ROY HILL INFRASTRUCTURE PTY LTD

Roy Hill Infrastructure Railway

Mulga, Other Flora and Communities Management Plan

RH1-001-30-EN-REP-0043

9 July 2010

SYNOPSIS

This document has been developed for the design and planning phase of the Roy Hill Infrastructure Railway. It provides information on the strategies to identify and manage potential impacts on significant flora and vegetation communities (including mulga) during the construction and operation of the Roy Hill Infrastructure Railway.

Disclaimer

REV	DESCRIPTION	ORIG	REVIEW	DATE	RHI APPROVAL	DATE
E	Draft	C La Fontaine G Barrett	I Pound	24/05/2010		
F	Draft	G Barrett	I Pound	30//06/2010	Ailan Tran	9/07/2010

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1. INTRODUCTION

1.1 Background

Roy Hill Infrastructure Pty Ltd (RHI) is proposing to construct and operate a railway (the Roy Hill Infrastructure Railway) and associated infrastructure to transport iron ore from the Roy Hill 1 Mine, near Newman, Western Australia, to port infrastructure at Port Hedland.

Following the consideration of several design route options, the base case option has been selected (Figure 1). The 300km route comprised two parts: the southern-most 120km extending from the Roy Hill 1 Mine to the point at which the BFS1 route crosses the BHP Billiton Iron Ore (BHPBIO) Port Hedland – Newman railway (the 'Southern Section'), and the remaining 180km north to Port Hedland (the 'Northern Section').

The railway will require assessment under both State and Commonwealth environmental legislation. A referral has been prepared for submission to the Western Australian Environmental Protection Authority (EPA) under the *Environmental Protection Act 1986* (Roy Hill Infrastructure, 2010). Assessment under the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* will occur concurrently. This management plan has been prepared as a supporting document to the referral.

1.2 Purpose and scope

This document is one of a series of management plans that has been prepared to provide strategies for identification and management of potential environmental impacts from construction and operation of the RHI Railway. This plan relates to potential impacts on mulga vegetation, which occurs along the southern portion of the railway, and other flora and vegetation communities. This version of the plan is aimed at the design and planning phase of the Project and will be reviewed and revised as the findings from studies are provided and input and advice is received from key stakeholders, in particular government agencies.

1.3 Objectives

The objectives of this plan are to:

- Identify, evaluate and minimise the potential impacts to significant flora and vegetation during the construction and operation of the Project;
- Outline the general management requirements for significant flora and vegetation that may be required within the railway corridor; and
- Identify, at this preliminary stage, some specific measures that will be incorporated into RHI's management program.

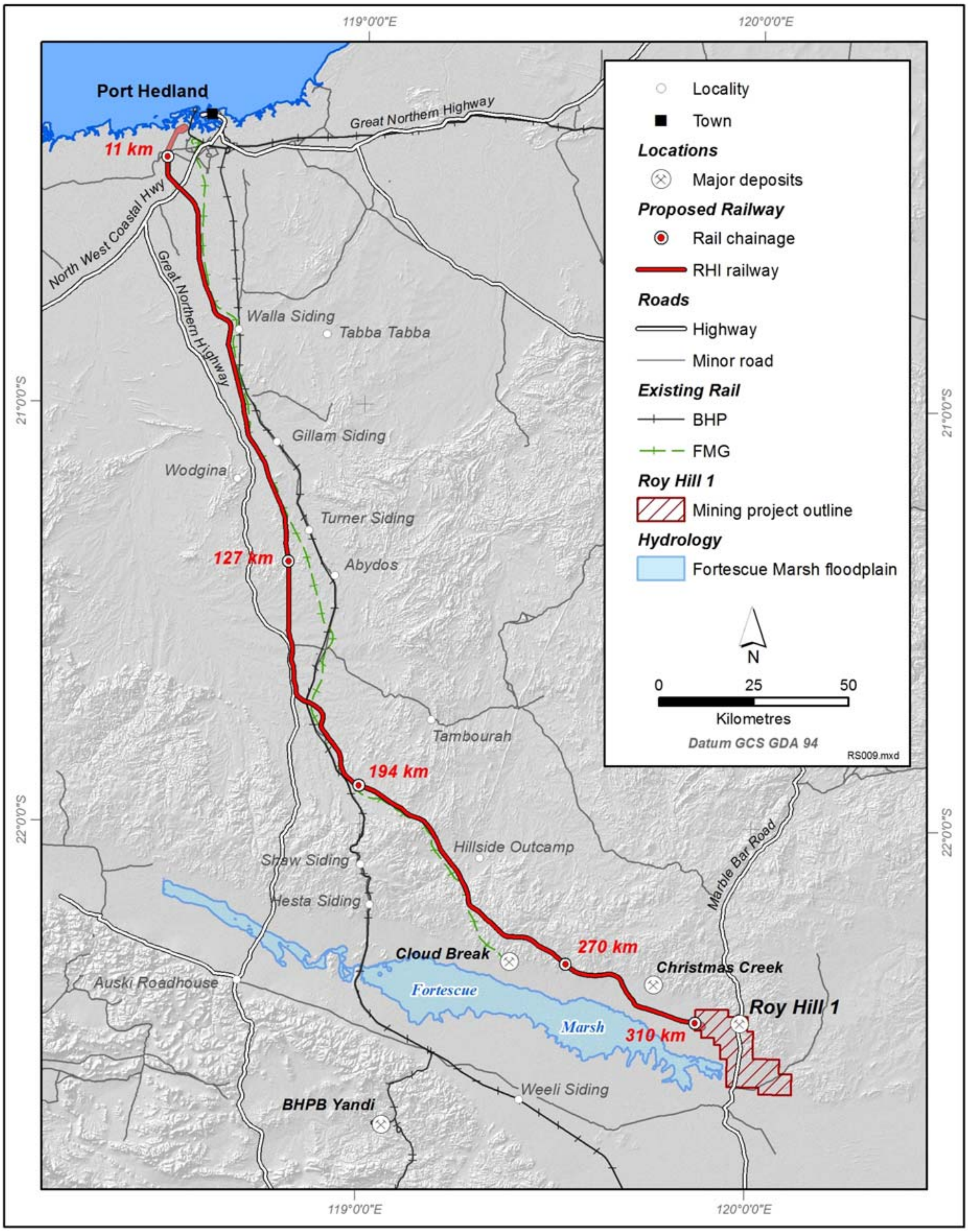

Figure 1: Overview map

1.4 Relevant Legislation

1.4.1 Commonwealth Legislation

The relevant Commonwealth legislation relating to significant flora and vegetation management is the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999.* The Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places - defined in the Act as matters of national environmental significance.

