[b]	Abydos Plain	None of these sites occur within the sections of the 2 km environmental approval corridor that overlap the previously mapped areas
High	*Triodia epactia*, *T. secunda* mid-dense hummock grassland	Apt1[a] and Apt 2[b]	Abydos Plain	This unit occurs within the 2 km environmental approval corridor and close to Ch 57, 90 and 175
High	*Triodia angusta* mid-dense hummock grassland	Apt5[b]	Abydos Plain	This unit occurs within the 2 km environmental approval corridor and close to Ch 78
High	*Acacia ampliceps* over *Triodia secunda*	Ac21[b]	Abydos Plain	This unit occurs within the 2 km environmental approval corridor and close to Ch 86

[a] these vegetation units occur on Uaroo Land System; [b] these vegetation units occur on the Uaroo, Mallina, Talga, Macroy, Boolaloo, Oakover and Granitic Land Systems

The Fortescue Marsh saltbush community and perennial grassland communities in the Fortescue Valley are listed among 'ecosystems at risk' in the Fortescue Plains (PIL2) sub-region (Kendrick 2001). The saltbush community is known to be threatened by grazing pressure and changed hydrology, while the perennial grasslands are threatened by grazing pressure, feral animals and soil erosion (Kendrick 2001). Samphire ecosystems are a high priority for preservation in the Fortescue (PIL2) sub-region, and are thought to be an important fauna habitat.

At its closest point the southern boundary of the 2 km environmental approval corridor is approximately 2.5 km from the Geoscience Australia boundary of the Marsh.

Table 8-7: Vegetation types of highest conservation significance occurring within the southern section of the 2 km environmental approval corridor

Significance	Vegetation	Vegetation mapping code	Location	Location within 2 km environmental approval corridor
Very high	*Acacia aneura* low open forest over *Chrysopogon fallax* very open tussock grassland over *Centipeda minima* herbland and open annual grassland	Fa10	Fortescue Valley	This unit was associated with the Washplain Land System which is not intersected by the 30 km reference corridor, the 2 km environmental approval corridor or the 200 m construction disturbance corridor. It is therefore unlikely that it occurs within the 2 km environmental approval corridor.
High	*Acacia aneura* open scrub to low open forest over *Dodonaea petiolaris*, *Eremophila forrestii* subsp. *forrestii*, *Cassia helmsii*, *Sida* sp. unisexual open heath with very open annual grassland	Fa1	Fortescue Valley	This unit was associated with the Boolgeeda, Jamindie, Turee and Washplain Land Systems. Biota mapped it within the corridor at Ch 284/287and it is possible that it will occur in other places within the 2 km environmental approval corridor as it traverses the Jamindie and Turee Land Systems
High	*Acacia aneura* low open forest over *Chrysopogon fallax*, *Digitaria brownii* open tussock grassland	Fa13	Fortescue Valley	This unit was associated with the Jamindie Land System. Biota mapped it within the corridor at Ch 309 and it is possible that it will occur in a number of places within the 2 km environmental approval corridor as it traverses the Jamindie Land System
High	*Acacia aneura*, *A. rhodophloia* low closed forest over *Eremophila forrestii* subsp. *forrestii*, *Indigofera georgei* low open shrubland over *Themeda trianadra*, *Digitaria brownii* open tussock grassland and annual grasses	Fa18	Fortescue Valley	This unit was associated with the Jamindie, Land System and, while not occurring within the section of the corridor that is coincident with that mapped by Biota, it is possible that it will occur in the 2 km environmental approval corridor as it traverses the Jamindie Land System

Significance	Vegetation	Vegetation mapping code	Location	Location within 2 km environmental approval corridor
High	*Acacia aneura*, low woodland over *A. rhodophloia* high shrubland over *Eremophila forrestii* subsp. *forrestii, Dodonaea petiolaris, Sida* sp.unisexual open shrubland over open grassland	Fa19	Fortescue Valley	This unit was associated with the Washplain Land System and it is unlikely that it will occur in the 2 km environmental approval corridor as it does not cross this land system
High	*Acacia catenulata*, *A. aneura* low open forest over *Eremophila forrestii* subsp. *forrestii*, *Sida* sp. unisexual open shrubland with open annual grassland	Fa20	Fortescue Valley	This unit was associated with the Boolgeeda and Washplain Land Systems and it is unlikely that it will occur in the 2 km environmental approval corridor as it does not cross these land systems
High	*Acacia aneura* low open woodland over *Themeda triandra* open tussock grassland and *Eragrostis leptocarpa*, *E. tenellula* annual grassland	Fa25	Fortescue Valley	This unit was associated with the Boolgeeda and Washplain Land Systems and it is unlikely that it will occur in the 2 km environmental approval corridor as it does not cross these land systems
High	*Acacia aneura*, *A. catenulata* tall open shrubland over *Aristida inaequiglumis, A. contorta* grassland	Fa27	Fortescue Valley	This unit was associated with the Washplain Land System and it is unlikely that it will occur in the 2 km environmental approval corridor as it does not cross this land system

Flora

Declared Rare Flora (DRF) are flora that have been adequately surveyed and are considered to be in danger of extinction, rare or otherwise in need of special protection within Western Australia. DRF are protected under the *Wildlife Conservation Act 1950* (as amended). Most DRF are also listed as Threatened Species under the EPBC Act 1999.

The DRF species *Lepidium catapycnon* is known from the Newman Land System, and while the study area is north of its main range, there is a small chance that this species may be present. DRF have a relatively high level of protection under the *Wildlife Conservation Act 1950*. There is only one other known DRF species in the Pilbara: *Thryptomene wittweri*. This species is only known from the southern extremity of the Pilbara, and is not likely to occur in the study area. *L. catapycnon* and *T. wittweri* are also protected as Threatened Species under the EPBC Act.

Additionally, four categories of Priority Flora are described in Western Australia. Priority 1 to 3 are poorly known flora and require more information in order to be assessed for inclusion as DRF. A fourth category (Priority 4) is for those species that have been adequately surveyed and are considered to be rare but not currently threatened. Priority Flora lists are maintained by the DEC's Threatened Species and Communities Branch and the most up-to-date rankings are published on FloraBase (Western Australian Herbarium, 2010). Priority Flora have limited specific protection, however there are general 'prevention of extinction' clauses and precautionary principles which apply to the conservation of Priority Flora species under the *Wildlife Conservation Act 1950* and *Environmental Protection Act 1986*.

A search of the DEC Threatened (Declared Rare) Flora database (these records are accurate and verified), Declared Rare and Priority Flora List and the Western Australian Herbarium Specimen database (these records are not always accurate and verified) was conducted in February 2010 for the broader study area and encompassing the corridors. No Declared Rare Flora (DRF) records for any of the corridors resulted from the database searches. Twenty-three Priority Flora records were identified within the 30 km local reference corridor (ten Priority 1, three Priority 2, seven Priority 3 and three Priority 4). Four Priority Flora records were identified in the 2 km environmental approval corridor (one Priority 1, one Priority 3 and two Priority 4) Biota (2002, 2004a and b), Astron (2008) and Ecologia (2009a) recorded numerous Priority Flora species in surveys carried out in the vincinity of the RHI Railway, Table 8-8 lists these species, Figure 8-3 illustrates the location of these species. No records were listed within the 200 m construction disturbance corridor.

Biota (2002a and b, 2004a and b), Astron (2008) and Ecologia (2009a) recorded numerous Priority Flora species in surveys carried out in the vicinity of the RHI Railway. Table 8-9 lists these species. Thirteen of the 23 Priority Flora species in this table are additional to those produced by the database searches.

Table 8-8: DEC and WAHERB records of Priority flora within the 30 km reference and 2 km environmental approval corridors for the proposed alignment *

Priority rank	Name	DEC or WAHERB record in 30 km local reference corridor	DEC or WAHERB record in 2 km environmental approval corridor
1	*Abutilon pritzelianum*	WHB	
1	*Acacia leeuweniana*	DEC&WHB	
1	*Eremophila spongiocarpa*	DEC&WHB	
1	*Heliotropium muticum*	WHB	WHB
1	*Nicotiana heterantha*	DEC&WHB	
1	*Peplidium* sp. Fortescue Marsh (S van Leeuwen 4865)	DEC&WHB	
1	*Ptilotus appendiculatus* var. *minor*	WHB	
1	*Tecticornia* sp. Christmas Creek (KA Shepherd & T Colmer et al. KS)	WHB	
1	*Tecticornia* sp. Fortescue Marsh (KA Shepherd et al. KS 1055)	DEC&WHB	
1	*Tephrosia rosea* var*. venulosa* ms	WHB	
2	*Euphorbia clementii*	DEC	
2	*Gomphrena pusilla*	WHB	
2	*Stylidium weeli wolli*	WHB	
3	*Acacia levata*	WHB	
3	*Eremophila forrestii* subsp. *viridis*	WHB	
3	*Gymnanthera cunninghamii*	DEC&WHB	DEC&WHB
3	*Nicotiana umbratica*	WHB	
3	*Polymeria distigma*	WHB	
3	*Rhagodia* sp. Hamersley (M Trudgen 17794)	WHB	
3	*Tecticornia* sp. Roy Hill (H Pringle 62)	WHB	
4	*Bulbostylis burbidgeae*	DEC&WHB	DEC&WHB
4	*Eremophila youngii* subsp. *lepidota*	WHB	
4	*Goodenia nuda*	DEC&WHB	WHB

* No DEC or WAHB Priority flora records occur within the 200m disturbance corridor

Table 8-9: Priority flora recorded during other surveys within or in the vicinity of the 2 km environmental approval corridor for the proposed alignment.

Priority rank	Name	B1	B2	B3	A1	E1	DEC/ WAHERB above?
1	*Eremophila pilosa*			x			No
1	*Eremophila spongiocarpa*		x				Yes
1	*Josephinia* ?sp. Marandoo (ME Trudgen 1554)		x				No
1	*Stemodia* sp. Battle Hill (A.L. Payne 1006)				x		No
2	*Euphorbia clementii*	x	x				Yes
2	*Indigofera ixocarpa*	x	x				No
2	*Paspalidium retiglume*		x				No
2	*Stylidium weeliwolli*		x				Yes
2	*Vigna* sp. Central (M.E. Trudgen 1626)				x		No
3	*Acacia glaucocaesia*			x		x	No
3	*Atriplex flabelliformis*				x		No
3	*Gymnanthera cunninghamii*	x	x				Yes
3	*Iotaspermum sessilifolium*				x		No
3	*Phyllanthus aridus*	x	x				No
3	*Polymeria* sp. Hamersley (M.E.Trudgen 11353)		x	x		x	Yes
3	*Rhagodia* sp. Hamersley (M. Trudgen 17794)			x		x	Yes
3	*Rostellularia adscendens* var. *latifolia*			x		x	Yes
3	*Swainsona* sp. Hamersley Station (A. A. Mitchell 196)				x		No
3	*Themeda* sp. Hamersley Station	x	x	x			No
4	*Bulbostylis burbidgeae*	x	x				Yes
4	*Eremophila youngii* subsp. *lepidota*		x			x	Yes
4	*Goodenia nuda*	x	x	x		x	Yes
4	*Ptilotus mollis*				x		No

Where B1, B2 and B3 = Biota 2002, 2004a, 2004b; A1 = Astron 2009; E1 = Ecologia 2009.

8.8.4 Weeds

A weed is defined in the Australian Weeds Strategy (DEWR 2007a) as ‘a plant which has, or has the potential to have, a detrimental effect on economic, social or conservation values’. Weeds can include species that have proliferated in bushland without direct human intervention or assistance (referred to as naturalised alien species).

Weeds that are pests or have the potential to become pests are formally declared under the *Agriculture and Related Resources Protection Act 1976* (ARRP Act). Declared Plants are subject to five priority groupings (P1, P2, P3, P4 or P5) and standard control codes outlining requirements for their control. Landholders are obliged to control Declared Plants at their own expense, and are encouraged to follow the standard control codes.

Eighty-five Declared Plants are listed as potentially occurring in the East Pilbara, and 86 in the Port Hedland and Ashburton regions (DAF, 2007). One has been found in the vicinity of the RHI Railway area during previous surveys—*Opuntia stricta* (Biota, 2002a)—and one was recorded during a baseline survey of the vegetation at the Roy Hill project area—*Parkinsonia aculeata* (Ecologia, 2009b).

The 29 weed species that have been found within or in the vicinity of the 30 km local reference corridor and at the Roy Hill project area are listed in Table 8-10. Two of these species are Declared Plants under the ARRP Act for the Ashburton, East Pilbara and Port Hedland regions. While not declared species in the Ashburton, East Pilbara and Port Hedland regions the remaining environmental weeds can pose a risk to local flora and fauna and as such will need to be carefully managed to prevent their proliferation.

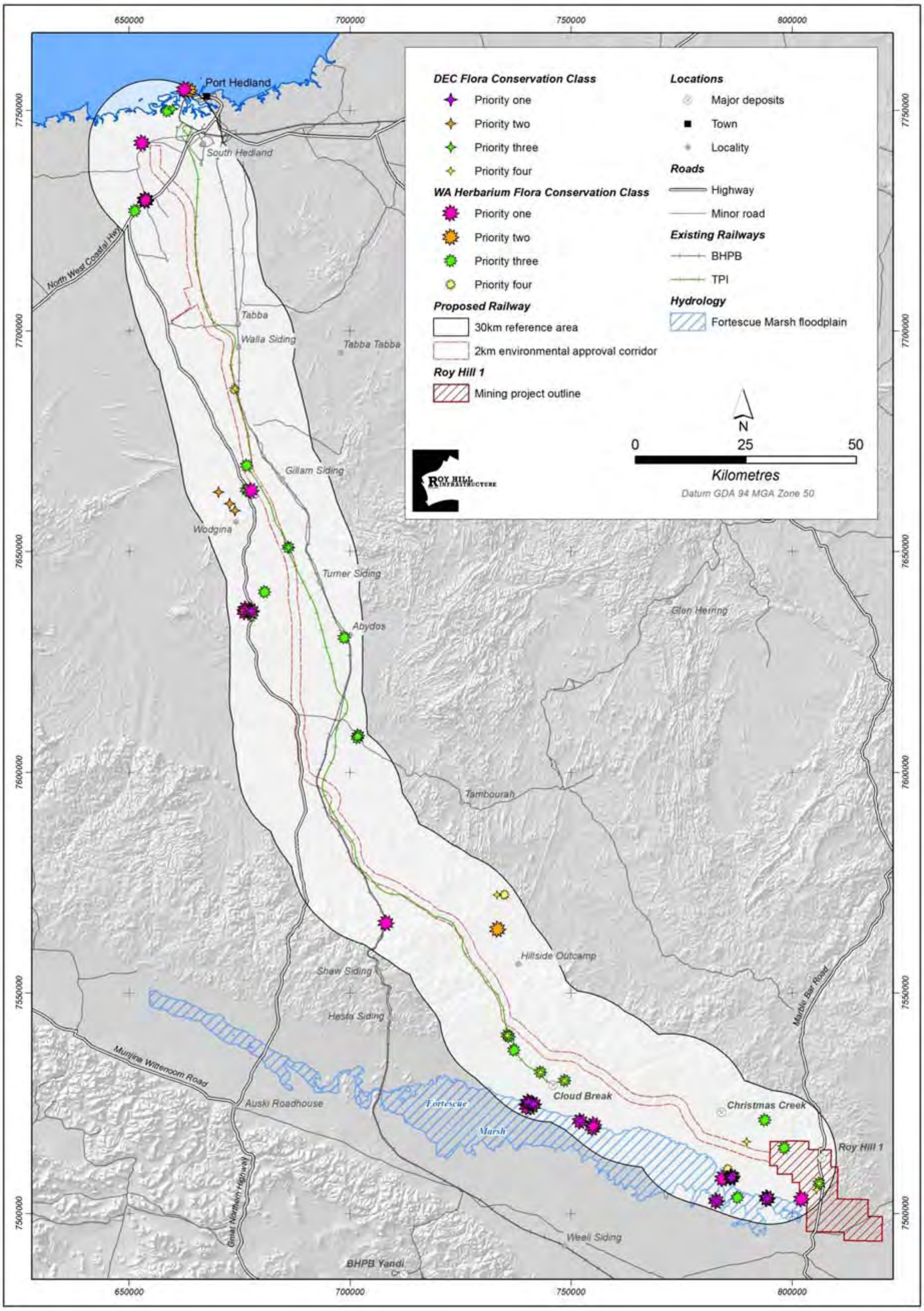

Figure 8-3: Priority Flora occurring within the 30 km reference corridor

Table 8-10: Weed species recorded within or in the vicinity of the 30 km reference corridor and at Roy Hill during previous surveys.

Scientific name	Common name	Information sources ¥			
		1	2	3	4
**Opuntia stricta* - DECLARED PLANT	Common prickly pear	X			
**Parkinsonia aculeata* – DECLARED	Parkinsonia, Jerusalem thorn				X
**Acetosa vesicaria*	Ruby dock			X	
**Aerva javanica*	Kapok	X	X	X	X
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican poppy	X		X	X
**Bidens bipinnata*	Beggar's ticks	X	X	X	X
**Cenchrus ciliaris*	Buffel grass	X	X	X	X
**Cenchrus setigerus*	Birdwood grass	X	X	X	
**Chloris virgata*	Windmill grass		X	X	X
**Citrullus colocynthis*	Cucurbid creeper/colocynth	X	X	X	X
**Citrullus lanatus*	Afghan melon, Pie melon, Wild melon				X
**Cucumis melo* subsp *agrestic*	Ulcardo melon	X			X
**Cymbalaria muralis*	Ivy-leafed toadflax				X
**Datura leichhardtii*	Native thornapple		X		
**Echinochloa colona*	Awnless barnyard grass	X		X	X
**Eragrostis cilianensis*	Stinkgrass				X
**Eragrostis minor*	Smaller stinkgrass	X			
**Euphorbia hirta*	Asthma plant	X			
**Heliotropium europaeum*	Common heliotrope				X
**Malvastrum americanum*	Spiked malvastrum	X	X	X	X
**Portulaca oleracea*	Purslane				X
**Setaria verticillata*	Whorled pigeon grass	X	X	X	X
**Sigesbeckia orientalis*	Indian's weed	X		X	
**Solanum nigrum*	Black berry nightshade	X	X		

Scientific name	Common name	Information sources ¥			
		1	2	3	4
**Sonchus oleraceus*	Common sowthistle	X		X	X
**Stylosanthes hamata*	Low perennial pea	X	X		
**Trianthema portulacastrum*	Giant pigweed				X
**Tridax procumbens*	Tridax	X			
**Vachellia farnesiana*	Needle bush				X

¥ Information sources: 1 – Biota 2002, 2 – Biota 2004a, 3 - Biota 2004b, 4 – Ecologia 2009.

8.9 Fauna

8.9.1 Surveys along or adjacent to RHI Railway

Table 8-11 summarises the previous fauna surveys conducted along or in the vicinity of the Roy Hill Infrastructure railway and is summarised in the report Ecological survey comparative analysis (Appendix A). The surveys in Table 8-11 have been extensively consulted during the preparation of this referral document.

Table 8-11: Previous Fauna surveys undertaken to date along or in the vicinity of the RHI railway

Survey	Project	Summary
Biota (2002b)	Hope Downs Railway	Surveys, description and assessment of fauna along the length of the proposed Hope Downs rail corridor from Port Hedland to Weeli Wolli Creek.
Biota (2004a)	FMG Stage A Railway	Surveys, description and assessment of fauna along the length of the FMG Stage A Railway using results from the Hope Downs rail corridor and additional surveys.
Environ (2005)	FMG Stage B Railway	Surveys, description and assessment of fauna along the length of the FMG Stage B rail corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas mine areas.
Davis et al. (2005)	Cloudbreak mine	Surveys, description and assessment of fauna at Cloudbreak Mine site.
Harvey (2006)	Cloudbreak Mine	SRE survey within the Cloudbreak region.
Ecologia (2008a)	BHPBIO RGP5 Railway	Level 2 surveys, description and assessment of fauna along the Chichester deviation of the RGP5 railway.

Survey	Project	Summary
Ecologia (2008b)	BHPBIO RGP5 Railway	SRE and targeted survey for the trapdoor spider *Aurecocrypta* sp. along the Chichester deviation of the RGP5 railway.
Ecologia (2008c)	HPPL Roy Hill Mine	Supplementary level 1 survey, description and assessment of fauna at the RHIO mine and associated infrastructure.
Ecologia (2009b)	HPPL Roy Hill Mine	Surveys, description and assessment of fauna at the RHIO mine and associated infrastructure.

Table 8-12 summarises the RHI funded fauna surveys near the RHI railway. Information given in this referral draws on investigations undertaken of various routes considered by RHI and studies and publications by other mining companies and Government. Many of these reports have been referenced for this environmental referral document.

