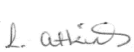
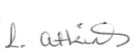
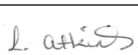
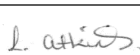
Appendix 1: Pilbara Transmission Project Flora and Vegetation Desktop Assessment

Pilbara Transmission Project Flora and Vegetation Desktop Assessment

Fortescue Metals Group

ecoscape

VERSION	AUTHOR	QA REVIEWER	APPROVED	DATE
Draft rev0	Jared Nelson	 Lyn Atkins Associate Environmental Scientist	 Lyn Atkins Associate Environmental Scientist	19/10/2018
Draft rev1	Carly Bishop	 Lyn Atkins Associate Environmental Scientist	 Lyn Atkins Associate Environmental Scientist	1/11/2018
Final	Carly Bishop	 Sonya Bateman Senior Spatial Planner	 Sonya Bateman Senior Spatial Planner	6/11/2018
Final rev1	Carly Bishop	 Sonya Bateman Senior Spatial Planner	 Sonya Bateman Senior Spatial Planner	20/11/2018

Direct all inquiries to:
Ecoscape (Australia) Pty Ltd
9 Stirling Highway • PO Box 50 NORTH FREMANTLE WA 6159
Ph: (08) 9430 8955 Fax: (08) 9430 8977

TABLE OF CONTENTS

FIGURES

TABLES

MAPS

1 INTRODUCTION

1.1 PROJECT BACKGROUND

Pilbara Energy Company Pty Ltd (PEC), a wholly owned subsidiary of Fortescue Metals Group Limited (Fortescue), is proposing to develop the Pilbara Transmission Project (the Project), a high voltage transmission network in the Pilbara region of Western Australia. The Project comprises:

- 220 kV overhead powerline infrastructure
- terminal, substation and gantry infrastructure.

The Project follows existing Fortescue rail corridors from Port Hedland to the Cloudbreak and Solomon mine sites and is approximately 375 km in length with pylons located approximately 300 m apart and at changes of direction/vertices. There is a degree of flexibility in the pylon placement (±50 m) that allows for avoidance or minimisation of impacts to conservation significant flora, significant vegetation, significant fauna habitat and at creek crossings. Clearing will only be required at pylon locations over an approximate 5 m radius and for minor tracks between pylons where required.

1.2 STUDY PURPOSE

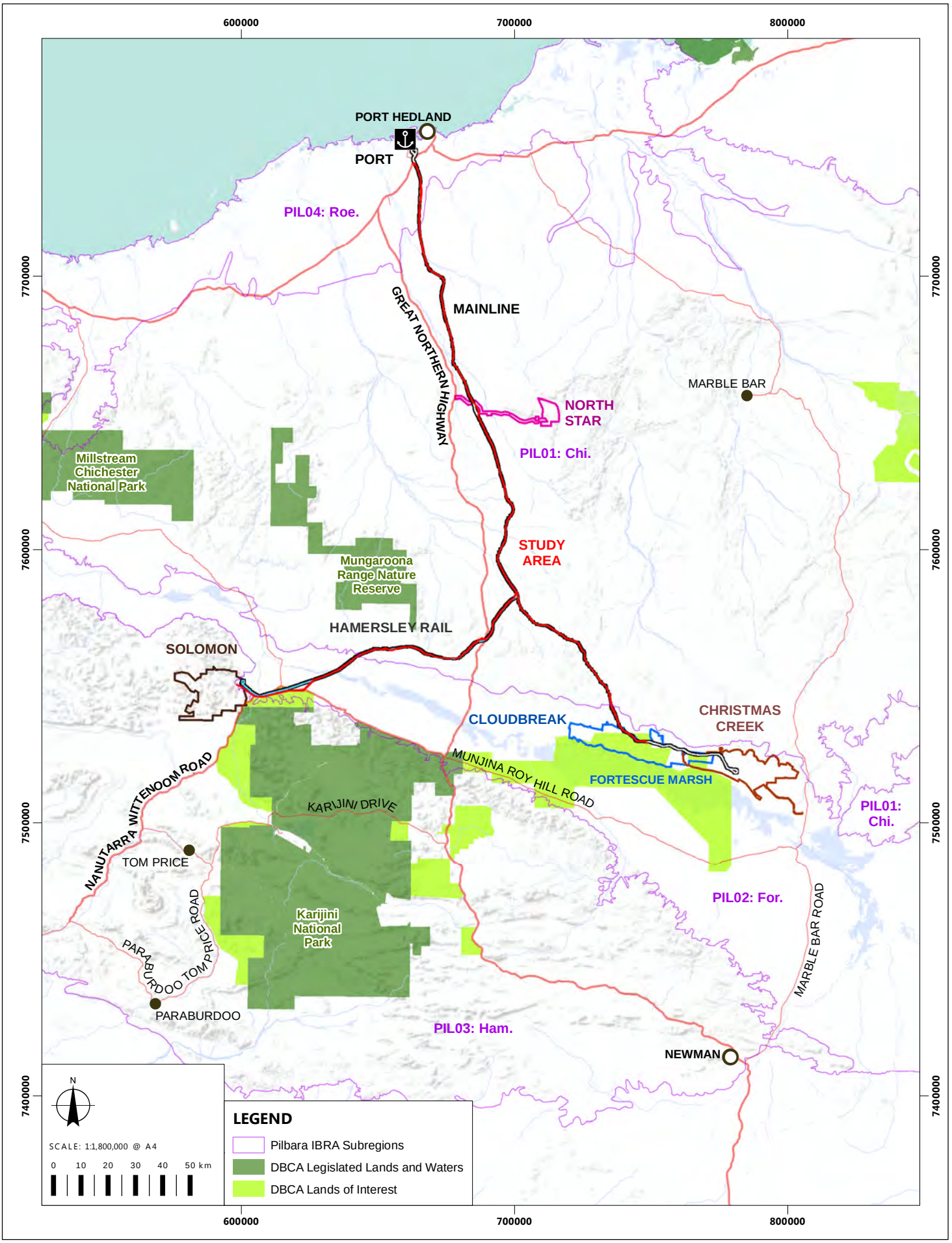
The purpose of this study is to document known locations of significant flora and vegetation within or in close proximity to the study area. The information from this assessment will support applications for approvals and permits under the Western Australian *Environmental Protection Act 1986* (EP Act) and *Mining Act 1978* (Mining Act) as well as the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

To address the study objectives Fortescue and publicly datasets regarding flora and vegetation assessments were collated to determine intersection of high conservation significant values with the development envelope.

1.3 STUDY AREA

The study area (totalling approximately 80,884 ha) consists of a 1 km buffer of the development envelope The development envelope is approximately 70 m to 90 m wide along its length (though it does extend to greater than 300 m wide in some areas) and occupies 5,471 ha. However, the extent likely to be cleared for pylons and access tracks has been estimated at approximately 300 ha (less than 0.04% of the total study area), althought the exact location within the study area has not yet been defined.

The study area largely corresponds with Fortescue's existing rail alignment within the Pilbara bioregion of Western Australia (see **Figure 1**).



COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
0	JN	LA	3/10/2018

DATASOURCES:
PROJECT/INFRASTRUCTURE LOCATIONS: FORTESCUE
TOPOGRAPHIC LAYERS: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCES: ESRI, USGS, NOAA

ecoscape

REGIONAL LOCATION OF STUDY AREA

FIGURE 01

1.4 STATUTORY FRAMEWORK AND GUIDANCES

This assessment took into account relevant sections of Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Wildlife Conservation Act 1950* (WC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act), partly enacted
- Western Australian *Biosecurity and Agriculture Management Act 2007* (BAM Act)
- Department of Environment Water Heritage and the Arts (2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999.*

The Minister for the Environment publishes lists of flora species in need of special protection because they are considered rare, likely to become extinct, or are presumed extinct. The current listings were published in the *Government Gazette* on 16 January 2018 (Government of Western Australia 2018b) and were taken into account.

As well as those listed above, the assessment took into account relevant section of:

- EPA (2016c) *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment*, known as *Flora and Vegetation Technical Guidance*
- EPA (2016b) *Statement of Environmental Principles, Factors and Objectives*.

Fortescue's internal management Guidelines and Procedures were also complied with, primarily *Flora and Vegetation Assessment Guidelines* (100-GU-EN-0005) (Fortescue 2014) and *Geographic Information Systems and Raw Data Guidelines* (100-GU-EN-0009) (Fortescue 2011).

1.4.1 WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian *Biodiversity Conservation Act 2016* (BC Act, the Act), parts of which were enacted on 21 September 2016, provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. The BC Act replaces the *Wildlife Conservation Act 1950*. The parts of the BC Act currently in effect are listed on the DBCA website (BDCA 2017, accessed 17 September 2017).

Threatened species (both flora and fauna) that meet the categories listed within the Act are highly protected and require authorisation by the Ministerial to take or disturb. These are known as Threatened Flora and Threatened Fauna. The conservation categories of critically endangered, endangered and vulnerable have been aligned with those detailed in the EPBC Act, as below.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species in the Act.

Threatened Ecological Communities are also protected under the Act and are categorised using the same criteria as threatened species.

At the time of writing this report, only some sections of the BC Act have been enacted, with the remaining sections yet to be proclaimed including those relating to penalties for breaches of the Act's provisions. As species of conservation interest (Specially Protected Species) and Threatened Ecological Communities are not included in the WC Act, there is currently no specific legal protection afforded to these within Western Australia beyond the usual protection of unlisted species and native vegetation under the Native Vegetation Clearing Regulations (Government of Western Australia 2004), unless they are protected under the Commonwealth EPBC Act.

1.4.2 WESTERN AUSTRALIAN ENVIRONMENTAL PROTECTION ACT 1986

The Western Australian *Environmental Protection Act 1986* was created to provide for an Environmental Protection Authority (the EPA) that has the responsibility for:

- prevention, control and abatement of pollution and environmental harm
- conservation, preservation, protection, enhancement and management of the environment
- matters incidental to or connected with the above.

The EPA is responsible for providing the guidance and policy under which environmental assessments are conducted. It conducts environmental impact assessments (based on the information included in environmental assessments and provided by the proponent), initiates measures to protect the environment and provides advice to the Minister responsible for environmental matters.

1.4.3 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

At a Commonwealth level, Threatened taxa are protected under the EPBC Act, which lists species and ecological communities that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, or Extinct in the Wild (**Table 11** in **Appendix One:)**.

1.4.4 FLORA

1.4.4.1 Threatened and Priority Flora

Conservation significant flora species are those that are listed as TF (Threatened Flora) and (within Western Australia) as PF (Priority Flora). TF species are listed as threatened by the Western Australian DBCA and protected under the provisions of the BC Act. Some State-listed TF are provided with additional protection as they are also listed under the Commonwealth EPBC Act.

Flora are listed as PF where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to TF categories. Whilst PF are not specifically listed in the BC Act, some may qualify as being of special conservation interest and these have a greater level of protection than unlisted species.

There are seven categories covering State-listed TF and PF species (DPaW 2017) which are outlined in **Table 12** in **Appendix One:**. PF for Western Australia are regularly reviewed by DBCA whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet the requirements outlined in **Table 12**.

1.4.4.2 Other Significant Flora

According to the *Flora and Vegetation Technical Guidance* (EPA 2016c) other than being listed as Threatened or Priority Flora, a species can be considered as significant if it is considered to be:

- locally endemic or association with a restricted habitat type (e.g. GDEs or SFDV)
- a new species or has anomalous features that indicate a potential new species
- at the extremes of range, recently discovered range extensions (generally considered greater than 100 km or in a different bioregion), or isolated outliers of the main range)
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids
- relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

1.4.5 ECOLOGICAL COMMUNITIES AND VEGETATION

1.4.5.1 Threatened and Priority Ecological Communities

Nationally Listed Threatened Ecological Communities

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat (Department of Environment and Conservation 2010; Government of Western Australia 2016). At Commonwealth level, Threatened Flora and Threatened Ecological Communities (TECs) are protected under the Commonwealth EPBC Act. An ecological community may be categorised into one of the three sub-categories:

- Critically Endangered, if it is facing an extremely high risk of extinction in the wild in the immediate future.
- Endangered, if it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
- Vulnerable, if it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

State Listed Threatened Ecological Communities

The Western Australian DBCA also maintains a list of TECs which are further categorised into three subcategories much like those of the EPBC Act. The full details of DBCA criteria are shown in **Table 13** in **Appendix One:**.

State Listed Priority Ecological Communities

DBCA maintains a list of Priority Ecological Communities (PECs). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined.

1.4.5.2 Other Significant Vegetation

Groundwater Dependent Ecosystems

Groundwater Definition

Groundwater is water that is found in the saturated zone of the soil, where all soil pores are filled with water. The water table is the upper surface of the saturated zone in an unconfined aquifer. Groundwater may also occur as a perched aquifer located above unsaturated rock formations as a result of a discontinuous permeable layer or held under pressure in a confined aquifer (Goulburn-Murray Water 2010).

Groundwater Dependent Ecosystems Definition

Groundwater Dependent Ecosystems (GDEs) have been defined as ecosystems that are dependent on groundwater for their survival at some stage or stages of their lifecycle, however groundwater use cannot be equated with groundwater dependence (Eamus 2009b). In some contexts, GDEs are also known as Groundwater Dependent Vegetation.

Hatton and Evans (1998) identified four types of GDEs based on their geographic setting: terrestrial vegetation (vegetation communities and dependent fauna that have seasonal or episodic dependence on groundwater), river base flow systems (aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow), aquifer and cave ecosystems, and wetlands.

Eamus *et al.* (2006) identified three primary classes based on type of groundwater reliance:

1. Aquifer and cave ecosystems.
2. All ecosystems dependent on the surface expression of groundwater:
    a) river base flows
    b) wetlands, swamplands
    c) seagrass beds in estuaries
    d) floodplains
    e) mound springs
    f) riparian vegetation

g) saline discharge to lakes
h) low lying forests.

3. All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the water table) when roots penetrate this zone:
   a) River Red Gum (*Eucalyptus camaldulensis*) forests
   b) Banksia woodlands
   c) Riparian vegetation in the wet/dry tropics.

GDEs in the Pilbara are generally determined to be vegetation associated with riparian areas. GDEs dependent on the surface expression of groundwater (Eamus *et al*. 2006 class 2) includes vegetation associated with wetlands (permanent or semi-permanent pools) within riparian areas, and generally includes *Melaleuca argentea* in association with other species described below. GDEs associated with the subsurface presence of groundwater (Eamus *et al*. 2006 class 3) includes riparian vegetation characterised by the phreatophytic species described below.

Direct impacts on GDEs i.e. clearing, and indirect impacts, including from dewatering and reinjection, frequently feature as being a significant environmental impact in mining approvals documents e.g. (Office of the Appeals Convenor 2016b; 2016c; Rio Tinto 2016).

Phreatophytic Species

Phreatophytic species (phreatophytes) rely on groundwater sources for water intake (Maunsell Australia Pty Ltd 2006); essentially the water requirements of phreatophytes are greater than can be provided from the surface soil profile (e.g. riparian vegetation) or they are dependent on free water availability (e.g. wetland species). They frequently show low tolerance to extended water stress due to a lack of physiological and/or morphological adaptation to drought, and respond to significant water deficit by a decline in health and eventual death (*ibid*.).

The EPA defines phreatophytes as species that utilise groundwater (EPA 2018).

Obligate phreatophytes are dependent on free access to water (i.e. they are wetland species) whereas facultative phreatophytes can switch their water source between the soil surface profile in times of rain, to groundwater in times of drought when the soil surface profile (vadosphere) is depleted (Grierson 2010).

Phreatophytes likely to occur in the study area include:

- *Eucalyptus camaldulensis* subsp. *refulgens*, which is regarded as a facultative phreatophyte that is dependent on groundwater for part of its lifecycle and/or in times of drought. This species has been reported to be tolerant of groundwater falls of up to 4 m per year (Maunsell Australia Pty Ltd 2006), has both lateral and sinker roots and is tolerant of waterlogging (Grierson 2010).
- *Eucalyptus victrix*, which may be regarded as a facultative phreatophyte. It is considered to be relatively drought tolerant and likely to be tolerant of gradual declines to the water table (to a degree) (Maunsell Australia Pty Ltd 2006). *Eucalyptus victrix* has lateral and sinker roots (i.e. a dimorphic root system) but is not tolerant of waterlogging (Grierson 2010). There is some conjecture that this species is actually a vadophyte (i.e. relies on water from within the soil surface profile, and is independent of groundwater; Equinox Environmental 2017) or, at best, weakly phreatophytic (Resource and Environmental Management Pty Ltd 2007). Depth to groundwater is likely to be an important indicator of groundwater dependence (Equinox Environmental 2017).
- wetland species such as *Melaleuca argentea*, which is an obligate phreatophyte (EPA 2018).

Vegetation containing *Eucalyptus camaldulensis* subsp. *refulgens* and *Melaleuca argentea* is generally considered to represent a GDE.

Vegetation characterised by *Eucalyptus victrix* is considered to potentially represent a GDE as there is supporting evidence that, in some circumstances, this species does not always depend on groundwater (Batini 2009; Eamus 2009a; EPA & Hamersley Iron Pty Ltd 2010; Equinox Environmental 2017; Resource and Environmental Management Pty Ltd 2007).

Mulga Vegetation

Mulga is the common name for a group of closely related *Acacia* species that were formerly known as *Acacia aneura* and its subtaxa. A recent taxonomic review (Maslin & Reid 2012) has resulted in a revision of this group, and Mulga now includes *Acacia aneura*, *A. aptaneura*, *A. ayersiana*, *A. caesaneura*, *A. craspedocarpa*, *A. fuscaneura*, *A. incurvaneura*, *A. macraneura*, *A. minyura*, *A. mulganeura*, *A. paraneura* and *A. pteraneura*, although not all are present in the Pilbara.

Mulga vegetation on valley floors can be considered as significant, and are recognised as such in a number of publications including the *Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (McKenzie *et al*. 2003) and various EPA approvals documents where environmental objectives are set or conditions imposed to restrict impacts on Mulga vegetation (EPA 2010; 2011; 2012; 2014; 2016a; Office of the Appeals Convenor 2016a).

Valley floor Mulga can be considered as significant vegetation due to threats associated with the hydrological change, particularly in relation to linear infrastructure (EPA 2010; 2011; 2012; 2014; 2016a; Office of the Appeals Convenor 2016a). Potential effects of changed hydrology as a result of interruptions to surface flows caused by linear infrastructure is most apparent in Sheet Flow Dependent Mulga (also known more generally as Sheet Flow Dependent Vegetation, SFDV) that occurs in groves (also known as 'grove-intergrove') or bands and can be inferred from species composition, community structure and topography. SFDV relies on overland (sheet) flow of water across a relatively flat landscape to regenerate (Muller 2005; The University of Western Australia *et al*. 2012). Subsequently, changes in topography caused by mining or linear infrastructure, including roads and railways, can have a significant impact. Mulga groves are formed when obstacles, including existing groves or piles of vegetation or timber (in a natural environment), impede water flow, and debris carried in the water (including seeds and plant material containing nutrients) is deposited upslope of the obstacle, forming the characteristic grove (depositional feature)/intergrove (erosional feature) formation. Sheet Flow Dependent Vegetation may also occur at the base of hills, when surface water sheets off the rocky formations carrying soil and plant debris; where the water loses sufficient velocity to deposit plant debris, linear groves of Mulga may occur, usually as a single band.

Other Significant Vegetation

According to the *Flora and Vegetation Technical Guidance* (EPA 2016c), other than being listed as a TEC or PEC, vegetation can be considered as significant if it is considered to have:

- restricted distribution
- a degree of historical impact from threatening processes
- a role as a refuge
- provides an important function required to maintain ecological integrity of a significant ecosystem.

1.4.5.3 Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests under the BAM Act). Under the BAM Act, Declared Pests are listed as one of the three categories, or exempt:

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage
- Exempt (no category).

1.5 CONSERVATION ESTATE

The National Reserve System is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate and representative reserve system for Western Australia. The Conservation and Parks Commission is the vesting body for conservation lands, forest and marine reserves that are managed by DBCA (Government of Western Australia 2018a).

2 METHODS

Ecoscape completed a detailed desktop assessment using the information supplied by Fortescue, publically available resources and Ecoscape's own data sources to identify conservation significant flora and vegetation values within the study area.

This desktop assessment is compliant with relevant Commonwealth and WA Technical Guidance's and procedures. The assessment includes a detailed literature review using both supplied and Ecoscape sourced material including publicly available data sources via State and Commonwealth Government web sites.

2.1 DATABASE AND LITERATURE REVIEW

The following were reviewed to identify significant flora and vegetation features within the study area:

- Threatened Flora and Ecological Communities listed under the Commonwealth EPBC Act 1999
- Threatened Flora listed under the Western Australian WC Act 1950
- Priority Flora and Threatened and Priority Ecological Communities listed DBCA
- DBCA Threatened Flora and Communities database searches
- *NatureMap* search
- *Protected Matter Search Tool* (PMST)
- review of the *Atlas of Groundwater Dependent Ecosystems*
- land system and geology mapping
- survey reports from the study area and surrounding region.

2.1.1 DATABASE SEARCHES

The following government database searches were undertaken to inform the desktop assessment:

- Commonwealth:
  - PMST for the study area including a 40 km buffer (see **Appendix Two:**)
- DBCA:
  - Threatened and Priority Flora (ref: 36-0818FL) within the study area and 40 km buffer
  - Ecological Communities (ref: 17-0618EC) within the study area and 5 km buffer.

In addition to these, Fortescue's Vegetation Type mapping and Flora Sampling spatial datasets were also interrogated for the study area plus a 20 km buffer.

2.1.2 PREVIOUS FLORA AND VEGETATION SURVEYS

The study area largely corresponds with Fortescue's rail alignment corridors. Consequently, a significant number of intersecting surveys have been conducted in support of environmental approvals. Management documents created by Fortescue, including monitoring requirements imposed through the environmental approvals process, e.g. as Ministerial Statement conditions, also have relevance to areas corresponding with or near the study area. A total of 72, 961 hectares of the study area has been surveyed which equates to 90% of the study area.

The documents in **Table 1** (prepared for Fortescue unless otherwise noted) were reviewed and provided information for this assessment.

Ecological attributes of species identified from previous surveys and database searches are indicated in **Table 16** in **Appendix Three**:, with attributes largely taken from *FloraBase* (Western Australian Herbarium [WAH] 1998-2018) and the *Rare and Priority Plants of the Pilbara mobile app* (Rio Tinto & Department of Parks and Wildlife 2015).

Table 1: Previous flora and vegetation surveys relevant to the study area by date

Report Title	Relevant Guidance	Survey date	Survey type
Eliwana Consolidated Detailed Flora and Vegetation (Biota Environmental Sciences Pty Ltd. 2017)	*Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (Environmental Protection Authority 2016c) *Fortescue Flora and Vegetation Assessment Guidelines* (100-GU-EN-0005)	Phase1: April & July 2017 Phase 2: August & September 2017	Detailed
Iron Bridge North Star Stage 2 Pityrodia sp. Marble Bar Regional Survey 2015, unpublished report for FMG Iron Bridge (Aust) Pty Ltd (Ecologia Environment 2016)	*Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (Environmental Protection Authority 2016c)	September 2015	Targeted
North Star Slurry and Infrastructure Corridors, Conservation Significant Flora and Vegetation Assessment (Ecologia Environment 2015)	Guidance for the Assessment of Environmental Factors. Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (Environmental Protection Authority 2004)	July 2015	Detailed
North Star Alternate Access Road, Flora and Vegetation Assessment (Coffey Environments 2014)	EPA Guidance Statement 51 (Environmental Protection Authority 2004) Fortescue Metals Group Ltd. 2014. Flora and Vegetation Assessment Guidelines. Environment. 100 GU-EN-0005. 5 February 2014. Fortescue Metals Group Ltd, Perth, Western Australia.	June 2014	Detailed
Investigator Project: Flora and Vegetation Assessment (Ecologia Environment 2014c)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2014	1 Phase Level 2
Solomon Hub: Flora and Vegetation Assessment (Ecologia Environment 2014d)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	April/May 2014	Detailed
Level 1 flora and vegetation survey of the Fortescue River Gas Pipeline (FRGP) Project, unpublished report for DBP (Mattiske Consulting Pty Ltd 2013)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	October 2013	Level 1/Recon
North Star Access Corridor Flora and Fauna Assessment (Ecologia Environment 2012a)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	May 2012	2 phase Level 2
North Star Vegetation and Flora Assessment (Ecologia Environment 2012b)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	April, June/July, August 2011	Level 2
Nyidinghu Rail Spur Flora and Vegetation Assessment (Cardno Pty Ltd 2012)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	July 2011	Level 2
Supplementary Flora, Vegetation and Fauna Assessment: Solomon Project (Coffey Environments 2011)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2011	Level 2

Report Title	Relevant Guidance	Survey date	Survey type
Cloudbreak Flora and Vegetation Assessment (ENV Australia Pty Ltd 2011b)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	July & August 2010	Detailed
Flora and Vegetation Assessment, Solomon Project and Investigator (Coffey Environments 2010a)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2008	1 Phase Level 2
Flora and Vegetation Assessment, Solomon Rail Project (Coffey Environments 2010b)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2008	Level 1/ Recon
Solomon Regional Flora Assessment (Coffey Environments 2010c)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2008	Level 2
Level Two Flora and Vegetation Assessment, Firetail Mining Area (Ecoscape (Australia) Pty Ltd 2010a)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2010	Detailed
Port Water Supply Flora and Vegetation Assessment (Ecoscape (Australia) Pty Ltd 2010b)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2010	2 Phase Level 2
*Solomon Project Rai*l Camp 1G Flora and Vegetation Assessment (Ecoscape (Australia) Pty Ltd 2010c)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2010	Level 1
Solomon Project Rail Re-Alignment Flora and Vegetation Assessment (Ecoscape (Australia) Pty Ltd 2010d)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2010	Level 1
Solomon Project: Kings. Flora and Vegetation Assessment (ENV Australia Pty Ltd 2010)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2010	1 Phase Level 2
Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure (Coffey Environments 2007)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2006	1 Phase Level 2
Flora and Vegetation Near Fortescue Marshes (Mattiske Consulting Pty Ltd 2007)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2006	1 Phase Level 2
Supplementary Flora Survey (ATA Environmental 2005)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2005	Level 1
Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor (Biota Environmental Sciences Pty Ltd 2004a)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2004	Phase 1 Level 2
Vegetation and Flora Survey of the Proposed FMG Stage B Rail Corridor, Christmas Creek, Mt Lewin, Mt Nicholas and Mindy Mindy Mine Areas (Biota Environmental Sciences Pty Ltd 2004b)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2004	-
Mattiske Consulting *Flora and Vegetation on the Cloud Break and White Knight Leases* (Mattiske Consulting Pty Ltd 2005)	EPA Guidance Statement 51 (Environmental Protection Authority 2004)	2004	1 Phase Level 2

The footprints for the above assessments are shown in **Map 1**.

Annual monitoring requirements and resultant reports commissioned by Fortescue were also reviewed for relevant information, including:

- Ecoscape (2018), *Vegetation Health Monitoring Program 2017 (100-RP-EN-0660)*
- Ecologia Environment (2014b), *Hamersley Rail Mulga Monitoring (R-RP-EN-1048)*
- Syrinx Environmental (2012), *Solomon Rail Project - Mulga Monitoring Baseline Survey (SO-RP-EN-0023)*, unpublished report for Fortescue Metals Group.

2.1.2.1 Consolidation of Vegetation Mapping

To allow mapping and determination of extent of significant vegetation values within the study area available vegetation type mapping was collated into a single spatial data layer. Priority was assigned to the most recent assessment with the highest level of survey (i.e. Detailed/Level 2 assessment in preference to Reconnaissance/Level 1 assessment) where vegetation mapping from multiple surveys overlapped. The final ranking employed (ordered highest to lowest) was as below:

- Biota Environmental Sciences (2017), *Eliwana Consolidated Detailed Flora and Vegetation*
- Coffey Environments (2014), *North Star Alternate Access Road, Flora and Vegetation Assessment*
- Ecologia Environment (2012a), *North Star Access Corridor Flora and Fauna Assessment*
- Ecologia Environment (2014d), *Solomon Hub: Flora and Vegetation Assessment*
- GHD (2012), *Port Hedland Outer Harbour Rail Flora and Fauna Report*
- ENV Australia (2011b), *Cloudbreak Flora and Vegetation Assessment*
- Coffey Environments (2010b) *Flora and Vegetation Assessment, Solomon Rail Project*
- Ecoscape (2010b), *Port Water Supply Flora and Vegetation Assessment*
- ATA Environmental (2005), *Supplementary Flora Survey*
- Biota Environmental Sciences (2004a), V*egetation and Flora Survey of the Proposed FMG Stage A Rail Corridor*.

2.1.3 PRIORITY FLORA LIKELIHOOD ASSESSMENTS

Ecoscape conducted a likelihood assessment to identify Priority flora species that have potential to occur within the study area. The likelihood of a species occurring is based on the following attributes, as listed on *FloraBase* (WAH 1998-2018; 2018), tailored to Pilbara populations, *Rare and Priority Plants of the Pilbara mobile app edition* (Rio Tinto & DPaW 2015) and including information from recent nearby surveys.

The attributes were:

- broad soil type usually associated with the species
- broad landform usually associated with the species
- usual vegetation (characteristic species) with which the species is usually associated, or
- species having previously been recorded from within approximately 40 km of the Project area (considered as 'nearby').

The relevant ecological attributes of these species are indicated in **Table 16** in **Appendix Three**, with attributes largely taken from *FloraBase* (Western Australian Herbarium [WAH] 1998-2018) and the *Rare and Priority Plants of the Pilbara mobile app* (Rio Tinto & Department of Parks and Wildlife 2015).

The likelihood rating is assigned using the categories listed in **Table 2**.

Table 2: Categories for likelihood of occurrence of conservation significant flora

Likelihood	Categories
Recorded	Species recorded within the study area
Possible	May occur within the study area (but has not been recorded); broadly, 2-4 of the required attributes (but always including records from nearby) are present in the study area
Unlikely	Could occur but is not expected; 1-3 of the required attributes are present in the Project area but: • it is not known from nearby, or • it is known from nearby but has no other required attributes, or • it is known from nearby but has at least one well-defined attribute that does not occur in the Project area (e.g. it is associated with a specific landform or soil type that does not occur in the Project area)
Highly Unlikely	The species characteristics include only one or none of the required attributes of soil, landform, associated vegetation and having previously been recorded nearby, or a critical element (often landform) is not within the Project area and as such it almost certainly does not occur.

2.1.4 DERIVATION OF PRIORITY FLORA POPULATIONS

Priority Flora populations were derived from individual flora database records. For each species, those records that were within 500 m of each other (and had no physical barriers to dispersal) were considered to be of the same population.

3 DESKTOP RESULTS

3.1 PHYSICAL ENVIRONMENT

3.1.1 CLIMATE

The study area is located within the Pilbara region, which includes two broad climatic zones. Coastal areas, as well as some higher rainfall inland areas, have a semi-desert tropical climate which experience 9-11 months of dry weather, with hot humid summers and warm winters. The remaining inland areas have a dry desert climate, typically with higher temperatures and lower rainfall, and often experience up to 12 months of dry weather, with hot dry summers and mild winters (Leighton 2004).

Monthly maximum temperatures range from an average of 25°C in July to 37°C in January, while minimum temperatures are experienced in these same months, with an average of 12°C in July and 25°C in January (McKenzie *et al.* 2009). December and January are the hottest months in inland areas, while coastal areas often experience their highest temperatures later in February or March due to the dampening effect of the ocean (Leighton 2004).

Annual rainfall in the Pilbara has substantial yearly variation, but generally follows an inland to coastal and southern to northern increasing trend (Leighton 2004). Tropical cyclones, many of which originate in the Timor Sea, along with local thunderstorms, produce much of the summer and early autumn rainfall. The driest months are in spring (September to October) (McKenzie *et al.* 2009), and winter rainfall is highly variable, generally decreasing from the coast through to inland areas (Leighton 2004).

According to the Köppen-Geiger climate classification, the study area has a hot desert climate (Peel *et al.* 2007). This classification includes arid regions where annual evaporation exceeds annual precipitation, and with a mean annual temperate ≥18°C.

Figure 2 to **Figure 4** shows the mean monthly temperatures and rainfall for the Port Hedland, Redmont and Wittenoom BoM stations, to provide an indication of the transition in climate along the study area as you move from the coast further inland.

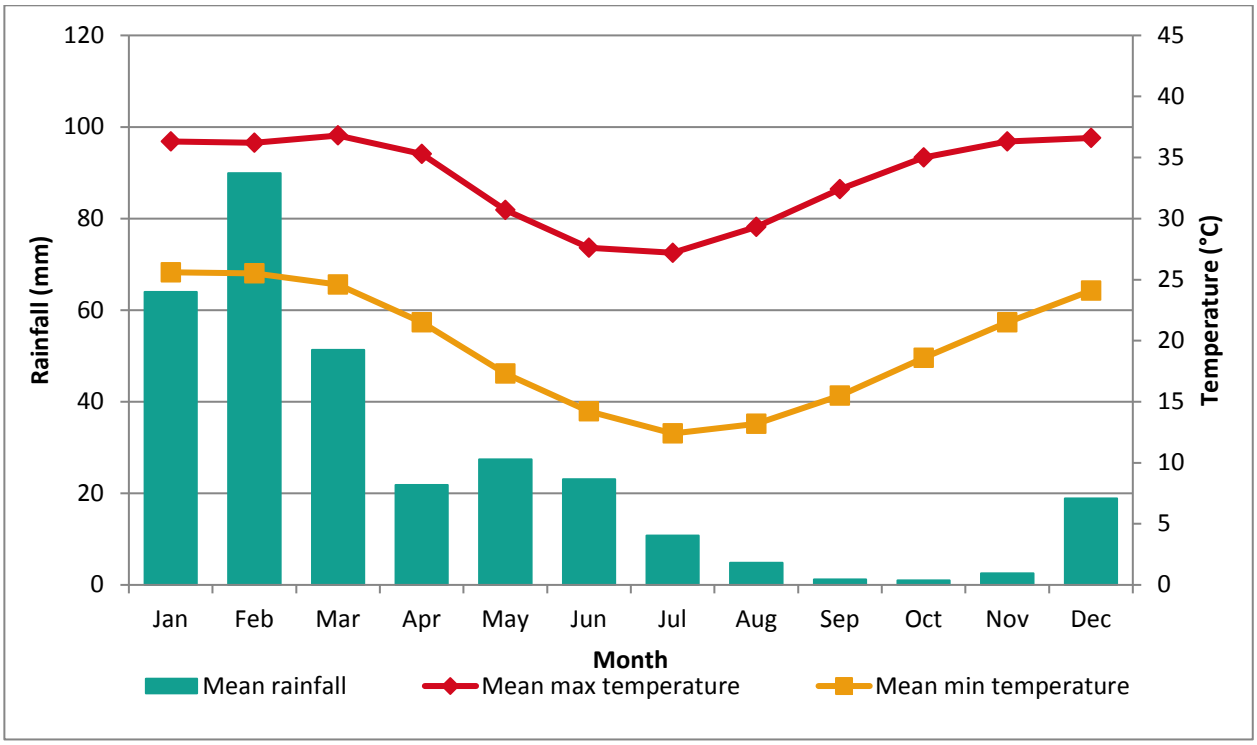


Figure 2: Mean temperatures and rainfall for Port Hedland Airport (BoM 2018)

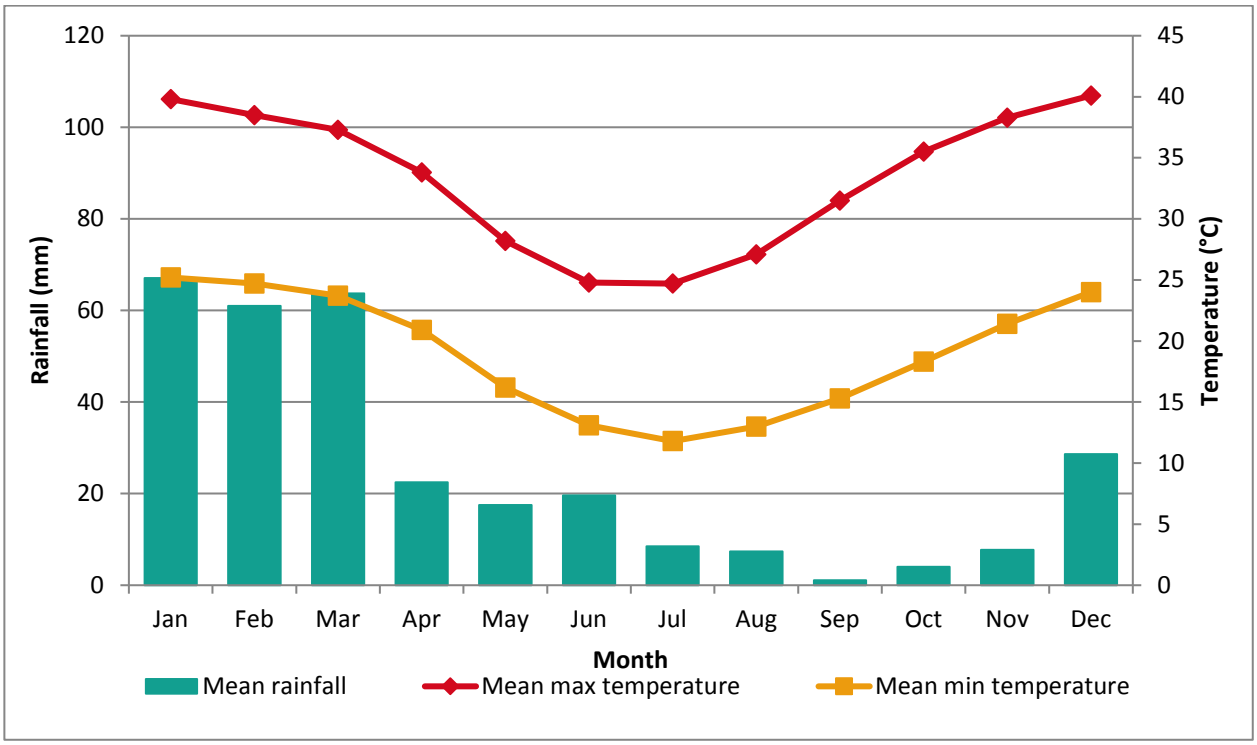


Figure 3: Mean temperatures and rainfall for Redmont (BoM 2018)

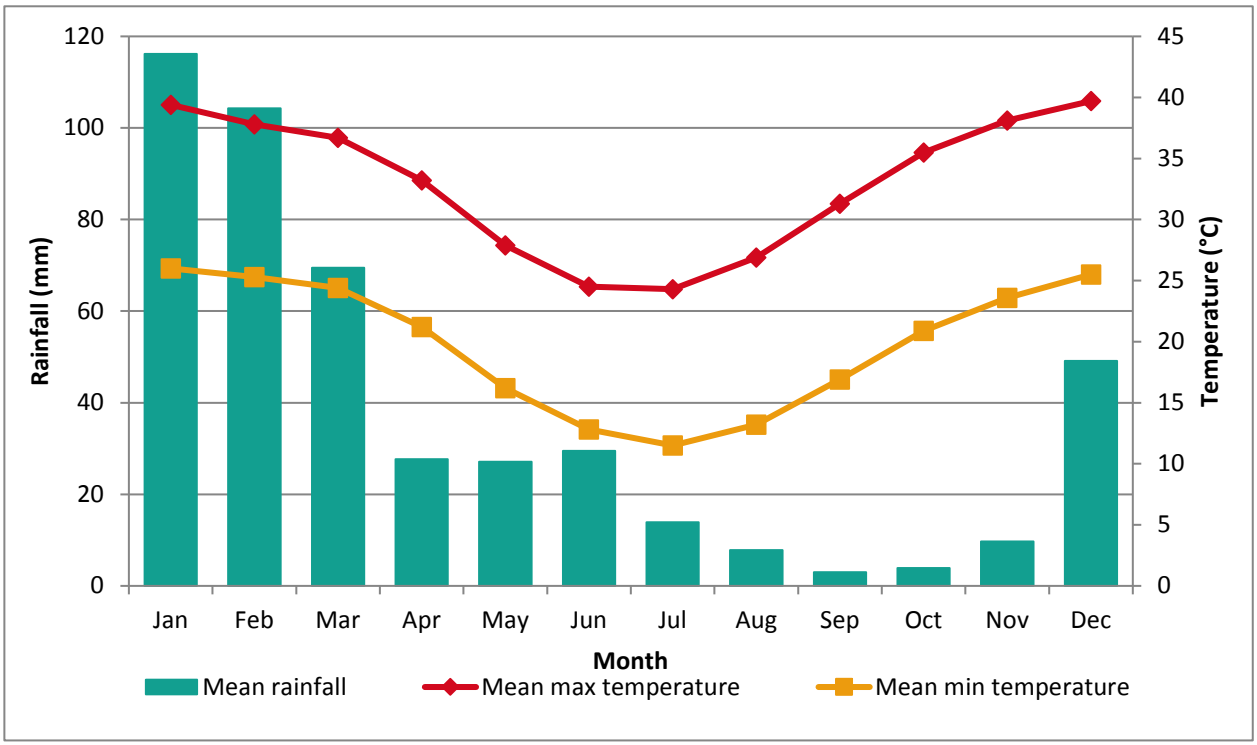


Figure 4: Mean temperatures and rainfall for Wittenoom (BoM 2018)

3.1.2 LAND SYSTEMS

As part of the rangeland resource surveys, the former Department of Agriculture comprehensively described and mapped the biophysical resources of the Pilbara together with an evaluation of the condition of the soils and vegetation (from an agricultural perspective) throughout (Van Vreeswyk *et al.* 2004). This included the development of an inventory of land types, land systems and land units with particular use capabilities, habitats or conservation values to assist in land use planning. The land systems occurring within the study area are listed in **Table 3** and shown on **Map 2**.

Table 3: Land Systems of the Pilbara occurring within the study area (Van Vreeswyk *et al.* 2004)

Land system	Description	Vegetation Condition	Extent of Study area (Ha)	% of Study Area
Bonney System	Low rounded hills and undulating stony plains supporting soft spinifex grasslands.	very good 65%, good 30%, fair 4%, poor 0%, very poor 1% (122 assessments)	1,580.32	1.95
Boolaloo System	Granite hills, domes, tor fields and sandy plains supporting spinifex grasslands with scattered shrubs.	very good 100% (71 assessments)	3,993.47	4.94
Boolgeeda System	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	very good 82%, good 13%, fair 4%, poor 1% (596 assessments)	5,419.62	6.70
Brockman System	Gilgai alluvial plains with cracking clay soils supporting tussock grasslands and low woodlands.	very good 19%, good 26%, fair 21%, poor 17%, very poor 17% (149 assessments)	473.14	0.58
Calcrete System	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands	very good 72%, good 17%, fair 8%, poor 2%, very poor 1% (177 assessments)	28.23	0.03
Capricorn System	Rugged sandstone hills, ridges, stony footslopes and interfluves supporting low acacia shrublands or hard spinifex grasslands with scattered shrubs.	very good 94%, good 4%, fair 2% (138 assessments)	16.72	0.02
Coolibah System	Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey.	very good 9%, good 14%, fair 17%, poor 34%, very poor 26% (182 assessments)	1,283.23	1.59
Granitic System	Rugged granitic hills supporting shrubby hard and soft spinifex grasslands.	very good 97%, good 2%, fair 1% (113 assessments)	3,408.54	4.21
Hooley System	Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands.	very good 21%, good 20%, fair 26%, poor 21%, very poor 12% (121 assessments)	421.60	0.52
Jamindie System	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.	very good 22%, good 26%, fair 25%, poor 15%, very poor 12% (221 assessments)	764.99	0.95
Jurrawarrina System	Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses.	very good 14%, good 18%, fair 19%, poor 24%, very poor 25% (117 assessments)	2,048.00	2.53
Macroy System	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.	very good 85%, good 9%, fair 5%, poor 1% (1502 assessments)	24,804.10	30.67
Mallina System	Sandy surfaced alluvial plains supporting soft spinifex grasslands and minor hard spinifex and tussock grasslands.	very good 42%, good 36%, fair 15%, poor 7% (423 assessments)	2,970.13	3.67
McKay System	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.	very good 88%, good 8%, fair 3%, poor 1% (132 assessments)	3,787.16	4.68

Land system	Description	Vegetation Condition	Extent of Study area (Ha)	% of Study Area
Newman System	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	very good 91%, good 7%, fair 1%, poor 1% (228 assessments)	4001.50	4.95
Oakover System	Breakaways, mesas, plateaux and stony plains of calcrete supporting hard spinifex shrubby grasslands.	very good 89%, good 6%, fair 1%, poor 4% (120 assessments)	102.20	0.13
River System	Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.	very good 56%, good 26%, fair 13%, poor 5% (401 assessments)	1025.91	1.27
Robe System	Low plateaux, mesas and buttes of limonite supporting soft spinifex and occasionally hard spinifex grasslands.	very good 86%, good 6%, fair 6%, poor 2% (98 assessments)	597.26	0.74
Rocklea System	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs.	very good 89%, good 7%, fair 2%, poor 2% (880 assessments)	4611.64	5.70
Talga System	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.	very good 93%, good 4%, fair 3% (144 assessments)	1000.86	1.24
Uaroo System	Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs.	very good 68%, good 24%, fair 7%, poor 1% (808 assessments)	10683.88	13.21
Urandy System	Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands.	very good 76%, good 13%, fair 7%, poor 4% (134 assessments)	3498.94	4.33
White Springs System	Stony gilgai plains supporting Roebourne Plains grass grasslands and hard spinifex grasslands.	very good 55%, good 17%, fair 13%, poor 15% (52 assessments)	572.61	0.71
Wona System	Basalt upland gilgai plains supporting Roebourne Plains grass and Mitchell grass tussock grasslands, minor hard spinifex grasslands or annual grasslands/herbfields.	very good 30%, good 20%, fair 20%, poor 22%, very poor 8% (205 assessments)	3789.60	4.69

3.1.1 GEOLOGY

There are sixty five geological units mapped by the Geological Survey of Western Australia that intersect the study area across the following four sheets of the 250,000 geological map series:

- Port Hedland - Bedout Island (Van Kranendonk & Smithies 2012)
- Marble Bar (Hickman 2010)
- Mount Bruce (Thorne *et al.* 1996)
- Roy Hill (Thorne & Tyler 1996).

The complete list of units and associated descriptions are provided in **Appendix Four**.

3.1.2 SURFACE HYDROLOGY AND WETLANDS

The study area intersects a number of significant drainage lines along its length including the Turner River, Turner East River, Yule River and Coonarie Creek along the Main Line Rail section and the Fortescue River Flats along the Hamersley Rail component. The Fortescue River flats section also corresponds with a portion of the mapped extent of the Fortescue Marshes within the Commonwealth Directory of Important Wetlands(Australian Government & Department of the Environment and Energy 2018) (Map 4). The study area also falls partly within the Fortescue Marsh draft proposed RAMSAR area at the Cloudbreak end of the study area as provided within the DBCA Ramsar Sites (DBCA-010) spatial dataset (DBCA 2018) (**Map 4**).

3.1.3 CONSERVATION ESTATE

The study area does not intersect any lands that are defined under acts which are applicable to DBCA. Tenure categories include but not limited to, National Park, Nature Reserve, Conservation Park, Marine Park, Marine Nature Reserve, marine management area, section 5(1)(g) reserves, State forest and timber reserves.

The study area does intersect some areas managed by DBCA (referred to as DBCA - Lands of Interest) in the vicinity of Solomon (UCL – former leasehold proposed for conservation – ex. Mt Florence) and Cloudbreak (UCL – former leasehold – 2015 excision – proposed for conservation – ex Mulga Downs Station). Included lands are those to which DBCA is recognised as the manager, but which are not vested under any Act that is administered by DBCA. These lands comprise of Crown land and Freehold land which DBCA has been acknowledged by the Department of Lands as the responsible agency. The location where these areas intersect the study area is shown on **Figure 1**.

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 BIOGEOGRAPHIC REGIONS

Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna and are defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Australian Government & Department of the Environment and Energy [DotEE] 2017).

The study area is located entirely within the Pilbara biogeographic region that includes four subregions; Chichester, Fortescue Plains, Hamersley and Roebourne (Thackway & Cresswell 1995). The three principal subregions that intersect the study area (from north to south) are described below (from the *2002 Biodiversity Audit of Western Australia's 53 Biogeographical Subregions* (McKenzie *et al*. 2003)) as:

Roebourne (PIL4, Kendrick & Stanley 2002):

> Quaternary alluvial and older colluvial coastal and subcoastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or A. pyrifolia and *A. inaequilatera.* Uplands are dominated by *Triodia* hummock grasslands. Ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* woodlands. Samphire, Sporobolus and mangal occur on marine alluvial flats and river deltas. Resistant linear ranges of basalts occur across the coastal plains, with minor exposures of granite. Islands are either Quaternary sand accumulations, or composed of basalt or limestone, or combinations of any of these three. Climate is arid (semi-desert) tropical with highly variable rainfall, falling mainly in summer. Cyclonic activity is significant, with several systems affecting the coast and hinterland annually. Subregional area is 2,008,983 ha.

Chichester (PIL1, Kendrick & McKenzie 2002):

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

Fortescue Plains (PIL2, Kendrick 2002):

> Alluvial plains and river frontage. Extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains in the east. Deeply incised gorge systems in the western (lower) part of the drainage. River Gum woodlands fringe the drainage lines. Northern limit of Mulga (*Acacia aneura*). An extensive calcrete aquifer (originating within a palaeo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of River Gum and Cadjeput Melaleuca woodlands. Climatic conditions are

semi desert tropical, with average rainfall of 300 mm, falling mainly in summer cyclonic events. Drainage occurs to the north-west. Subregional area is 2 041 914 ha.

A small fraction of the south western fringe of the study area also occurs along the boundary of the Fortescue Plains and Hamersley subregions in the vicinity of the Solomon Hub (see **Figure 1**).

3.2.2 VEGETATION MAPPING

A total of 218 vegetation types have been identified during previous surveys (**Table 18** in **Appendix Five:**).

Most of the vegetation types have no specific significance; those that have been identified as significant are discussed in the following sections.

Table 14 and **Table 15** in **Appendix One:** describes NVIS structural formation classes and NVIS height classes respectively that were used for the of the vegetation mapping.

3.2.3 CONSERVATION SIGNIFICANT VEGETATION

The extent of Conservation Significant Vegetation types within the study area are summarised below in **Table 4** and discussed in more detail in the following sections.

Table 4: Extent of Conservation Significant Vegetation Types within the study area

Conservation Significant Vegetation Classification	Mapped extent within development envelope (ha)	Hectares in study area (ha)	Percent of study area (%)
Wona Priority Ecological Community (P1 or P3 depending upon composition)	300.23	4,275.77	5.29
Sheet Flow Dependent Vegetation (Mulga)	96.46	2,186.26	2.70
Groundwater Dependant Ecosystems	89.05	1,537.21	1.90
Potential Groundwater Dependant Ecosystems	177.63	3,394.10	4.20
Other Significant Vegetation	127.77	3,602.24	4.45

3.2.3.1 Threatened and Priority Ecological Communities

No TECs listed for protection under the Commonwealth EPBC Act occur in the Pilbara bioregion.

No Western Australian TECs or PECs correspond with or are close to the study area in the northern section from Port Hedland south to the Hamersley Rail intersect (NatureMap, DPaW 2007-2018, accessed 14 June 2018; Ecologia Environment 2012a; 2015).

The study area near the Solomon Hub is located approximately 20 km from the nearest mapped occurrence of the Western Australian-listed *Themeda grasslands on cracking clays (Hamersley Station, Pilbara)* TEC (DPaW Species & Communities Branch 2016). The vegetation associated with the Hamersley Rail is well understood and the TEC is not known to occur within the alignment (Coffey Environments 2010b; Ecoscape 2010d; 2016).

The southern portion of the study area corresponds with or is close to several PEC occurrences or their administrative study areas (*ibid.*, Species and Communities Branch DBCA 2017), which include the following:

- *Four plant assemblages of the Wona Land System* ('Wona PEC', P1 or P3, depending on subtype), identified as corresponding with the Hamersley Rail (Coffey Environments 2010b) and Fortescue gas pipeline (Mattiske 2013)
- *Freshwater claypans of the Fortescue Valley* (P1), Cloudbreak area
- *Fortescue Marsh (Marsh Land System* P1), Cloudbreak area.

The location of the TEC and PECs and associated administrative study areas returned from the DBCA database search are shown in **Map 3**.

Wona PEC (P1 or P3)

The Wona PEC is the only conservation significant ecological community identified from the DBCA database searches that occurs within the study area. These occur along the Hamersley Rail section of the study area and occupy 4275.77 ha (5.29% of the study area) (see **Map 4**). Outside of the study area along the Nyidinghu Rail Spur there is a small area of cracking clay which is a potential occurrence of the Wona PEC, although unconfirmed by DBCA (Cardno Pty Ltd 2012). The Wona PEC consists of four different associations, all occurring on basalt upland gilgai plains throughout the Chichester Range, and are considered susceptible to grazing or have constituent rare/restricted species, as follow:

- Cracking clays of the Chichester and Mungaroona Range. This grassless plain of stony gibber community occurs on the tablelands with very little vegetative cover during the dry season, however during the wet a suite of ephemerals/annuals and short-lived perennials emerge, many of which are poorly known and range-end taxa (Priority 1).
- Annual Sorghum grasslands on self mulching clays. This community appears very rare and restricted to the Pannawonica-Robe valley end of Chichester Range (Priority 1).
- Mitchell grass plains (*Astrebela* spp.) on gilgai (Priority 3).
- Mitchell grass and Roebourne Plain grass (*Eragrostis xerophila*) plain on gilgai (typical type, this community is heavily grazed (Priority 3).

Table 5: Wona PEC Vegetation Types

Veg Code	Description
AlOc	Sparse grassland of *Aristida latifolia, Aristida inaequiglumis* and *Eriachne ciliata* mid sparse grassland over *Oldenlandia crouchiana, Heliotropium crispatum* and *Operculina aequisepala* low sparse herbland. Unconfirmed by DBCA (Cardno Pty Ltd 2012).
DSA2	Tall Open Shrubland of *Acacia xiphophylla* and *Acacia* aff. *aneura* (narrow fine veined; site 1259) to 6m over Scattered Tall Trees of *Acacia tetragonophylla* and *Acacia tetragonophylla* to 2.8m over Scattered Hummock Grasses of *Triodia longiceps* to 1.1m over Scattered Tussock Grasses of *Cymbopogon ambiguus* to 1.3m (Coffey Environments 2010a).
FGT1	Tussock Grassland to Open Tussock Grassland of *Eriachne obtusa*, *Astrebla pectinata* and *Aristida latifolia* to 0.5m (Coffey Environments 2010a).
FGT1/FGT2	Tussock Grassland to Open Tussock Grassland of *Eriachne obtusa*, *Astrebla pectinata* and *Aristida latifolia* to 0.5m/ Mid-dense Hummock Grassland of *Triodia secunda* to 1m over Low Shrubland of *Melaleuca eleuterostachya*, *Acacia stellaticeps* and *Acacia bivenosa* to 0.9m (Coffey Environments 2010a).
FSA1	Scattered Shrubs of *Acacia bivenosa*, *Grevillea wickhamii* subsp. *aprica* and *Acacia maitlandii* to 2m over Hummock Grassland of *Triodia* aff. *epactia* and *Triodia* aff. *basedowii* to 1m over Low Open Shrubland of *Acacia stellaticeps* to 0.4m (Coffey Environments 2010a).
FSA7	Tall Open Scrub to Tall Shrubland of *Acacia xiphophylla*, *Acacia synchronicia* and *Acacia victoriae* to 4m over Tussock Grassland to Scattered Tussock Grassland of *Astrebla pectinata*, *Aristida latifolia*, *Aristida contorta*, *Eragrostis xerophila*, *Eragrostis benthamii*, *Eragrostis leptocarpa* and *Cymbopogon ambiguus* to 1.1m (Coffey Environments 2010a).
FSA8	Tall Open Scrub of *Acacia xiphophylla* to 3.2m over Scattered Shrubs of *Senna artemisioides* subsp. *helmsii* to 15m over Open Tussock Grassland of *Astrebla pectinata*, *Chrysopogon fallax* and *Eriachne mucronata* (typical form) to 1.1m over Open Hummock Grassland of *Triodia epactia* (Form 2) and *Triodia wiseana* to 0.7m (Coffey Environments 2010a).
FSM3	Tall Closed Scrub to Tall Open Scrub of *Acacia* aff. *aneura* (narrow fine veined site 1, 259), *Acacia aneura* var. *conifera*, *Acacia aneura* var. *pilbarana*, *Hakea lorea* subsp. *lorea*, *Psydrax latifolia* and *Acacia pruinocarpa* to 8m over Open Tussock Grassland of *Aristida latifolia*, *Aristida contorta*, *Eragrostis xerophila*, *Chrysopogon fallax*, *Enneapogon polyphyllus* and *Paspalidium rarum* to 0.2m(Coffey Environments 2010a).
HSA1	Tall Open Shrubland to Scattered Tall Shrubs of *Acacia inaequilatera*, *Hakea lorea* subsp. *lorea*, *Acacia ancistrocarpa*, *Acacia bivenosa*, *Acacia orthocarpa* and *Grevillea pyramidalis* subsp. *leucadendron* to 4m over Mid-dense Hummock to Hummock of *Triodia epactia*, *Triodia wiseana* and *Triodia* aff. Shovelanna Hill to 1.3m (Coffey Environments 2010a).

Veg Code	Description
HSA2	Scattered Tall Shrubs of *Hakea lorea* subsp. *lorea*, *Acacia xiphophylla* and *Acacia victoriae* to 4m over Scattered Hummock Grassland of *Triodia epactia* (Form 1) to 1.1m over Open Tussock Grassland to Scattered Tussock Grasses of *Aristida holathera* var. *latifolia*, *Chrysopogon fallax*, *Eriachne obtusa* and *Brachyachne convergens* to 1.1m (Coffey Environments 2010a).
HSA5/HWE5/DWE7	Open Heath of *Acacia bivenosa*, *Senna artemisioides* subsp. *oligophylla*, *Senna glutinosa* subsp. *glutinosa* x *luerssenii* and *Acacia inaequilatera* to 1.8m over Closed Hummock Grassland of *Triodia wiseana* to 0.7m over Low Shrubland of *Heliotropium chrysocarpum* to 0.2m/ Low Woodland of *Corymbia hamersleyana* to 3m over Tall Open Shrubland of *Gossypium robinsonii* to 3m over Shrubland of *Acacia dictyophleba*, *Acacia pruinocarpa*, *Acacia bivenosa* and *Acacia inaequilatera* to 2m over Mid-dense Hummock Grassland of *Triodia wiseana* and *Triodia* aff. *basedowii* to 1.4m/ Woodland of *Corymbia hamersleyana* and *Eucalyptus victrix* to 12m over Tall Open Scrub of *Acacia bivenosa* and *Atalaya hemiglauca* to 3m over Open Shrubland of *Acacia pyrifolia* var. *pyrifolia* to 1.8m over Grassland of *Triodia* aff. epactia and *Chrysopogon fallax* to 1.1m over Very Open Sedgeland of *Cyperus vaginata* to 1m (Coffey Environments 2010a).
HWE1	Low Open Woodland to Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* to 7m over Scattered Tall Shrubs of *Grevillea wickhamii*, *Acacia atkinsiana*, *Grevillea pyramidalis* subsp. *leucadendron*, *Acacia elachantha* (golden hairy variant) *Hakea lorea* subsp. *lorea* and *Acacia ancistrocarpa* to 3m over Open Shrubland of *Senna glutinosa* and *Acacia tenuissima* to 1.5m over Closed to Mid-dense Hummock Grassland of *Triodia wiseana* and *Triodia* aff. *epactia* to 1.2m over Low Shrubland of *Sida* sp. Pilbara (N.F Norris 908), *Ptilotus rotundifolius*, *Acacia adoxa* var. *adoxa* and *Acacia hilliana* to 1m (Coffey Environments 2010a).
HWE11	Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* to 4m over Scattered Shrubs of *Acacia maitlandii*, *Acacia bivenosa*, *Senna glutinosa* subsp. *glutinosa*, *Senna glutinosa* subsp. *pruinosa* and *Acacia monticola* to 1.4m over Mid-dense Hummock Grassland of *Triodia* aff. *epactia* to 1m (Coffey Environments 2010a).
MDSA4	Tall Open Shrubland of *Acacia aneura* var. ? *aneura*, *Acacia synchronicia*, *Acacia tetragonophylla* and *Acacia coriacea* subsp. *pendens* to 6m over occasional *Corymbia hamersleyana* to 5m over Open Hummock Grassland of *Triodia* aff. *epactia* to 1.1m (Coffey Environments 2010a).
MDWE3/DWE4	Scattered Trees of *Eucalyptus victrix* to 15m over Tall Open Shrubland of *Acacia monticola*, *Acacia pyrifolia* var. *pyrifolia*, *Acacia maitlandii*, *Acacia citrinoviridis* and *Grevillea wickhamii* over Hummock to Open Hummock Grassland of *Triodia epactia* to 1.4m over Very Open to Scattered Tussock Grassland of *Cenchrus setiger* and *Themeda triandra* to 1m/ Woodland of *Eucalyptus victrix* to 20m over Tall Shrubland of *Acacia coriacea* subsp. *pendens* to 10m over Open Shrubland of *Vachellia farnesiana* to 1.6m over Open Hummock Grassland of *Triodia longiceps* to 1m (Coffey Environments 2010a).
MDWE4	Open Forest of *Melaleuca argentea*, *Eucalyptus victrix* and *Eucalyptus camaldulensis* var. *obtusa* to 22m over Tall Open Scrub of *Melaleuca glomerata*, *Melaleuca linophylla*, *Melaleuca argentea*, *Acacia coriacea* subsp. *pendens* and *Atalaya hemiglauca* to 12m over Very Open Sedgeland of *Cyperus vaginatus* and *Typha domingensis* to 1.2m (Coffey Environments 2010a).
MDWE5	Open Forest of *Eucalyptus camaldulensis* var. *obtusa* to 15m over Tall Open Shrubland of *Acacia ampliceps* and *Melaleuca linophylla* to 3m over Open Sedgeland of *Cyperus vaginatus* to 1.3m (Coffey Environments 2010a).

Freshwater claypans of the Fortescue Valley (P1)

Adjacent to the Fortescue River channel are a series of freshwater claypans that constitute the Freshwater Claypans of the Fortescue Valley PEC. This PEC of expansive clay flats is fringed by *Eriachne* spp. and *Eragrostis* spp. grasslands and Western Coolibah (MWH 2015).

The study area does not intersect with any occurences of the Freshwater claypans PEC (see **Map 3**). No vegetation types mapped within the study area are considered to be representative of this PEC.

Fortescue Marsh (P1)

The Fortescue Marsh Ecological Community occurs as a single unit associated with the Marsh Land System. The study area does not intersect any occurances of the Marsh Land System system but it does fall within the 5 km administrative study areas of the PEC in the vicinity of Cloudbreak (see **Map 3**).

None of the vegetation types within the study area are characterised by Samphire species (*Tecticornia* species in the Chenopodiaceae family) or otherwise halophytic species and therefore are not considered to

be representative of the PEC. Also, none of the vegetation types documented within the *Cloudbreak Life of Mine Flora and Vegetation Assessment* (ENV 2011b) as being associated with the PEC occur within the study area (vegetation types 13, 22, 25 and 26). Therefore, whilst the study area falls within the buffer of the Fortescue Marsh PEC the vegetation types that are representative of this PEC are not likely to be impacted.

3.2.3.2 Groundwater Dependent Ecosystems

The vegetation types considered to represent Groundwater Dependent Ecosystems and listed in **Table 6**.

The location of potential GDEs are shown on **Map 4**.

Table 6: GDE Vegetation Types

Veg Code	Description
EcAcEUaTe	*Eucalyptus camaldulensis* subsp. *refulgens*, *E. victrix* mid woodland over *Acacia citrinoviridis*, *Melaleuca glomerata* tall open shrubland over *Eulalia aurea* mid sparse tussock grassland over *Triodia epactia* low sparse hummock grassland (Biota Environmental Sciences Pty Ltd. 2017).
EcApCa (MDWE5/MDWE7)	*Eucalyptus camaldulensis* and *Melaleuca argentea* low woodland over *Acacia pyrifolia* tall sparse shrubland over *Tephrosia rosea* and *Corchorus crozophorifolius* mid sparse shrubland over *Cymbopogon ambiguus* open tussock grassland (Ecologia Environment 2014d).
EvAcpCv (MDWE4)	*Eucalyptus victrix*, *Eucalyptus camaldulensis* subsp. *obtusa* and *Melaleuca glomerata* mid woodland, over *Acacia coriacea* subsp. *pendens* and *Acacia trachycarpa* tall sparse shrubland, over *Cyperus vaginatus* open sedgeland (Coffey Environments 2010a).
EcOW	Open Woodland to 11m dominated by *Eucalyptus camaldulensis* var. *obtusa* with emergent *Melaleuca leucadrenda* over a Tall Shrubland to 3m dominated by *Melaleuca linophylla* and *Acacia adsurgens* over grassland[#] (ATA Environmental 2005).
M1	Open Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* var. *obtusa* with pockets of *Acacia coriacea* subsp. *pendens* over *Grevillea wickhamii* subsp. *aprica*, *Petalostylis labicheoides*, *Acacia tumida* over *Triodia longiceps*, *Chrysopogon fallax* (ATA Environmental 2005).
Ac1	*Eucalyptus victrix*, *Melaleuca argentea* low woodland to low open woodland (Biota Environmental Sciences Pty Ltd 2004b).
Ac2	*Eucalyptus camaldulensis* scattered low trees over *Melaleuca argentea* low open forest over *Melaleuca linophylla*, *Acacia ampliceps* high shrubland (Biota Environmental Sciences Pty Ltd 2004b).
Ac3	*Eucalyptus camaldulensis* woodland over Melaleuca spp. high shrubland to open scrub over *Triodia epactia*, tussock grasses and patches of sedges (Biota Environmental Sciences Pty Ltd 2004b).
Ac5	*Eucalyptus camaldulensis* low open woodland over *Acacia trachycarpa* high shrubland over *Triodia epactia* mid-dense hummock grassland and **Cenchrus ciliaris* very open tussock grassland (Biota Environmental Sciences Pty Ltd 2004b).

[#] description incomplete as original report unable to be obtained

Table 7: Potential GDE Vegetation Types

Veg Code	Description
EvAcEa	*Eucalyptus victrix* mid open woodland, over *Acacia citrinoviridis* tall sparse shrubland, over *Atalaya hemiglauca* and *Acacia tetragonophylla* mid sparse shrubland, over *Eriachne benthamii* and *Eulalia aurea* open tussock grassland (Ecologia Environment 2014d).
EvAcCc	*Eucalyptus victrix* low closed woodland *Acacia aneura* and *Acacia citrinoviridis* tall sparse shrubland over *Acacia victoriae* mid sparse shrubland over *Cenchrus ciliaris* tussock grassland (Ecologia Environment 2014d).
EvAppTt (MDWE3)	*Eucalyptus victrix* and *Eucalyptus xerothermica* low open woodland, over *Acacia coriacea* subsp. *pendens*, *Acacia ampliceps* and *Acacia trachycarpa* tall open shrubland, over *Cyperus vaginatus* sparse sedgeland and *Triodia epactia* sparse hummock grassland (Coffey Environments 2010b; Ecologia Environment 2014d).

Veg Code	Description
ExAcpTe (MDWE6)	*Eucalyptus victrix* and *Eucalyptus xerothermica* low open woodland, over *Acacia coriacea* subsp. *pendens*, *Acacia ampliceps* and *Acacia trachycarpa* tall open shrubland, over *Cyperus vaginatus* sparse sedgeland and *Triodia epactia* sparse hummock grassland (Coffey Environments 2010b; Ecologia Environment 2014d).
1	Open Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* with pockets of *Acacia coriacea* subsp. *pendens* over *Grevillea wickhamii* subsp. *aprica*, *Petalostylis labicheoides* and *Acacia tumida* over *Triodia longiceps*, *Chrysopogon fallax*, *Themeda triandra* (ENV Australia Pty Ltd 2011a).
Fc4	*Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens*, *A. aneura*, *Atalaya hemiglauca* low woodland over **Cenchrus ciliaris* tussock grassland (ATA Environmental 2005).
Ac4	*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 (Biota Environmental Sciences Pty Ltd 2004b).
Ac8	*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 (Biota Environmental Sciences Pty Ltd 2004b).
Ac14	*Eucalyptus victrix*, *Corymbia* spp. scattered trees to low open woodland over *Acacia colei* open scrub over *Triodia epactia* dense hummock grassland (Biota Environmental Sciences Pty Ltd 2004b).
Ac15	*Eucalyptus victrix* low open woodland to woodland over *Acacia colei* scattered tall shrubs to high open shrubland over *Triodia epactia* scattered hummock grasses and *Eriachne* spp. tussock grasses (Biota Environmental Sciences Pty Ltd 2004b).

3.2.3.3 Sheet Flow Dependent

Previous Surveys

Sheet Flow Dependent Vegetation (Mulga) has been recorded along the Hamersley and Chichester Rail alignments (e.g. Ecologia Environment 2014a; Syrinx Environmental 2012). Associated vegetation types have been documented in the Solomon LOM assessment (Hamersley Rail component) and Cloudbreak LOM reports and are presented on **Map 4**.

Table 8: Sheet Flow Dependant Vegetation (Mulga) Types

Veg Code	Description
AaElCf	*Acacia aneura* tall shrubland over *Eremophila lanceolata*, *Sida* sp. verrucose glands (F.H. Mollemans 2423) and *Solanum lasiophyllum* mid sparse shrubland over *Chrysopogon fallax* and *Aristida contorta* sparse tussock grassland (Ecologia Environment 2014d).
AaElfTe	*Acacia aneura* and *Acacia pruinocarpa* tall open shrubland over *Eremophila latrobei* subsp. *filiformis* and *Dodonaea petiolaris* mid sparse shrubland over *Triodia epactia* hummock grassland (Ecologia Environment 2014d).
AaImTe	*Acacia aneura* and *Acacia pruinocarpa* tall shrubland, over *Acacia ancistrocarpa* and *Eremophila longifolia* mid sparse shrubland, over *Indigofera monophylla* and *Sida* sp. verrucose glands (F.H. Mollemans 2423) low sparse shrubland, over *Cenchrus ciliaris* tussock grassland (Ecologia Environment 2014d).
AaPsCf	*Acacia aptaneura* open shrubland, over low *Abutilon otocarpum* sparse shrubland, over *Pterocaulon sphacelatum* and *Ptilotus obovatus* open forbeland, over open *Chrysopogon fallax* tussock grassland (Ecologia Environment 2014d).
AaSfAl	*Acacia aptaneura* open shrubland, over low *Sida fibulifera* sparse shrubland, over *Aristida latifolia* and *Chrysopogon fallax* tussock grassland (Ecologia Environment 2014d).
AaSvCc	*Acacia aneura* tall open shrubland over *Sida* sp. verrucose glands (F.H. Mollemans 2423) and *Sclerolaena cornishiana* mid sparse shrubland over *Abutilon otocarpum*, *Malvastrum americanum* and *Boerhavia coccinea* sparse herbland and *Cenchrus ciliaris* tussock grassland (Ecologia Environment 2014d).
3	Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura*, *Acacia pruinocarpa*, *Acacia tetragonophylla*, *Acacia tenuissima*, *Grevillea wickhamii* subsp. *aprica*, *Psydrax latifolia* over *Dodonaea petiolaris* and species of *Triodia* and *Aristida* (ENV Australia Pty Ltd 2011a).

Veg Code	Description
10	Low Open Woodland of *Acacia xiphophylla*, *Acacia victoriae*, *Acacia aneura* var. *aneura* over *Acacia tetragonophylla*, *Ptilotus obovatus*, *Senna* species and mixed species of *Maireana* and *Sclerolaena* (ENV Australia Pty Ltd 2011a).

3.2.3.4 Other Significant Vegetation Types

Other vegetation types noted to be of significance from previous surveys are outlined in **Table 9** and shown on **Map 4**.

Table 9: Other Significant Vegetation Types

Veg Code	Description
Ar3 and Ar4	*Tripogon loliiformis* grasslands and *Bulbostylis burbidgeae* sedgelands of granite outcrops - restricted habitats (Biota Environmental Sciences Pty Ltd 2004b).
Ar5, Ar6 and Ar7	Vegetation of granite ridges, quartz outcrops and dolerite dykes respectively - limited representation in the region; uncommon (Biota Environmental Sciences Pty Ltd 2004b).
Ah5a	Dominated by *Triodia* aff. *lanigera* (dwarf form) – limited representation on the basis of current knowledge; uncommon, possibly rare (Biota Environmental Sciences Pty Ltd 2004b).
Fx1	*Acacia xiphophylla*, *Cassia sturtii* shrublands with pockets of *Eragrostis xerophila* grassland - uncommon, probably has a restricted representation (Biota Environmental Sciences Pty Ltd 2004b).
Apt1 and Apt2	Hummock grasslands dominated by *Triodia secunda* – uncommon (Biota Environmental Sciences Pty Ltd 2004b).
Apt5 and Apt8	Hummock grasslands dominated by Triodia angusta, a species not particularly common in the area) – uncommon (Biota Environmental Sciences Pty Ltd 2004b).
Ac21	Unusual combination of *Acacia ampliceps* over *Triodia secunda* – probably restricted (Biota Environmental Sciences Pty Ltd 2004b).
Ac30	Soak vegetation - *Corymbia hamersleyana* Low Open Woodland over Mixed Open to Mid Dense Hummock Grassland – isolated occurrence in the rail corridor; uncommon (Biota Environmental Sciences Pty Ltd 2004b).
Fx1	Equivalent to Biota (2004b) unit (ATA Environmental 2005).
ChaW2	Equivalent to unit Ac30 from Biota (2004b): *Corymbia hamersleyana* Low Open Woodland over Mixed Open to Mid Dense Hummock Grassland (Coffey Environments 2007)
2	Communitiy sensitive to groundwater changes; Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura*, *Acacia citrinoviridis*, *Acacia pruinocarpa* over *Acacia tetragonophylla* and *Psydrax latifolia* over *Chrysopogon fallax*, *Stemodia viscosa*, *Blumea tenella*, *Themeda triandra* and *Triodia* and *Aristida* (ENV Australia Pty Ltd 2011b).

3.2.4 REGIONAL FLORA

A total of 495 vascular flora taxa (inclusive of species, subspecies, varieties and forms) from 58 families and 179 genera have been recorded from the study area. Thirty of the flora taxa recorded were introduced (weeds).

The most commonly represented families were Poaceae with 93 taxa, followed by Fabaceae (81 taxa) and Malvaceae (55 taxa), Amaranthaceae (27), Asteraceae (22 taxa) and Cyperaceae (21 taxa).

The most commonly represented genera were *Acacia* with 32 taxa, *Ptilotus* (16 taxa), *Sida* (15 taxa), *Triodia* (14 taxa), *Heliotropium* (12 taxa) and *Corchorus* (12 taxa).

A flora species list is included in **Appendix 5.**

3.2.5 CONSERVATION SIGNIFICANT FLORA

The desktop and database searches identified 56 conservation significant flora species as having previously been recorded within 9 km of the study area (**Table 10**).

No Threatened Flora species have been identified as occurring within the study area during previous surveys. Twenty Priority Flora species were found to have population extents known to intersect the study area, shown on **Map 5**.

Based on Ecoscape's likelihood assessment (as described in **Section 2.1.3**), a further 20 were found to possibly occur within the study area based upon nearby records and likely presence of associated habitat values, 14 of which intersect the Development Envelope (**Table 10**).

Table 10: Conservation significant flora identified from Fortescue and DBCA database searches (within the study area)

Species	Status	Number of populations intersecting	
		Study Area	Development Envelope
Abutilon sp. Pritzelianum (S. van Leeuwen 5095)	Priority 1	13	16
Tephrosia rosea var. Port Hedland (A.S. George 1114)	Priority 1	1	
Euphorbia australis var. *glabra*	Priority 2	1	
Paspalidium retiglume	Priority 2	3	
Teucrium pilbaranum	Priority 2	1	
Aristida jerichoensis var. *subspinulifera*	Priority 3	1	1
Eragrostis crateriformis	Priority 3	7	7
Euphorbia clementii	Priority 3	2	2
Glycine falcata	Priority 3	1	1
Gomphrena leptophylla	Priority 3	3	3
Gymnanthera cunninghamii	Priority 3	8	8
Heliotropium murinum	Priority 3	14	13
Nicotiana umbratica	Priority 3	2	
Phyllanthus hebecarpus	Priority 3	2	1
Rothia indica subsp. *australis*	Priority 3	1	1
Stylidium weeliwolli	Priority 3	4	4
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	Priority 3	1	
Bulbostylis burbidgeae	Priority 4	13	8
Goodenia nuda	Priority 4	19	13
Ptilotus mollis	Priority 4	2	1

The locations of conservation significant species records/populations are presented on **Map 5** for P1 and P2 species and **Map 6** for P3 and P4 species.

3.2.6 INTRODUCED SPECIES

Twenty eight introduced species (weeds) have been recorded from within the study area; twelve, in bold below, are categorised by Fortescue as Priority Weeds:

- * ***Aerva javanica*** (Kapok Bush)
- * *Argemone ochroleuca* (Mexican Poppy)
- * *Bidens* sp. (Beggartick)
- * ***Calotropis procera*** (Calotrope)
- * ***Cenchrus ciliaris*** (Buffel Grass)
- * *Cenchrus echinatus* (Burrgrass)
- * ***Cenchrus setiger*** (Birdwood Grass)
- * ***Chloris barbata*** (Purpletop Chloris)
- * ***Chloris virgata*** (Feathertop Rhodes Grass)
- * *Citrullus colocynthis*

- **Citrullus amarus*, previously **Citrullus lanatus*
- **Crotalaria juncea* (Sunnhemp)
- **Cucumis myriocarpus* (Prickly Paddymelon)
- ***Cynodon dactylon*** (Couch Grass)
- **Digitaria ciliaris* (Summer Grass)
- ***Echinochloa colona*** (Awnless Barnyard Grass)
- **Eragrostis minor* (Smaller Stinkgrass)
- **Flaveria trinervia* (Speedy Weed)
- **Malvastrum americanum* (Spiked Malvastrum)
- ***Opuntia* spp**.
- **Portulaca pilosa*
- ***Rumex vesicarius*** (Ruby Dock)
- ***Setaria verticillata*** (Whorled Pigeon Grass)
- **Solanum nigrum* (Blackberry Nightshade)
- **Sonchus oleraceus* (Common Sowthistle)
- **Stylosanthes hamata* (Verano Stylo)
- ***Vachellia farnesiana*** (Mimosa Bush).

4 DISCUSSION

The total extent of clearing likely to occur in relation to the proposed transmission line is estimated to be 305 ha, and will be comprised of cleared pads for pylons, access tracks and selected clearing of the powerline corridor. The corridor within which the transmission line is proposed is alongside existing railway corridors (within Fortescue's existing rail corridor) where vegetation has already been disturbed.

4.1 FLORA

4.1.1 FLORA INVENTORY

There have been 495 vascular flora taxa from 58 familes and 179 genera recorded within the study area identified from 67 survey reports over the period 2004 to 2017.

4.1.2 CONSERVATION SIGNIFICANT FLORA

The desktop and database searches identified 56 conservation significant flora as having previously been recorded within 10 km of the study area. Of these, 20 species were found to have population extents known to intersect the study area, 14 of which occur within the Development Envelope.

No Threatened Flora listed for protection under the Commowealth EPBC Act or Western Australian WC Act (nor Western Australian BC Act that is to be enacted in January 2019) correspond with the areas proposed for clearing, nor (based on Ecoscape's likelihood assessment) are likely to occur.

Priority listed flora do not have any statutory protection, although there is an expectation that impacts on these are avoided where possible, or minimised.