1.4.2 State Legislation

The relevant Western Australian legislation and regulations relating to flora management include the following:

- *Wildlife Conservation Act 1950;*
- *Environmental Protection Act 1986;*
- *Environmental Protection Regulations 1987;*
- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004;*
- *Soil and Land Conservation Act 1945;* and
- *Soil and Land Conservation Regulations 1992.*

2. EXISTING ENVIRONMENT

2.1 Land systems

The land systems of the Pilbara region have been described and mapped by van Vreeswyk et al. (2004). The following section discusses the land systems that are intersected by the RHI Railway (Figure 2).

The 0.2km wide construction disturbance corridor (0.1km either side of the base case centre line) and the 2km environmental approval corridor (1km either side of the base case centre line) both cross 17 of the land systems described by Van Vreeswyk et al. (2004). The 30km local reference area (15km either side of the base case centre line) crosses 34 of the land systems. The final construction corridor alignment will be within the 2km environmental approval corridor. Placement within the corridor will be dependent upon social, engineering and environmental constraints.

Appendix 1 lists the land systems and the extent of each within the construction disturbance corridor, the environmental approval corridor and the local reference area. The 0.2km wide construction corridor represents a conservative estimate of the clearing area that may be required for the railway and railway access tracks.

Estimates are listed of the level of impact on each land system at a regional (Pilbara) and local (30km reference area) scale. The potential disturbance to any of the land systems from the whole of the 0.2km disturbance corridor footprint does not exceed 1% at both regional and local scales. The highest disturbance at a local scale would be to the Calcrete Land System (0.84%) and at a regional scale to the Jamindie, Mallina and Uaroo Land Systems (0.09%).

Of the 17 land systems that could be impacted by the construction corridor, the Turee and White Springs Land Systems are considered to be poorly represented within the Pilbara, as their total areas are small - 26,564ha (White Springs) and 58,055ha (Turee). However, when compared to their land area, the indicative impacts on the Turee and White Springs Land Systems are less than 0.2% of their extent within the Pilbara.

The Wona Land System is not one of the smaller land systems in the Pilbara (181540 ha) but some of the vegetation units that occur on it have been listed at a PEC. Some of the Wona Land System is crossed by an existing track that is proposed to be upgraded for access to the rail alignment.

2.2 Flora and vegetation

2.2.1 Regional context

The study area is within the Pilbara IBRA region (Thackway & Cresswell 1995). There are 85 IBRA regions across Australia and the Pilbara is divided into four subregions. The study area crosses the Fortescue, Roebourne and Chichester subregions.