Table 8-12: Fauna surveys undertaken by RHI along or in the vicinity of the Roy Hill Infrastructure railway

Survey	Project	Summary
SMEC (2009a)	RH Mine Stage 1	Roy Hill 1 Iron Ore Mining Project Subterranean Fauna Assessment – Final Report: Boreholes sampled (March & May 08. P2 Aug Oct 08, P3 March May 09)
SMEC (2009b)	RH Mine Stage 2	Roy Hill 1 Iron Ore Mining Project Subterranean Fauna Assessment – Stage 2 Addendum: No surveys just commentary on longer life of mine
APM, Mar 2010(b)	Railway Options 3a and 3b	Fauna Risk Assessment for Roy Hill Iron Ore Pty Ltd Proposed Routes 3a and 3b Railway Corridors, desktop assessment.
APM, Aug 2009	Railway - Southern Option	Fatal Flaws Assessment Desktop Assessment
APM, Mar 2010(b)	Railway – Northern Option	Fatal Flaws Assessment Desktop Assessment
APM (2009a)	Murrays Hill (MH to Cloud break Haul Rd Corridor)	Fatal Flaws Assessment Desktop Assessment
APM (2009b)	Borefield - Pipeline Corridor	Fauna, Vegetation and Flora Assessment – Desktop Assessment
APM (2010b)	Rail - BFS4F Alignment	Flora, vegetation, vertebrate and invertebrate fauna desktop biological assessment
Bennelongia (2009a)	RH Mine Stage 2 Borefield	Stygofauna & Troglofauna, desktop assessment
Bennelongia (2009)	RH Mine Stage 2 Borefield	Stygofauna, Level 2 sampling results from 3 sessions (22-24 July 2009, 3-4 Sept 2009, 7-9 Dec 2009)
Bennelongia (2010a)	Rail - BFS2 Option	Roy Hill Infrastructure Pty Ltd, Risk Assessment of Subterranean Fauna from the RH1 BFS2 Rail Option, subterranean fauna desktop assessment

Survey	Project	Summary
Bennelongia (2010b)	Rail - BFS2 Option	Roy Hill Infrastructure Pty Ltd, Risk Assessment to Invertebrate Short Range Endemics from the RH1 BFS2 Rail Option, desktop assessment of Short Range Endemics
Biota (2009)	Port – Boodarie	Boodarie Infrastructure Level 1 Flora, Vegetation and Fauna Survey, Port Hedland, surveyed 25 and 26 May 2009
Biota (2010)	Port - Boodarie	Boodarie Port Infrastructure, Port Hedland - Level 1 Vegetation and Flora Survey and Fauna Review, surveyed 12-15th January 2010
ENV (2010a)	Rail - southern alignment (s of Marsh)	Southern Rail Option Fauna Desktop Assessment, vertebrate fauna desktop assessment
ENV (2010b)	Roy Hill Stage 2 Borefield	Roy Hill Borefield Vertebrate Fauna Survey – Level 2, survey 22nd to 31 July 2009
Ecologia (2010a)	Roy Hill Stage 2 Borefield & Pipeline Corridor	Hancock Prospecting Pty Ltd Remote Borefield Pipeline Short Range Endemic Survey Report, Level 1 SRE survey
Ecologia (2009c)	Roy Hill Stage 2 Borefield	Roy Hill Iron Ore Project Proposed Roy Hill Borefield Desktop Fauna Survey, Vertebrate fauna desktop survey
Ecologia (2010b)	Roy Hill Stage 1 surrounding areas	*Ramphotyphlops ganei* habitat in areas surrounding Roy Hill tenements, targeted survey (following on from infrastructure areas survey), survey timing 11-January-2010 and 19 February-2010
Ecologia (2008d)	Roy Hill Stage 1 Rail Spurs	Roy Hill Iron Ore Northern and Southern Rail Spurs and Connections Desktop Survey
Ecologia (2006a)	Roy Hill Stage 1	Roy Hill Iron Ore Project Terrestrial Vertebrate Fauna Assessment, Level 2 vertebrate fauna PER/EIA survey, survey 7-21 November 2005; 3-18 May 2006
Ecologia (2006b)	Roy Hill Stage 1	Hancock Prospecting Pty Ltd Roy Hill Iron Ore Project Short Range Endemic Survey, survey timing 1-7 June 2006
Ecologia (2008e)	Roy Hill Stage 1	Hancock Prospecting Pty Ltd Roy Hill Iron Ore Project Short-Range Endemic Survey, SRE baseline survey, survey timing 1-7 June 2006
Ecologia (2009c)	Roy Hill Stage 1	Hancock Prospecting Pty Ltd Roy Hill Additional SRE Survey, Level 1 Survey , survey timing October 2008
Ecologia (2008f)	Roy Hill Stage 1	Hancock Prospecting Pty Ltd - Roy Hill Short-range Endemic Desktop Survey, Invertebrate fauna baseline desktop survey
Ecologia (2009d)	Roy Hill Stage 1 infrastructure areas	Roy Hill Iron Ore Project Proposed Infrastructure Supplementary Level 1 Terrestrial Vertebrate Fauna Survey, survey timing 16 to 22 September 2008 (infrastructure area); 17 to 24 Nov and 17 to 19 Nov respectively (southern rail spur and production bore field)

Survey	Project	Summary
Bamford Consulting (2010b)	Roy Hill Stage 1 infrastructure areas	Summary of Potential Short-range Endemics Species in the HPPL Roy Hill Area, survey timing May to July 2009
SMEC (2009a)	Rail	Review of risk to the Night Parrot *Pezoporus occidentalis* from the proposed Roy Hill Infrastructure Rail Route

8.9.2 Fauna habitats

The RHI Railway 200 m construction corridor intersects 15 land systems and the 2 km environmental approval corridor intersects 16 land systems (refer to Section 7.8.2), as described by van Vreeswyk et al. (2004). All of these land systems form, to varying degrees, fauna habitat. However, the habitat requirements of many species are not well known and potential distribution has therefore been interpreted with caution.

Several habitat types that are significant on a local scale and may support taxa of regional and national significance have the potential to be impacted by the RHI Railway. These include:

- Major drainage systems – these areas are species-rich and able to support an abundance of taxa which are usually strongly associated with this type of habitat (pers. comm. M. Ladyman, APM, March 2010). Some fish species are present in the creeks and remnant pools that flow into the northern edge of the Fortescue Marsh, a number of which are endemic to the bioregion (Terrestrial Ecosystems, 2010a).
- Mulga communities – mulga groves across hill slopes typically support higher plant and animal diversity (Tongway & Ludwig 1989).
- Self-mulching cracking clays – these areas comprise varying vegetation overlying deep cracking clays. This habitat type is strongly associated with a number of fauna species (Biota 2004a).
- Also within the vicinity of the project area, but not directly impacted, is the Fortescue Marsh/Flats – these comprise an extensive, episodically inundated samphire marsh system. Deeply incised gorge systems occur in the western part of the drainage area. River gum woodlands fringe the drainage lines. During periods of inundation, the Marsh supports significant waterbird-breeding activities and is currently listed as a Wetland of National Importance under the *Directory of Important Wetlands in Australia* (DIWA) (Kendrick 2001). The Marsh also supports a number of fauna of national significance (as defined by the *EPBC Act*) including the Grey Falcon (*Falco hypoleucos)* and the Night Parrot (*Pezoporus occidentalis*). However, the closest point to the Marsh along the 2 km environmental approval corridor is 2.5 km.

8.9.3 Vertebrate fauna

A search of the NatureMap database using a localised rectangular search showed 21 priority species (not including marine species) potentially occur within 15 km of the environmental approval corridor. These comprise species of eight birds, nine mammals (including three introduced species) and four reptiles. The NatureMap search results are included in Appendix E NatureMap Priority Fauna Species.

Little is documented regarding the vertebrate fauna ecology of the Fortescue Marsh and the associated hinterland. It is known that the marsh supports a large number of migratory wetland birds, particularly when it is full, but little is known of this avian fauna and how important the marsh is for the long-term persistence of species that are either Pilbara residents or visitors to the bioregion.

All available biological surveys conducted in the region in habitats similar to those that occur in the 2 km environmental approval corridor were reviewed to identify all significant species recorded in nearby surveys.

Native fauna species that are rare, threatened with extinction or have high conservation value are protected under the Commonwealth *EPBC Act* and under the *WC Act* in Western Australia. International agreements include the:

- Japan-Australia Migratory Bird Agreement 1974 (JAMBA);
- China-Australia Migratory Bird Agreement 1986 (CAMBA);
- Republic of Korea-Australia Migratory Bird Agreement 2007 (ROKAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

The *EPBC Act* provides for the protection of those aspects of the environment deemed to be matters of national significance. This includes provisions for the protection of native fauna species, and in particular, to prevent the extinction and promote the recovery of threatened species, and ensure the conservation of migratory species listed under international agreements. Existing species listed under the *EPBC Act* may be classified as:

- Critically endangered;
- Endangered;
- Vulnerable;
- Conservation dependent; and
- Migratory.

Migratory species listed as matters of national environmental significance (MNES) are also included in a number of international agreements including JAMBA, CAMBA and ROKAMBA. These agreements list terrestrial, water and shorebird species that migrate between Australia and the respective countries.

These agreements require the parties to protect migratory birds by:

- Limiting the circumstances under which migratory birds are taken or traded;
- Protecting and conserving Important habitats;
- Exchanging information; and
- Building cooperative relationships.

Fauna species that are considered rare, threatened with extinction or have a high conservation value are listed by the Minister in the *Government Gazette*. The current list of specially protected fauna was released 23 February 2010 under the *Wildlife Conservation (Specially Protected Fauna) Notice 2010*. Classification of gazetted fauna species recognises four schedules of taxa comprising:

- Schedule 1 – fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;
- Schedule 2 – fauna which are presumed to be extinct and are declared to be fauna in need of special protection;
- Schedule 3 – birds 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 under special protection; and
- Schedule 4 – fauna in need of special protection, otherwise than for reasons mentioned above.

DEC also produces a supplementary list of Priority fauna that are not listed under the WC Act, but for which DEC recognises there is some cause for concern. There are four classifications of Priority fauna comprising:

- Priority 1 – 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 considerations can be given to declaration as threatened fauna;
- Priority 2 – 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 3 – 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 which are not under imminent 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 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 not yet threatened.

Table 8-13 presents the results of searches of the DEC and EPBC databases for conservation significant fauna species potentially occurring within the 30 km local reference area and 2 km environmental approval corridor.

Two Priority 4 bird species records occur within the 2 km environmental approval corridor, the Star Finch and the Bush Stone-curlew. The remaining records are from the 30 km reference area. Six threatened species listed under the *EPBC Act* records were produced from the EPBC search (Night Parrot, Mulgara, Northern Quoll, Greater Bilby, Pilbara Leaf-nosed Bat and Olive Python), four migratory terrestrial species (White-bellied Sea Eagle, Barn Swallow, Rainbow Bee-eater, Night Parrot) and four migratory wetland species (Great Egret, Cattle Egret, Oriental Plover / Oriental Dotterel and Oriental Pratincole). Sixteen records were produced from the DEC database search of the 30 km local reference corridor, and eight of these species are listed under the *WC Act*. Two of the EPBC listed species are also listed under the *WC Act.* The source of each record in Table 8-13 is indicated in column six.

According to Bamford Consulting (2010) (Appendix F Fauna Risk Assessment) three additional conservation significant species could potentially occur within the 30km reference area – the Blind Snake (*Ramphotyphlops ganei*), the Grey Falcon (*Falco hypoleucos*) and the Long-tailed Dunnart (*Sminthopsis longicaudata*).

The locations of vertebrate fauna protected under Western Australian legislation in relation to the RHI Railway are shown in Figure 8-4.

Although the Night Parrot was captured in the DEC, EPBC and NatureMap database searches, the likelihood of encountering it is low. It has been recorded in a wide range of habitats but is possibly associated closely with the spinifex/samphire ecotone around seasonal wetlands such as the Fortescue Marsh (Higgins 1999), and such habitat lies outside the rail corridor. The only observation occurred in 2005 and was made approximately 13 km southwest of the closest point of the RHI Railway to the Marsh.

Desktop assessments of the risks and impacts to the species potentially occurring along the railway were undertaken by fauna specialists Bamford (2010) and Terrestrial Ecosystems (2010b). These assessments are included in Appendix F and Appendix G respectively.

Table 8-13: Conservation significant fauna potentially occurring along the proposed Roy Hill Infrastructure railway

Species		**Conservation status**			**Database**
Common name	**Scientific name**	**DEC List**	***EPBC Act***	***WC Act***	**search**
Australian bustard	*Ardeotis australis*	P4			DEC
Barn Swallow	*Hirundo rustica*		Migratory		EPBC
Bilby	*Macrotis lagotis*	Vulnerable	Vulnerable	Schedule 1	DEC, EPBC
Brush tailed mulgara	*Dasycercus blythi*	P4			DEC
Bush stone-curlew [¥]	*Burhinus grallarius*	P4			DEC
Cattle egret	*Ardea ibis*		Migratory		EPBC
Crest tailed Mulgara	*Dasycercus cristicauda*	Vulnerable	Vulnerable	Schedule 1	DEC, EPBC
Eastern Great Egret	*Ardea modesta*		Migratory		EPBC
Fork-Tailed Swift	*Apus pacificus*		Migratory		EPBC
Ghost bat	*Macroderma gigas*	P4			DEC
Lakeland downs mouse	*Leggadina lakedownensis*	P4			DEC
Little North-western Mastiff Bat	*Mormopterus loriae cobourgiana*	P1			DEC
Oriental dotterel / Oriental Plover	*Charadrius veredus*		Migratory		EPBC
Oriental Pratnicole	*Glareola maldivarum*		Migratory		EPBC
Night parrot	*Pezoporus occidentalis*	Critical	Endangered / Migratory	Schedule 1	DEC, EPBC
Northern quoll	*Dasyurus hallucatus*	Endangered	Endangered	Schedule 1	DEC, EPBC
Pebble-mound mouse	*Pseudomys chapmani*	P4			DEC
Peregrine falcon	*Falco peregrinus*	Specially Protected		Schedule 4	DEC
Pilbara leaf-nosed bat	*Rhinonicteris aurantius*		Vulnerable	Schedule 1	EPBC
Pilbara olive python	*Liasis olivaceus barroni*		Vulnerable	Schedule 1	EPBC
Rainbow bee-eater	*Merops ornatus*		Migratory		EPBC
Skink	*Ctenotus nigrilineatus*	P1			DEC
Spectacled hare-wallaby	*Lagorchestes conspicillatus leichardti*	P3			DEC
Star finch [¥]	*Neochmia ruficauda subclarescens*	P4			DEC
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		Migratory		EPBC
Woma python	*Aspidites ramsayi*	Specially Protected		Schedule 4	DEC

Note: [¥] Database record within the 2 km environmental approval corridor.

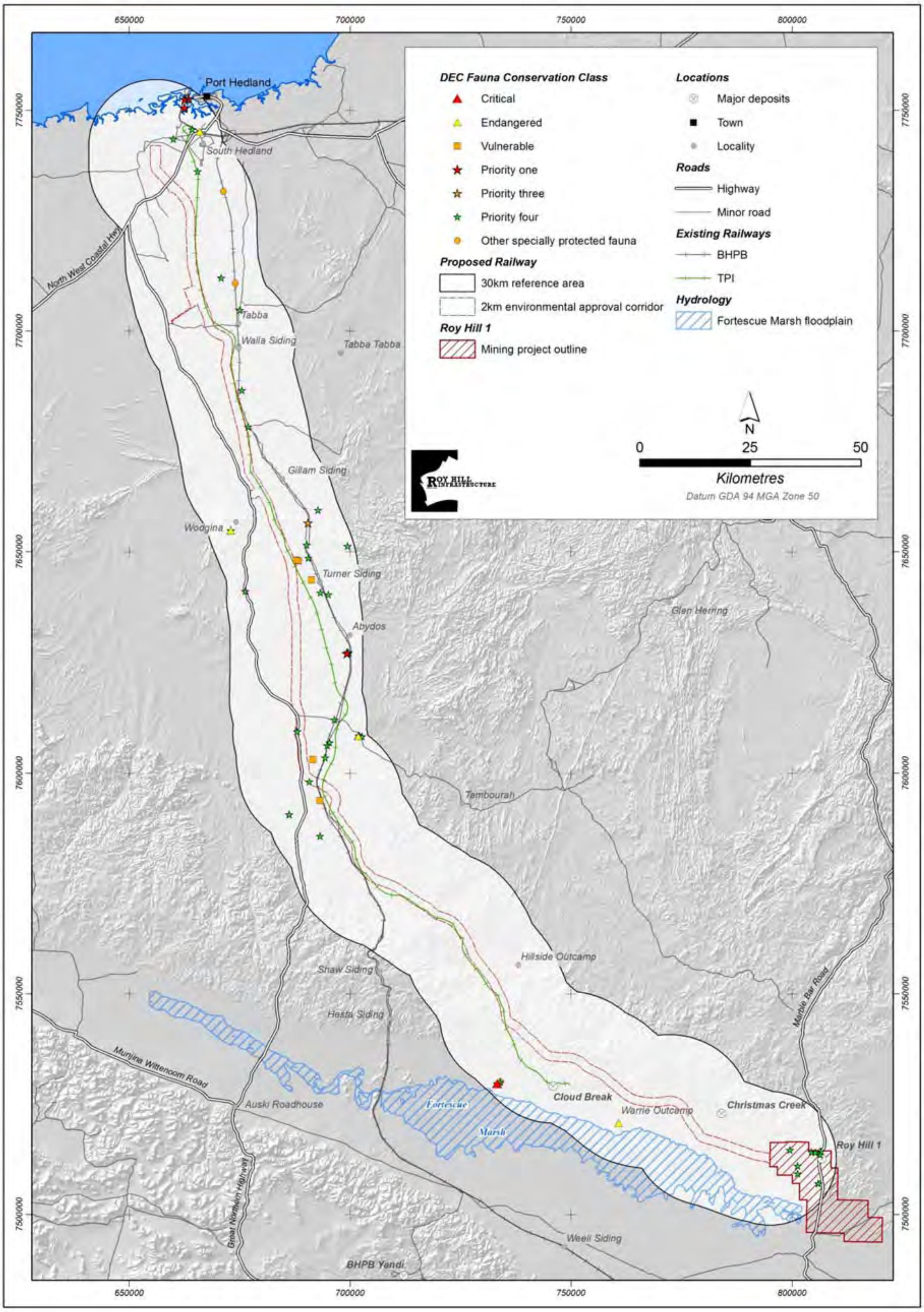

Figure 8-4: Threatened and Priority Fauna located within the 30 km reference area

8.9.4 Short-Range Endemic species

Short-range endemic (SRE) species are defined in EPA guidance statement no. 20 as 'terrestrial and freshwater invertebrates that have naturally small distributions of less than 10,000 km^2 (EPA 2009). The term SRE applies to highly-restricted invertebrate species belonging to specified groups, usually millipedes, mygalomorph spiders, pseudoscorpions, scorpions and land snails (Bennelongia 2010b) and, as a result of their restricted distribution, SRE species are vulnerable to extinction as a result of anthropogenic activities (Ponder & Colgan 2002). SREs also display the following characteristics:

- poor powers of dispersal;
- low rates of fecundity;
- confinement to discontinuous habitats; and
- highly seasonal activity patterns (Harvey 2002).
- A common characteristic of potential SRE habitat throughout Western Australia is their greater moisture-holding capacity compared with surrounding areas (Harvey 2002). In the Pilbara, potential SRE habitat is likely to be associated with south-facing rock faces and steep slopes, deep gorges and springs, rocky outcrops, and watercourses that have not been damaged by stock grazing or buffel grass invasion.
- There is a paucity of knowledge regarding SRE species composition and distribution within the Pilbara. Investigations into SREs have generally been carried out on a project-by-project basis and there is a lack of suitable reference collections and precise information regarding SRE species distribution and life histories.

Harvey (2002) identifies the invertebrate groups in the Pilbara most commonly containing SRE species as including mygalomorph spiders (Mygalomorphae) and millipedes and, less commonly Centipedes (Myriopoda), Scorpions (Scorpionida); Pseudoscorpions (Pseudoscorpionida), and Land snails (Gastropoda).

Harvey (2002) also indicates that, in some circumstances, earthworms (Oligochaeta) and slaters (Isopoda) will also contain SRE species and that SREs depend on discontinuous habitat, limited dispersal abilities, slow growth rates, and low fecundity – all of which render them vulnerable to disturbance.

RHI commissioned Bennelongia to conduct a desktop assessment of the risk to SRE fauna posed by the BFS2 route option (described in Section 3.3 Alternative Rail Routes). The BFS2 location remains relevant to the option being considered in this environmental referral. The report from Bennelongia (2010a) states that most SREs recorded in the vicinity of the RHI Railway have been collected in the Chichester Range and suggests that SREs occur predominantly in the Chichester Range rather than the adjacent Fortescue Valley. It is likely that the Chichester Range contains preferred SRE habitat.

In terms of the invertebrate groups in the Pilbara identified by Harvey (2002) as most commonly containing SRE species, Bennelongia (2010a) draws the following conclusions about possible SRE occurrence within areas traversed by the Roy Hill Infrastructure railway.

- *Centipedes* – the family Cryptopidae within the order Scolopendromorpha and the order Geophilomorpha contain the few centipede species thought to be SREs (ecologia Environment 2009c). At least one species of Geophilomorpha (*Geophilidae* sp.) has been recorded in the Chichester Range. The taxonomy of the three specimens collected remains unresolved but they are currently considered to be potential SREs.
- *Millipedes* – two families of polyxenid millipede (Synxenidae and Polyxenidae) have been collected from the vicinity of the RHI Railway and, although their taxonomy is poorly resolved, the species are generally regarded as SRE. Polydesmid millipedes are known to contain many SRE species (Outback Ecology, 2008). Two or more species of polydesmid species from the genus *Antichiropus* have been collected in the Chichester Range. *Antichiropus* is the most abundant and speciose millipede group in Western Australia (Outback Ecology, 2008). All *Antichiropus* species (except *Antichiropus variabilis*) are considered to be SREs, with many species known from only a few hundred square kilometres (Harvey et al. 2000; Harvey 2002).
- *Scorpions* – although the status of most of the scorpions collected in the vicinity of the RHI Railway is uncertain, few are thought to be SREs (Harvey 2002) and this is likely to be the case for most of the taxa belonging to the Buthidae and Urodacidae families listed as possible SREs by the Western Australian Museum. Species of the buthid genus *Lychas* are typically widespread (Outback Ecology 2008) and are unlikely to represent SREs, despite having highly restricted known distributions. Species of the genus *Isometroides* are also considered unlikely to be SREs. Although most species of *Uroducus* are widespread, the Western Australian Museum considers that *Urodacus* '*cloudbreak*' and *Urodacus 'linnaei'* may be SREs. However, *Urodacus 'linnaei'* is known from Barrow Island and Port Hedland and, if the Cloudbreak and western Pilbara specimens are in fact conspecific, the species is probably spread across the Pilbara. More taxonomic work is required. The status of the remaining *Urodacus* recorded on the museum's database is uncertain.
- *Mygalomorph spiders* – Western Australian Museum records list six species of mygalomorph spider from the Chichester Range, belonging to the families Actinopodidae, Barychelidae, Dipluridae and Idiopidae, as potential SREs. However, the taxonomy of all species is incomplete and the number of specimens collected is low, making it very difficult to accurately predict conservation status. Robert Raven (Queensland Museum, pers. comm.) contends that there are few known SRE mygalomorph spiders in the Pilbara, and suggests that although the Actinopodidae species, *Missulena* 'MYG045?', has been recorded only from two sites 3.5 km apart, it is likely to have a wind dispersal phase and be widespread. Raven has records of the Barychelidae species, *Aureocrypta* '*chittering*', extending over 1,000 km in the Pilbara. Accordingly, only the following spiders need to be treated as SREs in assessing risk arising from the RHI Railway.
    - *Synothele* 'sp. nov. 3', which is known from a single location;
    - *Synothele* '*cloudbreak* sp. 1', which is known from six sites with a linear range of 6km;
    - *Cethegus* '*cloudbreak* sp. 1', which belongs to a taxonomically poorly known group and is known from a single record; and

    - *Aganippe* '*cloudbreak* sp. 1', which is also known only from a single record.