4.1.3 LOCAL AND REGIONAL SIGNIFICANCE OF FLORA

The *Flora and Vegetation Technical Guidance* (EPA 2016c) lists reasons other than being listed as Threatened or Priority Flora that a species can be considered as significant. Such species, if they occur, do not have statutory protection.

None of the listed reasons are applicable to any of the flora known to occur within the study area.

None of the flora species previously recorded within the study area or nearby (as identified during previous surveys) are considered to be locally or regionally significant.

4.1.4 INTRODUCED SPECIES

Twenty eight taxa identified from previous surveys were introduced species.

Two of these, **Calotropis procera* (Rubber Bush) and **Opuntia* spp. (Prickly Pear Cactus types), are listed as Declared pest plants under the Western Australian BAM Act. **Calotropis procera* does not have any management requirements as it is in the Exempt category. However, **Opuntia* sp., depending on which species, may have management requirements. Many **Opuntia* sp. are C3 species that, as described under the BAM Act, **should** have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution of the organism or prevent or contain the spread of the organism. However, there is no **requirement** to control these species, and their prescence within the study area (if they occur) is not of significance for clearing approvals.

Additionally, the study area is largely associated with an existing infrastructure corridor where introduced species are likely to be established, and any additional clearing is unlikely to significantly increase the amount of available habitat for weeds or cause the introduction of new species.

4.2 CONSERVATION SIGNIFICANT VEGETATION

Unless listed for protection under the Commonwealth EPBC Act, there is currently no statutory protection for vegetation in Western Australia. However, when the BC Act is enacted in 2019, listed TECs will be protected under this Act.

4.2.1 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

There are no EPBC-listed TECs occurring within the Pilbara bioregion.

No Western Australian TECs correspond with the study area. Based on the results of previous surveys, no vegetation is considered similar to any currently described TECs.

Part of the Wona PEC intersects the study area (see **Map 3**). There is no statutory protection for PECs, although there is an expectation that clearing will be avoided or minimised in such areas. However, any clearing that is likely to occur within the PEC (if any) will be insignificant in extent and therefore insignificant in its impact on the PEC.

The vegetation of the Wona system is considered to represent the most locally and regionally significant vegetation within the survey area.

4.2.2 SHEET FLOW DEPENDENT VEGETATION (MULGA)

SFDV (Mulga) vegetation has been mapped primarily along the Hamersley Rail Line, with smaller occurrences located close to the Cloudbreak Mine, including ENV's vegetation type '2' (ENV 2011b) (see **Map 4**). This vegetation has potential to be affected by changes to surface water flows that may be caused by obstacles, including roads or railways (or any linear infrastructure), or any changes to topography that prevents heavy rainfall from moving across the slightly-sloping landscape as a 'sheet'.

However, the study area is close to the existing Fortescue railway and Fortescue is already managing the impact that the rail has on potential sheetflow, as is required under a number of Ministerial Statements associated with previous environmental approvals. In addition, the required works for a power line are more localised, restricted to smaller areas associated with pylons and access tracks that will have little traffic after construction. Thus, it is unlikely that there will be linear infrastructure that alters surface contours affecting sheet flow associated with these works and therefore the affect on SFDV is anticipated to be negligible.

4.2.3 GDES AND POTENTIAL GDES

GDEs are those characterised by phreatophytic species that require access to groundwater for at least part of their life cycle. GDEs or potential GDEs have been mapped widely throughout the study area typically corresponding with drainage lines (see **Map 4**). Any changes to groundwater at these locations has the potential to affect these vegetation types.

However, transmission line pylons would not be located within or on the banks of drainage lines due to the higher potential for damage during flood events, thus clearing within these areas will be avoided entirely. Access tracks may intersect with drainage lines, however, their impact is likely to be minimal as they will not be heavily used following construction and their footprint in riparian areas would be insignificant.

4.2.4 OTHER SIGNIFICANT VEGETATION

Numerous vegetation types have been identified from previous reports as being of significance for reasons other than those above; these have been mapped along various sections of the Main Line Rail. The majority of these vegetation types were considered potentially significant on the basis of being geographically restricted within the areas assessed. These vegetation types may be considered to be locally or regionally significant, however, this assessment is generally in association with a given survey area and is based largely on the report writer's perception of, and local understanding of, significance.

There is no statutory protection given to vegetation considered significant purely on its restricted extent within a given survey area, particularly as the vegetation, or similar, may be more common in areas outside the specific survey area.

5 CONCLUSION & RECOMMENDATIONS

Approximately 305 ha is proposed to be cleared for transmission line pylons and access tracks; this equates to approximately 0.04% of the study area from which the environmental assets discussed within this report has been identified. Fortescue proposes to use a mitigarion hierarchy to mitigate impacts to environmental assets.

The flora and vegetation of the study area/proposed development envelope is well understood as there have been a significant number of environmental surveys associated with the area.

The most significant environmental assets corresponding with the study area/proposed development footprint are:

- 20 Priority-listed flora populations with populations that correspond with the study area, 14 of which occur within the Development Envelope
- partly corresponds with the Wona PEC.

The study area/proposed development envelope also intersects with areas of Sheet Flow Dependent Vegetation (Mulga). The adjacent existing Fortescue rail alignment has greater impact on potential surface water flows than the proposed works (pylons and access track) is likely to have due to its nature (raised surface for rail, well trafficked track).

The study area/proposed development envelope also intersects with riparian areas that may represent GDE vegetation, however, pylons will not be located within creeklines thus potential impacts are unlikely to occur. Access tracks through these areas can be managed to avoid or minise impact.

5.1 FACTOR CONSIDERATIONS

Considerations for EIA for the factor Flora and Vegetation (EPA 2016a) include, but are not necessarily limited to:

- application of the mitigation hierarchy to avoid and minimise impacts to flora and vegetation, where possible
- the flora and vegetation affected by the proposal
- the potential impacts and the activities that will cause them, including direct and indirect impacts
- the implications of cumulative impacts
- whether surveys and analyses have been undertaken to a standard consistent with guidance
- the scale at which impacts to flora and vegetation are considered
- the significance of the flora and vegetation, and the risk to the flora and vegetation
- the current state of knowledge of flora and vegetation and the level of confidence underpinning the predicted residual impacts
- whether proposed management and mitigation approaches are technically and practically feasible
- whether the proposal area will be revegetated in a manner that promotes biological diversity and ecological integrity.

Various issues are frequently of significance within the environmental impact assessment process. These issues, and the potential impact from the proposed works, are summarised below.

5.1.1 HABITAT LOSS, DEGRADATION AND FRAGMENTATION

The total area requiring clearing is approximately 300 ha and largely corresponds with an existing rail corridor that includes areas of disturbance for the railway and well used access tracks. This clearing extent is unlikely to cause significant habitat loss in an area that is largely uncleared, with the existing rail corridor likely to have a greater effect on habitat loss than the proposed works.

Environmental degradation is unlikely to be increased by the proposed works as the proposed development envelope is largely within an area that has already been degraded.

Additional fragmentation is unlikely due to the proposed development envelope largely corresponding with existing linear infrastructure.

Additional fragmentation is unlikely due to the proposed development envelope largely corresponding with existing linear infrastructure.

Fortescue is proposing to use a mitigation hierarchy to avoid or minimise impacts; this is possible as there is flexibility in regard to the location of pylons and access tracks. This flexibility will permit P1 and P2 species to be avoided entirely, and P3 and P4 species will be avoided where possible.

5.1.2 INVASIVE SPECIES

Twenty six introduces species have been recorded from with the greater study area. Two of these are Declared Pest plants although neither have management requirements under the BAM Act.

The proposed development envelope is largely located within an existing rail corridor that has been disturbed and has significant weed invasion. Clearing for pylons and access tracks is unlikely to provide a significant amount of additional habitat for invasive species, nor are new weeds likely to be introduced due to the proposed works.

Weed hygiene (e.g. vehicles are required to be clean when moving to new areas) is a standard management practice to manage weed invasion, and will be implemented as part of the works.

5.1.3 FIRE REGIMES

Fire occurs naturally in the landscape as a result of lightning strike and vegetation has evolved to recover rapidly. Fire has also been used by Traditional Owners to flush game and generate new growth that attracts herbivores, and more recently caused by arson or accidental ignition.

Any proposed works are unlikely to alter the frequency, intensity or extent of fires.

5.1.4 CHANGING CLIMATE

Climate change impacts on native flora and vegetation may be of importance as a cumulative impact when taking all changing factors into account, however, of its own, climate change is unlikely to be to be a significant factor in the survey area. However, given the small scale of proposed works, any effects on the flora and vegetation cumulatively with climate change are unlikely to be significant.

5.1.5 STATE OF KNOWLEDGE

The study area is well known due to the number of surveys that have been conducted within the vicinity.

5.2 RECOMMENDATIONS

The following general recommendations are applicable to minimise the impact of the proposed works (construction of a high voltage transmission line requiring clearing of approximately 300 ha for pylons and access tracks) on the significant environmental attributes of the study area.

1. Avoid locating pylons on areas known to have P1 and P2 flora species. Specific targeted surveys may be required when the development footprint is better understood.
2. If possible, avoid tracks through areas known to have P1 and P2 species.
3. Minimise construction in known P3 and P4 flora species population areas.
4. Minimise the length of access tracks, and use existing tracks where possible.
5. Avoid construction of pylons within or close to drainage lines.
6. Avoid constructing tracks across drainage lines; if required they should be parallel to drainage lines.

REFERENCES

ATA Environmental 2005, *Preliminary Vegetation and Flora Assessment of Additional Areas of FMG's Stage B Rail Corridor*, unpublished report for Fortecue Metals Group.

Australian Government. *Environment Protection and Biodiversity Conservation Act 1999.*

Australian Government & Department of the Environment and Energy. 2017. *Australia's bioregions (IBRA)*. Available from: http://www.environment.gov.au/land/nrs/science/ibra.

Australian Government & Department of the Environment and Energy. 2018. *Directory of Important Wetlands in Australia - Information Sheet (Fortescue Marshes - WQA066)*. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW&doiw_refcodelist=WA066. [October 2018].

Batini, F. 2009, *Eucalyptus victrix, Karijini National Park.*, Report to EPA.

Biota Environmental Sciences Pty Ltd 2004a, *Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor*, Unpublished Report for Fortescue Metals Group Ltd, August 2004.

Biota Environmental Sciences Pty Ltd 2004b, *Vegetation and Flora Survey of the Proposed FMG Stage B Rail Corridor and Mines Areas*, Unpublished Report for Fortescue Metals Group Ltd, December 2004.

Biota Environmental Sciences Pty Ltd. 2017, *Eliwana Consolidated Detailed Flora and Vegetation Phase 2*.

Bureau of Meteorology. 2018. *Climate Data Online*. Available from: http://www.bom.gov.au/climate/data/.

Cardno Pty Ltd 2012, *Nyidinghu Rail Spur Flora and Vegetation Assessment*, Report prepared for Fortescue Metals Group.

Coffey Environments 2007, *Supplementary Vegetation and Flora Survey of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure*, Prepared for Fortescue Metals Group Ltd, August 2007, Report No. 2007/186: Version 1.

Coffey Environments 2010a, *Flora and Vegetation Assessment, Solomon Project and Investigator - Volume 1*, Unpublished report for Fortescue Metals Group Ltd.

Coffey Environments 2010b, *Flora and Vegetation Assessment, Solomon Rail Project - Volume 1*, Unpublished report for Fortescue Metals Group Ltd.

Coffey Environments 2010c, *Solomon Regional Flora Assessment Volume 1*, Unpublished report for Fortescue Metals Group Ltd.

Coffey Environments 2011, *Supplementary Flora, Vegetation and Fauna Assessment: Solomon Project*.

Coffey Environments 2014, *North Star Alternate Access Road Flora and Vegetation Assessment*, unpublished report prepared for Fortescue Metals Group Limited.

Department of Biodiversity Conservation and Attractions. 2017. *Biodiversity Conservation Act 2016*. Available from: https://www.dpaw.wa.gov.au/plants-and-animals/biodiversity-conservation-act.

Department of Biodiversity Conservation and Attractions. 2018. *Ramsar Sites (DBCA-010)*. Available from: https://catalogue.data.wa.gov.au/dataset/ramsar-sites. [October 2018].

Department of Environment and Conservation. 2010. *Definitions, categories and criteria for Threatened and Priority Ecological Communities*. Available from: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/tecs/tec-definitions-dec2010.pdf.

Department of Environment and Conservation. 2013. *Definitions, categories and criteria for Threatened and Priority Ecological Communities*. Available from: https://www.dpaw.wa.gov.au/images/plants-

animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf.

Department of Environment Water Heritage and the Arts 2009, *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*, Australian Government.

Department of Parks and Wildlife. 2007. *NatureMap: Mapping Western Australia's Biodiversity*. Available from: http://naturemap.dpaw.wa.gov.au.

Department of Parks and Wildlife. 2017. *Conservation Codes for Western Australia Flora and Fauna (updated 23 May 2017)*. Available from: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf.

Department of Parks and Wildlife Species & Communities Branch. 2016. *'Themeda' TEC and 'Brockman' PEC extent shapefile*. Available from:

Eamus, D. 2009a, *A review of the report written by Frank Batini entitled "Eucalyptus victrix, Karijini National Park"*, Unpublished report for Rio Tinto Iron Ore.

Eamus, D. 2009b. *Identifying groundwater dependent ecosystems: a guide for land and water managers*. Available from: http://lwa.gov.au/files/products/innovation/pn30129/pn30129_1.pdf.

Eamus, D., Froend, R., Loomes, R., Hose, G., & Murray, B. 2006. A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Australian Journal of Botany*, vol. 54, pp. 97-114

Ecologia Environment 2012a, *North Star Access Corridor Flora, Vegetation, Vertebrate Fauna and Fauna Habitat Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecologia Environment 2012b, *North Star Vegetation and Flora Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecologia Environment 2014a, *Baseline Mulga Monitoring 2014 - Main Line*, Fortescue Metals Group Limited.

Ecologia Environment 2014b, *Hamersley Rail Mulga Monitoring (R-RP-EN-1048)*, Unpublished report for Fortescue Metals Group Limited.

Ecologia Environment 2014c, *Investigator Flora and Vegetation Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecologia Environment 2014d, *Solomon Hub Flora and Vegetation Assessment*, Unpublished report prepared for Fortescue Metals Group Limited, SO-AS-EN-0057.

Ecologia Environment 2015, *North Star Slurry and Infrastructure Corridors Conservation Significant Flora and Vegetation Assessment*, Unpublished report for Iron Bridge and Fortescue Metals Group.

Ecologia Environment 2016, *Iron Bridge North Star Stage 2 Pityrodia sp. Marble Bar Regional Survey 2015*, Unpublished report for FMG Iron Bridge (Aust) Pty Ltd.

Ecoscape (Australia) Pty Ltd 2010a, *Level Two Flora and Vegetation Assessment, Firetail Mining Area*, Unpublished report for Fortescue Metals Group Ltd.

Ecoscape (Australia) Pty Ltd 2010b, *Port Hedland Water Supply Flora and Vegetation Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecoscape (Australia) Pty Ltd 2010c, *Solomon Project Rail Camp 1G Flora and Vegetation Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecoscape (Australia) Pty Ltd 2010d, *Solomon Project Rail Re-alignment Flora and Vegetation Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecoscape (Australia) Pty Ltd 2016, *Literature Review: Themeda Grasslands Threatened Ecological Community and Brockman Iron Cracking Clay Priority Ecological Community*, Unpublished report for Fortescue Metals Group Limited.

Ecoscape (Australia) Pty Ltd 2018, *Vegetation Health Monitoring Program 2017 (100-RP-EN-0660). Unpublished report for Fortescue Metals Group.*

ENV Australia Pty Ltd 2010, *Solomon Project: Kings Flora and Vegetation Assessment*, Unpublished report for Fortescue Metals Group Ltd.

ENV Australia Pty Ltd 2011a, *Cloudbreak Flora and Vegetation Assessment*, Unpublished report for Fortescue Metals Group Limited.

ENV Australia Pty Ltd 2011b, *Cloudbreak Life of Mine Flora and Vegetation Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Environmental Protection Authority 2004, *Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) No. 51 - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*, EPA, Perth, Western Australia.

Environmental Protection Authority 2010, *Jimblebar Iron Ore Project, BHP Billiton Iron Ore Pty Ltd. Report and recommendations of the Environmental Protection Authority* 1371.

Environmental Protection Authority 2011, *Report and recommendations of the Environmental Protection Authority. West Pilbara Iron Ore Project Stage 1 Mine and Rail Proposal, API Management Pty Ltd. Report 1409*.

Environmental Protection Authority 2012, *Cloudbreak Life of Mine Project. Report and Recommendations of the Environmental Protection Authority. Report 1429*, Government of Western Australia.

Environmental Protection Authority 2014, *Report and recommendations of the Environmental Protection Authority. Roy Hill Mining Project Stage 2 - inquiry under s46 of the Environmental Protection Act 1986 to amend Ministerial Statement 829. Roy Hill Iron Ore Pty Ltd. Report 1520*.

Environmental Protection Authority 2016a, *Report and recommendations of the Environmental Protection Authority. Solomon Iron Ore Project - Sustaining Production. Report 1588*.

Environmental Protection Authority. 2016b. *Statement of Environmental Principles, Factors and Objectives*. Available from: http://www.epa.wa.gov.au/statement-environmental-principles-factors-and-objectives.

Environmental Protection Authority. 2016c. *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment*. Available from: http://www.epa.wa.gov.au/policies-guidance/technical-guidance-flora-and-vegetation-surveys-environmental-impact-assessment.

Environmental Protection Authority 2018, *Evaluating the Environmental Condition of Weeli Wolli Creek: Supporting technical report*, Environmental Protection Authority, Perth, WA.

Environmental Protection Authority & Hamersley Iron Pty Ltd 2010, *Marandoo Mine Phase 2: Report and recommendations of the Environmental Protection Authority*, Environmental Protection Authority, Perth, Western Australia.

Equinox Environmental 2017, *Christmas Creek vegetation health investigation*, Unpublished report for Fortescue Metals Group Limited, CC-EN-0319.

Fortescue Metals Group Limited 2011, *Geographic Information Systems and Raw Data Guidelines. 100-GU-EN-0009, 10 January 2011*.

Fortescue Metals Group Limited 2014, *Flora and Vegetation Assessment Guidelines 100 GU-EN-0005, 5 February 2014*, Fortescue Metals Group Limited.

GHD (Pty Ltd) 2012, *Port Hedland Outer Harbour Rail Flora and Fauna Report*.

Goulburn-Murray Water. 2010. *Groundwater. Terms and definitions*. Available from: http://www.g-mwater.com.au/downloads/Groundwater/2977263-v5-GROUNDWATER_TERMS_AND_DEFINITIONS_GLOSS-1.pdf.

Government of Western Australia. *Wildlife Conservation Act 1950.*

Government of Western Australia. *Environmental Protection Act 1986.*

Government of Western Australia. *Environmental Protection (Clearing of Native Vegetation) Regulations 2004.*

Government of Western Australia. *Biosecurity and Agriculture Management Act 2007.*

Government of Western Australia. *Biodiversity Conservation Act 2016.*

Government of Western Australia. 2018a. *About the Conservation and Parks Commission*. Available from: https://www.conservation.wa.gov.au/.

Government of Western Australia. 2018b. *Government Gazette No. 9, 16 January 2018*. Available from: https://www.slp.wa.gov.au/gazette/gazette.nsf/searchgazette/756F5A64A233C8794825821600053C6C/$file/Gg009.pdf.

Grierson, P. 2010, Ecological water requirements of riparian vegetation, *In Kwongan Workshop 2010: On the ecology of WA's arid zone*, University of Western Australia.

Hatton, T. & Evans, R. 1998, *Dependence of ecosystems on groundwater and its significance to Australia*, Land and Water Research and Development Corporation (Australia), Occasional Paper No. 12/98, Canberra, ACT.

Hickman, A. H, 2010. *Marble Bar, WA Sheet SF 50-8 [3rd edition]*, 1:250,000 Geological Series. Geological Survey of Western Australia.

Kendrick, P. 2002, "Pilbara 2 (PIL2 - Fortescue Plains subregion)," in *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*, N. L. McKenzie, J. E. May, & S. McKenna eds., Department of Conservation and Land Management, pp. 559-567.

Kendrick, P. & McKenzie, N. 2002, "Pilbara 1 (PIL1 - Chichester subregion)," in *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*, N. L. McKenzie, J. E. May, & S. McKenna eds., Department of Conservation and Land Management, pp. 547-558.

Kendrick, P. & Stanley, F. 2002, "Pilbara 4 (PIL4 - Roebourne synopsis)," in *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*, N. L. McKenzie, J. E. May, & S. McKenna eds., Department of Conservation and Land Management, pp. 581-589.

Leighton, K. A. 2004, "Climate," in *Technical Bulletin 92 - An inventory and condition survey of the Pilbara region, Western Australia*, Western Australian Department of Agriculture, Perth, pp. 19-38.

Maslin, B. & Reid, J. 2012. A taxonomic revision of Mulga (*Acacia aneura* and its close relatives: Fabaceae) in Western Australia. *Nuytsia*, vol. 22, no. 4, pp. 129-267. Available from: http://florabase.dec.wa.gov.au/science/nuytsia/604.pdf

Mattiske Consulting Pty Ltd 2005, *Flora and Vegetation on the Cloudbreak and White Knight Leases*, Unpublished report for Fortescue Metals Group Ltd.

Mattiske Consulting Pty Ltd 2007, *Flora and Vegetation near Fortescue Marshes*, Unpublished report for Fortescue Metals Group Ltd.

Mattiske Consulting Pty Ltd 2013, *Level 1 flora and vegetation survey of the Fortescue River Gas Pipeline (FRGP) Project*, Unpublished report for DBP.

Maunsell Australia Pty Ltd 2006, *Pit Dewatering and Vegetation Monitoring Plan - Iron Ore Mine and Downstream Processing, Cape Preston, Western Australia*, Unpublished report prepared for Mineralogy Pty Ltd.

McKenzie, N.L., May, J.E., & McKenna, S. 2003. Bioregional Summary of the 2002 Biodiversity Audit for Western Australia.

McKenzie, N.L., van Leeuwen, S., & Pinder, A.M. 2009. Introduction to the Pilbara Biodiversity Survey, 2002–2007. *Records of the Western Australian Museum, Supplement*, vol. 78, pp. 3-89

Muller, C. 2005, *Water flow in Mulga areas adjoining Fortescue Marsh*, Unpublished report for Fortescue Metals Group Limited.

MWH 2015, *Ecohydrological Conceptualisation of the Fortescue Marsh Region*, BHP Billiton Iron Ore.

National Heritage Trust. 2003. *Australian Vegetation Attribute Manual Version 6.0*. Available from: http://www.environment.gov.au/erin/nvis/.

Office of the Appeals Convenor. 2016a. *Ministerial Statement No. 1033. Statement that a revised proposal may be implemented (Environmental Protection Act 1986): Pilbara Iron Ore and Infrastructure Project (Christmas Creek Mine, East-west Railway and Mindy Mindy Mine) - Revised Proposal*. Available from: http://www.epa.wa.gov.au/sites/default/files/1MINSTAT/Statement%20No.%201033.pdf.

Office of the Appeals Convenor. 2016b. *Ministerial Statement No. 1038. Statement that a proposal may be implemented (Environmental Protection Act 1986) Yandicoogina Iron Ore Project - revised proposal*. Available from: http://www.epa.wa.gov.au/sites/default/files/1MINSTAT/Statement%20No.%201038.pdf.

Office of the Appeals Convenor. 2016c. *Ministerial Statement No. 1044. Statement that a proposal may be implemented (Environmental Protection Act 1986) Revised Iron Valley Iron Ore Project*. Available from: http://www.epa.wa.gov.au/sites/default/files/1MINSTAT/Statement%20No.1044.pdf.

Peel, M.C., Finlayson, B.L., & McMahon, T.A. 2007. Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences*, vol. 11, pp. 1633-1644

Resource and Environmental Management Pty Ltd 2007, *Pirraburdoo Creek Groundwater Dependent Ecosystems study*, Unpublished report for Pilbara Iron.

Rio Tinto 2016, *Yandicoogina Pocket and Billiard South: detailed responses to public submissions in relation to flora and vegetation*.

Rio Tinto & Department of Parks and Wildlife. 2015. *Rare and Priority Plants of the Pilbara mobile app edition*. Available from: https://itunes.apple.com/au/app/rare-priority-plants-pilbara/id945178469?mt=8.

Species and Communities Branch Department of Biodiversity Conservation and Attractions. 2017. *Priority Ecological Communities for Western Australia Version 27 (30 June 2017)*. Available from: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/priority_ecological_communities_list.pdf.

Syrinx Environmental 2012, *Solomon Rail Project - Mulga Monitoring Baseline Survey (SO-RP-EN-0023)*, Unpublished report for Fortescue Metals Group Limited.

Thackway, R. & Cresswell, I. 1995. *An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0* Canberra, Australian Nature Conservation Agency.

The University of Western Australia, Grierson, P., & Page, G. 2012, *West Turner Syncline Stage 2: Potential impacts of mining operations on overland flow dependent vegetation, preliminary assessment*, Unpublished report for Rio Tinto.

Thorne, A. M. and Tyler, I. M., 1996. *Roy Hill, WA, Sheet SF 50-12*, 1:250 000 Geological Series. Perth, Western Australia: Geological Survey of Western Australia.

Thorne, A. M., Tyler, I. M., Blockley, J. G., and Blight, D. F., 1996. *Mount Bruce, W.A. Sheet SF 50-11 (2nd edition): Western Australia Geological Survey, 1:250 000 Geological Series*,

Van Kranendonk, M. J. and Smithies, R. H., 2012. *Port Hedland - Bedout Island*, 1:250 000 Geological Series. Geological Survey of Western Australia.

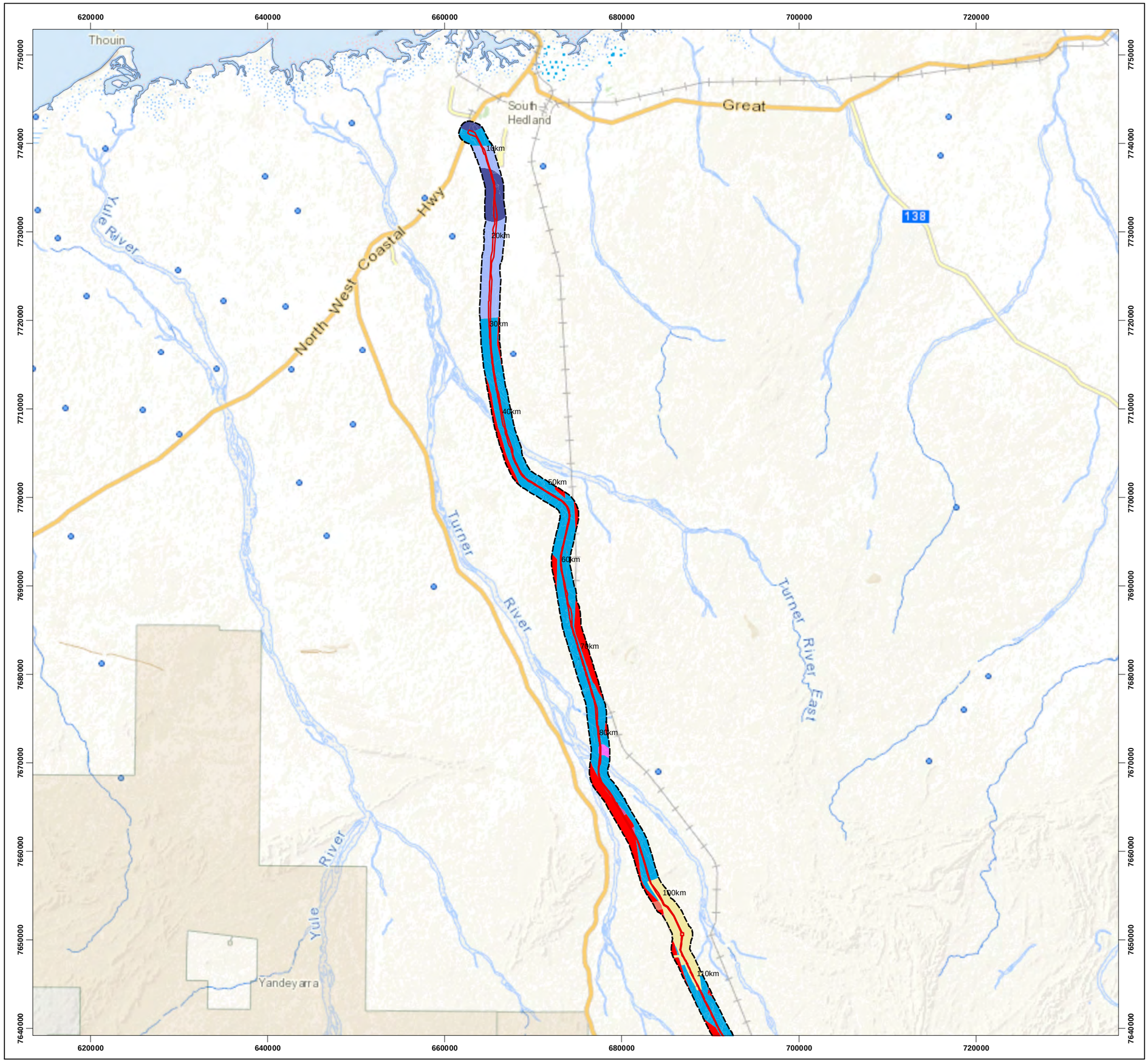
Van Vreeswyk, A.M.E., Payne, A.L., Leighton, K.A., & Hennig, P. 2004. *Technical Bulletin 92 - An inventory and condition survey of the Pilbara region, Western Australia* South Perth, Department of Agriculture.

Walker, J. & Hopkins, M. 1990, "Vegetation," in *Australian Soil and Land Survey. Field Handbook.*, 2nd edn, R. McDonald et al. eds., Inkata Press, Melbourne.

Western Australian Herbarium. 1998. *FloraBase - the Western Australian Flora. Department of Biodiversity, Conservation and Attractions*. Available from: https://florabase.dpaw.wa.gov.au/.

Western Australian Herbarium. 2018. *FloraBase: Descriptions by the Western Australian Herbarium, Department of Biodiversity, Conservation and Attractions. Text used with permission*. Available from: https://florabase.dpaw.wa.gov.au/help/copyright; https://florabase.dpaw.wa.gov.au/search/advanced.

MAPS



LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Coffey (2014) North Star Alternate Access Road: Flora and Vegetation Assessment
- Ecologia (2012) North Star Access Corridor Flora and Fauna Assessment
- Ecologia (2012) North Star Vegetation and Flora Assessment
- GHD (2012) Port Hedland Outer Harbour Rail Flora and Fauna Report
- Ecoscape (2010) Port Water Supply
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:421,000 @ A3

0 4 8 12 16 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP

1A

660000 680000 700000 720000

7650000 7640000 7630000 7620000 7610000 7600000 7590000 7580000

Wodgina West
Wodgina Mt Tinstone
Yandeyarra Rd
Great Northern Hwy
Round Hummock
Nardoopiquithanna Pool
Pincunah Hill
Falls Pound
GLACIER VALLEY
Cleland Rock
Turner Siding
Yandee
Abydos
Abydos Siding
Olympic Pool
Pyramid Hill
Mt Francisco
Wodgina Pool
Mundermullangunder Pool
Pilbaddy Ck
YANDEYARRA RESERVE
Pullcunah Hill
Hiller Well
Soansville Mining Centre
Nganaloonganna Pool
Woodstock
Tarra Pool
Gallery Hill
Mt Webber
Yandeyarra Outstation
Beapea Ck
Mt Gratwick
Quartz Hill
Red Granite Hill
Tambourah
Hillside
Mooratherra Hill
Yule River

100km 110km 120km 130km 140km 150km 160km 170km 180km 180km

LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Ecologia (2014) Solomon Hub Flora and Vegetation Assessment; Solomon Regional Veg Mapping Infill
- Ecologia (2012) North Star Access Corridor Flora and Fauna Assessment
- Ecologia (2012) North Star Vegetation and Flora Assessment
- Coffey (2010) Flora and Vegetation Assessment. Solomon Rail. Vegetation Mapping Recording.; Flora and Vegetation Assessment, Solomon Rail Project
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- ATA (2007) Supplementary Flora Survey
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:307,000 @ A3

0 2 4 6 8 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 1B

600000 620000 640000 660000 680000 700000

7620000 7610000 7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000 7520000 7510000

YANDEYARRA RESERVE

MUNGAROONA RANGE

MUNGAROONA RANGE NATURE RESERVE

CHICHESTER RANGE

West Yule River

YANDEYARRA RESERVE

95

140km 150km 160km 170km 180km 190km 200km 210km 220km 230km 240km 250km 260km 270km 280km 300km

Margaret

Fortescue River

CHICHESTER RANGE

Peak Hester

a Wittenoom Rd

Mt King

Wittenoom

136

Munjina Wittenoom Rd

Fortescue River

GOODIADARRIE HILL

KARIJINI NP

600000 620000 640000 660000 680000 700000

LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Biota (2017) Eliwana Consolidated Detailed Flora and Vegetation Phase 2
- Ecologia (2014) Solomon Hub Flora and Vegetation Assessment; Solomon Regional Veg Mapping Infill
- Coffey (2010) Flora and Vegetation Assessment. Solomon Rail. Vegetation Mapping Recording.; Flora and Vegetation Assessment, Solomon Rail Project
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- ATA (2007) Supplementary Flora Survey
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

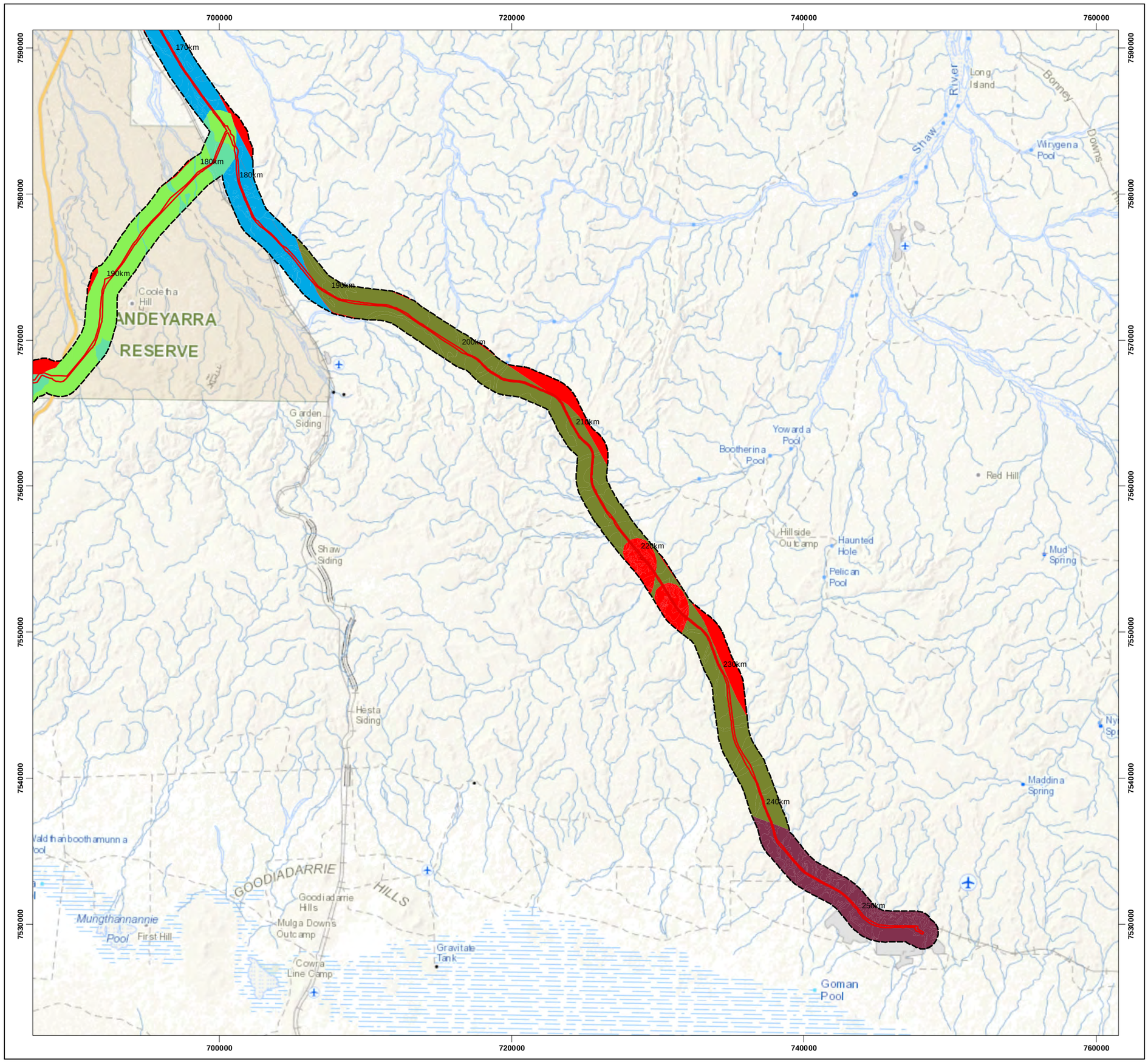
SCALE: 1:439,000 @ A3

0 4 8 12 16 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 1C



LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Ecologia (2014) Solomon Hub Flora and Vegetation Assessment; Solomon Regional Veg Mapping Infill
- ENV (2011) Cloudbreak Flora and Vegtation Assessment
- Coffey (2010) Flora and Vegetation Assessment. Solomon Rail. Vegetation Mapping Recording.; Flora and Vegetation Assessment, Solomon Rail Project
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- ATA (2007) Supplementary Flora Survey
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

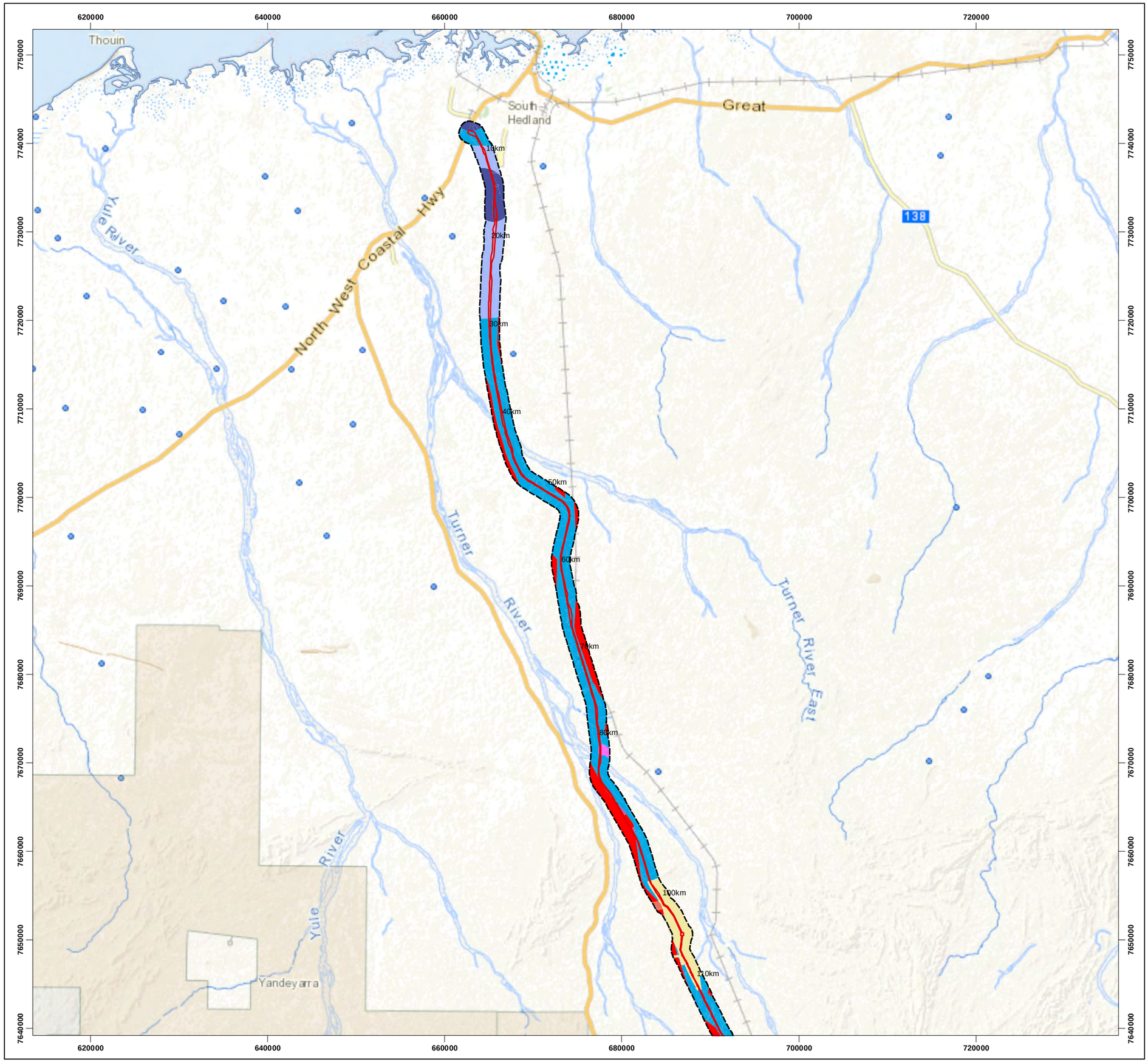
SCALE: 1:255,000 @ A3

0 2 4 6 8 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 1D



LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Coffey (2014) North Star Alternate Access Road: Flora and Vegetation Assessment
- Ecologia (2012) North Star Access Corridor Flora and Fauna Assessment
- Ecologia (2012) North Star Vegetation and Flora Assessment
- GHD (2012) Port Hedland Outer Harbour Rail Flora and Fauna Report
- Ecoscape (2010) Port Water Supply
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:421,000 @ A3

0 4 8 12 16 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP

1A

660000 680000 700000 720000

7650000 7640000 7630000 7620000 7610000 7600000 7590000 7580000

Wodgina West
Wodgina Mt Tinstone
Yandeyarra Rd
Great Northern Hwy
Round Hummock
Nardoopiquithanna Pool
Pincunah Hill
Falls Pound
GLACIER VALLEY
Cleland Rock
Turner Siding
Yandee
Abydos
Abydos Siding
Olympic Pool
Pyramid Hill
Mt Francisco
Wodgina Pool
Mundermullangunder Pool
Pilbaddy Ck
YANDEYARRA RESERVE
Pullcunah Hill
Hiller Well
Soansville Mining Centre
Nganaloonganna Pool
Woodstock
Tarra Pool
Gallery Hill
Mt Webber
Yandeyarra Outstation
Beapea Ck
Mt Gratwick
Quartz Hill
Red Granite Hill
Tambourah
Hillside
Mooratherra Hill
Yule River

100km 110km 120km 130km 140km 150km 160km 170km 180km 180km

LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Ecologia (2014) Solomon Hub Flora and Vegetation Assessment; Solomon Regional Veg Mapping Infill
- Ecologia (2012) North Star Access Corridor Flora and Fauna Assessment
- Ecologia (2012) North Star Vegetation and Flora Assessment
- Coffey (2010) Flora and Vegetation Assessment. Solomon Rail. Vegetation Mapping Recording.; Flora and Vegetation Assessment, Solomon Rail Project
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- ATA (2007) Supplementary Flora Survey
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:307,000 @ A3

0 2 4 6 8 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 1B

600000 620000 640000 660000 680000 700000

7620000 7610000 7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000 7520000 7510000

YANDEYARRA RESERVE

MUNGAROONA RANGE

MUNGAROONA RANGE NATURE RESERVE

CHICHESTER RANGE

West Yule River

YANDEYARRA RESERVE

95

140km 150km 160km 170km 180km 190km 200km 210km 220km 230km 240km 250km 260km 270km 280km 300km

Margaret

Fortescue River

CHICHESTER RANGE

Peak Hester

a Wittenoom Rd

Mt King

Wittenoom

136

Munjina Wittenoom Rd

Fortescue River

GOODIADARRIE HILL

KARIJINI NP

600000 620000 640000 660000 680000 700000

LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Biota (2017) Eliwana Consolidated Detailed Flora and Vegetation Phase 2
- Ecologia (2014) Solomon Hub Flora and Vegetation Assessment; Solomon Regional Veg Mapping Infill
- Coffey (2010) Flora and Vegetation Assessment. Solomon Rail. Vegetation Mapping Recording.; Flora and Vegetation Assessment, Solomon Rail Project
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- ATA (2007) Supplementary Flora Survey
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

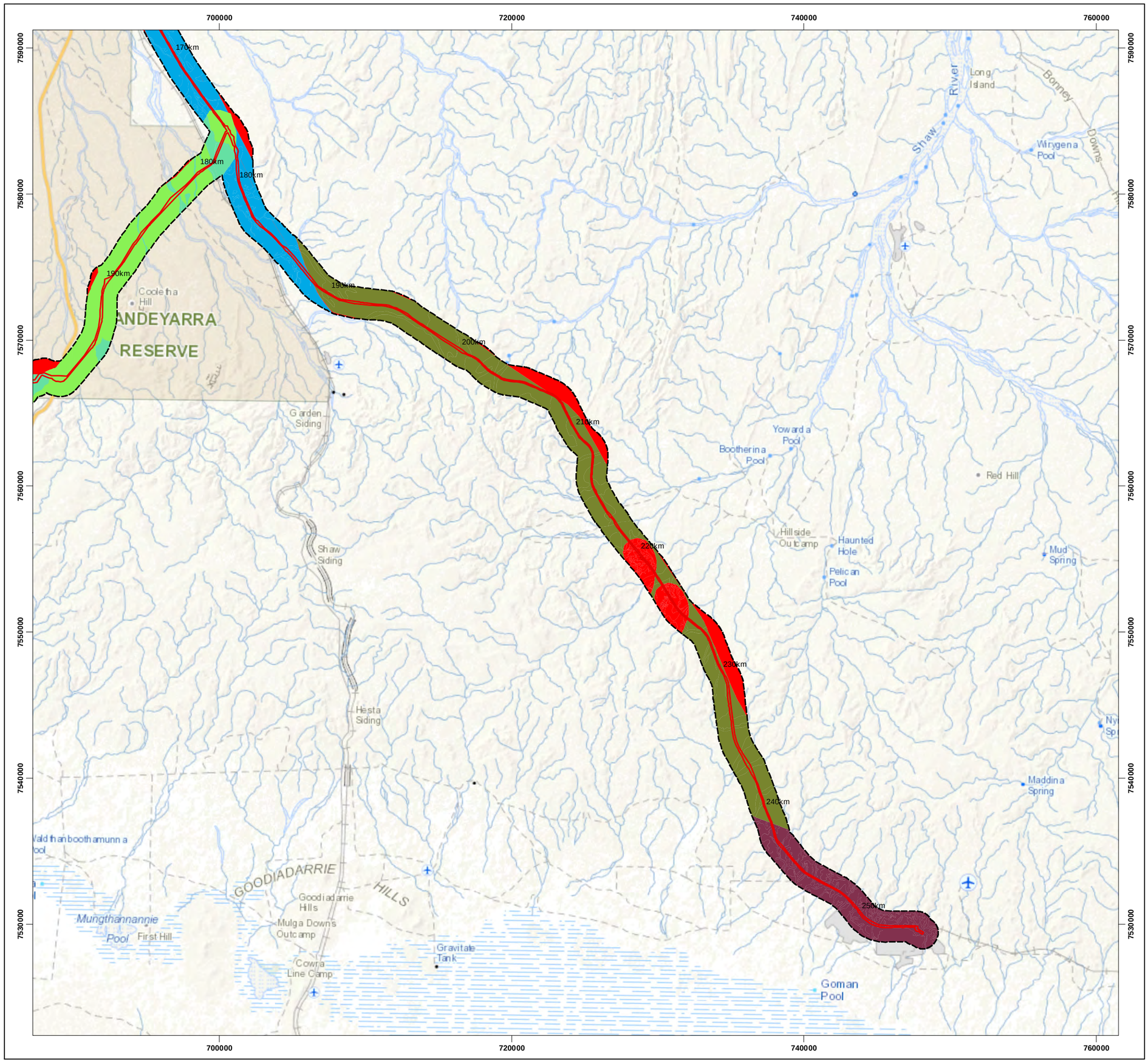
SCALE: 1:439,000 @ A3

0 4 8 12 16 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 1C



LEGEND

- Development Envelope
- Study Area
- Rail Chainage

Vegetation Mapping Source

- No Vegetation Type Data Available
- Ecologia (2014) Solomon Hub Flora and Vegetation Assessment; Solomon Regional Veg Mapping Infill
- ENV (2011) Cloudbreak Flora and Vegtation Assessment
- Coffey (2010) Flora and Vegetation Assessment. Solomon Rail. Vegetation Mapping Recording.; Flora and Vegetation Assessment, Solomon Rail Project
- Coffey (2008) Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure
- ATA (2007) Supplementary Flora Survey
- Biota (2004) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor

ecoscape

PREVIOUS FLORA AND VEGETATION ASSESSMENTS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:255,000 @ A3

0 2 4 6 8 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 1D

620000 640000 660000 680000 700000 720000

7740000 7720000 7700000 7680000 7660000 7640000

Thouin

South Hedland

Great

North West Coastal Hwy

Yule River

Turner River East

Yandeyarra

138

10km 20km 30km 40km 50km 60km 70km 80km 100km 110km

Li Ya Ri ED Ua Ma Mc Rt Tl Ro St Ca Bo Pl Bg

LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage

Lands Systems

- Bg: Boolgeeda System
- Bo: Boolaloo System
- Ca: Calcrete System
- Cp: Capricorn System
- ED: River bed phase
- Li: Littoral System
- Ma: Mallina System
- Mc: Macroy System
- Pl: Platform System
- Ri: River System
- Rk: Rocklea System
- Ro: Robe System
- Rt: Ruth System
- St: Satirist System
- Tl: Talga System
- Ua: Uaroo System
- Ya: Yamerina System

ecoscape

LAND SYSTEMS

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:420,000 @ A3

0 4 8 12 16 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	CB	JN	3/10/2018
01	DR	SB	30/10/2018

MAP 2A

660000 680000 700000 720000

7640000 7620000 7600000 7580000

YANDEYARRA RESERVE

100km 110km 120km 130km 140km 150km 160km 170km 180km 180km

Wodgina West
Yandeyarra Rd
Round Hummock
Nardoopiquithanna Pool
Great Northern Hwy
Turner Siding
Yandee
Abydos
Abydos Siding
Mt Francisco
Wodgina Pool
Mundermullangunder Pool
Pilbaddy Ck
Nganaloonganna Pool
Yandeyarra Outstation
Beabea Ck
Mt Gratwick
Woodstock
Tarra Pool
Quartz Hill
Moorratherra Hill
Yule River
Pullcunah Hill
Hiller Well
Gallery Hill
Mt Webber
Red Granite Hill
Tambourah
Hillside
Soansville Mining Centre
Pyramid Hill
Olympic Pool
Cleland Rock
GLACIER VALLEY
AGRIPPA RIDGE

LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage

Lands Systems

- Bg: Boolgeeda System
- Bo: Boolaloo System
- Cp: Capricorn System
- Gr: Granitic System
- Mc: Macroy System
- Mk: McKay System
- Ok: Oakover System
- Pl: Platform System
- Ri: River System
- Rk: Rocklea System
- Ro: Robe System
- Tl: Talga System
- Ua: Uaroo System
- Wh: White Springs System
- Wo: Wona System

ecoscape

LAND SYSTEMS

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

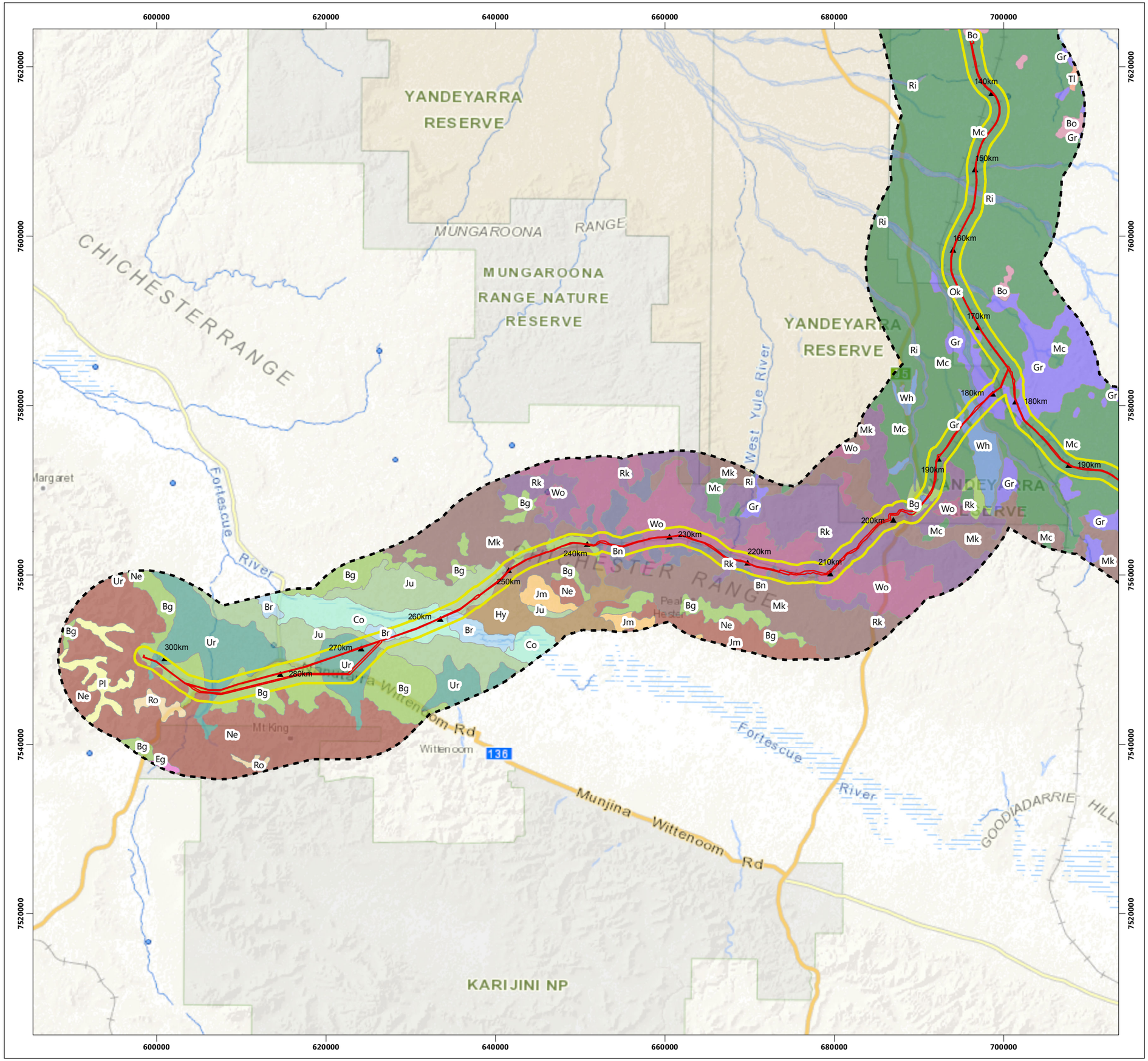
SCALE: 1:310,000 @ A3

0 2 4 6 8 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	CB	JN	3/10/2018
01	DR	SB	30/10/2018

MAP 2B



LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage

Lands Systems

- Bg: Boolgeeda System
- Bn: Bonney System
- Bo: Boolaloo System
- Br: Brockman System
- Co: Coolibah System
- Eg: Egerton System
- Gr: Granitic System
- Hy: Hooley System
- Jm: Jamindie System
- Ju: Jurrawarrina System
- Mc: Macroy System
- Mk: McKay System
- Ne: Newman System
- Ok: Oakover System
- Pl: Platform System
- Ri: River System
- Rk: Rocklea System
- Ro: Robe System
- Tl: Talga System
- Ur: Urandy System
- Wh: White Springs System
- Wo: Wona System

ecoscape

LAND SYSTEMS

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

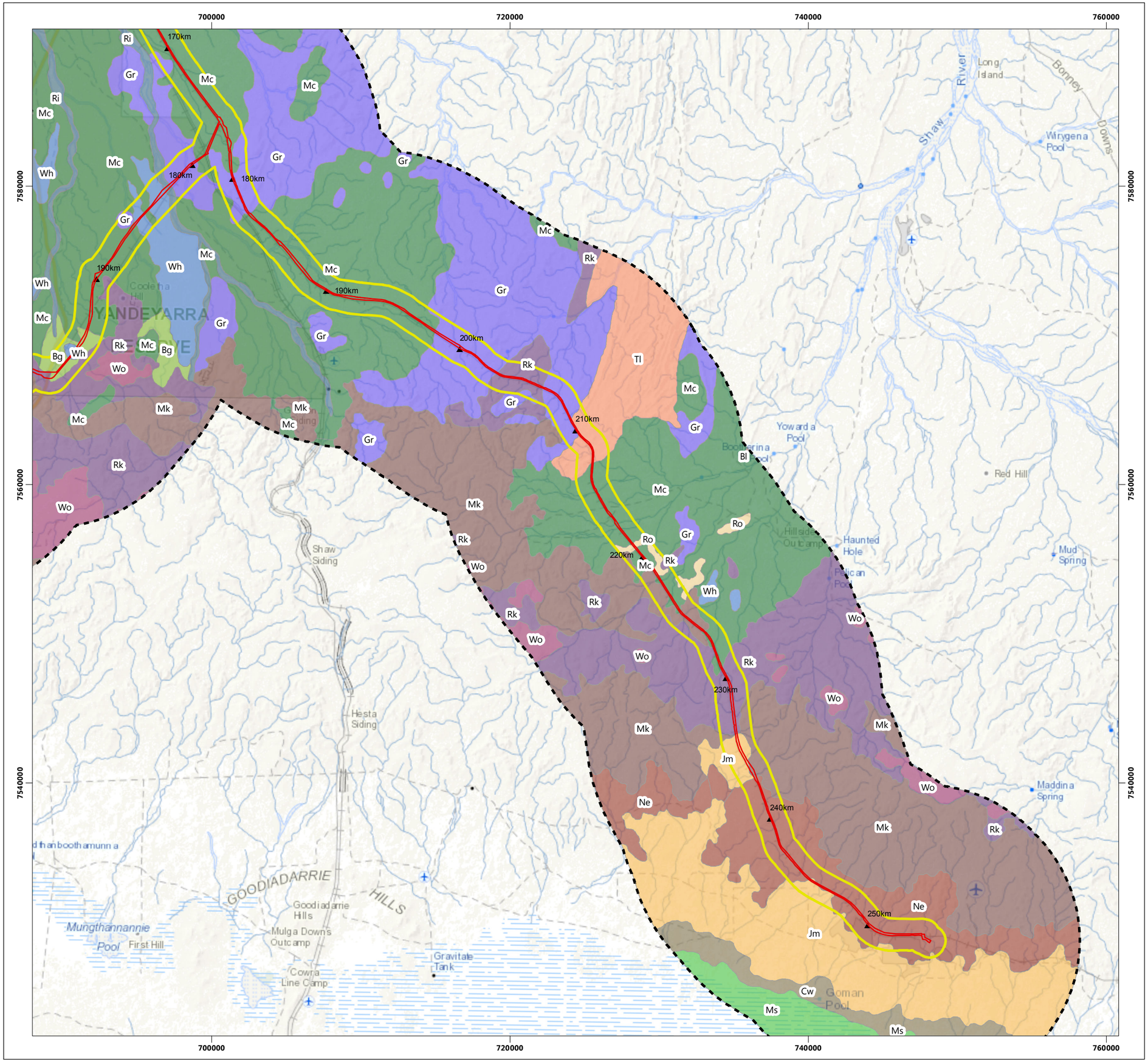
SCALE: 1:440,000 @ A3

0 4 8 12 16 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	CB	JN	3/10/2018
01	DR	SB	30/10/2018

MAP
2C



LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage

Lands Systems

- Bg: Boolgeeda System
- Bl: Black System
- Cw: Cowra System
- Gr: Granitic System
- Jm: Jamindie System
- Mc: Macroy System
- Mk: McKay System
- Ms: Marsh System
- Ne: Newman System
- Ri: River System
- Rk: Rocklea System
- Ro: Robe System
- Tl: Talga System
- Wh: White Springs System
- Wo: Wona System

ecoscape

LAND SYSTEMS

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

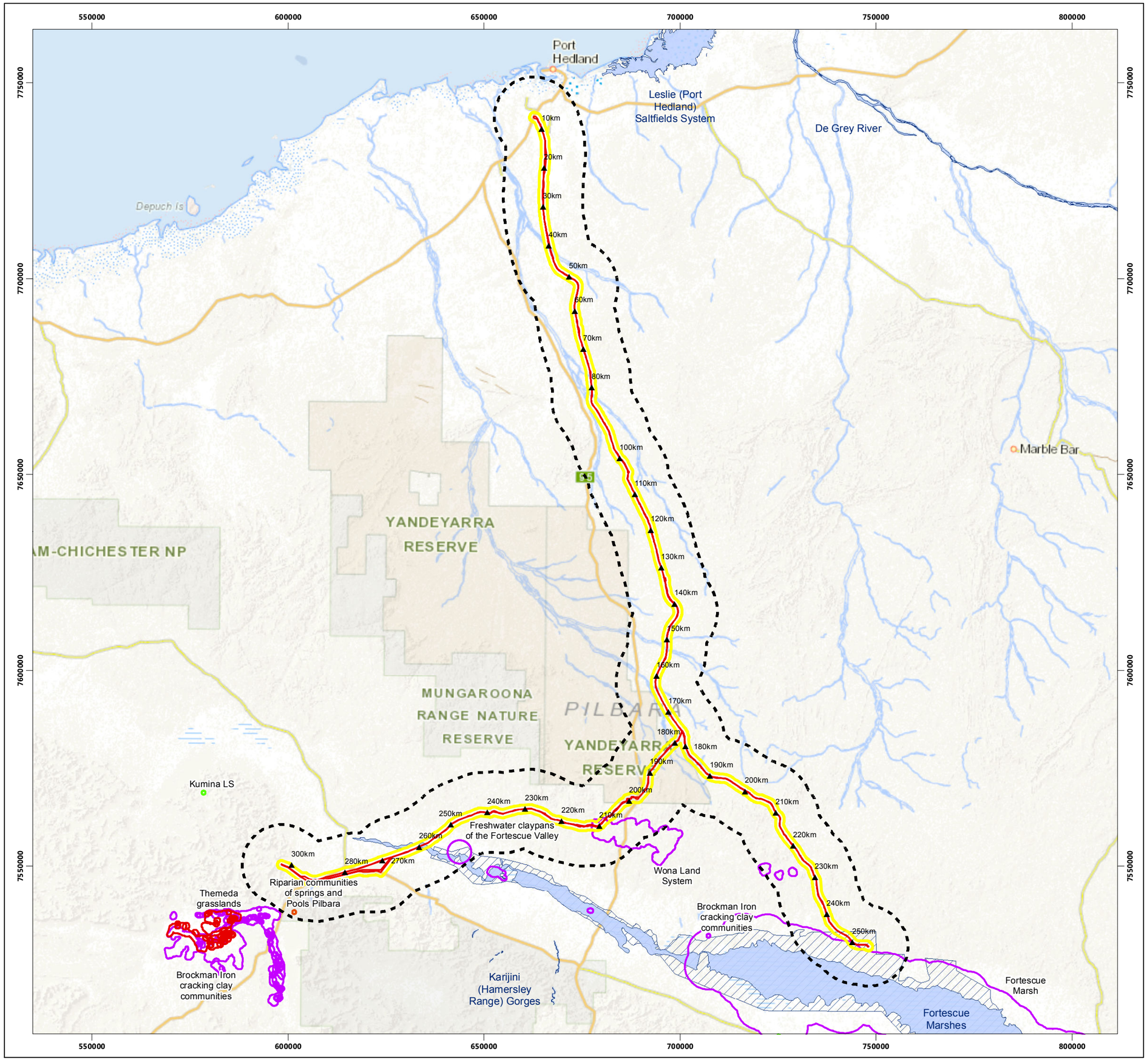
SCALE: 1:250,000 @ A3

0 2 4 6 8 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	CB	JN	3/10/2018
01	DR	SB	30/10/2018

MAP 2D



LEGEND

- Rail Chainage
- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Directory of Important Wetlands

Ramsar Sites (DBCA)

Status

- DRAFT Proposed Area

DBCA Ecological Database

- Vulnerable
- Priority 1
- Priority 2
- Priority 3

ecoscape

DESKTOP DATABASE LAYERS

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

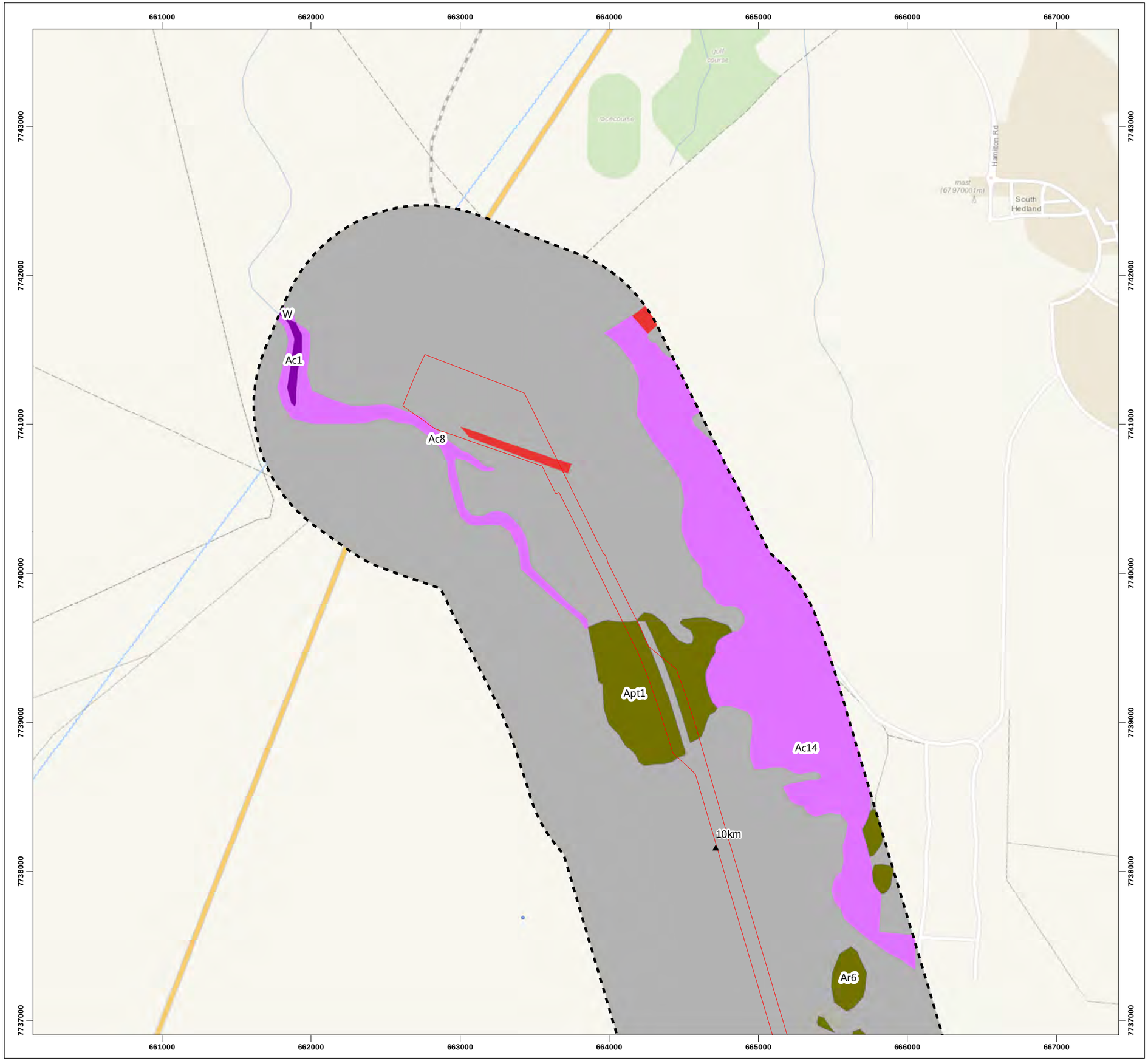
SCALE: 1:950,000 @ A3

0 10 20 30 40 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	30/10/2018

MAP 03

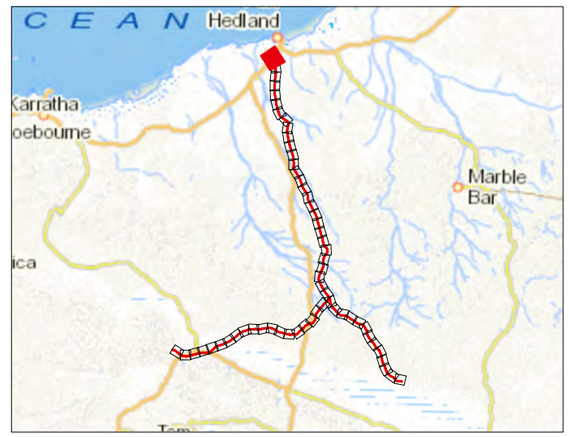


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.1

662000 663000 664000 665000 666000 667000 668000 669000

7737000 7736000 7735000 7734000 7733000 7732000

Ac14

Ar6

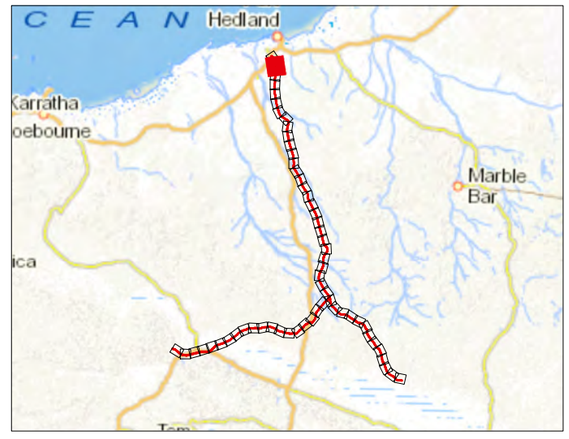
15km

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.2

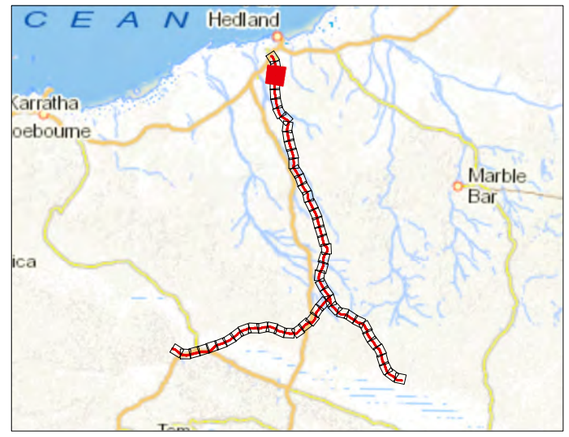
662000 663000 664000 665000 666000 667000 668000 669000

7731000 7730000 7729000 7728000 7727000 7726000

20km

LEGEND

- Rail Chainage
- Development Envelope
- Study Area
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.3

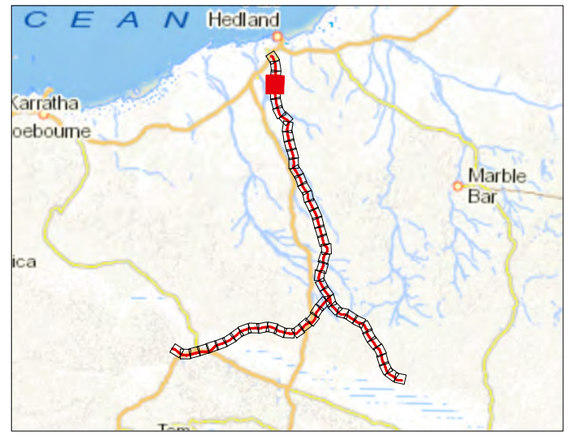
662000 663000 664000 665000 666000 667000 668000

7725000 7724000 7723000 7722000 7721000 7720000

25km

LEGEND

- Rail Chainage
- Development Envelope
- Study Area
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.4

662000 663000 664000 665000 666000 667000 668000 669000

7719000 7718000 7717000 7716000 7715000 7714000

30km

Ac30

35km

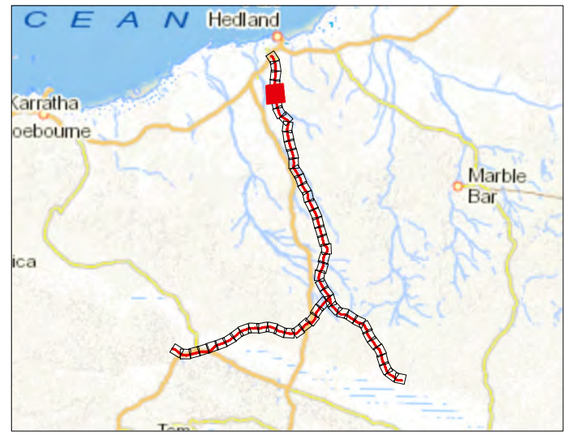
Ac15

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.5

663000 664000 665000 666000 667000 668000 669000

7713000 7712000 7711000 7710000 7709000 7708000

35km

Ah5a

Ac15

40km

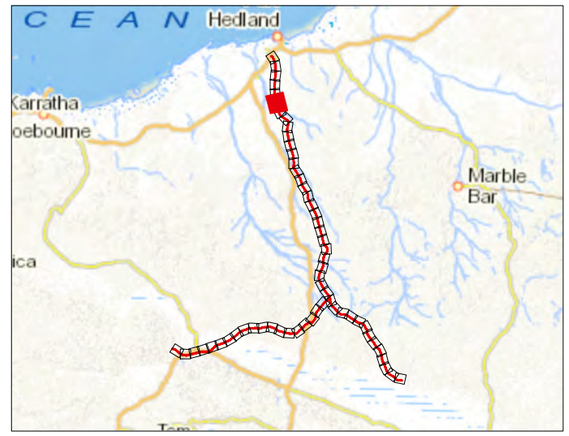
Ac1

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

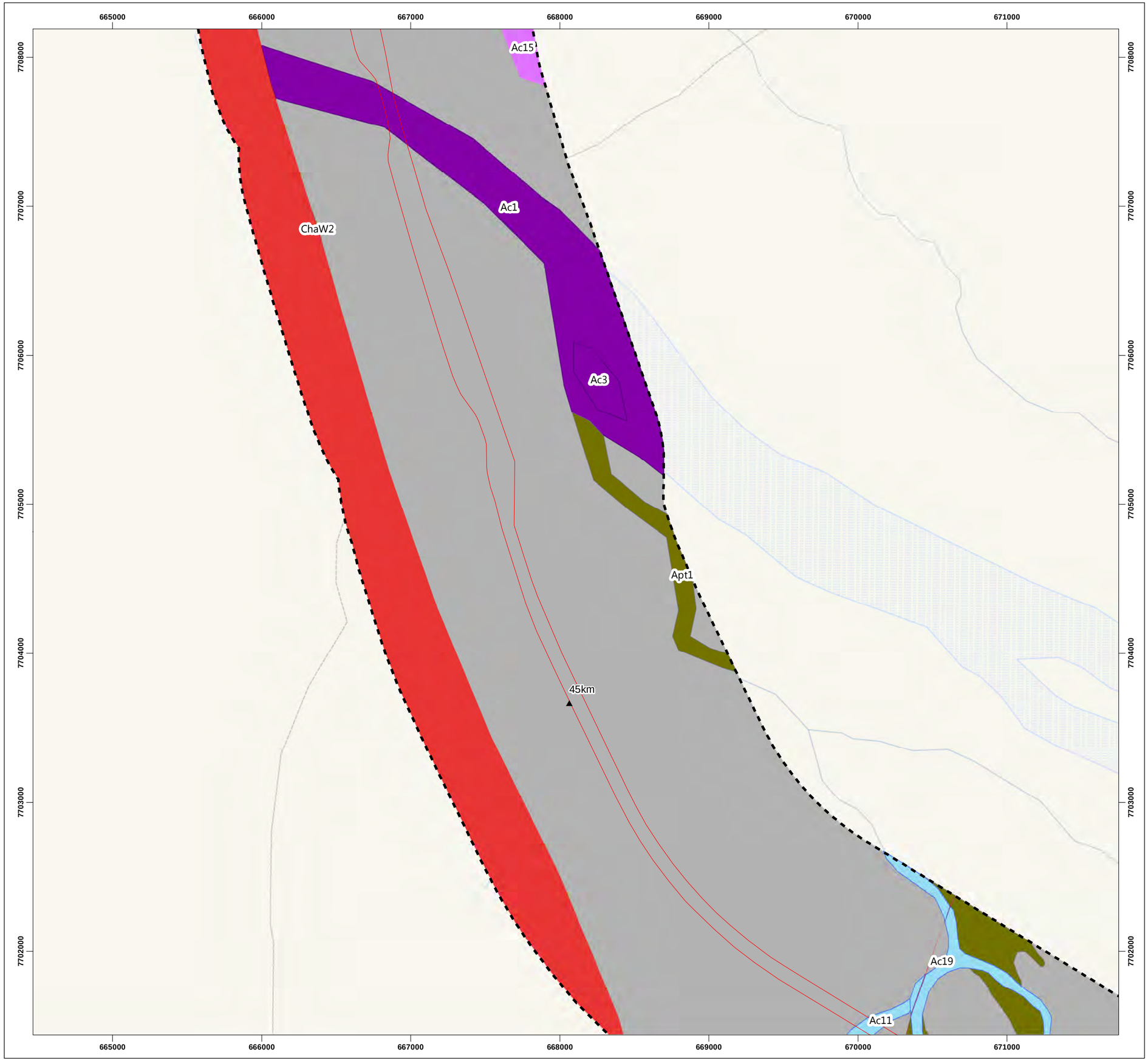
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.6

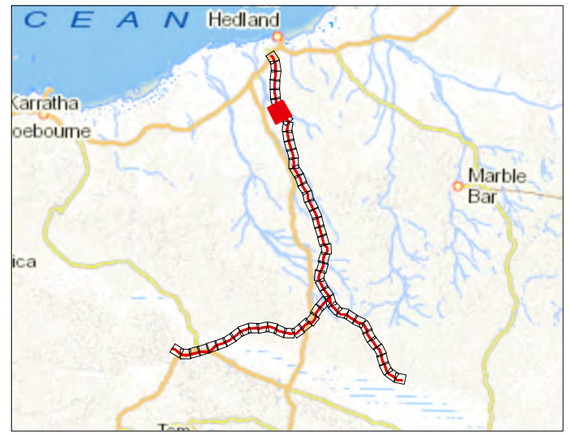


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.7

669000 670000 671000 672000 673000 674000 675000

7703000 7702000 7701000 7700000 7699000 7698000

tower (94.489998m)