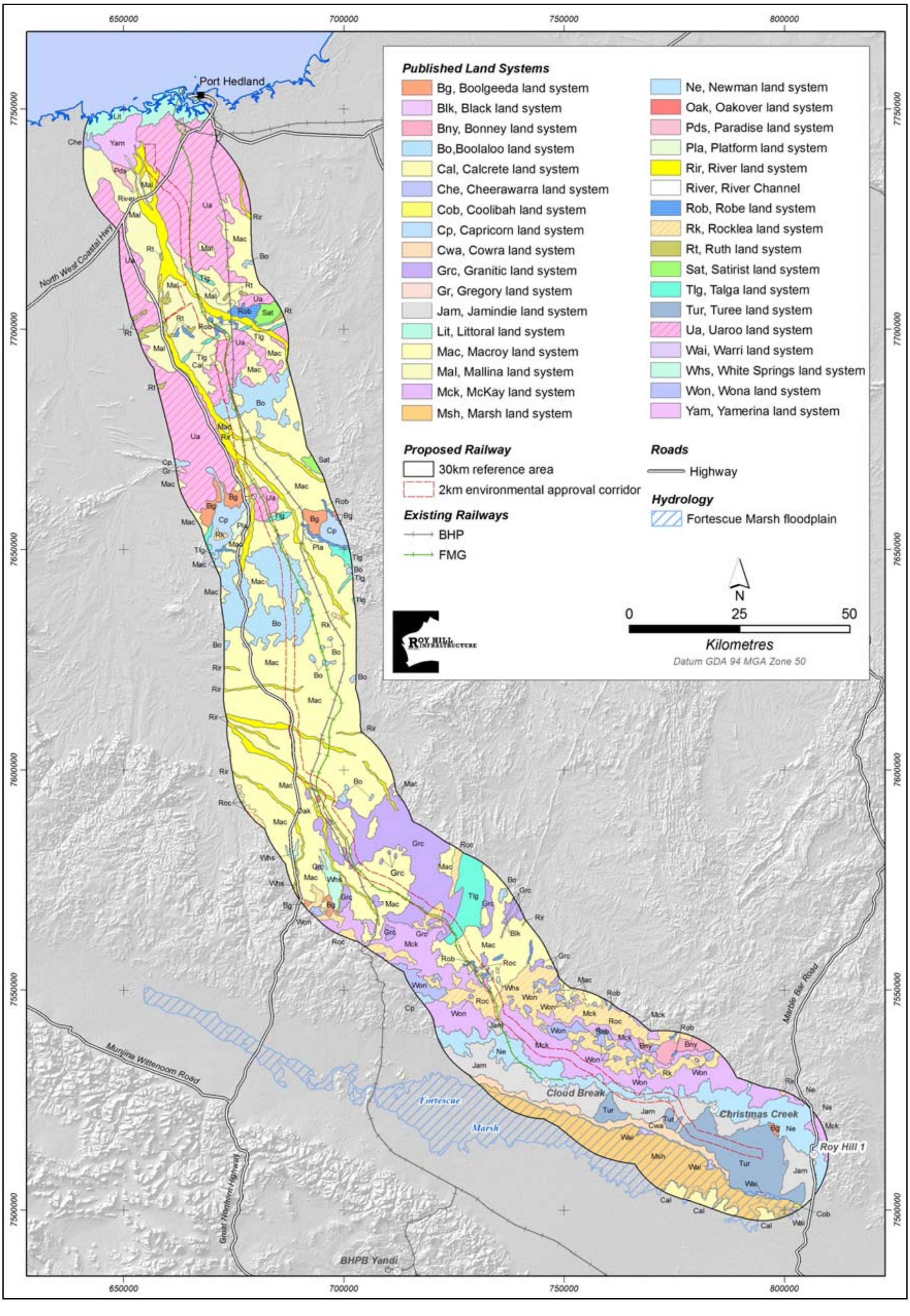

Figure 2: Land systems within the 30km reference area

2.2.2 Threatened and Priority Ecological Communities

Two Threatened Ecological Communities (TECs) listed under the Western Australian *Wildlife Conservation Act 1950* and 28 Priority Ecological Communities (PECs) are known from the Pilbara region. No Commonwealth TECs are listed for the Pilbara under the EPBC Act.

A search of DEC's TEC and PEC database revealed that no known occurrences of TECs or PECs were within or immediately adjacent to the 2km environmental approval corridor. However, the proximity of the study area to PEC 17: Fortescue Marsh is likely to be considered a factor in any assessment of this area.

There are intermittent occurrences of the PEC 21: Wona Land System occurring as a mosaic with the Rocklea Land System (Figure 2) in the Chichester Range. These occurrences are arranged in an intermittent, linear east to west band which the rail corridor crosses, however the 2km corridor does not include any of the Wona Land System as it has been mapped by Van Vreeswyk *et al*. (2004).

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).

The *Bioregional summary of the 2002 biodiversity audit for Western Australia* identifies 35 community types in the Pilbara considered to be at risk due to under-representation in DEC conservation reserves and estates. These include freshwater wetlands, mulga and snakewood communities, scree and hilltop communities, grasslands, salt marshes and cracking clay communities (Animal Plant Mineral Pty Ltd 2009).

Each of these community types has differing conservation status. Following advice from DEC's Environmental Management Branch, the scope of field surveys includes identifying the community type that the rail infrastructure would intersect and its status. From there, appropriate management actions will be implemented.

2.2.3 Flora and vegetation of conservation significance – northern section

CONSERVATION SIGNIFICANCE VEGETATION TYPES

Biota (2002) and Biota (2004) defined and classified terrestrial vegetation into distinct types during the respective flora and vegetation surveys. Those distinct types were then further classified into subtypes on the basis of structure and species composition of the dominant strata and landform.

Vegetation types of conservation significance that potentially occur within the Northern section of the proposed corridor, and which were considered by Biota (2002) and Biota (2004) to be of conservation significance, are discussed below:

'*Tripogon loliiformis* grasslands' and '*Bulbostylis burbidgeae* sedgelands of granite outcrops' (Ar3 and Ar4) on the Abydos Plain were considered to be among the highest conservation significance vegetation types by Biota (2002), as they were present in only a small proportion of the study area and had restricted habitats. *B. burbidgeae* is a Priority Flora species. The proposed centre line intersects an area scattered with these vegetation types around Chinnamon Creek, and an additional location around 10km south of South Hedland is within a 1 km buffer of the centre line.

Three vegetation types of granite ridges, quartz ridges and dolerite dykes of the Abydos Plain (Ar5, Ar6 and Ar7) were identified as being of high conservation significance by Biota (2002) as they occurred in only selected locations along the Hope Downs corridor, had restricted habitats and were thought to be regionally uncommon. None of the sites mapped by Biota (2002) occur within a 1km buffer of the centre line, and no further sites were identified by Biota (2004).

Three additional vegetation types of the Abydos Plain were considered to be of conservation significance by Biota (2002), although not of high conservation significance. All three vegetation types occur within a 1km buffer of the proposed centre line:

- *Triodia epactia*, *T. secunda* mid-dense hummock grassland (Apt1). This vegetation occurs on low sandy islands within the coastal mudflats and on sodic soils in low-lying, seasonally inundated areas within the Abydos Plain.

- *Triodia angusta* mid-dense hummock grassland (Apt5). Moderately dense hummock grasslands of *Triodia angusta*, with only scattered other species, were recorded from the central portion of the Abydos Plain.

- *Corymbia hamersleyana* scattered low trees over *Triodia* aff. *basedowii* mid-dense to closed hummock grassland (Ah5). This vegetation occurred on low calcrete rises throughout the project area, on orange brown loams with calcareous nodules.

FLORA OF CONSERVATION SIGNIFICANCE

A search of the DEC Threatened Species and Communities Branch and Western Australian Herbarium databases was conducted in February 2010. No known occurrences of Declared Rare Flora (DRF) were identified within the 2km environmental approval corridor. However, Table 1 and Figure 3 show the identified Priority Flora species that were found to occur:

a) within the railway environmental approval corridor (2km)

b) within 15km either side of the alignment but outside the proposed railway corridor.

Table 1: Priority species recorded within 15km of the proposed alignment – northern section.