- *Land snails* – the taxonomy of land snails in the eastern Pilbara is poorly resolved and the ranges of most species cannot be determined. Additionally, most of the land snail material in the Western Australian Museum's mollusc collection is unregistered and cannot be accessed, further limiting interpretation of species' distributions (C. Whisson, Western Australian Museum, pers. comm.). Nevertheless, two families of land snails recorded from the eastern Pilbara (Camaenidae and Bulimulidae) are considered to contain SREs (ecologia 2009c). Camaenid snails have been collected in the Chichester Range and there are additional species tentatively placed close to the genus *Quistrachia* in the museum database. There are no records in the museum database of Bulimulidae in the Chichester Range. Species of the Planorbidae and Pupillidae families recorded in the vicinity are considered to belong to widespread species, although this is yet to be confirmed.

No SRE species are currently listed as Specially Protected (Schedule 1) fauna in the Pilbara region.

8.9.5 Subterranean fauna

Subterranean fauna are largely invertebrate fauna divided into stygofauna (which are aquatic and occur in groundwater) and troglofauna (which breathe air and reside in underground cavities, fissures and interstitial spaces above the groundwater table) (Bennelongia 2010b). They exhibit relatively high levels of endemism and numerous species have extremely restricted ranges. They have been recorded in a variety of rock types, although records have been primarily from karstic or porous alluvium and gravel environments (Marmonier *et al.* 1993).

Studies of stygofauna have taken place since the late 1990s. The Pilbara region is known to support a widespread occurrence of stygofauna, with over 350 species recorded in surveys conducted by DEC in conjunction with the Western Australian Museum and the University of Western Australia. Forty-three species of stygofauna have been recorded in the vicinity of the RHI Railway (Bennelongia 2010b).

An investigation of potential stygofauna along the FMG Stage B railway corridor recorded no stygofauna after sampling of four sites at Christmas Creek, four sites at Mt Lewin and three sites at Mt Nicholas (Knott & Goater 2004). Sections of rail corridor which run parallel to the Fortescue Marsh are likely to be richer in stygofauna than the sections running through the Chichester Range (Bennelongia 2010b).

Troglofauna have only been studied relatively recently in Western Australia and have not been recorded as extensively as stygofauna. There is no species information related to troglofauna presence in the immediate vicinity of the RHI Railway (Bennelongia 2010b). There has been limited sampling in the Chichester Range (Bennelongia 2008; SMEC 2009) but records show that troglofauna do occur in the Chichester Range (Bennelongia 2010b).

Troglofauna may also occur in more elevated parts of the corridor along the alluvial floodplain beside Fortescue Marsh but, for much of its length, the rail corridor is close to (or below) an elevation of 410 m AHD (Australian Height Datum). The historical surface flow and flood levels of the area (FMG 2006) mean the occurrence of troglofauna around 410 m AHD is unlikely because suitable habitat will, at least periodically, be occupied by groundwater (Bennelongia 2010b).

8.10 Social and economic environment

8.10.1 Demographics

The Pilbara region comprises four local government authorities: the shires of Roebourne, Ashburton and East Pilbara, and the Town of Port Hedland (Figure 7-2). The RHI railway project is located in the latter three of these shires, with the main population centres being Newman and Port Hedland respectively. In 2009 the Pilbara’s total population was 45,983 people (Australian Bureau of Statistics 2009), more than 5,700 of whom are Aboriginal.

Most residents live in the region’s towns (approximately 70%). The remaining 30% reside in smaller towns, remote pastoral or mining locations or in Aboriginal communities (Pilbara Area Consultative Committee 2007). Indigenous communities are scattered across the region with resident populations ranging between 50 and 300 people (Department of Communities 2009).

8.10.2 Regional development

The Pilbara economy is dominated by the mining and petroleum industries. The Pilbara region is the premier mining region in Western Australia and is responsible for an estimated 16% of Australia’s national economy through exports, taxes and royalties (Pilbara Area Consultative Committee 2007).

Significant development in the Pilbara followed the discovery of vast deposits of iron ore in the region and large-scale mining began in the mid 1960s, and a number of mining towns were established in the Pilbara, including Dampier, Tom Price, Paraburdoo, South Hedland, Newman, Wickham, Pannawonica, Goldsworthy and Shay Gap (now closed). These towns provided logistical support and living quarters for the miners and were entirely dependent on the mining industry to sustain them. Mining tenements crossed by the proposed RHI railway are shown in Figure 8-6.

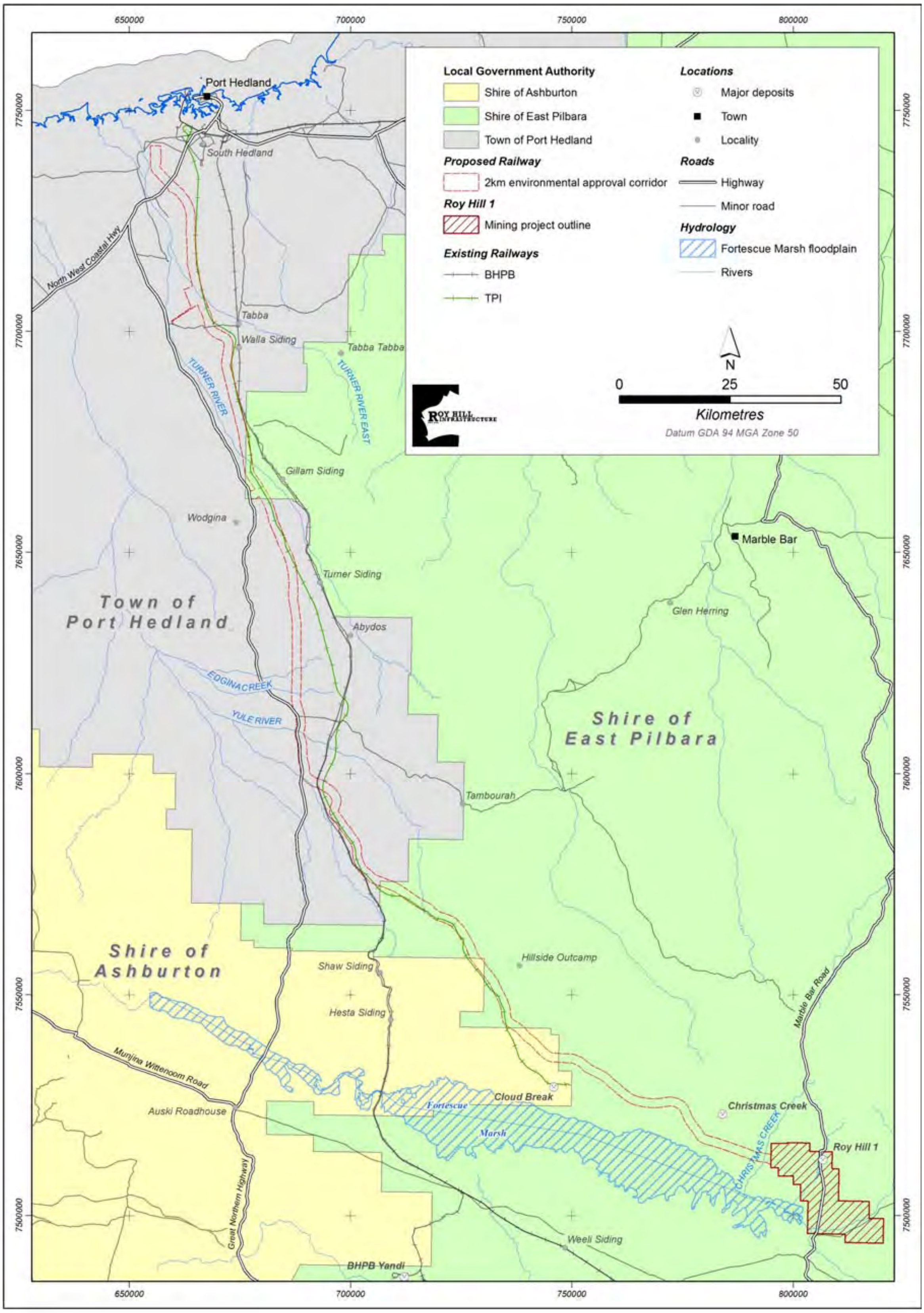

Figure 8-5: Local government areas crossed by the proposed RHI Railway

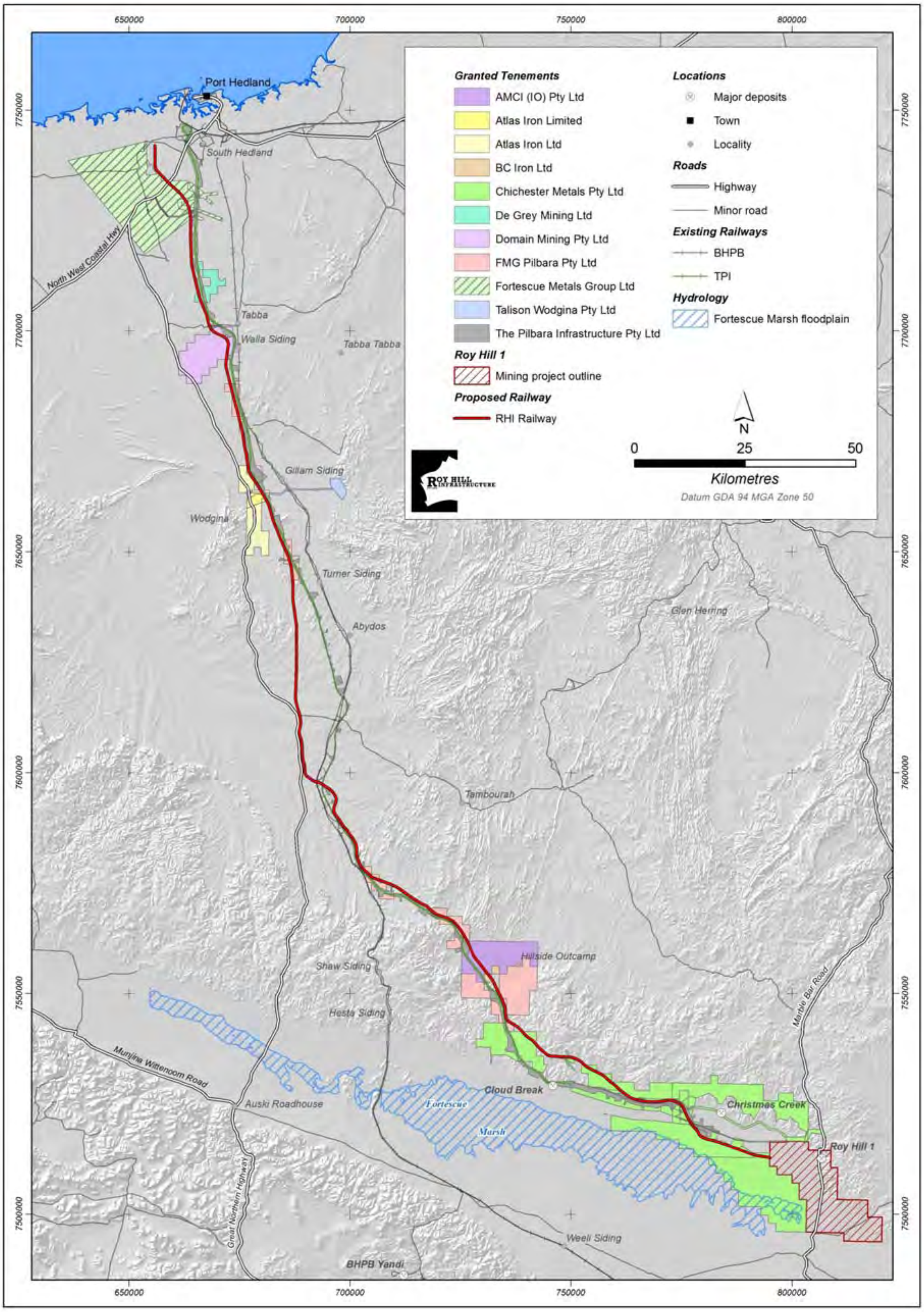

Figure 8-6: Mining tenements crossed by the proposed RHI Railway.

In the 1960s and 1970s, oil and natural gas were discovered off the Pilbara coastline on the North West Shelf in the Carnarvon Basin. In the 1980s, development of these oil and gas resources caused the Pilbara's economy and population to peak. The population has since waxed and waned in response to the regional economic situation (Taylor & Scambary 2005). The Pilbara continues to be a region of vital national significance. Despite the economic downturn, mining exports accounted for $118.50 billion between 2008 to 2009 Australia-wide, with the region's resources industry contributing more than 40% of Australia's mineral and gas exports (Department of Innovation Industry Science and Research 2010).

8.10.3 Native title

The proposed rail corridor intersects the boundaries of three registered native title claims: the Kariyarra, Palyku and Nyiyaparli (see Figure 8-7). RHI has reached, or is seeking to reach agreement with each of these Native Title claimants under the *Native Title Act 1993* to use the land for rail purposes.

In addition, the proposed rail corridor crosses one Aboriginal pastoral lease, Kangan Station, located approximately 100 km south of Port Hedland. RHI is also seeking to enter an access agreement with the pastoral lessee, Aboriginal Prospecting Pty Ltd.

8.10.4 Aboriginal heritage

According to the data held on the Register of Aboriginal Sites (maintained by the Department of Indigenous Affairs under Section 38 of the *Aboriginal Heritage Act 1972)*, 24 Aboriginal heritage sites have been identified to date within the proposed 200m wide rail construction corridor.

Both archaeological and ethnographic surveys will be undertaken of the entire rail corridor with the relevant Traditional Owners, prior to any ground disturbance activity in order to identify any further Aboriginal heritage sites. Should additional sites be located within the corridor, RHI will either undertake to re-design the rail alignment, or seek approval under Section 18 of the *Aboriginal Heritage Act 1972* to salvage any sites (in accordance with the wishes of the Traditional Owners) which cannot be avoided. All sites which can be avoided with be demarcated and/or fenced for their protection.

Approximately 55km of the proposed railway is within the Abydos-Woodstock Protected Area. RHI has sought Ministerial Consent under Regulation 10, *Aboriginal Heritage Regulations 1974* to undertake both Aboriginal heritage surveys and subsequent geo-technical work within Abydos-Woodstock.

The proposed corridor within the Abydos-Woodstock Protected Area will be finalised after completion of archaeological and ethnographic surveys undertaken with the traditional owners. The corridor will avoid all engraving sites and minimise disturbance of other sites of significance.

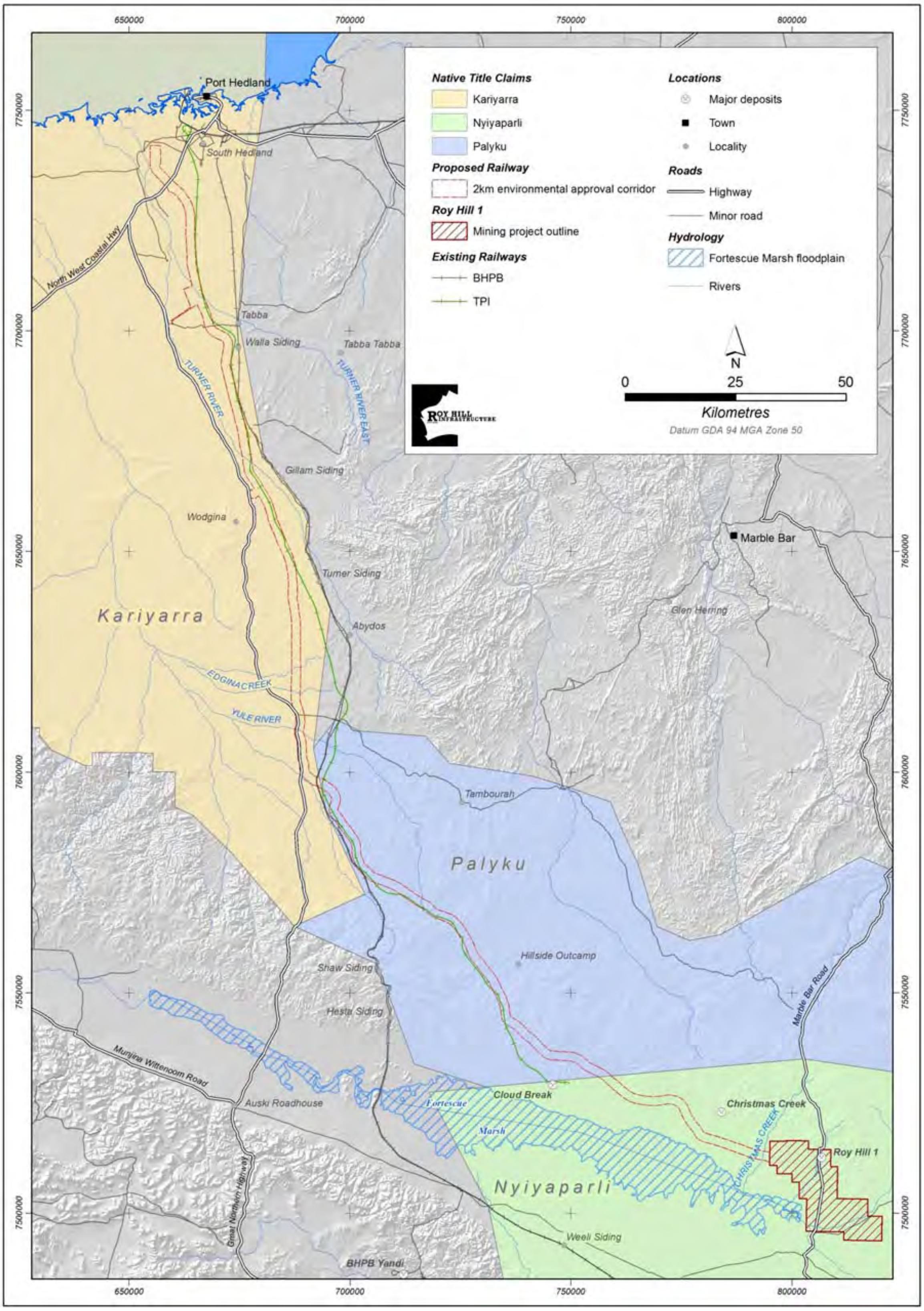

Figure 8-7: Native Title areas crossed by the proposed RHI Railway.

8.10.5 European heritage

A review of the databases of the Australian Heritage Commission, Heritage Council of Western Australia, National Trust and the Town of Port Hedland and Shire of East Pilbara (Municipal Inventory) found no sites of European heritage significance within the vicinity of the proposed railway corridor.

Abydos-Woodstock Protected Area is included in the Register of the National Estate. A section of the proposed railway corridor runs within the Abydos Woodstock Protected Area.

There are no anticipated impacts on European Heritage.

8.11 Visual Amenity

The proposed RHI Railway traverses pastoral leasehold land, reserves, roads, vacant crown land, and a small portion of freehold land (Figure 2-1). The route is approximately 3km from the nearest settlement (Abydos Woodstock Group Aboriginal community).

The visual amenity of the public access points (e.g. the Great Northern Highway crossing in the Northern Section) is a consideration in both the construction phase, from dust, and in the ongoing landscape. However the Pilbara's social environment and economy is dominated by the mining and petroleum industries and the rail infrastructure is expected to represent a typical visual character of the area.

The proposed RHI Railway does not pass through any existing conservation reserves or special tourist areas with specific visual amenity requirements. The proposed RHI Railway passes through 6 km of the Hillside pastoral lease, which is proposed for purchase in 2015 by DEC for addition to the Karajini National Park. While the national park does have substantial scenic and tourism value, it is unclear whether the area proposed to be traversed by the railway is planned for a high visitation area with visual amenity sensitivities in the future. Furthermore, this section runs parallel to the existing TPI railway and in the vicinity of FMG's Cloudbreak and Christmas Creek mines.

8.12 Geoheritage

Geoheritage sites are natural features of the Earth that are considered to be unique and/or to have significant geoscientific and educational value (DMP 2010). A register of WA Geoheritage Sites is maintained by the Geological Survey of Western Australia. There are no registered sites within the RHI Railway 2 km environmental approval corridor. The closest site the, 'Knossos' Archaean stromatolites, south-west of the Northern Section, is 14 km away.

The geoheritage of the area traversed by the RHI Railway in the section closest to the Roy Hill iron ore mine and FMG Christmas Creek mine is further addressed in the V & C Semeniuk Research Group *Assessment of sites of geoheritage significance in the Roy Hill area, mid-eastern Pilbara region, Western Australia* (Semeniuk 2009). Based on their investigation, the following features were identified as having possible geoheritage value:

- Alluvial fans occurring along the southern margin of the Chichester Range (regionally significant as wetlands but not as geomorphic units);
- Wetlands of the Fortescue Marsh (state-wide significance); and
- Intermittently flowing creeks and wadis of the Roy Hill and Ethel Creek suites feeding into the northern margin of the Fortescue Marsh (regionally significant as wetlands but not as geomorphic units).

9 IMPACTS, RISKS AND MANAGEMENT

9.1 Environmental management system

RHI will oversee the development of an environmental management system (EMS) for the RHI Railway. The EMS will be consistent with the principles of ISO 14001, including provisions for monitoring and continuous improvement of environmental performance. The EMS forms a component of the broader project management system addressing the occupational health and safety, community, heritage and environmental aspects of the rail project. A series of supporting management plans will be developed to implement the environmental management and monitoring commitments adopted for the project.

9.2 Outcome of risk assessment

The key environmental factors (see outcome of preliminary risk assessment in Appendix C) have been identified as:

- flora and vegetation (Section 9.3.1);
- fauna (Section 9.3.2); and
- surface water (Section 9.3.3)

In respect of these four factors, the risk assessment identified at least some medium to high inherent risks to the environment due either to the precautionary approach adopted or to scientific uncertainty.