Tabba

Ac11

Apt1

50km

Ac19

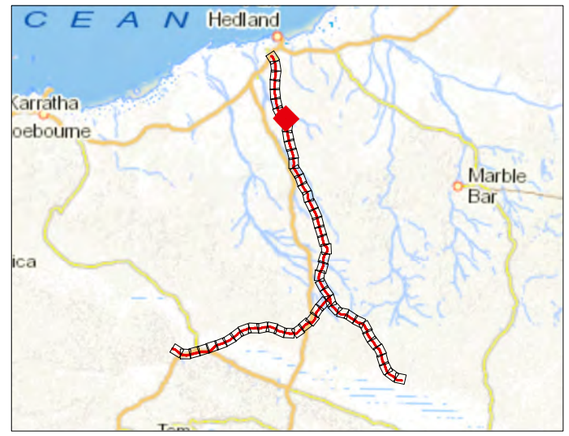
Ac24

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

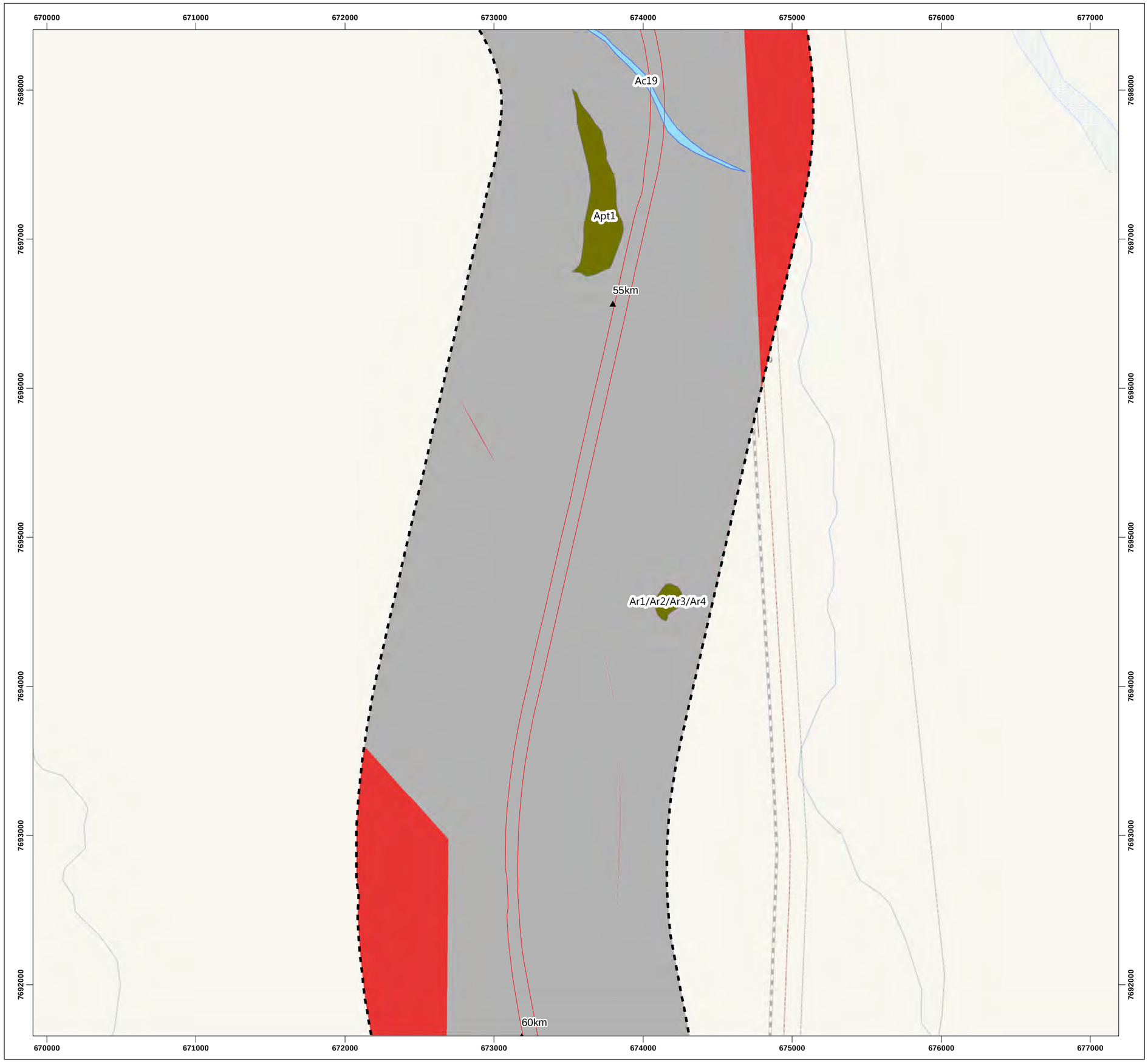
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.8

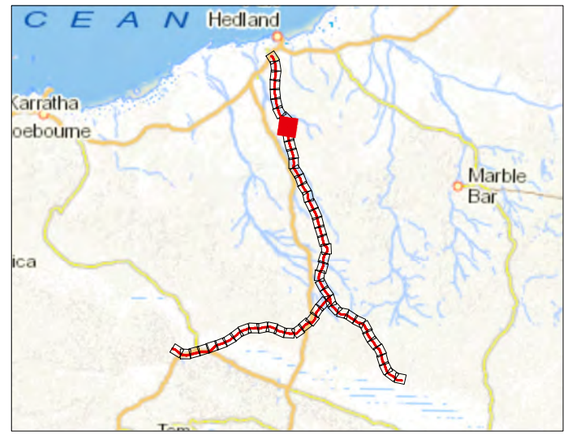


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

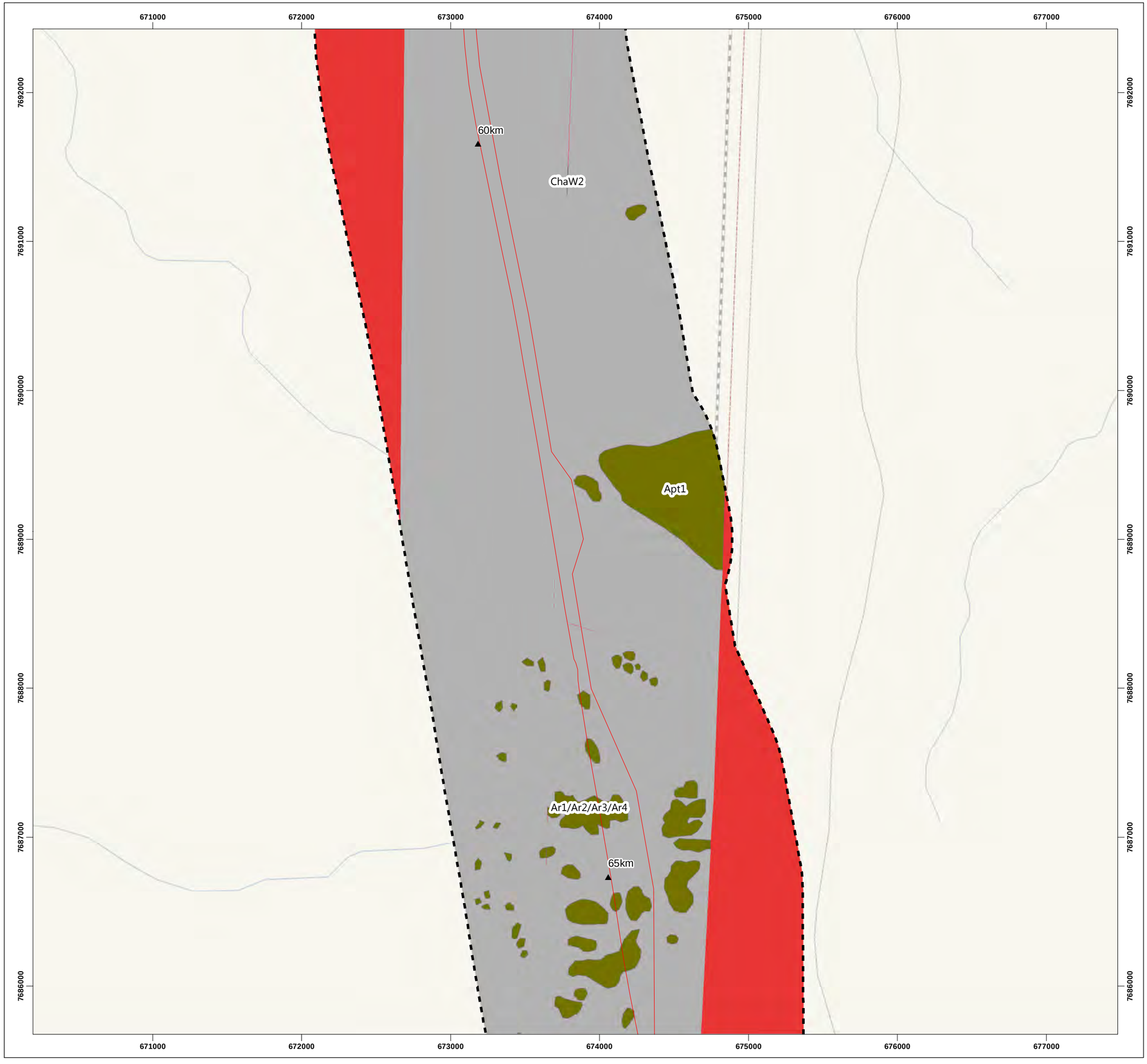
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.9

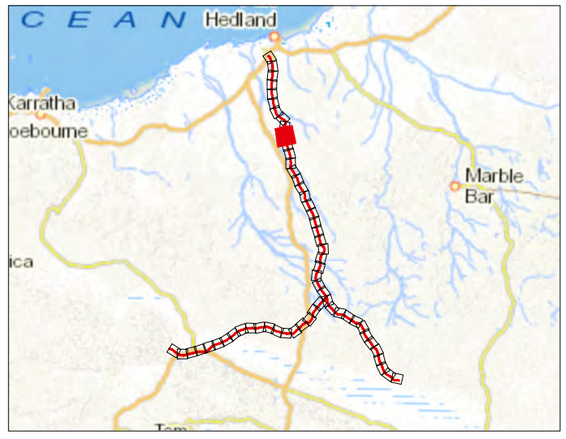


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.10

672000 673000 674000 675000 676000 677000 678000

7686000 7685000 7684000 7683000 7682000 7681000 7680000

Ar1/Ar2/Ar3/Ar4

70km

Ac12

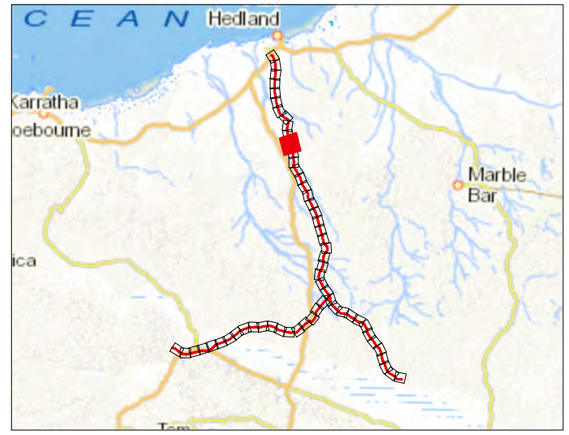
Apt5

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

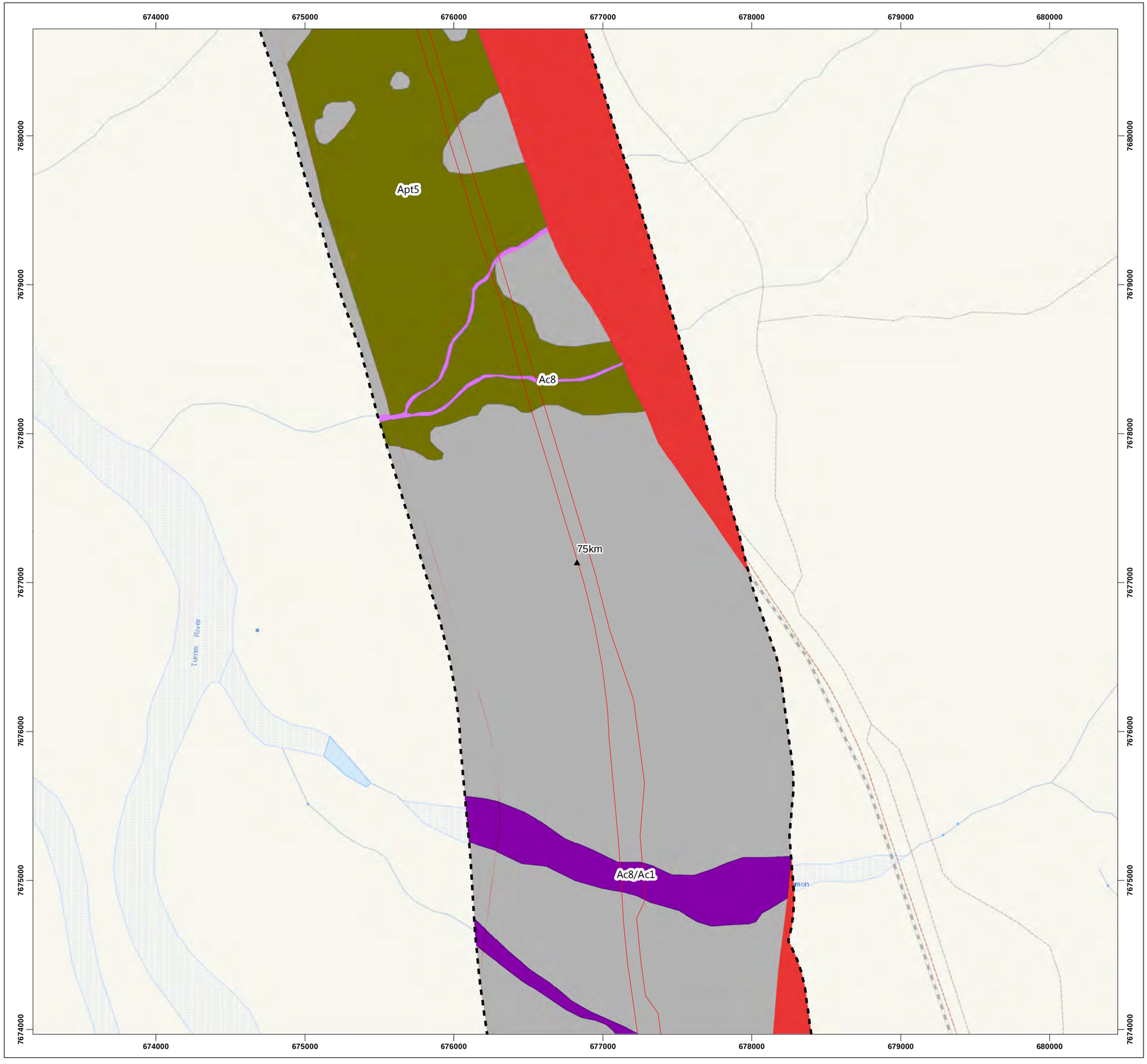
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.11

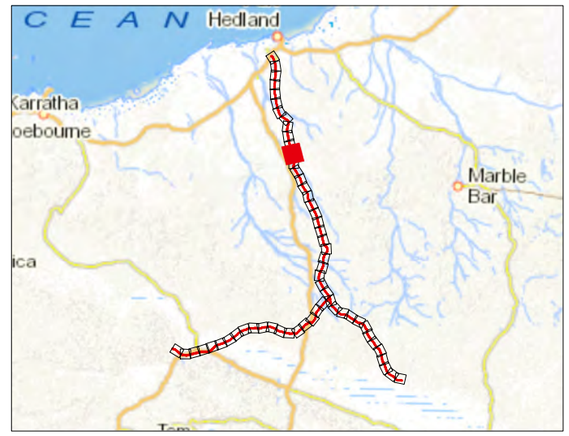


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

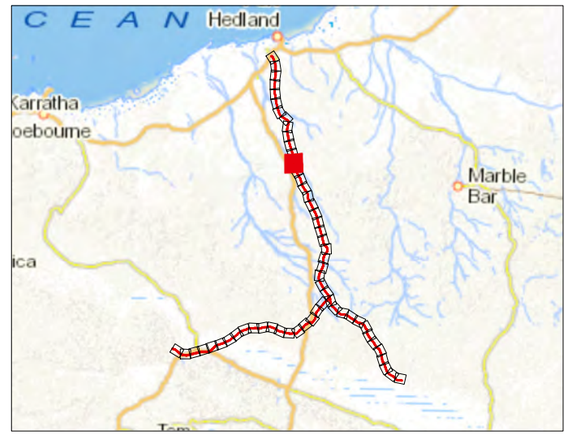
4.12

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:25,000 @ A3

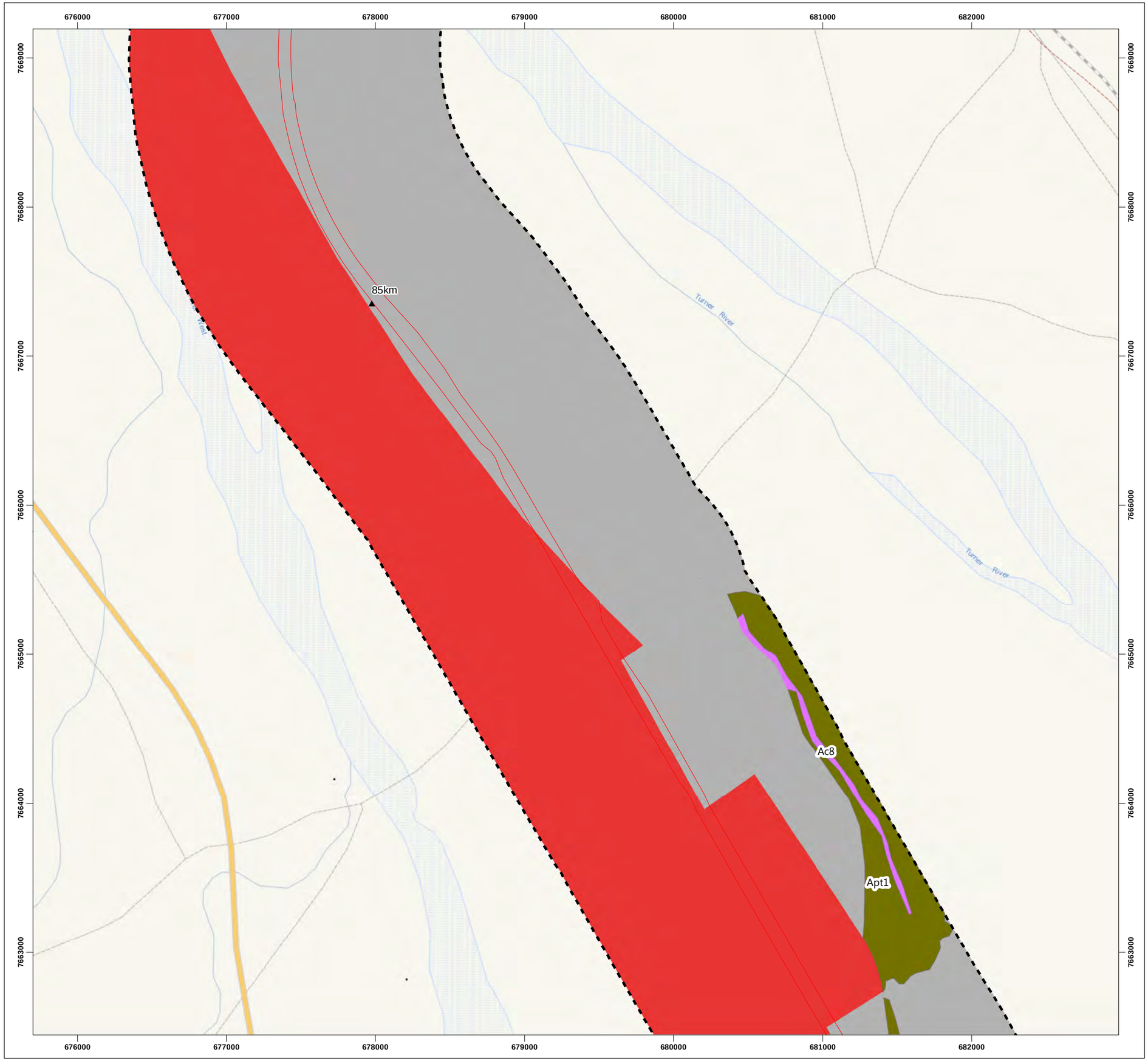
N

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.13

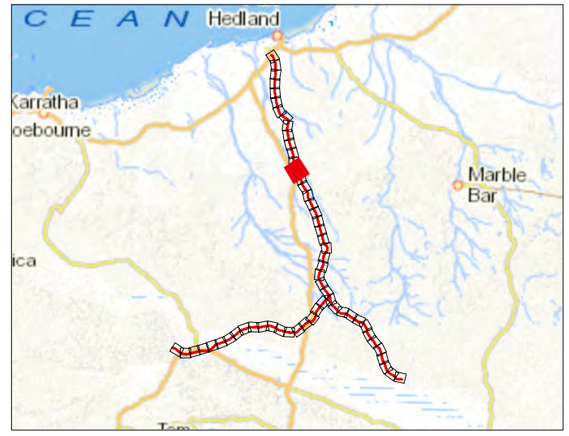


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

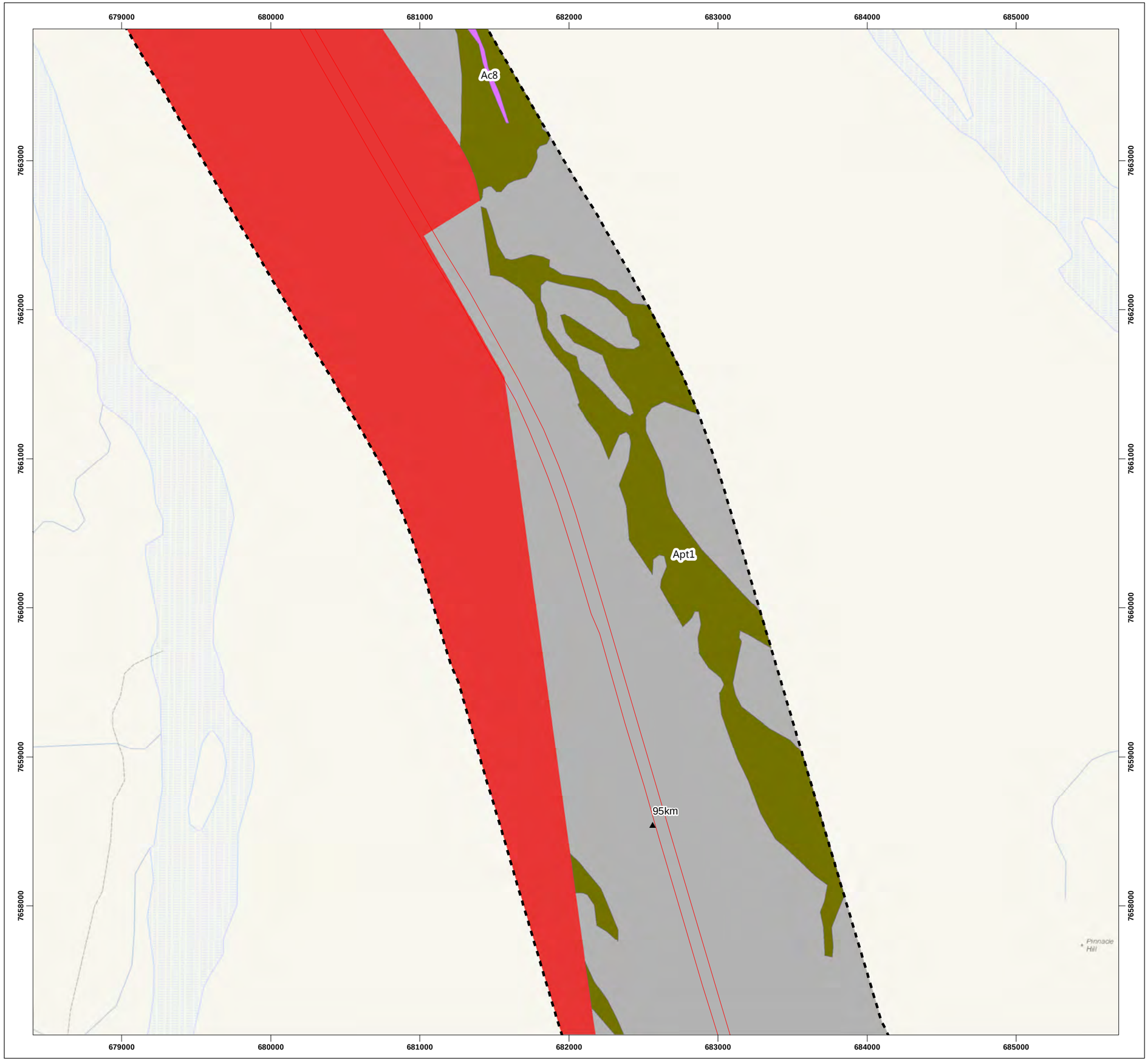
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.14

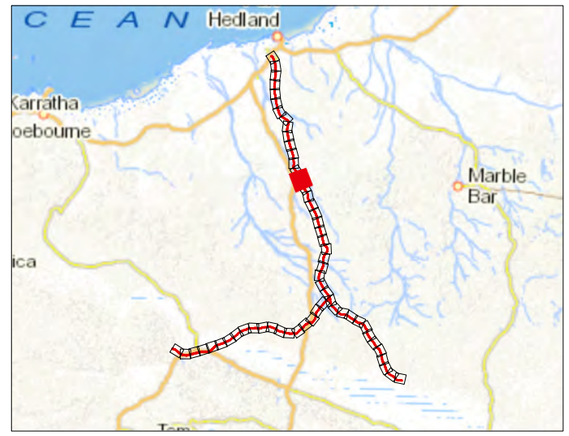


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

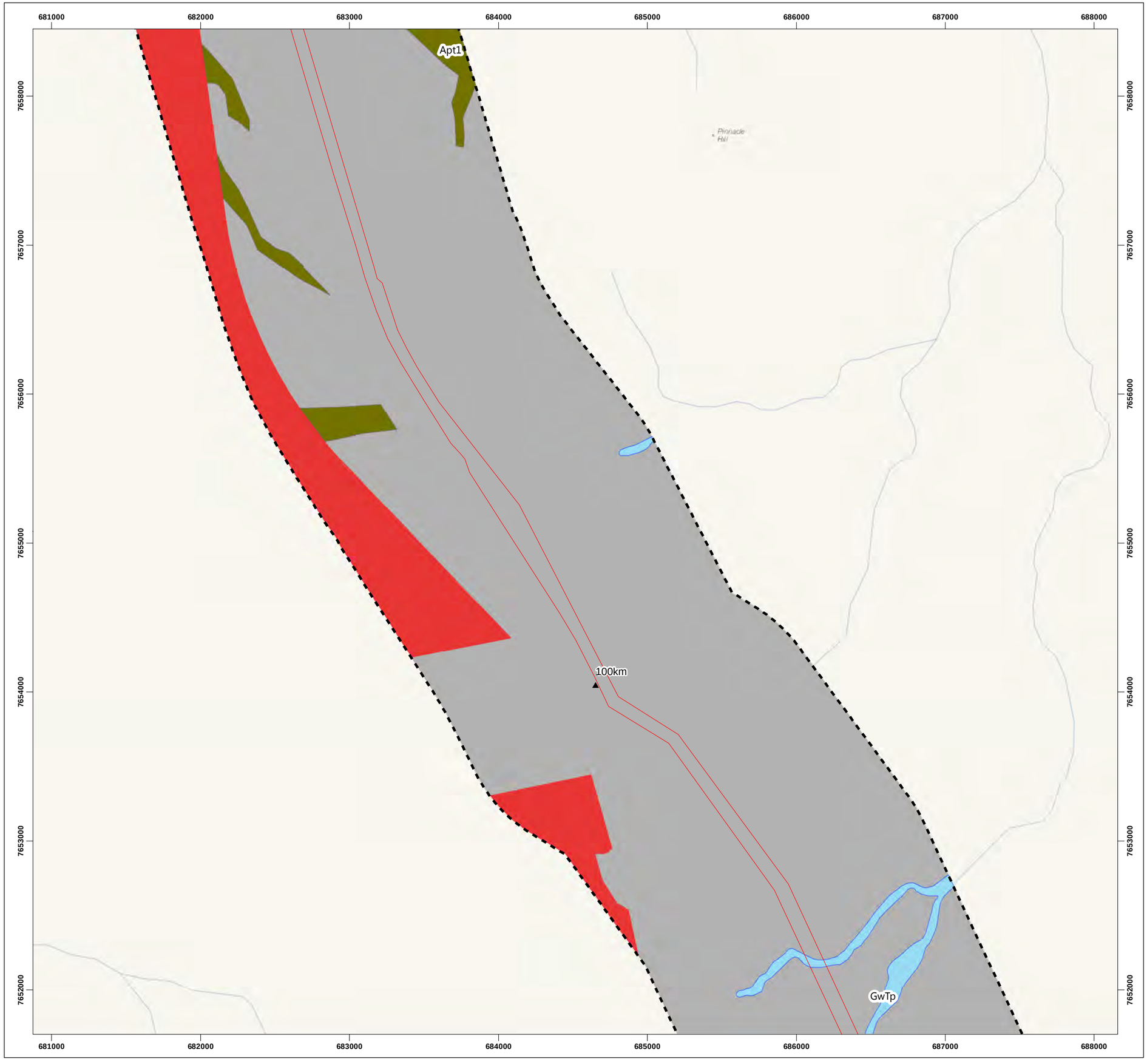
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.15

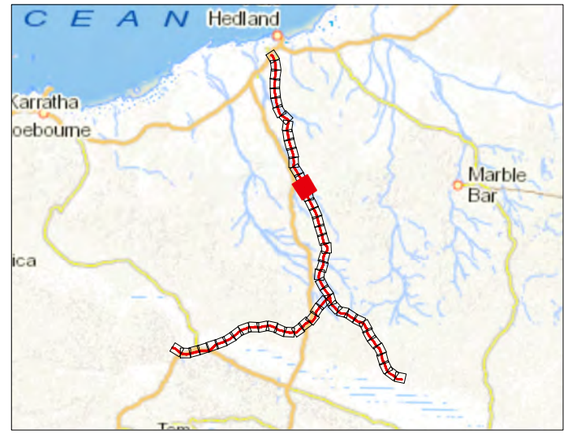


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

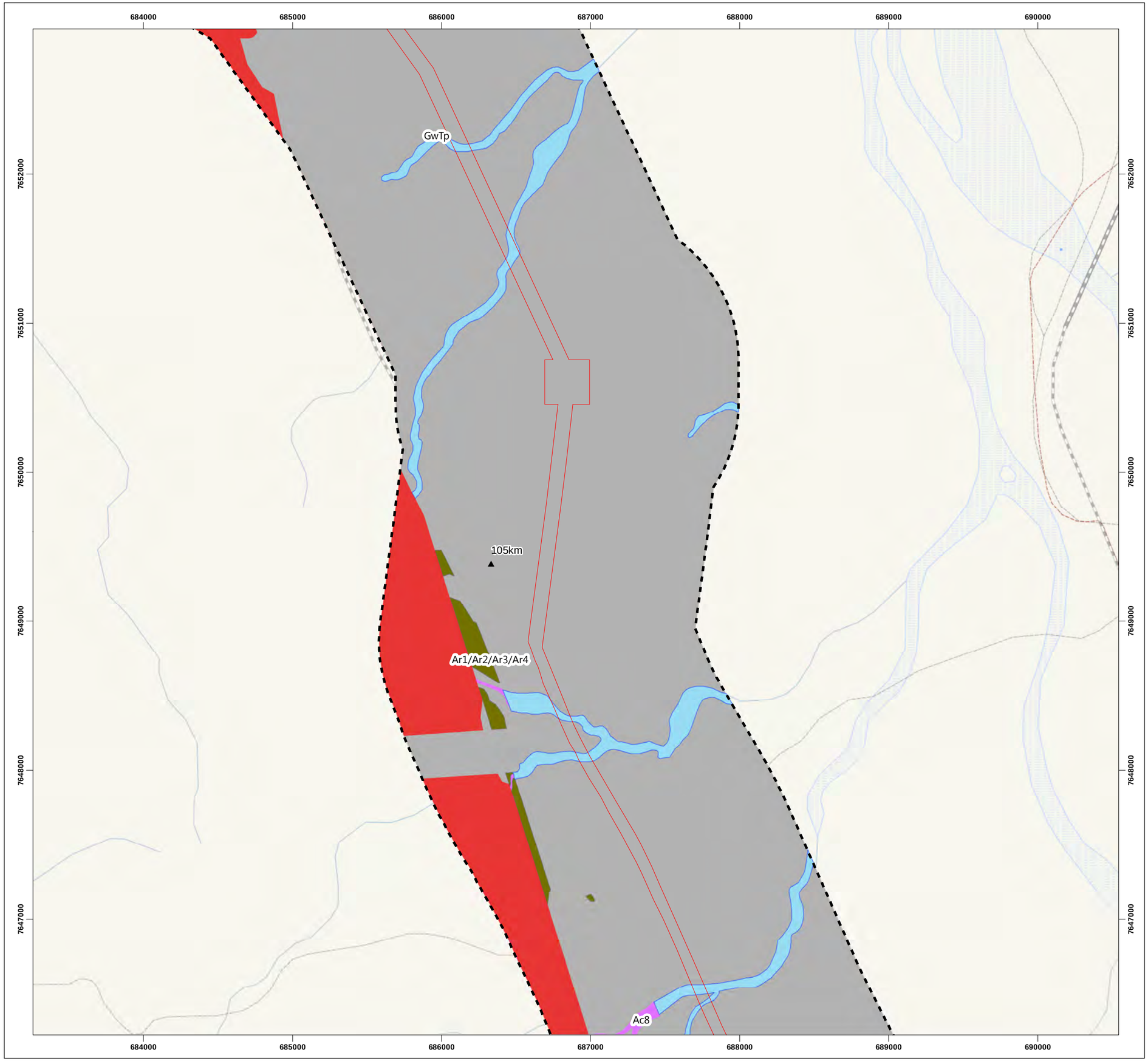
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.16

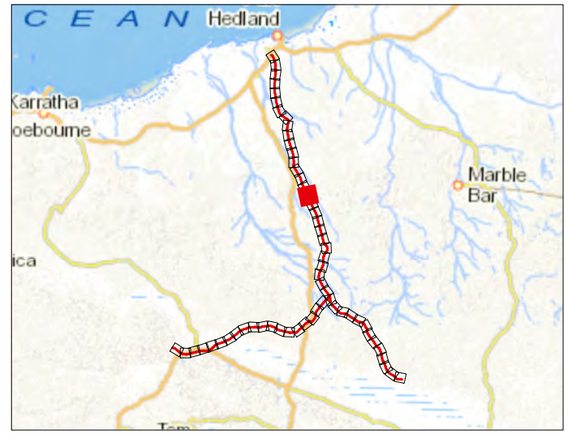


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.17

686000 687000 688000 689000 690000 691000 692000

7647000 7646000 7645000 7644000 7643000 7642000 7641000

GwTp

Ar1/Ar2/Ar3/Ar4

110km

Apt5

Apt8

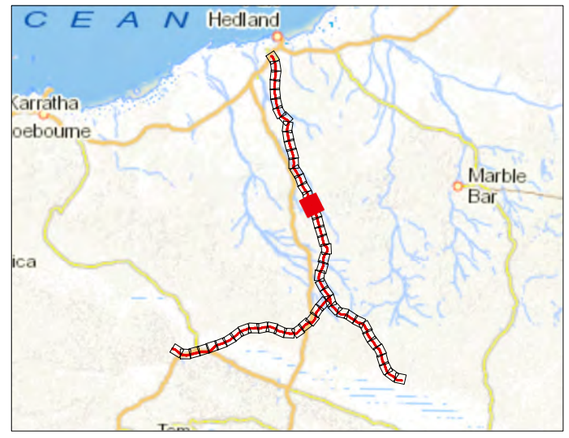
Ac8

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.18

689000 690000 691000 692000 693000 694000 695000

7641000 7640000 7639000 7638000 7637000 7636000

Ac8

115km

Apt5

Ar1/Ar2/Ar3/Ar4

120km

Ac12

Turner River

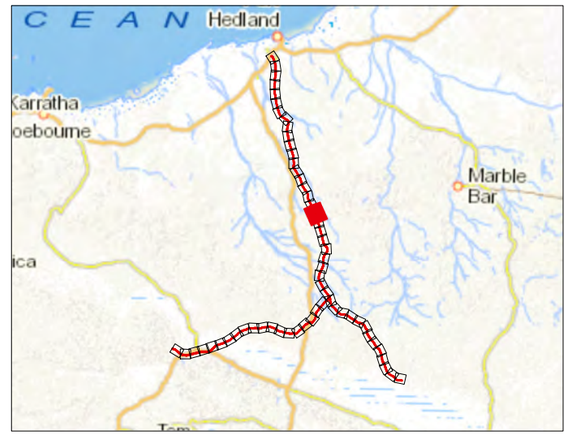
689000 690000 691000 692000 693000 694000 695000

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.19

690000 691000 692000 693000 694000 695000 696000 697000

7636000 7635000 7634000 7633000 7632000 7631000 7630000

120km

Ac8

Apt5

Ar1/Ar2/Ar3/Ar4

Ac12

125km

Ar5

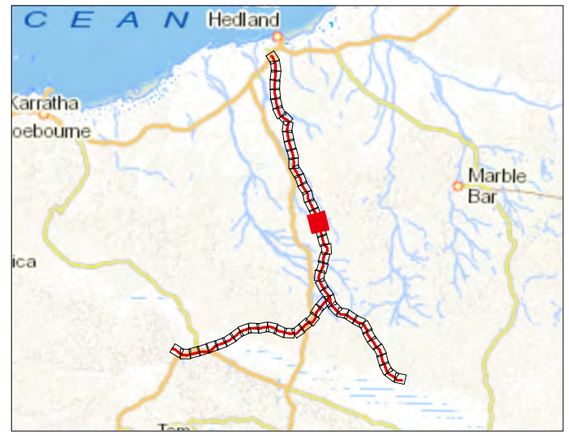
Ac20

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.20

692000 693000 694000 695000 696000 697000 698000

7630000 7629000 7628000 7627000 7626000 7625000 7624000

Apt5

Ac20

130km

Ac8

Ar5

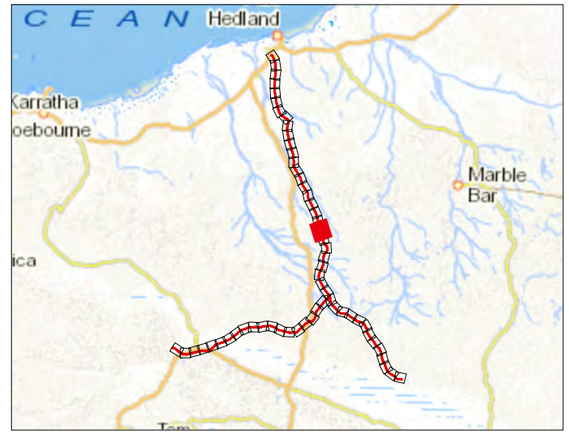
Ar1/Ar2/Ar3/Ar4

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.21

694000 695000 696000 697000 698000 699000 700000

7624000 7623000 7622000 7621000 7620000 7619000 7618000

Ar1/Ar2/Ar3/Ar4

Ac17

Apt5

135km

Ac28

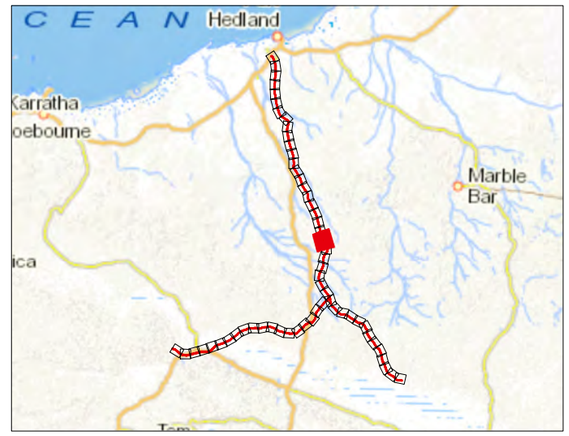
tower
(64.010002m)

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.22

696000 697000 698000 699000 700000 701000 702000

7618000 7617000 7616000 7615000 7614000 7613000 7612000

140km

Ac12

Ac28

Ac9

145km

White Well

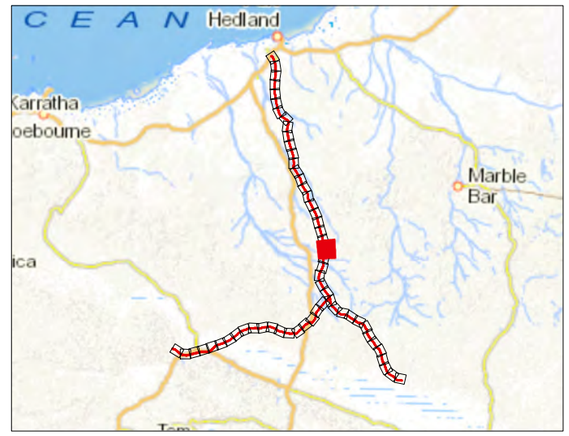
Hiller Well

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.23

694000 695000 696000 697000 698000 699000 700000

7612000 7611000 7610000 7609000 7608000 7607000

145km

150km

Ar1/Ar2/Ar3/Ar4

Ac1

waterhole

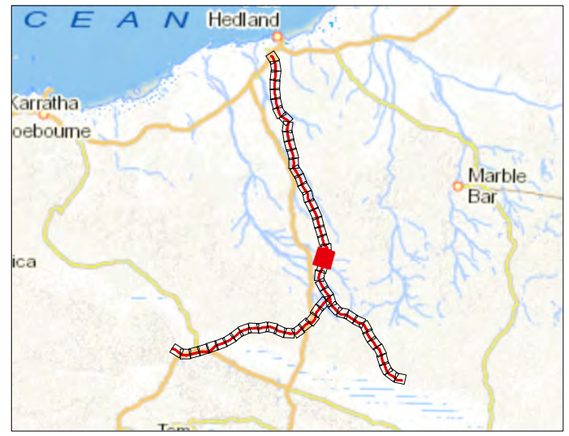
Coorong Ck

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.24

693000 694000 695000 696000 697000 698000 699000

7606000 7605000 7604000 7603000 7602000 7601000

Ac1

155km

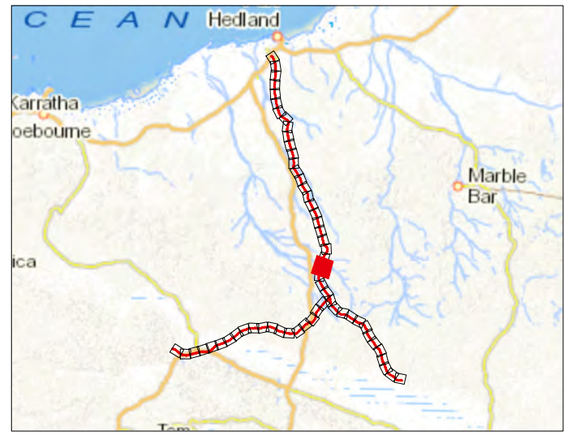
Ac9 Ac29 Ac28

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.25

691000 692000 693000 694000 695000 696000 697000

7601000 7600000 7599000 7598000 7597000 7596000 7595000

Ac28

Ac9

Ac29

160km

Ac1/Ac5

Coonarrie Ck

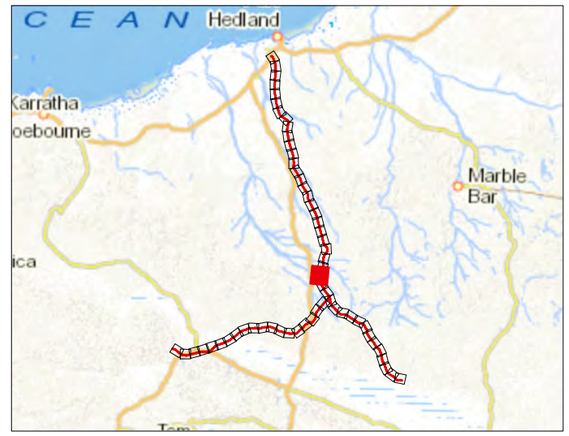
691000 692000 693000 694000 695000 696000 697000

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

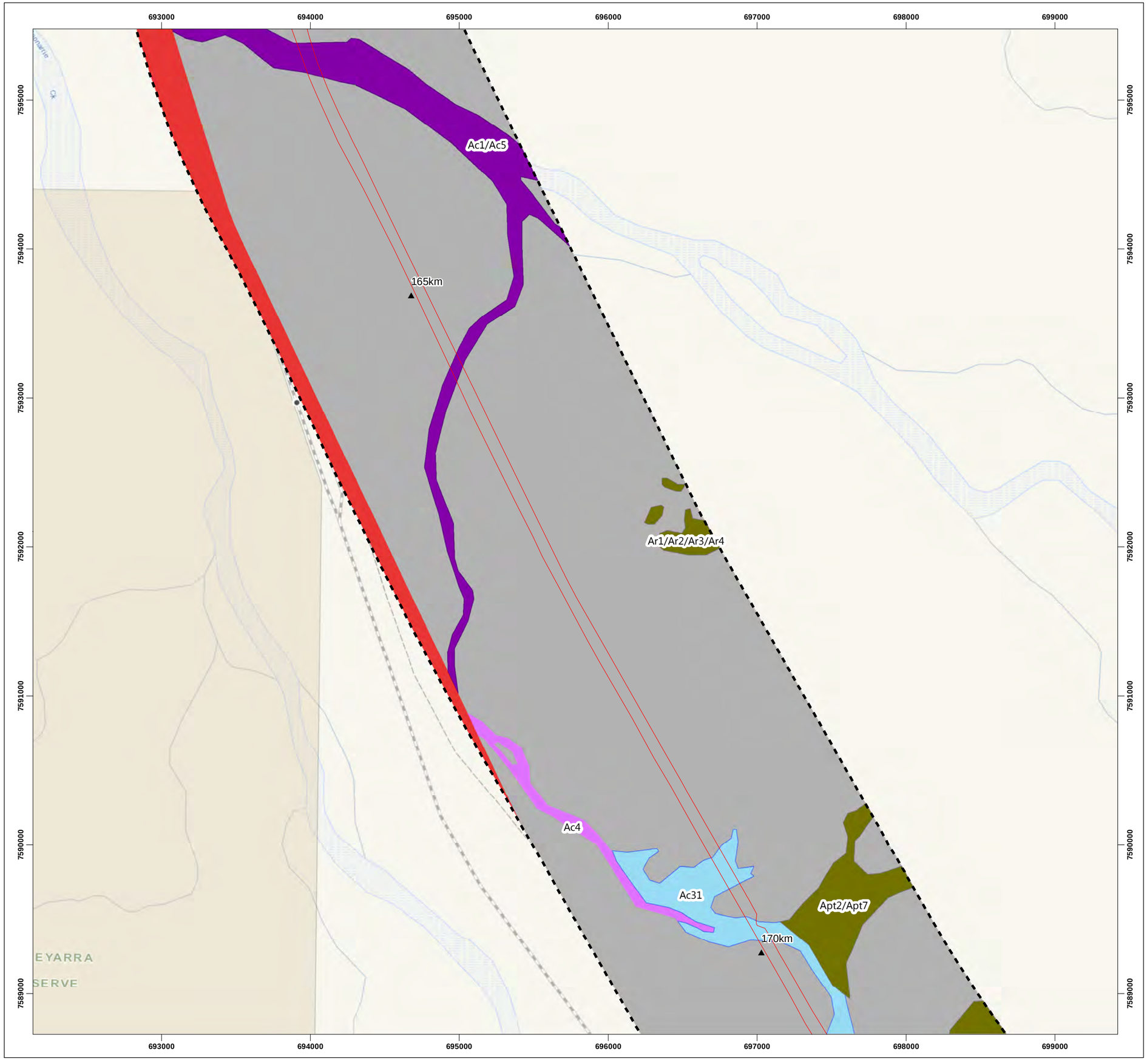
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.26

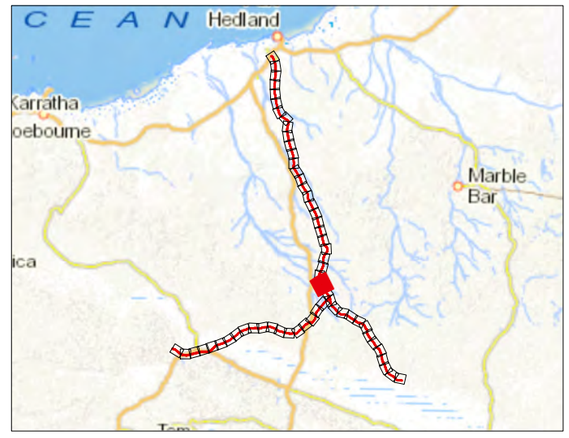


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

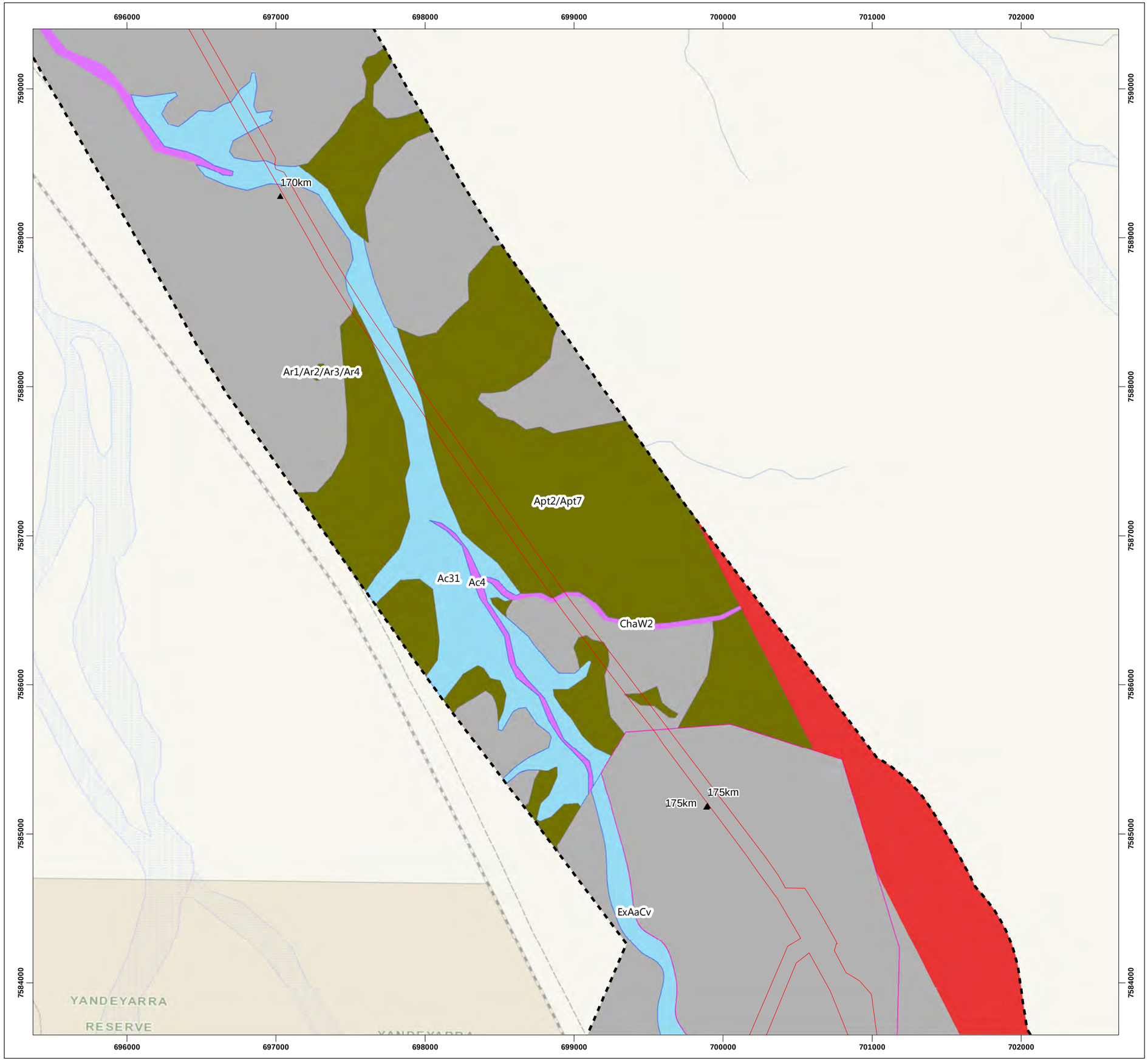
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.27

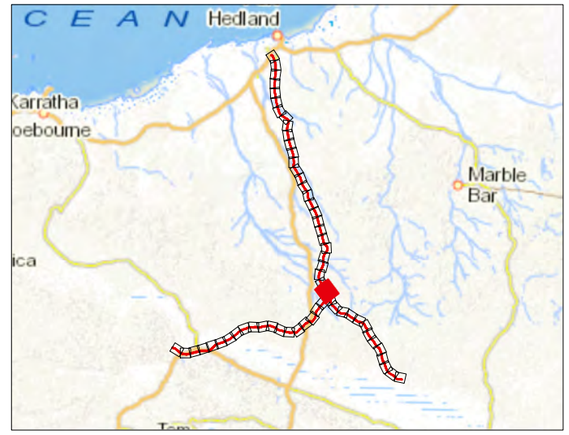


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:25,000 @ A3

N

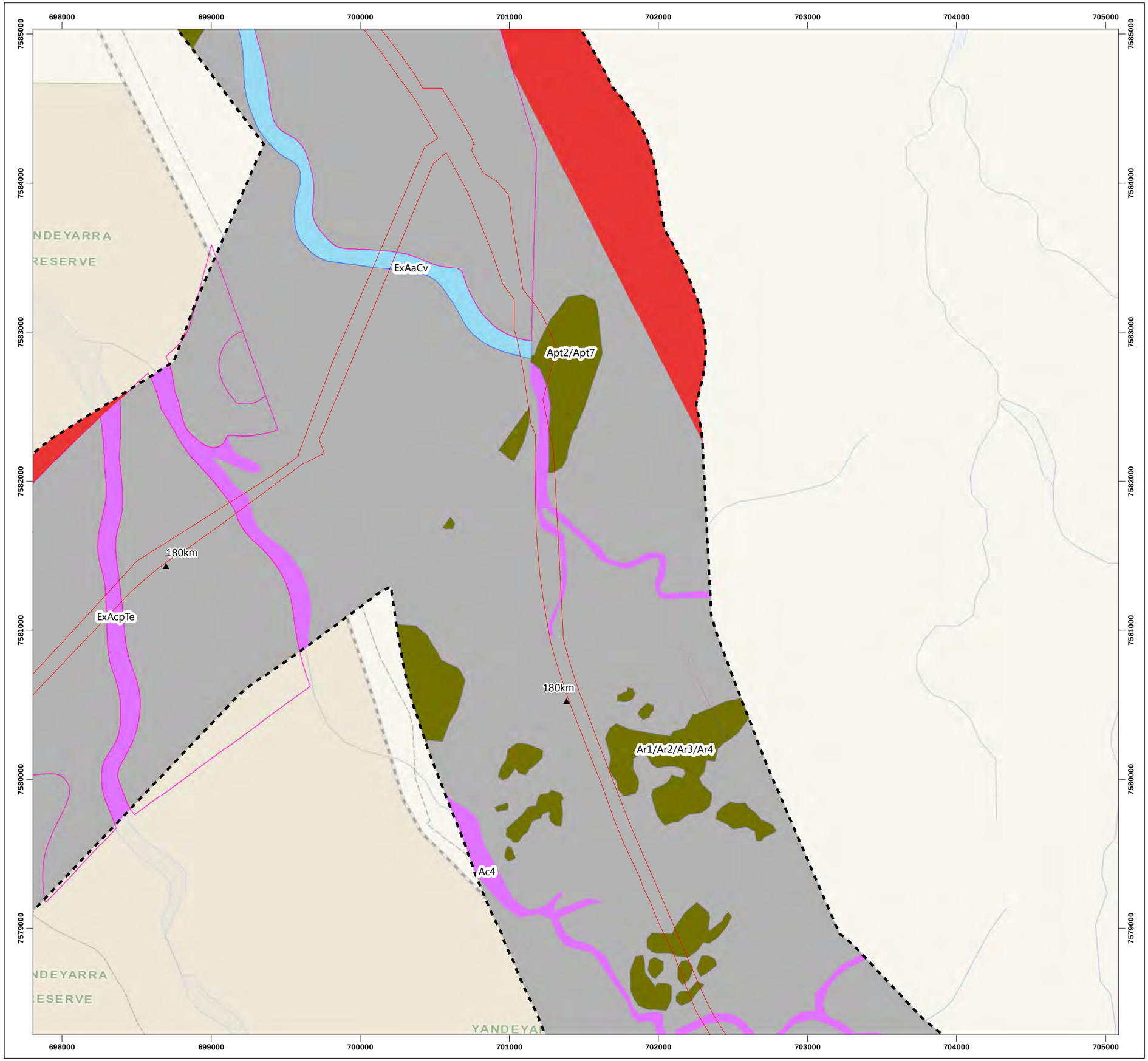
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.28

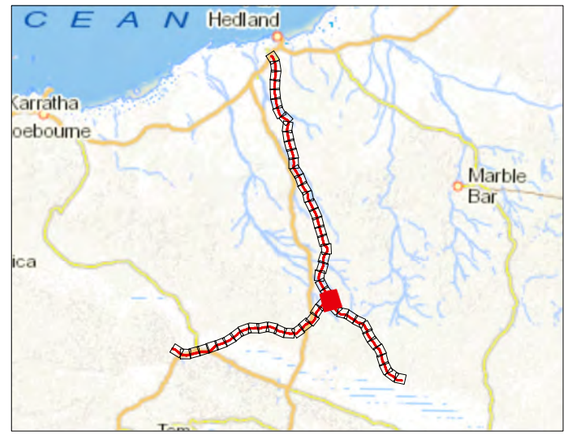


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

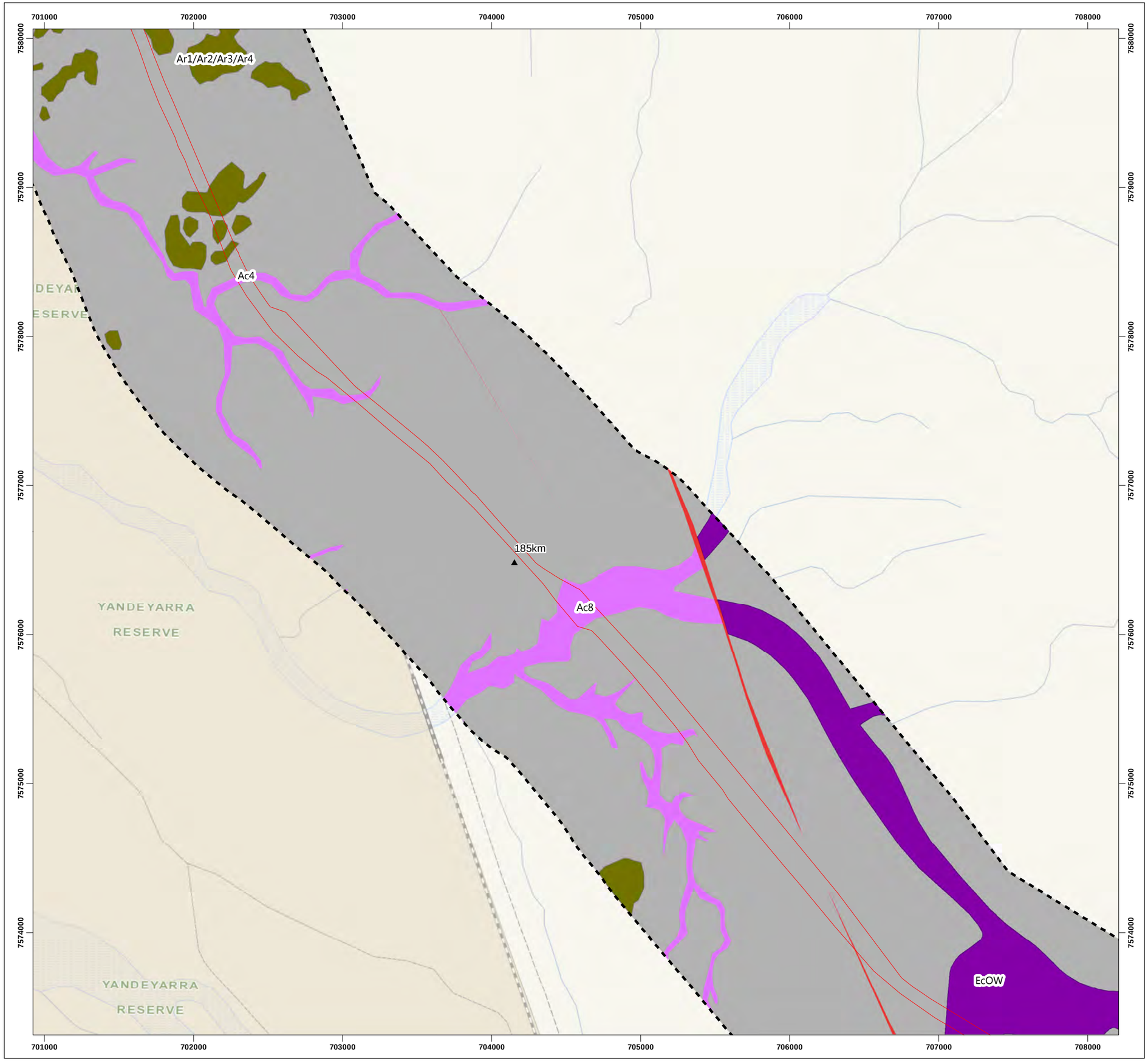
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.29

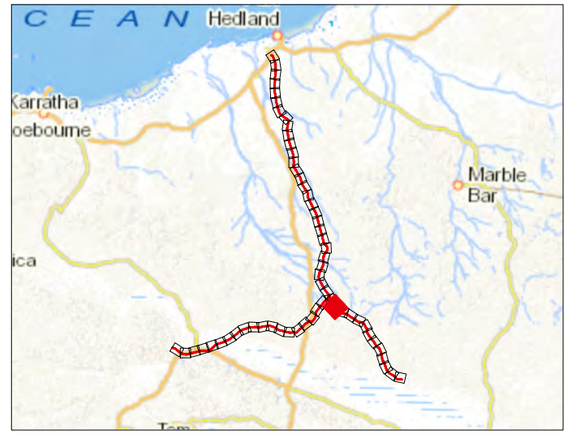


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

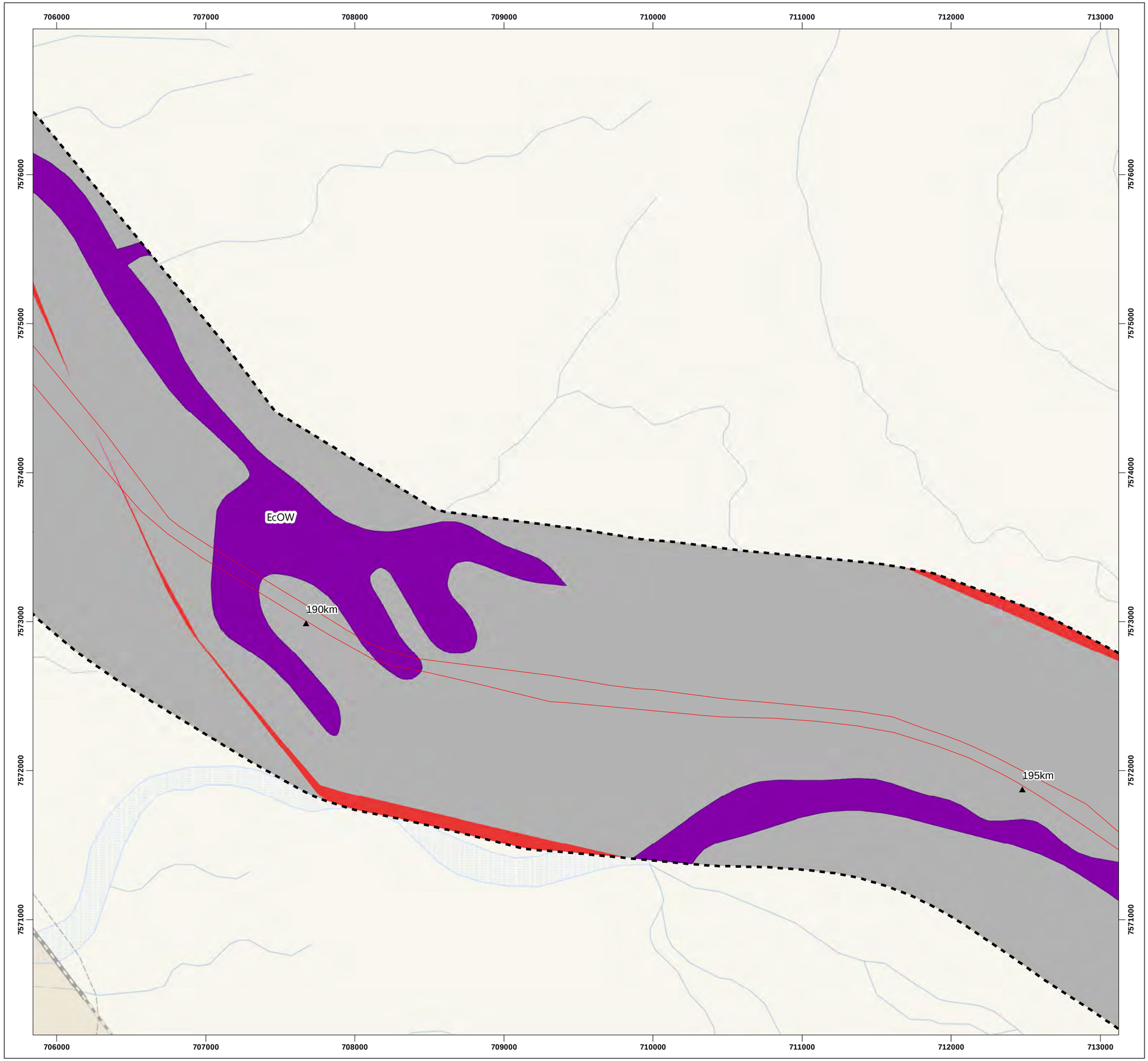
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.30

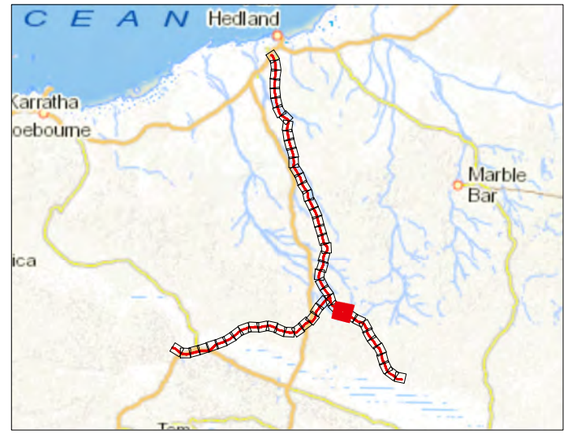


LEGEND

- ▲ Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.31

712000 713000 714000 715000 716000 717000 718000

7574000 7573000 7572000 7571000 7570000 7569000 7568000

Yule River

195km

EcOW

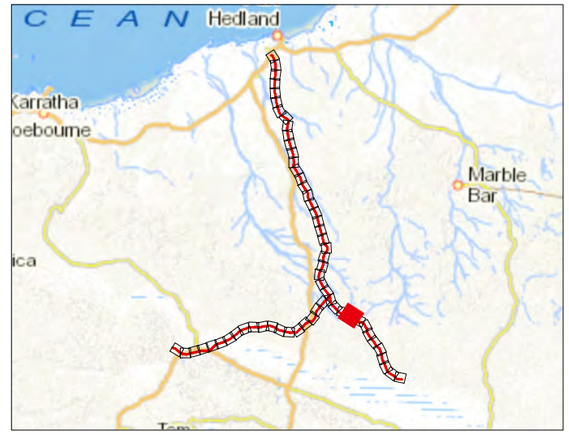
200km

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

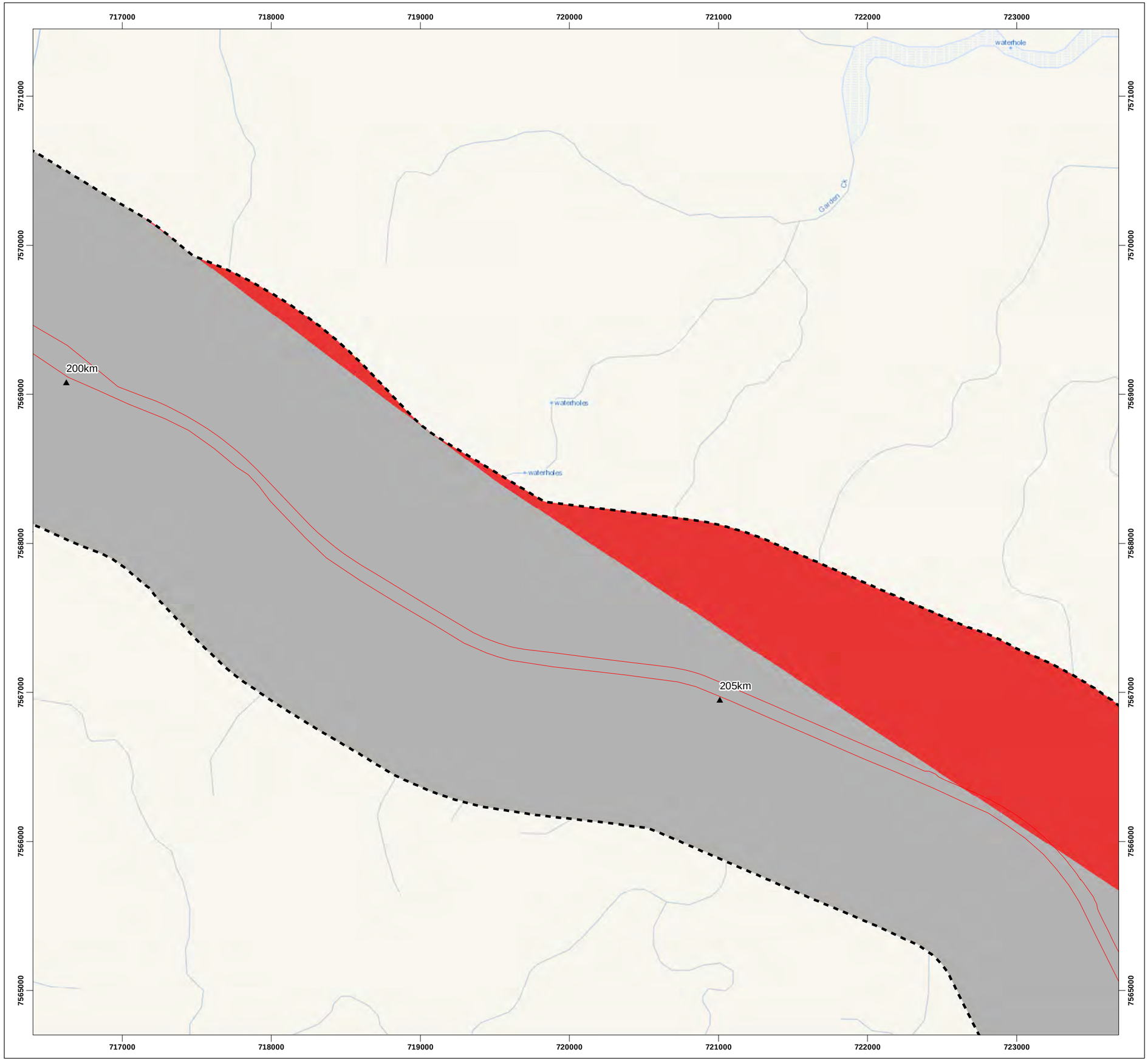
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

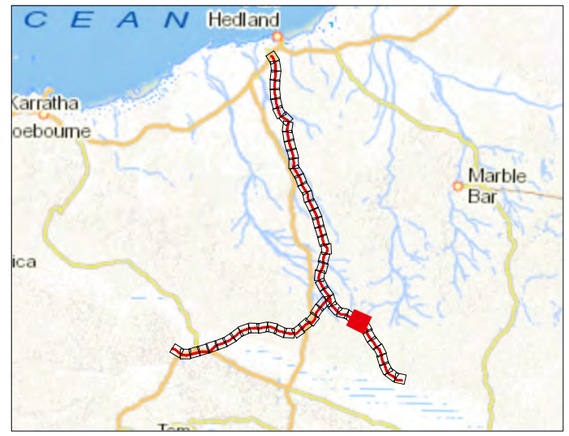
REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.32



LEGEND

- ▲ Rail Chainage
- Development Envelope
- Study Area
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.33

721000 722000 723000 724000 725000 726000 727000 728000

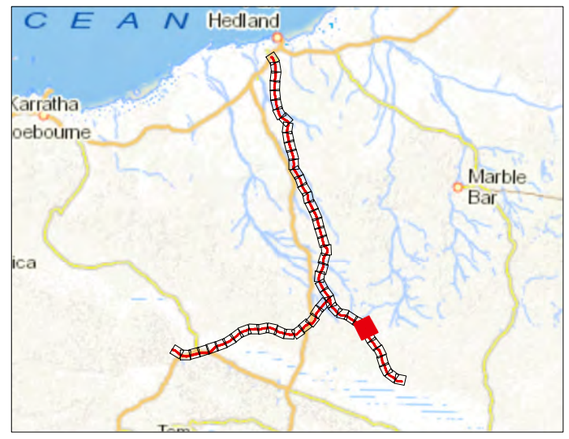
7567000 7566000 7565000 7564000 7563000 7562000 7561000

205km

210km

LEGEND

- Rail Chainage
- Development Envelope
- Study Area
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.34

724000 725000 726000 727000 728000 729000 730000

7562000 7561000 7560000 7559000 7558000 7557000 7556000

2.15km

Fx1

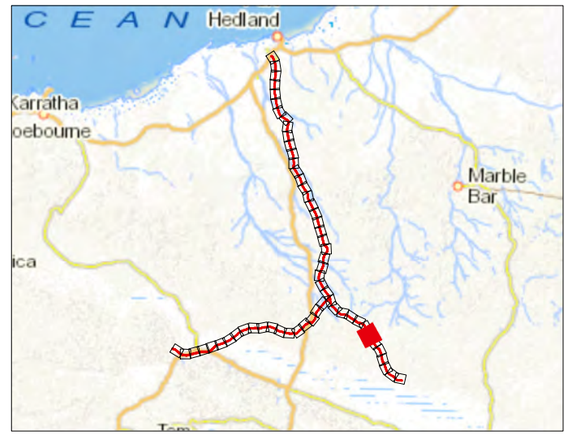
Fc4/Cc18

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

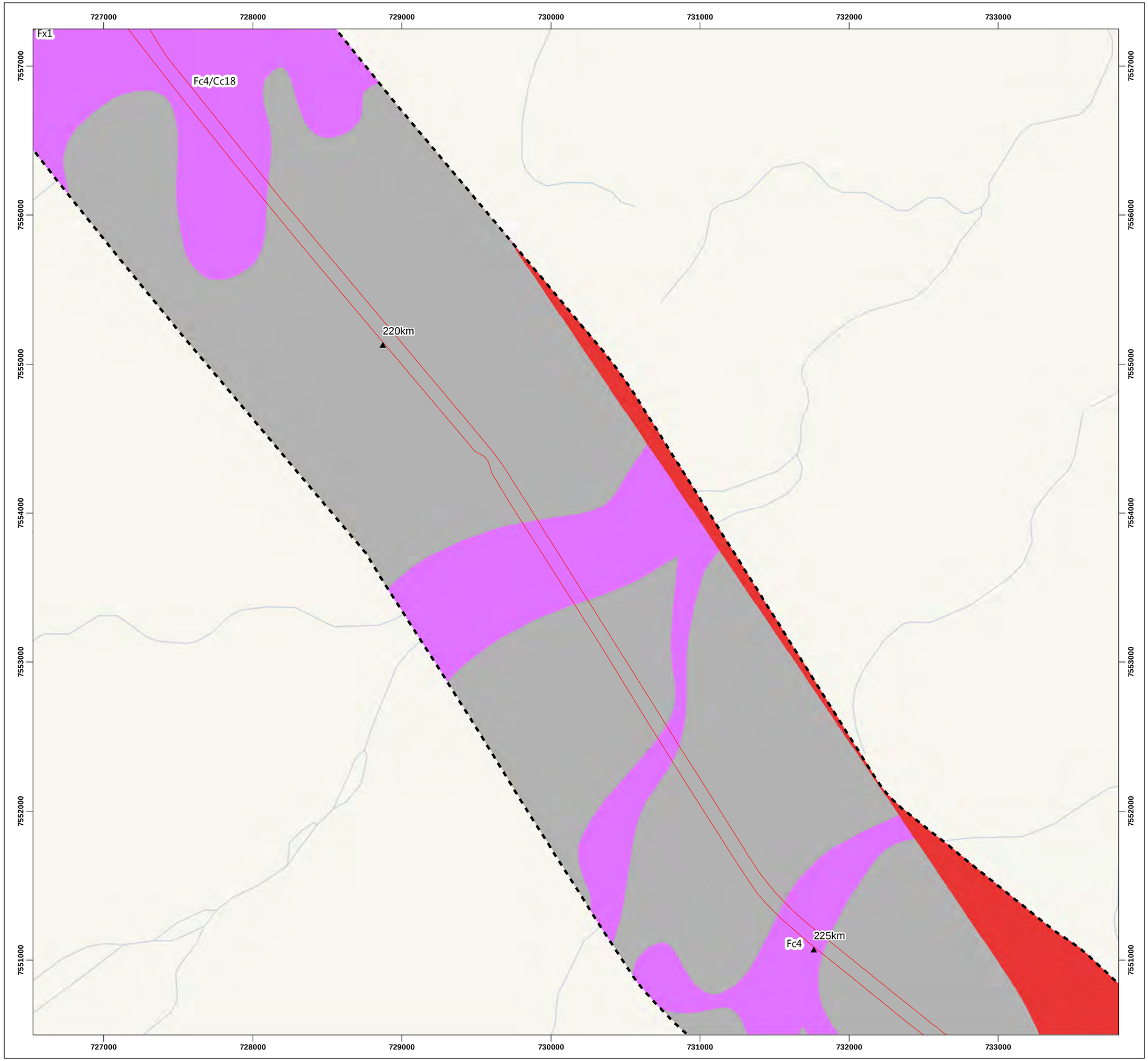
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.35