Name	Buffer (B) and/or corridor (C)	Priority status
Abutilon pritzelianum	B	1
Acacia leeuweniana	B & C	1
Eremophila spongiocarpa	B	1
Heliotropium muticum	B	1
Ptilotus appendiculatus	B	1
Euphorbia clementii	B	2
Acacia levata	B	3
Eremophila forrestii	B	3
Goodenia nuda	C	3
Gymnanthera cunninghamii	C	3
Nicotiana umbratica	B	3
Bulbostylis burbidgeae	C	4

2.2.4 Flora and vegetation of conservation significance – southern section

CONSERVATION SIGNIFICANT VEGETATION TYPES

The cracking clays associated with the Wona Land System support mixed tussock Grassland on the low-lying flats/plains. Biota (2002) identified two unusual cracking clay vegetation types that they 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 previously mentioned, the rail proposal does not intersect any of the Wona Land System, but the rail corridor is close to it so these vegetation types may be present in the corridor.

Mulga community distribution through the Pilbara's land systems has been well defined by Payne et al. (2004). The mulga communities of the Chichester Range represent the northern limit of mulga in Western Australia; however, the mulga communities within the proposed Southern rail corridor do not represent the northernmost extent within the range. The Jamindie, Jurrawarrina, Laterite, Pindering, Spearhole, Warri and Washplain land systems also contain Mulga communities (Payne 2004).

'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).

FLORA OF CONSERVATION SIGNIFICANCE

There are no known occurrences of Declared Rare Flora (DRF) or Priority Flora identified within the 2km environmental approval corridor. However, a number of Priority Flora species were identified as occurring within 10km either side of the centre-line but outside the proposed environmental approval corridor (see Table 2).

Additionally, Ecologia (EPA 2009) identified five species from the Roy Hill project area at the eastern end of the study area. These were *Rhagodia* sp. Hamersley (P3), *Goodenia nuda* (P3), *Polymeria* sp. Hamersley (P3), *Rostellularia adscendens* var. *latifolia* (P2) and *Eremophila youngii* subsp. *lepidota* (P4). Biota (2004) also recorded *Goodenia nuda* (P3) and *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3) from near Christmas Creek.

The DRF species *Lepidium catapycnon* is known from the Newman Land System, and while the study area is further north than 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.

Table 2: Priority species recorded within 15km of the proposed alignment – southern section.

Name	Buffer (B) and/or corridor (C)	Priority status
Eremophila spongiocarpa	B	1
Nicotiana heterantha	B	1
Peplidium sp. Fortescue Marsh (S van Leeuwen 4865)	B	1
Tecticornia sp. Christmas Creek (KA Shepherd & T Colmer et al. KS)	B	1
Tecticornia sp. Fortescue Marsh (KA Shepherd et al. KS 1055)	B	1
Stylidium weeliwolli	B	2
Goodenia nuda	B	3
Rhagodia sp. Hamersley (M Trudgen 17794)	B	3
Eremophila youngii subsp. *lepidota*	B	4

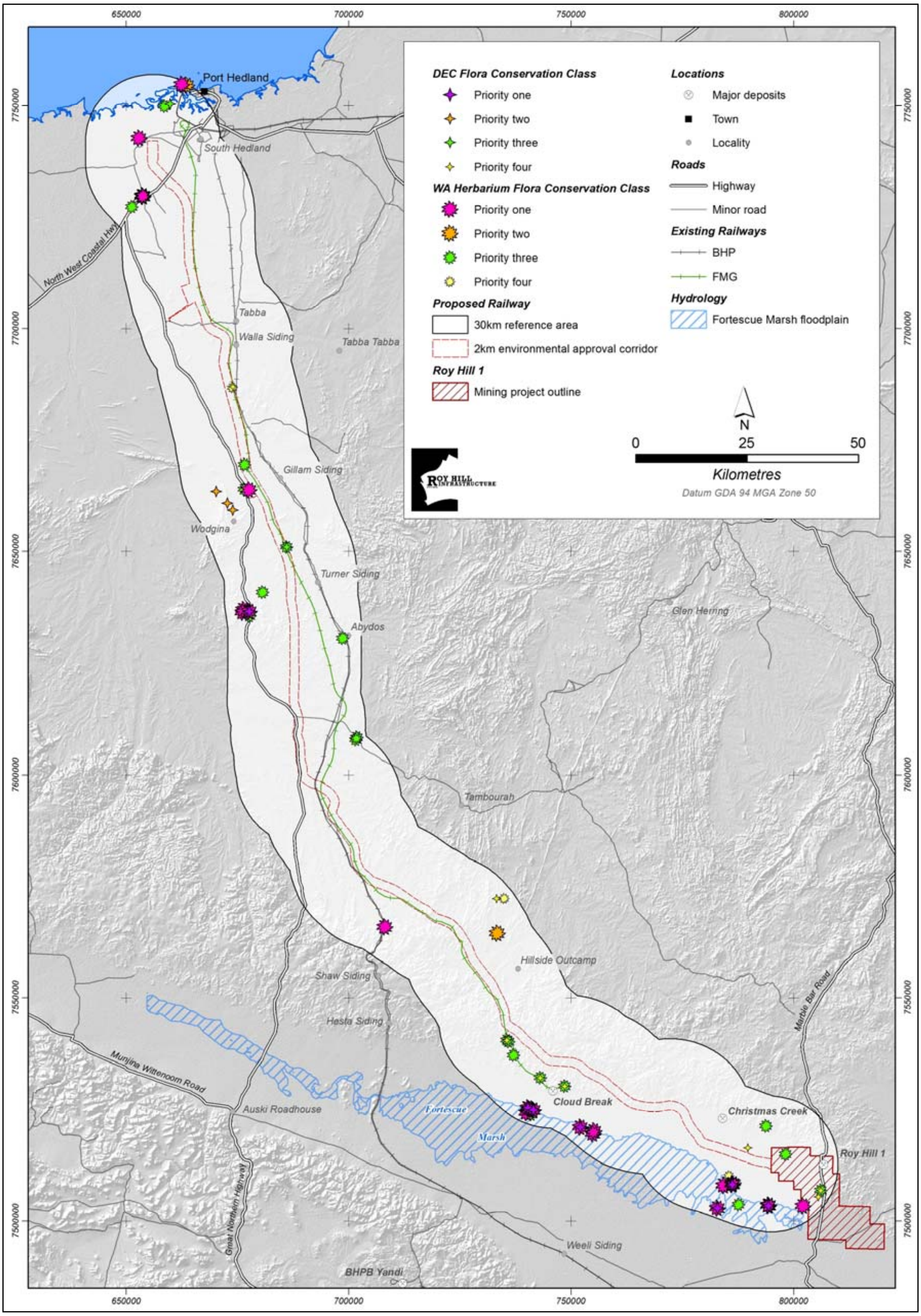

Figure 3: Priority Flora within the 30km reference area

3. POTENTIAL IMPACTS

The following section describes the potential threats and processes that may have an impact on significant flora and vegetation within the Project area.