- Other relevant factors are:
- groundwater (Section 9.4.1);
- social issues (Section 0);
- topsoil and rehabilitation (Section 8.4.3);
- acid sulfate soil management (Section 0);
- greenhouse gas emissions (Section 0);
- waste management (Section 9.4.6);
- fire (Section 9.4.7);
- chemical and hydrocarbon contamination (Section 0);
- noise and vibration (Section 9.4.9);
- visual amenity (Section 9.4.10); and
- cultural heritage (Section 11).

The potential impacts of each issue will be minimised through the implementation of management actions described in associated environmental management plans or management frameworks. The unmitigated (inherent) and managed (residual) risks assigned to each of these factors and the residual environmental impacts are further described below. Please refer to Appendix C Preliminary Risk Assessment for a summary of the inherent and residual risk to the environment.

RHI is committed to minimising the environmental impacts from the RHI Railway. A number of specialist studies have been planned to further define potential impacts on sensitive environmental features, in accordance with EPA and DEC requirements. The need for these studies has been identified at various stages of the impact assessment and consultation process. The results will be used to finalise the rail alignment and project EMPs and to apply for subsequent approvals for the project; for example, under sections 5C and 26C of the RIWI Act and Part V of the EP Act.

9.3 Key environmental issues

9.3.1 Flora and vegetation

Overview

Establishment of the construction corridor for the railway will involve clearance of a significant amount of native vegetation through a range of different land systems. The impact of the clearing on the conservation values of flora and vegetation needs to be considered as well as indirect impacts that may arise after clearing.

EPA Objectives

The following objective applies to management of impacts on flora and vegetation:

- To maintain existing flora and fauna at species levels through avoidance or management of adverse impacts and improvement in knowledge.

Legislation and Policy

The key statutory requirements, policy and guidance relevant to vegetation, flora and habitat within this Proposal are:

- *Wildlife Conservation Act 1950;*
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002);
- EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004c);
- EPA Guidance Statement No. 54a: Sampling methods and survey considerations for subterranean fauna in Western Australia (EPA 2006a);

Potential Impacts

Vegetation clearing (by land system)

Clearing for construction and maintenance of a permanent clearing for operation is the main source of direct impact on flora and vegetation. Land clearing has the potential to decrease the regional representation of particular vegetation communities, disturb protected flora species, or fragment habitats.

Approximately 4,454 ha of land will be cleared during the construction of the RHI Railway. This includes allowances for construction of the railway, associated access roads, clearing for borrow pits, camps and other infrastructure. An area of approximately 2,091 ha will remain permanently cleared along the railway and the adjacent access road. The remaining cleared areas not required for railway operation activities will be rehabilitated.

All of the land systems within the 30 km local reference area have less than 1% of their regional representation affected by the project. The most affected land systems are the Calcrete (0.84%), Granitic (0.54%) and Uaroo (0.54%) land systems (Table 9-1).

The cracking clay communities of the Wona Land System, which are known to be regionally significant and are listed as a PEC, are discussed further in the following sections.

Flora of conservation significance

There is potential for individual species of conservation significance to be affected by vegetation clearing or indirect effects. A number of Priority 1 and Priority 2 species potentially occur in the project area; the risk to each of these species is considered later in this section.

Mulga communities

The Jamindie and Turee land systems, which are intersected by the 2 km environmental approval corridor, are dominated by mulga communities according to the land system descriptions of van Vreeswyk et al. (2004).

Using a conservative estimate (200 m construction disturbance corridor), construction would directly impact 190 ha and 6 ha respectively of the Jamindie and Turee Land Systems before rehabilitation. The maximum calculated loss of mulga woodland in the Jamindie and Turee Land Systems occurring within the 30 km local reference corridor is presented in Table 9-2. The table shows that clearing would impact 0.5% or less of either of these vegetation communities present within the 30 km local reference corridor.

Table 9-1: Land systems and levels of associated construction disturbance for the proposed railway corridor

Land system	Land system code	¥Area of land system in Pilbara region (ha)	Area in 30 km reference corridor (ha)	Area in 2 km environmental approval corridor (ha)	Area in 200 m construction disturbance corridor (ha)	Construction disturbance corridor area (200 m) as a proportion of each land system (%)	Construction disturbance corridor area (200 m) as a proportion of each land system area in the 30 km reference corridor (%)
Black	BLK	16516	465	0	0	0.00	0.00
Bonney	BNY	75343	4215	0	0	0.00	0.00
Boolaloo	BOO	150183	42412	5103	109	0.07	0.26
Boolgeeda	BGD	774790	7190	0	0	0.00	0.00
Calcrete	CAL	144391	5540	311	47	0.03	0.84
Capricorn	CPN	529617	9945	51	0	0.00	0.00
Cheerawarra	CHE	19701	844	0	0	0.00	0.00
Coolibah	COB	101381	164	0	0	0.00	0.00
Cowra	CWA	20295	9661	0	0	0.00	0.00
Granitic	GRC	401990	44132	2626	238	0.06	0.54
Gregory	GRG	11289	215	0	0	0.00	0.00
Jamindie	JAM	207423	39597	2266	190	0.09	0.48
Littoral	LIT	157712	11740	0	0	0.00	0.00
Macroy	MAC	1309544	285988	19629	295	0.02	0.10
Mallina	MAL	255729	48924	4304	226	0.09	0.46
Marsh	MSH	97667	42297	0	0	0.00	0.00
McKay	MCK	420246	68518	6124	16	0.00	0.02
Newman	NEW	1457984	37686	2293	47	0.00	0.12
Oakover	OAK	152875	102	0	0	0.00	0.00
Paradise	PDS	147864	1204	0	0	0.00	0.00

Land system	Land system code	¥Area of land system in Pilbara region (ha)	Area in 30 km reference corridor (ha)	Area in 2 km environmental approval corridor (ha)	Area in 200 m construction disturbance corridor (ha)	Construction disturbance corridor area (200 m) as a proportion of each land system (%)	Construction disturbance corridor area (200 m) as a proportion of each land system area in the 30 km reference corridor (%)
Platform	PLA	156990	2247	0	0	0.00	0.00
River	RIV	408842	35347	2182	6	0.00	0.02
Robe	ROB	86460	5446	408	5	0.01	0.09
Rocklea	ROC	2299251	48895	1513	58	0.00	0.12
Ruth	RUT	34575	2257	0	0	0.00	0.00
Satirist	SAT	37677	2960	0	0	0.00	0.00
Talga	TLG	212429	14568	1006	72	0.03	0.50
Turee	TUR	58055	30812	3839	6	0.01	0.02
Uaroo	UAR	768141	121310	9562	658	0.09	0.54
Warri	WAI	30494	974	0	0	0.00	0.00
White Springs	WHS	26564	3966	85	7	0.02	0.17
Wona	WON	181540	11634	0	0	0.00	0.00
Yamerina	YAM	120670	7880	0	0	0.00	0.00

¥ Total areas sourced from Van Vreeswyk et al. 2004.

Table 9-2: Calculated loss of mulga communities as a result of clearing for the RHI Railway construction corridor

Land system	Biophysical characteristics	Land system area within 30 km local reference corridor (ha)	Land system area within 200 m construction corridor (ha)	Construction disturbance area as percentage of 30 km reference area (%)
Jamindie (JAM)	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey	39,597	190	0.48
Turee (TUR)	Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands	30,812	6	0.02

A management unit was defined for mulga communities on the lower slopes of the Chichester Range by EPA (2005), within which there was 164,100 ha of land containing mulga communities. It is therefore estimated that only 0.12% of total mulga communities on this section of the lower slopes of the Chichester Range would be impacted by the construction disturbance footprint.

In addition to any direct impacts to mulga, other impacts are possible. The proposed RHI railway crosses the sheetflow drainage patterns of the Turee and Jamindie Land Systems. Mulga communities are sensitive to changes in surface flow (van Vreeswyk *et al.* 2004). Unless properly designed and located, drainage culverts have the potential to create channelling in sheetflow areas causing erosion in some areas and water deprivation in others. Eroded channels provide habitat for weeds such as buffel grass (*Cenchrus ciliaris)*.

Vegetation assemblages of the Wona Land System (PEC21)

There are four vegetation assemblages within the stony gilgai upland plains of the Wona Land System that are considered to comprise PEC21 (DEC 2010). These upland gilgai land units comprise 70% of the Wona Land System as mapped by van Vreeswyk et al. (2004), and an individual unit can range from 100 m (Vital Options Consulting 2010) up to 4 km in extent (van Vreeswyk *et al.* 2004). The construction disturbance corridor and the environmental approval corridor do not cross the Wona Land System and it is anticipated that these four vegetation assemblages will not be affected by construction works.

Vegetation communities of the Fortescue Valley

Biota (2004c) stated that many of the communities in the Fortescue Valley are of high conservation significance. This is due to the likelihood that they are restricted to this area and therefore have a limited natural distribution. Both CALM (2002) and Biota (2004c) state that this area is not well represented within reserves. The results of further vegetation mapping will be used to avoid or minimise clearing of these conservation-significant vegetation communities.

Vegetation communities of the Fortescue Marsh (PEC17)

At its closest the rail conceptual centre line passes 3.5 km north of the spinifex-samphire ecotones that fringe the Fortescue Marsh. The RHI Railway 200 m construction disturbance corridor is not expected to have a significant direct impact on spinifex-samphire communities fringing the Marsh.

Groundwater-dependent vegetation

Large trees are likely to be indicators of localised groundwater dependency, in particular *Melaleuca argentea, Eucalyptus victrix and E. camaldulensis,* on drainage lines and drainage floors. Locations of potentially groundwater-dependent areas have been mapped by Vital Options Consulting (2010) and are found within the Christmas, Cowra, Jamindie and Turee land systems of the Fortescue sub-region and within the Capricorn, Granitic, Macroy, McKay, Newman, River and Rocklea land systems of the Chichester Range.

Impacts on groundwater-dependent vegetation may occur where groundwater is abstracted for construction purposes; however, due to the limited duration and volume of pumping it is considered that groundwater abstraction will not have significantly adverse or permanent impact on groundwater level.

Weeds

A total of 29 weed species, including two species Declared under the *Agriculture and Related Resources Protection Act 1976*, could potentially occur within the construction disturbance corridor. Vehicle movement and earthworks can spread weed seeds, leading to the establishment of new populations or the spread of existing ones.

Other indirect impacts

Disturbing or clearing vegetation has the potential to cause other indirect impacts including:

- Dust migrating beyond the construction boundary, which can block leaf pores and cause vegetation to become stressed;
- Surface contamination from hydrocarbon spills potentially damaging plants;
- Changes to fire regimes that have the potential to damage vegetation over a wide area; and
- Increased soil erosion potentially removing top- and sub-soils and preventing plant re-establishment.

Risk assessment and management

Table 9-3 summarises the general and specific risks to vegetation generally, vegetation communities and Priority 1 and Priority 2 listed species. It also describes management controls that will be used to minimise impacts to those communities and species. The mitigated risk to all communities and species will range from very low to medium. The medium risk level indicates that specific management attention is required for those matters, and the very low and low risk levels imply that the risk can be managed by routine procedures. The residual risks for all flora species are considered to be as low as reasonably practicable for the RHI Railway.

Table 9-3: Risk assessment for vegetation and flora

Risk issue (taxon or feature of environmental significance)	Typical habitat	Key impacting processes	Industry standard management	Consequence	Likelihood	Inherent Risk Level	Additional mitigation actions	Consequence	Likelihood	Residual risk level
Adverse impacts arising from approved clearing	All	Dust, erosion, weed infestation.	Ground Disturbance Permit system, weed controls, drainage design.	2	C	Low		2	C	Low
PEC 17 Fortescue Marsh	South-eastern section of rail in marsh catchment.	Alteration to surface water patterns.	Drainage design.	3	C	Medium	Surface water management plan, water monitoring.	3	E	Low
PEC 21 Five Plant Assemblages of the Wona Land System	Upland gilgai plains of the Wona Land System	Clearing, weed infestation, increased fire	Pre-construction surveys, Ground Disturbance Permit system, weed controls.	1	E	Very Low	No additional control measures	1	E	Very Low
Mulga-dominated vegetation communities	Jamindie and Turee Land Systems	Clearing, weed infestation, alteration to water patterns, increased fire, dust.	Pre-construction surveys, Ground Disturbance Permit system, weed controls, dust management.	3	C	Medium	Surface water management plan, mulga management plan, mulga monitoring.	3	C	Medium
Introduction or spread of weeds	All	Ecosystem degradation.	Weed hygiene program.	3	C	Medium		3	C	Medium
Lepidium catapycnon (DRF)	Skeletal soils on hillsides	Land clearing	Pre-construction surveys, Ground Disturbance Permit system.	2	E	Very low	No additional control measures	2	E	Very low
Abutilon pritzelianum (P1)	Red sand dunes, uncommon in project area	Clearing, weed incursion.	Pre-construction surveys, Ground Disturbance Permit system, weed controls.	3	E	Low	No additional control measures.	3	E	Low
Acacia leeuweniana (P1)	In rock fissures in outcrops, among boulders.	Clearing, weed incursion.	Pre-construction surveys, Ground Disturbance Permit system, weed controls.	3	D	Medium	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	Low
Eremophila pilosa (P1)	Shallow depressions in sandplains and on hardpan plains over granite	Clearing, weed incursion.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	D	Medium	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	Low
Eremophila spongiocarpa (P1)	Weakly saline alluvial plain on margins of marsh, very uncommon in project area.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	E	Low	No additional control measures.	3	E	Low

Risk issue (taxon or feature of environmental significance)	Typical habitat	Key impacting processes	Industry standard management	Consequence	Likelihood	Inherent Risk Level	Additional mitigation actions	Consequence	Likelihood	Residual risk level
Heliotropium muticum (P1)	Not known.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	D	**Medium**	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	**Low**
Josephinia ?sp. Marandoo (ME Trudgen 1554) (P1)	Plains, mixed shrubland of Senna and Acacia.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	D	**Medium**	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	**Low**
Nicotiana heterantha (P1)	Seasonally wet flats, very uncommon in project area.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	E	**Low**	No additional control measures.	3	E	**Low**
Peplidium sp. Fortescue Marsh (S van Leeuwen 4865) (P1)	Moist clay or sand edge of marsh.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	D	**Medium**	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	**Low**
Ptilotus appendiculatus var. *minor* (P1)	Not known (coastal?).	Clearing, weed incursion.	Pre-construction surveys, Ground Disturbance Permit system, weed controls.	3	E	**Low**	No additional control measures.	3	E	**Low**
Stemodia sp. Battle Hill (A.L. Payne 1006) (P1)	Cracking clay, floodplain.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	D	**Medium**	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	**Low**
Tecticornia sp. Christmas Creek (KA Shepherd & T Colmer et al. KS) (P1)	Assume margins of Fortescue Marsh, very unlikely to be directly affected.	Weed incursion, alteration to surface water patterns.	Weed controls, drainage design.	3	D	**Medium**	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	**Low**
Tecticornia sp. Fortescue Marsh (KA Shepherd et al. KS 1055) (P1)	Assume margins of Fortescue Marsh, very unlikely to be directly affected.	Weed incursion, alteration to surface water patterns.	Weed controls, drainage design.	3	D	**Medium**	Targeted survey, minor alteration of ancillary infrastructure where possible.	3	E	**Low**
Tephrosia rosea var. *venulosa* ms (P1)	Red sands near creeklines, unlikely to be affected.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	3	E	**Low**	No additional control measures.	3	E	**Low**
Euphorbia clementii (P2)	Gravelly hillsides, stony grounds.	Clearing, weed incursion.	Pre-construction surveys, Ground Disturbance Permit system, weed controls.	2	D	**Low**	No additional control measures.	2	D	**Low**
Gomphrena pusilla (P2)	Fine beach sand. Behind foredune, on limestone. Will not be affected.	Clearing, weed incursion.	Pre-construction surveys, Ground Disturbance Permit system, weed controls.	2	E	**Very Low**	No additional control measures.	2	E	**Very Low**
Indigofera ixocarpa (P2)	Skeletal red soils over massive ironstone.	Clearing, weed incursion.	Pre-construction surveys, Ground Disturbance Permit system, weed controls.	2	D	**Low**	No additional control measures.	2	D	**Low**

Risk issue (taxon or feature of environmental significance)	Typical habitat	Key impacting processes	Industry standard management	Consequence	Likelihood	Inherent Risk Level	Additional mitigation actions	Consequence	Likelihood	Residual risk level
Paspalidium retiglume (P2)	Clay.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	2	D	Low	No additional control measures.	2	D	Low
Stylidium weeliwolli (P2)	Gritty sand soil, sandy clay. Edge of watercourses. Unlikely to be affected except where alignment crosses watercourse.	Clearing, weed incursion, alteration to surface water patterns.	Pre-construction survey, Ground Disturbance Permit system, weed controls, drainage design.	2	E	Very Low	No additional control measures.	2	E	Very Low
Vigna sp. Central (M.E. Trudgen 1626) (P2)	No habitat information, wide distribution.	Clearing, weed incursion.	Pre-construction survey, Ground Disturbance Permit system, weed controls.	2	E	Very Low	No additional control measures.	2	E	Very Low

Before construction, RHI will undertake inspections along the final alignment and ancillary infrastructure areas for conservation significant flora and vegetation units. It is unlikely DRF will occur in the construction corridor. Detailed engineering design will be undertaken incorporating hydrology, topography, geotechnical information and the analysis of vegetation mapping, with the objective of minimising direct disturbance during construction. The clearing footprint will be minimised to the extent practicable, and locations where significant vegetation communities are known to exist will be avoided wherever practicable during design of the rail, camp, borrow and laydown areas. In the unlikely event that the final design requires the removal of identified DRF, permits will be obtained under the WC Act.

Clearing boundaries and areas that must not be cleared or disturbed will be delineated before clearing (e.g. using a ground disturbance control system). Surveys will be conducted post-construction to verify conformance to the authorised clearing.

A flora management framework and weed management framework have been developed to assist with the development of specific environmental management plans for the construction and operation of the RHI Railway. These are provided in Table 9-4 and Table 9-5. A draft Mulga, flora and other communities management plan is presented in Appendix H.

Both the construction and operation clearing pose an insignificant direct impact on the proposed conservation area.

It is not known what type of reserve the conservation estate will be classified as but its existing industrial land uses suggest the best fit would be a miscellaneous reserve (Class 5G). A ‘Class 5G’ reserve has a wide variety of purposes that are normally related to recreation, wildlife conservation and historical features. The reserve may accommodate a range of land uses, including mineral resource development and railways, as long as those land uses do not conflict with the purpose of the reserve. The RHI Railway located at the extremity of the proposed reserve is not expected to conflict with the objectives or environmental values of a ‘Class 5G’ conservation reserve.

Table 9-4: Flora and vegetation management framework

Flora and vegetation management framework	
Management issues	Construction of the railway may result in impacts to vegetation and flora. Land clearing may decrease the regional representation of particular vegetation communities, disturb protected flora species or vegetation communities, lead to the introduction or spread of weeds or fragment habitats. Secondary effects from general construction activities that may impact on flora and vegetation include changes in water flow, surface water contamination, vehicle movement, increased risk of fire and the generation of dust.
Objectives	Protect Declared Rare Flora (DRF) and minimise disturbance to other flora and vegetation communities. Comply with relevant legislation including the *Environmental Protection and Biodiversity Conservation Act 1999* and the *Wildlife Conservation Act 1950*.
Performance indicators	No impact to DRF, TECs or PECs. No unauthorised clearing of vegetation outside the approved disturbance corridor. Rehabilitation of cleared areas in accordance with contract specifications.

Flora and vegetation management framework	
Management strategies	Develop a vegetation and flora management plan to control and limit the impact of the project on flora. • Conduct a pre-construction vegetation and flora survey on the finalised rail alignment to identify locations and condition of DRF, Priority Flora and conservation-significant floristic communities listed as threatened under state or federal legislation. Align the railway to avoid or limit the impact on known habitats with sensitive species. Develop a ground disturbance procedure including a ground disturbance permitting system. Direct removal of any DRF will be carried out under further advice and specific approval under the *Wildlife Conservation Act 1950*. Clearing boundaries will be well marked and areas that must not be cleared or disturbed will be delineated. Drainage design will include environmental culverts and rip-rap rock protection to minimise disruption to natural surface water regimes in the immediate vicinity of the railway (see surface water management framework). Implement topsoil and rehabilitation management as part of the construction and operation EMPs. RHI will progressively rehabilitate borrow, laydown and construction areas as the railway construction front advances wherever practicable. Topsoil and cleared vegetation will be stockpiled and reused as part of rehabilitation to take advantage of the local seed bank. Implement fire prevention and management in accordance with the emergency response strategies in the construction and operation management plans. Implement weed hygiene management measures as part of the vegetation and flora management plan (see weed hygiene management framework).
Monitoring	Conduct contractor audits and enforce requirements for performance improvement. Conduct weekly work area inspections.
Reporting	Report all incidents using the incident reporting system. Investigate and report, as required, all incidents to the appropriate authority.
Corrective action	Rehabilitation will be undertaken of all areas outside the permanently cleared corridor.

Table 9-5: Weed hygiene management framework

Weed hygiene management framework	
Management issues	Importing of equipment and supplies into the project area may result in the introduction or spread of weed species. Movement of equipment and vehicles across the site may allow species to be transported along the alignment to previously uninfested areas, and clearing and disturbance in the construction area may create conditions for weeds to establish and spread.
Objectives	Prevent the introduction and spread of weeds, particularly any Declared weeds.
Performance indicators	No new weeds introduced into the project area due to construction activities. No spread of existing weeds outside their current area.
Management strategies	Develop weed hygiene management strategies as part of the vegetation and flora management plan. Promote awareness of weed management measures; provide specific training to staff in weed identification and management measures. Vehicles and machinery to be cleaned of vegetation and soil prior to entering the site, according to specific procedures (to be developed). The soil and vegetation removed shall be collected and disposed of offsite. Vehicles shall remain in cleared areas and use existing access roads. Stockpiles of soil and vegetation for replanting to be stored near their source. Stockpiles from weed risk areas will be bunded. Topsoil stripped from the weed risk areas will be used to rehabilitate the area it was collected from. Weeds shall be taken offsite to an approved facility for disposal and shall not be burnt. Develop and implement weed eradication programs. Implement vehicles and equipment hygiene inspections for weeds, seed and mud. Weed-free certification will be needed for vehicles and machinery entering site.
Monitoring	Implement a weed monitoring program. Undertake periodic weed surveys and eradication activities where RHI railway construction and operation is identified as the cause of new weeds infestations.
Reporting	Report new weed species, as required, to the appropriate authorities.
Corrective actions	Where practicable any new weed populations that arise in the project areas as a result of the construction work shall be removed.