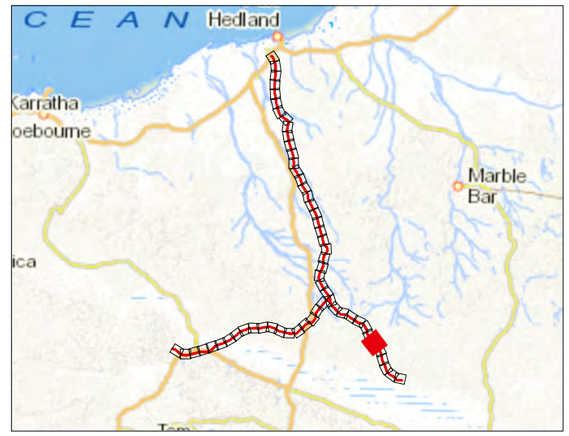


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

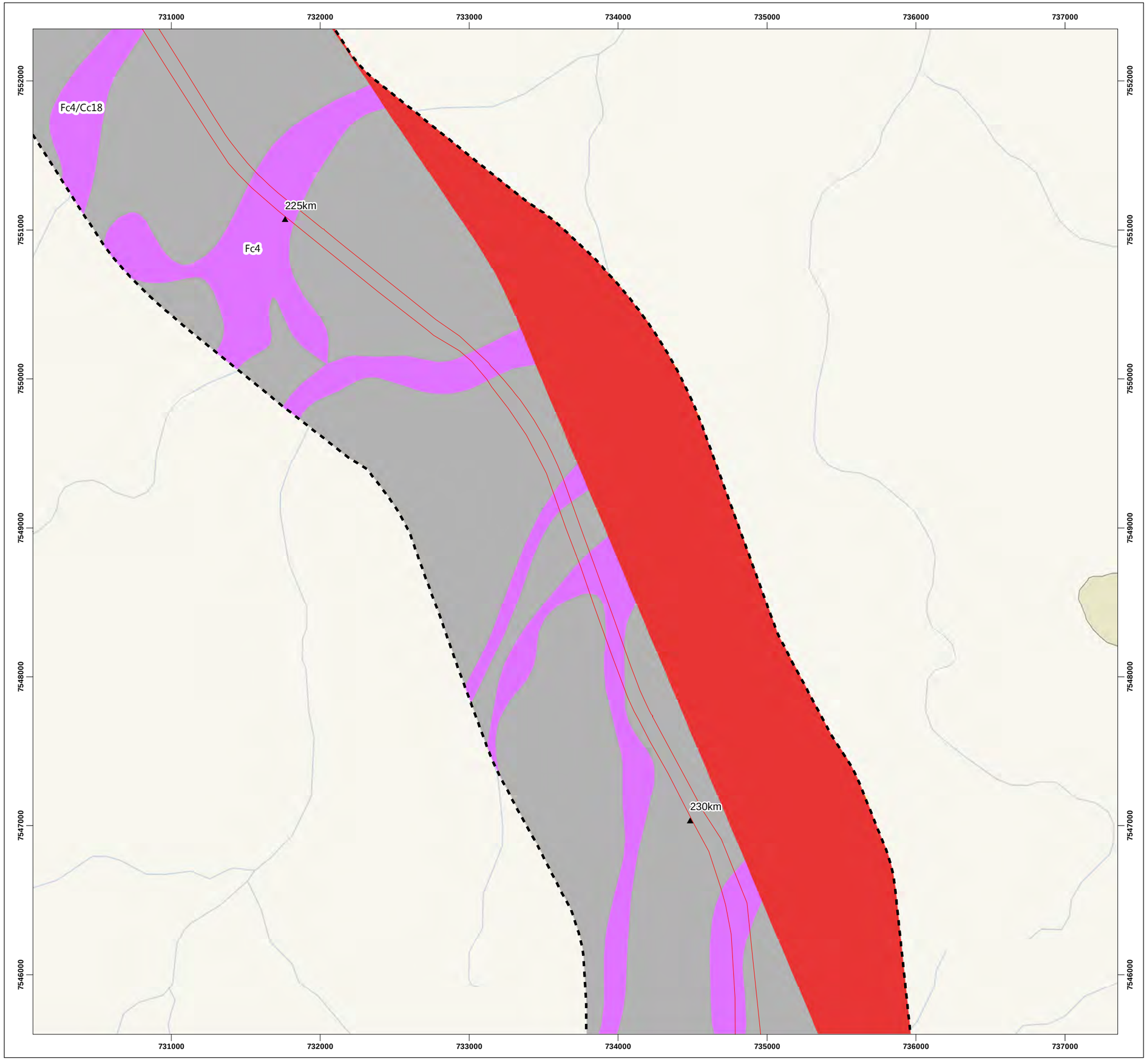
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.36



LEGEND

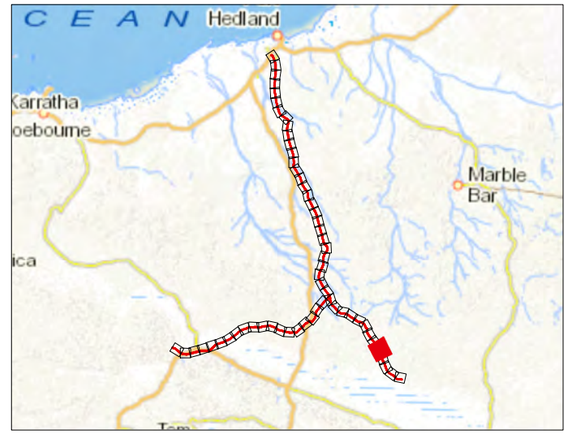
- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

Vegetation Mapping

- Potential GDE
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

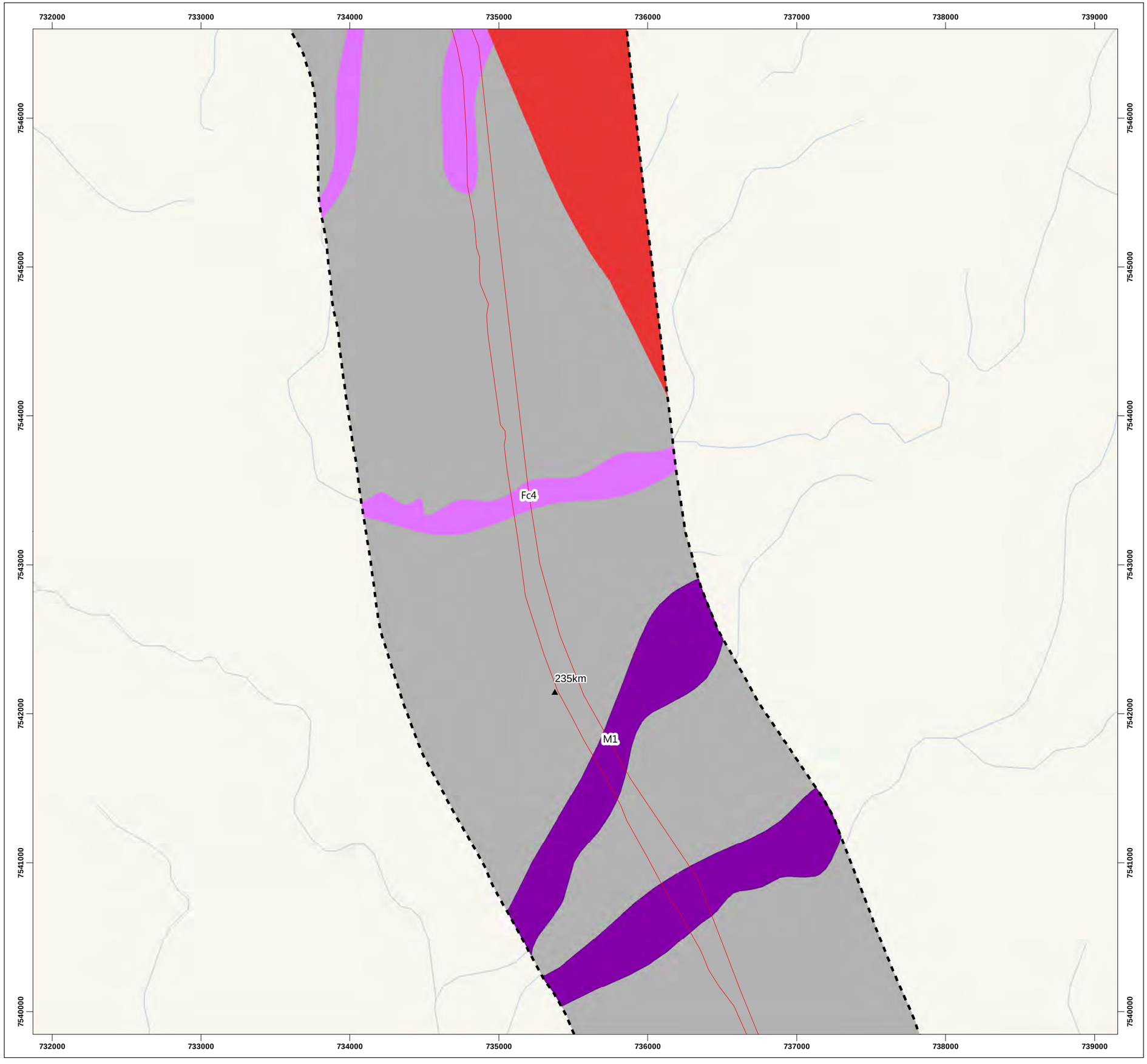
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.37

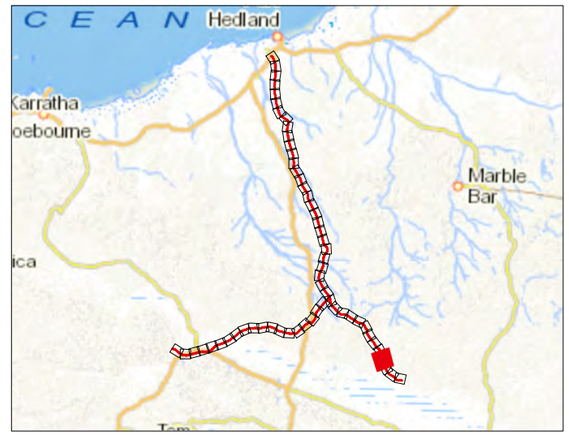


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

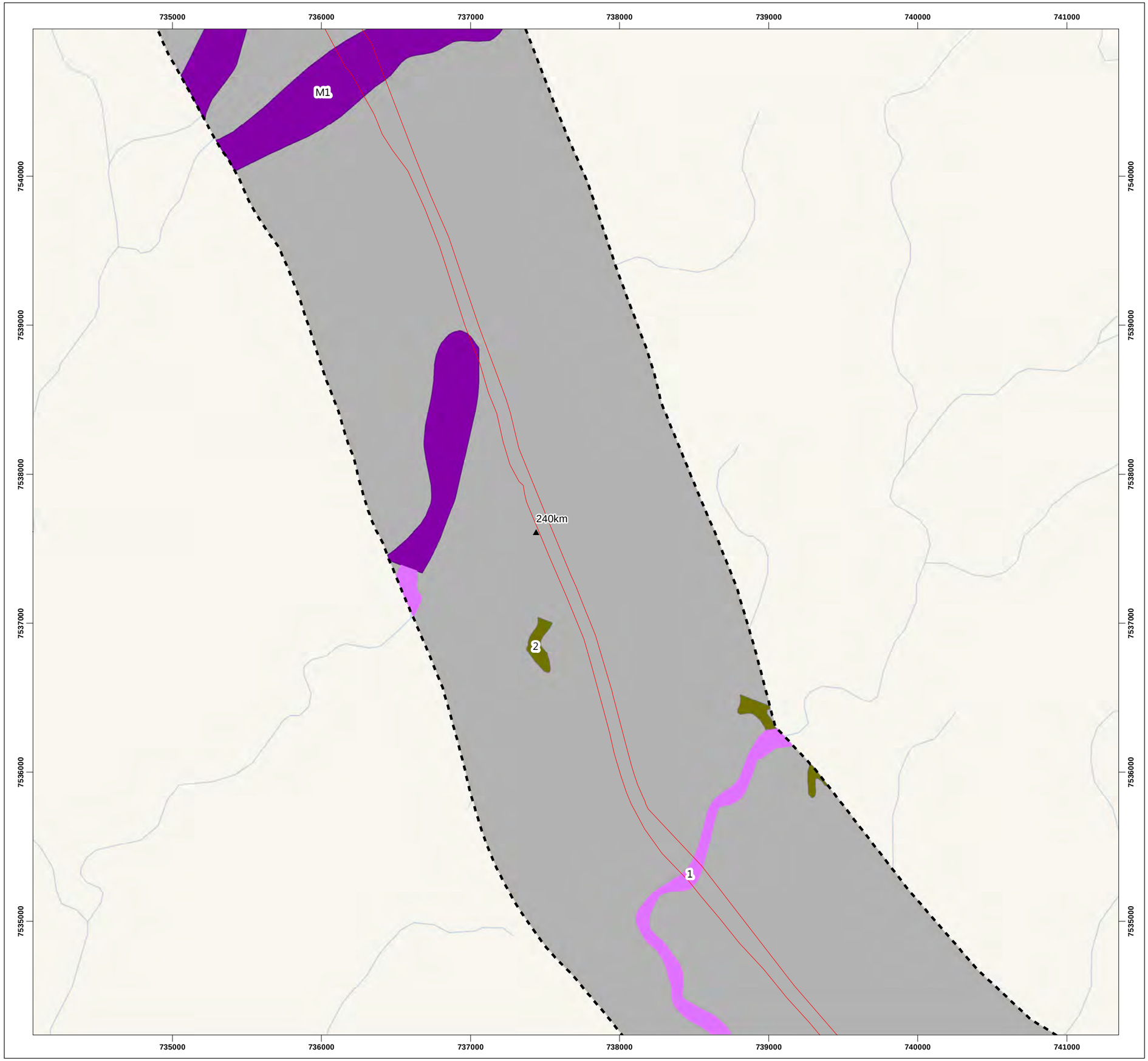
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.38

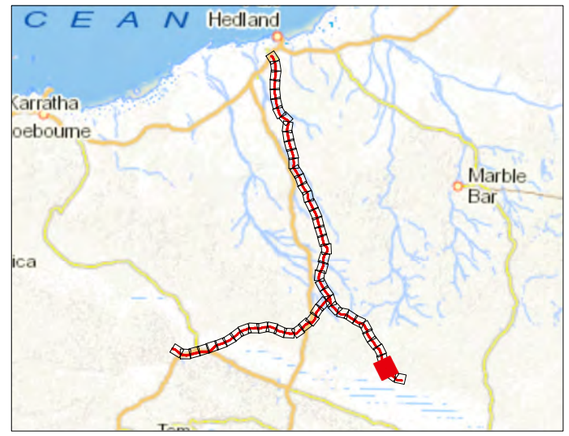


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other Significant Vegetation
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:25,000 @ A3

N

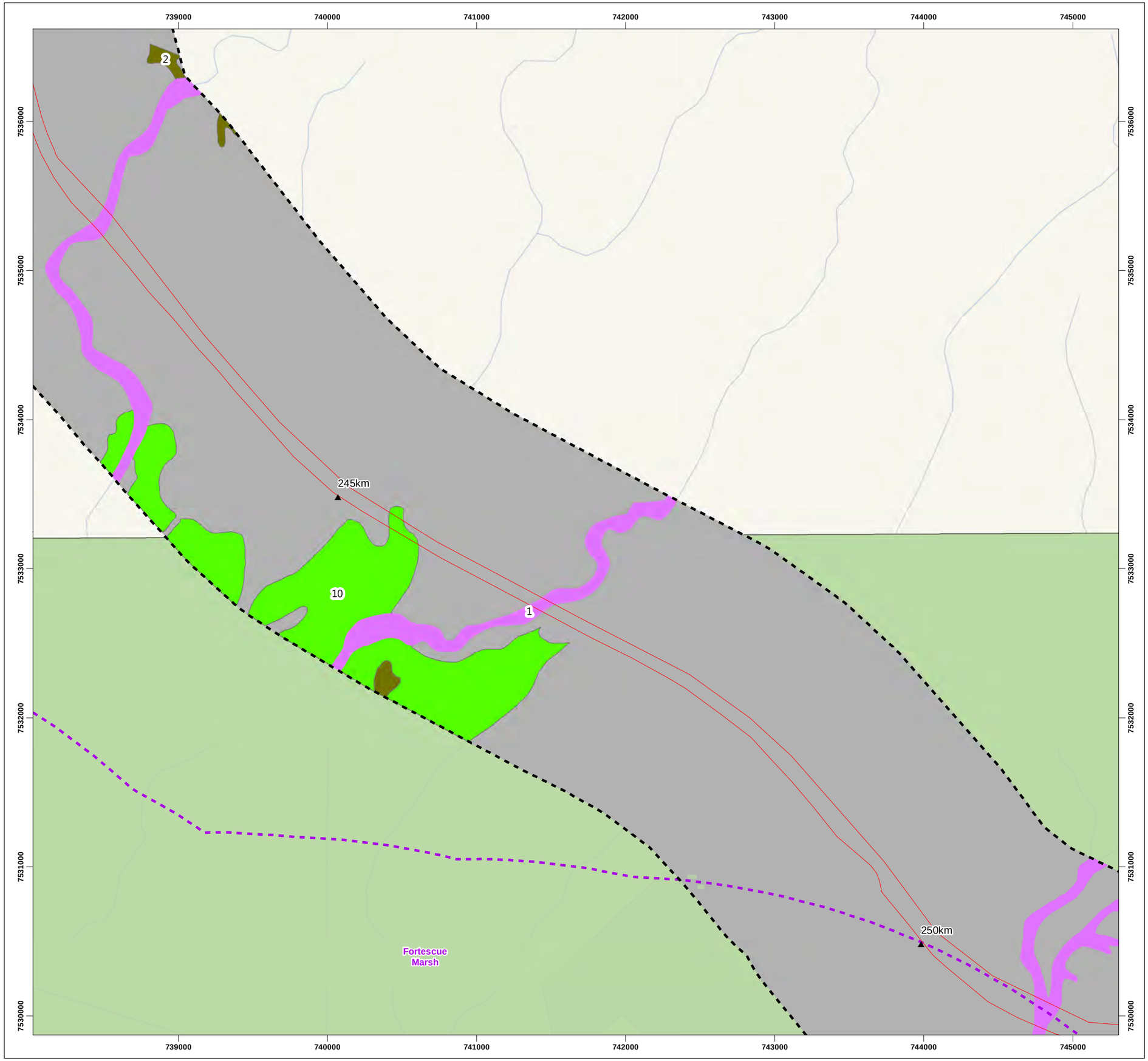
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.39



LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Ramsar Sites (DBCA)

Status

- DRAFT Proposed Area

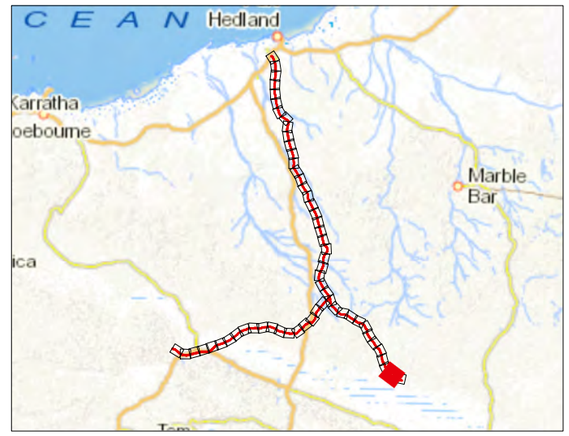
DBCA Ecological Database

State Category

- Priority 1

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Potential GDE
- Other Significant Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

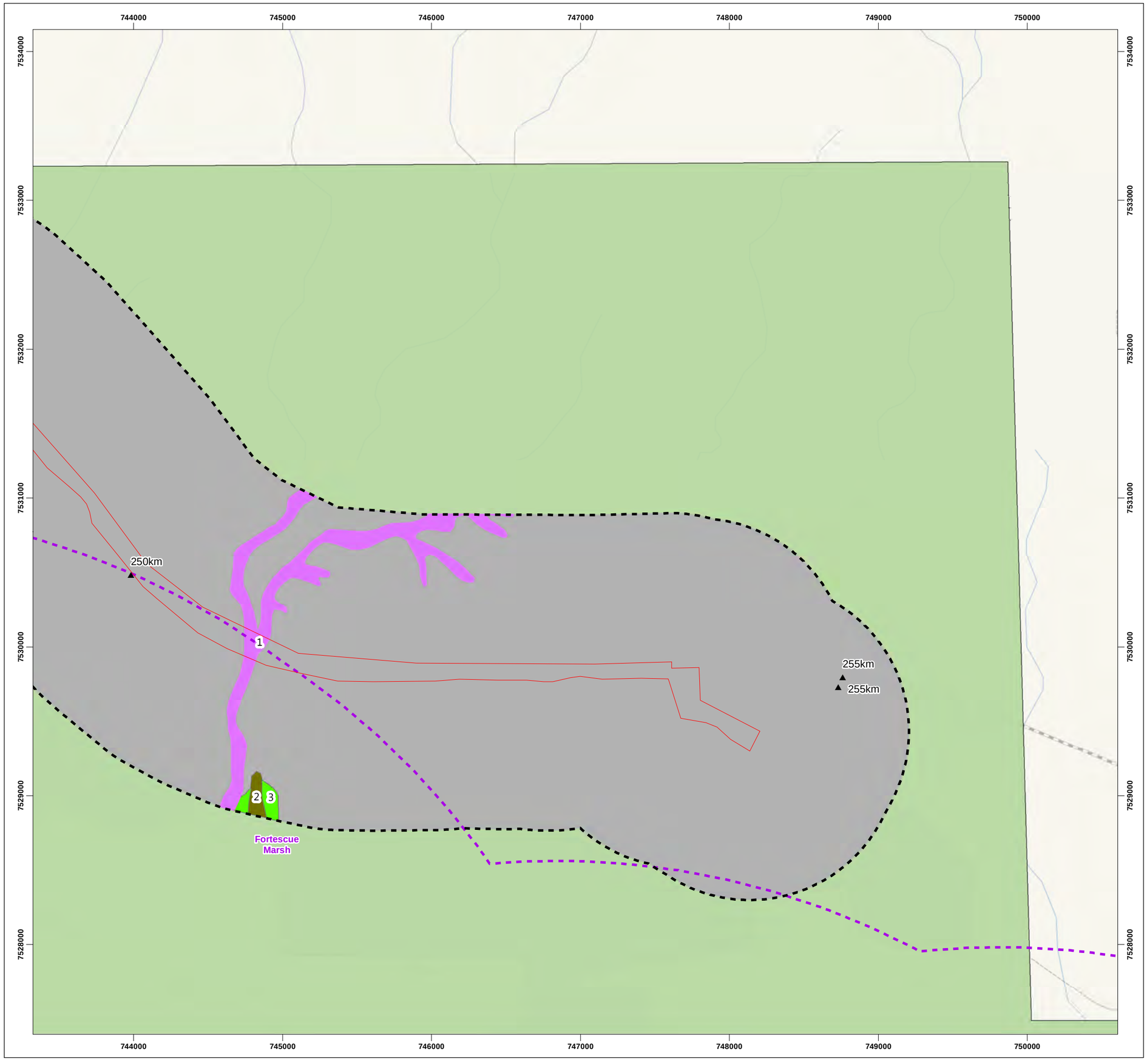
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.40



LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Ramsar Sites (DBCA)

Status

- DRAFT Proposed Area

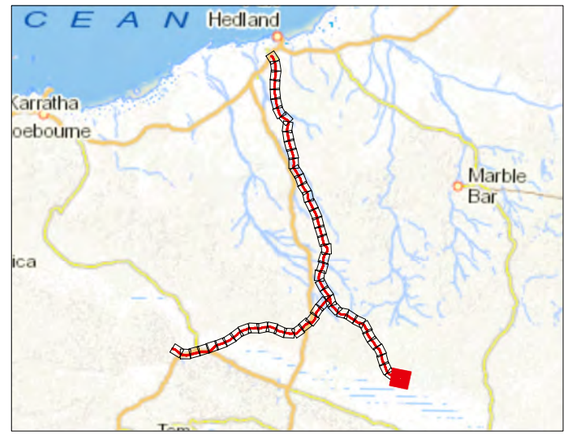
DBCA Ecological Database

State Category

- Priority 1

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Potential GDE
- Other Significant Vegetation
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.41

693000 694000 695000 696000 697000 698000 699000 700000

7583000 7582000 7581000 7580000 7579000 7578000 7577000

YANDEYARRA RESERVE

180km

ExAcpTe

EvAcCc

EvAcpCv

AtTl

185km

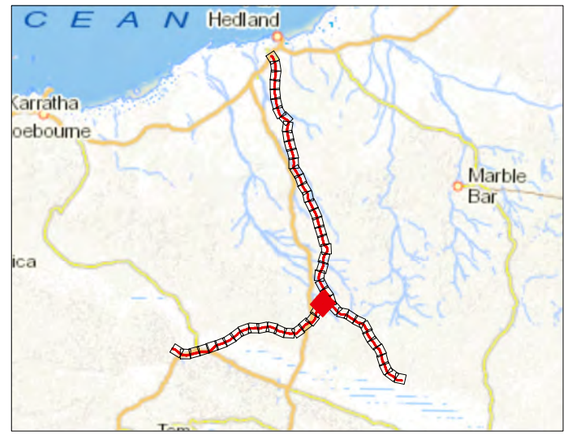
YANDEYARRA RESERVE

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

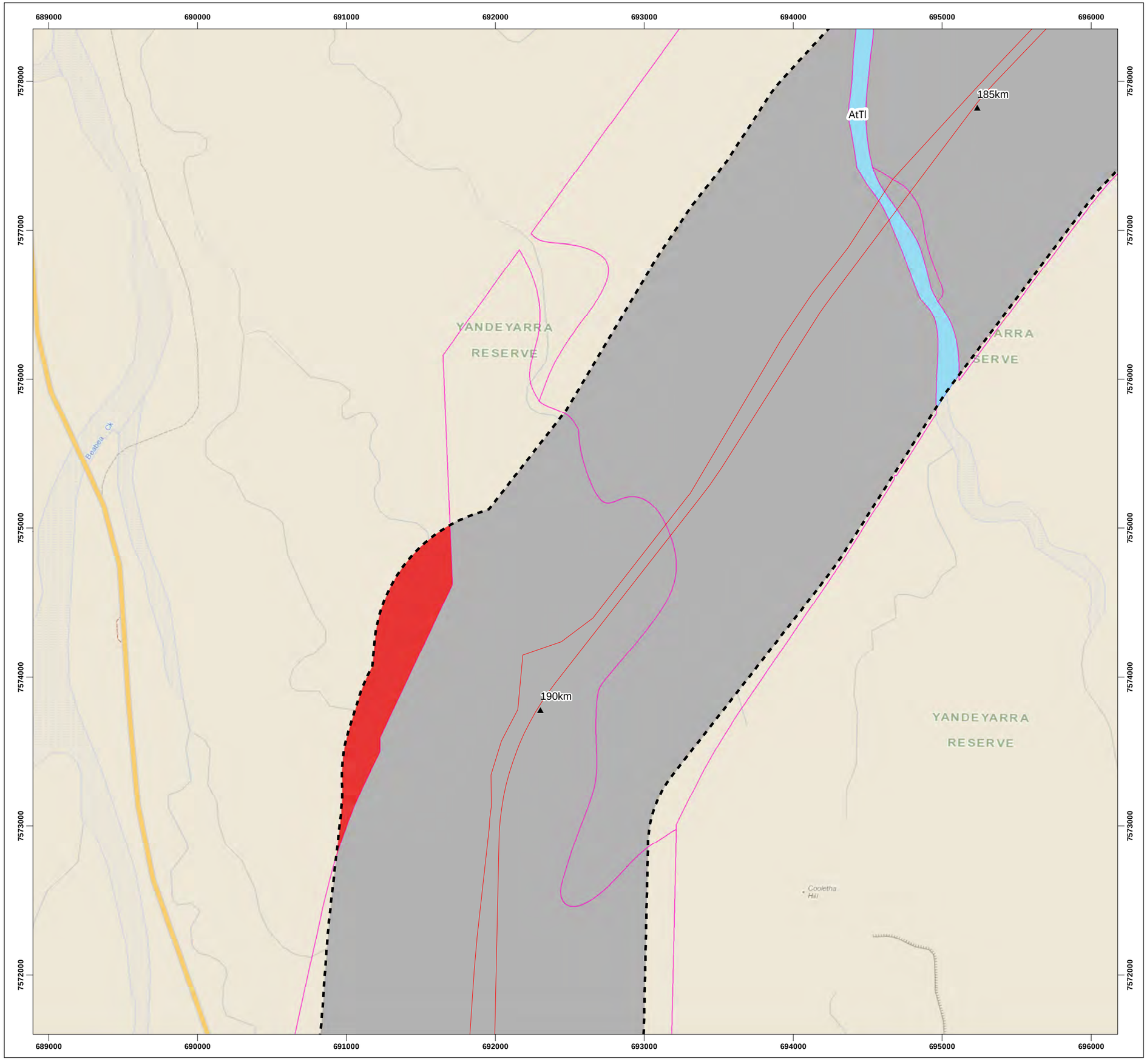
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.42

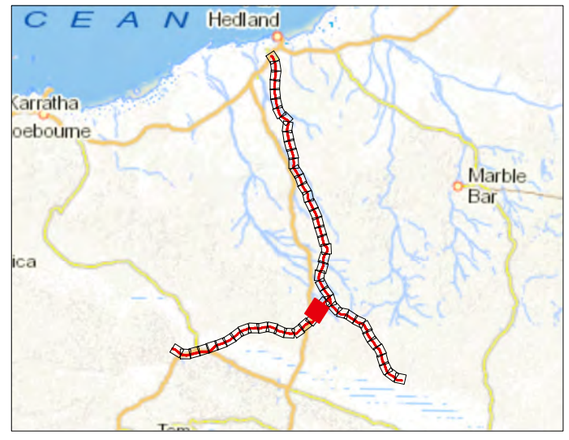


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.43

687000 688000 689000 690000 691000 692000 693000

7572000 7571000 7570000 7569000 7568000 7567000

Beabea Ck

YARRA
RVE

195km

ChApTe2

EcApCa

200km

ARRA
SERVE

LEGEND

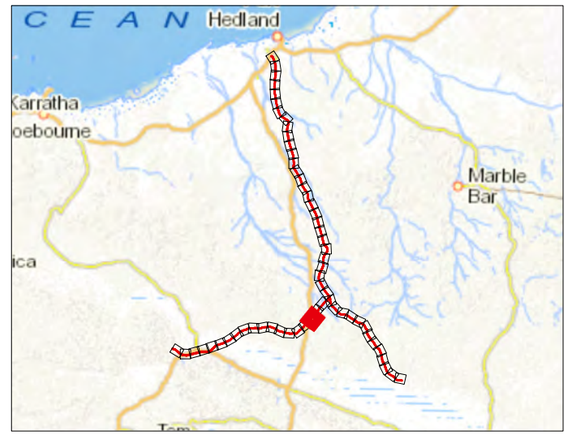
- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

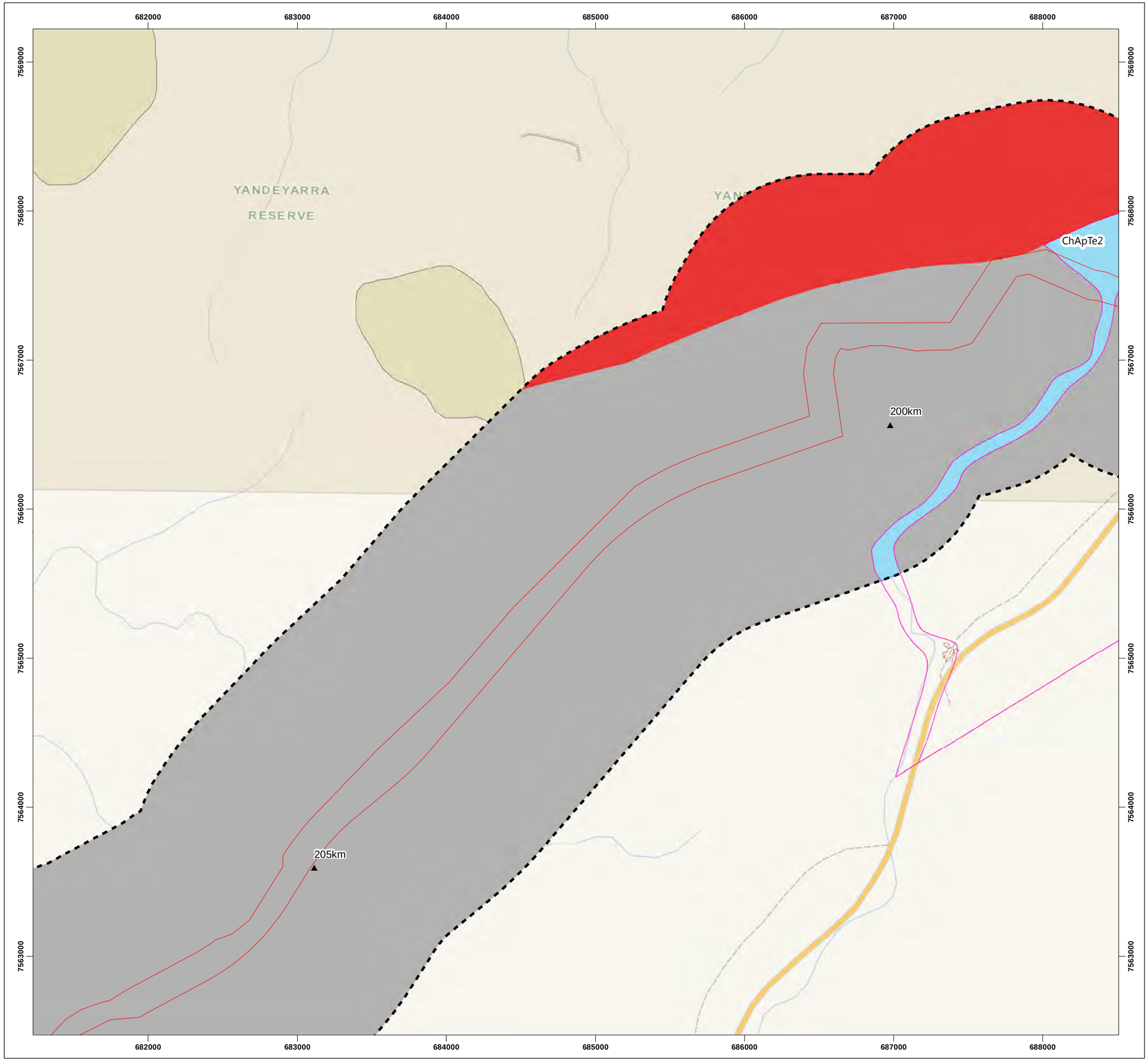
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.44



LEGEND

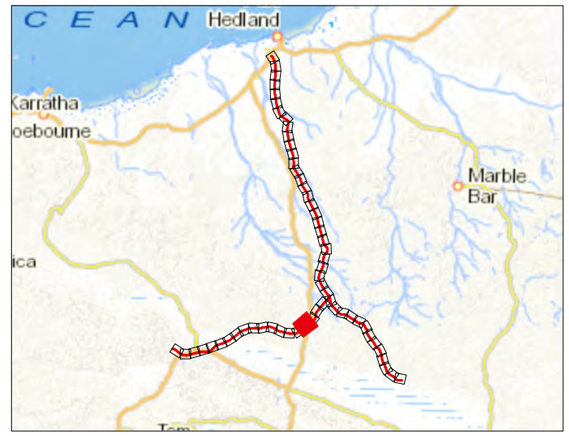
- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

Vegetation Mapping

- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.45

677000 678000 679000 680000 681000 682000 683000 684000

7565000 7564000 7563000 7562000 7561000 7560000 7559000

Cockenapa River

205km

MDWE4

HSA1

FSA7

HWE11

210km

EvAcpCv

MDWE3/DWE4

HSA5/HWE5/DWE7

EvAppTt

Wona Land System

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

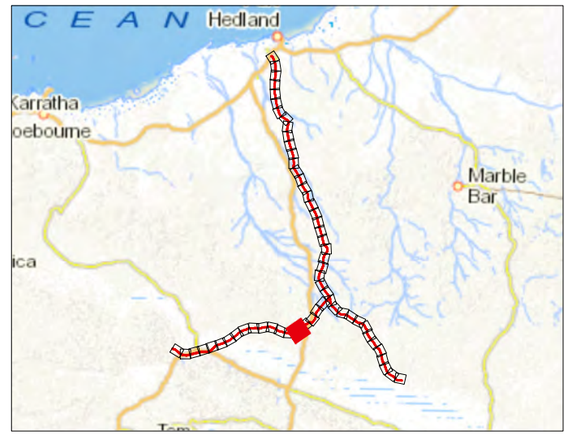
DBCA Ecological Database

State Category

- Priority 1

Vegetation Mapping

- PEC
- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.46

671000 672000 673000 674000 675000 676000 677000 678000

7563000 7562000 7561000 7560000 7559000 7558000

HSA2

FSA1

FSA7

DSA2

215km

MDWE3/DWE4

Wona Land System

HSA5/HWE5/DWE7

EvAppTt

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

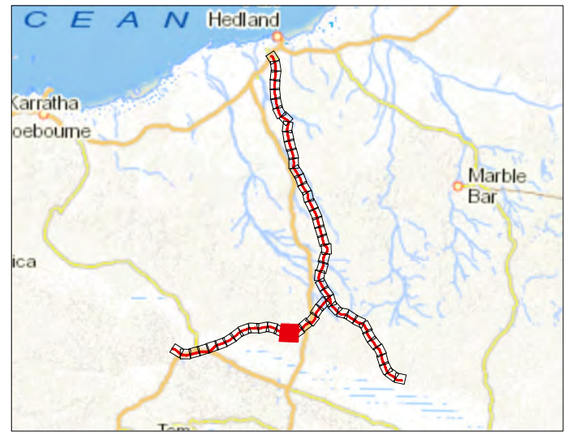
DBCA Ecological Database

State Category

- Priority 1

Vegetation Mapping

- PEC
- Potential GDE
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

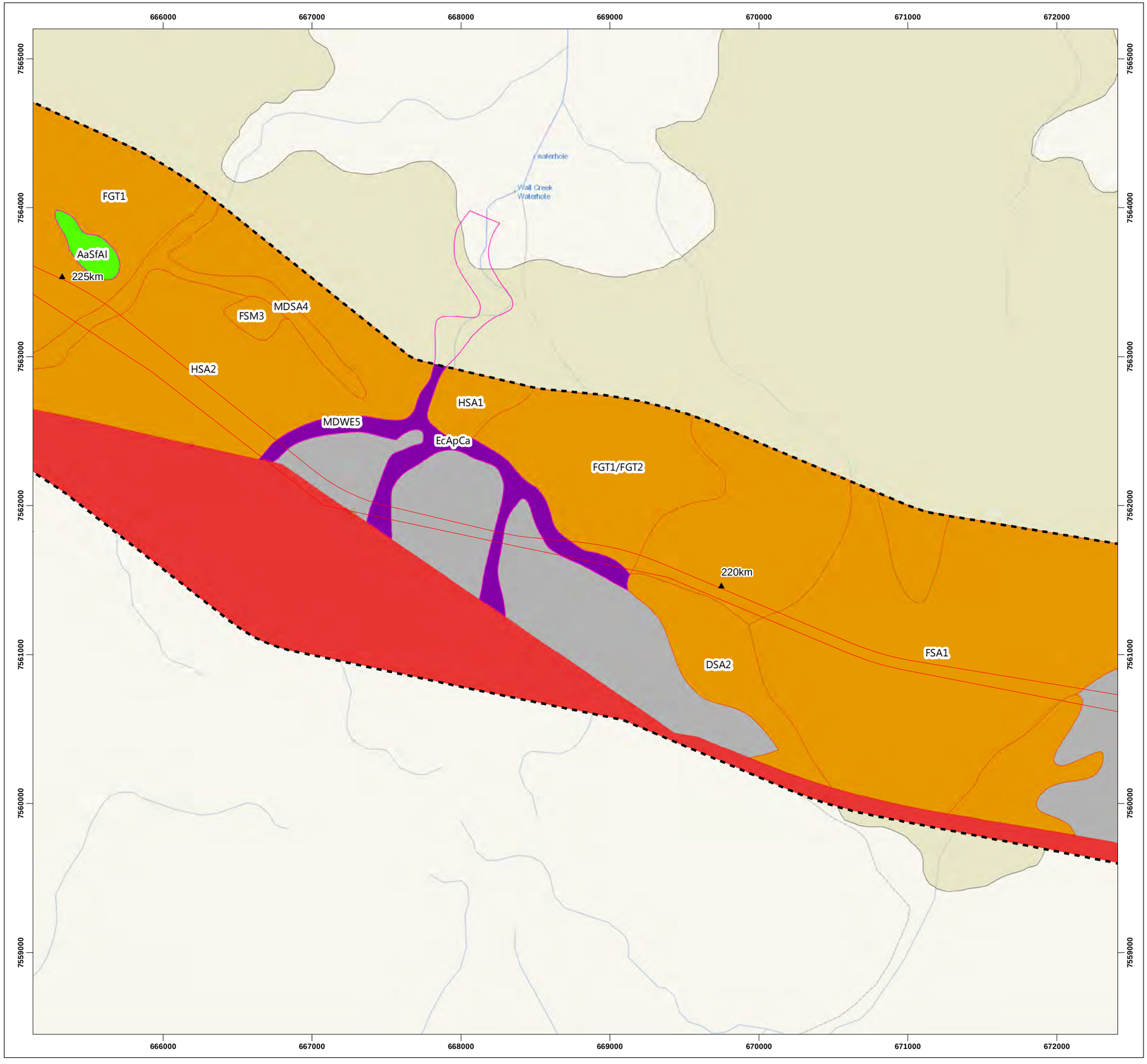
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.47



LEGEND

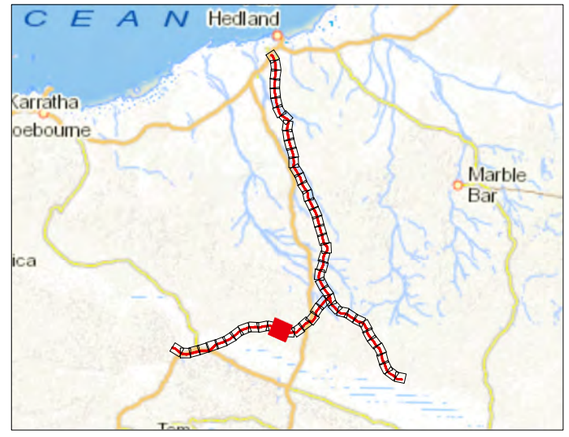
- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

Vegetation Mapping

- PEC
- Sheet Flow Dependant Vegetation
- Groundwater Dependant Vegetation (GDE)
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.48

660000 661000 662000 663000 664000 665000 666000

7567000 7566000 7565000 7564000 7563000 7562000 7561000

FGT1/FGT2
230km
FSA8
FGT1
FSA7
MDSA4
AaSfAl
225km
FSM3
HSA2
EcApCa
MDWE5

LEGEND

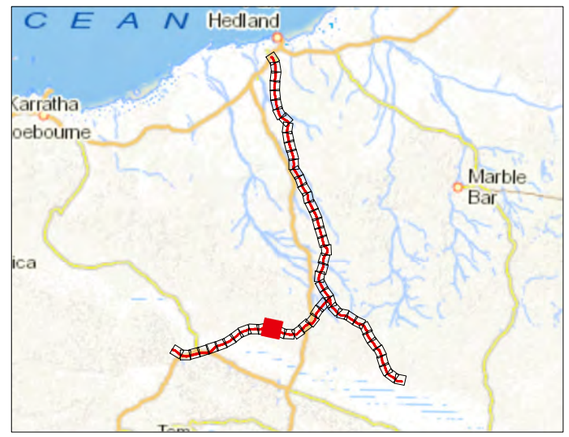
- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

Vegetation Mapping

- PEC
- Sheet Flow Dependant Vegetation
- Groundwater Dependant Vegetation (GDE)
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.49

654000 655000 656000 657000 658000 659000 660000

7567000 7566000 7565000 7564000 7563000 7562000 7561000

FGT1
FSA8
FGT1/FGT2
230km
FSM3
235km
FSA7
MDSA4
EvAppTt

LEGEND

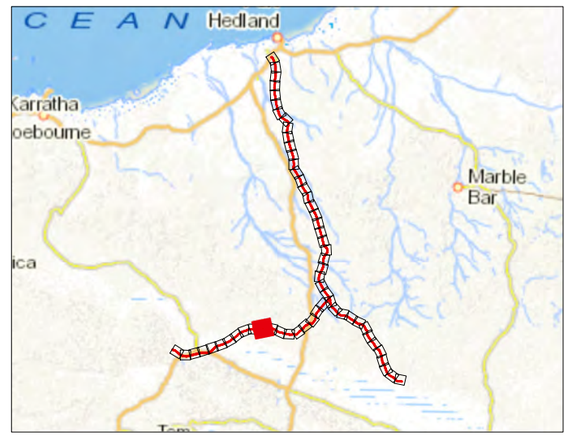
- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

Vegetation Mapping

- PEC
- Potential GDE
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

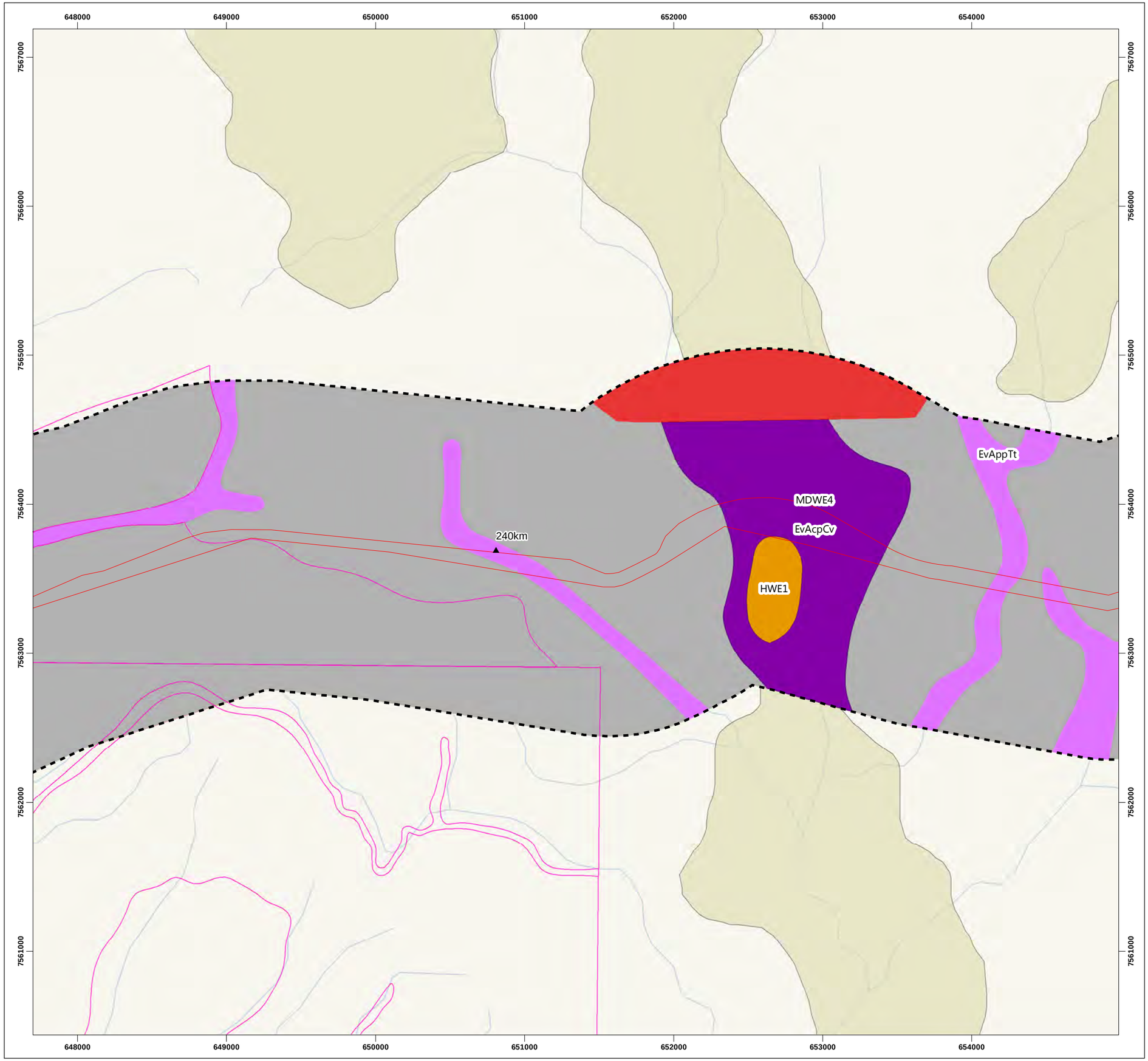
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.50



LEGEND

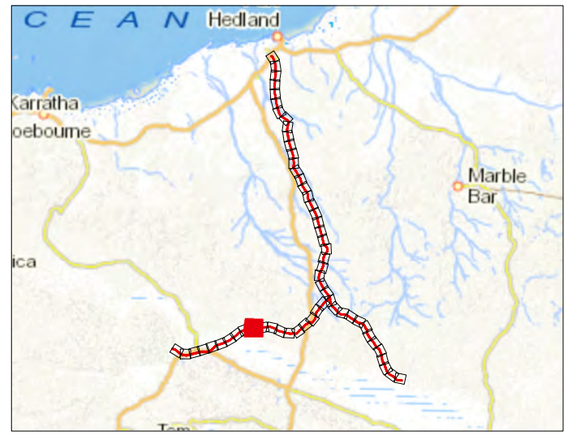
- Rail Chainage
- Development Envelope
- Study Area

Land Systems

- Wona System

Vegetation Mapping

- PEC
- Groundwater Dependant Vegetation (GDE)
- Potential GDE
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION
DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

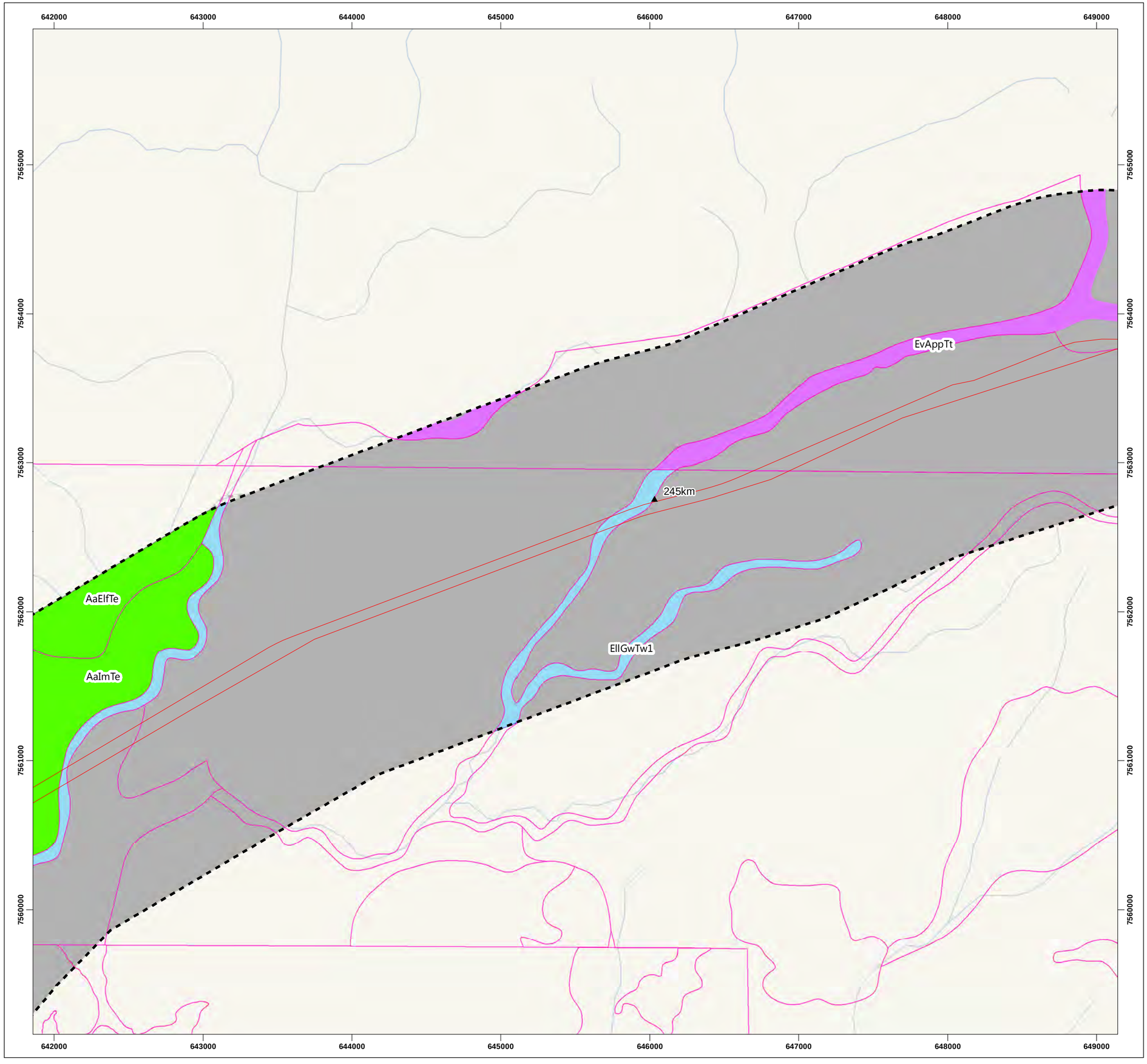
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.51

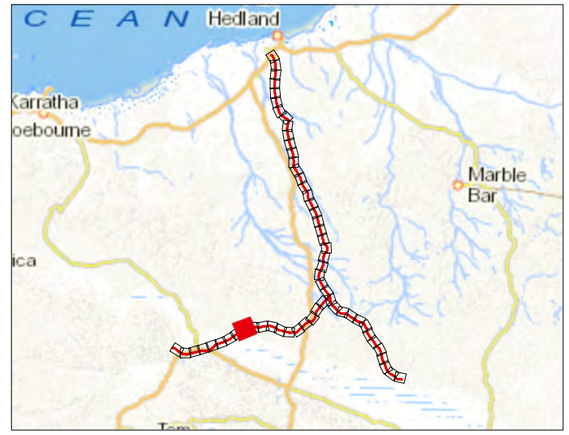


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Potential GDE
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

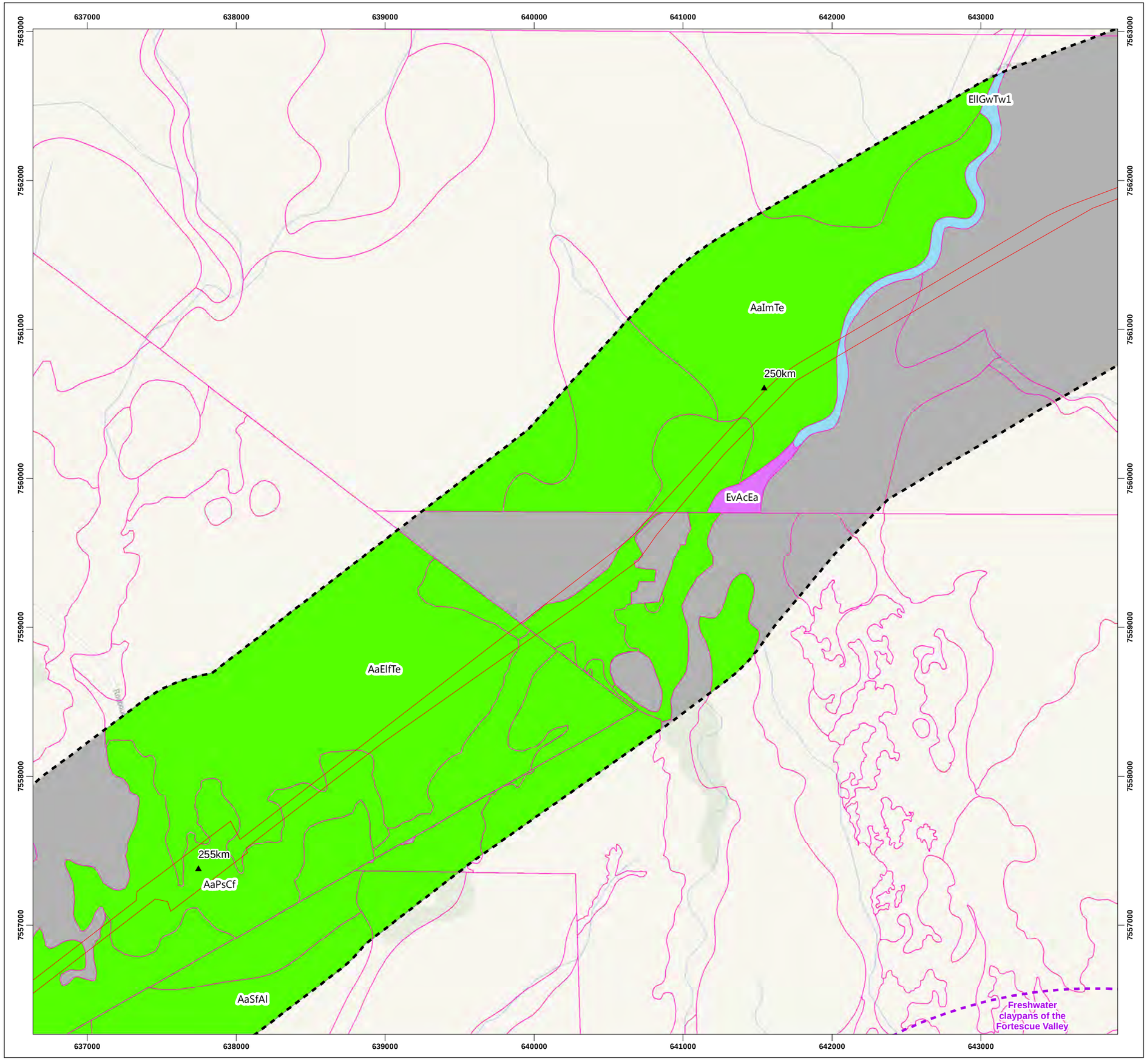
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.52



LEGEND

- Rail Chainage
- Development Envelope
- Study Area

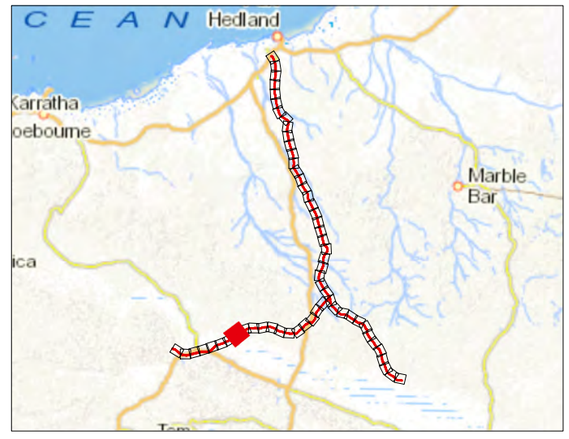
DBCA Ecological Database

State Category

- Priority 1

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Potential GDE
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:25,000 @ A3

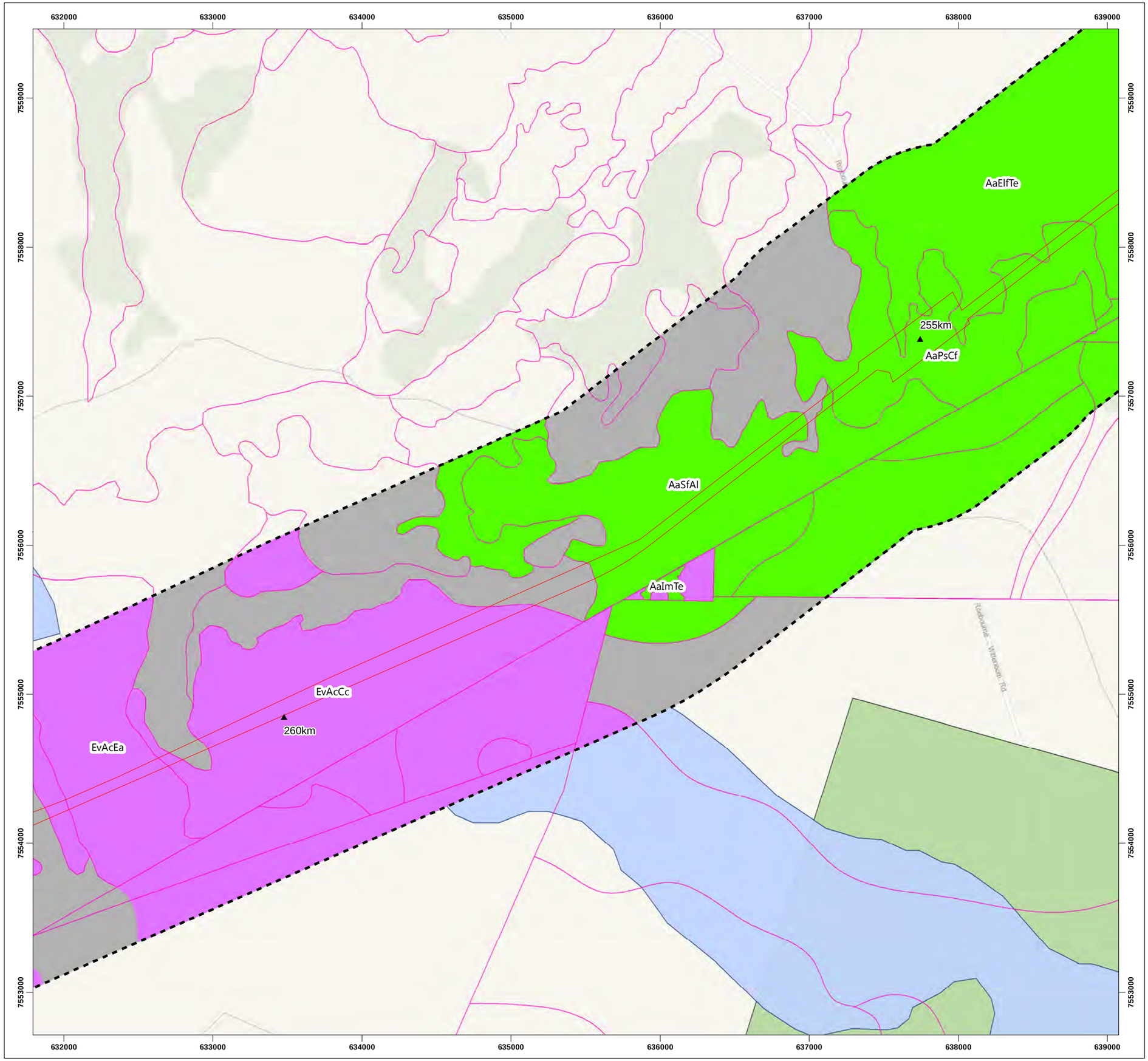
N

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.53



LEGEND

- Rail Chainage
- Development Envelope
- Study Area
- Directory of Important Wetlands

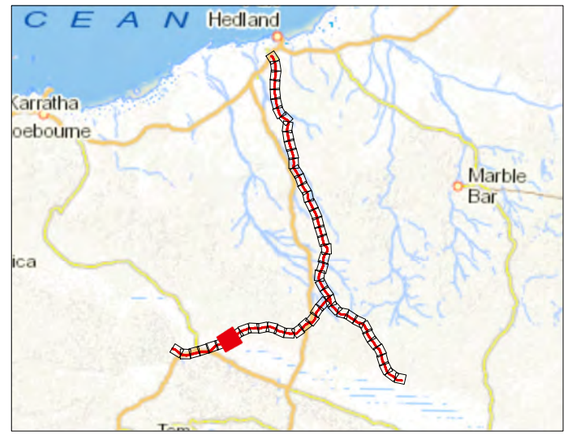
Ramsar Sites (DBCA)

Status

- DRAFT Proposed Area

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Potential GDE
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.54

627000 628000 629000 630000 631000 632000 633000

7556000 7555000 7554000 7553000 7552000 7551000

EvAcEa

EvAcCc

AaElCf

260km

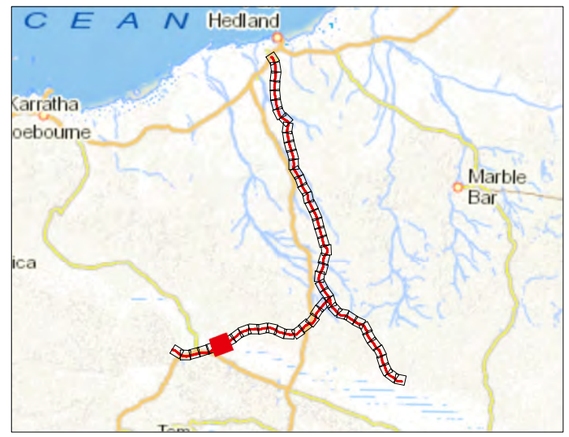
265km

LEGEND

- Rail Chainage
- Development Envelope
- Study Area
- Directory of Important Wetlands

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Potential GDE
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

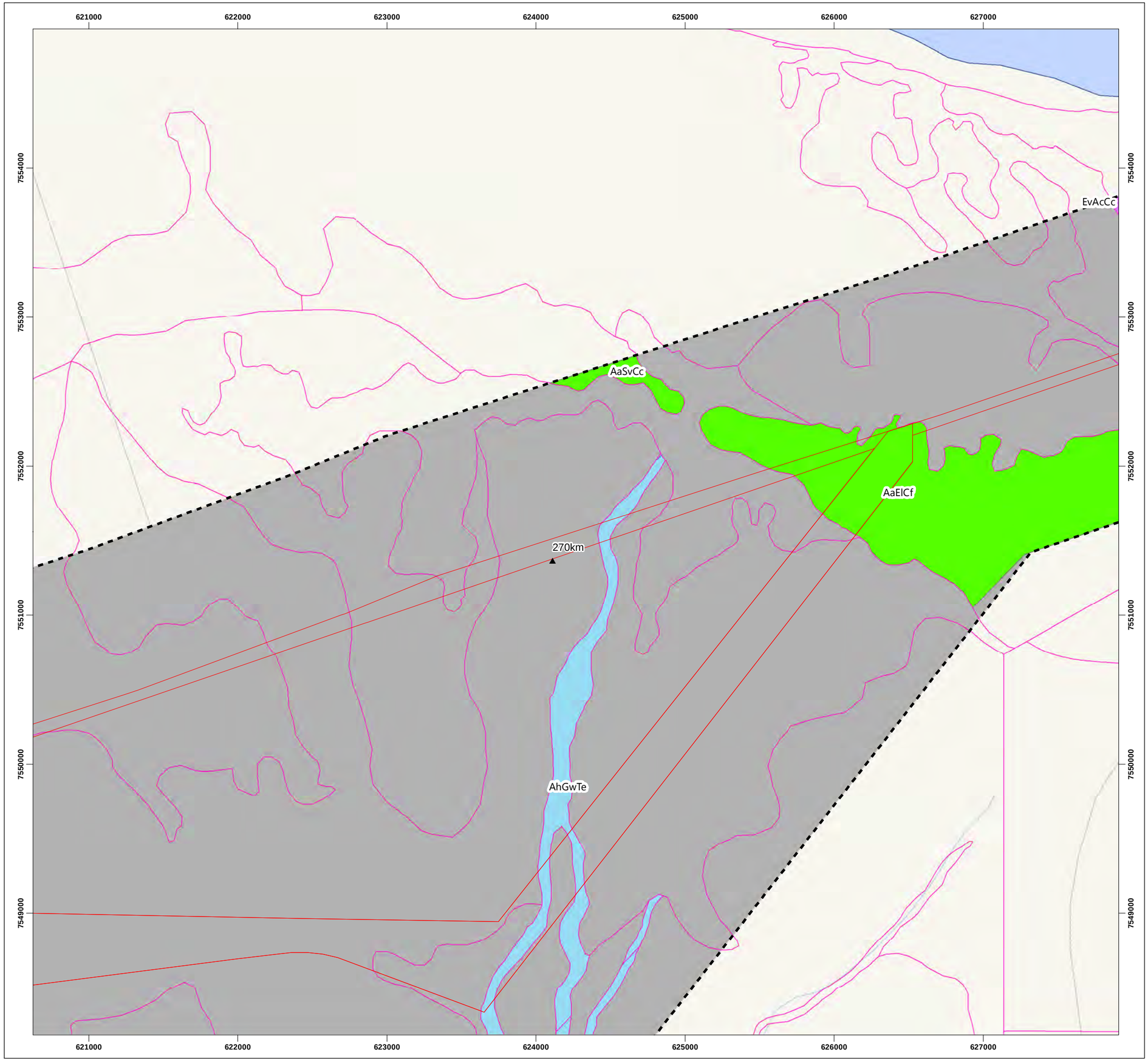
SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.55

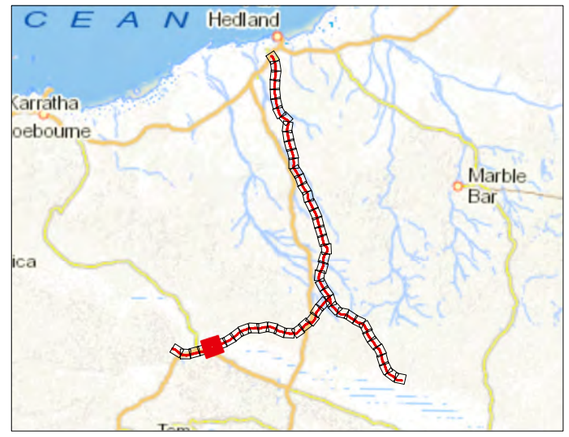


LEGEND

- Rail Chainage
- Development Envelope
- Study Area
- Directory of Important Wetlands

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Potential GDE
- Creekline (Riparian) Vegetation
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP 4.56

615000 616000 617000 618000 619000 620000 621000 622000

7552000 7551000 7550000 7549000 7548000 7547000

AaSvCc

27.5km

ChApTe1

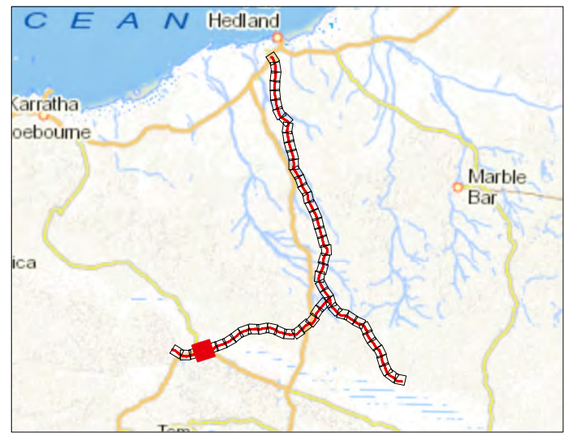
AhGwTe

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Sheet Flow Dependant Vegetation
- Creekline (Riparian) Vegetation
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.57

610000 611000 612000 613000 614000 615000 616000

7551000 7550000 7549000 7548000 7547000 7546000 7545000

Munjina Rd

Nanutarra

280km

ChApTe1

AhGwTe

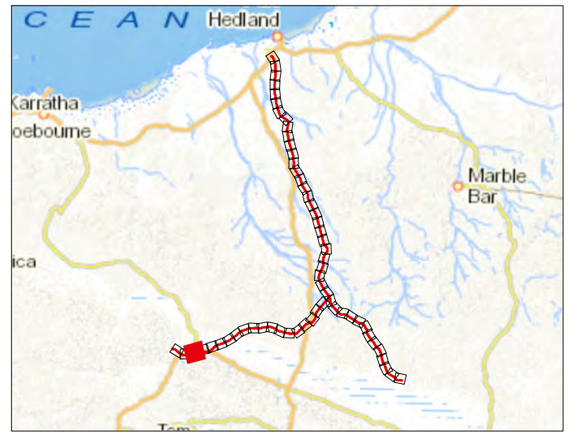
285km

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Creekline (Riparian) Vegetation
- Other vegetation



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

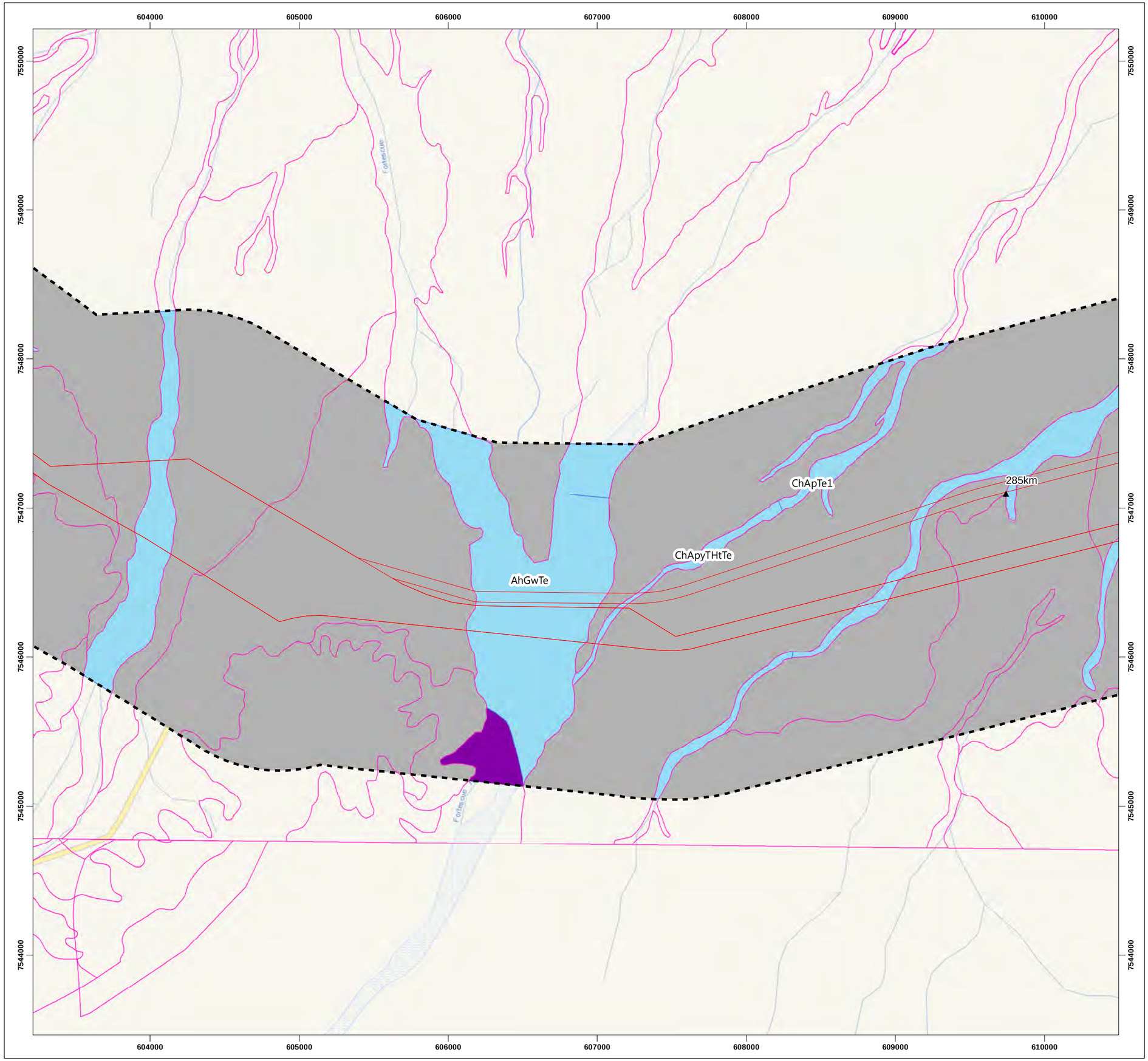
0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.58

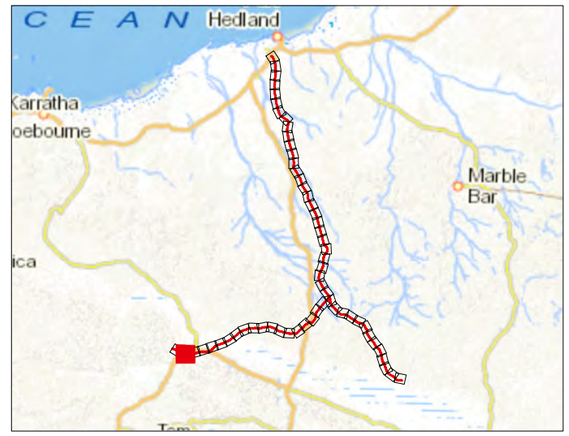


LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Groundwater Dependant Vegetation (GDE)
- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.59

598000 599000 600000 601000 602000 603000 604000

7552000 7551000 7550000 7549000 7548000 7547000 7546000

300km

295km

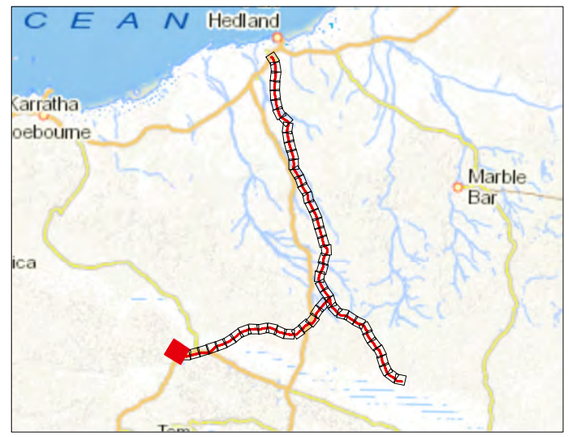
AhGwTe

LEGEND

- Rail Chainage
- Development Envelope
- Study Area

Vegetation Mapping

- Creekline (Riparian) Vegetation
- Other vegetation
- No Vegetation type data available



ecoscape

SIGNIFICANT VEGETATION WITHIN FORTESCUE DATABASES

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:25,000 @ A3

0 0.25 0.5 0.75 1 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	17/10/2018
01	DR	SB	31/10/2018

MAP

4.60

620000 640000 660000 680000 700000 720000

7740000 7720000 7700000 7680000 7660000 7640000

BOODARRIE LANDING
RED BANK
CARGIL SALT FARM
NGARLA COASTAL NGAMAL
INPARINYA
ALLEN SIDING
RYAN SIDING
GREAT NORTHERN HIGHWAY
TABBA TABBA CREEK
STRELLEY
STRELLEY COMMUNITY SCHOOL
MARBLE BAR ROAD
RED ROCK CREEK
BING SIDING
SOUTH HEDLAND RURAL ESTATE
15km
BEEBINGARRA CREEK
PIPPINGARRA ROAD
YULE RIVER
WEST YULE RIVER
BABBACOORINGANNA
NORTH WEST COASTAL HIGHWAY
WEST STRELLEY RIVER
BUNNENGARRA
40km
45km
INDEE ROAD
TABBA
50km
TURNER RIVER EAST
TABBA TABBA
WALLA SIDING
55km
60km
WALLA
MAGPIE RANGE
PILINYA CREEK
65km
70km
COORUNGCOORANA
GREAT NORTHERN HIGHWAY
75km
GILLAM CREEK
80km
HOUSTON CREEK
MCPHEE CREEK
CHINNAMON CREEK
SPRING CREEK
SULPHUR SPRINGS CREEK
EAST STRELLEY RIVER
PEAWAH RIVER
MOUNT SATIRIST
85km
GILLAM SIDING
TURNER RIVER
YANDEYARRA ROAD
95km
WODGINA WEST
WODGINA
FALLS POUND
FRIENDLY CREEK
100km
105km
CLELAND ROCK
SIX MILE CREEK
Ap
Ale
110km
YANDEYARRA
TURNER SIDING
115km
LEILIRA CREEK
SHAW RIVER

LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- PlaceNames
- Principal Road
- Secondary Road
- Minor Road
- Watercourse
- Watercourse Areas
- Land Subject To Inundation

Conservation Significant Species Records

Conservation Status, Label, Species

- 1, AP, *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095)
- 1, Ale, *Acacia leeuweniana*
- 1, TrPH, *Tephrosia rosea* var. Port Hedland (A.S. George 1114)
- 2, Gp, *Gomphrena pusilla*

ecoscape

SIGNIFICANT FLORA RECORDS: P1 AND P2

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:420,000 @ A3

0 4 8 12 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 5A

660000
680000
700000
720000
7640000
7620000
7600000
7580000

WODGINA WEST
WODGINA
FALLS POUND
CLELAND ROCK
AGRIPPA RIDGE
YANDEYARRA ROAD
SIX MILE CREEK
SHAW RIVER
LEILIRA CREEK
TURNER SIDING
TURNER RIVER
YANDEE
RED CREEK
LAPILLISTONE CREEK
LOWER RED CREEK
DALTON CREEK
ABYDOS
ABYDOS SIDING
SOANSVILLE CREEK
PILBARA
SOANSVILLE MINING CENTRE
GREAT NORTHERN HIGHWAY
PINGA CREEK
EDGINA CREEK
CORUNG CREEK
PORT HEDLAND WITTENOOM ROAD
YULE RIVER
TWO CAMEL CREEK
COONARRIE CREEK
PILBADDY CREEK
TAMBINA CREEK
MUNGAROONA RANGE
HOPE CREEK
COCKERAGA RIVER
WEST YULE RIVER
BEABEA CREEK
HILLSIDE WOODSTOCK ROAD
TAMBOURAH
GOON SIDING
ABYSSINIA CREEK

95km
100km
105km
110km
115km
120km
125km
130km
135km
140km
145km
150km
155km
160km
165km
170km
175km
175km
180km
180km
185km
185km