3.1 Ground disturbance

The primary potential impact to mulga, other flora and vegetation communities for the Project will be ground disturbance during construction. This has the potential to result in direct loss of individuals of conservation-significant flora species and the loss in the area of conservation-significant vegetation communities.

3.2 Hydrology

Alterations to surface water runoff (either a reduction or increase in the amount of water) can potentially affect native vegetation. A drainage shadow may form down slope of a built feature or infrastructure. Drainage shadows occur where water that would have run directly down slope is diverted around the infrastructure, forming an area down slope of the infrastructure where 'run on' water is reduced. The condition of vegetation in drainage shadows may decline over time. This is understood to be a more significant risk in mulga woodlands where there is a low gradient and, indeed, the degree of dependence on sheet flow is likely to vary between community types.

The presence of the rail alignment, without effective drainage controls in place, may potentially impact the sheet flow drainage patterns. The land systems likely to be affected, and which contain mulga vegetation, are Christmas, Cowra, Jamindie and Turee. The majority of any impact is likely to occur in the Jamindie land system.

3.3 Groundwater drawdown

Groundwater abstraction for construction water has the potential to cause the groundwater table in the vicinity to draw down. The depth and the rate of any drawdown will determine the effect that this has on flora and vegetation. Temporary groundwater drawdown can only potentially affect those plants that rely on groundwater as a primary water source.

Due to the limited duration of pumping it is not expected that groundwater abstraction would have a permanent impact on groundwater levels. This has been rated as a low risk and does not require further management through this plan.

3.4 Dust deposition

It is recognized that construction activities have the potential to generate substantial airborne dust. Dust can deposit on to nearby vegetation and cause a decrease in vegetation condition. Dust will require management to limit dust deposition on vegetation.

Dust lift off from iron ore being transported by rail is not predicted to be a significant issue due, in part, to the relatively high water content of this material.

3.5 Fire

While Australian native flora is often adapted to, and in some cases, dependent on fire, significant changes in fire regimes may result in vegetation being burnt too frequently or not often enough. Either scenario can lead to a reduction in plant health, mortality of plants or a change to the vegetation community. Rail construction and operations can introduce sources of fire beyond those that occur naturally. These include sparks from equipment used during construction and sparks from rail grinding during track maintenance.

3.6 Weeds

Weeds, if they become established, become direct competition for native plants, potentially smothering their growth or using scarce water and nutrient resources. This may reduce populations of conservation significant flora species or degrade vegetation communities of conservation significance.

Weeds may not provide suitable habitat or food resources for fauna. Once established, weeds can become extremely difficult to eradicate.

The construction of the rail will create opportunities for the movement of weed propagules with the potential for the establishment of new weed populations where they did not previously occur.

4. MANAGEMENT ACTIONS

This section identifies the general approach to be taken towards management of mulga and other flora and communities. The project design and development is at an early stage. These actions will be refined in subsequent revisions of the plan.

4.1 Ground disturbance

4.1.1 Pre-clearance surveys

Further studies and environmental management of flora and vegetation are summarised below.

Before construction, RHI will undertake vegetation and flora surveys to confirm the areas to be disturbed are clear of DRF. The methodology will follow that of previous surveys in the Pilbara. The main objectives of the survey will be to:

a) Search and describe any plants of conservation significance found in areas targeted for disturbance (DRF, priority, geographically restricted, endemic, limits of range, sub-species, variants etc.);

b) Define and map plant associations present;

c) Determine the condition of the vegetation in the survey area; and

d) Review the local and regional significance of the plant associations recorded.

4.1.2 Design review

Survey findings will be considered during final design with the objective of avoiding and minimising potential direct impacts on flora and vegetation where possible. The documented review will take the form of environmental constraints mapping. This will cover flora of conservation significance but also vegetation communities (see also Section 4.2).

4.1.3 Ground disturbance procedures

Clearing boundaries and areas that must not be cleared or disturbed will be delineated before clearing (e.g. using a ground disturbance permit system). Compliance with the ground disturbance control system will be monitored throughout the construction phase.

The ground disturbance permit system will be developed and implemented to manage clearing within the Project and include the following:

- An approved Ground Disturbance Permit (GDP) in place prior to any ground disturbing work;
- Survey and flagging to ensure disturbance remains within approved boundaries;
- Flagging of significant flora and vegetation avoidance sites;
- Site environmental staff approval prior to clearing within the vicinity of significant flora or vegetation;

- Where disturbance cannot be avoided, the relevant permits from the DEC shall be sought. No disturbance of DRF is to occur without a DEC approved permit;
- Road and other access alignments and borrow pit areas are to be constructed where practicable to avoid significant flora and vegetation;
- Ongoing audits by site environmental staff to confirm GDP compliance.

All vehicles and mobile machinery movements will be restricted to designated roads and off-road or off corridor driving is prohibited without an approved permit.

4.1.4 Rehabilitation

Successful rehabilitation is essential to ensure the return of a self-sustaining vegetation community that is able to support native flora and flora species of conservation significance and resembles as far as practicable the vegetation communities that were removed at the commencement of mining. With careful planning and implementation, key characteristics can be restored, allowing native vegetation to grow on the created landforms.

Progressive rehabilitation of the Project area will be conducted. Where clearing of significant flora and vegetation is required, this will focus on collecting seed and other propagules.