Residual Risks

Potential impact on vegetation on flora is a key factor for the RHI Railway Project. Of the specific risks identified, however, many are Low or Very Low. No risks were identified as High or Very High. For each potential risk the residual risk rating is medium or lower. Therefore the level of risk has been assessed as acceptable by technical specialists with effective measures in place. RHI has identified the management strategies necessary for these potential impacts and they will form part of the Roy Hill EMS. Consequently, RHI considers that the EPA's objectives can be met in respect of flora and vegetation.

9.3.2 Vertebrate and invertebrate fauna

Overview

Construction and operation of the railway has the potential to impact on native fauna, including species of conservation significance. There is a substantial amount of survey data for the project area on which the appropriate management strategies can be based. These are described in the following section.

EPA Objectives

The following objective applies to management of impacts on fauna:

- To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

Legislation and Policy

The key statutory requirements, policy and guidance relevant to vegetation, flora and habitat within this Proposal are:

- *Wildlife Conservation Act 1950;*
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002);
- EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004c);
- EPA Guidance Statement No. 54a: Sampling methods and survey considerations for subterranean fauna in Western Australia (EPA 2006);

Potential Impacts

Clearing and loss of habitat

The RHI Railway will result in the clearing of native vegetation and consequently a loss and alteration of some fauna habitat. Many areas in the 2 km environmental approval corridor through the Chichester Range and to the north appear to be of high quality and show little disturbance from cattle or other anthropogenic factors (Vital Options Consulting 2010).

Clearing of the vegetation and earthworks will result in the local loss of reptiles, frogs and small mammals. Most of the larger mammals, such as kangaroos and some of the larger reptiles (e.g. goannas), will move out of the area and find new activity areas. During clearing and earthworks activities reptile and mammal burrows may be destroyed or damaged, leading to the loss of the small fauna that retreat to them.

Nocturnal fauna that reside in burrows, dens and hollows during the day are particularly vulnerable to clearing and earthworks. To mitigate the potential burial of these species during land clearing, and the potential for them to be killed or injured when they attempt to escape from their burrows, a trapping program will be conducted before clearing and a search of identified burrows will be conducted immediately before clearing.

Most bird species will move into adjacent areas during clearing. This will result in some short-term adjustment for many individuals, including those forced to move and those in areas with new migrants. For the more sedentary species this will mean shifting activity areas and competing for resources and some individuals may not survive. For those individuals that are nomadic, transient, migratory or without defined home ranges that are forced to shift into new areas, the impact will generally not be significant.

The most recently published sighting of the Night Parrot occurred in 2005 (Davis & Metcalf 2008) and was on the northern side of the Fortescue Marsh approximately 13 km from the 2 km environmental approval corridor at its closest point. These parrots were seen drinking at the Minga Well but it was thought they foraged in the hummock grassland in adjacent areas. There is hummock grassland along sections of the northern fringe of the Fortescue Marsh, and this was one of the areas in which DEC staff and some ornithologists searched for further evidence of the Night Parrot. Although highly unlikely (because the southern boundary of the 2 km environmental approvals corridor is 2.5 km from the Geoscience Australia boundary of the Fortescue Marsh) clearing for the RHI Railway could potentially affect the Night Parrot if nests containing eggs are destroyed during the clearing process. Adult birds are likely to move away from the disturbance into adjacent areas. However, according to what little is known about the preferred habitat, the vegetation types impacted by vegetation clearing for the RHI Railway are not its preferred habitat. Bamford (2010) concluded that the “the risks posed by the proposed rail route are either low or can be considered low through management” (see Appendix F). Appropriate management measures will be adopted (e.g. clearing control) so that the construction and operation of the Roy Hill Infrastructure railway is unlikely to have a significant impact on this species.

Most fauna habitats in the 2 km environmental approval corridor are abundant in adjacent areas, so although some fauna may be lost, vegetation clearing and railway construction is not likely to have a significant impact on the vertebrate fauna in either a local or a bioregional context. As described in Section 7.4, the maximum impact on any one land system from the 200 m construction disturbance corridor in the Pilbara region and the 'local region' (15km either side of the alignment) does not exceed 0.09% and 0.84% respectively.

Table 9-6 calculates the area of habitat impacted by the 200 m construction disturbance corridor for each threatened species within the 30 km local reference area. Results of this analysis indicate the rail proposal is not likely to impact greater than 0.35% of the habitat area within the 30 km local reference area for any species.

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

Subterranean fauna species are likely to occur within sections of the rail corridor. The stygofauna community is expected to be moderately rich under the floodplain beside the Fortescue Marsh and the troglofauna community is expected to be moderately well developed in the Chichester Range (Bennelongia 2010b). Loss of habitat is considered to be the most significant potential risk to subterranean fauna. The following activities could cause local habitat loss:

- Groundwater drawdown from bores supplying water for construction, temporarily reducing the volume of stygofauna habitat; and
- Excavation through hills to reduce rail gradients.

The area of significant (>2 m) groundwater drawdown around Pilbara water supply bores for a typical railway construction is <2 ha. Based on water bore clusters being 5–10 km apart, the RHI Railway is likely to impact <1% of the minimum likely range of the most restricted stygofauna species (Bennelongia 2010b).

Habitat fragmentation

In addition to vegetation clearing, the construction of the railway and associated infrastructure has the potential to fragment habitat. Raised railway lines, linear bunds of blue metal and cleared linear tracks of land are 'unnatural' in this habitat. These linear structures could partition existing activity areas and home ranges, isolate sections of established communities and may alter long and medium-term patterns of movement and migration around established home ranges particularly for small mammals and reptiles. Cleared corridors can also provide improved or reduced predator access to some areas.

Table 9-6: Potential impacts to conservation significant fauna habitats of the rail proposal

Common name	Species	EPBC Act	WC Act	DEC	Habitat	Land systems occurring in 30 km local reference corridor which potentially provide suitable habitat	Area of identified land systems in 30 km local reference corridor (ha)	Area of identified land systems in indicative 200 m construction corridor (ha)	Area of land system in indicative 200 m construction corridor as a proportion of the area of land systems in the 30 km local reference corridor (%)
Mammals									
Northern Quoll	*Dasyurus hallucatus*	Endangered	Schedule 1	Endangered	Rocky areas (i.e. granite outcrops and rockpiles), woodland and eucalypt forests.	BGD, BLK, GRC, JAM, MAC, MCK, NEW, RIV, ROC, TLG, TUR, WAI	614,172	929	0.15%
Long-tailed Dunnart	*Sminthopsis longicaudata*				The Long-tailed Dunnart is a specialist rock dwelling species (Freeland, Winter & Raskin 1988). All sites it is known to frequent are within rugged rocky landscapes that support a low open woodland or shrubland of acacias (especially Mulga) with an understorey of spinifex hummocks and (occasionally) also perennial grasses and cassias.	MCK, NEW	106,204	63	0.06%
Crest-tailed Mulgara	*Dasycercus cristicauda*	Vulnerable	Schedule 1	Vulnerable	Mulgaras occur sporadically on spinifex grasslands throughout much of the arid zone (Woolley 2008).	BLK, BOO, BGD, CAL, CPN, GRC, JAM, MAC, MAL, MCK, NEW, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, UAR, WHS, WON	840,333	1,974	0.23%
Brush-tailed Mulgara	*Dasycercus blythi*			Priority 4	Mulgaras occur sporadically on spinifex grasslands throughout much of the arid zone (Woolley 2008).	BLK, BOO, BGD, CAL, CPN, GRC, JAM, MAC, MAL, MCK, NEW, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, UAR, WHS, WON	840,333	1,974	0.23%

Common name	Species	EPBC Act	WC Act	DEC	Habitat	Land systems occurring in 30 km local reference corridor which potentially provide suitable habitat	Area of identified land systems in 30 km local reference corridor (ha)	Area of identified land systems in indicative 200 m construction corridor (ha)	Area of land system in indicative 200 m construction corridor as a proportion of the area of land systems in the 30 km local reference corridor (%)
Greater Bilby	*Macrotis lagotis*	Vulnerable	Schedule 1	Vulnerable	Bilbies occupy a variety of habitats, including open tussock grasslands on uplands and hills, mulga woodland/shrub growing on ridges and rises; and hummock grassland in plains and alluvial areas (Pavey 2006). They have also been recorded in spinifex grasslands and cracking clays (Maxwell, Burbidge et al. 1996; Johnson 2008). They build characteristic large multi-entranced burrow systems (Biota 2005).	BLK, BOO, BGD, CAL, CPN, CWA, GRC, JAM, MAC, MAL, MSH, MCK, NEW, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, TUR, WAI, UAR, WHS, WON, YAM	931,957	1,981	0.21%
Northern Short-tailed Mouse, Lakelands Downs Mouse	*Leggadina lakedownensis*			Priority 4	Regionally recorded from cracking clay and adjacent habitats as well as *Triodia* tussock grasslands and acacia scrub.	PDS, RIV, SAT, WHS, WON, YAM	62,991	12	0.02%
Western Pebble-mound Mouse	*Pseudomys chapmani*			Priority 4	The pebble-mound mouse builds stone mounds that are most common on spurs and gentle slopes that have suitable-size stones.	BLK, ROC, BGD, OAK, PLA, TLG, CPN, RUT, GRC, BOO, JAM, MAC, MCK, NEW, TUR, WHS,WON	650,414	1,039	0.16%
Spectacled Hare-Wallaby	*Largochestes conspicullatus*			Priority 3	They live in open woodlands, shrublands and hummock grasslands, and large spinifex (*Triodia*) clumps (Biota 2005).	BOO, BGD, CAL, CPN, GRC, MAC, MAL, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, UAR, WHS, WON, YAM	701,948	1,721	0.25%
Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia*	Vulnerable	Schedule 1		Roost in caves in areas of high relief with gorges and watercourses (Armstrong 2001).	None	N/A	N/A	N/A

Common name	Species	EPBC Act	WC Act	DEC	Habitat	Land systems occurring in 30 km local reference corridor which potentially provide suitable habitat	Area of identified land systems in 30 km local reference corridor (ha)	Area of identified land systems in indicative 200 m construction corridor (ha)	Area of land system in indicative 200 m construction corridor as a proportion of the area of land systems in the 30 km local reference corridor (%)
Ghost Bat	*Macroderma gigas*			Priority 4	Rockpiles, caves.	BLK	465	0	N/A
Little North-western Mastiff Bat	*Mormopterus loriae cobourgiana*			Priority 1	Mangroves for prey foresting and roosting. Can be found in adjacent areas (Biota 2005).	LIT	11,740	0	0.00%
Reptiles									
Pilbara Olive Python	*Liasis olivaceus baroni*	Vulnerable	Schedule 1		Rocky habitats near water, particularly rock pools.	BLK, BOO, GRC, MAC, MCK, NEW, RIV, ROC, TLG, WON	589,646	841	0.14%
Blind Snake	*Ramphotyphlops ganei*			Priority 1	May be associated with moist gorges and gullies (Wilson & Swan 2003)	NEW, GRC	81,819	285	0.35%
Woma	*Aspidites ramsayi*		Schedule 4		Shows preference for coastal sands.	LIT	11,740	0	0.00%
Skink	*Ctenotus nigrilineatus*			Priority 1	Spinifex around granite outcrop and hilly interiors (BHPBilliton 2006)	BOO, GRC	86,545	347	0.40%
Birds									
Bush-stone Curlew	*Burhinus grallarius*			Priority 4	Long grass, woodland or open forest which provides shelter during the day (Ecologia 2008). Species requires permanent water nearby to be a resident (Johnstone & Storr 1998).	CWA, RIV, TUR, YAM	48,353	6	0.01%
Grey Falcon	*Falco hypoleucos*			Priority 4	Open timbered country (Macdonald, 1973)	BGD, COB, CWA, JAM, TUR, WAI	88,397	197	0.22%
Peregrine Falcon	*Falco peregrinus*		Schedule 4		Extremely diverse, from rainforest to arid scrub, from coastal heath to alpine (Morcombe 2004)	Potentially roosting in MCK and NEW, and foraging in all other habitats	106,204	63	0.06%

Common name	Species	EPBC Act	WC Act	DEC	Habitat	Land systems occurring in 30 km local reference corridor which potentially provide suitable habitat	Area of identified land systems in 30 km local reference corridor (ha)	Area of identified land systems in indicative 200 m construction corridor (ha)	Area of land system in indicative 200 m construction corridor as a proportion of the area of land systems in the 30 km local reference corridor (%)
Australian Bustard	*Ardeotis australis*			Priority 4	Grasslands especially tussock grasses, arid scrub and dry open woodland (Morcombe 2004).	BLK, BOO, BGD, CAL, CPN, GRC, JAM, MAC, MCK, MAL, NEW, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, TUR, UAR, WAI, WHS, WON, YAM	879,999	1,981	0.23%
Star Finch	*Neochmia ruficauda subclarescens*			Priority 4	Reedbeds and adjacent vegetation communities along permanent waterways. Also found in grasslands with sparse vegetation near permanent water (Johnstone & Storr 1998).	BOO, BGD, CAL, CPN, GRC, LIT, MAC, MAL, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, UAR, WHS, WON, YAM	713,688	1,721	0.24%
Night Parrot	*Pezoporus occidentalis*	Endangered Migratory	Schedule 1	Critical	Little known about this elusive bird. Most records from arid areas with *Triodia* spp., saltbush and samphire – usually in association with watercourses or saltmarshes or tussock grasslands (MacDonald 1973).	MSH, LIT,PDS, RIV, SAT, TUR, WHS, WON, YAM	147,840	19	0.01%
Eastern Great Egret,	*Ardea modesta*	Migratory			Inhabits mostly shallow fresh lakes, pools in rivers, lagoons, lignum swamps, clay pans and samphire flats, large dams and sewage ponds. It also inhabits shallow saltwater habitat such as mangrove creeks, tidal pools, samphire swamps and salt work ponds (Johnstone & Storr 1998).	LIT, MSH, RIV	89,385	6	0.01%

Common name	Species	EPBC Act	WC Act	DEC	Habitat	Land systems occurring in 30 km local reference corridor which potentially provide suitable habitat	Area of identified land systems in 30 km local reference corridor (ha)	Area of identified land systems in indicative 200 m construction corridor (ha)	Area of land system in indicative 200 m construction corridor as a proportion of the area of land systems in the 30 km local reference corridor (%)
Cattle Egret	*Ardea ibis*	Migratory			The species inhabits short grass, such as wetlands and damp pastures, and usually pastures habited by cattle, and occasionally other livestock (Johnstone & Storr 1998).	BLK, BOO, BGD, CAL, CPN, GRC, LIT, MAC, MAL, MSH, MCK, NEW, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, TUR, UAR, WHS, WON, YAM	893,466	1,791	0.20%
Rainbow Bee-eater	*Merops ornatus*	Migratory			Migrates between Indonesia and Australia, coming to Australia to breed. Prefers lightly wooded, preferably sandy environments close to water (Johnstone & Storr 1998). They nest in burrows dug in flat ground or sandy banks between August to January (Simpson & Day 2004).	BOO, CWA, LIT, MSH, RIV, UAR, YAM	270,648	773	0.29%
Fork-tailed Swift	*Apus pacificus*	Migratory			This is an aerial species, which feeds high above the tree canopy and rarely lower so is independent of terrestrial habitats (Johnstone & Storr 1998).	Independent of Habitat type	N/A	N/A	N/A
Oriental Plover, Oriental Dotterel	*Charadrius veredus*	Migratory			Found on sparsely vegetated plains including samphire (in spinifex plains particularly after fire) as well as beaches and tidal flats (Johnstone & Storr 1998).	BLK, BOO, BGD, CAL, CPN, CWA, GRC, JAM, LIT, MAC, MAL, MCK, MSH, NEW, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, TUR, UAR, WAI, WHS, WON, YAM	943,697	1,981	0.21%

Common name	Species	EPBC Act	WC Act	DEC	Habitat	Land systems occurring in 30 km local reference corridor which potentially provide suitable habitat	Area of identified land systems in 30 km local reference corridor (ha)	Area of identified land systems in indicative 200 m construction corridor (ha)	Area of land system in indicative 200 m construction corridor as a proportion of the area of land systems in the 30 km local reference corridor (%)
White-bellied Sea Eagle	*Haliaeetus leucogaster*	Migratory			Coasts and coastal islands, in vicinity of reefs, bays, headlands, beaches, estuaries, mangroves, swamps, lagoons and floodplains; often found far inland on large rivers (Morcombe 2004)	LIT, MSH, RIV, YAM	97,265	6	0.01%
Barn Swallow	*Hirundo rustica*	Migratory			Coastal bird, usually found in open sites in towns, often near water (Morcombe 2004)	BOO, BGD, CAL, CPN, GRC, LIT, MAC, MAL, OAK, PDS, PLA, RIV, ROB, ROC, RUT, SAT, TLG, UAR, WHS, WON, YAM	713,688	1,721	0.24%
Oriental Pratincole	*Glareola maldivarum*	Migratory			Often found over wetlands where clouds of insets accumulate, and more generally, on open plains, open areas around tidal flats, beaches and wetlands (Morcombe 2004).	LIT, RIV, YAM	54,968	6	0.01%

*An explanation of land system codes is presented in Section 5.2.3 Land systems

The railway will be placed on an elevated bed of coarse ballast and together with the adjacent access track may form a barrier to the movement of some terrestrial fauna in the area; therefore environmental culverts will be used to allow for fauna movement. Culverts constructed of circular corrugated pipe have been used along both BHP and TPI railway lines to allow for fauna movement. However, these are understood to be not ‘fauna friendly’ (i.e. vertebrate fauna are hesitant about moving through these culverts because of the corrugated iron base), so in many cases these types of culverts do not enable terrestrial fauna to move past the barrier (APM, 2010). Although the RHI Railway incorporates culverts for hydrological purposes, fauna-friendly passageways will be constructed where it is appropriate to allow for fauna migration.

Changed fire regime

Fire has been identified as a potential threatening process for some conservation-significant species in the Pilbara because a number of small mammal and bird species rely on long-unburnt vegetation.

A change in fire regime is often associated with increased human activity. Linear infrastructure such as rail lines and roads provide barriers to naturally occurring fires. Vital Options Consulting (2010) found that 100 years of cattle grazing has degraded much of the understorey and ground cover in many habitats in the Fortescue sub-region, reducing the likelihood that a natural fire regime exists in the area.

Construction activities and in particular hot work activities such as welding and grinding can increase the risk of fire. These activities will be managed through a hot works permit system.

Fire prevention strategies will include assisting DEC and local authorities with prescribed burns, implementation of a hot works permit system and regular inspections of work areas to ensure there is no fuel for fire.

Fire prevention and control will be managed with a fire management plan to be developed with consultation with DEC and other relevant stakeholders. The plan will provide management strategies and actions to reduce the risk of fires caused by construction or operational activities. A fire management framework is presented in Section 9.4.7.

Introduced plants

Introduced plant species can potentially invade areas of cleared or disturbed native vegetation. Weeds such as Buffel grass (*Cenchrus ciliaris*) are prolific in the Pilbara and readily invade disturbed areas, replacing native species. A weed management plan will provide management strategies and actions to prevent the introduction of weeds and control the spread of existing weed populations. The weed management framework is presented in Table 9-5.

Introduced fauna

An increase in human activity can be associated with an increase in the abundance of introduced species such as the house mouse (*Mus musculus*), feral cat (*Felis catus*) and wild dog (*Canis lupus*) in the absence of appropriate management. Increased abundance of introduced species can cause a decline in habitat vigour for endemic species and higher predation rates of native species.

The house mouse, cat and wild dog are known to be established in the general area. In many situations they have become a ‘naturalised’ species in the Australian bush. Increases in dog or cat numbers can have a detrimental impact on native fauna because they predate on and compete with native species, severely disrupting the natural balance. The extent to which feral herbivores such as goats, camels, donkeys and rabbits occur in the area does not appear to be known but can be reasonably presumed.

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

Risks associated with the introduction or increase of introduced species in the area will be reduced to a low residual risk with the implementation of management plans that include waste management strategies to ensure that food waste is not attracting species to the area. Reporting procedures will also be implemented to ensure populations can be monitored and controlled if necessary.

The draft fauna management plan (Appendix I) also includes strategies to prevent the introduction of pest species.

Road and rail deaths

An increase in fauna deaths is likely to occur where new roads are constructed or upgraded. Kangaroos, birds and ground-dwelling predators may be affected in particular. Most of the conservation-significant vertebrate fauna in the area, such as the Northern Quoll, Bilby, Bush Stone-curlew and the Pilbara Olive Python, can be casualties of night vehicle traffic. Species such as goannas and raptors and possibly Northern Quolls, are attracted to carrion on road verges and this may increase impacts to fauna.

Parts of the RHI Railway may be fenced to restrict human access, which will also restrict access for large fauna species such as pest camels and cattle. Vehicles will be restricted to designated roads and access tracks, speed limits will be enforced and traffic will be minimised as far as practicable to reduce the residual risk of traffic incidents. Any fauna death on the road or rail will be reported in accordance with the EMS, and corrective actions will be developed.

The probability of ecologically significant mortality levels caused by motor vehicles and iron ore trains is extremely low considering the low motor activity, minimal night activity and overriding dominance of droughts, floods and fire on population levels of all taxa in the investigation area.

Dust

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

A dust monitoring program will be implemented during construction and operation, including specific triggers for corrective action.

Fortescue Marsh adjacent area

The RHI Railway is located approximately 2.5 km from the Fortescue Marsh (using the Geoscience Australia reference boundary) at its closest point. Therefore, the direct construction footprint will not directly impact the Marsh or its immediate samphire fringe and is unlikely to have any indirect impact. A 7 km area along the boundary of the proposed 2015 conservation reserve will be intersected by the RHI Railway. The area of the proposed conservation estate is currently 42,388 ha. The temporary construction clearing (200 m) and permanent clearing (100 m) presents an insignificant impact on the conservation estate.