Ap
Ale
Cm

LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- PlaceNames
- Principal Road
- Minor Road
- Watercourse
- Watercourse Areas

Conservation Significant Species Records

Conservation Status, Label, Species

- 1, AP, *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095)
- 1, Ale, *Acacia leeuweniana*
- 1, Cm, *Cochlospermum macnamarae*

ecoscape

SIGNIFICANT FLORA RECORDS: P1 AND P2

PILBARA TRANSMISSION PROJECT
FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:310,000 @ A3

0 2 4 6 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 5B

600000 620000 640000 660000 680000 700000

7620000 7600000 7580000 7560000 7540000 7520000

MUNGOONA CREEK
POWDAR CREEK
CORUNG CREEK
EDGINA CREEK
PORT HEDLAND WITTENOOM ROAD
TURNER RIVER
YULE RIVER
TWO CAMEL CREEK
COONARRIE CREEK
CHICHESTER RANGE
SHERLOCK RIVER
MUNGAROONA RANGE
HOPE CREEK
COCKERAGA RIVER
BEABEA CREEK
COON SIDING
GREAT NORTHERN HIGHWAY
ROEBOURNE WITTENOOM ROAD
PILBADDY CREEK
HOOLEY CREEK
YAMMERA CREEK
HOOLEY ROAD
WEST YULE RIVER
CHICHESTER RANGE
ROEBOURNE WITTENOOM ROAD
MULGA DOWNS ROAD
RIVERINA (HESTERS CAMP)
FORTESCUE RIVER
GARDEN SIDING
CHICHESTER RANGE
SHAW SIDING
HESTA SIDING
HAMERSLEY ROAD
WITTENOOM
BOUTHO ROAD
YOUNGALEENA BUNJIMA
DRILLERS RIDGE
MUNJINA WITTENOOM ROAD
GOODIADARRIE HILLS
MULGA DOWNS OUTCAMP
COWRA LINE CAMP
NANUTARRA WITTENOOM ROAD
FORTESCUE RIVER SOUTH
JOFFRE CREEK
WENNOUN ROAD
AUSKI ROADHOUSE
MUNJINA CREEK
MUNJINA ROY HILL ROAD
FORT SIDING
HAMERSLEY MOUNT BRUCE ROAD
DALES GORGE LOOKOUT
BANJIMA DRIVE
MUNJINA EAST GORGE LOOKOUT
HAMERSLEY RANGE

135km 140km 145km 150km 155km 160km 165km 170km 175km 180km 185km 190km 195km 200km 205km 210km 215km 220km 230km 235km 240km 245km 250km 255km 260km 265km 270km 275km 280km 285km 295km 300km

Cm Es Pr Pr Dc Ea Ea Tp Tp Tp Gk Gk Gk Gk Gk Gk Gk Gk Gk Ac Dg

LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- PlaceNames
- Principal Road
- Secondary Road
- Minor Road
- Watercourse
- Watercourse Areas
- Land Subject To Inundation

Conservation Significant Species Records

Conservation Status, Label, Species

- 1, Cm, *Cochlospermum macnamarae*
- 1, Dch, *Dipteracanthus chichesterensis*
- 1, Eso, *Eremophila spongiocarpa*
- 2, Ac, *Adiantum capillus-veneris*
- 2, Dg, *Dicladanthera glabra*
- 2, Eag, *Euphorbia australis* var. *glabra*
- 2, Gk, *Gompholobium karijini*
- 2, Pr, *Paspalidium retiglume*
- 2, Tp, *Teucrium pilbaranum*

ecoscape

SIGNIFICANT FLORA RECORDS: P1 AND P2

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

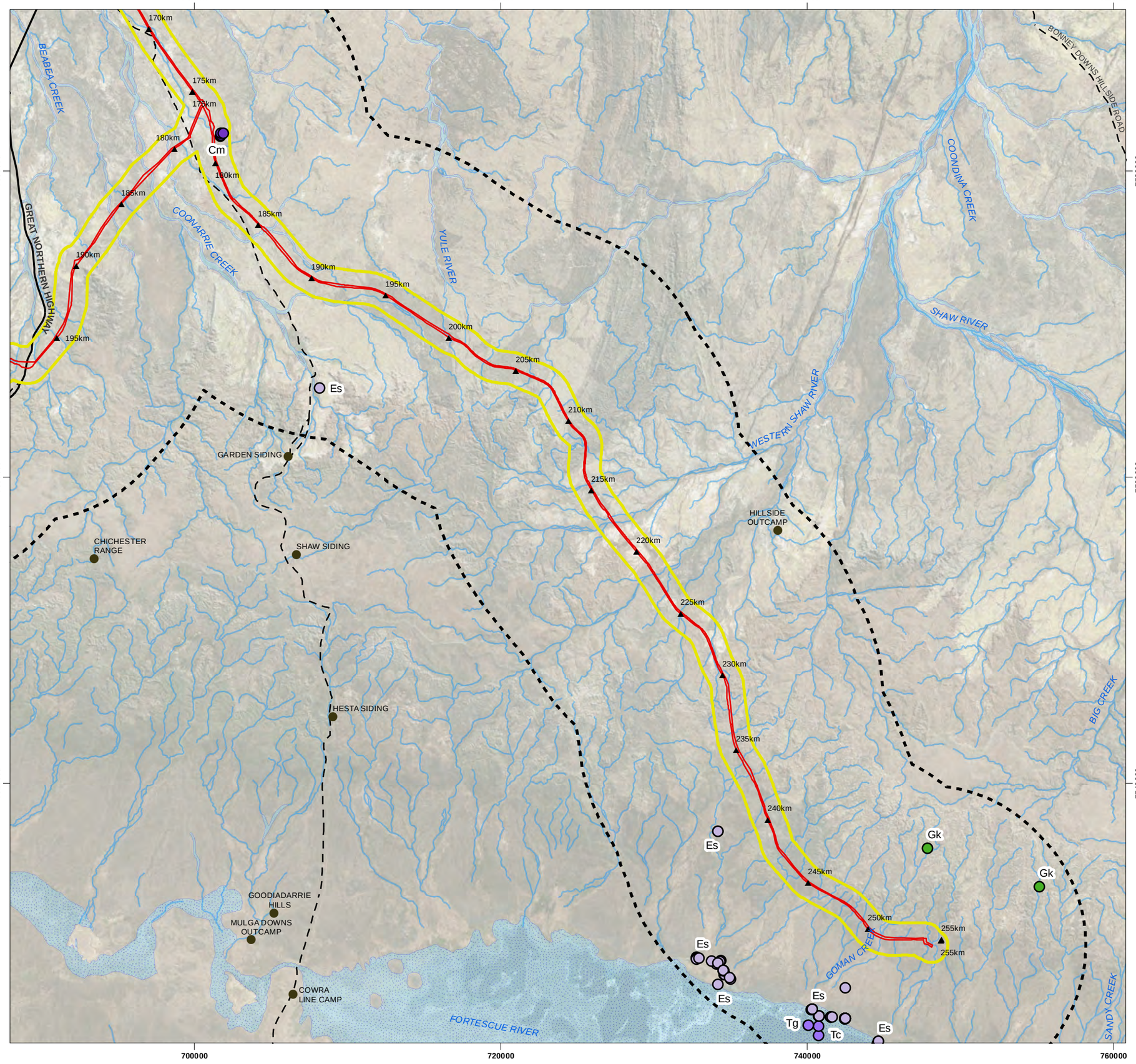
SCALE: 1:440,000 @ A3

0 4 8 12 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 5C



LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- PlaceNames
- Principal Road
- Minor Road
- Watercourse
- Watercourse Areas
- Land Subject To Inundation

Conservation Significant Species Records

Conservation Status, Label, Species

- 1, Cm, *Cochlospermum macnamarae*
- 1, Eso, *Eremophila spongiocarpa*
- 1, Tg, *Tecticornia globulifera*
- 2, Gk, *Gompholobium karijini*

ecoscape

SIGNIFICANT FLORA RECORDS: P1 AND P2

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:250,000 @ A3

0 2 4 6 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 5D

620000 640000 660000 680000 700000 720000

7740000 7720000 7700000 7680000 7660000 7640000

BOODARRIE LANDING
RED BANK
CARGIL SALT FARM
NGARLA COASTAL NGAMAL
TABBA TABBA CREEK
RYAN SIDING
ALLEN SIDING
WEDGEFIELD
PIPPINGARRA
BOFI SIDING
SOUTH HEDLAND
BING SIDING
GREAT NORTHERN HIGHWAY
JINPARINYA
STRELLEY
STRELLEY COMMUNITY SCHOOL
MARBLE BAR ROAD
RED ROCK CREEK
YULE RIVER
WEST YULE RIVER
BABBACOORINGANNA
BEEBINGARRA CREEK
PIPPINGARRA ROAD
WEST STRELLEY RIVER
BUNNENGARRA
NORTH WEST COASTAL HIGHWAY
TURNER RIVER
INDEE ROAD
TABBA
TURNER RIVER EAST
TABBA TABBA
WALLA SIDING
MAGPIE RANGE
COORUNGCOORANA
PILINYA CREEK
GREAT NORTHERN HIGHWAY
EAST STRELLEY RIVER
PEAWAH RIVER
HOUSTON CREEK
MCPHEE CREEK
CHINNAMON CREEK
SPRING CREEK
SULPHUR SPRINGS CREEK
MOUNT SATIRIST
GILLAM SIDING
YANDEYARRA ROAD
FALLS POUND
WODGINA WEST
FRIENDLY CREEK
CLELAND ROCK
SIX MILE CREEK
YANDEYARRA
TURNER SIDING
LEILIRA CREEK
SHAW RIVER

15km 20km 25km 30km 45km 50km 55km 60km 75km 80km 85km 95km 105km 115km

Gc Gn Ecr Bb Hm Ri Pm Ec Tc Gl Sw Nu Tsu

LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- Place Names
- Principal Road
- Secondary Road
- Minor Road
- Watercourse
- Land Subject To Inundation

Conservation Significant Species Records

- 3, Ec, *Euphorbia clementii*
- 3, Erc, *Eragrostis crateriformis*
- 3, Gc, *Gymnanthera cunninghamii*
- 3, Gl, *Gomphrena leptophylla*
- 3, Hmt, *Heliotropium muticum*
- 3, Nu, *Nicotiana umbratica*
- 3, Ph, *Phyllanthus hebecarpus*
- 3, Ria, *Rothia indica* subsp. *australis*
- 3, Sw, *Stylidium weeliwolli*
- 3, Tc, *Triodia*
- 3, Ts, *Terminalia*
- 4, Bb, *Bulbostylis burbidgeae*
- 4, Gn, *Goodenia nuda*
- 4, Pm, *Ptilotus mollis*

ecoscape

SIGNIFICANT FLORA RECORDS: P3 AND P4

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:420,000 @ A3

0 4 8 12 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 6A

660000
680000
700000
720000
7640000
7620000
7600000
7580000

WODGINA WEST
FALLS POUND
CLELAND ROCK
TURNER SIDING
YANDEE
ABYDOS
ABYDOS SIDING
AGRIPPA RIDGE
PILBARA
SOANSVILLE MINING CENTRE
MUNGAROONA RANGE
COON SIDING
TAMBOURAH

YANDEYARRA ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE WOODSTOCK ROAD

SIX MILE CREEK
SHAW RIVER
LEILURA CREEK
TURNER RIVER
RED CREEK
LAPILLISTONE CREEK
LOWER RED CREEK
DALTON CREEK
SOANSVILLE CREEK
PINGA CREEK
EDGINA CREEK
CORUNG CREEK
YULE RIVER
TWO CAMEL CREEK
COONARRIE CREEK
PILBADDY CREEK
HOPE CREEK
COCKERAGA RIVER
WEST YULE RIVER
BEABEA CREEK
TAMBINA CREEK
ABYSSINIA CREEK

95km
110km
115km
120km
125km
130km
135km
140km
145km
150km
155km
160km
165km
170km
175km
175km
180km
180km
185km
185km

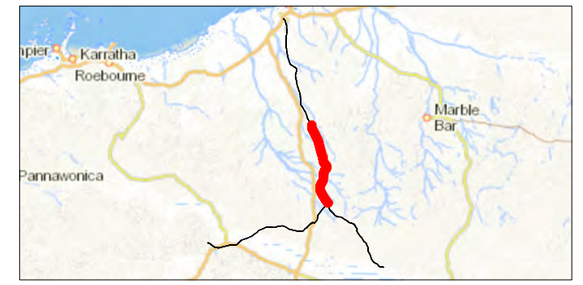
Tsu Gc Hm Ec Gn Gl Bb Sw Ecr Nu Ph Ri

LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- Place Names
- Principal Road
- Minor Road
- Watercourse

Conservation Significant Species Records

- 3, Ec, *Euphorbia clementii*
- 3, Erc, *Eragrostis crateriformis*
- 3, Gc, *Gymnanthera cunninghamii*
- 3, Gl, *Gomphrena leptophylla*
- 3, Hmt, *Heliotropium muticum*
- 3, Hmu, *Heliotropium murinum*
- 3, Nu, *Nicotiana umbratica*
- 3, Ph, *Phyllanthus hebecarpus*
- 3, Ria, *Rothia indica* subsp. *australis*
- 3, Sw, *Stylidium weeliwolli*
- 3, Ts, *Terminalia*
- 4, Bb, *Bulbostylis burbidgeae*
- 4, Gn, *Goodenia nuda*



ecoscape

SIGNIFICANT FLORA RECORDS: P3 AND P4

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

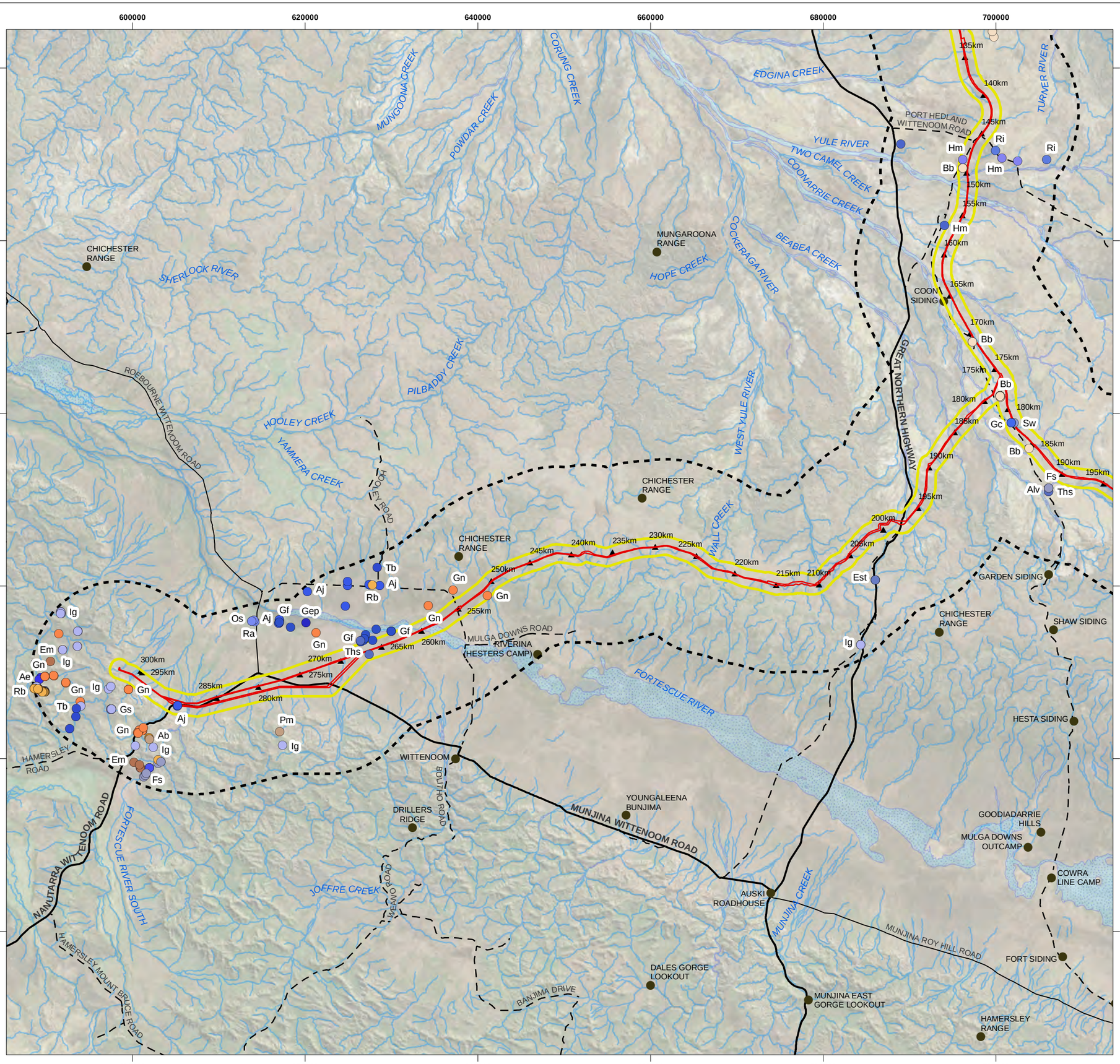
N

SCALE: 1:310,000 @ A3
0 2 4 6 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 6B

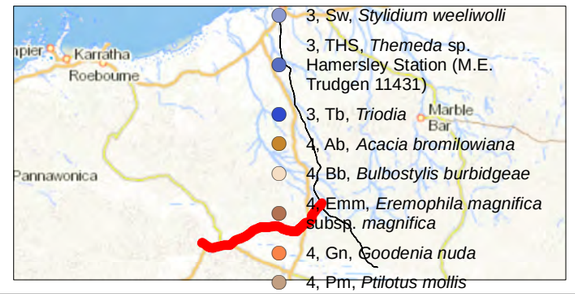


LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- Place Names
- Principal Road
- Secondary Road
- Minor Road
- Watercourse
- Land Subject To Inundation

Conservation Significant Species Records

- 3, Ad, *Acacia daweana*
- 3, Ae, *Acacia effusa*
- 3, Ajs, *Aristida jerichoensis* var. *subspinulifera*
- 3, Alv, *Acacia levata*
- 3, Emv, *Eremophila magnifica* subsp. *velutina*
- 3, Est, *Euphorbia stevenii*
- 3, Fs, *Fimbristylis sieberiana*
- 3, GEP, *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
- 3, Gc, *Gymnanthera cunninghamii*
- 3, Gf, *Glycine falcata*
- 3, Gs, *Grevillea saxicola*
- 3, Hmt, *Heliotropium muticum*
- 3, Hmu, *Heliotropium murinum*
- 3, Ig, *Indigofera gilesii*
- 3, OHS, *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479)
- 3, Om, *Olearia mucronata*
- 3, Ral, *Rostellularia adscendens* var. *latifolia*
- 3, Ria, *Rothia indica* subsp. *australis*
- 3, Sw, *Stylidium weeliwolli*
- 3, THS, *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- 3, Tb, *Triodia*
- 4, Ab, *Acacia bromilowiana*
- 4, Bb, *Bulbostylis burbidgeae*
- 4, Emm, *Eremophila magnifica* subsp. *magnifica*
- 4, Gn, *Goodenia nuda*
- 4, Pm, *Ptilotus mollis*
- 4, Rb, *Rhynchosia bungarensis*



ecoscape

SIGNIFICANT FLORA RECORDS: P3 AND P4

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

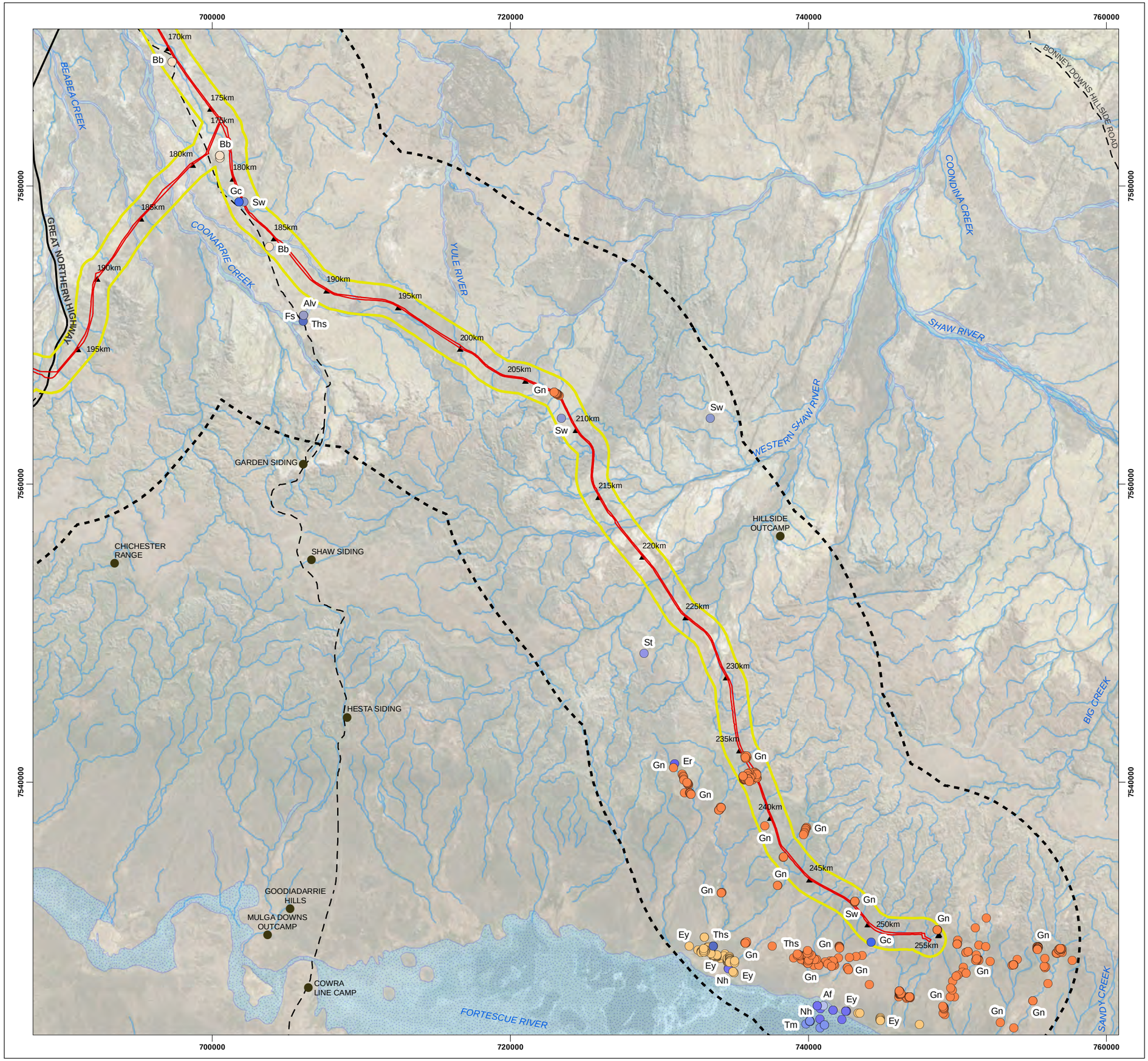
SCALE: 1:440,000 @ A3

0 4 8 12 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 6C

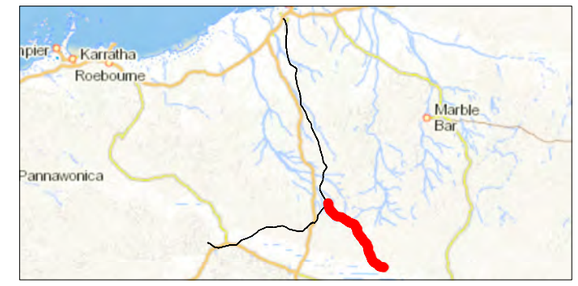


LEGEND

- Development Envelope
- Study Area
- Study Area (9 km Buffer)
- Rail Chainage
- Place Names
- Principal Road
- Minor Road
- Watercourse
- Land Subject To Inundation

Conservation Significant Species Records

- 3, Af, *Atriplex flabelliformis*
- 3, Alv, *Acacia levata*
- 3, Ero, *Eucalyptus rowleyi*
- 3, Fs, *Fimbristylis sieberiana*
- 3, Gc, *Gymnanthera cunninghamii*
- 3, Nh, *Nicotiana heterantha*
- 3, St, *Swainsona thompsoniana*
- 3, Sw, *Stylidium weeliwolli*
- 3, THS, *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- 3, Tm, *Tecticornia*
- 4, Bb, *Bulbostylis burbidgeae*
- 4, Eyl, *Eremophila youngii* subsp. *lepidota*
- 4, Gn, *Goodenia nuda*



ecoscape

SIGNIFICANT FLORA RECORDS: P3 AND P4

PILBARA TRANSMISSION PROJECT FLORA AND VEGETATION DESKTOP ASSESSMENT

FORTESCUE

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:250,000 @ A3

0 2 4 6 km

PROJECT NO: 4187-18

REV	AUTHOR	APPROVED	DATE
00	JN	LA	18/10/2018
01	DR	SB	30/10/2018

MAP 6D

APPENDIX ONE: DEFINITIONS AND CRITERIA

Table 11: EPBC Act categories for flora and fauna

EPBC ACT 1999 category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (EN)	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 12: Conservation codes for Western Australian flora and fauna (DPaW 2017)

Conservation Codes for Western Australian Flora and Fauna	
T	**Threatened species*** Published as Specially Protected under the *Wildlife Conservation Act 1950*, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora). • ***Threatened fauna*** is that subset of 'Specially Protected Fauna' declared to be ' likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act. • ***Threatened flora*** is flora that has been declared to be 'likely to become extinct or is rare, or is otherwise in need of special protection' pursuant to section 23F(2) of the Wildlife Conservation Act. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.
CR	**Critically Endangered species** Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EN	**Endangered species** Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
VU	**Vulnerable species** Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EX	**Presumed extinct species** Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
IA	**Migratory birds protected under an international agreement** Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.
CD	**Conservation Dependent fauna** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice
OS	**Other specially protected fauna** Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice
P	**Priority species** Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.
P1	**Priority One: Poorly-known species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road or rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	**Priority Two: Poorly-known species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	**Priority Three: Poorly-known species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

Conservation Codes for Western Australian Flora and Fauna	
P4	**Priority Four: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
[1]The definition of flora includes algae, fungi and lichens. [2]Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).	

Table 13: DBCA definitions and criteria for TECs and PECs (Department of Environment and Conservation 2013)

Criteria	Definition
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A. The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A. The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii. modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii. there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii. there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Criteria	Definition
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A. The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B. The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C. The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.
Priority ecological communities	
Priority One	*Poorly known ecological communities* Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	*Poorly known ecological communities* Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, state forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	*Poorly known ecological communities* i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; ii. Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. i. Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change These communities are usually represented on conservation lands. ii. Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table 14: NVIS structural formation terminology, terrestrial vegetation (NHT 2003)

	Cover characteristics							
	Foliage cover *	70-100	30-70	10-30	<10	» 0 (scattered)	0-5 (clumped)	unknown
	Cover code	d	c	i	r	bi	bc	unknown
Growth Form	**Height Ranges (m)**	**Structural Formation Classes**						
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	tree, palm
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	tree mallee
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrub, cycad, grass-tree, tree-fern
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrub
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrub
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrub
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrub
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grass
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grass
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grass
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedge
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rush
herb	<0.5,>0.5	closed herbland	herbland	open herbland	sparse herbland	isolated herbs	isolated clumps of herbs	herb
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	fern
bryophyte	<0.5	closed bryophyte-land	bryophyte-land	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophyte
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichen
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vine

Table 15: NVIS height classes (NHT 2003)

Height		Growth form				
Height Class	**Height Range (m)**	**Tree, vine (M & U), palm (single-stemmed)**	**Shrub, heath shrub, chenopod shrub,**	**Tree mallee, mallee shrub**	**Tussock grass, hummock grass, other**	**Bryophyte, lichen, seagrass, aquatic**
8	>30	tall	NA	NA	NA	NA
7	10-30	mid	NA	tall	NA	NA
6	<10	low	NA	mid	NA	NA
5	<3	NA	NA	low	NA	NA
4	>2	NA	tall	NA	tall	NA
3	1-2	NA	mid	NA	tall	NA
2	0.5-1	NA	low	NA	mid	tall
1	<0.5	NA	low	NA	low	low

Source: (based on Walker & Hopkins 1990)

APPENDIX TWO: PMST REPORT

Australian Government
Department of the Environment and Energy

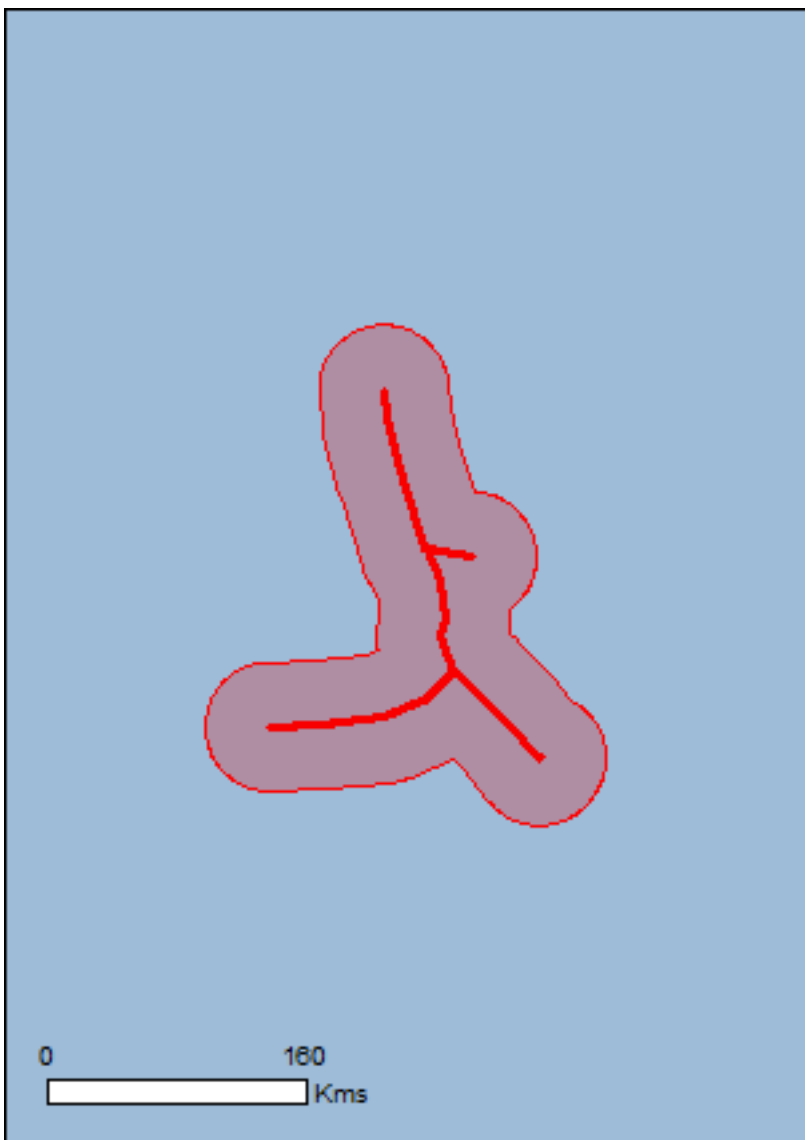
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

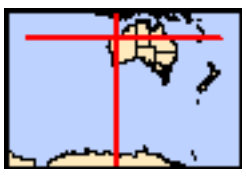
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 18/06/18 17:14:24



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 40.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	30
Listed Migratory Species:	60

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	102
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	16
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
Plants		
Pityrodia sp. Marble Bar (G.Woodman & D.Coultas GWDC Opp 4) [88310]	Endangered	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus angusticeps Northwestern Coastal Ctenotus, Airlie Island Ctenotus [25937]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area

Name	Threatened	Type of Presence
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur

Name	Threatened	Type of Presence within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Arenaria interpres](#) Ruddy Turnstone [872]		Species or species habitat known to occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
[Calidris alba](#) Sanderling [875]		Species or species habitat known to occur within area
[Calidris canutus](#) Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat known to occur within area
[Calidris ruficollis](#) Red-necked Stint [860]		Species or species habitat known to occur within area
[Calidris subminuta](#) Long-toed Stint [861]		Species or species habitat known to occur within area
[Calidris tenuirostris](#) Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
[Calonectris leucomelas](#) Streaked Shearwater [1077]		Species or species habitat likely to occur within area
[Charadrius leschenaultii](#) Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
[Charadrius mongolus](#) Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
[Charadrius ruficapillus](#) Red-capped Plover [881]		Species or species habitat known to occur within area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
[Cuculus saturatus](#) Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
[Fregata ariel](#) Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur within area
Himantopus himantopus Black-winged Stilt [870]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Stiltia isabella Australian Pratincole [818]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area

Name	Threatened	Type of Presence
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea		Species or species

Name	Status	Type of Presence
populations) [78900]		habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Karijini	WA
Mungaroona Range	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Fortescue Marshes	WA
Karijini (Hamersley Range) Gorges	WA
Leslie (Port Hedland) Saltfields System	WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-20.405373 118.555101,-20.552034 118.571581,-20.713969 118.615526,-20.8629 118.659471,-21.22434 118.777574,-21.270417 119.041246,-21.2269 118.794054,-21.393221 118.873705,-21.595111 118.898424,-21.679362 118.873705,-21.855363 118.936876,-21.998045 118.816027,-22.099874 118.563341,-22.135496 118.211779,-22.145672 117.926134,-22.135496 118.206285,-22.099874 118.557848,-22.003138 118.788561,-21.850264 118.942369,-21.942009 119.046739,-22.135496 119.249987,-22.318555 119.414781,-22.303309 119.425768

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

APPENDIX THREE: ATTRIBUTES OF CONSERVATION SIGNIFICANT FLORA

Table 16: Conservation significant flora database results (Rio Tinto & Department of Parks and Wildlife 2015; Western Australian Herbarium 2018)

Species name	Description	Vegetation	Flowering Period	Habitat incl. soils/landforms
Priority 1				
Abutilon sp. *Pritzelianum* (S. van Leeuwen 5095)	Erect shrub to 2m, yellow or orange flowers. Potentially a disturbance opportunist	*Eucalyptus camaldulensis; Acacia ancistrocarpa, Acacia inaequilatera, Triodia epactia; Eragrostis eriopoda grassland; Sida spp. low shrubland; Triodia grassland*	Jun-Nov	Alluvium, sand, red clay; creek lines, sandplains, floodplains
Acacia leeuweniana	Shapely, obconic trees with neither branchlets nor phyllodes pendulous; adolescent plants often with a conifer-like appearance. Bark 'Minni Ritchi'. Phyllodes (mature plants) linear, long and narrow, flat, straight, green to dull grey-green or sub-glaucous, not especially rigid; parallel longitudinal nerves very fine and close together; apices pungent or sub-pungent. Spikes light golden.	See habitat	April/May and also late October	Known from only three granite outcrops in the central Pilbara. Skeletal gritty red-grey granitic sandy loam, light orange-brown gravelly sand over granite. In rock fissures in outcrops, among boulders.
Cochlospermum macnamarae	Spreading multi-stemmed shrub	Very open *Triodia* grassland	In response to rain	Shallow stony soil/Upper slopes of a low hill over granite
Dipteracanthus chichesterensis	Spreading, glabrescent, perennial *subshrubs* to 30 cm tall	*Acacia xiphophylla tall hrublands. Triodia wiseana* very open hummock grassland with scattered shrubs to an open shrub layer, often with *Senna artemisioides* subsp. *× sturtii, S. artemisioides* subsp. *oligophylla, Ptilotus* aff. *Obovatus* and *Rhagodia eremaea.*	March, and sporadically following significant rainfall events	Three known locations within the Chichester Plateau 175 and the Wona Land System. Red-brown cracking clay soils associated with basalts. Various landforms on the plateau including slopes, tablelands, benches and creek margins.
Eremophila spongiocarpa	Compact, succulent-leaved shrub, to 1 m high	-	May or Sept	Weakly saline alluvial plain on margins of marsh

Species name	Description	Vegetation	Flowering Period	Habitat incl. soils/landforms
Samolus sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702)	Tall, flexuose, dichotomously and many-branched stems, producing a characteristically erect, tangled, divaricate form.	See habitat	-	Restricted to both the margins of semi-permanent/permanent freshwater pools and the margins of samphire shrublands where creeks discharge freshwater following periods of high rainfall
Tecticornia globulifera	Low sub-shrub to 0.8m with decussate, laterally-paired inflorescences comprised of distinctly undulate bracts.	Material has been observed in flower from August and fruits begin to mature in November. Associated with other samphire species	Has been observed in flower from August	Widespread across the saline flats of Fortescue Marsh on red-brown clay associated with other species Tecticornia.
Tecticornia sp. Christmas Creek (K.A. Shepherd & T. Colmer et al. KS 1063)	Low sub-shrub with decussate, laterally-paired inflorescences comprised of distinctly undulate bracts.	Associated with other species of *Tecticornia*	Not recorded	Widespread across the saline flats of Fortescue Marsh on red-brown clay associated with other species of *Tecticornia.*
Tephrosia rosea var. Port Hedland (A.S. George 1114)	Erect or sprawling shrub, maroon-red-purple or pink flowers	*Acacia coriacea; Triodia epactia; Spinifex longifolius; Acacia stellaticeps; *Cenchrus ciliaris*	Mar-Oct	Sand, sandy loam /Coastal dunes, plains
Priority 2				
Adiantum capillus-veneris	Rhizomatous, perennial fern	See habitat	-	Found on calcareous soils derived from calcrete, limestone or dolomite, just above the waterline of shaded banks and cliff faces along small, perennial rivers in low-altitude woodland, where there is a marked dry season. Although usually lithophytic, it has been recorded as being epiphytic on trees which receive the spray from waterfalls.
Dicladanthera glabra	Spreading perennial, herb or shrub, to 0.6(-1) m high	Recorded as growing in mixed shrubland with *Callitris sp.* on coarse sandy loam amongst rocks or iron rich alluvial soils. Also recorded in cobble beds of high-velocity creeks amongst *Acacia citrinoviridis* with an understorey of *Corchorus sp.* and *Cymbopogon sp.*	Apr or Aug to Oct	Alluvium. Along watercourses, near rock pools.
Euphorbia australis var. *glabra*	Prostrate herb	*Eucalyptus camaldulensis,* open forest or *E. victrix,* low forest on sandy to clayey-loam alluvium.	Apr-Sep	Cracking clays/Banks of semi-permanent pools, creeklines or alluvial flats
Gompholobium karijini	Glabrous, non-viscid, erect shrub with compound leaves and yellow	Occurs in open *Triodia* hummock grassland with	Jan and Aug to Sep	Recorded from skeletal soils on the edges of deep ravines or plateaux on banded ironstone.

Species name	Description	Vegetation	Flowering Period	Habitat incl. soils/landforms
	pea-like flowers.	scattered shrubs and trees		
Gomphrena pusilla	Slender branching annual, herb, to 0.2 m high	Grows in littoral vegetation	Mar to Apr or Jun	Fine beach sand. Behind fore dune, on limestone.
Paspalidium retiglume	Tufted annual, grass-like or herb	Tropical and subtropical sub-humid woodlands, arid and semi-arid low woodlands, arid tussock grasslands, and arid hummock grasslands.	Apr	Clay/Plains or gently undulating terrain
Teucrium pilbaranum	Upright shrub 0.2m high	Tussock grassland of self	May or Sep	Clay/Crab hole plains in river floodplains, margins of calcrete tables
Priority 3				
Acacia daweana	Spreading shrub, 0.3-1.5(-2) m high. Bark grey but peeling in a more or less Minni Ritchi fashion at base of stems	See habitat	June to Aug	Rocky red skeletal loam in spinifex on lower scree slopes; bajada outwash fans of rocky banded ironstone ranges and ridges (often along diffuse but well incised drainage lines).
Acacia effusa	Low spreading shrubs (0.6 to 3m across), domes or flat-topped, somewhat viscid shrubs to 1.2m tall. Bark Minni Ritchi.	See habitat	May to Aug	Stony red loam with surface strew of rocks in spinifex on lower scree slopes of low rocky ranges (often along diffuse drainage lines) or on the bajada alluvial plain at the base of large banded ironstone mountains. Often common where it occurs.
Acacia levata	Spreading shrubs, sometimes with a snakewood growth habit. This species is common in the places where it occurs sometimes forming extensive thickets.	Common associates are *A. hilliana* and *A. stellaticeps.*	Flowers have been collected in late May and pods with mature seeds from mid-October to early November.	Grows with spinifex in gently undulating, low rocky hills (often associated with seasonally dry watercourses), on shallow sand, sandy loam or clay-loam over granite or quartz.
Aristida jerichoensis var. *subspinulifera*	Compactly tufted perennial, grass-like or herb, 0.3-0.8 m high	*Eucalyptus, mulga (Acacia aneura)* and *Triodia* communities	Summer or in response to rain	Red earths and clays/Hardpan plains
Atriplex flabelliformis	Monoecious, fan-shaped herb, to 0.35 m high	See habitat	-	Clay loam, loam. Swampy or saline soils that are seasonally inundated
Eragrostis crateriformis	Annual, grass-like or herb, 0.17-0.42 m high	See habitat	Jan to end July	Clayey loam or clay/creek banks and depressions
Eremophila magnifica subsp. *velutina*	Erect aromatic shrub, to 1.3m tall	Common and growing amongst *Triodia* and *Acacia* species	June to Sep	Rocky red-brown loams on hill slopes and along ephemeral drainage lines

Species name	Description	Vegetation	Flowering Period	Habitat incl. soils/landforms
Eucalyptus rowleyi	Mallee	Often in small pure stands or in open mallee vegetation with other eucalypt species including *E. gamophylla–E. odontocarpa intergrades* and *E. victrix*, and usually with a *Triodia* ground storey.	Nov to June	Occurs on red sandy loams on plains and very minor and broad flood-out plains (similar to the habitat of *E. lucasii*)
Euphorbia clementii	Erect herb to 0.6 m high	*Triodia epactia, Acacia inaequilatera; Corymbia hamersleyana, Acacia tumida; Triodia basedowii; Triodia lanigera*	-	Red clay loam, colluvium, granitic/Sandplain, outwash fans, lower slopes
Euphorbia stevenii	Somewhat succulent perennial, herb, 0.1-0.5 m high	-	Probably, sporadically following significant rainfall events	Clay or clay-loam soils.
Glycine falcata	Mat-forming perennial, herb, to 0.2 m high	Typically in grasslands in low-lying area	May or July	Black clayey sand/Along drainage depressions in crabhole plains on river floodplains
Gomphrena leptophylla	Prostrate or erect to spreading annual herb to 0.15 m high, white flowers	*Triodia lanigera*	Mar to Sep	Sand, sandy clay, loam, granite, quartz, alluvium /Flats, creeks, salt pan edges, marshes, stony hills, floodplains
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	Open, erect annual or biennial, herb, to 0.2 m high	Growing in swamp on a major river system in *Eucalyptus victrix* woodland	September	Red-brown clay soil, calcrete pebbles. Low undulating plain, swampy plains.
Grevillea saxicola	Upright shrub or small tree with grey-black, rough bark	Often found growing in Mulga woodlands	Late spring to early autumn	Orange-brown to red-brown loam soils on the upper scree and crests often associated with banded iron formation outcropping.
Gymnanthera cunninghamii	Erect shrub 1-2 m high, cream-yellow-green flowers	*Eucalyptus victrix; Eucalyptus camaldulensis; Triodia pungens*	Jan-Dec	Sand, alluvium, clayey sand, basalt, ironstone, clay loam, limestone. Creeklines, scree, floodplains
Heliotropium murinum	Short-lived perennial, herb, up to 0.4 m high	*Triodia* hummock grasslands	May or Sep	Recorded from road verges on red sand plains, gibber plains and near granite

Species name	Description	Vegetation	Flowering Period	Habitat incl. soils/landforms
Heliotropium muticum	Short-lived perennial herb to 0.4 m high, white flowers	*Corymbia hamersleyana, Acacia inaequilatera, Triodia epactia; Triodia lanigera; Triodia pungens*	May to Sep	Sand, granitic sand, plains
Indigofera gilesii	Shrub, to 1.5 m high	Open shrub mallee consisting of *Eucalyptus gamophylla*	May or Aug	Usually high in the landscape on skeletal soils overlaying massive ironstones of the Brockman Iron Formation
Nicotiana heterantha	Decumbent, short-lived annual or perennial, herb, to 0.5 m high, forming low, spreading colonies	Typically associated with *Melaleuca* species	Mar to Jun or Sep	Black clay. Seasonally wet flats.
Nicotiana umbratica	Erect short-lived annual or perennial herb 0.3-0.7 m high, white flowers	*Eucalyptus victrix; Eucalyptus leucophloia;* Mulga*; Acacia arida*	Apr-Jul	Skeletal soils, ironstone, granite. Sheltered areas, creek lines, gorges, rocky outcrops, steep slopes, hills
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	Spreading annual, herb, 0.05-0.1m high	-	Mar	Cracking clay, basalt. Gently undulating plain with large surface rocks, flat crab-holed plain.
Olearia mucronata	Densely branched, unpleasantly aromatic shrub, 0.6-1 m high	-	Aug to Dec or Jan	Mesic areas amongst ironstone boulders and along creek lines sometimes local abundant on the margins of dry creek lines
Phyllanthus hebecarpus	Erect rigid, shrub	*Terminalia canescens, Acacia tumida, Acacia retivenea, Triodia epactia*	May-Jul	Only recorded in WA from sand areas between granite domes, occasionally persisting in rock cracks and almost lithophytic
Rostellularia adscendens var. latifolia	Herb or shrub, 0.1-0.3 m high	-	Apr to May	Ironstone soils. Near creeks, rocky hills.
Rothia indica subsp. *australis*	Prostrate annual, herb, to 0.3 m high, densely covered in spreading hairs.	-	Apr-Aug	Sandy soils/Sand hills and sandy flats
Stylidium weeliwolli	Annual herb to 25 cm high, pink flowers	*Eucalyptus victrix, Eucalyptus camaldulensis,* Mulga	Aug-Sep	Alluvium, clay, sand, wet soil /Watercourses, plains
Swainsona thompsoniana	A small tufted compound-leaved annual herb. Probably annual or ephemeral	See habitat	Flowering and seeding recorded all year.	Recorded from gibber plains, crabhole plains and gilgai, usually at some elevation and in association with tussock grasses
Tecticornia medusa	Medium to tall samphire. Articles succulent, green or yellowish-green.	Samphire	July and November	Grows in red-brown, gritty clay on a saline alluvial plain some distance from the shoreline. This area is likely to be inundated for longer periods and it is hypothesised that this species is more waterlogging-tolerant than

Species name	Description	Vegetation	Flowering Period	Habitat incl. soils/landforms
				other species found in the area.
Terminalia supranitifolia	Spreading, tangled shrub or tree, 1.5-3 m high	*Triodia epactia, Triodia wiseana, Acacia acradenia; Acacia bivenosa; Grevillea wickhamii, Rhagodia eremaea*	May or Jul or Dec	Sand. Among basalt rocks.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	Tussocky perennial, grass-like or herb, 0.9-1.8 m high	*Aristida* and *Astrebla* tussock grassland	Aug	Red clay/Clay pans, grass plains
Triodia basitricha	Hummock forming perennial grass, non-resinous or weakly resinous, not obviously stoloniferous; compact, c. 30–40 cm high, 40–60 cm diam.;	-	January to March	Collections are all from the slopes or crests of rocky hills
Triodia chichesterensis	Diminutive hummock forming perennial grass, 0.2–0.4 m tall, Leaf sheaths glabrous; orifice woolly to straight-pubescent with hairs 2–3 mm long	-	Florets observed February–April and August.	Occurs in rocky to gravelly substrates of loam or sand, often with quartzite pieces evident on the surface
Priority 4				
Acacia bromilowiana	Tree or shrub, to 12 m high, bark dark grey, fibrous; phyllodes more or less glaucous & slightly pruinose; inflorescence in spikes.	Dominated by very open low eucalypt woodlands (*Eucalyptus leucophloia*, *Corymbia hamersleyana*) over spinifex (e.g. *Triodia pungens*, *T. wiseana*).	Jul to Aug	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.
Bulbostylis burbidgeae	Tufted, erect to spreading annual sedge 0.03-0.25m high	*Triodia epactia*	Mar-Aug	Granitic soils/Granite outcrop, cliff bases
Eremophila magnifica subsp. *magnifica*	Shrub, 0.5-1.5m high	-	Aug to Sep	Skeletal soils over ironstone. Summits.
Eremophila youngii subsp. *lepidota*	Dense, spreading shrub, (0.2-) 1-3m high.	Recorded from mulga woodlands or shrub lands, often associated with chenopodiaceous shrubs	Jan or Mar or Jun or Aug to Sep	Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats.
Goodenia nuda	Erect to ascending herb, to 0.5m high Fl. yellow	*Acacia tumida, Triodia epactia*	Apr-Aug	Red-brown clay loam, ironstone/Low lying areas (floodplains, outwash areas) occasionally hills

Species name	Description	Vegetation	Flowering Period	Habitat incl. soils/landforms
Ptilotus mollis	Compact perennial shrub to 0.5m high, white/pink flowers	*Eucalyptus leucophloia, Corymbia hamersleyana; Eucalyptus kingsmillii; Acacia bivenosa, Acacia synchronicia; Triodia basedowii, Triodia pungens*	May-Sep	Ironstone, clay loam/Stony hills, scree, crests
Rhynchosia bungarensis	Compact, prostrate shrub, to 0.5m high	-	Mar to Jun	Pebbly, shingly coarse sand amongst boulders. Banks of flow line in the mouth of a gully in a valley wall.

APPENDIX FOUR: DESCRIPTION OF GEOLOGICAL UNITS

Table 17: Geological units that intersect the study area.

Code	Description
_A1	Alluvial sand, clay, silt, and gravel in active drainage areas
_A1c	Sand, silt, and gravel in active drainage channels; includes clay, silt, and sand in poorly defined drainage courses on floodplains
_A1f	Floodplain deposits; sand, silt, clay, and gravel adjacent to main drainage channels
_A1i	Mixed floodplain deposits; sand, silt, and clay adjacent to main drainage channels; numerous small claypans
_A2	Consolidated alluvial sand, silt, and gravel; dissected by present-day drainage
_A2-d-k	Consolidated alluvial gravel, sand, and silt; local carbonate cement; dissected by present-day drainage
_C1	Colluvial sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits; unconsolidated
_C2	Partly consolidated colluvial sand, silt, and gravel in proximal outwash fans; scree and talus; dissected by present-day drainage
_C2-f	Ferruginous colluvium; consolidated sand, silt, clay, and rock fragments in proximal outwash fans and scree; dissected by present-day d
_R1-g-pg	Residual quartzofeldspathic sand, with quartz and rock fragments; overlying and derived from granitoid rock
_R2	Residual deposits derived from underlying bedrock; dissected by present-day drainage
_R3	Residual or relict deposit
_W1	Silt, sand, and pebbles on distal outwash fans; no defined drainage
Ab	Metabasalt and metamorphosed pyroxene spinifex-textured basalt, chlorite schist, and tremolite schist
A-bk-P	Komatiitic basalt; local pyroxene-spinifiex textures; metamorphosed
A-BL-od	Dolerite dyke; local gabbro; weakly metamorphosed
Abm	Metamorphosed pyroxene spinifex-textured basalt and tremolite schist
A-CDm-s	MALLINA FORMATION: interbedded shale, siltstone, sandstone, and medium- to fine-grained wacke; metamorphosed
A-CEka-mggb	Meta biotite granodiorite and minor pegmatitic granite; fine- to medium-grained; foliated
A-cib-P	Banded iron-formation; metamorphosed
A-EH-g	Tonalite to syenogranite; local greenstone xenoliths; metamorphosed, with minor orthogneiss
A-EH-xgnl-gp	Leucogranite; medium- to coarse-grained; with abundant pegmatite and local greenstone and granitic gneiss xenoliths
AFj	JEERINAH FORMATION: pelite, metasandstone, chert, metabasaltic pillow lava and breccia, and metamorphosed felsic volcanic rock
AFjo	Woodiana Member: metamorphosed quartzitic sandstone, pelite, and chert (locally stromatolitic)
AFm	MADDINA BASALT: amygdaloidal metabasaltic flows and breccia
AFmk	Kuruna Member: metamorphosed volcanic sandstone, pelite, chert, and metadolomite; local accretionary lapilli and stromatolites
A-FOm-b	Massive, amygdaloidal, or vesicular basalt and basaltic andesite; local komatiitic basalt, dacite, and rhyolite
A-FOt-xb-k	Basaltic volcanic rocks and carbonate rocks
AFt	TUMBIANA FORMATION: metamorphosed mafic to intermediate volcanic sandstone, pelite, metabasaltic flows and breccia, chert, and metadolerite; local accretionary lapilli and stromatolites

Code	Description
AFtc	Meentheena Member: metamorphosed stromatolitic limestone and dolomite, pelite, and volcanic sandstone
AFti	Metabasaltic flows and breccia
A-GCe-ca	Banded iron-fomration, ferruginous chert, sandstone, siltstone, and shale; minor rey-white chert and felsic volcaniclastic rock; metamorphosed
A-GCe-cc	Chert, white and grey; minor jaspilite, ferruginous chert, and iron formation; metamorphosed
AgSm	Metamorphosed biotite monzogranite and minor granodiorite; weakly to strongly foliated; local metabasalt and metadolerite xenoliths intruded by a network of metamorphosed muscovite pegmatite veins
AgYa	TAMBOURAH GRANODIORITE: metamorphosed medium- to coarse-grained biotite granodiorite and monzogranite; weakly to strongly foliated; locally intruded by a network of metamorphosed muscovite pegmatite v
AHd	WITTENOOM FORAMTION: metamorphosed thin- to medium-bedded dolomite, dolomitic pelite, chert, and volcanic sandstone
AHm	MARRA MAMBA IRON FORMATION: chert, banded iron-formation, and pelite
Ahs	MOUNT McRAE SHALE and MOUNT SYLVIA FORMATION: pelite, chert, and banded iron formation
A-mogs-P	plagioclase (-hornblende-actinolite-epidote-chlorite) schist after gabbro; fine to medium grained; locally includes interleaved talc-se
A-murs-P	Tremolite-chlorite-talc schist
A-PI-xmb-mu	Metamafic and meta-ultramafic rock; includes local schist
A-PI-xmwa-g	Amphibolite intruded by granite veins (50%)
A-SRmi-gmp	MINNAMONICA MONZOGRANITE: porphyritic biotite(-muscovite) monzogranite; fine- to coarse-grained; quartz and K-feldspar phenocrysts; mas
A-SRnu-gmp	Medium- to coarse-grained feldspar(?quartz) porphyritic monzogranite; massive to weakly foliated; local flow-aligned feldspar phenocrysts; local garnet-bearing pegmatite and granite dykes
A-SRpo-gmv	POOCATCHE MONZOGRANITE: muscovite-biotite monzogranite; seriate to porphyritic; massive to weakly foliated; locally abundant pegmatite
A-SRta-gmd	Pegmatitic to coarse-grained granite; generally as irregular patches in foliated biotite granodiorite (?A-CEka-mggb)
A-SScp-ci	Banded iron-formation; jaspilitic; minor layered chert and shale; metamorphosed
A-STbe-gm	Biotite monzogranite; equigranular to feldspar-porphyritic; weakly to moderately foliated
A-ST-gmp	Biotite monzogranite with K-feldspar and local quartz phenocrysts; leucocratic; massive to weakly foliated; weakly metamorphosed
A-STpi-gmp	Feldspar(?quartz) porphyritic, (hornblende?)biotite monzogranite; weakly to moderately foliated with characteristic phenocryst alignment; minor pegmatite and leucogranite
A-STwo-gm	Biotite monzogranite; equigranular to feldspar-porphyritic; weakly to moderately foliated; locally abundant pegmatite and granodiorite dykes; magnetite-bearing leucogranite pods
A-TApe-mgtn	Tonalitic orthogneiss with sheeted pegmatitic granitic veins and local white leucogranite
A-WAa-b	Basalt, komatiitic basalt, serpentinized peridotite; local dolerite sills; minor felsic volcaniclastic rocks and chert; metamorphosed
Cza	Alluvium-partly consolidated silt, sand, and gravel; old alluvium dissected by present-day drainage
Czc	Colluvium - partly consolidated quartz and rock fragments in silt and sand matris; old valley-fill deposits, locally derived
Czk	Calcrete-sheet carbonate; found along major drainage lines
Czp	ROBE PISOLITE: pisolitic limonite deposits developed along river channels
Czr	Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

Code	Description
P_-MW-od	Dolerite dykes, sills, and small intrusions with locally abundant xenoliths and potassic alteration of wallrocks; includes minor quartz diorite, syenite, tonalite, and biotite monzogranite
P_-RH-od	Dolerite dyke, fine to medium-grained
PLHb	BROCKMAN IRON FORMATION: banded iron-formation, chert, and pelite
Qa	Alluvium - unconsolidated silt, sand, and gravel; in drainage channels and adjacent floodplains
Qc	Colluvium-unconsolidated quartz and rock fragments in soil; locally derived soil, and scree, and talus deposits
Qw	Alluvium and colluvium - red-brown sandy and clayey soil; on low slope and sheetwash areas

APPENDIX FIVE: VEGETATION MAPPING UNIT DESCRIPTIONS (NVIS LEVEL V)