Rehabilitation of construction disturbance that will not form part of ongoing operations, e.g. most borrow pits, will be rehabilitated within 12 months of the completion of construction. Options for borrow pit rehabilitation will be discussed with the DEC but the RHI objective will be to create self-draining structures wherever possible.

4.2 Hydrology

Detailed engineering design will consider hydrology, topography, geotechnical information and the results of flora and vegetation surveys. Opportunities to minimise the clearing footprint will be sought. Locations where significant vegetation communities are known to exist will be avoided, wherever practicable.

Management of potential impacts related to hydrology will focus on avoidance within engineering design. A desk top study followed by an on ground verification assessment will be undertaken to determine the effective drainage management required. This process is outlined in the Surface Water Management Plan.

Flood protection culverts will be installed along the railway embankment at the creek crossings and at the smaller drainage channels. Culverts will be designed to pass flows of magnitudes up to the 20-year flood level. Larger floods may overtop the embankment. The diameter of flood protection culverts will range between 600mm and 3600mm.

Sections of the rail alignment pass through areas of sheetflow-dependent mulga communities, although the distribution of these communities is yet to be confirmed. Additional culverts (environmental culverts) will be installed at appropriate intervals through these sections to maintain continuity of flows across the alignment and prevent downstream shadowing. Aprons of rock riprap will be installed at culvert outlets to slow and spread flows and to reduce scour potential. Offshoot drains, run along the contour, will assist in redistributing flows across sheetflow areas down gradient of the embankment.

The desktop study referred to above will be undertaken using analysis of aerial photography and topographic contours to locate environmental culverts in the sheetflow areas. If there are any sections of railway greater than 100m with no culverts, then additional environmental culverts will be installed at approximately 50m spacing in areas with sheet-flow dependent mulga communities.

During flood events where culverts are flowing full, outlet flows are expected to spread at an approximately 45° angle on exiting the culvert and passing over the rock apron.

Final design will address local impacts from obstruction to runoff or sheetflow, identify areas of mulga communities and ensure optimum placement and spacing of culverts for the maintenance of those communities.

Where surface gradients of the sheetflow areas promote flow along the toe of the rail embankment, a low guidebank will be installed at each culvert inlet to direct flow through the culvert. This will help to reduce culvert bypass and concentration of runoff flows at the incised creeklines.

A schematic plan sketch of the proposed environmental culvert design for a hypothetical section of railway along the northern extent of the Fortescue Marsh is provided in Figure 4. A schematic elevation looking downstream towards the culverts is provided in Figure 5. This shows the function of the low guide banks.

Scour protection blankets of rock or other suitable material will be used to stabilise the steeper inlets and channels.

Following the desktop assessment, but prior to construction, the locations of environmental culverts and other drainage control measures in sensitive environments will be reassessed and amended (if required) based on a visual in-field assessment of the vegetation, soils and drainage patterns at each culvert site.

More detail on effective drainage management in relation to mulga and other communities is outlined within the Surface Water Management Plan (RHI 2010).

In summary effective management of potential hydrology impacts will include:

a) Surveys to determine the extent and condition of riparian vegetation and sheetflow-dependent ecosystems along the rail corridor

b) Surface hydrology studies to describe and map the existing patterns of stream flow, surface drainage and sediment transport;

c) Detailed engineering design defining culvert sizing and locations for flood protection culverts at significant watercourses;

d) Detailed engineering design defining culvert sizing and nominal locations for environmental culverts in identified sheet flow areas;

e) Provision of information for Beds and Banks permit applications;

f) Surface Water Management Plan (SWMP); and

g) Construction environmental management plan and operations environmental management plan which will include management measures to mitigate potential impacts from contamination.