Any major ground disturbances in ephemeral watercourses during periods of flow can result in the displacement of large quantities of silt, which discolours the waterway downstream, and sediment can remain suspended for longer periods in remnant pools. These high levels of silt can impact upon the habitat of aquatic invertebrates and vertebrates. Any disturbance of watercourses will therefore be planned for periods when the creeks are unlikely to contain water in order to minimise this potential impact. It is not feasible to undertake construction works during high rainfall periods. In particular, the installation of bridges will be conducted in dry seasons to ensure the safety of construction workers, maintain the structural integrity of the works and to minimise environmental impact.

SRE terrestrial invertebrates and subterranean fauna

Bennelongia (2010b) conducted a desktop study of SREs for the BFS2 option along the northern side of the Fortescue Marsh. The conclusion presented was:

‘Within the constraints of a desktop study, it appears that the alignment will only present very low risk to SRE fauna, except in the Chichester Range where two habitat types with higher risk were identified, and in woodlands associated with creeks in the Fortescue Valley and Chichester Range where the risk is low.

The two Chichester Range habitats with greater risk are:

- South-facing slopes/mesas with rock outcrops or scree, with/without significant basal vegetation and likelihood of some shading; and
- Non-south facing slopes/mesas with rock outcrops or scree unlikely to receive significant shading.

The risks to SRE fauna in these two habitats, based on available information and the EPA guidelines, are considered to be moderate to high. Risk assessment for woodlands along creek lines would be improved by field inspection.' RHI will conduct further SRE investigations to clarify potential impacts.

There are few areas within the 2 km environmental approval corridor suitable for supporting SREs that are of conservation concern. Harvey (2006) reported *Dampetrus* 'Pilbara 1' and Slack-Smith (2006) reported an undescribed camaenid species of *Quistrachia* as possible SREs in the east-west TPI railway corridor. Fauna habitat along the 2 km environmental approval corridor is similar to that of the adjacent areas; these species may be found in adjacent areas. No stygofauna were reported from the field survey undertaken by FMG for the Stage B railway corridor.

Vertebrate species of conservation significance

The potential impacts on vertebrates of conservation significance are summarised in Table 9-7.

Table 9-7: Summary of impacts to conservation significant fauna

Species	Potential impacts
Blind snake *Ramphotyphlops ganei*	Little information is available on the biology of this species but records are all from south of the rail corridor (Newman, Pannawonica and Millstream, Storr et al. 2002). There are clearly extensive populations outside the rail corridor, and if the species is present most consequences are expected to be very localised and therefore Negligible. Mortality during clearing is probably inevitable while habitat alteration due to fire and weed invasion may be of concern (but still considered only Minor consequence as probably localised).
Pilbara Olive Python *Liasis olivaceus barroni*	Habitat (gullies, gorges and rocky ranges, particularly with watercourses) for the Pilbara Olive Python occurs in some sections of the rail corridor, particularly in the Chichester Range and possibly where major river systems (e.g. Yule and Turner Rivers) are crossed. Localised habitat loss is therefore inevitable, with some direct mortality, and the species is vulnerable to roadkill. Localised impacts and the species is widespread in the Pilbara. May occur at low population densities. Death from roadkill may be the greatest threat.
Woma *Aspidites ramsayi*	The Woma may occur on sandy soils along the rail corridor, particularly around Port Hedland. Localised habitat loss is inevitable, with some direct mortality, and the species is vulnerable to roadkill. These impacts should be localised and the species is widespread, especially to the north and east.
Fork-tailed Swift *Apus pacificus*	This is an almost entirely aerial species is Australia that is more or less independent of terrestrial developments. Therefore, all consequences are expected to be Negligible
Eastern Great Egret *Ardea modesta*	A widespread and abundant waterbird that may visit seasonal and permanent wetlands along the rail corridor. Because of its abundance, mobility and wide range of wetland types utilized, and the minimal impact expected of the rail corridor upon wetlands, all consequences are expected to be Negligible.

Species	Potential impacts
Cattle Egret *Ardea ibis*	A widespread and abundant waterbird across northern Australia, but an infrequent visitor in the Pilbara. Unlikely to be affected by the rail route because of its biology and the low impact upon wetlands, and impacts on individual birds would be of low importance as the species is effectively a vagrant in the region. Therefore, all consequences are expected to be Negligible.
White-bellied Sea Eagle *Haliaeetus leucogaster*	The White-bellied Sea-Eagle uses a variety of coastal habitats but will forage along major rivers, with records on the Fortescue Marshes (Bamford consulting database). The low impact of the rail development on broad, shallow wetlands and major rivers mean that all consequences are predicted to be Negligible.
Grey Falcon *Falco hypoleucos*	Occurs in low numbers along riverine woodlands in the Pilbara. Consequences of impacts are expected to be Negligible except for the possibility of hydrological change affecting Riverine trees, and fire regimes affecting the abundance of prey.
Peregrine Falcon *Falco peregrinus*	Occurs in low numbers along in the Pilbara, nesting on cliffs and in riverine trees. Consequences of impacts are expected to be Negligible except for the possibility of hydrological change affecting riverine trees, and fire regimes affecting the abundance of prey.
Australian Bustard *Ardeotis australis*	The Australian Bustard is very widespread and mobile, and impacts from the proposed railway arte likely to be Negligible except for roadkill, to which the species is sensitive, and possibly changed fire regimes.
Bush Stone-curlew *Burhinus grallarius*	The Bush Stone-curlew tends to occur along watercourses with associated dense acacia thickets in the Pilbara (M. Bamford pers. obs.). It is sensitive to roadkill and introduced predators, and possibly changed fire regimes and hydrological change. It appears to occur at low population densities and pairs may be sedentary, and therefore ongoing mortality can be a concern for local populations.
Migratory shorebirds sandpipers, some plovers and Oriental Pratincole	These shorebirds occur in large numbers along the coast near Port Hedland, and a few species occasionally occur in moderate numbers on the Fortescue Marshes (e.g. Common Greenshank and Marsh Sandpiper in this area in November 2009, Bamford Consulting database). Small numbers of migratory shorebirds could occur on wetlands anywhere in the region, while the Oriental Pratincole may occasionally occur in small numbers on grasslands. However, the low numbers, infrequent presence and low impact of the rail development on broad, shallow wetlands mean that all consequences are predicted to be Negligible.

Species	Potential impacts
Night Parrot *Pezoporus occidentalis*	Impacts upon the Night Parrot are difficult to quantify because the species is poorly-known. It has been recorded in a wide range of habitats but is possibly associated closely with the spinifex/samphire ecotone around seasonal wetlands such as the Fortescue Marshes (Higgins 1999), and such habitat lies outside the rail corridor. Impacts from changed fire regimes, introduced predators and weed invasion may be a concern, but the broad distribution of the species at apparently low densities, and its preference for habitats outside the rail corridor, mean that the consequences of these are predicted to be only Minor.
Rainbow Bee-eater *Merops ornatus*	A widespread and abundant species that could suffer some individual mortality, most likely from roadkill, but may also benefit from the creation of nesting habitat as it burrows in sloping banks. All consequences are expected to be Negligible.
Barn Swallow *Hirundo rustica*	A mostly aerial, non-breeding migrant in the Pilbara, usually seen only in coastal towns (M. Bamford pers. comm.). Consequences of any impacts therefore considered to be Negligible.
Star Finch *Neochmia ruficauda subclarescens*	In the Pilbara, the star finch is associated with semi-permanent or permanent creeks and ponds that support a dense vegetation of reeds. There should be little if any direct impact upon this environment, but it could be sensitive to hydrological change, while changed fire regimes can affect such riparian vegetation. The Star Finch is also at risk from roadkill as the birds will sometimes fly low, in flocks, along roads.
Mulgara *Dasycercus cristicauda,* *D. blythi*	The proposed rail corridor contains habitat (sandy soil vegetated with dense spinifex) suitable for mulgara from north of the Chichester Range to close to Port Hedland. Localised habitat loss is therefore inevitable, with some direct mortality and the species is vulnerable to roadkill. The species may also be affected by introduced predators that may move along the railway route using tracks for access, and is known to be sensitive to changed fire regimes. With the exception of fire, these impacts should be localised and the species is widespread regionally, including populations outside the Pilbara where habitat is more extensive. Changed fire regimes may be the greatest threat to the mulgara posed by the rail development.
Northern Quoll *Dasyurus hallucatus*	Habitat (gullies, rocky hills, gorges and rocky ranges) for the Northern Quoll occurs in some sections of the rail corridor, particularly in the Chichester Range. While the species is abundant in the Abydos and Panorama area, the rail route passes through plains between rocky hills in this area. Localised habitat loss is therefore inevitable, with some direct mortality and the species is vulnerable to roadkill. The species may also be affected by introduced predators and possibly changed fire regimes. However, these impacts should be localised and the species is widespread in the Pilbara. Incursions of introduced predators may be the greatest threat to the Northern Quoll posed by the rail development, with the route and associated service road potentially being used by predators to access areas where they might not otherwise occur.

Species	Potential impacts
Long-tailed Dunnart *Sminthopsis longicauda*	May occur in rocky environments such as the Chichester Range. Therefore small area of habitat loss and some direct mortality possible, but species is not known to be particularly sensitive to other impacting processes so consequences mostly Negligible.
Bilby *Macrotis lagotis*	The proposed rail corridor contains habitat (sandy soil vegetated with dense spinifex) suitable for the Bilby from north of the Chichester Range to close to Port Hedland, and the species is known to be patchily distributed through this region.. Localised habitat loss is therefore inevitable, with some direct mortality and the species is vulnerable to roadkill. The species is also known to be sensitive to introduced predators and changed fire regimes. While some of these impacts should be localised, the Bilby population is small and introduced predators and changed fire regimes have had Severe impacts on the species in other parts of its range. It is not thought that the rail route in isolation would have Severe impacts through introduced predators and changed fire regimes, but there may be cumulative consequences due to other projects.
Spectacled Hare-Wallaby *Lagorchestes conspicillatus*	The Spectacled Hare-Wallaby has declined across much of its range in Western Australia, with few recent sightings in the Pilbara. These include two recent records from the Abydos/Panorama area (Bamford Consulting database). Like the Bilby, the Spectacled Hare-Wallaby is particularly sensitive to introduced predators and changed fire regimes, although it is probably not so restricted in its distribution by soil type. With a small surviving population, mortality of individuals during operation may be significant, but changed fire regimes and incursion of introduced predators are likely to have the greatest consequence.
Ghost Bat *Macroderma gigas*	Roosting habitat is critical for this species in the Pilbara and there is limited roosting habitat along the rail route, although some in the general region of sections, such as around Abydos and possibly in the Chichester Range. Direct impacts are likely to be minimal but disturbance of roost caves during operation, such as from personnel visiting caves, may be a concern. When the route of the railway line is finalised, any caves likely to be disturbed should be investigated by a suitably trained and experienced zoologist to see whether they provide a roost for the species
Pilbara leaf-nosed Bat *Rhinonycteris aurantia*	Roosting habitat is critical for this species in the Pilbara and there is limited roosting habitat along the rail route, although some in the general region of sections, such as around Abydos and possibly in the Chichester Range. Direct impacts are likely to be minimal but disturbance of roost caves during operation, such as from personnel visiting caves, may be a concern, as this species is particularly sensitive to disturbance (Armstrong 2001). When the route of the railway line is finalised, any caves likely to be disturbed should be investigated by a suitably trained and experienced zoologist to see whether they provide a roost for the species.
Little North-western Mastiff Bat *Mormopterus loriae cobourgiana*	The Little North-western Mastiff Bat prefers mangrove habitats but can occur in adjacent areas. This bat species is relatively widespread and well represented in mangroves along the Pilbara coast (Biota 2005). It is unlikely that the proposed rail corridor will impact on this species.

Species	Potential impacts
Pebble-mound Mouse *Pseudomys chapmani*	The proposed rail corridor contains habitat (typically stony foothills supporting low spinifex) suitable for the Pebble-mound Mouse in several areas, and localised habitat loss and some direct mortality are inevitable. The species could also be affected by weed invasion and may be sensitive to changed fire regimes. However, it is widespread in the Pilbara and effects would be localised.
Lakeland Downs Mouse *Leggadina lakedownensis*	In the Pilbara, the Lakelands Downs Mouse is associated with grasslands on clay soils that may be subject to seasonal waterlogging. It may therefore be sensitive to hydrological change but other impacts, such as habitat loss, are likely to be vey localised. Suitable habitat is present along the rail corridor but is widespread across the Pilbara.
Skink *Ctenotus nigrilineatus*	The proposed rail corridor contains habitat suitable for Ctenotus nigrilineatus (Spinifex around granite outcrops and hilly interiors) and localised habitat loss from vegetation clearing could cause some mortality. The species could also be affected by changed fire regimes. Similar habitat will be present in areas adjacent to the rail corridor.
Short range endemic (SRE) invertebrates	Consequences of impacts upon SRE invertebrates will depend greatly upon the sorts of habitats affected along the railway. Isolated and relictual mesic environments can be important for SRE biodiversity. For this reason, hydrological change and fire may be important and have a consequence of Moderate. The consequence is not considered higher than this as the railway passes through often uniform landscapes and where environments are mesic, they are mostly drainage systems rather than isolated refugia. This means that the habitats they provide are extensive rather than fragmented and therefore very restricted SRE species are not expected.
Stygofauna	Consequences mostly considered low as stygofauna should be little-affected by clearing and minor earthworks associated with a railway. However, hydrological change may be a factor to be considered, depending upon the relationship between surface and sub-surface hydrology.

Risk assessment and management

Table 9-8 presents a risk assessment for DEWHA and DEC listed fauna species that may be present or potentially affected by the RHI Railway. Bamford (2010) conducted a risk assessment of threatened species found in the DEC database thought to be in the vicinity of the RHI Railway. Bamford Consulting did not include the Little North-western Mastiff Bat or the skink, *Ctenotus nigrillineatus* in its review as they were not thought likely to occur within the environmental approval corridor.

The Bamford (2010) risk assessment in Appendix F concluded that "the Bush Stone-curlew and Night Parrot have a mitigated or residual risk of Medium because of uncertainty and because they may be vulnerable to several impacting processes, meaning there is cumulative impact to be considered. The other species at risk have fewer impacting processes of concern, with some of these in common. Processes of greatest concern and most vulnerable species are: operating mortality (Pilbara Olive Python, Greater Bilby and Spectacled Hare-Wallaby), hydrological change (stygofauna), introduced predators (Northern Quoll, Bilby and Spectacled Hare-Wallaby) and changed fire regimes (Mulgara, Bilby and Spectacled Hare-Wallaby)."

Table 9-8, adapted from Bamford (2010), shows most risks to fauna are considered medium or low and therefore are manageable following the application of management controls. For each species, key impact processes, controls, inherent and mitigated risks are identified. Risks of concern are highlighted.

Table 9-8: Risk assessment for individual species of conservation significance.

Species	Key impacting processes	Risk level	Mitigation actions	Risk level
Blind snake	Clearing, habitat degradation (weeds), changed fire regimes	Medium	Clearing controls, rehabilitation, weed management	Low
Pilbara Olive Python	Clearing and operations, hydrological change, predators	Medium	Clearing controls, traffic management, relocation, underpasses, drainage management, predator management	Medium
Woma Python	Clearing and operations, predators	Medium	Clearing controls, traffic management, underpasses, predator management	Low
Fork-tailed Swift	Nil	Very Low		Very Low
Eastern Great Egret	Possibly hydrological change	Very Low		Very Low
Cattle Egret	Possibly hydrological change	Very Low		Very Low
White-bellied Sea-Eagle	Possibly hydrological change	Very Low		Very Low
Grey Falcon	Hydrological and fire regime change	Low	Drainage and fire management	Very Low
Peregrine Falcon	Hydrological and fire regime change	Low	Drainage and fire management	Very Low
Australian Bustard	Operation and changed fire regimes	Medium	Traffic and fire management	Low
Bush Stone-curlew	Clearing operations, habitat loss and degradation, hydrological change, introduced predators and changed fire regimes	Medium	Clearing controls, rehabilitation, weed management, traffic management, predator control and fire management	Medium
Migratory shorebirds	Possibly hydrological change	Very Low		Very Low
Night Parrot	Clearing, operations, habitat loss and degradation, hydrological change, introduced predators, disturbance and changed fire regimes	Medium	Clearing controls, rehabilitation, weed management, traffic management, predator control, fire management and management of dust, noise, light and disturbance	Medium
Rainbow Bee-eater	Possibly operations	Low	Traffic management during breeding season	Very Low

Species	Key impacting processes	Risk level	Mitigation actions	Risk level
Skink *Ctenotus nigrilineatus*	Clearing, habitat loss, fragmentation and degradation (weeds), changed fire regimes	Medium	Clearing controls, rehabilitation, weed management	Low
Little North-western Mastiff Bat	Disturbance	Low		Low
Barn Swallow	Nil	Very Low		Very Low
Star Finch	Operations, hydrological change, habitat degradation (weeds) changed fire regimes	Medium	Weed management, traffic management and fire management	Low
Mulgara	Clearing, operations, habitat loss, introduced predators and changed fire regimes	High	Clearing controls, rehabilitation, traffic management, predator control and fire	Medium
Northern Quoll	Clearing, operations, habitat loss, introduced predators and changed fire regimes	High	Clearing controls, rehabilitation, traffic management, predator control and fire	Medium
Long-tailed Dunnart	Clearing, habitat loss	Medium	Clearing controls, rehabilitation	Low
Greater Bilby	Clearing, operations, habitat loss and degradation, introduced predators and changed fire regimes	High	Clearing controls, rehabilitation, traffic management, weed management, predator control and fire	Medium
Spectacled Hare-Wallaby	Clearing, operations, habitat degradation (weeds), introduced predators and changed fire regimes	High	Clearing controls, traffic management, weed management, predator control and fire	Medium
Ghost Bat	Disturbance	Low	Personnel awareness	Low
Pilbara leaf-nosed Bat	Disturbance	Medium	Personnel awareness	Low
Pebble-mound Mouse	Clearing, habitat fragmentation and degradation (weeds), and changed fire regimes	Medium	Clearing controls, weed management, fire management	Low
Lakeland Downs Mouse	Clearing, habitat fragmentation and degradation, hydrological change and changed fire regimes	Medium	Clearing controls, weed, drainage and fire management	Low
SRE invertebrates	Clearing, population reduction and fragmentation, hydrological change, habitat degradation (weeds), changed fire regimes	High	Clearing controls, weed, drainage and fire management	Low
Stygofauna	Hydrological change	Medium	Drainage management	Medium

Vegetation clearing and construction activities have the potential to impact upon these fauna and their habitat. Pre-construction clearing surveys of the final 200 m construction corridor will be conducted to:

- Identify key terrestrial habitats and specifically any active or inactive dens or burrows;
- Identify threatened or significant species in areas where information is lacking;
- Use this information in the rail design to avoid or minimise impact on these habitats to the extent practicable;
- Identify the areas to be avoided and link to the Ground Disturbance Permit system; and
- Develop additional mitigation measures where required beyond those stated in the draft Fauna management plan (Appendix I).

A draft fauna environmental management plan is included as Appendix I, which will be implemented during construction and operation. The following management strategies will also be implemented:

- Detailed engineering design incorporating hydrology, topography and geotechnical information to determine disturbance area, drainage design, proposed excavations and specific sources of borrow materials;
- Surface water management will be implemented as described in Appendix J;
- A groundwater management plan will be implemented to minimise impacts to SRE and subterranean fauna habitat; and
- Other potential impacts (primarily fire and hydrocarbon contamination) will be managed through the construction and operation EMPs. For example, a fire prevention strategy will be implemented and include a requirement that all vehicles and equipment carry a fire extinguisher and fire blanket, with all personnel to be trained in fire response.

These measures are considered to be standard for rail construction and operation within the Pilbara. With the implementation of these measures, potential project impacts on identified conservation significant fauna species are not likely to be significant. The possible presence of a conservation significant species in the railway corridor should not be interpreted as indicating the development of the RHI Railway will have a significant impact on the local persistence of these species. Adult conservation-significant birds such as the Peregrine Falcon, Grey Falcon, Australian Bustard and Bush Stone-curlew are expected to move to areas adjacent to the construction corridor and the 2 km environmental approval corridor once ground disturbance activity begins.

Fauna survey information and the implementation of standard management measures will further minimise potential impacts to fauna and their habitat.

Although the environmental risk to SREs is generally low, RHI will undertake a targeted SRE survey within prospective SRE habitats identified by Bennelongia (2010b). Results from the survey will used to avoid or minimise impacts on SRE and develop appropriate additional mitigation measures if required.

A framework for fauna management is presented in Table 9-9. A draft fauna management plan is presented in Appendix I.

Table 9-9: Fauna management framework

Fauna management framework	
Management issues	Impacts on terrestrial fauna from construction activities include disturbance outside the approved areas, loss of habitat from cleared areas, habitat fragmentation, human interaction and noise and dust.
Objectives	Avoid known habitats that host sensitive species. Prevent death of fauna as a result of construction activities as far as possible. Prevent the spread of introduced species.
Performance indicators	No direct impact to fauna outside the approved disturbance corridor. No impact to fauna of conservation significance. Incidents relating to native fauna will be reported on an incident report.
Management strategies	Conduct pre-construction vertebrate and SRE fauna surveys in targeted areas along the railway corridor to identify any threatened and significant species in areas where information is lacking. Minimise the disturbance footprint and conduct rehabilitation progressively. Demarcate approved clearing areas and any buffers for areas to be avoided. Implement a ground disturbance system and procedure. Provide inductions and training to raise fauna awareness and educate the workforce on fauna management procedures. Backfill trenches and pits as soon as practicable and fit fauna escape measures as required for all excavations left open overnight. Implement dust suppression measures. Avoid night works as far as practicable. If night works must occur then lighting shall be arranged to minimise illumination of known fauna habitats outside working areas. Implement traffic management strategies, limit vehicles to approved access roads. Implement fire management strategies to prevent spread of fire from the working areas. Record all fauna sightings. Implement pest control programs where necessary. Implement housekeeping measures to limit introduced species access to resources.

Fauna management framework	
Monitoring	Monitor disturbance in and adjacent to the working areas for the duration of the works. Inspect all open trenches and pits daily before work begins to remove trapped or injured fauna. Undertake inspections for introduced/feral species; record all follow-up actions.
Reporting	Report all incidents using the incident reporting system. All sightings of EPBC Act listed species will be reported to the DEC. Report fauna injury or death as a result of construction activities and carry out an investigation to determine cause of injury or death. A register of all fauna sightings will be maintained.
Corrective action	Death or injury to fauna arising as a result of construction activities will be investigated. Management actions will be reviewed and changes implemented to prevent reoccurrence of any death or injury event. Review the feral/introduced animal control programs if pest populations increase.