Table 18: Vegetation mapping units

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
Unmapped	Unmapped	NA	NA	7923.31	9.771%
1	Open Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* with pockets of *Acacia coriacea* subsp. *pendens* over *Grevillea wickhamii* subsp. *aprica*, *Petalostylis labicheoides* and *Acacia tumida* over *Triodia longiceps*, *Chrysopogon fallax*, *Themeda triandra*	ENV.Australia	24/02/2011	103.39	0.127%
2	Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura*, *Acacia citrinoviridis*, *Acacia pruinocarpa* over *Acacia tetragonophylla* and *Psydrax latifolia* over *Chrysopogon fallax*, *Stemodia viscosa*, *Blumea tenella*, *Themeda triandra* and *Triodia* and *Aristida*	ENV.Australia	24/02/2011	12.29	0.015%
3	Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura*, *Acacia pruinocarpa*, *Acacia tetragonophylla*, *Acacia tenuissima*, *Grevillea wickhamii* subsp. *aprica*, *Psydrax latifolia* over *Dodonaea petiolaris* and species of *Triodia* and *Aristida*.	ENV.Australia	24/02/2011	3.24	0.004%
8	Closed Scrub to Tall Shrubland of *Acacia pruinocarpa, Acacia tumida, Acacia ancistrocarpa, Acacia maitlandii, Acacia kempeana*, *Acacia tetragonophylla* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Triodia epactia*, *Themeda*	ENV.Australia	24/02/2011	29.53	0.036%
9	Closed Scrub to Shrubland of *Acacia ancistrocarpa*, *Acacia maitlandii*, *Acacia kempeana*, *Acacia monticola* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Senna*, *Triodia basedowii* and *Aristida* species.	ENV.Australia	24/02/2011	280.65	0.346%
10	Low Open Woodland of *Acacia xiphophylla*, *Acacia victoriae*, *Acacia aneura* var. *aneura* over *Acacia tetragonophylla*, *Ptilotus obovatus*, *Senna* species and mixed species of *Maireana* and *Sclerolaena*.	ENV.Australia	24/02/2011	146.28	0.180%
16	Hummock Grassland of *Triodia basedowii* with pockets of *Triodia epactia* and *Triodia lanigera* with emergent patches of *Eucalyptus leucophloia*, *Corymbia deserticola* over Acacia *ancistrocarpa*, *Acacia hilliana*, *Acacia acradenia*, *Acacia pyrifolia*, *Hakea lorea*	ENV.Australia	24/02/2011	711.93	0.878%
17	Hummock Grassland of *Triodia basedowii* with pockets of *Triodia epactia* and *Triodia lanigera* with emergent patches of *Eucalyptus leucophloia*, *Corymbia deserticola* over *Acacia ancistrocarpa*, *Acacia pyrifolia*, *Hakea lorea* subsp. *lorea* over *Goodenia*	ENV.Australia	24/02/2011	1472.06	1.815%
AaAbTe	*Acacia aneura* and *Acacia pruinocarpa* tall sparse shrubland over *Acacia bivenosa* and *Acacia atkinsiana* mid sparse shrubland over *Triodia epactia* hummock grassland	Ecologia Environment	10/10/2014	989.41	1.220%
AaApAl	*Corymbia hamersleyana*, *Acacia* aff. *aneura* (narrow fine veined: site 1, 259) and *Acacia pruinocarpa* low open forest, over *Acacia pteraneura* and *Dodonaea petiolaris* mid sparse shrubland and *Maireana villosa* low sparse shrubland, over *Aristida latifolia*	Ecologia Environment	31/10/2014	5.77	0.007%
AaAtAc	*Acacia aptaneura*, *Acacia pteraneura* and *Acacia pruinocarpa* low woodland, over *Acacia tetragonophylla*, *Senna artemisioides* subsp. *oligophylla* and *Vachellia farnesiana* mid sparse shrubland, over *Aristida contorta* and *Enneapogon polyphyllus* open tussock grass	Ecologia Environment	31/10/2014	12.84	0.016%
AaAtAl	*Acacia* aff. *aneura* (narrow fine veined: site 1, 259), *Acacia pteraneura* and *Acacia aptaneura* tall open shrubland, over *Acacia tetragonophylla* and *Acacia victoriae* sparse shrubland, over *Aristida latifolia*, *Cenchrus ciliaris* and *Cenchrus setiger* sparse tussock	Ecologia Environment	31/10/2014	62.63	0.077%
AaAvCc	*Acacia aneura*, *Acacia pruinocarpa* and *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Acacia victoriae* and *Senna artemisioides* subsp. *oligophylla* mid sparse shrubland over *Cenchrus ciliaris* tussock grassland	Ecologia Environment	10/10/2014	406.59	0.501%
AacrS2	*Acacia acradenia* and *Acacia inaequilatera* Tall Open Shrubland over a Hummock Grassland of *Triodia schinzii*.	Coffey Environments	22/08/2007	37.13	0.046%
AaElCf	*Acacia aneura* tall shrubland over *Eremophila lanceolata*, *Sida* sp. verrucose glands (F.H. Mollemans 2423) and Solanum lasiophyllum mid sparse shrubland over Chrysopogon fallax and *Aristida contorta* sparse tussock grassland	Ecologia Environment	10/10/2014	294.46	0.363%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
AaElfTe	*Acacia aneura* and *Acacia pruinocarpa* tall open shrubland over *Eremophila latrobei* subsp. *filiformis* and *Dodonaea petiolaris* mid sparse shrubland over *Triodia epactia* hummock grassland	Ecologia Environment	10/10/2014	458.59	0.566%
AaImTe	*Acacia aneura* and *Acacia pruinocarpa* tall shrubland, over *Acacia ancistrocarpa* and *Eremophila longifolia* mid sparse shrubland, over *Indigofera monophylla* and *Sida* sp. *verrucose* glands (F.H. Mollemans 2423) low sparse shrubland, over *Cenchrus ciliaris tuss*	Ecologia Environment	10/10/2014	361.42	0.446%
AancS1	*Acacia ancistrocarpa* and *Acacia bivenosa* Open Shrubland over *Ptilotus exaltatus* var. *exaltatus*, *Senna glutinosa* subsp. *luersseni*, *Acacia victoriae*, *Ptilotus clementii* Low Open Shrubland over a Hummock Grassland of *Triodia lanigera*.	Coffey Environments	22/08/2007	0.37	0.000%
AancS3	*Acacia ancistrocarpa* Open Shrubland to Open Heath over Hummock Grassland of *Triodia lanigera*, *Triodia epatica* and *Triodia angusta*.	Coffey Environments	22/08/2007	11.70	0.014%
AaPsCf	*Acacia aptaneura* open shrubland, over low *Abutilon otocarpum* sparse shrubland, over *Pterocaulon sphacelatum* and *Ptilotus obovatus* open forbeland, over open *Chrysopogon fallax* tussock grassland	Ecologia Environment	10/10/2014	217.25	0.268%
AaSfAl	*Acacia aptaneura* open shrubland, over low *Sida fibulifera* sparse shrubland, over *Aristida latifolia* and *Chrysopogon fallax* tussock grassland	Ecologia Environment	10/10/2014	468.68	0.578%
AaSvCc	*Acacia aneura* tall open shrubland over *Sida* sp. *verrucose* glands (F.H. Mollemans 2423) and *Sclerolaena cornishiana* mid sparse shrubland over *Abutilon otocarpum*, *Malvastrum americanum* and *Boerhavia coccinea* sparse herbland and *Cenchrus ciliaris* tussock grassland	Ecologia Environment	10/10/2014	236.07	0.291%
AaTb	Minor creeklines and floodplains	Cardno	10/08/2012	194.11	0.239%
AaTe	*Acacia acradenia*, *Acacia ancistrocarpa* and *Acacia tumida* var. *pilbarensis* tall open shrubland over *Triodia epactia*, *Triodia aff. lanigera* and *Triodia wiseana* mid open hummock grassland.	Coffey Environments	26/08/2014	88.84	0.110%
AaTw4	*Acacia acradenia* and *Acacia inaequilatera* sparse mid shrubland over *Triodia wiseana* and *Triodia lanigera* hummock grassland	Ecologia Environment	16/03/2012	5.89	0.007%
AaVfTH2	*Acacia aneura* shrubland, over mid *Vachellia farnesiana* sparse shrubland, over *Chrysopogon fallax* and *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland	Ecologia Environment	10/10/2014	210.74	0.260%
AbAsTe	*Acacia bivenosa*, *Grevillea wickhamii* subsp. *aprica* and *Acacia maitlandii* mid sparse shrubland, over *Acacia stellaticeps* low isolated shrubs, over *Triodia* aff. *epactia* and *Triodia* aff. *basedowii* sparse hummock grassland.	Ecologia Environment	31/10/2014	734.72	0.906%
AbHcTw	*Acacia bivenosa*, Senna artemisioides subsp. oligophylla, Senna glutinosa subsp. glutinosa x luerssenii mid open shrubland, over *Acacia inaequilatera*, *Senna artemisioides* subsp. *oligophylla* and *Heliotropium chrysocarpum* low sparse shrubland, over *Triodia*	Ecologia Environment	31/10/2014	1111.78	1.371%
AbiS3	*Acacia bivenosa* and *Acacia orthocarpa* Open Shrubland over *Acacia stellaticeps* Low Shrubland over Tussock Grassland of *Triodia lanigera*.	Coffey Environments	22/08/2007	0.00	0.000%
AbTb	*Acacia bivenosa* mid sparse shrubland, over *Triodia brizoides* closed hummock grassland	Ecologia Environment	31/10/2014	94.60	0.117%
AbTOS/AoAbAmTS	Tall Open Shrubland dominated by *Acaia bivenosa* over a Grassland of *Triodia basedowii* with scattered *Ptilotus gomphrenoides* var. *gomphrenoides* and *Eucalyptus leucophloia* subsp. *leucophloia* on rocky soils.	ATA Environmental	N/A	1585.82	1.956%
Ac1	*Eucalyptus victrix*, *Melaleuca argentea* low woodland to low open woodland	Biota Environmental Sciences	1/08/2004	231.22	0.285%
Ac1/Ac5	see Ac1 / Ac5	Biota Environmental Sciences	1/08/2004	90.82	0.112%
Ac11	*Corymbia* spp. scattered low trees over *Acacia tumida*, *A. colei* open scrub over *Triodia epactia* hummock grassland	Biota Environmental Sciences	1/08/2004	24.18	0.030%
Ac12	*Corymbia hamersleyana* scattered low trees over *Acacia tumida* high shrubland over *Triodia lanigera*, *T. epactia* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	27.44	0.034%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
Ac14	*Eucalyptus victrix*, *Corymbia* spp. scattered trees to low open woodland over *Acacia colei* open scrub over *Triodia epactia* dense hummock grassland	Biota Environmental Sciences	1/08/2004	85.31	0.105%
Ac15	*Eucalyptus victrix* low open woodland to woodland over *Acacia colei* scattered tall shrubs to high open shrubland over *Triodia epactia* scattered hummock grasses and *Eriachne* spp. tussock grasses	Biota Environmental Sciences	1/08/2004	432.06	0.533%
Ac17	*Acacia tumida*, *A. colei* open scrub over mixed tussock grassland	Biota Environmental Sciences	1/08/2004	31.94	0.039%
Ac19	Corymbia hamersleyana scattered low trees over Acacia ampliceps, A. tumida high shrubland over Triodia lanigera, *T. epactia* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	48.56	0.060%
Ac2	*Eucalyptus camaldulensis* scattered low trees over *Melaleuca argentea* low open forest over *Melaleuca linophylla*, *Acacia ampliceps* high shrubland	Biota Environmental Sciences	1/08/2004	120.01	0.148%
Ac20	*Acacia ampliceps* open scrub over *A. trachycarpa* shrubland over **Cenchrus ciliaris*, *Diplachne fusca* closed tussock grassland	Biota Environmental Sciences	1/08/2004	4.26	0.005%
Ac21	*Acacia ampliceps* open scrub over *Triodia secunda* hummock grassland	Biota Environmental Sciences	1/08/2004	21.26	0.026%
Ac22	*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	Biota Environmental Sciences	1/08/2004	78.13	0.096%
Ac24	*Acacia acradenia*, *A. colei* open scrub to high shrubland over *Triodia lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	5.07	0.006%
Ac27	*Acacia ancistrocarpa* open scrub over *Triodia epactia* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	3.80	0.005%
Ac28	*Acacia bivenosa* open heath over *Triodia lanigera* hummock grassland	Biota Environmental Sciences	1/08/2004	232.03	0.286%
Ac29	*Acacia farnesiana*, *A. sclerosperma* scattered tall shrubs over **Cenchrus ciliaris*, *Chrysopogon fallax* closed tussock grassland	Biota Environmental Sciences	1/08/2004	44.69	0.055%
Ac3	*Eucalyptus camaldulensis* woodland over *Melaleuca* spp. high shrubland to open scrub over *Triodia epactia*, tussock grasses and patches of sedges	Biota Environmental Sciences	1/08/2004	9.73	0.012%
Ac30	*Corymbia hamersleyana*, *C. candida* low open woodland over *Acacia colei*, *A. tumida* scattered tall shrubs over *Triodia epactia* hummock grassland and very open herbland	Biota Environmental Sciences	1/08/2004	14.31	0.018%
Ac31	*Acacia bivenosa* shrubland to open heath over *Triodia longiceps* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	162.18	0.200%
Ac4	*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	Biota Environmental Sciences	1/08/2004	85.15	0.105%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
Ac5/Ac6	see Ac5 / Ac6	Biota Environmental Sciences	1/08/2004	1.19	0.001%
Ac8	*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	Biota Environmental Sciences	1/08/2004	210.85	0.260%
Ac8/Ac1	see Ac8 / Ac1	Biota Environmental Sciences	1/08/2004	88.75	0.109%
Ac9	*Corymbia* spp. scattered low trees over *Acacia trachycarpa* open scrub over *Triodia lanigera* mid-dense hummock grassland and **Cenchrus ciliaris* tussock grassland	Biota Environmental Sciences	1/08/2004	67.26	0.083%
AcCmnTe	*Acacia citrinoviridis* open shrubland over *Crotalaria medicaginea* var. *neglecta* mid sparse shrubland over *Triodia epactia* sparse tussock grassland	Ecologia Environment	10/10/2014	7.12	0.009%
Ah1	*Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland to mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	1015.50	1.252%
Ah1/Aps1	see Ah1 / Aps1	Biota Environmental Sciences	1/08/2004	137.22	0.169%
Ah2/Aps3	see Ah2 / Aps3	Biota Environmental Sciences	1/08/2004	195.84	0.242%
Ah4	*Acacia ancistrocarpa, A. inaequilatera* scattered tall shrubs over *Triodia brizoides* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	48.89	0.060%
Ah5	*Corymbia hamersleyana* scattered low trees over *Triodia aff. basedowii* mid-dense to closed hummock grassland	Biota Environmental Sciences	1/08/2004	35.67	0.044%
Ah5a	*Acacia inaequilatera* scattered tall shrubs over *Triodia* aff. *lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	52.44	0.065%
Ah6	*Acacia ancistrocarpa* scattered shrubs over *Acacia stellaticeps* scattered low shrubs over *Triodia epactia, T. schinzii* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	40.31	0.050%
AhGwTe	*Atalaya hemiglauca* low open woodland over *Grevillea wickhamii* and *Acacia pyrifolia* mid open shrubland, over *Corchorus lasiocarpus, Indigofera monophylla* and *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) low open shrubland over *Triodia epac*	Biota Environmental Sciences	20/11/2017	209.08	0.258%
AiGwTp	*Acacia inaequilatera* and *Acacia ancistrocarpa* tall sparse shrubland over *Grevillea wickhamii* mid sparse shrubland over *Senna artemisioides* subsp. *oligophylla* low sparse shrubland over *Triodia pungens* hummock grassland	Ecologia Environment	10/10/2014	201.39	0.248%
AinS1	*Acacia inaequilatera* and *Acacia colei* var. *colei* Tall Open Shrubland with scattered *Corymbia* ? *hamersleyana* over *Acacia ancistrocarpa* Shrubland over *Acacia stellaticeps* and *Pluchea tetranthera* Low Shrubland over a Mid Dense	Coffey Environments	22/08/2007	0.00	0.000%
AinS5	*Acacia inaequilatera* Open Shrubland over a Closed Hummock Grassland of *Triodia lanigera*.	Coffey Environments	22/08/2007	0.00	0.000%
AinS7	*Acacia inaequilatera* Scattered Tall Shrubs over Hummock Grassland to Middense Hummock Grassland of *Triodia wiseana, Triodia longiceps* and *Triodia epatica*. *epatica*.	Coffey Environments	22/08/2007	0.00	0.000%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
AiSaoTw	*Acacia inaequilatera*, *Acacia ancistrocarpa* and *Acacia bivenosa* tall sparse shrubland, over *Senna artemisioides* subsp. *oligophylla* x *helmsii* mid sparse shrubland, over *Triodia wiseana* and *Triodia epactia* open hummock grassland.	Ecologia Environment	31/10/2014	2064.95	2.546%
AiTb	*Acacia inaequilatera*, *Acacia acradenia* and *Grevillea wickhamii* sparse shrubland, over *Triodia basedowii* and *Triodia wiseana* hummock grassland	Ecologia Environment	1/07/2012	55.63	0.069%
Aj2	N/A	Biota Environmental Sciences	1/08/2004	15.04	0.019%
AlOc	*Aristida latifolia*, *Aristida inaequiglumis* and *Eriachne ciliata* mid sparse grassland over *Oldenlandia crouchiana*, *Heliotropium crispatum* and *Operculina aequisepala* low sparse herbland	Cardno	10/08/2012	7.98	0.010%
AmaiS1	*Acacia maitlandii* and *Acacia orthocarpa* Tall Open Shrubland over an Open Hummock Grassland of *Triodia epactia*, *Triodia lanigera* and *Fimbristylis dichotoma*.	Coffey Environments	22/08/2007	0.00	0.000%
AmaiS3	*Acacia maitlandii* and *Hakea lorea* ssp. *lorea* Tall Open Shrubland over Acacia *inaequilatera* and *Acacia bivenosa* Open Shrubland over a Tussock Grassland dominated by *Triodia lanigera*.	Coffey Environments	22/08/2007	0.11	0.000%
AoAbAmTS	Tall Shrubland to 2.5m dominated by *Acacia orthrocarpa*, *Acacia bivenosa* and *Acacia maitlandii* with emergent *Eucalyptus leucophloia* subsp. *leucophloia* over an Open Shrubland dominated by *Acacia stellaticeps*	ATA Environmental	N/A	30.35	0.037%
AoAbTl	*Acacia orthocarpa* and *Acacia trachycarpa* tall open shrubland, over *Acacia bivenosa Acacia stellaticeps* and *Acacia pyrifolia* var. *pyrifolia* mid sparse shrubland, over *Triodia longiceps* and *Triodia epactia* hummock grassland.	Ecologia Environment	31/10/2014	284.51	0.351%
AorS1	*Acacia orthocarpa* and *Acacia maitlandii* Open Shrubland over a Hummock Grassland of *Triodia lanigera*.	Coffey Environments	22/08/2007	1.05	0.001%
AorS2	*Acacia orthocarpa* Open Heath to Tall Open Scrub over a Hummock to Closed Hummock Grassland of *Triodia lanigera*, *Triodia epatica, Triodia angusta* and *Triodia wiseana*.	Coffey Environments	22/08/2007	5.19	0.006%
AoTb	*Acacia orthocarpa* open mid shrubland over *Indigofera monophylla* sparse low shrubland over *Triodia basedowii* open hummock grassland	Ecologia Environment	16/03/2012	134.69	0.166%
ApAaTe	*Acacia pruinocarpa* and *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Acacia atkinsiana* mid sparse shrubland over *Hibiscus sturtii* and *Senna glutinosa* subsp. *glutinosa* low sparse shrubland over *Triodia epactia* hummock grassland	Ecologia Environment	10/10/2014	3247.37	4.005%
ApAatSENgTe	*Acacia pruinocarpa*, *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Acacia atkinsiana* mid sparse shrubland over *Senna glutinosa* subsp. *glutinosa* mid sparse shrubland over *Triodia epactia* mid hummock grassland	Biota Environmental Sciences	20/11/2017	312.93	0.386%
ApAlCc	*Acacia pteraneura*, *Acacia pruinocarpa* and *Psydrax latifolia* tall shrubland, over *Androcalva luteiflora*, *Senna glutinosa* subsp. *glutinosa* and *Acacia pyrifolia* var. *pyrifolia* mid sparse shrubland, over *Cenchrus ciliaris* and *Eulalia aurea* sparse tussock grass	Ecologia Environment	31/10/2014	12.03	0.015%
ApDpTe	*Acacia* aff. *aneura* (narrow fine veined; site 1259) and *Acacia pteraneura* and *Acacia pruinocarpa* low woodland, over *Dodonaea petiolaris*, *Grevillea berryana* and *Eremophila forrestii* subsp. *forrestii* mid sparse shrubland, over *Enneapogon polyphyllus*	Ecologia Environment	31/10/2014	56.35	0.069%
ApDpTp	Stony plain and hill vegetation – spinifex *domina**	Cardno	10/08/2012	74.78	0.092%
Aps1	*Acacia orthocarpa* high open shrubland to open scrub over *Triodia epactia* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	359.90	0.444%
Aps1/Aps2	see Aps1 / Aps2	Biota Environmental Sciences	1/08/2004	2281.95	2.814%
Aps1/Aps3	see Aps1 / Aps3	Biota Environmental Sciences	1/08/2004	274.73	0.339%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
Aps2	*Acacia orthocarpa* high shrubland to open scrub over *Triodia lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	388.96	0.480%
Aps2/Aps3	see Aps2 / Aps3	Biota Environmental Sciences	1/08/2004	312.95	0.386%
Aps2/Aps8	see Aps2 / Aps8	Biota Environmental Sciences	1/08/2004	376.53	0.464%
Aps3	*Acacia orthocarpa* high open shrubland to high shrubland over *Triodia wiseana* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	209.77	0.259%
Aps5	*Corymbia hamersleyana* scattered low trees over *Acacia colei* shrubland over *Triodia lanigera* hummock grassland	Biota Environmental Sciences	1/08/2004	42.12	0.052%
Aps6	*Acacia tumida* open shrubland to shrubland over *Triodia schinzii* hummock grassland	Ecoscape	1/01/2011	118.54	0.146%
Aps7	*Acacia colei* high shrubland over *Triodia epactia*, *T. lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	942.21	1.162%
Aps8	*Acacia maitlandii* open scrub over *Triodia lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	29.58	0.036%
Apt1	*Triodia epactia*, *T. secunda* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	509.87	0.629%
Apt10	*Acacia stellaticeps* scattered shrubs to low shrubland over *Triodia epactia* dense hummock grassland	Biota Environmental Sciences	1/08/2004	451.38	0.557%
Apt11	*Acacia* spp. scattered tall shrubs over *A. stellaticeps* low open shrubland over *Triodia lanigera* hummock grassland	Biota Environmental Sciences	1/08/2004	772.23	0.952%
Apt12	Acacia inaequilatera scattered tall shrubs over *Triodia lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	3422.35	4.220%
Apt12/Aps1	see Apt12 / Aps1	Biota Environmental Sciences	1/08/2004	669.92	0.826%
Apt12/Aps8	see Apt12 / Aps8	Biota Environmental Sciences	1/08/2004	496.83	0.613%
Apt13	*Acacia ancistrocarpa* open shrubland to open heath over *Triodia lanigera* hummock grassland	Biota Environmental Sciences	1/08/2004	2443.77	3.014%
Apt13/Ah1	see Apt13 / Ah1	Biota Environmental Sciences	1/08/2004	273.16	0.337%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
Apt13/Ah2	see Apt13 / Ah2	Biota Environmental Sciences	1/08/2004	655.55	0.808%
Apt14	*Acacia inaequilatera* scattered tall shrubs to high open shrubland over *Triodia epactia* hummock grassland to mid-dense hummock grassland	Ecoscape	1/01/2011	36.21	0.045%
Apt15	*Acacia inaequilatera*, *A. ancistrocarpa* scattered tall shrubs over *Triodia epactia, T. lanigera* hummock grassland	Biota Environmental Sciences	1/08/2004	1033.37	1.274%
Apt15/Aps7	see Apt15 / Aps7	Biota Environmental Sciences	1/08/2004	57.37	0.071%
Apt16	*Acacia colei*, *A. tumida* high open shrubland over *Triodia epactia* hummock grassland	Biota Environmental Sciences	1/08/2004	350.19	0.432%
Apt18	*Acacia inaequilatera*, *A. ancistrocarpa* scattered tall shrubs over *Triodia basedowii* closed hummock grassland	Biota Environmental Sciences	1/08/2004	74.22	0.092%
Apt2/Apt7	see Apt2 / Apt7	Biota Environmental Sciences	1/08/2004	505.81	0.624%
Apt3	*Triodia epactia* hummock grassland to mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	155.43	0.192%
Apt4	*Triodia longiceps*, *T. epactia* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	1434.01	1.768%
Apt4/Apt1	See Apt4/Apt1	Biota Environmental Sciences	1/08/2004	255.32	0.315%
Apt5	*Triodia angusta* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	628.99	0.776%
Apt6	*Acacia stellaticeps*, *Pluchea ferdinandi-muelleri* low open shrubland over *Triodia lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	240.31	0.296%
Apt7	*Acacia* spp., *Pluchea ferdinandi-muelleri* scattered shrubs over *Triodia longiceps* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	1283.60	1.583%
Apt8	*Acacia stellaticeps*, *Pluchea ferdinandi-muelleri* low open shrubland over *Triodia angusta*, *T. lanigera* mid-dense hummock grassland	Biota Environmental Sciences	1/08/2004	0.25	0.000%
ApTp	Stony plain and hill vegetation – spinifex *domina**	Cardno	10/08/2012	109.56	0.135%
Ar1/Ar2/Ar3 /Ar4	see Ar1 / Ar2 / Ar3 / Ar4	Biota Environmental Sciences	1/08/2004	997.97	1.231%
Ar5	*Acacia inaequilatera* scattered tall shrubs over *Gossypium australe* (Whim Creek form) open shrubland over *Triodia epactia* hummock grassland	Biota Environmental	1/08/2004	13.07	0.016%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
		Sciences			
Ar6	*Acacia tumida*, *Grevillea wickhamii* scattered shrubs to open shrubland over *Triodia epactia* open hummock grassland to hummock grassland	Ecoscape	1/01/2011	13.74	0.017%
AsTl	*Acacia stellaticeps* sparse low shrubland over *Triodia longiceps* hummock grassland over *Bulbostylis barbata* isolated sedges	Ecologia Environment	16/03/2012	20.22	0.025%
AstS1	*Acacia stellaticeps* Open Heath to Low Shrubland over a Hummock to Mid Dense Hummock Grassland of *Triodia epactia*.	Coffey Environments	22/08/2007	0.01	0.000%
AtCcTl	*Acacia trachycarpa*, *Atalaya hemiglauca*, *Acacia coriacea* subsp. *pendens* tall open shrubland, over *Crotalaria cunninghamii* and *Acacia pyrifolia* var. *pyrifolia* mid sparse shrubland, over *Triodia longiceps* sparse hummock grassland and *Cenchrus ciliaris*	Ecologia Environment	31/10/2014	15.22	0.019%
AtGwTw	*Acacia trachycarpa* tall open shrubland over *Grevillea wickhamii* mid sparse shrubland over *Corchorus tectus*, *Ptilotus astrolasius* and *Ptilotus calostachyus* low sparse shrubland over *Triodia pungens* and *Triodia wiseana* hummock grassland	Ecologia Environment	10/10/2014	2.17	0.003%
AtTl	*Atalaya hemiglauca*, *Acacia xiphophylla* and *Acacia trachycarpa* tall shrubland, over *Triodia longiceps* and *Triodia wiseana* sparse hummock grassland.	Ecologia Environment	31/10/2014	29.86	0.037%
AtuS2	*Acacia tumida* and *Acacia colei* Tall Open Scrub over mixed tussock grassland.	Coffey Environments	22/08/2007	0.01	0.000%
AxAvAl	*Hakea lorea* subsp. *lorea Acacia tetragonophylla* and *Acacia xiphophylla* tall sparse shrubland, over *Acacia victoriae* mid sparse shrubland, over *Aristida latifolia* and *Chrysopogon fallax* sparse tussock grassland, and *Triodia epactia* sparse tussock grassland	Ecologia Environment	31/10/2014	357.99	0.441%
AxEx	*Acacia xiphophylla*, *Acacia synchronicia* and *Acacia victoriae* tall open shrubland, over *Eragrostis xerophila*, *Eragrostis leptocarpa* and *Cenchrus ciliaris* sparse tussock grassland.	Ecologia Environment	31/10/2014	814.79	1.005%
AxSahTw	*Acacia xiphophylla* tall open shrubland, over *Senna artemisioides* subsp. *helmsii* mid sparse shrubland, over *Cymbopogon ambiguus* sparse tussock grassland and *Triodia epactia* sparse hummock grassland.	Ecologia Environment	31/10/2014	158.89	0.196%
AxSaoTl	*Acacia xiphophylla* and *Acacia* aff. *aneura* (narrow fine veined; site 1259) tall open shrubland, over *Senna artemisioides* subsp. *oligophylla* x *helmsii* and *Senna glutinosa* subsp. *glutinosa* mid sparse shrubland, over *Triodia longiceps* sparse hummock grassland	Ecologia Environment	31/10/2014	95.39	0.118%
Cc20	*Corymbia* spp. scattered low trees over *Acacia coriacea* subsp. *pendens*, *A. ancistrocarpa*, *A. tenuissima* tall open shrubland over *Triodia epactia* mid-dense hummock grassland and open tussock grasses	ATA Environmental	N/A	109.16	0.135%
CfW1	N/A	Coffey Environments	22/08/2007	0.00	0.000%
Ch15	*Acacia bivenosa* scattered shrubs over *Triodia longiceps* mid-dense hummock grassland	ATA Environmental	N/A	644.88	0.795%
Ch17	*Acacia aneura*, *A. adsurgens*, *G. wickhamii*, *Senna glutinosa* subsp. *glutinosa*, *S. glutinosa* subsp. x l*uerssenii* scattered shrubs over *Triodia* aff. *basedowii* mid-dense hummock grassland	ATA Environmental	N/A	2338.40	2.884%
Ch17/Ch20	*Acacia aneura*, *A. adsurgens*, *G. wickhamii*, *Senna glutinosa* subsp. *glutinosa*, *S. glutinosa* subsp. *x luerssenii* scattered shrubs over *Triodia* aff. *basedowii* mid-dense hummock grassland	ATA Environmental	N/A	547.28	0.675%
Ch18	N/A	ATA Environmental	N/A	256.29	0.316%
Ch24	*Acacia bivenosa* open shrubland over *Triodia wiseana* mid-dense hummock grassland	ATA Environmental	N/A	732.76	0.904%
ChAaTw	*Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* low sparse woodland, over *Acacia arida* and *Grevillea wickhamii* mid sparse shrubland, over *Acacia adoxa* var. *adoxa* low sparse shrubland, over *Triodia wiseana* hummock grassland	Ecologia Environment	10/10/2014	0.35	0.000%
ChAbTl	Stony plain and hill vegetation – spinifex domina*	Cardno	10/08/2012	3.02	0.004%
ChAbTp	Minor creeklines and floodplains	Cardno	10/08/2012	3.71	0.005%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
ChAbTw	Stony plain and hill vegetation – spinifex domina*	Cardno	10/08/2012	265.19	0.327%
ChAcTe	*Corymbia hamersleyana* low isolated trees, over *Acacia aneura, Acacia coriacea* subsp. *pendens* and *Acacia synchronicia* tall sparse shrubland, over *Triodia epactia* sparse hummock grassland.	Ecologia Environment	31/10/2014	146.66	0.181%
ChAdTe1	*Corymbia hamersleyana* low sparse woodland, over *Acacia dictyophleba* mid sparse shrubland, over *Triodia epactia* hummock grassland	Ecologia Environment	10/10/2014	380.67	0.469%
ChAiTw	*Corymbia hamersleyana* and/ or *E. leucophloia* subsp. *leucophloia* low open woodland over *Acacia inaequilatera* and/ or *A. bivenosa* mid sparse shrubland over *Triodia wiseana* low open hummock grassland	Biota Environmental Sciences	20/11/2017	188.86	0.233%
ChAiTw1	*Corymbia hamersleyana* low open woodland over *Acacia inaequilatera*, *Hakea lorea* subsp. *lorea* and *Eremophila longifolia* mid sparse shrubland over *Triodia wiseana* hummock grassland	Ecologia Environment	10/10/2014	2.72	0.003%
ChAiTw2	*Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* low sparse woodland over *Acacia inaequilatera* and *Grevillea wickhamii* tall sparse shrubland over *Triodia wiseana* hummock grassland	Ecologia Environment	10/10/2014	1709.32	2.108%
ChAiTw4	*Corymbia hamersleyana* low sparse woodland, over *Acacia inaequilatera* tall sparse shrubland over *Senna glutinosa* subsp. *glutinosa* mid sparse shrubland over *Triodia wiseana* hummock grassland	Ecologia Environment	10/10/2014	1885.41	2.325%
ChAoCf	*Corymbia hamersleyana* low woodland over Tall *Acacia aptaneura* open shrubland, over low *Abutilon otocarpum* sparse shrubland, over *Pterocaulon sphacelatum* and *Ptilotus obovatus* open forbeland, over open *Chrysopogon fallax* tussock grassland	Ecologia Environment	10/10/2014	180.95	0.223%
ChApTe1	*Corymbia hamersleyana* low sparse woodland, *Acacia pyrifolia* and *Acacia tumida* var. *pilbarensis* mid sparse shrubland over *Triodia epactia* closed hummock grassland	Ecologia Environment	10/10/2014	232.78	0.287%
ChApTe2	*Corymbia hamersleyana* low sparse woodland over *Acacia pyrifolia* tall sparse shrubland over *Triodia epactia* hummock grassland	Ecologia Environment	10/10/2014	414.73	0.511%
ChApyTHtTe	*Corymbia hamersleyana* low open woodland over *Acacia pyrifolia* and/or *A. tumida* var. *pilbarensis* mid sparse shrubland occasionally over *Gossypium australe* low sparse shrubland over *Themeda triandra* open tussock grassland over *Triodia epactia* mid open hummock grassland	Biota Environmental Sciences	20/11/2017	8.79	0.011%
ChaW2	*Corymbia hamersleyana* Low Open Woodland over Mixed Open to Mid Dense Hummock Grassland.	Coffey Environments	22/08/2007	0.03	0.000%
ChGplTe	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low isolated trees, over *Acacia atkinsiana*, *Grevillea pyramidalis* subsp. *leucadendron* and *Acacia elachantha* tall sparse shrubland, over *Triodia epactia* hummock grassland.	Ecologia Environment	31/10/2014	636.82	0.785%
Cleared	N/A	Coffey Environments	20/11/2009	15.34	0.019%
CzAaTl	*Corymbia zygophylla* sparse low woodland over *Acacia ancistrocarpa* mid sparse shrubland over *Triodia* aff. *lanigera* mid hummock grassland.	Coffey Environments	26/08/2014	42.92	0.053%
dist	N/A	Biota Environmental Sciences	1/08/2004	2.84	0.004%
EcAcEUaTe	*Eucalyptus camaldulensis* subsp. *refulgens*, *E. victrix* mid woodland over *Acacia citrinoviridis*, *Melaleuca glomerata* tall open shrubland over *Eulalia aurea* mid sparse tussock grassland over *Triodia epactia* low sparse hummock grassland	Biota Environmental Sciences	20/11/2017	20.37	0.025%
EcApCa	*Eucalyptus camaldulensis* and *Melaleuca argentea* low woodland over *Acacia pyrifolia* tall sparse shrubland over *Tephrosia rosea* and *Corchorus crozophorifolius* mid sparse shrubland over *Cymbopogon ambiguus* open tussock grassland	Ecologia Environment	10/10/2014	147.61	0.182%
EcOW	Open Woodland to 11m dominated by *Eucalyptus camaldulensis* var. *obtusa* with emergent *Melaleuca leucadrenda* over a Tall Shrubland to 3m dominated by *Melaleuca linophylla* and *Acacia adsurgens* over a Grassland	ATA Environmental	N/A	353.25	0.436%
EgAatAtuTe	*Eucalyptus gamophylla* low open mallee woodland over *Acacia atkinsiana*, *A. tumida var pilbarensis* and /or *A. bivenosa* and *Senna artemisioides* subsp. *oligophylla* mid sparse shrubland over *Themeda triandra* mid sparse tussock grassland over *Triodia epactia*,	Biota Environmental Sciences	20/11/2017	200.71	0.248%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
EgAaTe3	*Eucalyptus gamophylla* and *Eucalyptus leucophloia* subsp. *leucophloia* low sparse woodland, over *Acacia atkinsiana* and *Senna glutinosa* subsp. *glutnosa* mid sparse shrubland, over *Keraudrenia nephrosperma* and *Acacia spondylophylla* low sparse shrubland	Ecologia Environment	10/10/2014	1115.88	1.376%
EgAaTe4	*Eucalyptus gamophylla* low sparse woodland over *Acacia atkinsiana* and *Acacia tumida* var. *pilbarensis* mid sparse shrubland over *Triodia epactia* hummock grassland and *Themeda triandra* tussock grassland	Ecologia Environment	10/10/2014	129.64	0.160%
ElAbTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Acacia bivenosa* mid sparse shrubland over *Triodia wiseana* mid closed hummock grassland	Biota Environmental Sciences	20/11/2017	157.83	0.195%
ElAdAadTw	*Eucalyptus leucophloia* subsp. *leucophloia*, *Corymbia hamersleyana* low open woodland over *Acacia dictyophleba* and/ or *A. tenuissima* and *A. cowleana* mid sparse shrubland over *A. adoxa* var. *adoxa* low sparse shrubland over *Triodia wiseana* mid hummock grassland	Biota Environmental Sciences	20/11/2017	257.39	0.317%
ElEgApTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Eucalyptus gamophylla* mid open mallee woodland over *Acacia pruinocarpa* and/ or *A. pyrifolia* tall sparse shrubland over *Triodia wiseana* mid hummock grassland	Biota Environmental Sciences	20/11/2017	39.90	0.049%
ElHlAatPTcTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Acacia atkinsiana*, *A. bivenosa*, *A. maitlandii* mid sparse shrubland over *Ptilotus calostachyus* low sparse shrubland over Triodia wiseana c	Biota Environmental Sciences	20/11/2017	25.48	0.031%
EllAbTw1	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland, over *Acacia bivenosa* and *Senna glutinosa* subsp. *glutinosa* mid sparse shrubland, over *Triodia wiseana* closed hummock grassland	Ecologia Environment	10/10/2014	140.99	0.174%
EllAbTw4	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland, over *Acacia bivenosa* and *Senna glutinosa* subsp. *glutinosa* mid sparse shrubland over *Triodia wiseana* closed hummock grassland	Ecologia Environment	10/10/2014	85.41	0.105%
EllAiTw	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low sparse woodland over *Acacia inaequilatera* tall sparse shrubland over *Acacia bivenosa* and *Senna glutinosa* subsp. *glutinosa* mid sparse shrubland over *Ptilotus calostachyus* low sparse s	Ecologia Environment	10/10/2014	284.71	0.351%
EllAmTe	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland, over *Acacia monticola*, *Acacia spondylophylla* and *Acacia bivenosa* mid sparse shrubland, over *Triodia epactia* open hummock grassland.	Ecologia Environment	31/10/2014	485.47	0.599%
EllAxTp	Low *Eucalyptus leucophloia* subsp. *leucophloia* open woodland, over tall *Acacia xiphophylla* sparse shrubland, over mid *Acacia bivenosa* sparse shrubland, over open *Triodia pungens* and *Triodia basedowii* hummock grassland	Ecologia Environment	10/10/2014	49.40	0.061%
EllGwTw1	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low sparse woodland over *Grevillea wickhamii* tall sparse shrubland over *Acacia monticola* mid sparse shrubland over *Corchorus lasiocarpus* low sparse shrubland over *Triodia wiseana* open hummock grassland	Ecologia Environment	10/10/2014	418.68	0.516%
EllHcTw2	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low sparse woodland over *Hakea chordophylla* mid sparse shrubland over *Acacia hilliana* and *Acacia adoxa* var. *adoxa* low sparse shrubland over *Triodia wiseana* hummock grassland	Ecologia Environment	10/10/2014	16.17	0.020%
EllHcTw4	*Eucalyptus leucophloia* subsp. *leucophloia* low sparse woodland over *Hakea chordophylla* tall sparse shrubland over *Senna glutinosa* subsp. *glutinosa* mid sparse shrubland over *Triodia wiseana* closed hummock grassland	Ecologia Environment	10/10/2014	257.35	0.317%
EllHlTw	*Eucalyptus leucophloia* subsp. *leucophloia* low sparse woodland over *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Acacia atkinsiana*, *Acacia bivenosa* and *Acacia maitlandii* mid sparse shrubland, over *Ptilotus calostachyus* low sparse shrubland	Ecologia Environment	10/10/2014	931.11	1.148%
EoApAl	*Eriachne obtusa*, *Astrebla pectinata* and *Aristida latifolia* open tussock grassland.	Ecologia Environment	31/10/2014	1217.90	1.502%
Ev	*Eucalyptus victrix* Open Woodland Formation	GHD	1/09/2012	0.43	0.001%
EvAcCc	*Eucalyptus victrix* low closed woodland *Acacia aneura* and *Acacia citrinoviridis* tall sparse shrubland over *Acacia victoriae* mid sparse shrubland over *Cenchrus ciliaris* tussock grassland	Ecologia Environment	10/10/2014	875.61	1.080%
EvAcEa	*Eucalyptus victrix* mid open woodland, over *Acacia citrinoviridis* tall sparse shrubland, over *Atalaya hemiglauca* and *Acacia tetragonophylla* mid sparse shrubland, over *Eriachne benthamii* and *Eulalia aurea* open tussock grassland	Ecologia Environment	10/10/2014	160.27	0.198%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
EvAcpCv	*Eucalyptus victrix*, *Eucalyptus camaldulensis* subsp. *obtuse* and *Melaleuca glomerata* mid woodland, over *Acacia coriacea* subsp. *pendens* and *Acacia trachycarpa* tall sparse shrubland, over *Cyperus vaginatus* open sedgeland.	Ecologia Environment	31/10/2014	282.60	0.348%
EvAppTt	*Eucalyptus victrix* mid woodland, over *Acacia pyrifolia* var. *pyrifolia*, *Acacia maitlandii* and *Acacia tumida* var. *pilbarensis* mid sparse shrubland, over *Triodia epactia* sparse hummock grassland and *Themeda triandra* sparse tussock grassland.	Ecologia Environment	31/10/2014	263.23	0.325%
EvMlTp	Major creeklines	Cardno	10/08/2012	64.32	0.079%
ExAaCv	*Eucalyptus xerothermica* low isolated trees, over *Acacia ampliceps*, *Acacia coriacea* subsp. *pendens* and *Melaleuca glomerata* tall sparse shrubland, over *Cyperus vaginatus* sparse sedgeland and *Triodia longiceps* sparse hummock grassland.	Ecologia Environment	31/10/2014	43.32	0.053%
ExAcpTe	*Eucalyptus victrix* and *Eucalyptus xerothermica* low open woodland, over *Acacia coriacea* subsp. *pendens*, *Acacia ampliceps* and *Acacia trachycarpa* tall open shrubland, over *Cyperus vaginatus* sparse sedgeland and *Triodia epactia* sparse hummock grassland.	Ecologia Environment	31/10/2014	59.15	0.073%
Fc4	*Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens*, *A. aneura, Atalaya hemiglauca* low woodland over **Cenchrus ciliaris* tussock grassland	ATA Environmental	N/A	192.23	0.237%
Fc4/Cc18	*Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens*, *A. aneura*, *Atalaya hemiglauca* low woodland over **Cenchrus ciliaris* tussock grassland	ATA Environmental	N/A	453.63	0.559%
Fc5/Fc6/Cc18	*Acacia coriacea* subsp. *pendens* low woodland over *Hakea lorea* subsp. *lorea*, *Acacia tetragonophylla*, *A. pyrifolia*, *Atalaya hemiglauca* tall open shrubland over **Cenchrus ciliaris* closed tussock grassland	ATA Environmental	N/A	145.69	0.180%
Fx1	*Acacia xiphophylla* open scrub over *Cassia sturtii* shrubland to low open heath over *Eragrostis xerophila* open tussock grassland	ATA Environmental	N/A	267.32	0.330%
Fx10	*Acacia synchronicia* tall open shrubland over *Aristida latifolia* open tussock grassland and *Ptilotus gomphrenoides* var. *gomphrenoides*, *Chloris pectinata* open annual herbland / grassland	ATA Environmental	N/A	439.54	0.542%
Fx11/Fx12	N/A	ATA Environmental	N/A	142.21	0.175%
GwiS1	*Grevillea wickhamii* and *Acacia maitlandii* Tall Open Shrubland over *Acacia stellaticeps* Open Heath with occasional *Sida* sp. over a Mid-Dense Hummock Grassland of *Triodia lanigera*.	Coffey Environments	22/08/2007	0.00	0.000%
GwTp	*Grevillea wickhamii* sparse tall shrubland over *Triodia pungens* open hummock grassland and isolated *Eragrostis cumingii* tussock grasses *Cyperus squarrosus* sedges and *Stemodia viscosa* herbs	Ecologia Environment	16/03/2012	77.33	0.095%
HcTb	*Heliotropium cunninghamii* and *Acacia inaequilatera* sparse shrubland, over *Triodia basedowii* and *Triodia pungens* open hummock grassland	Ecologia Environment	1/07/2012	2.48	0.003%
HD	Highly Degraded	GHD	1/09/2012	131.59	0.162%
HllAvCf	*Hakea lorea* subsp. *lorea* and *Atalaya hemiglauca* tall sparse shrubland over *Acacia victoriae* mid sparse shrubland over *Chrysopogon fallax* and *Eulalia aura* tussock grassland	Ecologia Environment	10/10/2014	87.52	0.108%
ImTp	*Indigofera monophylla* and *Solanum phlomoides* sparse open shrubland over *Triodia pungens* and *Triodia basedowii* sparse hummock grassland with *Mollugo molluginea* and *Bonamia linearis* isolated herbs	Ecologia Environment	16/03/2012	1104.89	1.363%
ImTs	*Indigofera monophylla* isolated low shrubs over *Triodia schinzii* open hummock grassland over *Ptilotus astrolasius* isolated herbs	Ecologia Environment	16/03/2012	6.30	0.008%
Infrastructure	Infrastructure	ENV.Australia	24/02/2011	314.78	0.388%
M1	Open Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* var. *obtusa* with pockets of *Acacia coriacea* subsp. *pendens* over *Grevillea wickhamii* subsp. *aprica*, *Petalostylis labicheoides*, *Acacia tumida* over *Triodia longiceps*, *Chrysopogon fallax*, *Themeda*	ATA Environmental	N/A	197.61	0.244%
M17	*Hummock Grassland* of *Triodia basedowii* with pockets of *Triodia epactia* and *Triodia lanigera* with emergent patches of *Eucalyptus leucophloia*, *Corymbia deserticola* over *Acacia ancistrocarpa*, *Acacia pyrifolia*, *Hakea lorea* subsp. *lorea* over *Goodenia stobbsia*	ATA Environmental	N/A	253.01	0.312%
M9	Closed Scrub to Shrubland of *Acacia ancistrocarpa, Acacia maitlandii, Acacia kempeana*, *Acacia monticola* with	ATA Environmental	N/A	87.49	0.108%

Map Unit	NVIS Level V Association	Company	Report Date	Area (ha)	% in study area
	occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Senna* species, *Triodia basedowii* and *Aristida* species.				
MeTs	*Melaleuca eleuterostachya*, *Acacia stellaticeps* and *Acacia bivenosa* low, sparse shrubland, over *Triodia secunda* hummock grassland.	Ecologia Environment	31/10/2014	20.37	0.025%
N/A	Not Assessed	Biota Environmental Sciences	1/08/2004	11.86	0.015%
PfTe	*Pluchea ferdinandi-muelleri* low sparse shrubland over *Triodia epactia* and *Triodia secunda* mid open hummock grassland.	Coffey Environments	26/08/2014	8.23	0.010%
PlTl	*Petalostylis labicheoides* and *Corchorus parviflorus* sparse shrubland, over *Triodia lanigera* open hummock grassland	Ecologia Environment	1/07/2012	9.59	0.012%
SMS1	Scattered Mixed Low Shrubs and Mixed Herbs over a Mid-Dense Hummock Grassland of *Triodia longiceps*.	Coffey Environments	22/08/2007	0.00	0.000%
TanHG1	*Triodia angusta* Hummock to Mid Dense Hummock Grassland.	Coffey Environments	22/08/2007	2.40	0.003%
TeAo	*Triodia epactia*\ *Acacia orthocarpa* Hummock Grassland	GHD	1/09/2012	3.71	0.005%
TeAs	*Triodia epactia* \ *Acacia stellaticeps* Hummock Grassland	GHD	1/09/2012	368.69	0.455%
TepTlaHG1	*Triodia angusta* and *Triodia lanigera* Hummock Grassland with scattered *Acacia stellaticeps*.	Coffey Environments	22/08/2007	0.07	0.000%
TepTloHG1	*Triodia epactia* and *Triodia longiceps* Open Hummock to Closed Hummock Grassland.	Coffey Environments	22/08/2007	13.04	0.016%
TlAs	*Triodia lanigera* \ *Acacia stellaticeps* Hummock Grassland	GHD	1/09/2012	933.12	1.151%
TloHG1	*Triodia longiceps* Hummock to Mid Dense Hummock Grassland.	Coffey Environments	22/08/2007	0.00	0.000%
Tp	*Triodia pungens* open hummock grassland	Ecologia Environment	16/03/2012	485.34	0.599%
TsAs	*Triodia secunda* \ *Acacia stellaticeps* Hummock Grassland	GHD	1/09/2012	1.76	0.002%
Tw4	*Triodia wiseana* hummock grassland	Ecologia Environment	16/03/2012	16.52	0.020%
VfAl	*Vachellia farnesiana* sparse shrubland, over *Aristida latifolia*, *Eriachne benthamii* grassland	Ecologia Environment	10/10/2014	125.54	0.155%
			TOTAL	**81,090**	**100%**

APPENDIX SIX: VEGETATION MAPPING – SPECIES LIST

Table 19: Vegetation Mapping – Species List

Family	Species
Acanthaceae	*Dipteracanthus australasicus subsp. australasicus*
	Rostellularia adscendens
	Rostellularia adscendens var. clementii
Aizoaceae	*Trianthema oxycalyptra*
	Trianthema pilosa
	Trianthema triquetra
	Trianthema turgidifolia
Amaranthaceae	*Achyranthes aspera*
	Aerva javanica
	Alternanthera denticulata
	Alternanthera nana
	Amaranthus cuspidifolius
	Amaranthus undulatus
	Gomphrena canescens subsp. canescens
	Gomphrena cunninghamii
	Gomphrena leptoclada
	Gomphrena leptophylla
	Gomphrena sordida
	Ptilotus aervoides
	Ptilotus astrolasius
	Ptilotus auriculifolius
	Ptilotus axillaris
	Ptilotus calostachyus
	Ptilotus clementii
	Ptilotus exaltatus var. exaltatus
	Ptilotus fusiformis
	Ptilotus gaudichaudii var. gaudichaudii
	Ptilotus gomphrenoides
	Ptilotus macrocephalus
	Ptilotus nobilis subsp. nobilis
	Ptilotus obovatus
	Ptilotus obovatus var. obovatus
	Ptilotus rotundifolius
	Ptilotus sp.
Apocynaceae	*Calotropis procera*
	Gymnanthera cunninghamii
Araliaceae	*Trachymene oleracea*
Asteraceae	*Bidens bipinnata*
	Bidens subalternans
	Blumea tenella
	Calotis porphyroglossa
	Centipeda minima subsp. macrocephala
	Flaveria trinervia

Family	Species
Asteraceae	*Pluchea dentex*
	Pluchea dunlopii
	Pluchea ferdinandi-muelleri
	Pluchea rubelliflora
	Pluchea tetranthera
	Pseudognaphalium luteoalbum
	Pterocaulon serrulatum
	Pterocaulon sphacelatum
	Pterocaulon sphaeranthoides
	Rhodanthe margarethae
	Sonchus oleraceus
	Streptoglossa bubakii
	Streptoglossa decurrens
	Streptoglossa liatroides
	Streptoglossa odora
Boraginaceae	*Heliotropium ? Chrysopcarpum*
	Heliotropium ammophilum
	Heliotropium chrysocarpum
	Heliotropium conocarpum
	Heliotropium crispatum
	Heliotropium cunninghamii
	Heliotropium heteranthum
	Heliotropium inexplicitum
	Heliotropium muticum
	Heliotropium ovalifolium
	Heliotropium pachyphyllum
	Heliotropium tenuifolium
	Trichodesma zeylanicum
Brassicaceae	*Lepidium pholidogynum*
Cactaceae	*Optunia spp*
	Opuntia spp
Campanulaceae	*Lobelia arnhemiaca*
	Wahlenbergia tumidifructa
Caryophyllaceae	*Polycarpaea corymbosa*
	Polycarpaea holtzei
	Polycarpaea longiflora
Celastraceae	*Stackhousia intermedia*
Chenopodiaceae	*Dysphania kalpari*
	Dysphania plantaginella
	Dysphania rhadinostachya
	Dysphania rhadinostachya subsp. rhadinostachya
	Dysphania sp.
	Maireana planifolia
	Maireana villosa
	Rhagodia eremaea

Family	Species
Chenopodiaceae	*Salsola australis*
	Salsola tragus
	Sclerolaena cornishiana
	Sclerolaena costata
	Sclerolaena densiflora
Cleomaceae	*Cleome oxalidea*
	Cleome uncifera
	Cleome viscosa
Convolvulaceae	*Bonamia erecta*
	Bonamia linearis
	Bonamia media
	Bonamia media var. villosa
	Bonamia pannosa
	Bonamia rosea
	Convolvulaceae sp.
	Convolvulus clementii
	Duperreya commixta
	Evolvulus alsinoides var. villosicalyx
	Evolvulus alsinoides
	Evolvulus alsinoides subsp. alsinoides
	Evolvulus alsinoides var. decumbens
	Ipomoea macrantha
	Ipomoea muelleri
	Ipomoea polymorpha
	Ipomoea sp.
	Operculina aequisepala
	Polymeria ?ambigua
	Polymeria ambigua
Cucurbitaceae	*Austrobryonia pilbarensis*
	Citrullus colocynthis
	Citrullus lanatus
	Cucumis maderaspatanus
	Cucumis melo
	Cucumis myriocarpus
	Cucumis variabilis
Cyperaceae	*Bulbostylis barbata*
	Bulbostylis burbidgeae
	Bulbostylis turbinata
	Cyperus ?blakeanus
	Cyperus blakeanus
	Cyperus bulbosus
	Cyperus difformis
	Cyperus hesperius
	Cyperus iria
	Cyperus ixiocarpus

Family	Species
Cyperaceae	*Cyperus sp.*
	Cyperus squarrosus
	Cyperus vaginatus
	Eleocharis geniculata
	Fimbristylis depauperata
	Fimbristylis dichotoma
	Fimbristylis leucocolea
	Fimbristylis microcarya
	Fimbristylis simulans
	Fuirena ciliaris
	Lipocarpha microcephala
Droseraceae	*Drosera indica*
Elatinaceae	*Bergia trimera*
Euphorbiaceae	*Adriana tomentosa*
	Adriana tomentosa var. tomentosa
	Euphorbia ? australis
	Euphorbia alsiniflora
	Euphorbia australis
	Euphorbia australis var. glabra
	Euphorbia australis var. subtomentosa
	Euphorbia biconvexa
	Euphorbia boophthona
	Euphorbia clementii
	Euphorbia drummondii
	Euphorbia schultzii
	Euphorbia sp.
	Mallotus nesophilus
	Microstachys chamelea
Fabaceae	*Acacia acradenia*
	Acacia ampliceps
	Acacia ancistrocarpa
	Acacia aptaneura
	Acacia arida
	Acacia atkinsiana
	Acacia bivenosa
	Acacia citrinoviridis
	Acacia colei
	Acacia colei var. colei
	Acacia colei var. ileocarpa
	Acacia coriacea subsp. pendens
	Acacia elachantha
	Acacia eriopoda
	Acacia inaequilatera
	Acacia maitlandii
	Acacia orthocarpa

Family	Species
	Acacia pruinocarpa
	Acacia pyrifolia
	Acacia pyrifolia var. pyrifolia
	Acacia sibirica
	Acacia sp.
	Acacia spondylophylla
	Acacia stellaticeps
	Acacia synchronicia
	Acacia tenuissima
	Acacia tetragonophylla
	Acacia trachycarpa
	Acacia tumida var. pilbarensis
	Cajanus cinereus
	Cajanus pubescens
	Crotalaria cunninghamii
	Crotalaria dissitiflora subsp. benthamiana
	Crotalaria juncea
	Crotalaria medicaginea
	Crotalaria novae-hollandiae subsp. novae-hollandiae
	Cullen martinii
	Desmodium filiforme
	Dichrostachys spicata
Fabaceae	*Fabaceae sp.*
	Glycine argillacea
	Glycine canescens
	Glycine falcata
	Gompholobium polyzygum
	Indigofera colutea
	Indigofera monophylla
	Indigofera sp.
	Isotropis atropurpurea
	Lotus australis
	Neptunia dimorphantha
	Petalostylis labicheoides
	Rhynchosia minima
	Rothia indica subsp. australis
	Senna artemisioides
	Senna artemisioides subsp. helmsii
	Senna artemisioides subsp. oligophylla
	Senna glutinosa subsp. glutinosa
	Senna glutinosa subsp. pruinosa
	Senna glutinosa subsp. x luerssenii
	Senna notabilis
	Senna symonii
	Sesbania cannabina

Family	Species
Fabaceae	*Stylosanthes hamata*
	Swainsona stenodonta
	Swainsona tanamiensis
	Tephrosia rosea
	Tephrosia rosea var. clementii
	Tephrosia rosea var. Fortescue Creeks (M.I.H. Brooker 2186)
	Tephrosia rosea var. glabrior
	Tephrosia rosea var. Port Hedland (A.S. George 1114)
	Tephrosia rosea var. rosea
	Tephrosia sp.
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)
	Tephrosia sp. Pilbara (A.L. Payne PRP 1393)
	Tephrosia spechtii
	Tephrosia supina
	Vachellia farnesiana
	Vigna lanceolata
Goodeniaceae	*Dampiera candicans*
	Goodenia cusackiana
	Goodenia forrestii
	Goodenia lamprosperma
	Goodenia microptera
	Goodenia muelleriana
	Goodenia nuda
	Goodenia prostrata
	Goodenia scaevolina
	Goodenia stobbsiana
	Scaevola amblyanthera
	Scaevola amblyanthera var. centralis
	Scaevola browniana
	Scaevola parvifolia subsp. parvifolia
	Scaevola spinescens
	Velleia connata
Gyrostemonaceae	*Codonocarpus cotinifolius*
Haloragaceae	*Gonocarpus ephemerus*
	Haloragis gossei
	Haloragis gossei var. gossei
Lamiaceae	*Teucrium pilbaranum*
	Cassytha filiformis
Loganiaceae	*Mitrasacme connata*
Loranthaceae	*Amyema hilliana*
Lythraceae	*Ammannia baccifera*
Malvaceae	*Abutilon cunninghamii*
	Abutilon halophilum
	Abutilon lepidum
	Abutilon otocarpum

Family	Species
Malvaceae	*Abutilon oxycarpum*
	Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)
	Abutilon sp. Pilbara (W.R Barker 2025)
	Abutilon sp. Pritzelianum (S. van Leeuwen 5095)
	Corchorus ?tectus
	Corchorus crozophorifolius
	Corchorus incanus
	Corchorus incanus subsp. lithophilus
	Corchorus laniflorus
	Corchorus lasiocarpus
	Corchorus lasiocarpus subsp. lasiocarpus
	Corchorus parviflorus
	Corchorus sidoides
	Corchorus sidoides subsp. sidoides
	Corchorus tectus
	Corchorus tridens
	Gossypium australe
	Gossypium robinsonii
	Hibiscus ?leptocladus
	Hibiscus austrinus
	Hibiscus austrinus var. austrinus
	Hibiscus burtonii
	Hibiscus coatesii
	Hibiscus leptocladus
	Hibiscus sturtii
	Hibiscus sturtii var. campylochlamys
	Hibiscus trionum var. vesicarius
	Malvastrum americanum
	Melhania oblongifolia
	Rulingia luteiflora
	Seringia elliptica
	Sida arenicola
	Sida arsiniata
	Sida cardiophylla
	Sida clementii
	Sida echinocarpa
	Sida fibulifera
	Sida sp.
	Sida sp. Articulation below (A.A. Mitchell PRP 1605)
	Sida sp. Golden calyces glabrous (H.N. Foote 32)
	Sida sp. Pilbara (A.A. Mitchell PRP 1543)
	Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)
	Sida sp. spiciform panicles (E. Leyland s.n. 33099
	Sida sp. Supplejack Station (T.S. Henshall 2345)
	Sida sp. verrucose glands (F.H. Mollemans 2423)

Family	Species
Malvaceae	*Sida spinosa*
	Triumfetta chaetocarpa
	Triumfetta maconochieana
	Triumfetta ramosa
	Waltheria indica
Marsileaceae	*Marsilea exarata*
	Marsilea hirsuta
Menispermaceae	*Tinospora smilacina*
Molluginaceae	*Mollugo molluginea*
Myrtaceae	*Calytrix carinata*
	Corymbia hamersleyana
	Corymbia opaca
	Eucalyptus camaldulensis
	Eucalyptus gamophylla
	Eucalyptus leucophloia
	Eucalyptus victrix
	Melaleuca argentea
	Melaleuca glomerata
	Melaleuca linophylla
Nyctaginaceae	*Boerhavia coccinea*
	Boerhavia sp.
Oleaceae	*Jasminum didymum subsp. lineare*
Onagraceae	*Ludwigia perennis*
Orobanchaceae	*Buchnera linearis*
Papaveraceae	*Argemone mexicana*
	Argemone ochroleuca
Phyllanthaceae	*Flueggea virosa subsp. melanthesoides*
	Notoleptopus decaisnei
	Phyllanthus aridus
	Phyllanthus erwinii
	Phyllanthus hebecarpus
	Phyllanthus maderaspatensis
Plantaginaceae	*Stemodia grossa*
	Stemodia kingii
	Stemodia sp.
	Stemodia viscosa
Plumbaginaceae	*Plumbago zeylanica*
Poaceae	*Aristida contorta*
	Aristida holathera
	Aristida holathera var. holathera
	Aristida inaequiglumis
	Aristida jerichoensis var. subspinulifera
	Aristida latifolia
	Astrebla elymoides
	Bothriochloa ewartiana

Family	Species
Poaceae	*Cenchrus ciliaris*
	Cenchrus echinatus
	Cenchrus setiger
	Chloris barbata
	Chloris pectinata
	Chloris virgata
	Chrysopogon fallax
	Cymbopogon ambiguus
	Cymbopogon obtectus
	Cynodon convergens
	Cynodon dactylon
	Cynodon prostratus
	Dactyloctenium radulans
	Dichanthium sericeum
	Dichanthium sericeum subsp. humilius
	Digitaria ciliaris
	Digitaria ctenantha
	Echinochloa colona
	Enneapogon ?lindleyanus
	Enneapogon lindleyanus
	Enneapogon polyphyllus
	Enneapogon robustissimus
	Enteropogon ramosus
	Eragrostis crateriformis
	Eragrostis cumingii
	Eragrostis dielsii
	Eragrostis elongata
	Eragrostis eriopoda
	Eragrostis falcata
	Eragrostis minor
	Eragrostis sp.
	Eragrostis speciosa
	Eragrostis tenellula
	Eragrostis xerophila
	Eriachne aristidea
	Eriachne benthamii
	Eriachne ciliata
	Eriachne lanata
	Eriachne mucronata
	Eriachne obtusa
	Eriachne pulchella
	Eriachne pulchella subsp. dominii
	Eriachne pulchella subsp. pulchella
	Eriachne sp.
	Eriachne tenuiculmis

Family	Species
Poaceae	*Eulalia aurea*
	Ischaemum albovillosum
	Iseilema macratherum
	Panicum decompositum
	Panicum effusum
	Panicum sp.
	Paraneurachne muelleri
	Paspalidium clementii
	Paspalidium jubiflorum
	Paspalidium rarum
	Paspalidium retiglume
	Perotis rara
	Poaceae sp.
	Setaria dielsii
	Setaria verticillata
	Sorghum plumosum
	Sorghum timorense
	Sporobolus actinocladus
	Sporobolus australasicus
	Sporobolus caroli
	Themeda sp. Hamersley Station (M.E. Trudgen 11431)
	Themeda triandra
	Triodia ? basedowii
	Triodia ? epactia
	Triodia ? pungens
	Triodia ?brizoides
	Triodia basedowii
	Triodia brizoides
	Triodia epactia
	Triodia epactia/pungens (sterile)
	Triodia lanigera
	Triodia longiceps
	Triodia pungens
	Triodia schinzii
	Triodia sp.
	Triodia wiseana
	Tripogon loliiformis
	Urochloa occidentalis (C.A.Gardner & C.E.Hubb.) B.K.Simon ms
	Urochloa occidentalis var. ciliata
	Yakirra australiensis
Poeaceae	*Cenchrus ciliaris*
	Cenchrus setiger
	Chloris virgata
	Echinochloa colona
Polygalaceae	*Polygala isingii*

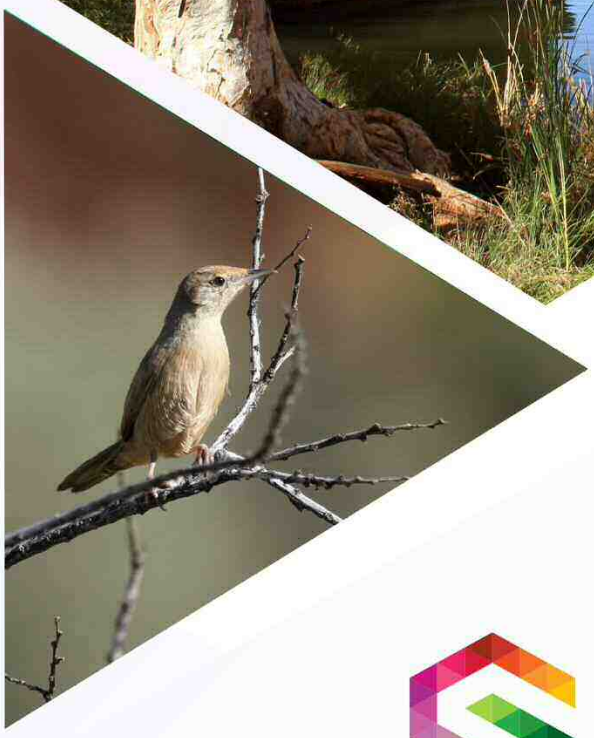
Family	Species
Polygonaceae	*Rumex vesicarius*
Portulacaceae	*Calandrinia tepperiana*
	Portulaca conspicua
	Portulaca cyclophylla
	Portulaca oleracea
	Portulaca pilosa
Proteaceae	*Grevillea berryana*
	Grevillea pyramidalis
	Grevillea pyramidalis subsp. leucadendron
	Grevillea wickhamii
	Grevillea wickhamii ?subsp. aprica
	Grevillea wickhamii subsp. hispidula
	Hakea chordophylla
	Hakea lorea subsp. lorea
Pteridaceae	*Cheilanthes sieberi*
Rubiaceae	*Oldenlandia crouchiana*
	Oldenlandia galioides
	Psydrax latifolia
	Spermacoce brachystema
	Synaptantha tillaeacea var. tillaeacea
Santalaceae	*Santalum sp.*
Sapindaceae	*Atalaya hemiglauca*
	Dodonaea coriacea
	Dodonaea petiolaris
Scrophulariaceae	*Eremophila lanceolata*
	Eremophila latrobei subsp. filiformis
	Eremophila latrobei subsp. glabra
	Eremophila longifolia
	Eremophila maculata subsp. brevifolia
Solanaceae	*Nicotiana benthamiana*
	Nicotiana occidentalis subsp. occidentalis
	Nicotiana umbratica
	Solanum diversiflorum
	Solanum horridum
	Solanum lasiophyllum
	Solanum nigrum
	Solanum phlomoides
	Solanum sp.
	Solanum sturtianum
Stylidiaceae	*Stylidium desertorum*
	Stylidium weeliwolli
Typhaceae	*Typha sp.*
Violaceae	*Hybanthus aurantiacus*
Zygophyllaceae	*Tribulus astrocarpus*
	Tribulus hirsutus

Family	Species
Zygophyllaceae	*Tribulus macrocarpus*
	Tribulus suberosus

Appendix 2: Pilbara Transmission Project Terrestrial Fauna Desktop Assessment

PILBARA TRANSMISSION PROJECT
TERRESTRIAL FAUNA DESKTOP ASSESSMENT

PREPARED FOR: FORTESCUE METALS GROUP



Spectrum ECOLOGY

ABN 68 615 115 243
PO Box 314 Leederville
Western Australia 6902
Ph: (08) 9317 8233
Email: info@spectrumecology.com.au

Project ID: 1809	Pilbara Transmission Project Terrestrial Fauna Desktop Assessment
Prepared for:	Fortescue Metals Group
Date of issue:	19-Oct-18
Prepared by:	Damien Cancilla, Astrid Heidrich
Reviewed by:	Damien Cancilla, Matthew Macdonald
Approved for issue:	Damien Cancilla

TABLE OF CONTENTS

Spectrum ECOLOGY

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Pilbara Energy Company Pty Ltd (PEC) is proposing to develop the Pilbara Transmission Project (the Project), a high voltage transmission network in the Pilbara region of western Australia. The Project comprises;

- 220 kV overhead powerline, and
- Terminal, substation and gantry infrastructure.

The proposed development envelope follows existing Fortescue Metals Group (FMG) rail alignments from Port Hedland to the Cloudbreak and Solomon mine sites. The approved North Star mine will connect to the network via a spur within the North Star project's approved infrastructure corridor.

The Project is intended to be referred to both the Commonwealth and EPA due to the likelihood of suitable habitat for EPBC listed conservation significant fauna species (Northern Quoll, Pilbara Olive Python, Greater Bilby and some Migratory Bird Species) within the Project corridor.

The objective of this study is to complete a terrestrial fauna assessment of the study area, which is a 1 km buffer around the current proposed powerline route. Due to the significant amount of field surveys conducted across the region surrounding the study area, a desktop assessment was considered to be suitable.

Five database searches were completed, including;

- Two database searches were completed to determine conservation significant vertebrate fauna species associated with the project, and
- Three WA Museum database searches were completed to indicate the presence of SRE Invertebrate species.

Data from nine Level 2, seven Level 1 and 22 targeted/monitoring fauna assessments were utilised to provide data for the terrestrial fauna assessment.

A total of 14 fauna habitat types were mapped from inside the study area;

- Sandy/Loamy Plain with Spinifex Grassland,
- Stony Plains and Low Rises with Hummock Grassland,
- Loamy/Stony Plain with mixed Shrubland,
- Sandy/Loamy Plains with mixed Shrubland
- Spinifex covered Hills,
- Clay Pan,
- Quarry,
- Mulga Woodland,
- Granite Outcrops,
- Major River,
- Minor Creekline,
- Minor Drainage Line,
- Rockface/Cliff, and
- Cleared/Disturbed.

The literature review and database searches identified a total of 73 vertebrate fauna species, listed as either threatened fauna (EPBC Act, BC Act Schedule) or as priority fauna (DBCA Priority list), that could potentially occur within the study area. Due to the proximity of the study area to Port Hedland, several of these species

are considered obligate marine species and were excluded accordingly. An additional ten migratory bird species that are typically restricted to coastal habitats were also identified. Due to the study area not including this habitat type, these species have not been discussed in detail. Ten mammal species, ten bird species, five reptile species and one fish species of conservation significance were identified as potentially occurring within the study area.

EPBC listed threatened species recorded from the study area include Northern Quoll (*Dasyurus hallucatus*), Greater Bilby (*Macrotis lagotis*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form)), Ghost Bat (*Macroderma gigas*) and Pilbara Olive Python (*Liasis olivaceus barroni*). The WC/BC Act listed Grey Falcon (*Falco hypoleucos*) has also been recorded from the study area.

Suitable habitats for each EPBC listed species have been mapped and these areas should be avoided where possible and management strategies applied to minimise impacts to individuals of these species that occur in any areas that cannot be avoided. Impacts to migratory bird species that utilise the Port Hedland Wastewater Treatment facility should be considered, and mitigation measures included where necessary.

A total of 15 morpho-species of crustacea, seven species of mygalomorph spider, 27 morpho-species of pseudoscorpion, five taxa of millipede, nine species of scorpion, and four taxa of mollusc were previously recorded in the region and have the potential to be a short range endemic species.

The study area covers an extensive range of habitats and microhabitat types that are considered suitable for SRE invertebrate species. The development of the project, however is expected to require minimal vegetation clearing due powerline infrastructure only requiring small areas to be cleared (estimated 10 m x 10 m per pylon pad), that are relatively widely spaced (typically 200-400 m) and where possible will utilise previously disturbed areas associated with the adjacent rail infrastructure. The landscape features that are typically associated with SRE invertebrate micro-habitats, such as creeklines and rocky slopes are not associated with suitable locations for powerline pylon construction. The minimal vegetation clearing, preferred locations for pylon construction on flat stable landforms and preferential placement on previously disturbed area indicates that the potential impact of this project on potential SRE invertebrate populations that may be present is expected to be very low.

1. INTRODUCTION

1.1. Project Background

Pilbara Energy Company Pty Ltd (PEC) is proposing to develop the Pilbara Transmission Project (the Project), a high voltage transmission network in the Pilbara region of western Australia. The Project comprises;

- 220 kV overhead powerline, and
- Terminal, substation and gantry infrastructure.

The development envelope comprises 4,369ha and follows existing Fortescue Metals Group (Fortescue) rail alignments from Port Hedland to the Cloudbreak and Solomon mine sites. Fortescue's approved North Star mine will connect to the network via a spur within North Stars approved infrastructure corridor. The Project will be located on Mining Act 1978 tenure that is the subject of current applications to the Department of Mines, Industry Regulation and Safety.

The Project will utilise existing disturbance areas where possible (e.g. rail access track), reducing the requirement for new disturbances. Pylons are typically placed at every change in direction or every 200 – 400m along the straight sections. Pylons spacing can be adjusted to avoid habitat of conservation significant species.

The Project is intended to be referred to both the Commonwealth and EPA due to the likelihood of suitable habitat for EPBC listed conservation significant fauna species (Northern Quoll, Pilbara Olive Python, Greater Bilby and some Migratory Bird Species) within the Project corridor.

1.2. Objectives

The objective of this study is to complete a terrestrial fauna (vertebrate and short-range endemic (SRE) invertebrate) assessment of the Study area (Figure 1.1). Due to the significant amount of field surveys conducted across the region surrounding the study area, a desktop assessment was considered to be suitable and includes the following;

- Identification of all previous surveys and monitoring that has been completed in the areas adjacent to the powerline corridor to confirm that the corridor has been adequately assessed. Including an assessment on suitability of the existing surveys in terms of methods used and how that relates to current guidelines,
- Mapping of all the conservation significant fauna records based on the latest listings under both the EPBC Act and the WC Act/BC Act,
- Mapping of all EPBC Act and WC Act/BC Act listed conservation significant fauna habitats within a 1 km corridor of the centreline,
- Literature review of potential impacts to fauna associated with overhead high voltage powerlines with specific emphasis on the conservation significant fauna, and
- Literature review of the potential short range endemic invertebrate fauna habitats within the power line corridor.

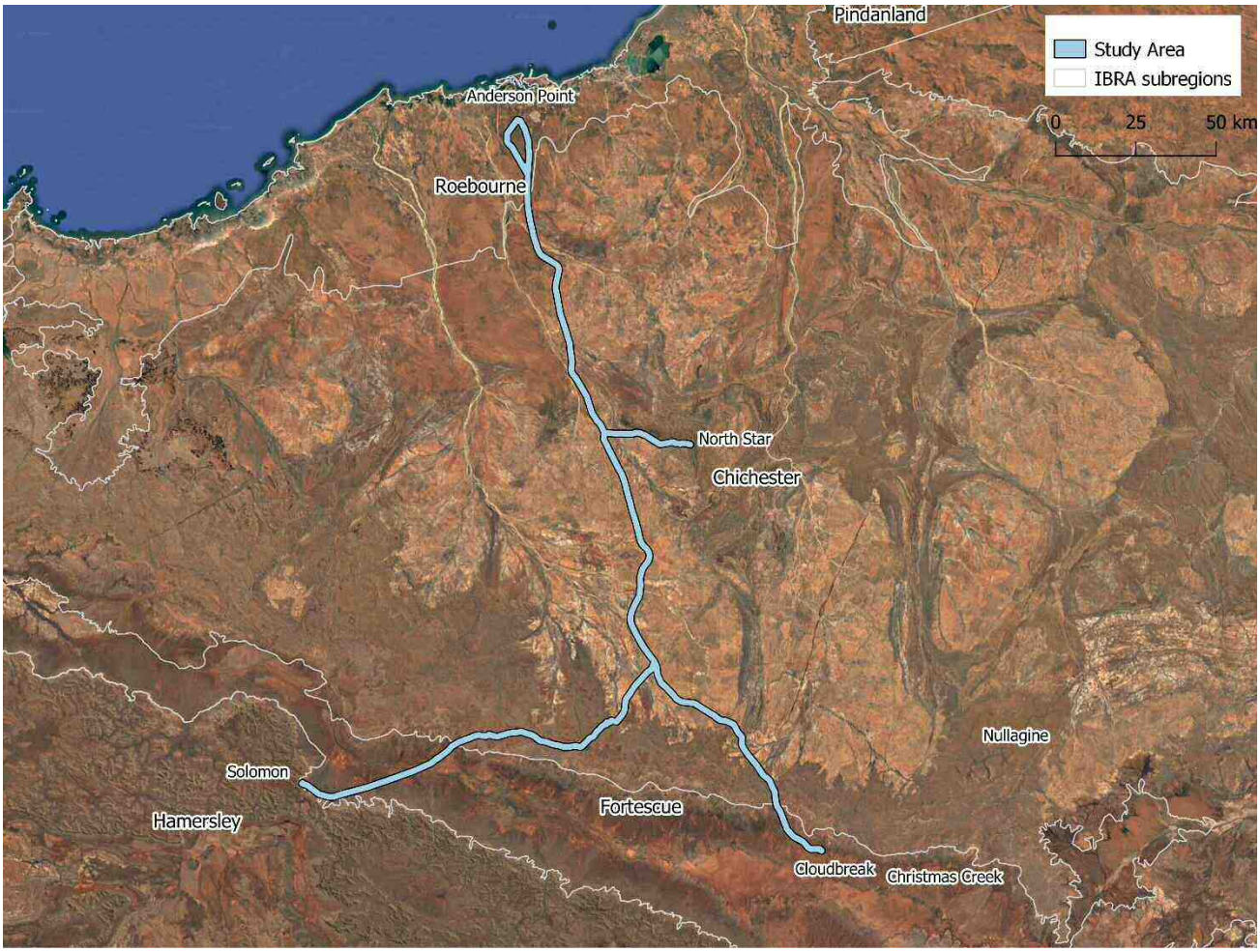


Figure 1.1: Location of the Study area

1.3. Determination of Assessment Design and Intensity

Determination of the level of assessment required for this Project was completed following the information in the Technical Guidance – Terrestrial Fauna Surveys (Environmental Protection Authority, 2016) document. A summary of the assessment design factors considered is included in Table 1.1.

The fauna assemblage associated with the study area has been well documented in the previous fauna survey reports (Section 2). As such this assessment focussed on Identifying the conservation significant fauna species that occur within the study area, identifying areas where suitable habitat occurs (Section 3) and mapping the habitats that are suitable for each EPBC listed conservation significant fauna species that occurs within the study area (Section 4).

The Project will use existing disturbed areas associated with Fortescue's rail infrastructure where possible. Due to the minimal ground disturbance and flexibility in placement of Project infrastructure, impacts to terrestrial fauna species is expected to be minimal and spread across a long linear corridor. As such the assessment of SRE invertebrate fauna was focussed on describing areas that typically form suitable microhabitats and linking this with broader fauna habitats so that areas with a higher potential for SRE invertebrate species can be managed appropriately.

Table 1.1: Assessment Design Factors

Factor	Relevance
Bioregion – level of existing survey/knowledge of the region and associated ability to predict accurately.	The Pilbara bioregion has been surveyed thoroughly, in particular in the region surrounding the study area. Numerous surveys have been completed within the study area and in the surrounding region. In addition, ongoing monitoring programs for conservation significant fauna species have been completed inside the study area since 2012.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The study area stretches over four IBRA subregions: Hamersley, Fortescue, Chichester and Roebourne. The landforms are diverse; however, their distribution is not restricted to the study area.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present.	Multiple surveys were completed inside the study area over different seasons and multiple years. The majority were completed following the recommendations of spring and autumn, with targeted surveys and monitoring carried out during relevant seasons as per relevant guidelines.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	Nine Level 2, seven Level 1 and 22 targeted/monitoring fauna assessments have been completed within or adjacent to the study area. This level of surveying provides a detailed understanding of the habitats and conservation significant fauna species that occur within the study area.
Number of different habitats or degree of similarity between habitats within a study area.	A total of 14 distinct fauna habitats are present inside the study area. These were: Sandy/loamy Plain with Spinifex Grassland, Stony Plains and Low Rises with Hummock Grassland, Loamy/stony Plain with mixed Shrubland, Spinifex covered Hills, Clay Pan, Quarry, Mulga Woodland, Granite Outcrops, Major River, Minor Creekline, Minor Drainage Line and Rockface/cliff.
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods).	The Pilbara region can experience extreme weather conditions with hot wet season and cyclonic rains followed by warm dry seasons with occasional unpredictable rainfall. Due to the large number of surveys undertaken over several seasons and years, climatic constraints have not been experienced overall.
Sensitivity of the environment to the proposed activities.	All habitat types present within the study area which are well represented within the surrounding region. The proposed activities will require minimal habitat clearing which is restricted to the pylon pads and sections of access track as required.
Size, shape and location of the proposed activities.	The study area is long (approx. 340 km) and relatively narrow (approximately 2 km) covering approximately 115,000 ha. The proposed activity however will be restricted to a much narrower construction corridor with clearing of pylon pads expected to be restricted to only 10 m x 10 m). The corridor connects Solomon mine site with Cloudbreak mine site, North Star mine site and Port Hedland.
Scale and impact of the proposal.	The proposed powerline infrastructure will follow current rail infrastructure utilising cleared and previously disturbed areas where possible. Clearing will be restricted to pylon pads and access tracks where required.

2. PREVIOUS TERRESTRIAL FAUNA ASSESSMENTS

A significant number of terrestrial fauna surveys have been undertaken both within the Study area and more broadly. Data from five public databases and a total of 38 previous fauna survey and monitoring reports were utilised to determine the conservation significant fauna species that occur along the study area. Details of the completed database searches are listed in Table 2.1 and details of each previous survey is presented Table 2.3, Table 2.4 & Table 3.1.

2.1.1. Database searches

Five database searches were completed, including.

- two database searches were completed to determine conservation significant vertebrate fauna species associated with the project, and
- three WA Museum database searches were completed to indicate the presence of SRE Invertebrate species.

Table 2.1: Database Search Details

Custodian	Database	Species Group	Search Details
Department of Environment and Energy	Protected Matters Search	EPBC listed vertebrate and invertebrate fauna species	Line area search with 10 km buffer
Department of Biodiversity, Conservation and Attractions	Threatened Fauna Database Search	Vertebrate Fauna species	Records within 20 km of the study area
Western Australian Museum	Arachnida & Myriapoda Database	SRE invertebrate fauna species	Search area: NW corner: -20.659 118.361 SE corner: -21.837 119.169
	Crustacea Database		
	Mollusc Database		

The results of the Threatened Fauna Database Search include 68 terrestrial fauna species recorded within 20 km of the study area. These records are displayed in Figure 2.1, Figure 2.2 and Figure 2.3. The database results are presented using the conservation status only as location data including species names are not permitted to be published.

2.1.2. Previous Surveys and Guideline

A significant number of previous terrestrial fauna surveys have been completed that are relevant to the Project. Data from nine Level 2, seven Level 1 and 22 targeted/monitoring fauna assessments were utilised to provide data for the terrestrial fauna assessment of the Project. Details of each project are summarised below (Table 2.2, Table 2.3 & Table 2.4) and the locations of survey sites in relation to the study area are shown in Figure 2.4, Figure 2.5 and Figure 2.6. Not all survey sites from these reports are displayed in the relevant maps as the project areas often extended away from the study area.

The previous fauna surveys and monitoring that has been completed within and adjacent to the study area include surveys from 2001 -2018. Although the surveys completed prior to the development of the survey guidelines do not fully meet the requirements of those guidelines, they do still provide relevant data that is used in this assessment. The fauna surveys and monitoring detailed below have been completed across all seasons and over a wide range of environmental conditions allowing a comprehensive list of conservation significant fauna specie to be determined.

Table 2.2: Previous Level 2 Terrestrial Fauna surveys

Report Title & Description	Phases	Trapping Grid	Ornithological surveys	Bat Surveys	Additional methods
Biota (2004): Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor (R-AS-EN-0016) Level 2 fauna assessment of the proposed FMG port located at Port Hedland and the proposed north-south rail infrastructure linking with the proposed Mindy Mindy mine area (located south of the Fortescue Marsh). The survey area was located in proximity to the BHP rail infrastructure which allowed the use of data previously collected in 2001 to be utilised. * Note: Additional surveys conducted in 1998 and 1999 are not included as they were based around Weeli Wolli creek and Juna Downs and therefore are not considered relevant to this project.	3 phases	March/April 2004: 18 sites, 3-7 nights, 1 phase April/May 2003: 18 sites, 4-6 nights April - November 2001: 44 sites, 3-14 nights, 1-2 phases	64 sites surveyed, time per survey not detailed	35 sites using Anabat II	Targeted invertebrate groups sampled from trapping grids and opportunistically Active searches of opportunistic sites
Biota (2004) Fauna Habitats of the Proposed FMG Stage B Rail Corridor & Mindy Mindy, CC, Mt Lewin & Mt Nicholas (100-RP-EN-6701) Level 2 fauna assessment of the proposed FMG rail infrastructure and mining areas located along the northern edge of the Chichester Range.	2 Phases	March/April 2004: 6 sites, 1-5 nights (all located south of the Fortescue Marsh). July 2004: 30 sites, 4-7 nights.	50 sites surveys, 40 – 80 mins per site	4 sites using Anabat II	Targeted invertebrate groups sampled from trapping grids and opportunistically Active searches of opportunistic sites
Bamford (2005) Fauna survey of proposed Iron Ore Mine, Cloud Break Level 2 vertebrate fauna survey of the proposed Cloudbreak Iron Ore mine. Survey techniques conform to current guidelines however less than the recommended nights of trapping was completed.	1 phase	7-17 April 2005: 8 sites, 5-6 nights	8 sites surveys, 30 mins per survey	3 mist nets and 1 Anabat II detector used opportunistically	Nocturnal spotlighting Active searches of opportunistic sites
ENV Australia (2009) Outer Harbour Development, Fauna Assessment (P-AS-EN-0009) Two phase Level 2 vertebrate fauna survey of the Outer Harbour development area located from Finucane Island to approximately 25 km south.	2 Phases	October/November 2007: 8 sites, 8 nights May 2008: 10 Sites (2 sites added), 8 nights	General location descriptions and habitat types described. 72.5 hours during summer, 21 hours during winter	10 sites during summer (1.5 hours per site), 7 sites during winter (10 hours per site)	Active searches of opportunistic sites
ecologia Environment (2011) Cloudbreak Level 2 Terrestrial Vertebrate Fauna Assessment (CB-AS-EN-0028) Single phase Level 2 vertebrate fauna survey of the Cloudbreak mine site forming the second phase to the 2005 Level 2 fauna survey (Bamford 2005)	1 Phase	18-29 October 2010: 8 Sites, 8 nights	4-6x 20-min surveys per trapping site	7 sites using Anabat II	Targeted Searches: Night Parrot, Northern Quoll and Mulgara. Separate SRE assessment completed concurrently
GHD (2012) Report for Pilbara Gateway Port: Flora and Vegetation, Vertebrate Fauna and Short-Range Endemic Fauna Assessment Single Phase Level 2 Terrestrial Fauna Survey of the Port Hedland area focussing in areas not previously surveyed.	1 Phase	28 May – 6 June 2012: 5 sites, 7 nights	20-min surveys completed at each trapping site	5 sites using Anabat II	5 Northern Quoll cage trapping sites 3 Mulgara Elliott trapping sites Motion Cameras Targeted SRE survey sites
ecologia Environment (2012) North Star Project Level 2 Terrestrial Vertebrate Fauna Assessment (660NS-00000-RP-EN-0001) Two phase Level 2 terrestrial fauna assessment with additional infrastructure areas surveyed during the same season as Phase 2. Systematic survey methods that meet current guidelines.	2 Phases	29 March – 9 April 2011: 8 Sites, 8 Nights 25 October – 5 November 2011: 8 Sites, 8 Nights Additional Areas: 10-21 October 2011: 8 Sites, 8 Nights	4x 20-min surveys per trapping site per phase	1 night (12 hours) per site including trapping sites and 18 opportunistic sites	Motion Cameras: Overnight at 14 opportunistic sites. Separate detailed SRE assessment completed concurrently
ecologia Environment (2014) Investigator Project: Terrestrial Vertebrate Fauna Assessment (EX-AS-EN-0044) Single phase Level 2 vertebrate fauna survey of a small project area (5,207 ha) located over a central section of the Hamersley Rail Line section of the study area. Survey methods meet current guidelines for survey techniques.	1 phase	20-30 May 2013: 6 sites, 7 nights	30 min / 2 ha 4 surveys at each trapping site plus 18 opportunistic surveys	Overnight recording (13 hours) at 7 sites	Motion Cameras: Overnight at 3 sites. Separate detailed SRE assessment completed concurrently
ecologia Environment (2014) Solomon Hub: Terrestrial Vertebrate Fauna and Fauna Habitat Assessment Single phase Level 2 vertebrate fauna survey and consolidation of all previous terrestrial fauna surveys associated with the Solomon Hub project. Includes the consolidation of multiple previous surveys.	1 phase	22 April – 4 May 2014: 16 sites, 7 nights	30 min / 2 ha 4 surveys at each trapping site plus 11 opportunistic surveys	Overnight recording (13 hours) at 22 sites	Active search: 28 sites Motion Cameras: 38 long-term sites (10 weeks). Separate detailed SRE assessment completed concurrently

Table 2.3: Previous targeted conservation significant fauna survey and monitoring projects

Report Title & Description	Location	Target Species	Survey Effort and Techniques
Bamford (2005) Survey for the Night Parrot *Pezoporus occidentalis* in the Cloud Break Project Area, Fortescue Metals Group. Targeted survey in May 2005 for Night Parrot following the sighting of 2-3 individuals at Minga Well during the Level 2 Fauna survey. Nine personnel were used during the targeted surveys including staff from Department of Conservation and Land Management.	Cloudbreak mine site/Fortescue Marsh	Night Parrot (*Pezoporus occidentalis*)	Listening Surveys: 101 sites Mist Netting: 7 sites Active Searches: 12 sites
Bamford (2006) Survey for the Night Parrot *Pezoporus occidentalis* in the Cloud Break Project Area, Fortescue Metals Group. Repeat targeted survey in March 2006 for Night Parrot following the sighting of 2-3 individuals at Minga Well during the Level 2 Fauna survey in 2005. Seven personnel were used during the targeted surveys including staff from Department of Conservation and Land Management. Previous Significant rainfall precluded water hole observations	Cloudbreak mine site/Fortescue Marsh	Night Parrot (*Pezoporus occidentalis*)	Listening Surveys: 50 sites Mist Netting: 3 sites Walk-in/Driftnet Fence: 9 sites
Bamford (2007) Survey for the Night Parrot *Pezoporus occidentalis* in the Cloud Break Project Area, Fortescue Metals Group. Repeat targeted survey in November 2007 for Night Parrot following the sighting of 2-3 individuals at Minga Well during the Level 2 Fauna survey in 2005. Five personnel were used during the targeted surveys including staff from Department of Environment and Conservation.	Cloudbreak mine site/Fortescue Marsh	Night Parrot (*Pezoporus occidentalis*)	Waterhole Observations: 4 sites Mist Net: 3 sites Active Search: 8 sites
ATA Environment (2007) Pre-clearing fauna surveys and mulgara relocation from the rail loop, Port Hedland. Targeted trapping program to relocate Brush-tail Mulgara from within the FMG rail loop located in Port Hedland. 50 individuals were translocated approximately 4km west of the capture sites.	Main Line Rail Loop	Brush-tailed Mulgara (*Dasycercus blythi*)	600 Elliott traps over 9900 trap nights
Bamford (2009) Report on September 2008 search for the Night Parrot. A Fortescue Metals Group Project Repeat targeted survey in September 2008 for Night Parrot following the sighting of 2-3 individuals at Minga Well during the Level 2 Fauna survey in 2005. Five personnel were used during the targeted surveys with techniques focusing on the most efficient previously trialled. Search area expanded to the west of Cloudbreak	Cloudbreak mine site/Fortescue Marsh	Night Parrot (*Pezoporus occidentalis*)	Listening Surveys: 45 sites Waterhole Observations: 4 sites Spotlighting: 2 nights of transects Active Searches: opportunistic
Bamford (2010) Report on December 2009 search for the Night Parrot. A Fortescue Metals Group Project Repeat targeted survey in December 2009 for Night Parrot following the sighting of 2-3 individuals at Minga Well during the Level 2 Fauna survey in 2005. Four personnel were used during the targeted surveys with techniques focusing on the most efficient previously trialled.	Cloudbreak mine site/Fortescue Marsh	Night Parrot (*Pezoporus occidentalis*)	Listening Surveys: 17 sites Waterhole Observations: 12 sites Motion Camera: 7 sites
Bamford (2011) Report on 2010 search for the Night Parrot. A Fortescue Metals Group Project Repeat targeted survey from September - November 2010 for Night Parrot following the sighting of 2-3 individuals at Minga Well during the Level 2 Fauna survey in 2005. Motion Cameras were the main technique used with two areas targeted.	Cloudbreak mine site/Fortescue Marsh	Night Parrot (*Pezoporus occidentalis*)	Long-term Motion Camera: 19 sites
Bamford (2012) 2011/2012 Night Parrot Survey Summary Report. A Fortescue Metals Group Project Repeat targeted survey from July 2011 – January 2012 for Night Parrot following the sighting of 2-3 individuals at Minga Well during the Level 2 Fauna survey in 2005. Motion Cameras were the main technique used with two areas targeted.	Cloudbreak mine site/Fortescue Marsh	Night Parrot (*Pezoporus occidentalis*)	Long-term Motion Camera: 22 sites
Coffey Environments (2011) Targeted Surveys Northern Quolls, Mulgara and Pilbara Olive Python – Solomon Rail Project (SO-SV-EN-0005) Targeted fauna survey using trapping, motion cameras and active searches. Traps targeting Northern Quoll were spread across areas of suitable habitat located along the survey area instead of systematic sites.	Hamersley Line Rail	Northern Quoll (*Dasyurus hallucatus*)	151 traps over 7 nights, 23 motion camera locations average 6.5 nights per camera.
		Brush-tailed Mulgara (*Dasycercus blythi*)	Two sites (50 & 45 trap points) over 7 nights.
		Pilbara Olive Python (*Liasis olivaceus barroni*)	Opportunistic searches during Northern Quoll surveys
ecologia Environment (2011) North Star Project Targeted Conservation Significant Fauna Survey (660-00000-SV-EN-0001) Targeted fauna survey focusing on Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat.	North Star Mine and Infrastructure Corridor	Northern Quoll (*Dasyurus hallucatus*)	17 Cage Trapping Sites 34 Motion Camera Sites
		Pilbara Olive Python (*Liasis olivaceus barroni*)	14 Active Search Sites
		Pilbara Leaf-nosed (*Rhinonicteris aurantia*)	25 Bat Recorder Sites
Outback Ecology (2013) Fortescue Metals Group Ltd Proposed Gas Pipeline Targeted Threatened Fauna Survey Desktop assessment and targeted fauna survey of a proposed gas pipeline located along a similar alignment to the Main Line Rail and Hamersley Rail Line project areas	Main Line Rail | Hamersley Rail Line	All conservation significant fauna species	5 Active Search Sites 13 Habitat Assessment Sites 34 Motion Camera Sites 2 SM2Bat recorder sites

Report Title & Description	Location	Target Species	Survey Effort and Techniques
ecologia (2013) Solomon Iron Ore Project - Rail, Conservation Significant Fauna Monitoring Report 2012 Ongoing monitoring of conservation significant fauna along the Hamersley Rail Line infrastructure corridor	Hamersley Rail Line	Northern Quoll (*Dasyurus hallucatus*)	7x impact and 4x control sites, 7 nights. 9x motion camera sites
		Brush-tailed Mulgara (*Dasycercus blythi*)	Trapping grids (50 Elliott traps per grid) at 4x impact sites and 4x control sites, 7 nights. 2x motion camera sites
ecologia (2014) Solomon Iron Ore Project - Rail, Conservation Significant Fauna Monitoring Report 2013 Ongoing monitoring of conservation significant fauna along the Hamersley Rail Line infrastructure corridor	Hamersley Rail Line	Northern Quoll (*Dasyurus hallucatus*)	6x impact and 4x control sites, 7 nights. 9x motion camera sites
		Brush-tailed Mulgara (*Dasycercus blythi*)	Trapping grids (50 Elliott traps per grid) at 4x impact sites and 4x control sites, 7 nights. 2x motion camera sites
ecologia (2015) Solomon Iron Ore Project - Rail, Conservation Significant Fauna Monitoring Report 2014 Ongoing monitoring of conservation significant fauna along the Hamersley Rail Line infrastructure corridor	Hamersley Rail Line	Northern Quoll (*Dasyurus hallucatus*)	6x impact and 4x control sites, 7 nights. 9x motion camera sites
		Brush-tailed Mulgara (*Dasycercus blythi*)	Trapping grids (50 Elliott traps per grid) at 4x impact sites and 4x control sites, 7 nights. 3x motion camera sites
ecologia Environment (2014). Additional Rail Infrastructure Project Conservation Significant Fauna Monitoring Program Ongoing monitoring of conservation significant fauna along the Main Line Rail infrastructure corridor	Main Line Rail	Northern Quoll (*Dasyurus hallucatus*)	9x impact and 3x control sites
		Brush-tailed Mulgara (*Dasycercus blythi*)	Trapping grids (50 Elliott traps per grid) at 6x impact sites and 6x control sites. Active searches of 73x opportunistic sites
		Night Parrot (*Pezoporus occidentalis*)	Acoustic recording, Listening surveys, Water Point observations, Motion Cameras (including feeding stations).
		Pilbara Olive Python (*Liasis olivaceus barroni*)	Nocturnal Road spotting of > 40 km. Active searches of water pools and rocky areas
		Pilbara Leaf-nosed (*Rhinonicteris aurantia*)	Acoustic recorders at 16 sites: 12 sites (1 night), 2 sites (2 nights), 2 sites (6 nights)
		Greater Bilby (*Macrotis lagotis*)	Active searches of 73x opportunistic sites, Cage trapping at 2x impact sites and 2x control sites
ecologia Environment (2015) Additional Rail Infrastructure Project, Conservation Significant Fauna Monitoring Project 2013/2014 Ongoing monitoring of conservation significant fauna along the Main Line Rail infrastructure corridor.	Main Line Rail	Northern Quoll (*Dasyurus hallucatus*)	4x impact and 4x control sites, 25 traps per site
		Brush-tailed Mulgara (*Dasycercus blythi*)	Trapping grids (50 Elliott traps per grid) at 6x impact sites and 6x control sites
		Night Parrot (*Pezoporus occidentalis*)	Acoustic recording, Listening surveys, Water Point observations, Motion Cameras (including feeding stations).
		Pilbara Olive Python (*Liasis olivaceus barroni*)	Active searches of 4x impact sites and 4x control sites, Nocturnal Road spotting of > 40 km.
		Pilbara Leaf-nosed (*Rhinonicteris aurantia*)	Acoustic recorders at 4x impact sites and 4x control sites over 4 nights in both summer the wet and dry seasons
		Greater Bilby (*Macrotis lagotis*)	Active searches (transects) of 20x impact sites and 20x control sites, Trapping at one confirmed Greater Bilby presence site