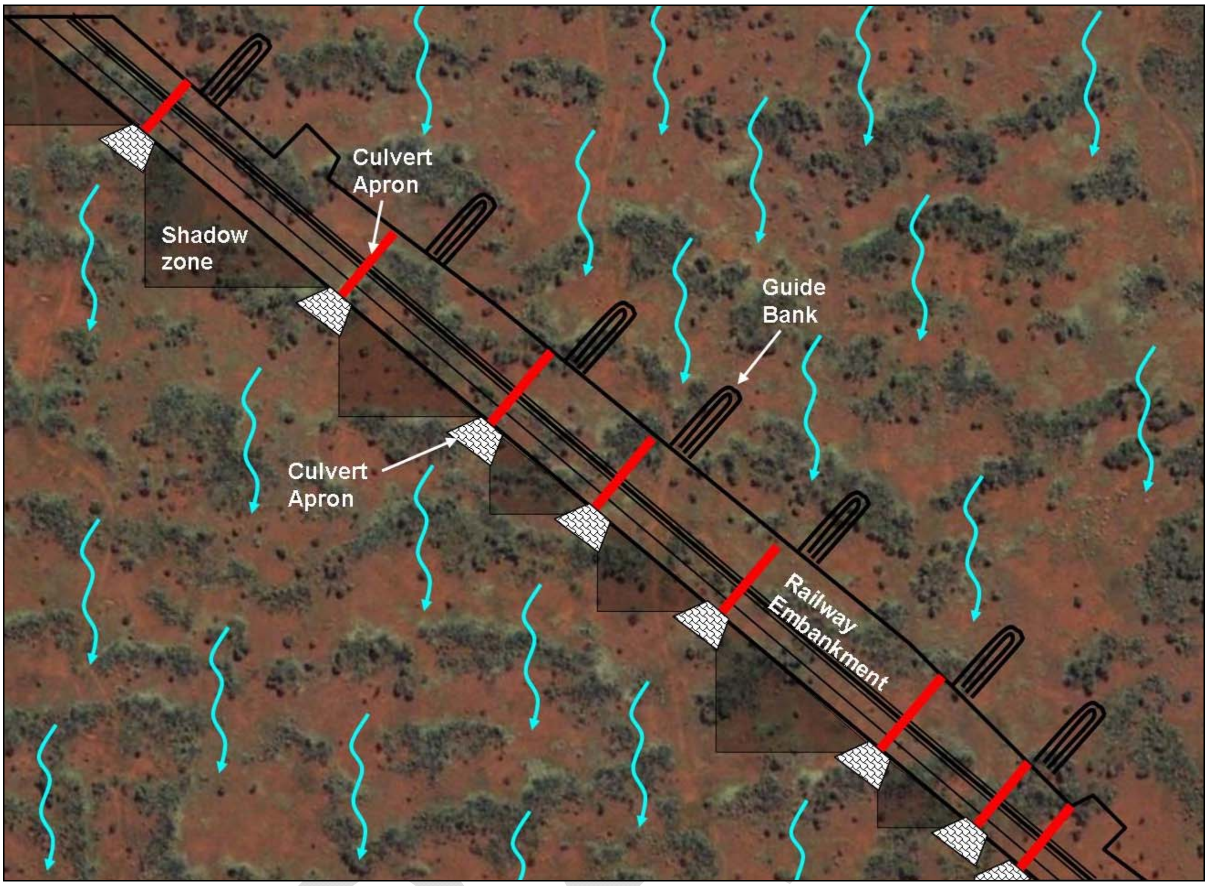

Figure 4: Schematic showing hypothetical section of railway with environmental levees, culverts and rock aprons

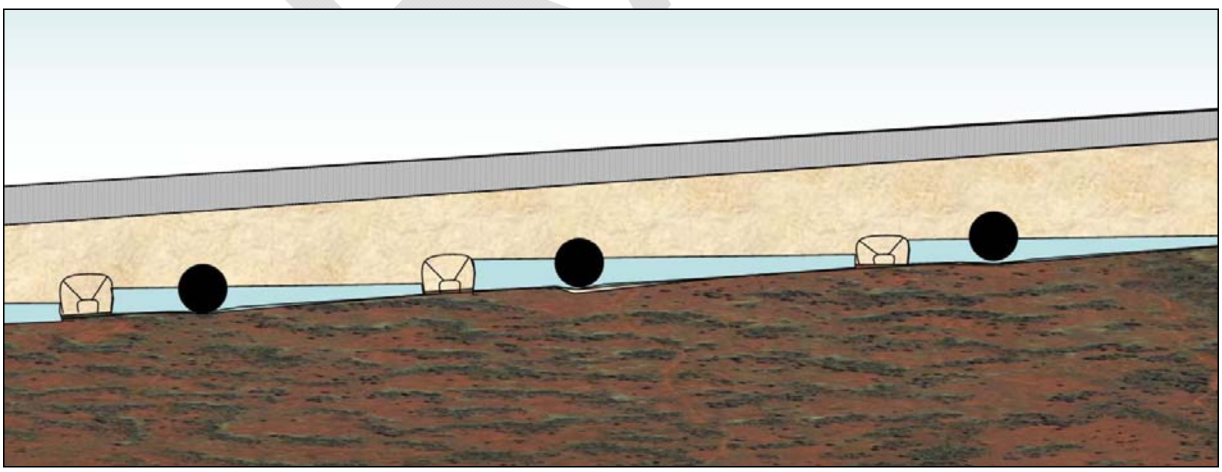

Figure 5: Schematic elevation showing function of the low guide banks

A monitoring program will be developed and implemented to identify any potential impacts arising from changes to surface water patterns. The program has not yet been developed but it will focus on those vegetation communities believed to be dependent to some degree on sheet flow by which potential impacts can be identified. The program will identify those communities prior to construction. Criteria will be developed.

The monitoring program will include visual monitoring before the onset of the wet season and again after significant rainfall events that produce surface runoff. These visual inspections will assess the following;

a) Modifications to the creek, drainage and/or sheetflow morphology (i.e. identify whether construction of the railway has significantly altered the hydrologic regime);

b) Identify whether the culverts have successfully re-established sheetflow downstream of the railway; and

c) Ensure all culvert and drainage control measures are operating as intended.

The results of visual monitoring will be reported on an annual basis to provide an ongoing assessment of surface water flow.

4.3 Groundwater

A groundwater management framework will be developed and implemented. This will consider any vegetation recorded during the surveys that may be groundwater-dependent.

4.4 Dust Management

A dust management plan will be developed and implemented for the construction and operation phases. Damage to vegetation through dust deposition will be managed primarily by dust suppression undertaken by water trucks.

4.5 Fire

Fire management will involve the development of procedures to form part of the project management system. Particular issues to be considered during the construction phase include the implementation of a hot work permit system, procedures for the correct storage and use of hydrocarbons and chemicals, and employee and contractor training associated with both of these issues. The provision and availability of firefighting equipment is also an important consideration.

Prior to operations, procedures for fire risk reduction for activities associated with track maintenance (e.g. track grinding) will be developed and implemented.

4.6 Weeds

A weed hygiene management plan will be developed and implemented prior to the commencement of construction. The plan will cover hygiene procedures for the prevention of weed seed introduction to work areas or movement or weed seed from one area to another. It will also address control of weed populations within the rail corridor where these have arisen as a consequence of the RHI Railway or, where feasible, in existing populations. A record of weed populations, and any treatment efforts, will be maintained via a database.

5. REVIEW AND REVISION

This plan will be reviewed and revised in the light of:

- Significant project design changes;
- The results of survey work;
- Feedback from government agencies and other stakeholders; and
- Development of RHI environmental management systems.

At a minimum, this plan will be revised prior to construction to reassess the potential risks and impacts and suitability of management strategies once detailed project design is available.