Residual Risks

Potential impact on fauna is a key factor for the RHI Railway Project. RHI's assessment has identified a number of potential impacts on fauna, including fauna of conservation significance. For each potential risk the residual risk rating is medium or lower. Therefore the level of risk has been assessed as acceptable by technical specialists with effective measures in place. RHI has identified the management strategies necessary to address these potential impacts and they will form part of the Roy Hill EMS. Specifically, a fauna management plan will be implemented. Consequently, RHI considers that the EPA's objectives can be met in respect of fauna.

9.3.3 Surface Water

Overview

The proposed railway will cross several major drainage lines occur in this area north of the Chichester Range, including the Turner, Yule and Shaw rivers, all of which drain northwards to the coast. The area of investigation also includes the drainage basin for the Fortescue Marsh. The rail embankment has the potential to alter surface water flows significantly, in terms of both in quality and quantity, which can lead to environmental degradation.

EPA Objectives

The following objective applies to management of impacts on surface water:

- To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.

Legislation and Policy

The key statutory requirements, policy and guidance relevant to surface water are:

- EPA Position Statement No.2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000); and
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000).

Potential Impacts

The RHI railway is proposed to be located adjacent to the Turner River in the northern-most 30km of the route and then crosses several major ephemeral drainage lines in the Turner, Upper Yule Upper Shaw and Upper Fortescue river catchments. The railway runs parallel to the surface water flow direction in the Upper Yule, Upper Shaw and Upper Fortescue river catchments. Bridges will be constructed over the large rivers, while culverts will be installed along the railway embankment for creek crossings and smaller drainage channels.

Potential impacts include changes to flooding characteristics, scouring, erosion and siltation of drainage channels, inundation of upstream areas and loss of water to downstream areas. The use of effective drainage controls are expected to mitigate the above impacts, especially on the Upper Fortescue Basin and the Fortescue Marsh.

The proposed railway will not completely or substantially block any major drainage line as the bridges will be designed for a 1-in-100 year flood event. Where minor drainage lines are crossed without bridges being used, there could be local- to medium-scale impacts from some obstruction to stream or sheetflows. This will need to be addressed in final design to minimise this risk. Excavations for borrow pits or alteration of the terrain for cut and fill earthworks required for the rail may interrupt natural surface water drainage and will require treatment. The proposed RHI Railway crosses areas of sheetflow on which stands of mulga depend for survival. It is a design requirement that sheetflow is re-established within a short distance of the downstream side of the embankment in these areas.

Environmental culverts will be installed along the rail embankment in areas with sheetflow-dependent vegetation and in areas near the Fortescue Marsh. Riprap pads will be installed in areas to re-establish the natural sheetflow pattern by slowing and spreading the flow out of the environmental culverts. Other drainage controls will be used to maintain the quantity and quality of surface water inflows and runoff patterns around the Fortescue Marsh including ditches and levee banks to spread and slow runoff of surface water. Scour protection blankets will also be installed in the inlets and outlets of culverts to reduce the potential for erosion and scouring. The position of environmental culverts and other drainage control measures in sensitive environments will be chosen based on a visual assessment of the vegetation, soils and drainage patterns.

Surface water channels and floodplain areas will need managed vegetation clearing, as exposed areas could increase erosion and sedimentation during runoff events. The cleared areas not required for the long-term operation of the RHI Railway will be progressively rehabilitated. To reduce the erosion potential, stabilising materials will be used on steep areas adjacent to drainage channels that have been cleared.

The formation of windrows during grading of the access road can increase the sediment load in surface water runoff. However, this can be prevented by installing the railway access road downslope of the railway embankment to prevent water flow mobilising sediment from the windrows and increasing the sediment loading into the downstream drainage channels.

Hydrocarbon contamination could also affect the surface water quality. However, direct water contamination is unlikely because construction will not occur near waterways during the wet season, due to the typically intense rainfall and flooding patterns making construction activities difficult. Spills at other times would be controlled by management practices.

Risk assessment and management

While the inherent risk associated with surface water management can be significant, this risk can be readily mitigated. Table 9-10 outlines the processes associated with the risk and the mitigation that can be conducted to reduce the risk to an acceptable level.

The surface water management framework is presented in Table 9-11. A draft surface water management plan is presented in Appendix J.

Table 9-10: Risk assessment for surface water.

Aspect	Key impacting processes	Risk level	Mitigation actions	Risk level
Altered hydrological regime	Lack of or inadequate drainage design; failure to maintain subtle flows such as sheet flow; altered flows to groundwater-dependent vegetation; reduced water quality arising from erosion or contamination.	High	Design of rail infrastructure to appropriate engineering standards; inclusion of 'environmental' culverts at appropriate locations along the alignment; suitable stabilisation works where drainage channels are disturbed during construction; water and vegetation monitoring.	Low

Table 9-11: Surface water management framework

Surface water management framework	
Management issues	Construction may change surface water quality and quantity and subsequently adversely impact: • downstream water quality and quantity; • downstream vegetation and fauna communities; • downstream erosion, siltation, sedimentation and turbidity processes.
Objectives	Maintain the function and environmental values of watercourses and sheetflow. Limit disturbance from clearing, excavation and construction in and around water courses. Comply with relevant legislation and standards
Performance indicators	Maintain the quality of the surface water flows upstream and downstream of the railway. No unmitigated releases of hydrocarbons or chemicals. No loss of significant vegetation outside of the approved disturbance corridor due to changes to surface quality or quantity.
Management strategies	Design bridges, culverts and river crossings to limit impacts on flows and water quality during flood events.; Crossings will be designed to accommodate 1-in-100 year rainfall events. Scour protection measures will be taken into account for all crossings and low-lying sections subject to seasonal inundation; Appropriate drainage structures will also be designed to maintain existing sheetflow to downstream mulga communities. Limit dust and silt runoff into streams and watercourses – implement sediment and erosion controls to prevent scouring and erosion. Minimise clearing footprint wherever possible and progressively rehabilitate areas. • Manage chemicals and hydrocarbons in accordance with the *Dangerous Goods Safety Act 2004* and *Australian Standard 1940* – see chemical and hydrocarbon management framework.
Monitoring	Visually monitor vegetation communities to determine the effect of surface water changes. Inspect culverts and riprap pads before the onset of the typical wet season, and following significant rainfall events that create surface runoff. Visual inspection of work areas and chemical and hydrocarbon storage areas to ensure compliance with the *Dangerous Goods Safety Act 2004* and *Australian Standard 1940* – see chemical and hydrocarbon management framework.

Surface water management framework	
Reporting	Site environmental staff will be informed if there is any damage or blockage of culverts, riprap pads or any other erosion, and remediation action will be taken. Report all incidents using the incident reporting system. All spills and contamination events will be immediately cleaned up following spill procedures and reported to site environmental staff. Investigate and report all incidents and non-compliances and implement corrective actions.
Corrective actions	Any impact on vegetation communities from surface water changes will be investigated and surface water management controls will be reviewed and revised as required.

The proposed environmental surveys and management plans to address potential impacts on surface water are described below.

- Reconnaissance surveys with biological survey teams and engineering design teams to:
  - describe and map the existing surface drainage and streamflow patterns and sediment transport;
  - identify sheetflow locations and use this information for design of, and site selection for, culverts to be installed along the rail corridor to minimise impacts on sheetflow; and
  - provide information for applications for beds and banks permits.
- Detailed engineering design incorporating hydrology and topography information to determine floodplain widths, bridge lengths and culvert sizing will be undertaken.
- Develop and implement a Surface Water Management Plan (Appendix J).
- Develop and implement a Mulga, flora and other communities Management Plan (Appendix H); and
- Implement procedures to address chemical and hydrocarbon contamination risks (see Chemical and Hydrocarbon Management Framework in Section 0).

Residual Risks

The residual risk for surface water management is Low. The potential impacts can be readily mitigated and the EPA's objective in respect of surface water can be met.

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9.4 Other environmental factors

9.4.1 Groundwater

EPA Objective

The following objective applies to management of impacts on groundwater:

- To maintain the quantity of water so that existing and potential environmental values, including ecosystem.

Potential impacts

Groundwater abstraction for construction is the main activity likely to affect the groundwater environment in the project area. Groundwater is required for dust suppression, soil compaction, maintenance works, construction camp water supply and for servicing the marshalling yard. The project is expected to require approximately 5 GL of water during construction, with less than 2 GL/a required during operation. For construction, individual water source locations spaced 10 km to 15 km apart will be developed consisting of two to five production bores that will have a combined capacity to supply 15 L/s. The groundwater is to be sourced from minor aquifers (described in Section 8.6) which have limited extent. Abstraction has the potential to decrease local groundwater levels and quality.

Groundwater abstraction has potential to affect:

- subterranean fauna (stygofauna/troglofauna);
- groundwater-dependent ecosystems; and
- other groundwater users.

It is expected that abstraction bores will be used for periods of one to six months during the construction phase for individual sections of the rail proposal. Individual bores may also be used intermittently as a water source during railway operation. This ‘short-term’ operating regime alleviates permanent impacts on the groundwater environment as groundwater levels and quality will quickly rebound after abstraction ceases. On similar projects in this region of the Pilbara, it has been observed that groundwater-dependent ecosystems are tolerant of significant short-term fluctuations in groundwater levels.

Groundwater monitoring will be undertaken to manage abstraction and options for action will be prepared in case any issues arise.

The bore configurations will be designed to optimise abstraction against aquifer and well losses, which determine the degree of groundwater-level decline. Changes in quality are hard to predict because of limited historical data and may only become evident upon the monitored operation of the bores over a six to 12 month period. This would be managed as part of the groundwater and bore management plan and 5C License conditions. From knowledge of the operation of bores in similar localities, it is possible that salinity may increase locally during periods of low rainfall and high abstraction, and decrease after periods of rainfall due to infiltration recharge.

It is possible that impacts may occur where groundwater abstraction from production bores target the same aquifer as third-party bores within the local area (<1,000 m apart). A stakeholder management plan will be implemented where impacts on third-party boreholes are evident as a result of abstraction for this project.

Due to the limited duration of pumping it is unlikely there will be any long-term impacts on groundwater levels. The existing bores near the RHI Railway that have been installed for water supply for construction of either rail or road have been operated on a temporary basis without apparent adverse impacts on the groundwater environment.

The main environmentally sensitive environments are the fractured rock aquifers that may support stygofauna or troglofauna. The results of simplistic modelled analyses of likely responses during abstraction show that drawdown impact zones are unlikely to extend more than 250 m from the production bores. Groundwater levels are expected to recover within four to five weeks after the discontinuation of pumping. Effects on fractured rock aquifers during groundwater abstraction are likely to be limited to the more permeable fracture zones, which because of their depth and limited extent are unlikely to significantly affect groundwater-dependent vegetation. Similar studies elsewhere in the Pilbara have shown that stygofauna populations can tolerate significant short-to medium-term fluctuations in groundwater levels. As such, the short-term nature of the abstractions associated with the railway construction are unlikely to result in long-term impacts.

Due to the limited nature of water resources in the Pilbara, water-use efficiency should be considered across all components of the project. For railway construction purposes, the following opportunities for water-use reduction should be considered:

- turkey's nest dams should be limited to 30 m x 30 m to reduce the surface area subject to evaporative losses;
- cut-off switches should be used to ensure that dams do not overflow; and
- where practicable, the use of additives in dust suppression water should be investigated for use during rail construction to reduce water usage for general dust suppression.

It is unlikely that any regional-scale impacts to aquifers and vegetation health would occur from increases or decreases in recharge effectiveness from the construction and operation of the RHI Railway.

There is a minor risk to water quality from surface contamination by hydrocarbon spills. Groundwater in most areas is 20 m or more from the surface, so direct contamination by a spill is unlikely. During the construction and operation phases of the RHI Railway, appropriate controls (e.g. hydrocarbon spill response procedures) will be in place to clean up any spill and to minimise the risk of contamination of groundwater.

Management

A framework for the management of groundwater impacts is presented in Table 9-12.

Table 9-12: Groundwater management framework

Groundwater management framework	
Management issues	Construction may have temporary impacts on groundwater quality and quantity.
Objectives	Maintain the availability and quality of groundwater so that existing environmental values are protected. Minimise the potential for groundwater contamination to ensure that pollution does not adversely affect environmental values or health, the welfare and amenity of people and of land uses consistent with the *Australian and New Zealand guidelines for fresh and marine water quality* (ANZECC & ARMCANZ 2000) and taking into consideration the existing baseline water quality.
Performance indicators	No permanent measurable change to existing groundwater levels and groundwater quality following cessation of groundwater abstraction for construction.

Groundwater management framework	
Management strategies	• Implement an integrated water use management strategy for managing water supplies that will include issues addressing water balances, sustainable groundwater use, minimising impacts to other waterbodies, DoW licence compliance, groundwater and bore management strategies (as part of the construction and operation management plans) and contingency water sources. • Continue investigations into water sources, including liaising with surrounding land users regarding the use of existing bores. Investigations may include the following: • use existing bore data to create groundwater maps and hydrological models to the level required for construction project and 5C licensing; and • pump tests and water quality tests of project and other bores for the purposes of collecting baseline data and ongoing monitoring results to the level required for 5C licensing. Licences to sink bores under Section 26D and to take groundwater under Section 5C of the *Rights in Water and Irrigation Act 1914* shall be obtained and the conditions adhered to for all bores used for construction activities. Design of infrastructure and selection of laydown areas to limit the potential for groundwater contamination, e.g. fuel tank locations, locomotive refuelling sites. Manage chemicals and hydrocarbons in accordance with the *Dangerous Goods Safety Act 2004; the Occupational Safety and Health Regulations 1996;* Code of Practice for the Control of Workplace Hazardous Substances and *Australian Standard 1940* – see the chemical and hydrocarbon management framework.
Monitoring	Visual inspection of work areas and chemical storage areas to verify that chemicals and hydrocarbons are being stored and managed in accordance with the *Dangerous Goods Safety Act 2004* and *Australian Standard 1940* – see chemical and hydrocarbon management framework.
Reporting	Any removal or damage to groundwater production bores shall be reported to the site environmental staff.
Corrective actions	Investigations will be undertaken to determine the cause and the bore either remediated or replaced. For the appropriate spill response – see the chemical and hydrocarbon management framework.

9.4.2 Social issues

EPA Objective

The EPA does not have an objective that applies to this factor.

Potential impacts

The construction workforce will be accommodated in construction camps located along the railway route and will have limited demand on the social resources of the regional communities. Workforce impacts are therefore considered to be negligible. During operation of the railway proposal the locomotive drivers and rail personnel will be accommodated in Port Hedland or at the Roy Hill mine camp.

During construction, there will be a temporary increase in the volume and type of traffic on roads used to access the corridor. During the rail operation, the potential impact on communities is the temporary disruption of road traffic at crossings, noise from trains and locomotives, obstruction to livestock movements and disruption to mustering arrangements.

Consultation fatigue is a potential risk for RHI in its dealings with stakeholders and communities. There are a number of projects currently underway in this area and consultation will occur according to good consultation guidelines and standards, including techniques from the Ministerial Council on Mineral & Petroleum Resources (MCMPR) and the International Association for Public Participation.

Management

These construction and operation impacts will be managed through the construction and operation environmental management plans and stakeholder consultation.These will include:

- identify and confirm the roles of key stakeholders in the project.
- define the level of consultation according to the relative influence of the stakeholders and develop the appropriate communication tools, as part of a stakeholder consultation strategy; and
- ongoing stakeholder consultation.

9.4.3 Topsoil and rehabilitation management

EPA Objective

The following objective applies to rehabilitation:

- To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.

Potential impacts

- The potential impacts from poor topsoil management techniques are a reduction in the effectiveness of rehabilitation efforts and an increase in sedimentation of waterways through erosion.

Management

Topsoil will be handled and stored appropriately to maximise its quality for rehabilitation and to promote survival of the seed bank in the soil. RHI will develop a topsoil and rehabilitation management plan using the management framework proposed in Table 9-13.

Table 9-13: Topsoil and rehabilitation management framework

Topsoil and rehabilitation management framework	
Management issues	Clearing of vegetation may have detrimental effects on the topsoil through increased erosion or contamination; these problems may continue if inappropriate rehabilitation occurs.
Objectives	Minimise erosion and sedimentation effects related to vegetation clearing and topsoil removal. Maximise the re-use of topsoil for rehabilitation. Comply with the *Soil and Land Conservation Act 1945* (WA).
Performance indicators	Rehabilitation of the construction area using stored topsoil.

Topsoil and rehabilitation management framework	
Management strategies	Develop topsoil and rehabilitation management strategies as part of the construction management plan. Topsoil shall be retained for rehabilitation. Topsoil stripped from weed risk areas shall be stored near to its source and disposed of or only used to rehabilitate the area from which it was collected, as per the weed hygiene management strategies to be set out in the construction and operation management plans. Ensure all vegetation removed is placed directly on disturbed areas to reduce erosion, stockpiled for use in rehabilitation. Progressively rehabilitate borrow, laydown and construction areas as the railway construction front advances in accordance with the topsoil and rehabilitation management strategies, to be set out in the construction management plan. Burning of cleared vegetation will not take place. Topsoil stockpiles should be no higher than 1.5m, clearly signposted and identified on a site plan; subsoil can be stockpiled up to 4m high. Topsoil and cleared vegetation will be stockpiled and reused as part of rehabilitation to take advantage of the local seed bank. Subsoil stockpiles shall be surveyed, and the quantities of soil, source coordinates and date stripped shall be recorded.
Monitoring	Monitoring of the effectiveness of control methods (erosion, sedimentation etc.). Visual and photographic monitoring of rehabilitation through sequential stages of rehabilitation.
Reporting	Report all incidents using incident reporting system. External compliance reporting as required.
Corrective actions	Results of monitoring programs will be reviewed and opportunities to improve assessed continually throughout rehabilitation.

9.4.4 Acid sulfate soil management

EPA Objective

The following objective applies to management of acid sulphate soils:

- To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria

Potential impacts

The DEC acid sulfate soil risk map indicates that acid sulfate soils are not present along the proposal RHI Railway construction corridor. However, there are unconfirmed reports that these soils may be present in areas intersected by the rail proposal near the Boodarie Industrial Estate. The presence of acid sulfate soils in these areas will be further investigated and confirmed upon route and infrastructure finalisation.

The disturbance of acid sulfate soils has the capacity to directly impact on the basic natural assets of soil, water and biota, and thus may affect other industries as well as human health and visual amenity. The environmental, social and economic consequences that may result include:

- soil acidification leading to reduction of soil stability and fertility;
- adverse changes to the quality of soil and water (groundwater, surface water, wetlands, watercourses and estuaries);
- degradation of wetlands and water-dependant ecosystems by invasion and dominance of acid-tolerant water plants and plankton species;
- loss of habitat and biodiversity;
- loss of/deterioration in quality of water sources for stock, irrigation and human use by increasing acidity and heavy metal concentrations;
- loss of visual amenity by rust coloured stains, scums and slimes from iron precipitates;
- risk of long-term infrastructure damage through acidic water corroding metallic and concrete structures (concrete cancer) such as roads, bridges, pumps, subsurface pipes; and
- increased financial burden of treating and rehabilitating affected areas and maintenance of infrastructure.

Management

Management and future studies will include:

- design of the railway to avoid disturbance of acid sulfate soils wherever possible; and
- use of an acid sulfate soils EMP to minimise potential impacts, where disturbance of these soils is unavoidable.

An acid sulphate soils management plan will be developed using the management framework proposed in Table 9-14.

Table 9-14: Acid sulphate soils management framework

Acid sulfate soils management framework	
Management issues	Construction of the railway may result in disturbance to acid sulfate soils. Disturbance of these soils may generate acid release and damage to nearby vegetation and watercourses.
Objectives	Apply DEC guidelines appropriately to the project's scope of work: • *Identification and investigation of acid sulfate soils* (October 2004) • *Treatment and management of disturbed acid sulfate soils* (October 2004) Take all reasonable and practicable measures to minimise the discharge of waste and prevent pollution to the environment, as required by the *Environmental Protection Act 1986.*
Performance indicators	Appropriate storage and disposal of disturbed acid sulfate soils; No release of contaminated water into the environment; and Rehabilitation of disturbed areas in accordance with guidelines.
Management strategies	Accurate identification of acid sulfate soils and their associated risk to ensure that any disturbance of land containing these soils is planned and managed to avoid adverse effects on the natural environment. Using the guiding principle that the disturbance of acid sulfate soils should be avoided wherever possible. Where disturbance of acid sulfate soils by development is unavoidable, development should be undertaken in a manner that mitigates potential adverse impacts on the built and natural environment using the most appropriate management techniques. Potential impacts of disturbance must be treated and managed to prevent potential short- and long-term environmental harm.
Monitoring	Surface water and groundwater monitoring as outlined in the surface water management plan and groundwater management strategies, to be set out in the construction and operation management plans.
Reporting	Report all incidents using the incident reporting system. Investigate all incidents and, where necessary, report to the appropriate authority.
Corrective action	Where it is evident that contaminated water is affecting areas adjacent to or downstream of the acid sulfate soils disturbed due to construction activities, direct remedial action will be undertaken to prevent further contamination.

9.4.5 Air quality and greenhouse gas

EPA Objectives

The following objectives apply to management of air quality and greenhouse gases:

- To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards; and
- To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.

Potential impacts

Changes to air quality from construction activities may result in adverse impacts on vegetation, fauna, human health, air quality and safety. Dust can be produced by vegetation clearing which exposes soil surfaces that are then mobilised by wind, vehicle and machinery movements and earthworks that require moving soil. During operations, the contents of the open rail cars could erode and create dust. Dust can move offsite and affect surrounding vegetation and any members of the public within the area of impact.

The nearest sensitive receptors for dust offsite are:

- road users at the road crossings, where dust may reduce visibility or visual amenity;
- vegetation may be smothered by dust, reducing local vegetation health; and
- Indee homestead and the Abydos Woodstock community at least 3 km from the RHI Railway may be affected under certain wind conditions.

The dust impacts from construction are expected to be minor as dust will be managed as part of occupational health and safety requirements, thus limiting the possibility for major or widespread impacts offsite. Operational impacts from dust are expected to be negligible, as the iron ore will be damp during transport and dust lift-off is unlikely during normal operations.