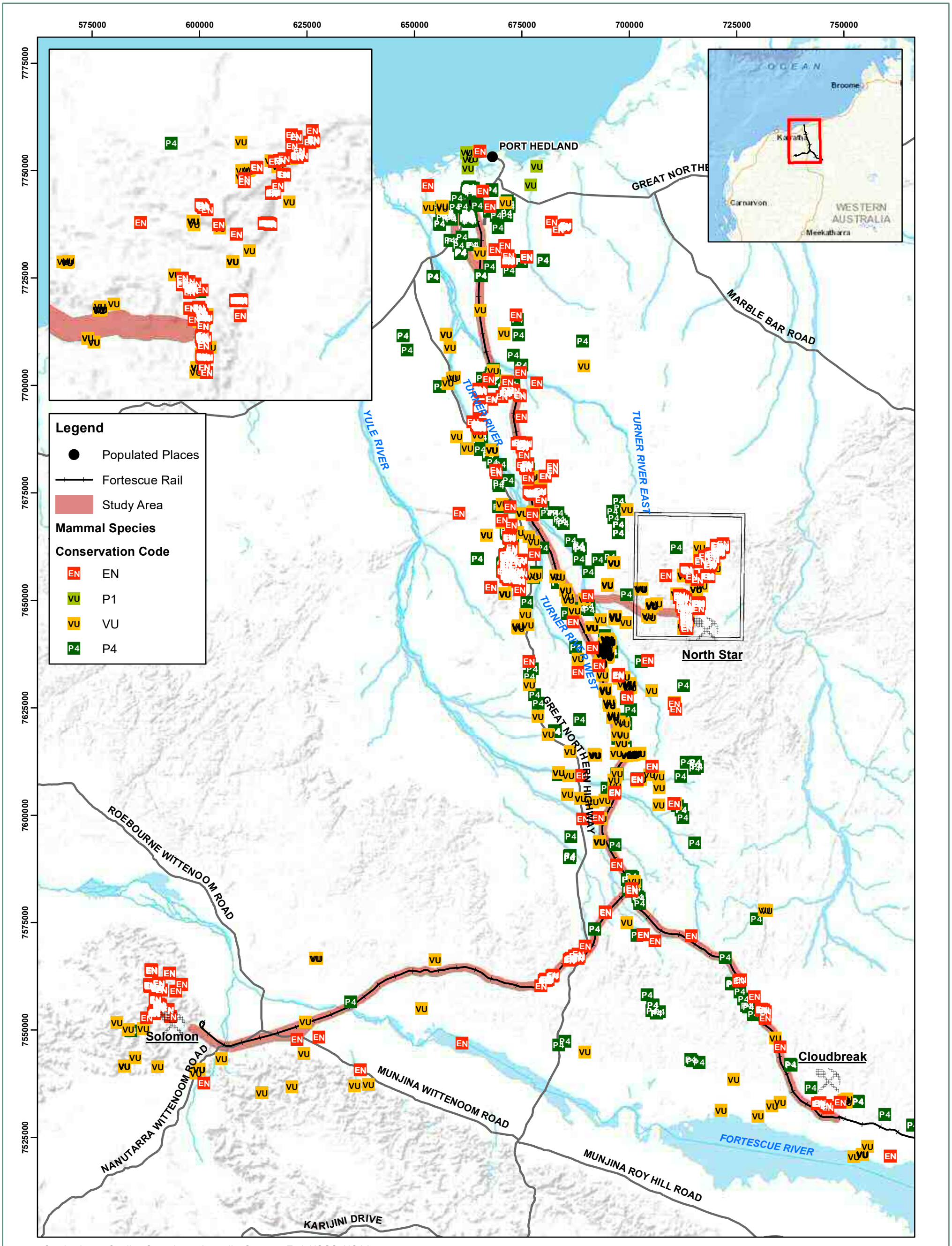
Report Title & Description	Location	Target Species	Survey Effort and Techniques
ecologia Environment (2015) Additional Rail Infrastructure Project, Conservation Significant Fauna Monitoring Project 2014/2015 (R-RP-EN-1082) Ongoing monitoring of conservation significant fauna along the Main Line Rail infrastructure corridor.	Main Line Rail	Northern Quoll (*Dasyurus hallucatus*)	4x impact and 4x control sites, 25 traps per site
		Brush-tailed Mulgara (*Dasycercus blythi*)	Trapping grids (50 Elliott traps per grid) at 6x impact sites and 6x control sites
		Night Parrot (*Pezoporus occidentalis*)	Acoustic recording, Listening surveys, Water Point observations, Motion Cameras (including feeding stations).
		Pilbara Olive Python (*Liasis olivaceus barroni*)	Active searches of 4x impact sites and 4x control sites, Nocturnal Road spotting of > 40 km.
		Pilbara Leaf-nosed (*Rhinonicteris aurantia*)	Acoustic recorders at 4x impact sites and 4x control sites over 4 nights in both summer the wet and dry seasons
		Greater Bilby (*Macrotis lagotis*)	Active searches (transects) of 20x impact sites and 20x control sites, Trapping at one confirmed Greater Bilby presence site
Ecoscape (2016) Vegetation and Fauna Habitat Mapping of the Northern Tenement Area, Cloudbreak Reconnaissance level targeted fauna survey of tenements located to the North of the Cloudbreak mine site. Targeted trapping completed following Northern Quoll motion camera record.	Main Line Rail | Cloudbreak	Northern Quoll (*Dasyurus hallucatus*)	Reconnaissance Survey: 6 Motion cameras sites (10 cameras per site) for 4 nights each. Targeted Survey: 5 trapping sites (16-20 traps per site) for 7 nights. 5 Motion Camera sites (10 cameras per site, 5 cameras at 1 site). Collar Retrieval Surveys: 3 trapping sites (8-16 traps per site) for total of 6 nights each
		Greater Bilby (*Macrotis lagotis*)	Active searches of previous Greater Bilby record locations
		Pilbara Leaf-nosed (*Rhinonicteris aurantia*) Ghost Bat (*Macroderma gigas*)	Reconnaissance Survey: 6 SM2Bat+ sites recording for 4 nights each Targeted Survey: 5 SM2Bat+ sites recording for 4 nights each
Ecoscape (2016) Conservation Significant Fauna Monitoring 2015-2016: Operations Ongoing monitoring of conservation significant fauna across all Fortescue operational areas.	Main Line Rail | Hamersley Rail Line	Northern Quoll (*Dasyurus hallucatus*)	6x impact and 6x control sites, Active searches 2 hours x 10 days, 10 motion cameras x 12 days/nights
		Brush-tailed Mulgara (*Dasycercus blythi*)	Main Line Rail - Trapping grids (50 Elliott traps per grid) at 6x impact sites and 6x control sites Hamersley Rail Line - Trapping grids (20 Elliott traps per grid) at 3x impact sites
		Greater Bilby (*Macrotis lagotis*)	Active searches (transects) of 20x impact sites and 20x control sites, Trapping at one confirmed Greater Bilby presence site
		Conservation Significant Birds	20 min search at 6x impact and 6x control sites

Report Title & Description	Location	Target Species	Survey Effort and Techniques
Ecoscape (2017) Conservation Significant Fauna Monitoring 2016-2017: Operations Ongoing monitoring of conservation significant fauna across all Fortescue operational areas.	Main Line Rail | Hamersley Rail Line	Northern Quoll (*Dasyurus hallucatus*)	6x impact sites, 50 traps per site for 4 nights. Active searches, 5 motion cameras x 4 nights
		Greater Bilby (*Macrotis lagotis*)	Active searches (transects) of 3x impact and 3x control sites, 10x motion cameras for 12 nights at each site
		Ghost Bat (*Macroderma gigas*)	Acoustic recorders at 3x impact sites and 3x control sites over 7 nights with 4x SM2Bat+ recorders per site
		Conservation Significant Birds	20 min search at 6x impact and 6x control sites
Ecoscape (2018) Conservation Significant Fauna Monitoring 2017-2018: Operations Ongoing monitoring of conservation significant fauna across all Fortescue operational areas.	Main Line Rail | Hamersley Rail Line	Northern Quoll (*Dasyurus hallucatus*)	6x impact sites, 50 traps per site for 4 nights, 5 motion cameras x 4 nights per site. Active searches 10 hrs per site.
		Greater Bilby (*Macrotis lagotis*)	Abundance transect searches at 1x impact and 1x control site, 4x long term motion cameras per site. 40x occupancy search sites (dry season), repeat 20x occupancy search sites (wet season).
		Ghost Bat (*Macroderma gigas*)	Acoustic recorders at 12x impact sites and 12x control sites over 7 nights
		Conservation Significant Birds	20 min search at 6x impact and 6x control sites
Spectrum Ecology (in prep) Conservation Significant Fauna Monitoring 2018-2019: Operations Ongoing monitoring of conservation significant fauna across all Fortescue operational areas.	Main Line Rail | Hamersley Rail Line	Northern Quoll (*Dasyurus hallucatus*)	6x impact sites, 50 traps per site for 4 nights, 5 motion cameras x 4 nights per site. Active searches 10 hrs per site.
		Greater Bilby (*Macrotis lagotis*)	Abundance transect searches at 1x impact and 1x control site, 4x long term motion cameras per site. 40x occupancy search sites (dry season)

Table 2.4: Previous Level 1 Terrestrial Fauna Assessments

Report Title & Description	Assessments completed
ATA Environment (2007) Assessment of Conservation Significant Vertebrate Fauna for the Proposed Rail Corridor and Associated Borrow Pits Active searches of suitable habitats within the rail corridor, borrow pit and water reserve areas for secondary evidence of conservation significant fauna species. Use of Anabat II acoustic recorders was indicated as being used outside suitable cave structures, however no locations nor survey effort is described.	6-10 June 2006 Rapid habitat assessment via helicopter to identify Greater Bilby and Mulgara habitat and caves. 19-23 June 2006, 26 June – 6 July 2006, 7-13 August 2006 and 2, 11, 20 September 2006 Active systematic searches of project area
Ecoscape (2009) Targeted Flora & Fauna Surveys of Rail Corridor GDP areas 2449, 2462 & 2515 Targeted searches for secondary evidence of conservation significant fauna species located within several GDP areas located along the Main Line Rail project area	8-12 June 2009 Active searches of GDP areas
Coffey Environments (2010) Level 1 Vertebrate Fauna Assessment - Solomon Rail Project (SO-AS-EN-0035) Rapid fauna habitat assessments completed over three phases. Fauna habitats mapped using points.	12-26 September 2008; 1-8 December 2009; 27-29 January 2010 433 habitat assessments completed
Bamford Consulting Ecologists (2010) Targeted Fauna Assessment of the Rail Duplication (R-RP-EN-1006) Active searches of seven areas (approx. 18 km) located along the Main Line Rail section of the study area for secondary evidence of conservation significant fauna.	Targeted Fauna searches Active searches of 50 m wide corridor adjacent to current rail infrastructure. Two sites surveyed for bats over 1 night each
Ecoscape (2010) Port Hedland Water Supply Fauna Assessment Level 1 fauna survey of the proposed water supply area located to the south of Port Hedland.	28 June – 3 July 2010 8 Motion cameras across 7 nights 1 Anabat Recorder site, 5 nights
Ecoscape (2010) Solomon Project Rail Camp Sites 1, 2 and 3, Fauna Assessment Level 1 fauna survey of three proposed rail camp locations located along the Hamersley Rail Line project corridor	12-14 May 2010 15 min 2 ha Ornithological surveys Active searches Habitat assessments
Ecoscape (2010) Solomon Project Rail Re-Alignment Fauna Assessment Level 1 fauna survey of proposed realignment options for the Hamersley Rail Line project corridor	6-7 May 2010 15 min 2 ha Ornithological surveys Active searches 16 Habitat assessments

DBCA THREATENED SPECIES DATABASE SEARCH RESULTS: MAMMALS



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

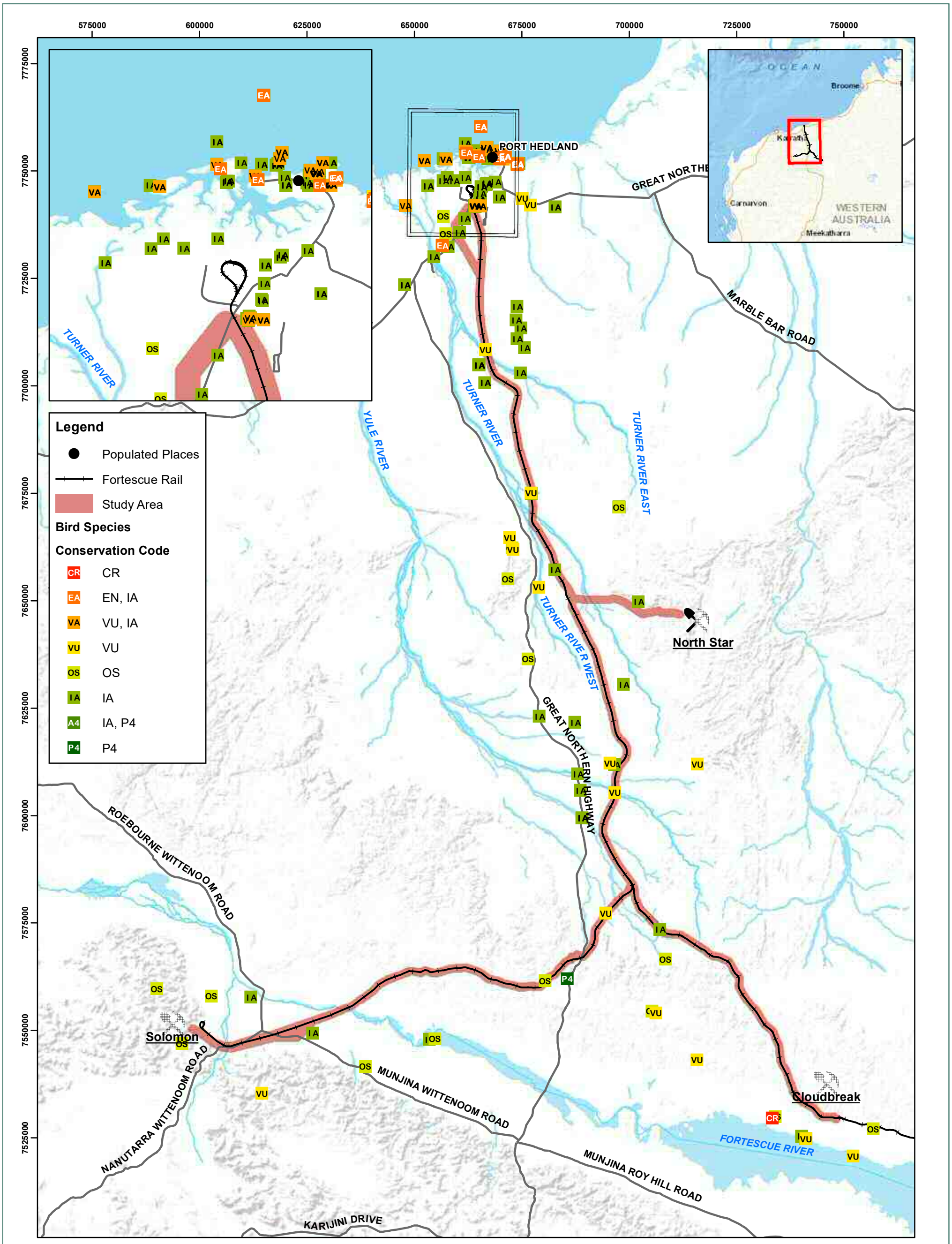
0 20 40 Km

Absolute Scale: 1:825,000 @ A3

DRAWN: C.PARKER
DATE: 12/10/2018

FIGURE 2.1

Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 20 40 Km

Absolute Scale: 1:825,000 @ A3

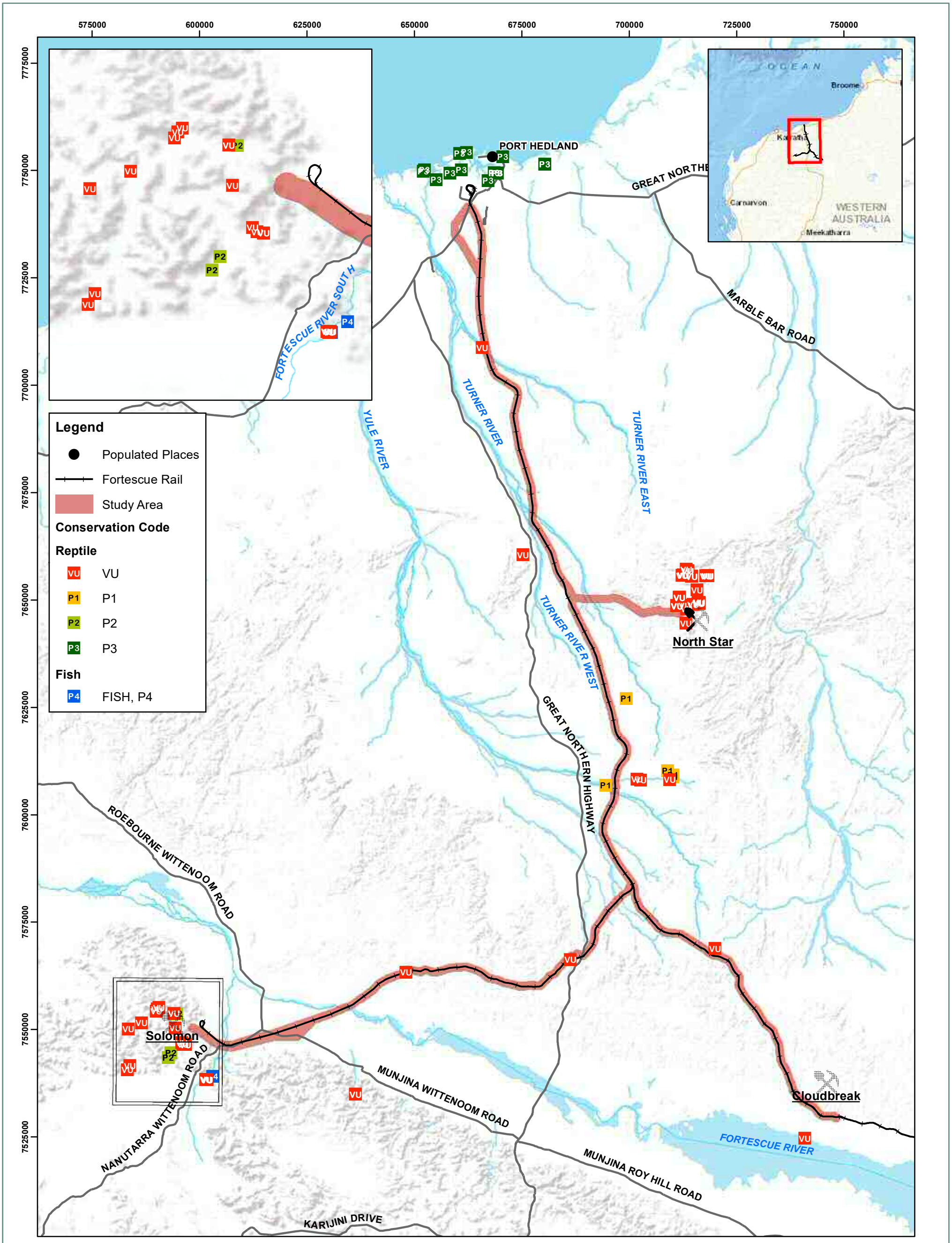
DBCA THREATENED SPECIES DATABASE SEARCH RESULTS: BIRDS

DRAWN: C.PARKER
DATE: 12/10/2018

FIGURE 2.2

Spectrum ECOLOGY

DBCA THREATENED SPECIES DATABASE SEARCH RESULTS: REPTILES AND FISH



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 20 40 Km

Absolute Scale: 1:825,000 @ A3

DRAWN: C.PARKER
DATE: 12/10/2018

FIGURE 2.3

Spectrum ECOLOGY

650000 675000 700000 725000

7750000 7725000 7700000 7675000 7650000

PORT HEDLAND

GREAT NORTHERN HIGHWAY

NORTH WEST COASTAL HIGHWAY

GREAT NORTHERN HIGHWAY

TURNER RIVER

TURNER RIVER WEST

YULE RIVER

Wodgina

Abydos

North Star

OCEAN

Broome

Karratha

Carnarvon

WESTER

Legend

- Populated Places
- Fortescue Rail
- Study area

Previous Terrestrial Fauna Surveys

Pilbara Olive Python

- PO — Pilbara Olive Python Monitoring Site
- PO — Pilbara Olive Python Search Site

Northern Quoll

- NQ — Northern Quoll Targeted Trap Site
- NQ — Northern Quoll Targeted Motion Camera
- NQ — Northern Quoll Monitoring Motion Camera
- NQ — Northern Quoll Monitoring Trap Site

Greater Bilby

- BL — Bilby Monitoring Site
- BL — Bilby Monitoring Site (Motion Camera)
- BL — Bilby Search Site

Bat

- BT — Bat Targeted Site (SM2Bat+)
- BT — Bat Targeted Site (AnabatII)
- BT — Bat Monitoring Site (SM2Bat+)

Night Parrot

- NP — Night Parrot Monitoring Site (ARU Recordings)
- NP — Night Parrot Monitoring Site (Motion Camera)
- NP — Night Parrot Monitoring Site (Searches)
- NP — Night Parrot Survey Site

Non EPBC Survey Sites

- OS — Active Search Site
- OS — Level 2 Trapping Grid
- OS — Mulgara Trapping Grid
- OS — Ornithological survey

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

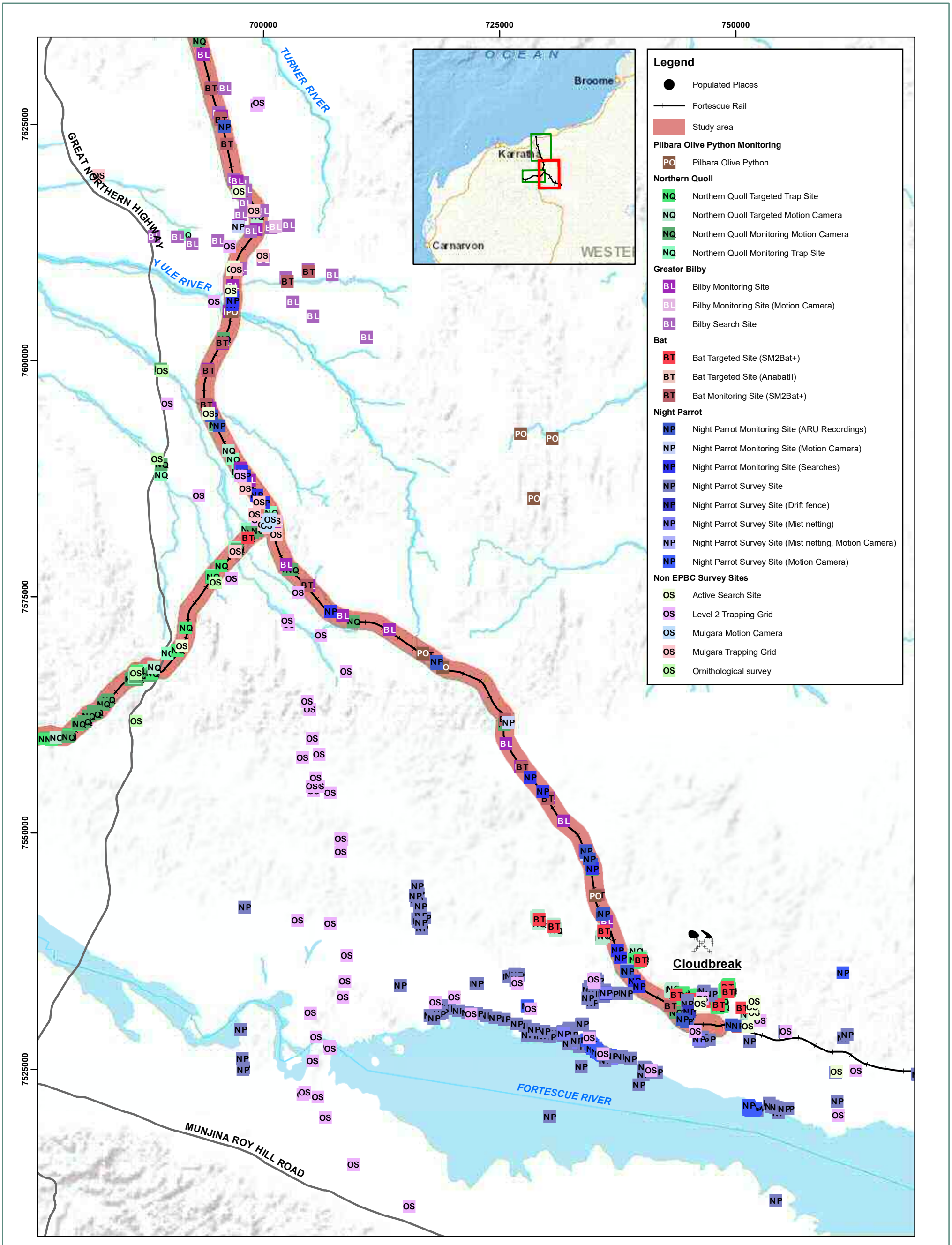
Absolute Scale: 1:375,000 @ A3

PREVIOUS TERRESTRIAL FAUNA SURVEYS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 2.4

Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

Absolute Scale: 1:375,000 @ A3

PREVIOUS TERRESTRIAL FAUNA SURVEYS

DRAWN: C.PARKER
DATE: 26/09/2018

FIGURE 2.5

Spectrum ECOLOGY

600000 615000 630000 645000 660000 675000 690000

7575000

7560000

7545000

Legend

Previous Terrestrial Fauna Surveys

Northern Quoll

- NQ — Northern Quoll Targeted Trap Site
- NQ — Northern Quoll Targeted Motion Camera
- NQ — Northern Quoll Monitoring Motion Camera
- NQ — Northern Quoll Monitoring Trap Site

Greater Bilby

- BL — Bilby Monitoring Site

Bat

- BT — Bat Targeted Site (SM2Bat+)
- BT — Bat Monitoring Site (SM2Bat+)

Night Parrot

- NP — Night Parrot Monitoring Site (ARU Recordings)
- NP — Night Parrot Monitoring Site (Searches)
- NP — Night Parrot Survey Site

Non EPBC Survey Sites

- OS — Active Search Site
- OS — Level 2 Trapping Grid
- OS — Mulgara Trapping Grid
- OS — Ornithological survey

ROEBOURNE WITTENOOM ROAD

GREAT NORTHERN HIGHWAY

Solomon

FORTESCUE RIVER SOUTH

NANUTARRA WITTENOOM ROAD

FORTESCUE RIVER

MUNJINA WITTENOOM ROAD

Legend

- Fortescue Rail
- Roads
- Study Area

PREVIOUS TERRESTRIAL FAUNA SURVEYS

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

FIGURE 2.6

0 2.5 5 10 15 Km

N

Absolute Scale: 1:250,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

3. FAUNA HABITATS

A total of 14 fauna habitat types were mapped from inside the study area;

- Sandy/Loamy Plain with Spinifex Grassland,
- Stony Plains and Low Rises with Hummock Grassland,
- Loamy/Stony Plain with mixed Shrubland,
- Sandy/Loamy Plains with mixed Shrubland
- Spinifex covered Hills,
- Clay Pan,
- Quarry,
- Mulga Woodland,
- Granite Outcrops,
- Major River,
- Minor Creekline,
- Minor Drainage Line,
- Rockface/Cliff and
- Cleared/Disturbed.

Larger areas that are cleared and disturbed do not represent habitats as such; however, they have been included in the below sections. The extend of each habitat and the percentage of the total study area is listed in Table 3.1. The table also lists the percentage of each habitat that is already cleared or disturbed as part of the rail infrastructure project. The details of each habitat type are described below in sections 3.1 - 3.14 and mapped in Figure 3.1 - Figure 3.12.

Table 3.1: Habitat Types mapped inside Corridor

Habitat	Area (ha)	Percentage of study area (%)	Area previously disturbed	Percentage of habitat type previously disturbed (%)	Area within proposed development envelope (ha)
Sandy/Loamy Plains with Spinifex Grassland	22259.74	26.1	2,532.43	11.4	774.28
Stony Plains and Low Rises with Hummock Grassland	41362.2	48.6	3,895.13	9.4	2014.44
Loamy/Stony Plains with mixed Shrubland	347.10	0.4	22.77	6.6	10.34
Sandy/Loamy Plains with mixed Shrubland	951.13	1.1	55.27	5.8	33.26
Spinifex covered Hills	3415.12	4.0	276.96	8.1	99.25
Clay Pan	12.76	0.01	1.51	11.8	2.43
Quarry	1.85	0.002	-	-	-
Mulga Woodland	2055.69	2.4	130.87	6.4	101.09
Granite Outcrops	1112.48	1.3	27.16	2.4	17.95
Major River	1073.31	1.3	57.50	5.4	1.14
Minor Creekline	2326.23	2.7	153.42	6.6	39.44
Minor Drainage Line	2166.21	2.5	213.95	9.9	144.55
Rockface/Cliff	6.05	0.007	-	-	-
Total	85127.32		8,015.37	-	4,840.04

3.1. Sandy/Loamy Plains with Spinifex Grassland

The Sandy/Loamy Plains with Spinifex Grassland habitat type dominates the northern section of the study area and is typical for the Abydos plain (Figure 3.1 - Figure 3.7). It covers 22259.74 ha (26.17 % of the study area) of which 2,532.43 ha (11.4 % of this habitat type) was cleared or disturbed as part of the construction of the Main Line Rail infrastructure.

The Sandy/Loamy Plains with Spinifex Grassland habitat is dominated by hummock grasses with patches of low to moderate shrubs (such as *Acacia stellaticeps*, *A. inaeqilatera*, *A. maitlandii*, or *A. pyrifolia*). Trees are typically lacking. The substrate is often soft and sandy, allowing for the construction of burrows. This habitat is predominantly inhabited by species that use the spinifex grasses as shelter or burrow into the substrate. Fire scars are often visible from regular bush fires which can travel long distances over the spinifex plains.

3.2. Stony Plains and Low Rises with Hummock Grassland

The Stony Plains and Low Rises with Hummock Grassland habitat type is the most common habitat recorded within the study area and is widespread in the southern half of the study area (Figure 3.1 - Figure 3.12), where it borders with Spinifex covered Hills and Rockface/Cliff habitat within the Hamersley Range and Chichester Range. The Stony Plains and Low Rises with Hummock Grassland covers 41362.2 ha (48.59 % of the study area) of which 3,895.13 ha (9.4 % of this habitat type) is cleared or disturbed inside the corridor.

The Stony Plains and Low Rises with Hummock Grassland habitat is often intersected by minor drainage lines and minor creeklines. The vegetation is typically dense to moderately dense *Triodia* hummock grassland (depending on fire age) with scattered mixed shrubs (*Acacia bivenosa*, *A. inaequilatera*, *A. tumida*, *Grevillea wickhamii*). Some areas of flat plains support *Corymbia hamersleyana* open woodland, with scattered *Eucalyptus leucophloia* trees occurring in more elevated areas (low rises). The substrate associated with this habitat type is loamy clay soils with a continuous rocky mantle. The Stony Plains and Low Rises with Hummock Grassland habitat is often burnt by large bush fires which travel long distances, in particular reducing the size and complexity of the spinifex hummock grasses.

Fauna species associated with this habitat type typically utilise the hummock grasslands and the scattered shrubs for shelter and food resources. The substrate typically does not attract the construction of burrows with the exception of small reptiles which tend to dig fairly shallow burrows.

3.3. Loamy/Stony Plain with mixed Shrubland

The Loamy/Stony Plain with mixed Shrubland habitat type is generally found in the southern half of the study area as smaller patches, mostly in association with creeklines or other minor drainage channels (Figure 3.3 - Figure 3.7 & Figure 3.11). This habitat type has similar characteristics and vegetation structure to the Minor Drainage Line habitat but is not associated with drainage depressions. Covering only 347.1 ha (0.41% of the study area) this habitat type is relatively uncommon along the study area, however it is not considered rare or unique. Of this, 22.77 ha (6.6 % of the habitat type) is cleared or disturbed as part of the rail infrastructure inside the corridor.

The Loamy/stony Plain with mixed Shrubland habitat comprises of loamy substrate with or without a large amount of pebbles which supports patches of dense to moderately dense mixed shrubs such as *Acacia tumida*, *Grevillea wickhamii* or *Indigofera monophyla*. The areas of this habitat are often not distinct enough to support a specific fauna assemblage, however they can attract a variety of bird species when the shrubs are flowering. The substrate is mostly hard and compact, and the construction of burrows can be difficult or only possible in pockets with softer substrate.

3.4. Sandy/Loamy Plains with mixed Shrubland

The Sandy/Loamy Plains with mixed Shrubland habitat type is also found in small patches but is located in the central part of the study area (Figure 3.4 - Figure 3.8). Predominantly found along the edge of Minor Creeklines or Minor Drainage Line habitats, it covers 951.13 ha (1.12 % of the study area) of which 55.27 ha (5.8 % of the habitat type) is cleared or disturbed as part of the rail infrastructure inside the corridor.

The Sandy/Loamy Plains with mixed Shrubland habitat is dominated by sandy to loamy soft substrate which supports a mix of moderately open to dense thickets of *Acacia* shrubs (*Acacia bivenosa*, *A. ancistrocarpa*, *A. trachycarpa*, *A. orthocarpa*, *A. tumida*, *A. coriacea*, and *A. colei*) over mixed *Triodia* (*T. angusta*, *T. epactia*, *T. longiceps*, or *T. pungens*) grassland.

3.5. Spinifex covered Hills

The Spinifex covered Hills habitat type is limited to the North Star rail spur (Figure 3.5,), the Chichester Range north-west of Cloudbreak (Figure 3.9) and the Hamersley Range adjacent to the Solomon mine (Figure 3.12). This habitat is one of the most elevated habitat types and comprises of mid slopes, upper slopes and ridgetops. It covers 3415.12 ha (4.01 % of the study area) of which 276.96 ha (8.1 % of the habitat type) is cleared or disturbed.

The vegetation of the Spinifex covered Hills habitat is typically open and is dominated by spinifex hummock grassland (*Triodia wiseana, T. basedowii*, *T. epactia* and *T. longiceps*). Shrubs are scattered and consist of *Grevillea wickhamii, Hakea lorea*, *Acacia inaequilatera*, *A. pyrifolia*, *A. ancistrocarpa*. Trees are very sparse and include scattered *Eucalyptus leucophloia* and *Corymbia deserticola*. The substrate is typically very rocky with sparse loamy clay soils. Shelter and food resources are similar to those found on the Stony Plains and Low Rises with Hummock Grassland with the substrate typically too hard for the construction of burrows and shelter limited to the spinifex hummocks and rock crevices.

3.6. Clay Pan

The Clay Pan habitat type was mapped from only one location in the northern section of the study area (Figure 3.2). The area only covers 12.76 ha (0.015 % of the study area) of which 1.51 ha (11.8 % of the habitat type) is cleared or disturbed. The Clay Pan is a depression in the landscape which seasonally inundates concentrating clay soils.

Vegetation is sparse and is concentrated along the fringe of the Clay Pan. The clay soil causes rainwater to collect and persist for a longer period than surrounding habitat types creating ephemeral wetland habitats. It is surrounded by a plain with spinifex grassland on sandy/loamy substrate. The vegetation on the outside of the Clay Pan includes *Corymbia hamersleyana*, over *C. candida* over *Acacia colei*, and *A. tumida* shrubs, over *Triodia epactia* spinifex grass. The vegetation located in the centre of the Clay Pan consists of small annual herbs due to the seasonal inundation. Fauna would utilise the large trees and large shrubs that border the Clay Pan for shelter and foraging. The Clay Pan habitat would be utilised by wetland species such as water birds, frogs and turtle when surface water is present.

3.7. Quarry

The Quarry habitat was mapped from one location inside the study area and is associated with construction of the BHPBIO rail infrastructure (Figure 3.3). The quarry covers 1.85 ha (0.002 % of the study area) and is located adjacent to Granite Outcrop habitats). Quarries are an artificial habitat and technically are a disturbed habitat type; however, they provide suitable conditions for a number of conservation significant fauna species. The rocky boulder piles contain numerous crevices and cracks of different sizes for fauna species to shelter. Surface water often collects on the bottom of the quarry occasionally forming large deep pools that persist for extended periods. This increased the humidity in the crevices above and in the surrounding. all of which create suitable habitat for fauna species including Northern Quoll and Pilbara Olive Python. Vegetation is typically very sparse and is dominated by disturbance specialists.

3.8. Mulga Woodland

The Mulga Woodland habitat type is limited to relatively small areas along the edge of the Chichester Range (Figure 3.9, Figure 3.11 & Figure 3.12) and is mostly associated with the floodplains of the Fortescue IBRA sub-region. Mulga Woodland habitats cover 2,055.69 ha (2.41 % of the study area) of which 130.87 ha (6.4 % of the study area) has been cleared or disturbed.

The vegetation is dominated by *Acacia aneura* and can also include areas dominated by Snakewood (*Acacia xiphophylla*). Other shrubs such as *Acacia pruinocarpa*, *A. tetragonophylla*, *A. tenuissima*, mixed soft grasses or *Triodia epactia* grass can also occur. The substrate is often hard clays with or without a rocky pebble matrix. Wood litter and leaf litter can be present in patches but is typically concentrated under patches of trees, creating microhabitats and shelter for fossorial species. Denser patches of Mulga are often utilised by small flocks of foraging birds.

3.9. Granite Outcrops

Granite Outcrops are a major feature of the Abydos Plain and are present across the central section of the study area (Figure 3.2 - Figure 3.7). The Granite Outcrops habitat consists of exposed granites that range in size and structure from large expanses of stone to small boulder piles or any combination of both. Granite Outcrops habitat covers 1,112.48 ha (1.31 % of the study area) of which 27.16 ha (2.4 % of the habitat) was cleared or disturbed.

Vegetation is typically sparse and comprises of some low shrubs (*Acacia orthocarpa*, *A. ancistrocarpa*, *A. inaequilatera)* over low spinifex hummock grassland (*Triodia lanigera* and *T. epactia*). Occasionally small shrubs (*Indigofera colutea*, *Corchorus laniflorus*) can emerge from rock crevices in between the boulders and soft grasses (*Eriachne pulchella*) grow in pockets of shallow sandy substrates. Granite Outcrops are typically associated with a unique fauna assemblage (*Pseudantechinus macdonnellensis*, *Egernia epsisolus* etc.) that find shelter in the crevices created by exfoliated granite slabs and crevice located between the granite boulders. These areas are also relatively protected from bush fires and can form refuges during fire events. The sandy substrate typically does not retain surface water after rainfall events and dries out relatively quickly. The construction of burrows is possible in pockets of sandy soil in between or underneath the granite rocks.

3.10. Major River

The Major River habitat type occurs across the study area with more areas located in the north of the study area where the Turner River and the headwaters of the Yule River dominate the landscape (Figure 3.1 - Figure 3.7). The Major River habitat covers 1,073.31 ha (1.26 % of the study area) of which 57.50 ha (5.4 % of the habitat) is cleared or disturbed. Construction of the rail infrastructure required the building of bridges to cross the major river systems along the route. The Major River habitat is generally undisturbed due to the bridges infrastructure with additional microhabitats created including boulder piles due to the rock armour and high sheltered perches for many bird species underneath the bridge structure. The substrate of the Major River habitat is typically too soft to support extensive burrow systems, however the adjacent floodplains and small islands in the middle of the creekbed can form ideal habitat for burrowing species. During the wet season this habitat type often gets flooded, leaving small to large pools of surface water for extended periods.

The Major River habitat is characterised by a sandy or gravelly substrate with fringing large eucalypt or *Melaleuca* trees. Buffel Grass **Cenchrus ciliaris* is often the dominant understory plant species along the floodplain. This habitat type is transformative between seasons and with large surface water pools forming after heavy rainfall events resulting in increased humidity levels and an accumulation of food resources. Large trees including hollow logs and branches can provide shelter for a variety of species. Major Rivers also often function as dispersal corridors for fauna species due to the availability of food and water resources, shelter and open areas to travel along. This is shown in the higher occurrence of feral fauna species in this habitat type.

3.11. Minor Creekline

The Minor Creekline habitat occurs throughout the study area (Figure 3.1 - Figure 3.12) and is characterised by a defined creek bed which is dominated by fringing shrublands (e.g. mixed *Acacia* species). The Minor Creekline habitat covers 2,326.23 ha (2.73 % of the study area) of which 153.42 ha (6.6 % of the habitat) is cleared or disturbed. The substrate of the Minor Creekline habitat can be sandy to gravelly but can also include rocky areas. The Minor Creeklines are considerably smaller than the Major Rivers with a vegetation dominated by shrubs such as *Acacia tumida*, *A. trachycarpa*, *Grevillea wickhamii* causing the structure to be lower in height and often much denser. Scattered trees of *Eucalyptus victrix* and *Corymbia hamersleyana* can intercept the shrublayer. The understorey can also be dominated by Buffel Grass **Cenchrus ciliaris* however many areas are dominated by moderately dense *Triodia epactia*. *T. lanigera* and *T. pungens* hummock grassland.

Sandy areas are often suitable for the construction of burrow systems, whereas rocky areas can provide areas with rock crevices and boulder pile habitats. Small pools of surface water often accumulate after heavy rainfall creating increased food resources with an increase in invertebrate activity in these areas. Habitats associated with large trees, such as hollows, is generally limited. Fauna species often utilise the areas of dense vegetation for shelter.

3.12. Minor Drainage Line

The Minor Drainage Line habitat occurs throughout the study area (Figure 3.1 - Figure 3.12) and is characterised by a minor drainage depression which is dominated by shrublands (e.g. mixed *Acacia* species). The Minor Drainage Line habitat covers 2,166.21 ha (2.54 % of the study area) of which 213.95 ha (9.9 % of the habitat) is cleared or disturbed. There is no creek bed or defined edges along the Minor Drainage Line habitat. This habitat type is a linear feature is an extension of a Minor Creekline or Major River habitat types. Due to the increased soil moisture associated with this habitat type the vegetation is often denser than in the surrounding Plains habitat and comprises of mixed shrubs such as *Acacia xiphophylla*, *A. pyrifolia*, *Grevillea wickhamii* over lower shrubs (*Senna artemisoides*). The understory can comprise soft grasses (*Cymbopogon ambiguus*) or spinifex grasses (*Triodia* sp.) depending on the adjacent habitat types. The type of substrate varies and can be sandy, loamy, or clay with or without a rocky mantle.

3.13. Rockface/Cliff

The Rockface/Cliff habitat type is limited to small sections in the south-west and south-east of the corridor (Figure 3.9, Figure 3.10 & Figure 3.12) and covers only 6.05 ha (0.007 % of the study area). This habitat type has not been disturbed or cleared. The Rockface/Cliff type contains vertical cliff faces at the edge of Spinifex covered Hills. The Rockface/Cliff habitat is sparsely vegetated due to the lack of soil. Small patches of soft grasses occur in pockets of soil substrate and the *Astrotricha hamptonii* and *Ficus brachypoda* can be found anchored in very small rock crevices. The rock structure typically contains numerous small crevices and cracks including smaller caves and overhangs which provide shelter for fauna species of different size. Insects and other smaller species find shelter and humid microhabitats with larger insectivorous species utilising the Rockface/Cliffs habitat for foraging purposes and shelter.

3.14. Cleared or Developed Areas

A total of 8,015 ha (9.4% of the study area) was cleared or disturbed during the development of the Fortescue rail infrastructure projects. The majority of these area have been rehabilitated and will develop into similar habitats present prior to clearing. Areas that remain cleared as components of the rail infrastructure are of very low value to fauna species due to the lack of vegetation and habitat as such. Some common species can utilise the open areas on a temporary basis when foraging along surrounding habitats.

650000
660000
670000
7760000
7750000
7740000
7730000

Legend

Study area

Fauna Habitat Mapping

Cleared

Minor creekline

Sandy/loamy Plain with spinifex grassland

GREAT NORTHERN HIGHWAY

NORTH WEST COASTAL HIGHWAY

TURNER RIVER

E A N Hedland

Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.1

Spectrum ECOLOGY

660000

670000

7720000

7710000

7700000

Legend

Study area

Fauna Habitat Mapping

Cleared

Major River

Minor creekline

Clay Pan

Sandy/loamy Plain with spinifex grassland

Stony Plains and Low Rises with Hummock Grassland

Granite Outcrops

TURNER RIVER EAST

GREAT NORTHERN HIG

Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.2

Spectrum ECOLOGY

670000
680000
690000
7690000
7680000
7670000

Legend

Study area

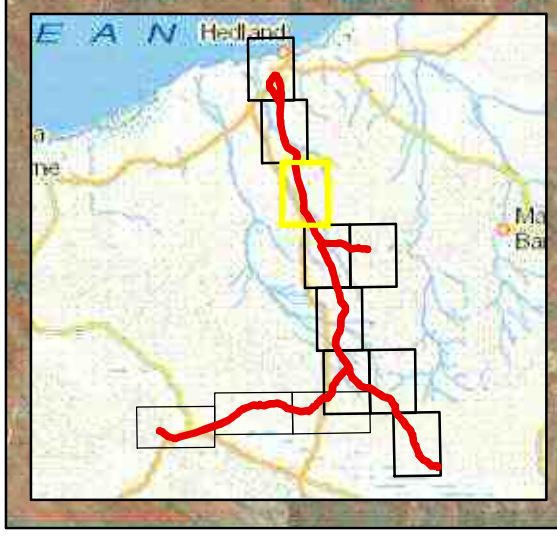
Fauna Habitat Mapping

- Cleared
- Major River
- Minor creekline
- Loamy/stony Plain with mixed shrubland
- Sandy/loamy Plain with spinifex grassland
- Stony Plains and Low Rises with Hummock Grassland
- Granite Outcrops
- Quarry

GREAT NORTHERN HIGHWAY

TURNER RIVER

TURNER RIVER WEST



Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

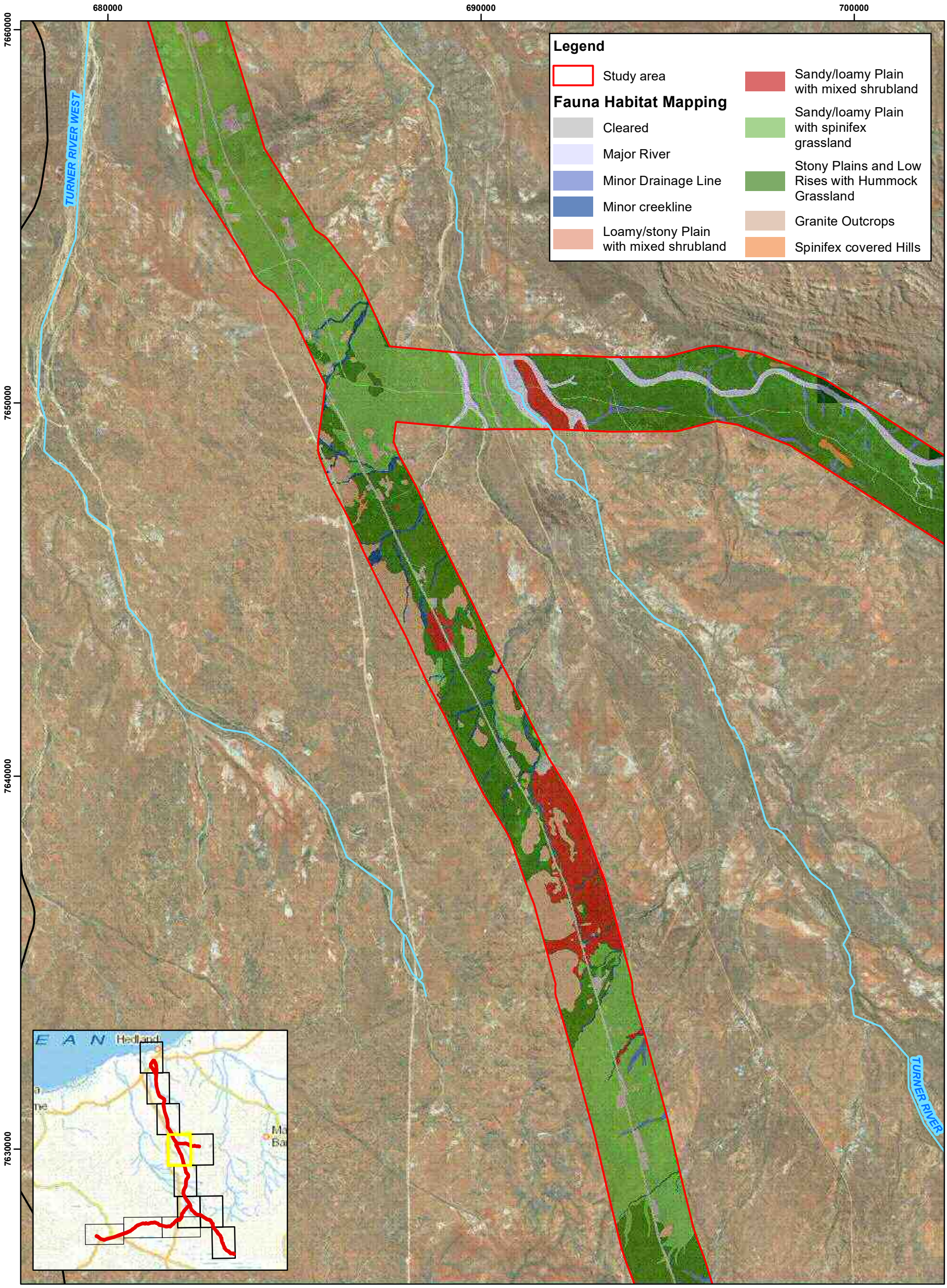
Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.3

Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.4

Spectrum ECOLOGY

710000

720000

7660000

7650000

7640000

7630000

Legend

Study area

Fauna Habitat Mapping

Cleared

Major River

Minor Drainage Line

Minor creekline

Loamy/stony Plain with mixed shrubland

Stony Plains and Low Rises with Hummock Grassland

Spinifex covered Hills

Rockface/cliff

North Star

E A N Hedland

Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.5

Spectrum ECOLOGY

690000

700000

7620000

7610000

7600000

Legend

Study area

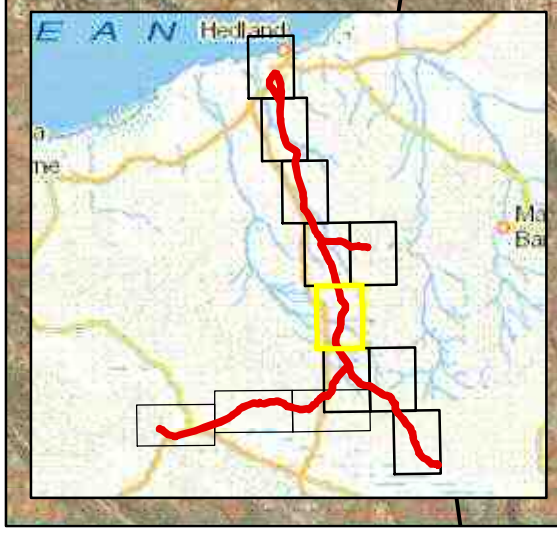
Fauna Habitat Mapping

- Cleared
- Major River
- Minor Drainage Line
- Minor creekline
- Loamy/stony Plain with mixed shrubland
- Sandy/loamy Plain with mixed shrubland
- Sandy/loamy Plain with spinifex grassland
- Stony Plains and Low Rises with Hummock Grassland
- Granite Outcrops

GREAT NORTHERN HIGHWAY

YULE RIVER

TURNER RIVER



Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.6

Spectrum ECOLOGY

690000

700000

710000

7590000

7580000

7570000

7560000

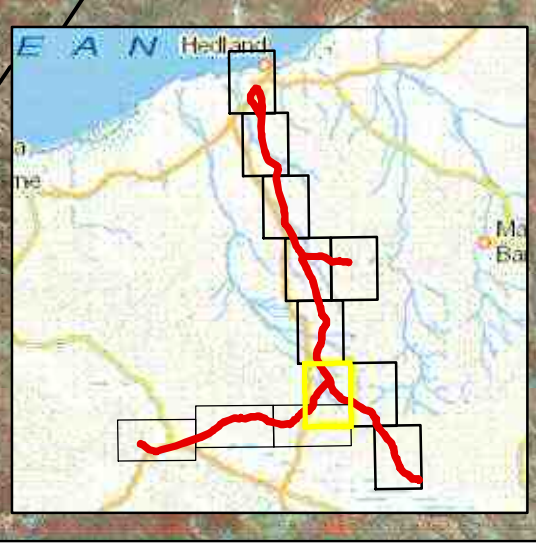
GREAT NORTHERN HIGHWAY

Legend

Study area

Fauna Habitat Mapping

- Cleared
- Major River
- Minor Drainage Line
- Minor creekline
- Loamy/stony Plain with mixed shrubland
- Sandy/loamy Plain with mixed shrubland
- Sandy/loamy Plain with spinifex grassland
- Stony Plains and Low Rises with Hummock Grassland
- Granite Outcrops
- Spinifex covered Hills



Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.7

Spectrum ECOLOGY

720000

730000

7590000

7580000

7570000

7560000

YULE RIVER

Legend

Study area

Fauna Habitat Mapping

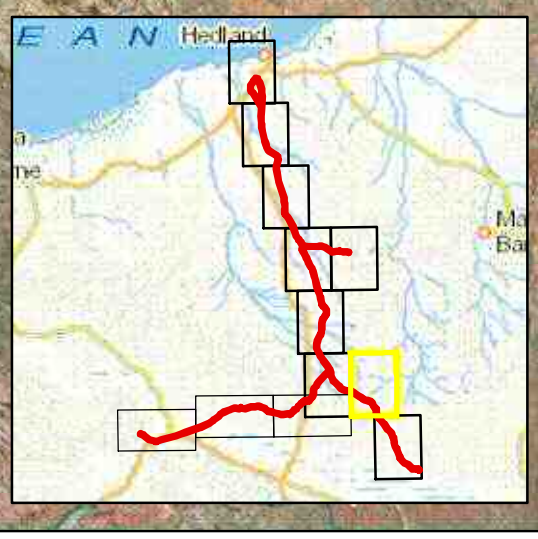
Cleared

Minor creekline

Sandy/loamy Plain with mixed shrubland

Stony Plains and Low Rises with Hummock Grassland

Spinifex covered Hills



Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.8

Spectrum ECOLOGY

730000

740000

7550000

7540000

7530000

Legend

Study area

Fauna Habitat Mapping

Cleared

Minor Drainage Line

Minor creekline

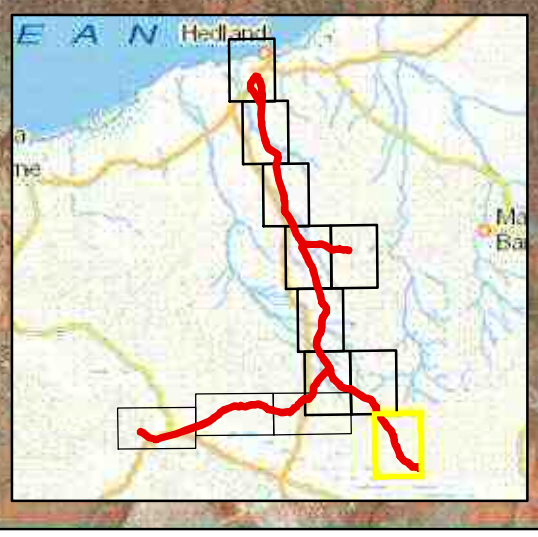
Mulga Woodland

Stony Plains and Low Rises with Hummock Grassland

Spinifex covered Hills

Rockface/cliff

Cloudbreak



Service Layer Credits: Geoscience Australia, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

FAUNA HABITATS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 3.9

Spectrum ECOLOGY

590000 600000 610000 620000

7560000

7550000

ROEBOURNE WITTENOOM ROAD

FORTESCUE RIVER

NANUTARRA WITTENOOM ROAD

Solomon

Legend

- Study Area
- **Fauna Habitat Mapping**
  - Cleared
  - Minor Drainage Line
  - Mulga Woodland
  - Stony Plains and Low Rises with Hummock Grassland
  - Spinifex covered Hills
  - Rockface/cliff

FAUNA HABITATS

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

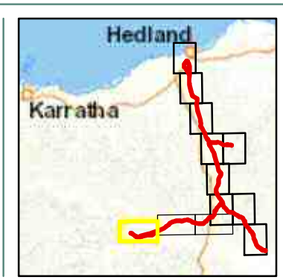


FIGURE 3.10

N

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

630000 640000 650000 660000 670000

7570000

7560000

7550000

FORTESCUE RIVER

FORTESCUE RIVER

Legend

- Study Area
- **Fauna Habitat Mapping**
- Cleared
- Minor Drainage Line
- Minor creekline
- Mulga Woodland
- Loamy/stony Plain with mixed shrubland
- Stony Plains and Low Rises with Hummock Grassland

FAUNA HABITATS

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

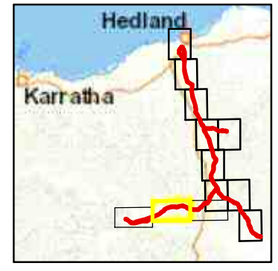


FIGURE 3.11

N

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

680000
690000
700000
710000
7570000
7560000
7550000
GREAT NORTHERN HIGHWAY

Legend

- Study Area

Fauna Habitat Mapping

- Cleared
- Minor Drainage Line
- Minor creekline
- Mulga Woodland
- Loamy/stony Plain with mixed shrubland
- Stony Plains and Low Rises with Hummock Grassland
- Rockface/cliff

FAUNA HABITATS

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

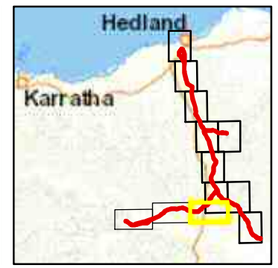


FIGURE 3.12

N

0 2.5 5 Km

Absolute Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

4. CONSERVATION SIGNIFICANT FAUNA SPECIES

The literature review and database searches identified a total of 73 vertebrate fauna species, listed as either threatened fauna (EPBC Act, BC Act Schedule) or as priority fauna (DBCA Priority list), that could potentially occur within the study area. Due to the proximity of the study area to Port Hedland, several of these species are considered obligate marine species and were excluded accordingly. An additional ten migratory bird species that are typically restricted to coastal habitats were also identified however due to the study area not including this habitat type, these species have not been discussed in detail.

Ten mammal species, ten bird species, five reptile species and one fish species of conservation significance were identified as potentially occurring within the study area. An assessment of their likelihood of occurrence was completed, based on the categories outlined in Table 4.1, with relevant information for each species summarised in Table 4.2. Species that are listed under the EPBC Act, WC/BC Act or by DBCA, and have a moderate to likelihood of occurrence, or have been recorded inside the study area, are discussed in further detail in sections 4.1-4.9 below.

Table 4.1: Likelihood of occurrence criteria – vertebrate fauna

Likelihood of occurrence	Criteria
Recorded	Species recorded within the study area within the previous ten years.
High	Species recorded within or in proximity to the study area within the previous 20 years. Suitable habitat occurs in the study area.
Moderate	Species recorded within or in proximity to the study area more than 20 years ago. Species recorded outside the study area but within 50 km. Suitable habitat occurs in the study area.
Low	Species rarely or not recorded within 50 km of the study area. Suitable habitat does not occur within or in proximity to the study area.
Very Low	Species not recorded within 50 km despite multiple recent surveys. Suitable habitat does not occur within the study area. Species considered locally extinct.

Table 4.2: Summary of conservation significant fauna species with potential to occur in the study area

Species	Conservation Status			Preferred Habitats	Previous Records	Likelihood of Occurrence
	EPBC Act	WC/BC Act	DBCA			
Mammals						
Northern Quoll *Dasyurus hallucatus*	EN	S2 (EN)		Most commonly recorded on dissected rocky escarpments, gorges and granite boulder piles. Typically prefer rocky areas with suitable denning sites and access to surface water. Also found in eucalypt forest/woodland and along major drainage lines.	Northern Quoll have been recorded from across the study area. Targeted surveys and ongoing monitoring of this species has resulted in over 400 records from across the study area. Over 190 of those records are from the DBCA Indee station monitoring site.	**Recorded** Populations tend to occur in granite boulder piles on the Abydos plain and rocky gorges and escarpments associated with the Chichester Range, Hamersley Range and the Wodgina region.
Greater Bilby *Macrotis lagotis*	VU	S3 (VU)		Variety of habitats with suitable soil substrates and availability of food resource plants species. Habitats can include spinifex hummock grassland, acacia shrubland, open woodland and cracking clays.	Secondary evidence of Greater Bilby has been recorded from several locations across the Abydos Plain however they are not typically observed during fauna surveys. One population (Site ML GB SET 114) is currently being monitored with the resident female present since 2012.	**Recorded** Secondary evidence of Greater Bilby has been recorded from the northern half of the study area. Records typically associated with alluvial plains associated with creeklines
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Pilbara form)	VU	S3 (VU)		Dissected rocky escarpments with suitable roost caves (high humidity (95%) and temperature (32°C)). Able to forage in a variety of habitats particularly along water bodies and fringing vegetation.	Pilbara Leaf-nosed Bats have been recorded foraging from several sites along major creekline habitats located in the Abydos plain region near Wodgina.	**Recorded** Recorded from foraging sites only. No suitable roost habitat has been identified along the study area to date.
Ghost Bat *Macroderma gigas*	VU	S3 (VU)		Utilises a wide variety of habitats with suitable roosts (caves, rock piles and abandoned mines). Will travel over 2 km from roost to hunt and utilise other structures as feeding roosts (culverts, rock overhangs, trees).	Ghost Bats calls have been recorded from 6 locations located adjacent to rocky escarpment habitats (Cloudbreak and North Star) however scats and the remains of prey have been recorded from six culverts located along the Main Line Rail. Multiple regional records from across the study area.	**Recorded** Ghost bats have been recorded from several locations across the study area. Large culverts located along the Main Line Rail appear to be suitable as nocturnal foraging roosts. No diurnal roost have been recorded from the study area.
North-western Free-tailed Bat *Mormopterus* (*Ozimops*) *cobourgianus*			P1	Typically recorded from mangrove forests, monsoon forest adjacent to large waterways and semi deciduous vine thickets.	North-western Free-tailed Bats have been recorded from the mangrove habitats located around Port Hedland.	**Low** Although suitable mangrove habitat exists adjacent to the study area, no records and no suitable habitat have been recorded from within the study area.
Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*)			P3	Inhabits grasslands, open forests, open woodlands and tall shrublands and shelters during the day under tussocks of *Triodia* spp. Long unburnt areas most suitable.	Several recent records from the Abydos plain between 70-140 km south of Port Hedland.	**Moderate** Several recent records from the central region of the study indicating that although this species is rarely recorded, it may occur within the study area.
Brush-tailed Mulgara *Dasycercus blythi*			P4	Sand plains and gibber plains with moderately dense spinifex with 'runways' between clumps.	Recorded from several areas along the study area north of the Chichester Range. Has been recorded in high densities from areas of suitable habitats.	**Recorded** Has been recorded from several areas along the study area. Several populations were monitored along the Main Line Rail and Hamersley Rail Line over four years

Species	Conservation Status			Preferred Habitats	Previous Records	Likelihood of Occurrence
	EPBC Act	WC/BC Act	DBCA			
Long-tailed Dunnart *Sminthopsis longicaudata*			P4	Rocky hills, ranges and escarpments with spinifex.	Recorded from only two locations associated with the North Star project.	**Moderate** Long-tailed Dunnart have not been recorded from within the study area. Suitable habitats are associated with rocky habitats typically found in the Chichester
Northern Short-tailed Mouse *Leggadina lakedownensis*			P4	Spinifex and tussock grassland on cracking clays. Also, acacia shrubland, samphire, woodlands, and stony ranges in northern Australia.	One record from the Fortescue plain (Investigator project) and two records from the Abydos plain. Several additional records from cracking clay habitats in the Chichester Range.	**Recorded** Typically recorded from cracking clay habitats associated with the Wona landsystem. Widely dispersed but not commonly recorded
Western Pebble-mound Mouse *Pseudomys chapmani*			P4	Rocky ranges and rocky hills where the ground has continuous small pebbles and vegetated by spinifex.	Multiple records of active and inactive pebble mounds from across the study area.	**Recorded** Active and inactive pebble mounds recorded from across the study area in suitable habitat. No records within 50 km of the coast.
Birds						
Night Parrot *Pezoporus occidentalis*	EN	S1 (CE)		Most records from long unburnt *Triodia* grasslands and/or chenopod shrublands featuring large dense clumps of vegetation.	One confirmed record of two to three individuals from Minga Well located on the northern edge of the Fortescue Marsh.	**Low** Due to frequent fires across the Pilbara region, there is minimal long-unburnt spinifex habitats within the study area. Efforts to detect and monitor the Night Parrot have not produced any records to date.
Grey Falcon *Falco hypoleucos*		S3 (VU)		Generally open inland plains and woodland habitats.	Grey Falcon have been recorded from across the length of the study area. Several records are associated with breeding activity on radio repeater towers located along the various rail infrastructure in the region.	**Recorded** Several records of individuals from within the study area. Records include individuals foraging and Adult and juvenile combination indicating a breeding population
Peregrine Falcon *Falco peregrinus*		S7 (OS)		Widespread; coastal cliffs, riverine gorges and wooded watercourses.	Several widespread records from across the study area, however records appear to be grouped around the Chichester Range, Hamersley Range and the small range at Wodgina.	**Recorded** Recorded from the study area in the Chichester Range. Several widespread regional records indicating presence across the whole study area
Fork-tailed Swift *Apus pacificus*	Mig	S5		Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts.	Several widespread records from across the study area.	**Recorded** The Fork-tailed Swift is highly nomadic and has been recorded from across the Pilbara region. Records typically associated with suitable climatic conditions instead of habitat types.
Common Greenshank, *Tringa nebularia* Wood Sandpiper, *Tringa glareola* Common Sandpiper, *Actitis hypoleucos* Oriental Pratincole, *Glareola maldivarum* Glossy Ibis, *Plegadis falcinellus*	Mig	S5		Migratory bird species are typically associated with coastal habitats. These five species also utilise inland ephemeral wetland habitat types when present. Can also be found foraging in adjacent open grassland habitats	These species have been recorded intermittently across the study area when suitable ephemeral habitats are present.	**Recorded/High** Not commonly recorded, these species can utilise ephemeral wetland habitats which can occur across most of the study area after significant rainfall.

Species	Conservation Status			Preferred Habitats	Previous Records	Likelihood of Occurrence
	EPBC Act	WC/BC Act	DBCA			
Letter-winged Kite *Elanus scriptus*			P4	Open country and grasslands in arid and semi-arid Australia, where there are tree-lined streams or water courses.	Single regional record from Bea Bea Gorge in 2000.	Very Low Letter-winged Kites may disperse into Western Australia occasionally. Single regional record however this species is not typically recorded from the region.
Reptiles						
Pilbara Olive Python *Liasis olivaceus barroni*	VU	S3 (VU)		Watercourses and areas of permanent water in rocky gorges, escarpments and gullies.	Several scattered records just outside the study area in suitable habitats typically associated with the Chichester Range, Hamersley Range, North Star and the small range at Wodgina. One record inside the study area.	Recorded This species is not commonly recorded despite significant survey effort. Associated with rocky habitats however has been recorded from Minor Creekline habitat with fringing rocky edges.
North-western Coastal Ctenotus *Ctenotus angusticeps*	VU		P3	Landward fringe of salt marsh communities in samphire shrubland or marine couch grassland (Maryan et al. 2013) in the intertidal zone along mangrove margins.	Several records restricted to coastal habitats near Port Hedland.	Low Although recorded from habitats adjacent to the study area, no suitable habitat occurs within the study area
Gane's Blind Snake *Anilios ganei*			P1	Variety of habitats; thought to prefer moist gorges. Cryptic nature reduces likelihood of recording during fauna assessments.	Single record from the Stage A baseline survey located to the south of the study area.	Moderate Suitable habitats occur within the study area however cryptic nature of the species reduces likelihood of being recorded.
Pin-striped Finesnout Ctenotus *Ctenotus nigrilineatus*			P1	Spinifex plains adjacent to granite outcrops and water courses.	Five regional records from the upper Yule and Turner River catchments. One recent (2012) record from the BHPBIO rail adjacent to the study area.	High No records from within the study area however the study area crosses areas of suitable habitat.
Pilbara Barking Gecko *Underwoodisaurus seorsus*			P2	Rocky upland habitats including hills, plateaus and ranges.	Three regional records located to the west of the study area and associated with the Solomon Project and Mt Sheila.	Low Current records indicate that it is restricted to the upland habitats in the Hamersley Range which are outside of the study area.
Fish						
Fortescue Grunter *Leiopotherapon aheneus*			P4	Permanent water pools or streams.	Three records from Hamersley Gorge (DBCA Database).	Moderate Creekline habitat that connects Hamersley Gorge with the Fortescue River during periods of seasonal inundation crosses the study area.

4.1. Northern Quoll (*Dasyurus hallucatus*)

4.1.1. Conservation Status

- EPBC Act: Endangered,
- WC/BC Act: Schedule 2 (Endangered)

4.1.2. Distribution and Ecology

The Northern Quoll is the smallest of the four quoll species occurring in Australia (Oakwood, 2008). The species formerly occurred across the northern parts of Australia. Since the arrival of the Cane Toad (*Rhinella marina*) the Northern Quolls' distribution has declined significantly, especially in the more arid parts of its range (DotEE 2018a). The species' diet varies widely, fluctuating based on available habitats and environmental conditions. The Northern Quoll is an opportunist feeder that mostly consumes insects, fruits, vegetation, molluscs but also a large number of vertebrate species (mammals, birds, reptiles and frogs) (Dunlop, Rayner and Doherty, 2017).

4.1.3. Habitat

The Pilbara population is associated with rocky habitats where the species finds refuge during the day in crevices, cracks and small caves. These critical denning habitats include rocky gorges, basalt hills, escarpments, mesas, plateaux, granite boulder piles, caves and adjacent cliff faces but also along coastal fringes and beaches (DotEE 2018a). Foraging can occur across any adjacent habitat type that provides suitable cover and food resources. Drainage lines and rivers are used for dispersal and foraging of the species. The species is adaptable and has also been recorded in artificial habitat such as rock armour underneath bridges (Ecoscape 2018), in quarries (DMP 2013), camp sites (ecologia 2012c) and along breakwaters (Ecoscape 2016a, 2016b).

4.1.4. Previous Survey Effort

Targeted Northern Quoll surveys and ongoing monitoring of the species has occurred across the study area. Targeted Northern Quoll surveys have been completed in the Port Hedland area, along the Main Line Rail, Hamersley Rail Line, at the Solomon Hub, Cloudbreak tenement M42/4112 and North Star mine (ATA 2007; ENV 2009; Bamford 2010b; Coffey 2011; Ecologia 2011a, 2014f; Outback 2013; Ecoscape 2017d). Additional targeted surveys have also been completed within the Atlas Iron Wodgina Mine and Mt Dove mines however this data was not available and has not been included. During targeted surveys completed within and adjacent to the study area, over 20 trapping sites (over 330 targeted trapping points) and a total of 207 motion camera points have been surveyed.

Ongoing monitoring of the species has been completed along the Main Line Rail and Hamersley Rail spur (2012-2018), as well as regionally at Cloudbreak (2017-2018), Solomon Hub (2012-2018) and North Star (2014-2018) mine sites (Ecologia 2014a, 2014d, 2014g, 2015b, 2015c, 2015a, Ecoscape 2016d, 2017b). Monitoring of Northern Quoll populations in the study area and adjacent region included cage trapping at a total of 96 sites (over 3,000 trap points) and 276 motion camera points (Figure 2.4).

4.1.5. Occurrence in the Study Area

The Northern Quoll has been recorded from several locations across the study area (Figure 4.2 and Figure 4.3). Conservation significant fauna monitoring indicates that high density permanent Northern Quoll populations occur in the Granite outcrops located between Port Hedland and Wodgina (Ecologia 2015a; Ecoscape 2016c, 2017a, 2018) including the Turner River adjacent to Indee station (Dunlop, 2017). These populations also extend into the rocky ranges associated with the Iron Bridge's North Star (Figure 4.1) and Atlas Iron's Abydos and Wodgina projects (data not included). Additional high-density populations also occur in the Hamersley Range adjacent to the Fortescue Solomon Hub project (Figure 4.3).

Low density populations have been recorded from the Chichester Range with a single individual recorded (multiple times) from adjacent to the Fortescue Cloudbreak mine (Figure 4.2) and low numbers recorded from sites located along the Hamersley Rail Line (Figure 4.3) including DBCA's Hooley monitoring site (Dunlop, 2017).

Female quolls have been recorded from Granite Outcrops, Major River and Minor Creekline habitats with numerous males roaming through-out these habitat types. The Major River and Minor Creekline habitats where Northern Quolls were recorded were typically associated with rocky substrate and Granite Outcrops and Rockface/Cliff habitats. Breeding populations (presence of females) were recorded in 2013 and 2014 which indicates that this habitat is of a high suitability for the species (Ecoscape 2018).

Based on published information and observations made inside the study area, suitable habitats within the study area consist of:

- Granite Outcrops: Denning/breeding and foraging
- Quarry: Denning/breeding and foraging
- Major River: Dispersal and foraging; Denning/breeding if in association with rocky areas/boulder piles
- Minor Creekline: Dispersal and foraging
- Rockface/Cliff: Potential denning and foraging

Small and isolated areas of these habitats are less suitable than larger areas that are connected to other suitable Northern Quoll habitats. Granite Outcrops habitat can vary greatly depending on location and connectivity to other suitable habitats, as well as the structure, including the presence of boulder pile. Flat low-laying granites do not provide suitable habitats for Northern Quoll.

The area of suitable habitat within the proposed development envelope is presented in Table 4.3.

Table 4.3: Suitable Northern Quoll habitat within the proposed development envelope

Habitat	High suitability (ha)	Moderate suitability (ha)	Low suitability (ha)
Granite Outcrops	0.61	15.20	2.14
Major River	15.45	29.99	1.45
Minor Creekline	6.18		36.84
Minor Drainage Line			2.14
Total	**22.23**	**45.19**	**42.57**

650000
675000
700000
725000
7750000
7725000
7700000
7675000
7650000
PORT HEDLAND
GREAT NORTHERN HIGHWAY
NORTH WEST COASTAL HIGHWAY
GREAT NORTHERN HIGHWAY
TURNER RIVER
YULE RIVER
TURNER RIVER WEST
Wodgina
Abydos
North Star
OCEAN
Broome
Carnarvon
WESTER
Legend
Northern Quoll Records
Populated Places
Study area
Suitable Northern Quoll Habitat
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0 10 20 Km
Absolute Scale: 1:375,000 @ A3
NORTHERN QUOLL RECORDS AND SUITABLE HABITAT
DRAWN: C.PARKER
DATE: 27/09/2018
FIGURE 4.1
Spectrum ECOLOGY

700000
725000
750000
7625000
7600000
7575000
7550000
7525000
GREAT NORTHERN HIGHWAY
TURNER RIVER
Y ULE RIVER
FORTESCUE RIVER
MUNJINA ROY HILL ROAD
Cloudbreak
OCEAN
Broome
Karratha
Carnarvon
WESTER
Legend
Northern Quoll Records
Study area
Suitable Northern Quoll Habitat
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0 10 20 Km
Absolute Scale: 1:375,000 @ A3
NORTHERN QUOLL RECORDS AND SUITABLE HABITAT
DRAWN: C.PARKER
DATE: 26/09/2018
FIGURE 4.2
Spectrum ECOLOGY

600000
615000
630000
645000
660000
675000
690000
7575000
7560000
7545000
ROEBOURNE WITTENOOM ROAD
GREAT NORTHERN HIGHWAY
Solomon
FORTESCUE RIVER SOUTH
NANUTARRA WITTENOOM ROAD
FORTESCUE RIVER
MUNJINA WITTENOOM ROAD

Legend

- Northern Quoll Records
- Suitable Northern Quoll Habitat
- Study Area

NORTHERN QUOLL RECORDS AND SUITABLE HABITAT

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

FIGURE 4.3

0 2.5 5 10 15 Km

N

Absolute Scale: 1:250,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

4.2. Greater Bilby (*Macrotis lagotis*)

4.2.1. Conservation Status

- EPBC Act: Vulnerable,
- WC/BC Act: Schedule 3 (Vulnerable).

4.2.2. Distribution and Ecology

The Greater Bilby is a medium-sized marsupial that formerly inhabited the arid and semi-arid zones of 70% of Australia (DEC 2012). Its distribution has declined to about 20% of its former range, where it remains in parts of the Tanami Desert (Northern Territory), southern Kimberley and the Pilbara region (Western Australia), and in small isolated areas in south-west Queensland (DEC 2012). The Greater Bilby is a nocturnal species that forages for spiders, termites, roots, bulbs and fungi before sheltering during the day in an extensive burrow system of up to 3 m length. (DotE 2018b). The size of the Bilby's home range is estimated to be between 0.18 km^2 and 3.16 km^2 depending on the location and available of foraging habitat (Pavey, 2006). A single individual often uses a number of burrows and sudden shifts in spatial distribution can occur in particular in sandy deserts in response to changing availability of food sources. Females appear to display long-term site fidelity whereas males display a roaming behaviour allowing them to mate with multiple females (Pavey, 2006).

4.2.3. Habitat

In Western Australia, the Greater Bilby is reported to inhabit sandplains, sand dunes, interdune corridors, mulga shrubland on loamy or stony plains, *Acacia* shrubland over *Triodia* grassland on stony plains, samphire shrubland on the edge of salt-lakes, and lower slopes or ranges (Pavey, 2006). In the Pilbara region it has been recorded from mulga shrubland on clay, salt lakes, and sandplain habitat that is dominated by grassland and/or shrubland (DEC 2012).

4.2.4. Previous Survey Effort

Targeted surveys and ongoing monitoring of Greater Bilby populations has been focused along the Abydos plain due the large areas of suitable habitat. Little to no suitable habitat has been recorded along the Chichester Range and the Fortescue Valley sections of the study area. The species was targeted during a number of baseline surveys (Biota 2004; Bamford 2005a; Biota, 2005; ENV 2009). Due to the low population densities found in the Pilbara region and the nomadic nature of the species, targeted searches and monitoring of Greater Bilby populations consisted primarily of active searches for secondary evidence of the species. Active searches at 293 sites was completed between 2013 – 2018 with cage trapping at 13 sites and 14 long-term motion camera sites also surveyed (Ecologia 2014a, 2015b, 2015a, Ecoscape 2017b, 2017a, 2018).

4.2.5. Occurrence in the Study Area

Evidence of Greater Bilby has been recorded from several locations along the Main Line Rail (ATA 2007; Ecologia 2014a, 2015a, 2015b, Ecoscape 2017a, 2018) with the majority occurring in suitable habitat adjacent to the Turner and Yule river systems on the Abydos Plain. Many records of diggings have been previously reported however as they can be easily confused with diggings from other species these records have been excluded. Records of burrows, scats and confirmed tracks have been included in this assessment.

Greater Bilby populations with the Pilbara region are generally recorded in low population densities. Genetic analysis of Greater Bilby scats has recorded populations with between 1-4 individuals per site (Ecologia 2015a, 2015b, Ecoscape 2017a, 2018). Only one population consisting of a single female and her offspring has been recorded consistently from the same site (2013 – 2018). All other monitoring sites have recorded Greater Bilby activity over 1-3 years before the animals disperse away from the monitoring site (Ecologia Environment, 2014a, 2015a, 2015b, Ecoscape 2017a, 2018).

The majority of populations recorded during the monitoring of Greater Bilby along the Main Line Rail have been recorded from the Sandy/loamy Plains with Spinifex Grassland habitat type and an adjacent Minor Creekline habitats that have suitable sandy substrates. Sites also contain patches of dense *Acacia stellaticeps* which have been shown to be utilised extensively for foraging (Ecologia 2015a, 2015b, Ecoscape 2017a, 2018).

Within the study area, the following habitats have been identified as potentially suitable for the Greater Bilby:

- Sandy/loamy Plains with Spinifex Grassland
- Sandy/loamy Plains with mixed Shrubland (Partial)
- Major River (Partial)
- Minor Drainage Line (Partial)
- Minor Creekline (Partial)

The suitability of the five habitat types can be variable often including areas that are only used for dispersal or on a temporary basis as populations disperse into habitats capable of supporting the population over longer time periods. The suitability of habitat can vary based on the availability and quality of food resources, suitability of the substrate for burrowing, fire history, presence or absence of introduced herbivores and predators.