6. DEFINITIONS

DEC	Department of Environment and Conservation
DEWHA	Department of Water Heritage and the Arts
DRF	Declared Rare Flora
EMP	Environmental Management Plan
EMS	Environmental Management System
EPBC	Environmental Protection and Biodiversity Conservation Act 1999
GDP	Ground Disturbance Permit
PEC	Priority Ecological Community
RHI	Roy Hill Infrastructure Pty Ltd
Significant Flora and Vegetation	For the purposes of this EMP significant flora and vegetation refers to DRF, TEC and PEC, and other vegetation communities such as mulga that are regarded by DEC and Roy Hill Infrastructure as being of conservation significance.
TEC	Threatened Ecological Community

7. REFERENCES

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Appendix 1
Land systems and levels of associated construction disturbance for the proposed railway corridor

Land system	Land system code	Habitat	¥Area of land system in Pilbara (ha)	Area of land system in 30km reference corridor (ha)	Area of land system in 2km environmental approval corridor (ha)	Area of land system in 0.2km construction disturbance corridor (ha)	Construction disturbance corridor area (0.2km) as a proportion of each land system's area in the Pilbara (%)	Construction disturbance corridor area (0.2km) as a proportion of each land system's area in the 30km reference corridor (%)
Black	BLK	Linear ridges of dolerite or basalt supporting hard spinifex grasslands, with unvegetated boulder slopes and rock piles along summits	16516	465	0	0	0.00	0.00
Bonney	BNY	Low rounded hills and undulating stony plains supporting soft spinifex grasslands	75343	4553	0	0	0.00	0.00
Boolaloo	BOO	Granite hills, domes and tor fields and sandy plains with shrubby spinifex grasslands.	150183	42412	5103	109	0.07	0.26
Boolgeeda	BGD	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	774790	7190	0	0	0.00	0.00
Calcrete	CAL	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.	144391	5540	311	47	0.03	0.84
Capricorn	CPN	Hills and ridges of sandstone and dolomite supporting low shrublands or shrubby spinifex grasslands.	529617	9945	51	0	0.00	0.00
Cheerawarra	CHE	Sandy coastal plains and saline clay plains supporting soft and hard Spinifex grasslands and minor tussock grasslands	19701	844	0	0	0.00	0.00

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Coolibah	COB	Flood plains with weakly gilgaied clay soils supporting coolabah woodlands with tussock grass unnderstorey	101381	164	0	0	0.00	0.00
Cowra	CWA	Plains fringing the Marsh land system and supporting snakewood and mulga shrublands with some halophytic undershrubs	20295	9661	0	0	0.00	0.00
Granitic	GRC	Rugged granitic hills supporting shrubby hard and soft spinifex grasslands.	401990	44132	2627	238	0.06	0.54
Gregory	GRG	Linear dunes and restricted sandplains supporting shrubby hard Spinifex (and occasionally soft spinifex) grasslands	11289	215	0	0	0.00	0.00
Jamindie	JAM	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey	207423	39597	2266	190	0.09	0.48
Littoral	LIT	Bare coastal mudflats with mangroves on seaward fringes, samphire flats, sandy islands, coastal dunes and beaches.	157712	11740	0	0	0.00	0.00
Macroy	MAC	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands.	1309544	285988	19629	295	0.02	0.10

Land system	Land system code	Habitat	¥Area of land system in Pilbara (ha)	Area of land system in 30km reference corridor (ha)	Area of land system in 2km environmental approval corridor (ha)	Area of land system in 0.2km construction disturbance corridor (ha)	Construction disturbance corridor area (0.2km) as a proportion of each land system's area in the Pilbara (%)	Construction disturbance corridor area (0.2km) as a proportion of each land system's area in the 30km reference corridor (%)
Mallina	MAL	Sandy surfaced alluvial plains supporting soft spinifex (and occasionally hard spinifex) grasslands.	255729	48924	4304	226	0.09	0.46
Marsh	MSH	Lakebeds and floodplains subject to regular inundation, supporting samphire shrublands, salt water couch grasslands and halophytic shrublands	97667	42297	0	0	0.00	0.00
McKay	MCK	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands	420246	68518	6124	16	0.00	0.02
Newman	NEW	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands	1457984	37686	2293	47	0.00	0.12
Oakover	OAK	Breakaways, mesas, plateaux and stony plains of calcrete supporting hard spinifex grasslands.	152875	102	0	0	0.00	0.00
Paradise	PDS	Alluvial plains supporting soft spinifex grasslands and tussock grasslands.	147864	1204	0	0	0.00	0.00
Platform	PLA	Dissected slopes and raised plains supporting hard spinifex grasslands.	156990	2247	0	0	0.00	0.00

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River	RIV	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	408842	35374	2182	6	0.00	0.02
Robe	ROB	Low plateaux, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.	86460	5446	408	5	0.01	0.09
Rocklea	ROC	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	2299251	48895	1513	58	0.00	0.12
Ruth	RUT	Hills and ridges of volcanic and other rocks supporting hard spinifex (occasionally soft spinifex) grasslands.	34575	2257	0	0	0.00	0.00
Satirist	SAT	Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands.	37677	2960	0	0	0.00	0.00
Talga	TLG	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.	212429	14568	1006	72	0.03	0.50
Turee	TUR	Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands	58055	30812	3839	6	0.01	0.02

Land system	Land system code	Habitat	¥Area of land system in Pilbara (ha)	Area of land system in 30km reference corridor (ha)	Area of land system in 2km environmental approval corridor (ha)	Area of land system in 0.2km construction disturbance corridor (ha)	Construction disturbance corridor area (0.2km) as a proportion of each land system's area in the Pilbara (%)	Construction disturbance corridor area (0.2km) as a proportion of each land system's area in the 30km reference corridor (%)
Uaroo	UAR	Broad sandy plains supporting shrubby hard and soft spinifex grasslands.	768141	121310	9562	658	0.09	0.54
Warri	WAI	Low calcrete platforms and plains supporting mulga and cassia shrublands	30494	974	0	0	0.00	0.00
White Springs	WHS	Stony gilgai plains supporting tussock grasslands and hard spinifex grasslands.	26564	3966	85	7	0.02	0.17
Wona	WON	Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands.	181540	11634	0	0	0.00	0.00
Yamerina	YAM	Flood plains and deltaic deposits supporting tussock grasslands, grassy woodlands and minor halophytic low shrublands.	120670	7880	0	0	0.00	0.00

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