Greenhouse gas emissions will be a matter for the project as a whole—encompassing the mine, rail and port operations. Potential impacts from these emissions are expected to be insignificant. The main impacts are from burning of fuel in trucks during construction and locomotives.

Management

Future studies and management of air quality and greenhouse gas emissions are presented in the management framework in Table 9-15.

Table 9-15: Air quality and greenhouse gas management framework

Air quality and greenhouse gas management framework	
Management issues	Changes to air quality from construction activities may result in adverse impacts on vegetation, fauna, human health, air quality and safety.
Objectives	Minimise emissions (dust and greenhouse gases) during construction.
Performance indicators	Dust complaints lodged by the community will be addressed. Audits and regular maintenance and servicing of contractors vehicles and equipment.
Management strategies	Regular inspections of servicing and maintenance records for vehicles and equipment to ensure that vehicles and equipment maintain efficiency. Emissions from the project will be reported as part of RHI company-wide emissions if RHI triggers reporting thresholds as a corporation and is therefore required to report under the *National Greenhouse and Energy Reporting Act 2007*. Minimise the requirements for clearing and rehabilitate progressively wherever practicable. Use water to suppress dust emissions, increase frequency when appropriate. Management of vehicle speed while on construction areas to reduce dust emissions. Areas not required for ongoing operations will be rehabilitated to restore the pre-clearing vegetation biomass over time.
Monitoring	Measure greenhouse gas emissions to allow for reporting under the *National Greenhouse and Energy Reporting Act 2007*. Regular visual inspections of vehicles and equipment to ensure that emissions are not excessive.
Reporting	Report all incidents using the incident reporting system. Investigate all complaints of excessive emissions and report to the appropriate authority. Greenhouse gas emissions (for RHI as a whole company) may be required under the *National Greenhouse and Energy Reporting Act 2007.*
Corrective action	In the event of public complaints, actions will be implemented to investigate and resolve the cause of the complaint.

9.4.6 Waste management

EPA Objective

The following objective applies to waste management:

- To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

Potential impacts

Inappropriate waste storage can reduce social amenity, affect fauna health and attract scavenging fauna to the project area. These risks can be effectively minimised with management procedures.

Resource wastage will also be managed to minimise any unnecessary demand for water, energy, materials or landfill facilities.

Management

A waste management plan will be developed and implemented for both the construction and operation phases of the RHI Railway. The framework for the waste management plan is presented in Table 9-16.

Table 9-16: Waste management framework

Waste management framework	
Management issues	Inappropriate disposal and poor management of both solid and liquid waste has the potential to cause environmental contamination.
Objectives	Minimise the generation of waste and prevent uncontrolled waste discharge into the environment. Ensure that disposal/management of waste does not adversely affect environmental values or amenity for people and land use. Dispose of waste in accordance with regulatory and legislative requirements including Environmental Protection (Controlled Waste) Regulations 2004.
Performance indicators	No waste left outside designated containers at the end of any work day. All controlled waste tracked and recorded.

Waste management framework	
Management strategies	Implement the waste hierarchy in managing waste: avoidance; re-use; recycling; treatment; containment; and disposal Promote continuous improvement initiatives and incorporate the four 'R' principles (reduce, re-use, recycle and recover) in induction procedures and at site meetings. Include waste management procedures in site induction. Manage waste so that any disposal minimises environmental impacts, e.g. controlled landfill that is sealed, lined and covered. Practice waste minimisation/reduction; include this in tenders for supply and construction. Provide waste stations that include segregation of waste types (green waste, general rubbish, recycling, controlled waste etc.). Recycle scrap metal. Store and dispose of contaminated wastes (hydrocarbon contaminated material) appropriately (designated storage drums stored on bunded pallets or within a bunded containment, disposed of at a licensed facility). Obtain approval and disposal permits for hazardous waste from local authorities prior to transporting waste from the site. Controlled waste to be removed from the site by a licensed waste contractor in accordance with the Controlled Waste Regulations 2004. All rubbish will be contained and prevented from blowing away while being stored or during transportation for proper disposal. Comply with the *Environmental Protection Act 1986, Waste Avoidance and Resource Recovery Act 2007* and the *Health Act 1911 (Part IV).*
Monitoring	Visual inspections for littering and inappropriate waste disposal (clean up where necessary). Regular inspection of waste storage and disposal facilities. Monitor and record volumes of waste disposed to on-site landfill or removed from site (recycled or disposed).
Reporting	Waste inventory catalogue developed; document disposal volumes, types and disposal locations. Unauthorised waste disposal will be reported to DEC as a breach of the Environmental Protection (Controlled Waste Regulations) 2004.
Corrective actions	Spill or suspected contamination will be investigated, cleaned up, documented and reported.

9.4.7 Fire management

EPA Objective

The following objective applies to fire management:

- To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

Potential impacts

Construction activities can increase the risk of fire and may result in damage to the environment, health and safety issues and loss of property. Fire breaks and other management procedures will be implemented to minimise the fire risk.

Management

The framework presented in Table 9-17 will be used to develop the fire management plans and procedures to be used in the construction and operation of the RHI railway.

Table 9-17: Fire management framework

Fire management framework	
Management issues	Construction activities can increase the risk of fire and may result in damage to the environment.
Objectives	Carry out efficient, effective and safe management of fire within the construction area to protect humans, animals, vegetation, property and environmental values. Implement fire prevention controls. Comply with *Bush Fires Act 1954.*
Performance indicators	No unplanned fires during construction and operation.

Fire management framework	
Management strategies	Develop and implement a fire and emergency response plan and procedure. Implement a fire break around camps, key infrastructure (e.g. telecoms towers) and active construction locations. All vehicles to be equipped with fire extinguishers (and fire-proof blankets) Implement a hot work permitting system which includes a detailed risk assessment that must be completed before any hot works begin. A daily weather check for fire ban status will be undertaken before any hot works begin. An exemption from FESA to Section 22B of the *Bush Fires Act 1954* for hot work activities producing flames or sparks (such as grinding and welding) on total fire ban days in WA shall be obtained before any hot works begin. Regular inspections of fire-fighting equipment shall be conducted to ensure it is maintained in working order. Fire-fighting equipment commensurate with the risk shall be available for high fire-risk activities. Flammable products will be stored in flammable goods storage cabinets in accordance with AS1940-1988. Fire protection and prevention training shall be incorporated into site inductions and include a discussion of high fire-risk activities. Selected personnel will be trained in fire fighting. Smoking shall be confined to designated smoking areas.
Monitoring	Monitoring of contractor and employee behaviour to ensure that fire protection and prevention procedures are being followed. Regular inspections of fire prevention and control equipment to ensure that the equipment is maintained in working order and is available as required by procedures.
Reporting	Reporting procedures consistent with regulatory requirements will be developed.
Corrective actions	In the event of a fire, investigate the root cause of the fire and implement actions to ensure that similar incidents do not occur.

9.4.8 Chemicals and hydrocarbon management

EPA Objective

The following objective applies to chemical and hydrocarbon management:

- To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

Potential impacts

The construction and operation phases involve fuel and chemical storage and use of machinery and vehicles. Spills of waste could, fauna and vegetation. Spills and incorrect disposal of chemicals or hydrocarbons may affect the health of humans by contaminating potable surface and groundwater supplies. It may also impact vegetation and the habitats of native fauna.

Management

A management plans and procedures will be developed using the framework presented in Table 9-18.

Table 9-18: Chemicals and hydrocarbon management framework

Chemicals and hydrocarbon management framework	
Management issues	Spills of chemicals or hydrocarbons may contaminate soil, subsoil, surface water and groundwater, damage vegetation and injure or kill fauna.
Objectives	To minimise the environmental impacts of storage, handling, usage and transportation of hydrocarbons and chemicals on-site. To ensure a rapid response to all spills. To comply with Environmental Protection (Unauthorised Discharges) Regulations 2004, *Environmental Protection Act 1986* and *Health Act 1911 (Part IV), AS 1940,* and *Dangerous Goods Safety Act 2004.*
Performance indicators	No unmitigated release of hydrocarbons or chemicals; all spills managed according to procedure; Chemicals and hydrocarbons are stored in areas designed to appropriate standards; and Relevant personnel trained in spill response and safe handling and storage of hazardous materials.

Chemicals and hydrocarbon management framework	
Management strategies	Store, handle and transport all hydrocarbons and chemicals according to the *AS 1940* and *Dangerous Goods Safety Act 2004*. Material safety data sheets (MSDSs) will be available where each chemical or hydrocarbon product is used or stored. Staff will be appropriately trained to safely handle the chemicals and hydrocarbons relevant to their work. Fire-fighting equipment will be available in hazardous chemical storage areas. Flammable products will be stored in flammable goods storage cabinets in accordance with AS1940-1988. Selected personnel will be trained in spill response and fire-fighting. All hazardous chemicals and hydrocarbons will be stored in bunded areas as per project bunding specifications outlined in the chemical and hydrocarbon management plan. Develop a spill prevention and response procedure and an emergency response procedure for larger spills. Information on correct materials' handling procedures, spill management and spill response procedures will be included in inductions for all site personnel. Emergency spill kits shall be maintained on-site in easily accessible locations. Develop an approvals process for chemicals and hydrocarbons to be allowed onsite; use only approved chemicals and hydrocarbons. All hydrocarbon contaminated material and items listed in Schedule 1 will be managed in accordance with the Environmental Protection (Controlled Waste) Regulations 2004.
Monitoring	Regular checking of storage, handling and transportation procedures for all hydrocarbons and chemicals. Regular inspection of bund integrity and storage areas for hydrocarbons and hazardous chemicals. Regular inspections of fire-fighting equipment will be undertaken to ensure that it is in working order.
Reporting	Report all incidents using the incident reporting system. All spills and contamination events will be immediately cleaned up and where appropriate reported to the site environmental staff and to appropriate authorities according to regulatory requirements.
Corrective Action	Spills or suspected new contamination will be investigated, documented and reported to the appropriate authorities. Revision of procedures where necessary.

9.4.9 Noise and vibration management

EPA Objective

The following objective applies to chemical and hydrocarbon management:

- To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

Potential impacts

Noise and vibration can disturb fauna and other land users. The noise and vibration receptors of concern for the rail project are:

- relatively immobile fauna found within or very near the project area;
- Indee homestead and the Woodstock Abydos Group community are relatively close to the alignment.

Fauna may experience a minor and temporary impact, although previous studies have concluded that, although initially frightened, many animals are able to quickly adapt to ignore human-generated noise if other sensory systems are not also stimulated (Fletcher & Busnel 1978).

The main noise and vibration generating activities of vehicle and machinery use are unlikely to significantly affect the surrounding communities. If the final design shows the possibility of significant noise being generated (e.g. extensive blasting in an area), then construction noise reduction measures will be applied.

Noise sensitive design will be used to minimise the impacts during operation (e.g. sizing rail loops to facilitate the smooth approach of trains). The impact to the sensitive receptors will be modelled to inform the design of the rail infrastructure.

Management

A noise and vibration management plan and supporting procedures will be developed using the framework presented in Table 9-19.

Table 9-19: Noise and vibration management framework

Noise and vibration management framework	
Management issues	Noise and vibration during construction may result in detrimental impacts to fauna through stress and changes in their natural behaviour.
Objectives	Limit noise-generating activities and avoid noise at night so that impacts on fauna are limited. Ensure that noise and vibration impacts from construction activities comply with statutory requirements and appropriate standards.

Noise and vibration management framework	
Performance indicators	Noise levels do not exceed those listed in the Environmental Protection (Noise) Regulations 1997.
Management strategies	Noise and vibration management actions will be included in the CEMP and OEMP. All activities will be conducted in accordance with the Environmental Protection (Noise) Regulations 1997 and *Australian Standard 2436-1981: Guide to noise control on construction, maintenance and demolition sites.* Where necessary equipment will be appropriately fitted with noise reduction devices and vibration suppression controls. Work outside of the above timeframe will be demonstrated to be necessary and carried out according to section 6 of *AS 2436-1981.* Blasting noise to be managed according to Regulation 11 of the Environmental Protection (Noise) Regulations 1997.
Monitoring	Maintain and monitor noise control strategies to determine effectiveness.
Reporting	Report all incidents using the incident reporting system. Investigate all complaints and report complaints to the appropriate authority.
Corrective action	Investigations will be made to establish the cause of excessive noise or vibration and actions will be taken to reduce noise and vibration.

9.4.10 Visual amenity

EPA objective

The following objective applies to chemical and hydrocarbon management:

- To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.

Potential impacts and management

During construction and operations RHI Railway, infrastructure and associated equipment will be visible from the surrounding pastoral stations within the immediate vicinity of the railway and could be viewed from roads and pastoral tracks near the development. However, the visual impact of the railway is anticipated to be low due to the relatively modest height of equipment and structures. Rehabilitation will begin from the construction phase. Areas of temporary disturbance will be rehabilitated to a state of the landscape's former aesthetic value to the greatest practicable extent.

The Pilbara region has a social environment and economy that is dominated by the mining and petroleum industries and thus the RHI Railway is expected to represent a typical and therefore unremarkable visual characteristic of the area.

9.4.11 Cultural Heritage

EPA Objectives

The following objective applies to management of impacts on heritage:

- To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

Potential Impacts

Failure to undertake the appropriate surveys is very likely to result in an unauthorised loss of Aboriginal cultural materials and a breach of the legislation.

Management

To date, 152 Aboriginal heritage sites previously recorded on the DIA Aboriginal sites register have been identified within the 2 km environmental approval corridor. Further survey work is necessary to fully document the ethnographic and archaeological values. Once this has occurred, the *Aboriginal Heritage Act 1972* dictates the areas must either be avoided or disturbance permitted under Section 18.

Prior to ground disturbance construction activity taking place, archaeological and ethnographic surveys will be undertaken with the relevant traditional owners as part of finalising the alignment and placement of infrastructure, including borrow pits. RHI will meet with the three native title claimant groups (Palyku, Kariyarra and Nyiyaparli) to arrange for the necessary Aboriginal heritage surveys to identify sites and discuss the survey results.

Should additional sites be located within the corridor, RHI will either re-design the railway to avoid impacting upon them or, where this is not practicable, seek Ministerial consent under Section 18 of the *Aboriginal Heritage Act 1972* to use the land on which sites are located. Sites which can be avoided will be demarcated for their protection to ensure that inadvertent disturbance does not occur during construction activities. A Cultural Heritage Management Plan will be prepared and implemented.

The framework for the cultural heritage management plan is presented in Table 9 20.

Table 9-20: Cultural heritage management framework

Cultural heritage management framework	
Management issues	Construction activities may disturb cultural heritage, sites and objects.
Objectives	Limit the impact of the rail construction on cultural heritage values, artefacts and traditional land uses. Ensure the project complies with the *Aboriginal Heritage Act 1972, Heritage Of Western Australia Act 1990* and *Environmental Protection and Biodiversity Conservation Act 1999*.
Performance indicators	No unauthorised access to, or disturbance of, cultural heritage sites. Protection and management of preserved cultural heritage sites. No disturbance of areas of heritage significance without approval under Section 18 of the *Aboriginal Heritage Act 1972*.
Management strategies	Develop a cultural heritage management plan. Develop a ground disturbance procedure that ensures sites to be preserved can be identified and avoided during clearing activities. A site register shall be maintained with the GPS locations of all protected areas around identified sites. The area work clearance permit issued before work starts in any new areas will include a requirement to check the site register for locations of identified sites. Heritage consultants shall assess the construction area during the early phase of construction. Before construction, Indigenous heritage surveys shall be completed for proposed construction areas. All cultural heritage sites shall be identified and reported to DIA. Approval under Section 18 of the AH Act to disturb sites will be obtained where avoiding identified sites is not possible. Develop a cultural heritage induction with site access inductions that detail any areas where access is prohibited. Subject to meeting operational and occupational health and safety requirements, provide access to protected heritage sites for Indigenous people.
Monitoring	Monitoring of the activities and impacts of the site preparation workforce on the social and cultural environment will be undertaken. Aboriginal heritage surveys shall be completed before construction begins and all sites found will be flagged. Inspections shall be carried out during construction to ensure flagging is in place and sites are not disturbed unless a Section 18 approval has been obtained.

Cultural heritage management framework	
Reporting	Any unauthorised access or disturbance of heritage areas shall be reported to the construction manager immediately. Report all incidents using the incident reporting system. If a site is identified or discovered, contractors shall cease work and report the site to the construction manager immediately. Work shall not recommence until the site is investigated, documented and reported and permission is obtained for work to recommence. Any disturbance of heritage areas to be reported to DIA. External compliance reporting shall occur as per requirements of any Section 18 approval.
Corrective actions	If a site is identified or discovered, work will cease in the immediate vicinity until the site is investigated and permission is given to recommence work. Any unauthorised access shall be investigated and changes to procedures made to prevent a reoccurrence.

Future studies and management will include:

- archaeological and anthropological surveys as part of finalising the railway construction corridor and borrow pit locations;
- implementing a cultural heritage management plan;
- ongoing consultation with relevant native title claim groups;
- applications will be made for approval to disturb sites that will be impacted by construction work.

The residual risk for cultural heritage management is Low. The potential impacts can be readily mitigated and the EPA's objective in respect of cultural heritage can be met.

10 OFFSETS

RHI has sought to avoid and mitigate significant environmental impacts where practicable. As the project proceeds, practicable measures to avoid, mitigate and manage the environmental impacts of the railway will be incorporated within the project design, construction methods and operational practices. This includes development and implementation of environmental management plans (EMPs) addressing key environmental issues, supported by an ISO 14001 compliant environmental management system (EMS).

RHI recognises that despite these measures the proposed railway will result in some unavoidable environmental impacts on areas of significant environmental value, through activities such as vegetation clearing, with consequent temporary or permanent loss of habitat and dependent species. RHI is committed to appropriately compensating for these impacts through an effective environmental offsets package. The full detail of such an offsets package can only be defined as the design of the railway, its operational requirements and the findings of field investigations are reported. RHI is consulting stakeholders and gaining their input during development of the offsets package. Elements of the package have already been identified by RHI, informed by its investigations and consultation with the DEC, EPA, DEWHA and various technical experts.

In formulating an environmental offsets package RHI will have regard to the principles of the EPA position statement no. 6: '*Environmental offsets*' (EPA 2006) and the Department of Environment and Water Resources (DEWR, now DEWHA) discussion paper: '*Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999'* (DEWR 2007).

The offsets package will comprise of:

- *Direct offsets:* environmentally beneficial activities undertaken to counterbalance an adverse environmental impact or harm, with the goal of achieving 'no net loss' and preferably a 'net environmental benefit'. Examples may include actions such as restoration, rehabilitation or re-establishment.
- *Contributing offsets:* environmentally beneficial activities undertaken to complement and enhance the direct offset activity. Contributing offsets do not assist in a 'no net loss' outcome, but instead add materially to environmental knowledge, research, management and/or protection.

The offset package will address unavoidable impacts through contributions to biodiversity conservation initiatives such the proposed Fortescue Marsh conservation estate. It will contribute to the knowledge base of issues considered significant at both the state and federal levels and include contributions to existing DEC programmes, new research programmes and land acquisitions.

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11 CONCLUSIONS

Roy Hill Infrastructure Pty Ltd proposes to construct and operate a railway from the Roy Hill 1 Iron Ore Project to a port facility at Port Hedland.

This document identifies the potential environmental impacts associated with the project and outlines how those impacts can be effectively managed. With appropriate management measures in place all potential impacts have a medium or lower risk rating and have been assessed as acceptable by various technical specialists. It is the view of the company that these impacts can be managed in a manner that does not compromise the EPA's objective in relation to both the key and other environmental factors.

Therefore the project raises a small number of key environmental factors that can be readily managed, the project meets EPA objectives and stakeholder interest is limited locally.

Finally, Table 11-1 shows how RHI in planning and implementing the railway proposal has and will continue to adopt the principles of environmental protection as outlined in section 4A of the EP Act and expanded upon in *EPA position statement no. 7* (2004a), which are:

- the precautionary principle;
- the principle of intergenerational equity;
- the principle of conservation of biological diversity and ecological integrity;
- principles relating to improved valuation, pricing and incentive mechanisms; and
- principles of waste minimisation.

In particular, these principles were considered as part of an options assessment and selection process, including selection of a preferred route.

Table 11-1: Principles of environmental protection

Principle of environmental protection	Relevant	Consideration
Precautionary principle	Yes	Scientific studies have been completed to determine the baseline conditions of the existing environment (Section 5.1). RHI has completed a risk assessment for the railway proposal which identified the key environmental factors for the proposal (Section 8.10.1).

Principle of environmental protection	Relevant	Consideration
Principle of intergenerational equity	Yes	RHI is committed to the principles of sustainable development and considers that the railway proposal can be implemented without adverse impact on the environment for future generations. Where practicable, Aboriginal heritage sites will be avoided. If any Aboriginal sites or objects will be disturbed, RHI will obtain relevant consents under the AHA.
Principle of conservation of biological diversity and ecological integrity	Yes	Biological investigations have been used to identify the environmental baseline. The railway proposal will adhere to Western Australian and Commonwealth statutes and regulations as well as key international agreements that may apply.
Principles relating to improved valuation, pricing and incentive mechanisms	Yes	RHI recognises and accepts the costs of managing the railway proposal and its environmental impacts. The cost of environmental management will be included in the costs provided to the RHI Board for approval. Within the execution phase of the railway proposal, RHI will make procurement decisions that incorporate valuation, pricing and incentive mechanisms. RHI will look to adhere to these principles in all phases of implementing the railway proposal including decommissioning.
Principles of waste minimisation	Yes	RHI will adopt the following approach to waste management for the railway proposal: • avoid waste creation and reduce waste generation at the source; • re-use and recycle; and • treat and/or dispose of waste.

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Engineering Drawings

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Appendix A: Ecological Survey Comparative Analysis

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Appendix B: Multi-Criteria Analysis

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Appendix C: Preliminary Risk Assessment

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Appendix D: Addendum to Environmental Referral November 2009

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Appendix E: NatureMap Priority Fauna Species

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Appendix F: Bamford Fauna Risk Assessment

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Appendix G: Terrestrial Ecosystems Fauna Risk Assessment

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Appendix H: Draft Mulga, Flora and Other Communities Management Plan

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Appendix I: Draft Fauna Management Plan

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Appendix J: Surface Water Management Plan

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