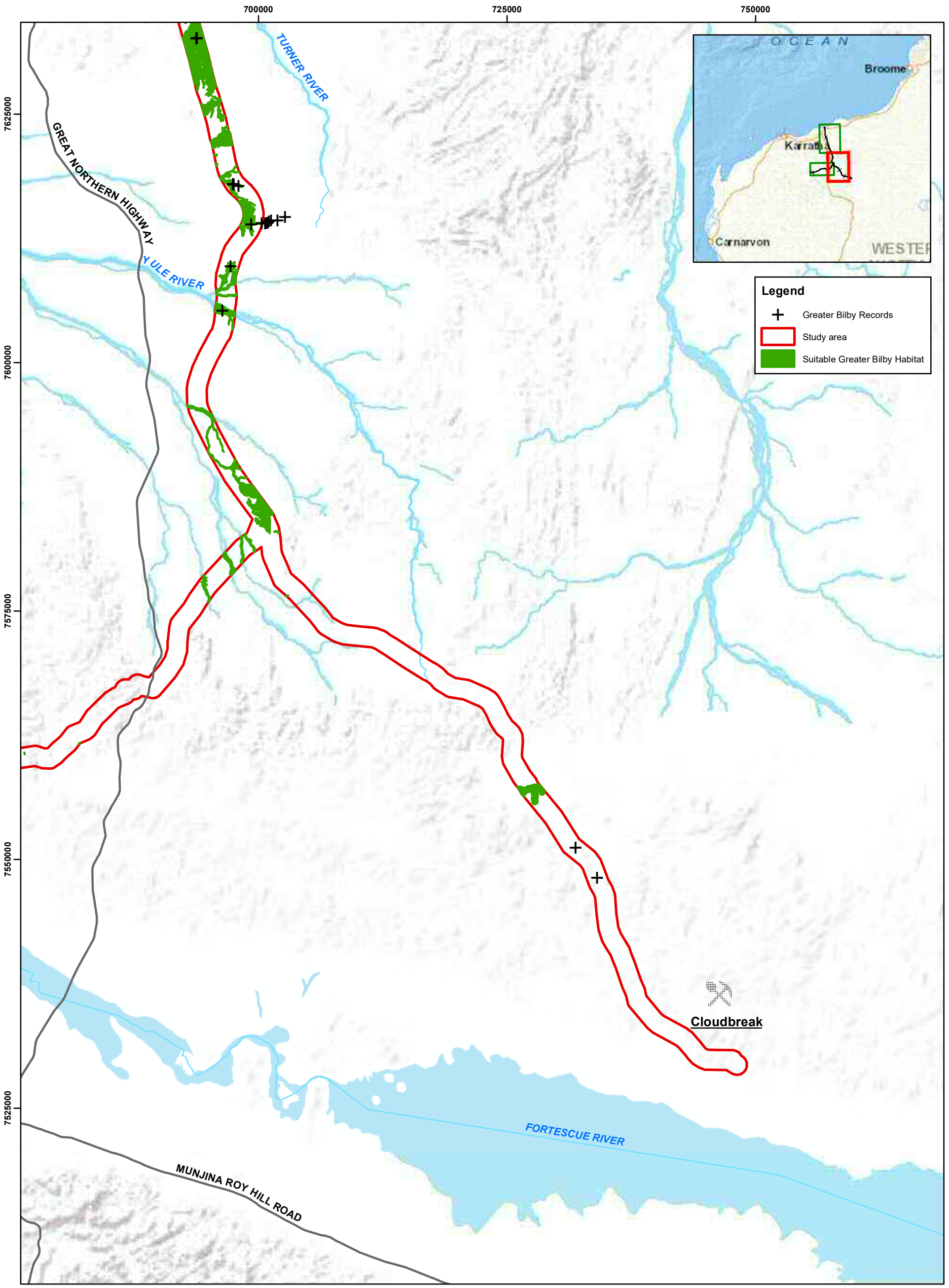
The Greater Bilby has also been recorded from Mulga Woodland habitats adjacent to the Fortescue Marsh; however, the Mulga Woodland habitat type located inside the study area is not considered suitable for the species due to its isolated location and adjacent rocky habitats (Stony Plains and Low Rises with Hummock Grassland).

The area of suitable habitat within the proposed development envelope is presented in Table 4.4.

Table 4.4: Suitable Greater Bilby habitat within the proposed development envelope

Habitat	High suitability (ha)	Moderate suitability (ha)	Low suitability (ha)
Sandy/loamy Plains with Spinifex Grassland	208.09	104.08	302.72
Sandy/loamy Plains with mixed Shrubland	-	-	19.92
Major River	-	10.76	7.28
Minor Creekline	-	11.26	27.27
Minor Drainage Line	-	1.74	-
Total	**208.09**	**127.84**	**357.19**

650000
675000
700000
725000
7750000
7725000
7700000
7675000
7650000
PORT HEDLAND
GREAT NORTHERN HIGHWAY
NORTH WEST COASTAL HIGHWAY
GREAT NORTHERN HIGHWAY
TURNER RIVER
YULE RIVER
TURNER RIVER WEST
MARBL
OCEAN
Broome
Karratha
Carnarvon
WESTER
Legend
Greater Bilby Records
Populated Places
Study area
Greater Bilby Habitat
North Star
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0
10
20 Km
Absolute Scale: 1:375,000 @ A3
GREATER BILBY RECORDS AND SUITABLE HABITAT
DRAWN: C.PARKER
DATE: 26/09/2018
FIGURE 4.4
Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

Absolute Scale: 1:375,000 @ A3

GREATER BILBY RECORDS AND SUITABLE HABITAT

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 4.5

Spectrum ECOLOGY

600000 615000 630000 645000 660000 675000 690000

7575000

7560000

7545000

ROEBOURNE WITTENOOM ROAD

GREAT NORTHERN HIGHWAY

Solomon

FORTESCUE RIVER SOUTH

NANUTARRA WITTENOOM ROAD

FORTESCUE RIVER

MUNJINA WITTENOOM ROAD

Legend

- Study Area
- Suitable Greater Bilby Habitat

GREATER BILBY SUITABLE HABITAT

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

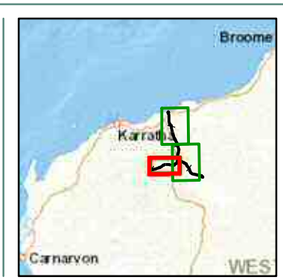


FIGURE 4.6

0 2.5 5 10 15 Km

N

Absolute Scale: 1:250,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

4.3. Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

4.3.1. Conservation Status

- EPBC Act: Vulnerable,
- WC/BC Act Schedule 3 (Vulnerable).

4.3.2. Distribution and Ecology

The Pilbara Leaf-nosed Bat is the Pilbara form of the Orange Leaf-nosed Bat, a small orange coloured bat, that occurs across the north of Australia (Armstrong, 2006). The two separate populations of the Orange Leaf-nosed Bat, one in the Pilbara and the other one in the Kimberley region, have been separated for approximately 30,000 years. The two populations differ in morphological features and the frequency of their echolocation calls (Armstrong, 2001, 2003).

Pilbara Leaf-nosed Bat feed on insects, with a large proportion of the diet consisting of moths, termites and beetles. The bats emerge from their nocturnal roost shortly after dusk and typically after other species of bats have left the roost travelling along rock faces, rocky gullies, gorges, and creeklines (Churchill, 2009; DotEE 2018c). In particular water holes will be visited for a drink and to feed on insects. The Pilbara Leaf-nosed Bat is vulnerable to the loss of body heat and moisture, and therefore requires a stable warm microclimate. Their breeding cycle stretches over a 9-month period, with mating taking place in July and the dispersal of independent young in February/March (Churchill, 2009; DotEE 2018c).

4.3.3. Habitat

The Pilbara Leaf-nosed Bat requires two different habitats, one for roosting during day time (typically a cave), and an external habitat for foraging during the night. In the Pilbara, the species roosts during the day in deep, warm and humid caves and adits (horizontal tunnel). Some caves are used all year around, whereas others are visited for a variety of purposes including specific maternity roost caves (Churchill, 2009; DotEE 2018c). A standardised nomenclature for the different roost types has been established and include four types of roosts:

- Permanent diurnal roost
- Non-permanent breeding roost
- Transitory diurnal roosts
- Nocturnal refuge

Permanent diurnal roosts are occupied all year and likely include activities such as mating and rearing of young. Non-permanent breeding roosts are also used during parts of the 9-month breeding cycle. Transitory diurnal roosts are occupied outside the breeding season which enables the species to undertake long-distance dispersal. The first three roost types are considered critical for the survival of the species, whereas the fourth type (Nocturnal refuge) is used only during night time for resting and feeding and is considered important for the persistence of the species on a local level (Churchill, 2009; DotE 2018c). Foraging habitats include shallow gullies, rocky gorges, creeks and rivers with surface water, and amongst granite boulders, but also the entrance of the diurnal roost cave can be used to catch insects (DotE 2018c).

4.3.4. Previous Survey Effort

The Pilbara Leaf-nosed Bat is readily recorded using the ultrasonic SM2Bat+ or SM4Bat recorders which were widely used during targeted and monitoring surveys after around 2010. Prior to the use of these recorders, the Anabat II system was commonly used which retrospectively has shown to have limitations in the detection of the Pilbara Leaf-nosed Bat.

A total of 95 targeted bat sites have been surveyed to date using the SM2Bat+ recorders: 25 sites at North Star, 11 bat sites at tenement M42/4112 (adjacent to Cloudbreak), two sites along the Main Line Rail, seven sites at Investigator, and 50 sites at Solomon (Ecologia 2012c, 2014c, 2014f; Outback 2013; Ecoscape 2017d). In addition, eight sites were surveys at the Cloudbreak mine and 17 sites near Port Hedland were surveyed using Anabat II systems (ENV 2009; Ecologia 2011a). Annual monitoring along the Main Line Rail comprised of 56 monitoring sites (surveyed annually since 2013) using SM2Bat+ or SM4Bat acoustic recorder systems. Another four sites have been monitored at the Poondanoo mine (Astron, 2015).

4.3.5. Occurrence in the Study Area

Pilbara Leaf-nosed Bat roosts have been recorded from the ranges associated with the Wodgina and North Star projects (Ecologia 2015b; GHD, 2015; Ecoscape 2016c). Records from adjacent to the Solomon Hub project are all foraging calls made during the middle of the night and attributed to roosts that have been recorded from ranges located to the north-west of Tom Price (Ecologia 2014g). No records of Pilbara Leaf-nosed Bat have been made along the Chichester Range and the Fortescue Valley in the vicinity of the Hamersley Rail Line, however one record of a foraging individual was made near the Cloudbreak mine site (Ecoscape 2017d) with the nearest roost located in the Hamersley Range near the RTIO Koodaideri project.

Pilbara Leaf-nosed Bats have been recorded from areas of the study area located in proximity to the ranges associated with the Wodgina and North Star projects (Figure 4.7 and Figure 4.8). The study area does not include diurnal or nocturnal roost habitat and no caves or large overhangs have been recorded from the study area to date. Foraging activity can occur across all the habitat types in the study area with distance from suitable roost structures considered the main limitation. As such no foraging habitat has been specifically mapped.

4.4. Ghost Bat (*Macroderma gigas*)

- EPBC Act: Vulnerable,
- WC/BC Act: Schedule 3 (Vulnerable).

4.4.1. Distribution and Ecology

The Ghost Bat is a large, specialist carnivorous bat and is the sole survivor of its genus (Hoyle, Pople and Toop, 2001; Worthington Wilmer *et al.*, 2008). Historically it was widely distributed across Australia but the species is now only recorded from isolated locations across northern Australia, including the Pilbara region (Armstrong and Anstee, 2000).

The Ghost Bat is a predator and feeds on other bats, rodents and birds. Prey detection is completed by a combination of passive listening, vision and some echolocation, where the detection through movement is thought to be the primary stimulus (Pettigrew *et al.*, 1988). Studies undertaken by Boles (1999) have shown that Ghost Bats often take roosting birds and small rodents which was also observed along the Main Line Rail where Ghost Bat scats and remains of prey (Fairy Martins and Budgerigar wings and rodent carcasses) were collected from inside the culverts (Ecoscape 2018). During the wet season grasshoppers, beetles and cicadas are heavily preyed upon (Toop, 1985; Pettigrew *et al.*, 1986).

4.4.2. Habitat

Ghost Bats utilise a range of cave structures for a variety of purposes ranging from short-term transient feeding roosts through to maternity roosts (DotE 2018c). Short-term transient feeding roosts can include overhangs, small shallow caves, granite boulders, and even rail culverts (Armstrong and Anstee, 2000; Ecoscape 2017c, 2018). These sites have microclimates that is similar to ambient conditions. Maternity roosts however require a more stable, warm and humid climate with a relative humidity of over 80%. They are usually deep complex or large domed caves (or mine adits) with an ideal isothermal zone (23-26°C) and a cavern size large enough for the species to manoeuvre in (Pettigrew *et al.*, 1986; Hall *et al.*, 1997). Medium-sized caves with suitable microclimates are used for a variety of activities from brief visits to consume prey to long-term roosting. Caves that provide complete darkness are reported to be preferred for roosting (Schulz and Menkhorst, 1986).

Female Ghost Bats exhibit long-term philopatry, which means they tend to use the same roost caves, which results in a very low diversity of mitochondrial DNA (Worthington Wilmer *et al.*, 2008). Females and males aggregate for breeding purposes at the end of the wet season (April) (Pettigrew *et al.*, 1986). Tracking studies have shown that up to 75% of the population disperse in winter with the remaining individuals (possibly pregnant females) occupying the warm caves over winter (Toop, 1985). The dispersing parties typically consist of small groups of paired Ghost Bats which can utilise smaller caves than those used during the breeding season. Females give birth to young between the end of August and November, with the timing depending on the location. The young are nursed in the large maternity caves over the wet season with the hot and humid ambient climate allowing the females to move young between a number of maternity caves in the local region (Toop, 1985).

4.4.3. Previous Survey Effort

The Ghost Bat hunt primarily by passive listening, vision and some echolocation with a strong tendency for visual detection (Pettigrew *et al.*, 1988). For this reason, the species is difficult to be detected using ultrasonic or acoustic bat recorder. Cave inspections and searches are often the most useful and appropriate survey techniques. Prior to 2016, the species was listed as DBCA Priority 4. Their status was upgraded to Vulnerable under the EPBC Act in May 2016. Survey effort undertaken prior to 2016 typically did not specifically focus on this species in detail. The species however was targeted during baseline surveys at Solomon (50 sites), North Star (25 sites), tenement M42/4112 located adjacent to Cloudbreak (11 sites), along the Main Line Rail (56 sites) (Ecologia 2012c, 2014f, 2015b, 2015a; Outback 2013; Ecoscape 2016c, 2017b, 2018) and during opportunistic searches along the rail as part of the fauna monitoring, in particular at the 25 rail culvert monitoring sites (Ecologia Environment, 2014a, 2015a, Ecoscape 2016c, 2017b, 2018).

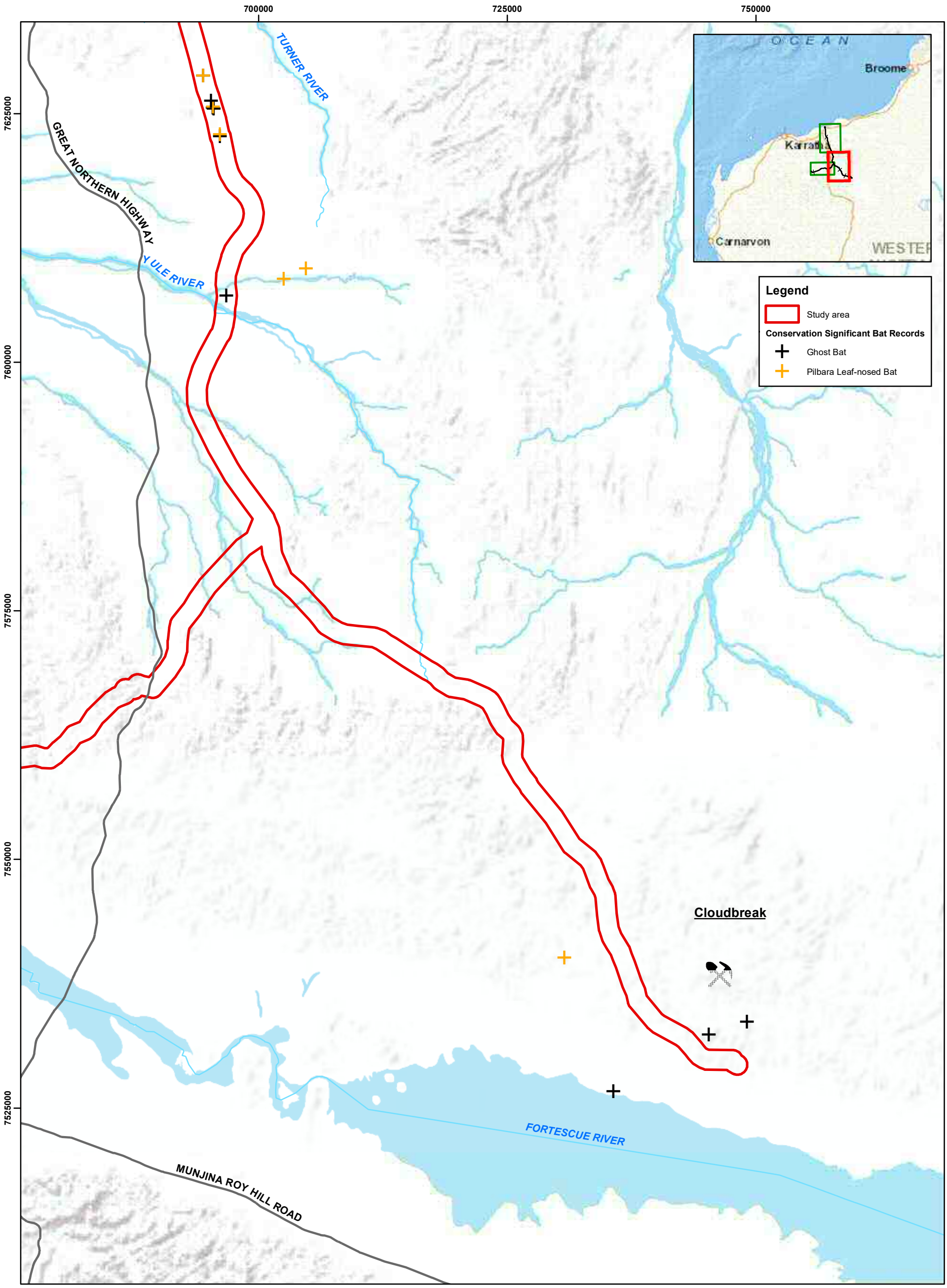
4.4.4. Occurrence in the Study Area

The Ghost Bat has been recorded intermittently from along the study area which corresponds with its widespread distribution patterns and poor detectability using acoustic recording devices (Figure 4.7 and Figure 4.8). Ghost Bat records from the DBCA threatened fauna database search appear to be concentrated around the ranges associated with the Wodgina and North Star projects (Figure 2.1) with additional records from the area in between. The data suggests that Ghost Bats roost in caves located in these ranges and hunt across the plains adjacent to the ranges. This is confirmed by several records of feeding activity (scats and prey remains) have been made from large culverts located along the Main Line Rail.

Widely scattered Ghost Bat records also occur across the Chichester and Hamersley Ranges indicating that some suitable roost caves potentially exist, however no records have been made from the sections adjacent to the study area. Similar to the Pilbara Leaf-nosed Bat suitable roost caves are thought to occur some distance away from the study area, particularly in the Hamersley Range with some individuals or small groups utilising habitats within the study area to forage and hunt.

The study area does not include diurnal or nocturnal roost habitat and no caves or large overhangs have been recorded from the study area to date. Foraging activity can occur across all the habitat types in the study area with distance from suitable roost structures considered the main limitation. As such no foraging habitat has been specifically mapped. Of note is that the construction of the rail infrastructure and associated water culverts has created additional nocturnal feeding roosts across the region potentially allowing Ghost Bats access to additional foraging habitats.

650000
675000
700000
725000
7750000
7725000
7700000
7675000
7650000
PORT HEDLAND
GREAT NORTHERN HIGHWAY
NORTH WEST COASTAL HIGHWAY
GREAT NORTHERN HIGHWAY
TURNER RIVER
YULE RIVER
TURNER RIVER WEST
Wodgina
Abydos
North Star
OCEAN
Broome
Carnarvon
WESTER
Legend
Populated Places
Study area
Conservation Significant Bat Records
Ghost Bat
Pilbara Leaf-nosed Bat
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0 10 20 Km
Absolute Scale: 1:375,000 @ A3
CONSERVATION SIGNIFICANT BAT RECORDS
DRAWN: C.PARKER
DATE: 27/09/2018
FIGURE 4.7
Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

Absolute Scale: 1:375,000 @ A3

CONSERVATION SIGNIFICANT BAT RECORDS

DRAWN: C.PARKER
DATE: 26/09/2018

FIGURE 4.8

Spectrum ECOLOGY

600000
615000
630000
645000
660000
675000
690000

7575000
7560000
7545000

ROEBOURNE WITTENOOM ROAD
GREAT NORTHERN HIGHWAY
Solomon
FORTESCUE RIVER SOUTH
NANUTARRA WITTENOOM ROAD
FORTESCUE RIVER
MUNJINA WITTENOOM ROAD

Legend

Study Area

CONSERVATION SIGNIFICANT BAT RECORDS

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

FIGURE 4.9

0 2.5 5 10 15 Km

N

Absolute Scale: 1:250,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

4.5. Night Parrot (*Pezoporus occidentalis*)

- EPBC Act: Endangered
- WC/BC Act: Schedule 1 (Critically Endangered).

4.5.1. Distribution and Ecology

The Night Parrot is a rarely encountered, elusive, nocturnal parrot that is primarily ground-feeding (Bamford 2005b, 2008). Records are very rare and therefore the information about this species is limited (DPaW 2018). Historically, the species occurred over much of the semi-arid and arid zone of Australia (Garnett, Szabo and Dutson, 2011). Recently Night Parrots have been recorded from Pullen Pullen reserve in Queensland and from the central desert regions of Western Australia (Murphy *et al.*, 2015). There are less than ten accepted records of the Night Parrot since 1935 of which only three sightings are from the Pilbara region (1979, 1980 and 2005) with the most recent one from Minga Well (Figure 4.10) located to the south west of the Cloudbreak mine site (Bamford 2005a).

Ecological information is currently very limited with information on breeding and diet limited to observations made in Queensland and historic records (Murphy, Austin, *et al.*, 2017a). Roosting appears to occur in mature long unburnt *Triodia* hummock grassland. Breeding activities appear to be triggered by above average rainfall. Nests are also built in long-unburnt *Triodia* hummock grasses. Historically, feeding habitat was thought to consist of chenopod vegetation, salt lake fringing *Triodia* spinifex grasslands and other grassland (Garnett *et al.*, 1993; Bamford 2005b). Recent observation in Queensland confirms that chenopods, soft perennial grasses, *Triodia* hummock grass and herbs are used for foraging with no particular specialisation observed (Murphy *et al.*, 2018).

4.5.2. Habitat

Based on the limited information and observations, it is thought that a range of habitats are utilised by the Night Parrot. Roosting and foraging habitats can differ in the composition of plants. Roosting sites are located in *Triodia* grassland where the Night Parrot shelters under spinifex hummock (Murphy *et al.*, 2018). Historical records also suggest that roosting may take place under dense succulent samphire shrubs (*Tecticornia* sp.) (Murphy *et al.*, 2018). Foraging sites are visited during the night and are located in tree-less non-*Triodia* open grasslands and herb fields. The foraging areas are often associated with drainage systems which concentrate limited rainfall and provide a rich floristic diversity (Murphy *et al.*, 2018). Radio-tracking studies have shown that the species can travel up to 40 km each night in a cumulative manner, with roost and feeding sites being not more than 10 km apart (Murphy *et al.*, 2018). Open water sources, including artificial water holes have been recorded multiple times to be visited for drinking during the night (Bamford 2005b; McDougall *et al.*, 2009; Murphy *et al.*, 2018).

There is no information on migration activities of the Night Parrot but literature suggests that the species may migrate in response to changing climatic conditions and associated changes in food resource availability (Fortescue 2005; Bamford 2008; Murphy *et al.*, 2018).

4.5.3. Previous Survey Effort

The observation of 2-3 Night Parrots from Minga Well in 2005 (Bamford 2005a, 2005b) triggered a significant amount of targeted survey work along the northern edge of the Fortescue Marsh and into the Chichester Range to the north. Due to the very limited ecological information available, the nocturnal and cryptic lifestyle, the Night parrot is relatively difficult to detect and survey methods included a range of techniques such as nocturnal listening surveys, water point observations (typically around sunset), acoustic recordings, searches on foot, mist netting, trapping, motion camera and feeding stations (Figure 4.10).

Between 2005 and 2012 targeted Night Parrot surveys were conducted along the Northern edge of the Fortescue Marsh and into the Chichester range to the north. The targeted surveys consisted of 213 nocturnal listening survey sites, 13 mist netting sites, 9 walk-in/drift fence trap sites, 20 water hole observation sites, 48 motion camera sites and 20 active search sites (Bamford 2005b, 2006, 2007, 2009, 2010c, 2012).

Monitoring of Night Parrots was also attempted along the Main Line Rail between 2013-2015 (Ecologia 2014a, 2015a, 2015b). Some survey techniques trailed during the above targeted surveys were adopted and several novel techniques were also trialled. Nocturnal listening surveys were completed at 12 sites and repeated over the three years. Five water point were repeatedly observed post dusk and motion cameras were set adjacent to the edge of the water to potentially capture images of drinking birds. Novel techniques included setting SongMeter2 acoustic recorders at 24 sites to record any nocturnal bird calls. All calls were listened to by an experienced ornithologist to detect any unusual bird calls and once Night Parrot calls were recorded in 2016, the recordings were re-checked by Steve Murphy against these recorded calls.

4.5.4. Occurrence within the Study Area

The Night Parrot has not been recorded from the study area to date. The most recent Pilbara record is from Minga Well, which is located adjacent to the Fortescue Marsh, approximately 6 km south of the study area (Bamford 2005b). Numerous subsequent targeted surveys and monitoring events along the Main Line Rail, Cloudbreak mine site and the Fortescue Marsh did not positively identify any additional records of the species (Bamford Consulting, 2005b, 2006, 2007, 2009, 2010c, 2011, 2012, Ecologia 2014d, 2015a; Murphy *et al.*, 2018).

Habitats present within the study area are not thought to provide suitable conditions for Night Parrot roosting or foraging sites as frequent large-scale fires limit the availability of long-unburnt habitats. The mapped habitats inside the corridor such as Sandy/loamy Plains with Spinifex Grassland, Stony Plains and Low Rises with Hummock Grassland and Spinifex covered Hills could potentially provide suitable roosting habitat if protected from fire and allowed to form of large spinifex clumps. There is also a lack of foraging habitat inside the corridor such as soft perennial grasses, chenopods or other grasslands associated with the Fortescue Marsh.

The information collected to date is still limited and new information is still being collected, particularly studies from Queensland and from Western Australia which are ongoing (Greatwich, 2017; Jackett *et al.*, 2017; Murphy, Austin, *et al.*, 2017b; Murphy, Silcock, *et al.*, 2017). This information will feed into the development and improvement of survey methods, which are being updated on a regular basis (DPaW 2017). As a result of improved survey techniques, further records are expected to be made in Western Australia which will then further inform detailed Pilbara specific habitat requirements.

700000
725000
750000
7625000
7600000
7575000
7550000
7525000
TURNER RIVER
GREAT NORTHERN HIGHWAY
Y ULE RIVER
FORTESCUE RIVER
MUNJINA ROY HILL ROAD
Cloudbreak
OCEAN
Broome
Karratha
Carnarvon
WESTER
Legend
Night Parrot Record
Study area
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0 10 20 Km
Absolute Scale: 1:375,000 @ A3
NIGHT PARROT RECORD
DRAWN: C.PARKER
DATE: 27/09/2018
FIGURE 4.10
Spectrum ECOLOGY

4.6. Pilbara Olive Python (*Liasis olivaceus barroni*)

4.6.1. Conservation Status

- EPBC Act: Vulnerable,
- WC/BC Act: Schedule 3 (Vulnerable).

4.6.2. Distribution and Ecology

The Pilbara Olive Python is a large python species and growing up to 4.5 m in length and is considered to be one of the largest snake species in Australia (Wilson and Swan, 2017). The Pilbara Olive Python is a subspecies of the Olive Python and is geographically separated by the Great Sandy Desert from populations in the Kimberley region, Northern Territory and Queensland (Wilson and Swan, 2017). The Pilbara Olive Python occurs widely across the Pilbara. Pilbara Olive Pythons are ambush predators, which is why they are often seen positioning themselves next to or inside water pools where they wait for prey to come in for a drink (Pearson, 2003; Ecologia 2012c). Juveniles prey on birds, rodents and bats whereas larger adults feed on larger birds and larger mammals such as Rothschild's Rock-wallabies (Ellis, 2010; Wilson and Swan, 2017). Males Pilbara Olive Pythons travel up to 4 km during the winter months (July and August) in search of females to mate with. Some studies suggest that home ranges can be up to 450 hectares (Pearson, 2003). When temperatures start to warm up in September and October, eggs are laid in a rocky incubation site. As with other pythons, the females will protect and warm the clutch and during this period, the females cease feeding (D. Pearson, pers. comms., 2017). The young hatch at the start of the wet season, between December and January when activity patterns and foraging conditions for reptiles are ideal. During the wet season, the females recommence feeding and the young disperse. Based on radio tracking studies, it is unlikely that breeding takes place annually. Females require a certain level of body condition, which may take up to five years to regain due the sporadic feeding activities after breeding (D. Pearson, pers. comms., 2017).

4.6.3. Habitat

Habitat requirements of the Pilbara Olive Python are likely to vary throughout the year due to changes in temperature and breeding activities. Pearson (2003) suggests that during the wet season the species disperses across rocky habitats that support water sources and drainage lines with water holes and other surface water features utilised for hunting. Pools of surface water are preferred when these are present along rocky gorge habitat as individuals can then shelter in nearby caves and crevices after feeding. Major Rivers and other drainage lines can also be used for foraging with pythons seeking refuge in tree hollows or under debris piles. During the cooler dry season studies have indicated that escarpments, mesas and other rocky habitat away from water are preferred habitats for breeding females, with males travelling along drainage lines and rivers in searches of receptive females. Females then lay eggs in suitable rocky crevices (D. Pearson, pers. comms., 2017).

4.6.4. Previous Survey Effort

Targeted surveys for the Pilbara Olive Pythons have been completed both inside and outside of the study area due to the majority of suitable habitat being located in the ranges associated with the Wodgina, Solomon Hub and North Star mine sites. At least of 30 sites have been specifically surveyed or monitored for Pilbara Olive Python in the North Star project area and along the Main Line Rail, however the species can also be recorded during opportunistic searches and when completing other monitoring activities (Northern Quoll and conservation significant bat surveys). Twenty of the 30 sites were installed at the North Star mine and vicinity where ranges and rocky habitats are widespread (ecologia 2012c, 2014d, Ecoscape 2015, 2016d, 2018). The remaining eight sites and over 40 km of nocturnal road transects were repeatedly monitored along the Main Line Rail for three years before confirming that a permanent population is not present within the study area (Ecologia 2015b, 2015a).

4.6.5. Occurrence in the Study Area

Confirmed records of the Pilbara Olive Python exist from three locations inside the study area with another 14 records exist from within 10 km of the study area (Figure 2.3 and Figure 4.12). Permanent Pilbara Olive Python populations have been recorded from the ranges associated with the North Star project, the Hamersley Range around the Solomon Project/Karijini National Park and also in low numbers along the Chichester Range. Scattered records from across the Abydos Plain are typically associated with rivers and other drainage features indicating dispersing individuals moving between areas of more suitable habitats.

Within the study area suitable habitats for Pilbara Olive Python are shown in Figure 4.11 - Figure 4.13 and includes:

- Major River
- Minor Creekline (if rocky)
- Rockface/cliffs

The Major River and Minor Creekline habitats are of considered to be of higher suitability if in association with Rock face/Cliff habitats.

The area of suitable habitat within the proposed development envelope is presented in Table 4.5.

Table 4.5: Suitable Pilbara Olive Python habitat within the proposed development envelope

Habitat	High suitability (ha)	Moderate suitability (ha)	Low suitability (ha)
Major River	-	15.45	-
Minor Creekline	-	33.08	17.94
Total	**-**	**48.53**	**17.94**

650000
675000
700000
725000
7750000
7725000
7700000
7675000
7650000
PORT HEDLAND
GREAT NORTHERN HIGHWAY
NORTH WEST COASTAL HIGHWAY
GREAT NORTHERN HIGHWAY
TURNER RIVER
YULE RIVER
TURNER RIVER WEST
North Star
OCEAN
Broome
Carnarvon
Legend
Pilbara Olive Python Records
Populated Places
Study area
Pilbara Olive Python Habitat
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0 10 20 Km
Absolute Scale: 1:375,000 @ A3
PILBARA OLIVE PYTHON RECORDS AND SUITABLE HABITAT
DRAWN: C.PARKER
DATE: 26/09/2018
FIGURE 4.11
Spectrum ECOLOGY

700000
725000
750000
7625000
7600000
7575000
7550000
7525000
TURNER RIVER
GREAT NORTHERN HIGHWAY
Y ULE RIVER
FORTESCUE RIVER
MUNJINA ROY HILL ROAD
Cloudbreak
OCEAN
Broome
Karratha
Carnarvon
WESTER
Legend
Pilbara Olive Python Records
Study area
Suitable Pilbara Olive Python Habitat
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0 10 20 Km
Absolute Scale: 1:375,000 @ A3
PILBARA OLIVE PYTHON RECORDS AND SUITABLE HABITAT
DRAWN: C.PARKER
DATE: 26/09/2018
FIGURE 4.12
Spectrum ECOLOGY

600000 615000 630000 645000 660000 675000 690000

7575000

7560000

7545000

ROEBOURNE WITTENOOM ROAD

GREAT NORTHERN HIGHWAY

Solomon

FORTESCUE RIVER SOUTH

NANUTARRA WITTENOOM ROAD

FORTESCUE RIVER

MUNJINA WITTENOOM ROAD

Legend

- \+ Pilbara Olive Python Records
- Study Area
- Suitable Pilbara Olive Python Habitat

PILBARA OLIVE PYTHON RECORDS AND SUITABLE HABITAT

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

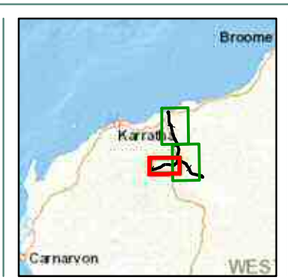


FIGURE 4.13

0 2.5 5 10 15 Km

N

Absolute Scale: 1:250,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

4.7. EPBC-listed Shorebirds

4.7.1. Conservation Status

There is a total of 45 bird species which are listed as Critically Endangered, Endangered, Vulnerable or Migratory under the EPBC Act and are associated with water bodies (coastline or inland waterbodies) have been recorded from the database searches. The species names and their EPBC status are summarised in Table 4.6 and locations mapped in Figure 2.2. Of the 45 species the majority occur exclusively on off shore islands or in coastal habitats. The Wood Sandpiper, Common Sandpiper, Common Greenshank and Oriental Pratincole are the only four species that have been recorded from within the study area or have a high likelihood to occur and occupy habitats that are present inside the study area (Figure 4.14, Figure 4.15 and Figure 4.16). The Fork-tail Swift has also been recorded from the study area however this species is almost entirely aerial and is not expected to utilise any terrestrial habitats associated with the study area.

Table 4.6: EPBC-listed Migratory Bird Species

Common name	Species name	EPBC listing	
		Threatened	Migratory
Eastern Curlew	*Numenius madagascariensis*	Critically Endangered	•
Curlew Sandpiper	*Calidris ferruginea*	Critically Endangered,	•
Eastern Curlew	*Numenius madagascariensis*	Critically Endangered,	•
Great Knot	*Calidris tenuirostris*	Critically Endangered	•
Lesser Sand Plover	*Charadrius mongolus*	Endangered	•
Red Knot	*Calidris canutus*	Endangered	•
Australian Fairy Tern	*Sternula nereis nereis*	Vulnerable	-
Greater Sand Plover	*Charadrius leschenaultii*	Vulnerable	•
Asian Dowitcher	*Limnodromus semipalmatus*		•
Bar-tailed Godwit	*Limosa lapponica*	Vulnerable	•
Black-tailed Godwit	*Limosa limosa*		•
Bridled Tern	*Onychoprion anaethetus*		•
Broad-billed Sandpiper	*Limicola falcinellus*		•
Caspian Tern	*Sterna caspia*		•
Common Greenshank	*Tringa nebularia*		•
Common Sandpiper	*Actitis hypoleucos*		•
Common Tern	*Sterna hirundo*		•
Crested Tern	*Thalasseus bergii*		•
Eastern Osprey	*Pandion haliaetus*		•
Fork-tailed Swift	*Apus pacificus*		•
Glossy Ibis	*Plegadis falcinellus*		•
Grey Plover	*Pluvialis squatarola*		•
Grey-tailed Tattler	*Tringa brevipes*		•
Gull-billed Tern	*Gelochelidon nilotica*		•
Lesser Frigatebird	*Fregata ariel*		•

Common name	Species name	EPBC listing	
		Threatened	Migratory
Little Curlew	*Numenius minutus*		•
Little Tern	*Sternula albifrons*		•
Long-toed Stint	*Calidris subminuta*		•
Marsh Sandpiper	*Tringa stagnatilis*		•
Oriental Plover	*Charadrius veredus*		•
Oriental Pratincole	*Glareola maldivarum*		•
Pin-tailed Snipe	*Gallinago stenura*		•
Pacific Golden Plover	*Pluvialis fulva*		•
Red-necked Stint	*Calidris ruficollis*		•
Ruddy Turnstone	*Arenaria interpres*		•
Ruff	*Philomachus pugnax*		•
Sanderling	*Calidris alba*		•
Sharp-tailed Sandpiper	*Calidris acuminata*		•
Terek Sandpiper	*Xenus cinereus*		•
Whimbrel	*Numenius phaeopus*		•
White-winged Black tern	*Chlidonias leucopterus*		•
Wood Sandpiper	*Tringa glareola*		•
Yellow Wagtail	*Motacilla flava*		•

4.7.2. Distribution and Ecology

The Wood Sandpiper, Common Sandpiper and Common Greenshank have been recorded from within the study area and the Oriental Pratincole has been recorded from just outside of the study area (DBCA Threatened Fauna Database). The four species are non-breeding visitors to Australia. They breed in Eurasia, Palearctic regions, Asia, India and Africa, and overwinter in Australia. They are common throughout the northern and western areas of Australia in particular along the coastline when they migrate in autumn and spring (DotEE 2018a, DotEE 2018c).

The Wood Sandpiper, Common Sandpiper and Common Greenshank feed on molluscs, crustacean, insects, fish and frogs. They wade through shallow waters and eat by sight and sometimes by touch. The Common Greenshank is also known to eat lizards, rodents, and annelids. The Oriental Pratincole feeds on dragonflies, moths, ants, termites, grasshoppers, flies, bees and cicadas (DotEE 2018a, DotEE 2018c, DotEE 2018d).

4.7.3. Habitat

The Wood Sandpiper, Common Sandpiper and Common Greenshank inhabit well-vegetated, shallow wetlands, swamps, floodplains, water holes, artificial wetlands, in channels, clay pans, inland lakes, estuaries and coastal areas, particularly in north-west Australia.

The Oriental Pratincole differs to the other three species in their habitat preference. The Oriental Pratincole can be found in salt marshes, billabongs, lakes, sewage farms, beaches, mudflats, floodplains and clay pans, but they also inhabits open plains, short grasslands and farmlands with extensive bare areas. They often sit in hoofprints of stock or on cow pats during the heat of the day (Simpson and Day, 2004; Ecologia 2012a).

4.7.4. Previous Survey Effort

Conservation significant birds are regularly targeted during baseline ornithological surveys as part of the EIA process. In addition, the annual fauna monitoring includes targeted sites for EPBC listed waterbirds. The majority of Night Parrot search sites and water point observations, were searched for waterbirds listed under the EPBC Act (Bamford 2005b, 2006, 2007, 2009, 2010c, 2010a, 2011, 2012, Ecologia Environment, 2014a, Ecologia 2015b). In addition, sites for these species have been monitored along the Main Line Rail, Hamersley Rail Line and Cloudbreak mine. A total of six sites have been monitored inside the study area over four years (2015-2018) (Ecoscape 2016c, 2017b, 2018), however most records are collected opportunistically.

4.7.5. Occurrence in the Study Area

The Wood Sandpiper, Common Sandpiper and Common Greenshank have been recorded mostly from the northern section of the study area, with some records scattered south to the Fortescue Marsh (Figure 4.14-Figure 4.16). The Oriental Pratincole has been recorded from Port Hedland, the BHP Rail Line and along the Greater Northern Highway (DBCA Threatened database). The Major River and Clay Pan habitat provides temporary suitable conditions during the wet season after heavy rainfalls when water pools are formed. The shallow edges may be used for foraging. The Oriental Pratincole can also be found across other open habitats such as the Sandy/loamy Plains with Spinifex Grasslands, in particular in disturbed and grazed areas along Minor Creeklines. The remaining three species are more reliant on the presence of surface water and are unlikely to occur away from water pools.

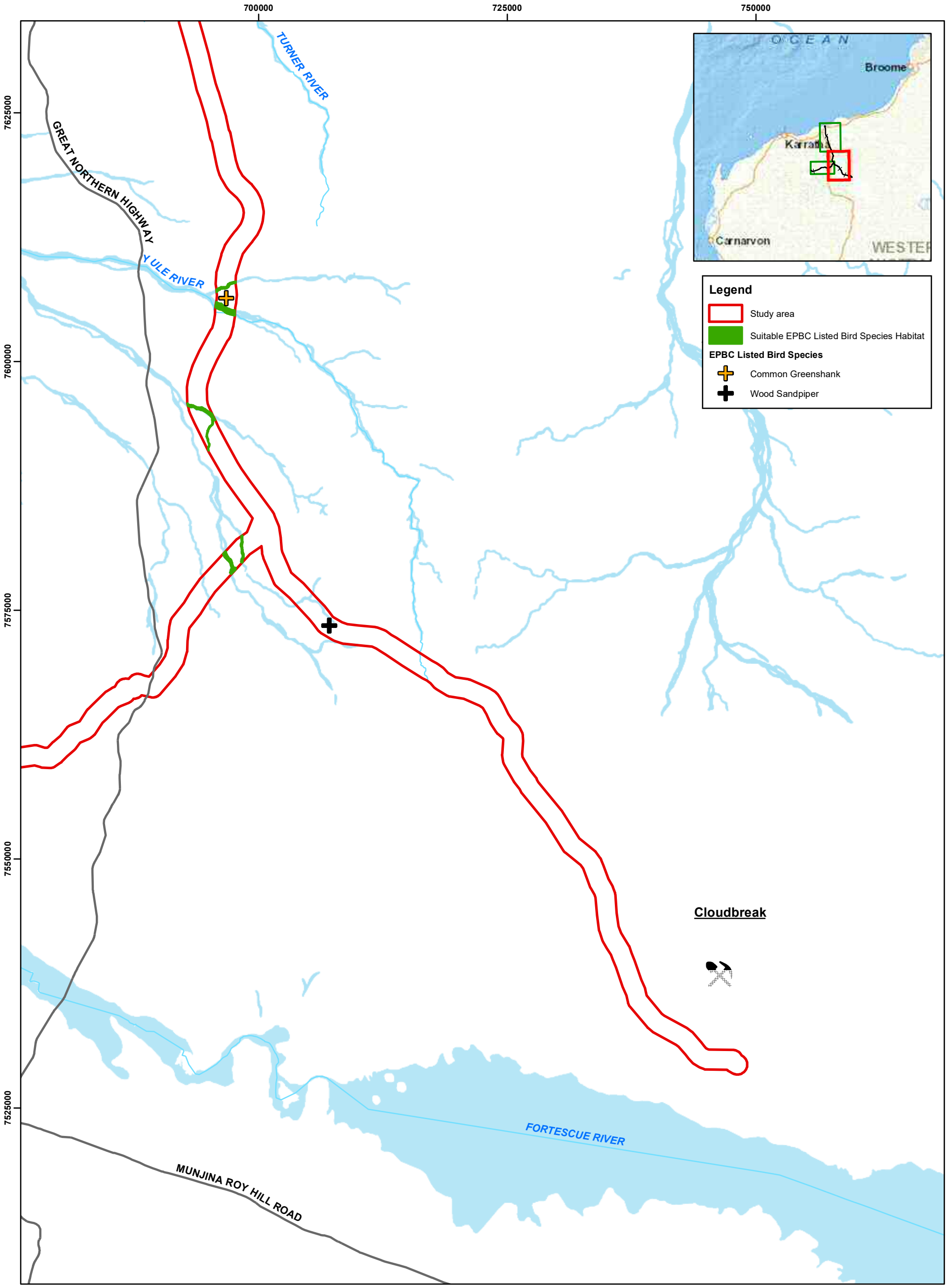
The Port Hedland waste water treatment facility is located at the northern edge of the study area and EPBC listed migratory bird species are consistently recorded there as they often seek non-saline surface water in proximity to coastal habitats (DPaW 2018). Due to the proximity of the proposed powerline infrastructure to this site, management strategies may be required to minimise any potential impacts from bird collisions with the powerline particularly when first constructed.

The area of suitable habitat within the proposed development envelope is presented in Table 4.7.

Table 4.7: Suitable Migratory Bird habitat within the proposed development envelope

Habitat	Temporary suitability after heavy rainfall
Major River	18.04
Total	**18.04**

650000
675000
700000
725000
7750000
7725000
7700000
7675000
7650000
PORT HEDLAND
GREAT NORTHERN HIGHWAY
NORTH WEST COASTAL HIGHWAY
GREAT NORTHERN HIGHWAY
TURNER RIVER
YULE RIVER
TURNER RIVER WEST
North Star
OCEAN
Broome
Carnarvon
WESTER
Legend
Populated Places
Study area
Suitable EPBC Listed Bird Species Habitat
EPBC Listed Bird Species
Common Sandpiper
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0
10
20 Km
Absolute Scale: 1:375,000 @ A3
EPBC LISTED BIRD SPECIES RECORDS AND SUITABLE HABITAT
DRAWN: C.PARKER
DATE: 26/09/2018
FIGURE 4.14
Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia,

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

Absolute Scale: 1:375,000 @ A3

EPBC LISTED BIRD SPECIES RECORDS AND SUITABLE HABITAT

DRAWN: C.PARKER
DATE: 26/09/2018

FIGURE 4.15

Spectrum ECOLOGY

600000 615000 630000 645000 660000 675000 690000

7575000

7560000

7545000

ROEBOURNE WITTENOOM ROAD

GREAT NORTHERN HIGHWAY

Solomon

FORTESCUE RIVER SOUTH

NANUTARRA WITTENOOM ROAD

FORTESCUE RIVER

MUNJINA WITTENOOM ROAD

Legend

- Study Area
- SuitableEPBC Listed Bird Species Habitat

EPBC LISTED BIRD SPECIES RECORDS AND SUITABLE HABITAT

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

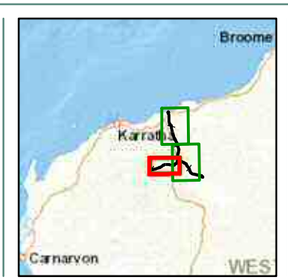


FIGURE 4.16

0 2.5 5 10 15 Km

N

Absolute Scale: 1:250,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

4.8. North-western coastal Ctenotus (*Ctenotus angusticeps*)

4.8.1. Conservation Status

- EPBC Act: Vulnerable,
- DBCA: Priority 3.

4.8.2. Distribution and Ecology

The North-western coastal Ctenotus is a small, slender skink with a series of longitudinal white and grey spots. It was once thought to have a very restricted distribution however recent surveys have shown that the species occurs across 12 locations in the north-west of Western Australia (DotEE 2018b) The main population are known from Airlie Island in the south, the Roebuck Bay near Broome in the north and from coastal region around Port Hedland (Figure 4.17) (Turpin and Ford, 2011; Maryan *et al.*, 2013). The recent extension in the species population distribution and size has resulted in the reclassification of its conservation status at a state level to Priority 3.

4.8.3. Habitat

The North-western coastal Ctenotus is a habitat specialist which is highly restricted to specific habitats. On the mainland, it inhabits samphire shrubland along mangroves and salt marshes (DotEE 2018b). The dominant vegetation comprises of *Tecticornia halocnemoides* and *Suaeda arbusculoides* on clay soil. Some grass cover (*Muellerolimon salicorniaceum* and *Sporobolus virginicus*) can also be present. The skink hides in crab holes and forages during the day in between the samphire shrubs and under Acacia shrubs (Maryan *et al.*, 2013).

4.8.4. Occurrence in the Study Area

The species has been recorded from the coast north of the study area where samphire shrubland is present around the mangroves and salt marsh. The study area does not contain any suitable habitat for the species. Based on the consistency of the habitat requirements across all records made to date it is highly unlikely that the species occurs inside the study area.

Figure 4.17: Locations of North-western coastal Ctenotus records (NatureMap)

4.9. Non-EPBC Listed Species

4.9.1. Spectacled Hare-wallaby (*Lagorchestes conspicillatus*)

- DBCA: Priority 3.

The Spectacled Hare-wallaby is a small, stocky and thickset Wallaby with shaggy grey-brown fur and a distinctive orange eye-patch. It is a solitary, nocturnal animal that feeds on the green tips of grasses, herbs and shrubs and breeds throughout the year. It occurs from the Queensland coast to the Pilbara region of Western Australia (Menkhorst and Knight, 2001). It was once presumed to be locally extinct in the Pilbara and know from populations on Barrow and Boomerang Islands off the coast of Western Australia (Short and Turner, 1991), however several records including specimens collected as road kill have been made across the Abydos Plain.

Spectacled Hare-wallaby are known to inhabit hummock grasslands with a mid-dense or sparse overstory where it shelters under long, unburnt spinifex (Menkhorst and Knight, 2001; van Dyck and Strahan, 2008). The Spectacled Hare-wallaby's diet of grasses and herbs is dependent on climatic changes and individuals are expected to be nomadic in response to local environmental conditions, however widespread fires can limit the availability of suitable patches of long-unburnt spinifex.

The majority of Spectacled Hare-wallaby records in the Pilbara are historical (prior to 1992) (DPaW 2018). A number of confirmed records were also made in 2015 from the Greater Northern Highway, west of the study area (DPaW 2018). The DBCA Threatened Fauna Database Search indicates that there are 45 historical and recent records (from 1899-2003) from Marble Bar and Pilgangoora area (approximately 20 km east of the study area). The species is present in the vicinity of the study area, but no actual records exist from inside the corridor. The Sandy/loamy Plains with Spinifex Grassland habitat inside the study area may provide suitable habitat and the species has a moderate likelihood of occurrence.

4.9.2. Brush-tailed Mulgara (*Dasycercus blythi*)

- DBCA: Priority 4.

The Brush-tailed Mulgara is a medium-sized carnivorous marsupial, that is sandy in colour with black bushy hair on its tail (van Dyck and Strahan, 2008). The current distribution occurs in the interior of Western Australia, Northern Territory and along the borders to Queensland and South Australia (Woolley, Haslem and Westerman, 2013). The Brush-tailed Mulgara appears to be a relatively solitary species that feeds on insects, arachnids and rodents, as well as reptiles, centipedes and small marsupials (Chen, Dickman and Thompson, 1998).

The species inhabits sandy and loamy plains with spinifex grassland where it lives in burrows that are dug into the flat ground. Entrances are often located at the edge of spinifex clumps (van Dyck and Strahan, 2008).

The Brush-tailed Mulgara has been recorded from several locations across the central section of the study area, north of the Chichester Range (Figure 4.19-Figure 4.21). Several populations were monitored along the Hamersley Rail Spur and the Main Line Rail during the Fortescue's fauna monitoring program between 2012 and 2015 (Ecologia 2012a, 2013, 2014b, 2014a, 2014h, 2015b). The species was recorded to be a permanent resident along the two rail lines and it can be relatively abundant in suitable patches of the Sandy/loamy Plains with Spinifex Grassland habitat type.

4.9.3. Long-tailed Dunnart (*Sminthopsis longicaudata*)

- DBCA: Priority 4.

The Long-tailed Dunnart is a small nocturnal white-grey marsupial and is the only Dunnart species with a tail more than twice the length of its body including a small terminal tuft of long hairs at the end. It occurs in the Pilbara, Murchison, north-eastern Goldfields, Ashburton and Gibson Desert region. In Western Australia, populations have been found to be relatively isolated which indicates a very poor dispersal capability. The Long-tailed Dunnart feeds on a range of invertebrates including grasshoppers, beetles, ants, cockroaches and spiders (van Dyck and Strahan, 2008).

The Long-tailed Dunnart is often found in rocky landscape, such as lateritic plateaux, flat-topped hills and mesas as well as breakaways. The vegetation is often dominated by low open woodland or mixed shrubland of *Acacia* spp. over *Triodia* grassland (Government of Western Australia, 2018). It is a specialist rock dwelling species that has great agility climbing between rocks, using its striated foot pads and long tail for balance. The Long-tailed Dunnart feeds on a range of invertebrates such as spiders, centipedes, grasshoppers and beetles (Menkhorst and Knight, 2001).

The species has not been recorded from inside the study area. The closest records were made from the top of a mesa at North Star mine (Ecologia 2012c). The Long-tailed Dunnart is not likely to inhabit the study area due to the lack of rocky mesas and ridges present inside the corridor.

4.9.4. Northern Short-tailed Mouse (*Leggadina lakedownensis*)

- DBCA: Priority 4.

The Northern Short-tailed Mouse is a small grey-brown to grey rodent. It is a nocturnal, solitary animal and its diet consists mostly of invertebrates, with plants eaten occasionally to supplement water requirements (van Dyck and Strahan, 2008).

They occur on a variety of habitats from spinifex and tussock grasslands, samphire shrublands, sedgelands and open woodlands however, most are recorded from seasonally inundated sandy-clay soils or in the Pilbara, cracking clay (Kutt and Kemp, 2005; van Dyck and Strahan, 2008). They have been recorded across northern Australia from the tropical coast to semi-arid regions further south (van Dyck and Strahan, 2008).

The Northern Short-tailed Mouse was recorded from a location inside the study area (Hamersley Rail spur) (Figure 4.19-Figure 4.21) (Ecologia 2014c). An additional 17 records exist from Mulga Downs station, the Chichester Range and north of Wittenoom (DBCA Threatened Fauna Database). There is limited suitable habitat for the species present inside the study area. Some locations within the Mulga Woodland habitat may include Cracking Clays and are therefore suitable for the Northern Short-tailed Mouse.

4.9.5. Western Pebble-mound Mouse (*Pseudomys chapmani*)

DBCA: Priority 4.

The Western Pebble-mound Mouse is a small brown mouse growing to around 60 mm in body length and is one of a few species in Australia that is known to build large pebble mounds (van Dyck and Strahan, 2008). It has a complex social structure and is known to occur in social groups of up to 12 animals (Anstee, Roberts and Shea, 1997). Each family may use several mounds. Male home ranges were found to be considerably larger than those of females, in particular during breeding season (Anstee, Roberts and Shea, 1997).

The Western Pebble-mound Mouse is known to occur on gentle slopes of rocky ranges with hard spinifex and scattered outcropping shrubs. Though this habitat is patchy, it is widespread and has been recorded from across the central and southern Pilbara, and extending into the ranges of the Little Sandy Desert (van Dyck and Strahan, 2008).

The Western Pebble-mound Mouse has been recorded from several locations from inside and outside the study area, in particular in the southern section where the Spinifex covered Hills habitat and the Stony Plains and Low Slopes with Hummock Grasslands habitats are dominate (Figure 4.19-Figure 4.21).

4.9.6. Grey Falcon (*Falco hypoleucos*)

- WC/BC Act: Schedule 3.

The Grey Falcon is a medium sized, robust Falcon with broad wings and a short tail. Its colouring ranges from near white, on the underwings, to near-black, on the upper side (Schoenjahn, 2010).

The Grey Falcon is considered the rarest falcon in Australia with only approximately 1000 pairs. It occurs very sparsely in a wide variety of arid habitats (Schoenjahn, 2011). It nests by modifying the stick nests of other large birds (in particular *Corvus* sp.) and is often found on human infrastructure such as repeater towers or power-line pylons. Nests are often used over several years and can be in close proximity to nests of other Falcons or raptor species (Schoenjahn, 2013).

The Grey Falcon forages in open landscapes such as rocky plains with hummock grasslands, lower shrublands, and small drainage lines where they predominantly feed on birds (Schoenjahn, 2013).

The Grey Falcon has been recorded on multiple occasions along the Main Line Rail and Hamersley Rail Line during baseline surveys and during the fauna monitoring program. The DBCA Threatened Fauna Database indicates 16 records within 20 km of the study area (Figure 2.2, Figure 4.19-Figure 4.21) (Ecologia 2015b). The species is likely to use the study area for foraging on an infrequent basis. Breeding sites may be present; however, these are typically built in artificial infrastructure such as repeater towers and development of powerline infrastructure may increase the availability of nesting sites.

4.9.7. Peregrine Falcon (*Falco peregrinus*)

- WCBC Act: Schedule 7.

The Peregrine Falcon is a medium-sized bird of prey, or raptor, with long, pointed wings and a long, slightly rounded tail. Adults have a slate-grey back and a charcoal head with a pale cream bib, and juveniles are darker and browner. Peregrine Falcons are widespread throughout the world, and occur across most of Australia but are an uncommon species and are rare across all states and territories (Bird Life Australia, 2012).

Peregrine Falcons usually nest by digging a scrape on a high cliff edge where two to three eggs are laid. Hunting is mainly done during the day and feeding is primarily on small to medium sized birds which are caught in flight, often above drainage lines and rivers (Bird Life Australia, 2012).

The Peregrine Falcon was recorded along the Main Line Rail during previous surveys and 18 records have been identified from within 20 km of the study area (DBCA Threatened Fauna Database) (Figure 2.2, Figure 4.19-Figure 4.21). The species is likely to utilise the study area as part of its hunting range. There is no potential breeding habitat present within the corridor to support a breeding pair of Peregrine Falcons.

4.9.8. Pin-striped Finesnout Ctenotus (*Ctenotus nigrilineatus*)

- DBCA: Priority 1.

The Pin-striped Ctenotus is a swift and diurnal slender skink with a pattern of eight pale stripes down its back. Most Ctenotus skinks forage as invertebrate generalists feeding on exposed terrain or along vegetation edges (Wilson and Swan, 2017). It is endemic to the Pilbara region and records are isolated and limited to Nullagine, Meentheena and Marble Bar (DPaW 2018).

The Pin-striped Ctenotus is known to occur on Spinifex plains adjacent to granite outcrops and watercourses (Wilson and Swan, 2017). Very little information is known about this species due to the small number of records made to date.

The Pin-striped Finesnout Ctenotus have been recorded from five locations adjacent to the study area, all of which are located in the headwaters of the Yule and Turner Rivers. The species has the potential to occur within the Sandy/loamy Plains with Spinifex Grassland habitat, in particular in the vicinity of the Granite Outcrops, in the center of the study area.

4.9.9. Gane's Blind Snake (*Anilios ganei*)

- DBCA: Priority 1.

The Gane's Blind Snake is an elusive, moderately robust Blind Snake that lives underground. Due to the burrowing lifestyle of the species it is rarely recorded and relatively little information is known. The Gane's Blind Snake has a rounded snout, that is greyish on the upper side and cream on the underside (Wilson and Swan, 2017).

Its distribution is limited to the Pilbara region between Newman and Pannawonica (Wilson and Swan, 2017; DPaW 2018). The species is likely to burrow into social insect nests to feed on termite and ants, as well as their eggs and pupae. The Gane's Blind Snake is known to occur within rocky gorges and gullies (Wilson and Swan, 2017).

Records have been made from dominantly rocky habitats, however individuals have also been caught in clay substrate (Ecologia 2012b). The species was recorded regionally from the Stage A fauna survey (Biota 2004) (Figure 4.19-Figure 4.20). No other regional records exist within the proximity of the study area.

Despite this, the Gane's Blind Snake has the potential to occur in the southern and western section of the rail where stony plains, rocky hills and rockfaces are present.

4.9.10. Fortescue Grunter (*Leiopotherapon aheneus*)

- DBCA: Priority 4.

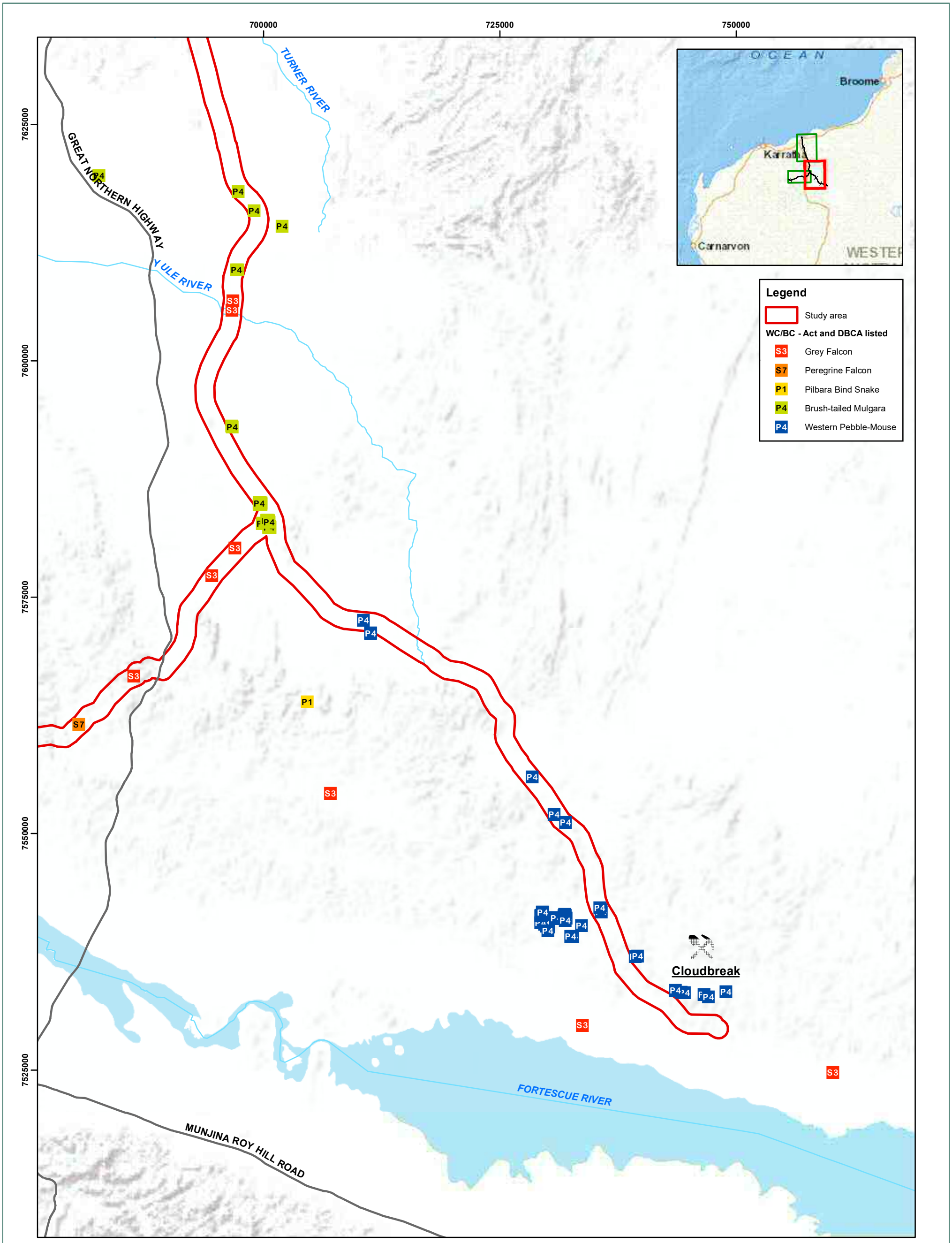
The Fortescue Grunter is a small bronze to brownish species of Freshwater Fish that grows approximately to 8 cm and to a maximum length of 13 cm. It has been recorded in waters of the Fortescue and Ashburton Rivers and, within Karijini National Park (Figure 4.18). It feeds of small prawns and juvenile fishes but is mostly an omnivore (Allen, Midgley and Allen, 2002).

The Fortescue Grunter is known to occur in rocky pools and slow to fast flowing sections of streams, as well as the base of waterfalls (Allen, Midgley and Allen, 2002).

The species has not been recorded from inside the study area. It may be present at times of flooding when creeklines connected to Karijini National Park support flowing water.

Figure 4.18: Location of Fortescue Grunter records (NatureMap)

650000
675000
700000
725000
7750000
7725000
7700000
7675000
7650000
PORT HEDLAND
GREAT NORTHERN HIGHWAY
NORTH WEST COASTAL HIGHWAY
GREAT NORTHERN HIGHWAY
YULE RIVER
TURNER RIVER
TURNER RIVER WEST
OCEAN
Broome
Karratha
Carnarvon
WESTER
P4
fP4
S3
North Star
Legend
Populated Places
Study area
WC/BC - Act and DBCA listed
S3 Grey Falcon
P4 Brush-tailed Mulgara
P4 Long-tailed Dunnart
P4 Western Pebble-Mouse
Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA
N
System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
0 10 20 Km
Absolute Scale: 1:375,000 @ A3
WC/BC-ACT AND DBCA LISTED SPECIES RECORDS
DRAWN: C.PARKER
DATE: 1/10/2018
FIGURE 4.19
Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

Absolute Scale: 1:375,000 @ A3

WC/BC-ACT AND DBCA LISTED SPECIES RECORDS

DRAWN: C.PARKER
DATE: 26/09/2018

FIGURE 4.20

Spectrum ECOLOGY

600000 615000 630000 645000 660000 675000 690000

7575000

7560000

7545000

ROEBOURNE WITTENOOM ROAD

GREAT NORTHERN HIGHWAY

Solomon

FORTESCUE RIVER SOUTH

NANUTARRA WITTENOOM ROAD

FORTESCUE RIVER

MUNJINA WITTENOOM ROAD

P4 P4 P4 P4 P4 P4

S3 S3 S3 S7

Legend

- Study Area
- **WC/BC - Act and DBCA listed**
  - S3 Grey Falcon
  - S7 Peregrine Falcon
  - P4 Brush-tailed Mulgara
  - P4 Short-tailed Mouse
  - P4 Western Pebble-Mouse

WC/BC-ACT AND DBCA LISTED SPECIES RECORDS

DATE: 12/10/2018
DRAWN: C.PARKER

Spectrum ECOLOGY

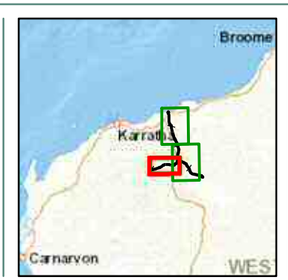


FIGURE 4.21

0 2.5 5 10 15 Km

N

Absolute Scale: 1:250,000 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

5. POTENTIAL IMPACTS ASSOCIATED WITH POWERLINES

5.1. Potential Impacts

5.1.1. Powerlines

The construction of linear infrastructure such as power lines, conveyors, roads, pipelines and rail have the potential to impact migratory birds. Flying birds can collide with prominent structures that intrude into open airspace including power lines, fences, communication masts, wind turbines and buildings. Such collisions occur under conditions of both high and low visibility (Erickson, Johnson and Young, 2005).

The impact of avian collisions with overhead power lines have been documented world-wide and are of conservation concern, particularly in migration corridors (Jenkins, Smallie and Diamond, 2010; Barrientos *et al.*, 2011, 2012; Dwyer, Harness and Donohue, 2014; Luzenski *et al.*, 2016). Many large, heavy bodied terrestrial and wetland birds and some smaller, fast-flying species are prone to colliding with powerlines (Jenkins, Smallie and Diamond, 2010; Pearse, Brandt and Krapu, 2016). Though this may be due to a detection bias driving lower incidental observations of smaller birds (Drewitt and Langston, 2006).

A high proportion of these are threatened species and for some, collision with power lines and other man-made structures is a significant and damaging source of anthropogenic mortality adding pressure to the population (Jenkins, Smallie and Diamond, 2010; Luzenski *et al.*, 2016; Smith and Dwyer, 2016). The majority of research regarding collision with powerlines originates from North America, Scandinavia, southern Europe and South Africa. Most commonly affected birds include cranes, bustards, flamingos, waterfowl, shorebirds, game birds and falcons and collision frequency is thought to be an influential factor in ongoing population declines in several species of cranes, bustards and diurnal raptors (Jenkins, Smallie and Diamond, 2010).

The coastline of north western Australia forms an important rest stop for migratory birds travelling between Asia and Australia. The annual cycle of migratory birds that follow the East Asian-Australian Flyway can be divided into four broad periods. Breeding takes place between May and August in the northern hemisphere, followed by a southward migration between August and November. Migratory Birds then spend December to February in the southern hemisphere before migrating back to the northern hemisphere between March and May (Bamford *et al.*, 2008). Migratory species would therefore utilise suitable habitats associated with the Study area over the wet season between October and March.

The Study area included several areas which may attract migratory bird species when surface water is present;

- the ponds associated with the Port Hedland Wastewater Treatment Plant located adjacent to the north eastern edge of the study area (Figure 5.1) are known to attract migratory bird species that utilise coastal habitats around Port Hedland.
- areas where the major tributaries and river channels associated with the Turner and Yule rivers cross the Study area that support surface water for extended periods of time.
- large depressions located along the Main Line Rail that support surface water for extended periods.

The presence of powerline infrastructure adjacent to these locations where migratory birds can congregate could result in birds colliding with the powerlines when the birds are landing and taking off.

Figure 5.1: Location of Port Hedland Wastewater Treatment plant

A number of inadvertent though positive ecological impacts of linear infrastructure have also been observed. The main types of positive effects of powerline infrastructure on birds included:

- powerlines, fences, etc. along roads: providing perches for hunting activities (Meunier, Verheyden and Jouventin, 2000; Chace and Walsh, 2006).
- bridges, pylons, tree lines along roadsides, bases of powerline pylons: providing nesting sites and cover from predators (Morelli *et al.*, 2014).

A number of these positive effects have also been observed by Spectrum Ecology Staff in the Pilbara region, particularly along the rail infrastructure that connects the port in Port Hedland with mines in the Chichester and Hammersley ranges. Grey Falcons (*Falco hypoleucos*) are considered a cryptic species that have been rarely recorded across Australia (Olson and Olson, 1986; Schoenjahn, 2013). Over the last 7-8 years this species has been recorded repeatedly and consistently using radio repeater towers as roosting and nesting sites, with several successful breeding attempts recorded.

5.1.2. Vegetation clearing

Vegetation clearing, and the associated habitat loss can be a significant factor in the development of most infrastructure projects. The development of the powerline infrastructure will only require small areas to be cleared (10 m x 10 m per pylon pad), that are relatively widely spaced (approximately 400 m) and will utilise where possible previously disturbed areas associated with the adjacent rail infrastructure. This will reduce the level of impact associated with vegetation clearing significantly.

Powerline infrastructure does not create any barriers to dispersal that maybe created by other linear infrastructures.

5.2. Mitigation

Substantial research (though not in Australia) has been undertaken examining the effect of mitigation measures upon avian mortality and power lines (Bevanger, 1994; Jenkins, Smallie and Diamond, 2010; Barrientos *et al.*, 2011, 2012). While there is no one size fits all mitigation measure for reducing bird mortality a range of measures have been suggested.

These include:

- reviewing the placement of proposed new lines
- removing the earth-wire which is usually the highest, thinnest and most problematic component in an overhead power line configuration
- fitting wires with markers – brightly coloured 'aviation' balls, thickened wire coils, luminescent, shiny or hinged flashing or flapping devices.

There is much uncertainty about the best configuration of mitigation measures due to variations in efficiency based on differences in local species and conditions. Numerous studies have been undertaken with respect to the effectiveness of line marking using flight diverters (Frost, 2008; Yee, 2008; Murphy *et al.*, 2009; Barrientos *et al.*, 2012). It is generally considered that flight diverters are effective at reducing bird collisions with wires, though it will not eliminate all collisions. Use of flight diverters as a mitigation response has been adopted by Western Power on Western Australia transmission infrastructure and if appropriately deployed would provide a suitable mitigation response for the Project.

Sections of powerline infrastructure that could potentially attract migratory bird species should be targeted for line marking. These areas include;

- the ponds associated with the Port Hedland Wastewater Treatment Plant located adjacent to the north eastern edge of the study area (Figure 5.1),
- areas where the major tributaries and river channels associated with the Turner and Yule rivers cross the Study area that support surface water for extended periods of time and
- large depressions located along the Main Line Rail that support surface water for extended periods.

6. SHORT RANGE ENDEMIC INVERTEBRATE FAUNA

6.1.1. Short Range Endemic Database Results

The short range endemic (SRE) invertebrate species which were identified in the WAM database searches are listed in Appendix 1 and displayed in Figure 6.1 - Figure 6.4. A total of 15 morpho-species of crustacea, seven species of mygalomorph spider, 27 morpho-species of pseudoscorpion, five taxa of millipede, nine species of scorpion, and four taxa of mollusc were previously recorded in the surrounding region and have the potential to be a short range endemic species.

The relatively large number of potential SRE species is likely due to the long linear shape of the study area and the fact that it covers all four Pilbara IBRA sub-regions, and the associated large variety of habitat types and associated microhabitats. In addition, the Arachnid database was supplied containing all Arachnid records previously reported from the region. The WA Museum does not provide any input to determine if a species is considered a potential or confirmed SRE. The determination of each taxa's SRE status has been based on the Precautionary Principle (lack of knowledge results in the species to be considered as potential SRE). In addition, the taxonomic knowledge of the listed genera and taxa is low and unresolved species taxa have been included in the interpreted list (e.g. *Beierolpium* 'sp. indet. (juvenile 6/2) small'). Taxonomic reviews of these unresolved morpho-species may provide ecological information including population distributions that may indicate the species are widespread.

6.1.2. Short Range Endemic Invertebrate Habitats

Invertebrate species that exhibit short range endemism are generally influenced by several factors that lead to the isolation of the species. These processes included (Main, 1999; Ponder and Colgan, 2002):

- Morphological or physiological aspects that limit the ability to disperse
- Reliance on specific habitats
- Habitat availability
- Geographical barriers
- Low fecundity
- Slow growth rate
- Historical conditions (habitat fragmentation)

Once a taxa has been isolated by one or multiple of the above processes, a genetic drift between the populations is promoted with selective pressures over time and repeated mutations and restrictions in migration pattern between populations creating distinct taxa and species. Short range endemism often occurs when migration is limited by poor dispersal ability of the taxon (e.g. morphological features or physiological requirements) and geographical barriers. In general terms the extent of migration restrictions is often the strongest determinant of short range endemism.

Terrestrial short range endemic invertebrate species are thought to evolve through two primary processes; Relictual short range endemism and Habitat specialisation. In both cases, SRE species typically have a very restrictive biology, that limits dispersal over long-distances (such as lack of functional wings) (Harvey, 2002):

Short range endemics that are considered to be relictual taxa are the remnant populations of species that have become extinct elsewhere due to changes in climate, habitats and geographical features. Relictual taxa include very old species that can be traced back to the Gondwana period, approximately 180-65 million years ago (Harvey, 2002) when climatic conditions were warmer and wetter. In Western Australia, relictual species can traced back to the Miocene period (25-13 million years ago) and have been impacted over time by the aridification of Australia. This process has forced populations to retract to pockets with suitable

conditions such as moist habitats (Hill, 1994). With the progression of dryer conditions overall, suitable habitats for short range endemics have become increasingly fragmented and relictual species often only persist in areas that maintain moisture and shade. Proximity to the coastline, freshwater areas, caves, rocky outcrops, woody debris, deep leave litter beds, and southern slopes of hills and ranges can provide these conditions (Main, 1996, 1999; Biologic, 2015).

The second primary process, habitat specialisation, is also thought to be able to lead to short range endemism of species. Habitat specialists are species that have adapted to particular isolated habitats. In combination with a restrictive biology the specialisation limits the dispersal of the species and limits the genetic exchange between populations which then forms distinct species. These habitats occur in Western Australia and include rocky ridges, BIF formations, salt lakes, swamps and other river systems. In inland areas like the majority of the Pilbara region, SRE specialised habitats are often restricted to rocky areas that support shady pockets and vegetated drainage lines. Unlike relictual SREs in mesic habitats, habitat specialists can be found in arid environments.

Surveys undertaken at Yeelirrie mine have shown that SRE species were most diverse in hardpan mulga woodland habitats, closely followed by calcrete dominated shrublands (Ecologia 2011c). The calcrete dominated habitats also support the highest abundance of invertebrate SRE species. However, there was no statistically significant difference between SRE species diversity and habitat types (Ecologia 2011c). This was consistent with other surveys completed at Cloudbreak (Ecologia 2011b). The Snakewood/mulga woodland was found to support the highest number of invertebrate SRE species, and the creekline habitat supported the highest diversity. However, there was no statistically significant relationship between the habitat type and species richness. It was suggested that the occurrence of SRE species is dependent on micro-habitats rather than broad scale habitat types (Ecologia Environment, 2011b, 2014e; Biologic, 2015).

The Study area covers an extensive range of habitats and microhabitat types that are considered suitable for SRE invertebrate species. Features of the Project listed below, indicate that the potential impact of the Project on potential SRE invertebrate populations is expected to be very low;

- landscape features that are typically associated with SRE invertebrate micro-habitats, such as creeklines and rocky slopes generally are not associated with suitable locations for powerline pylon construction.
- preferential placement of infrastructure on previously disturbed areas.
- minimal vegetation/habitat clearing as pylon construction requires only a small clearing footprint (10 m x 10 m) with pylons with each cleared area separated by 200-400 m across a long linear corridor.
- powerline infrastructure does not create any physical barriers to animal movement.

650000

700000

7700000

7650000

7600000

TURNER RIVER

TURNER RIVER WEST

GREAT NORTHERN HIGHWAY

YULE RIVER

North Star

North Star - Abydos

OCEAN

Broome

Karratha

Carnarvon

WESTERN AUSTRALIA

Meekatharra

Legend

Fortescue Rail

Study area

Arachnid Records

- AS Afrosternophorus sp.
- AE Aname `MYG001 group`
- AE Aname `MYG034`
- AE Aname `MYG099`
- AE Aname `MYG372-DNA`
- AE Aname `sp. 1`
- AE Aname `sp. 3`
- AE Aname mellosa
- AU Antichiropus `DIP005`
- AU Antichiropus `DIP028`
- AU Antichiropus `DIP033`
- AU Antichiropus `DIP037`
- AM Apocheiridium sp.
- AI Austrochthonius `pilbara`
- BM Beierolpium `8/4`
- BM Beierolpium `sp. 8/2`
- BM Beierolpium `sp. 8/3`
- BM Beierolpium `sp. 8/4 lge`
- BM Beierolpium `sp. 8/4`
- BM Beierolpium `sp. indet. (juvenile 6/2) lge`
- BM Beierolpium `sp. indet. (juvenile 6/2) small`

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

Absolute Scale: 1:400,000 @ A3

LOCATION OF ARACHNID DATABASE RECORDS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 6.1

Spectrum ECOLOGY

650000

700000

7700000

7650000

7600000

TURNER RIVER

TURNER RIVER WEST

GREAT NORTHERN HIGHWAY

YULE RIVER

North Star - Abydos

North Star

OCEAN

Broome

Karratha

Carnarvon

WESTERN AUSTRALIA

Meekatharra

Legend

Fortescue Rail

Study area

Arachnid Records

- CE Cheiridiinae `PSEAAB`
- CS Cryptops `sp. MN`
- CS Cryptops `sp. indet.`
- IA Indohya `PSE002`
- IM Indolpium `long chelal hand`
- LS Lychas `sp. 1`
- LS Lychas `sp. 2`
- LS Lychas `sp. 4`
- LS Lychas `sp. 6`
- OE Olpiidae `Genus 7/4`
- OE Olpiidae `PSEAAA`
- OS Oratemnus `PSE018`
- OS Oratemnus `PSE060`
- SS Synsphyronus `PSE008`
- SS Synsphyronus `PSE012`
- SS Synsphyronus `PSE094, long chelal hand`
- SS Synsphyronus heptatrichus
- TS Troglochernes `sp. nov. 001`
- TU Tyrannochthonius `sp. AB A`
- TU Tyrannochthonius `sp. AB B`
- TU Tyrannochthonius `sp. AB`
- TU Tyrannochthonius `sp. nov. near aridus`
- TU Tyrannochthonius aridus
- US Unixenus `mjoebergi complex`
- UU Urodacus `sp. 1`
- UU Urodacus `sp. 2`
- UU Urodacus `sp. 5`
- UU Urodacus `sp. 9`
- UU Urodacus `sp. Pilbara 8`

Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 10 20 Km

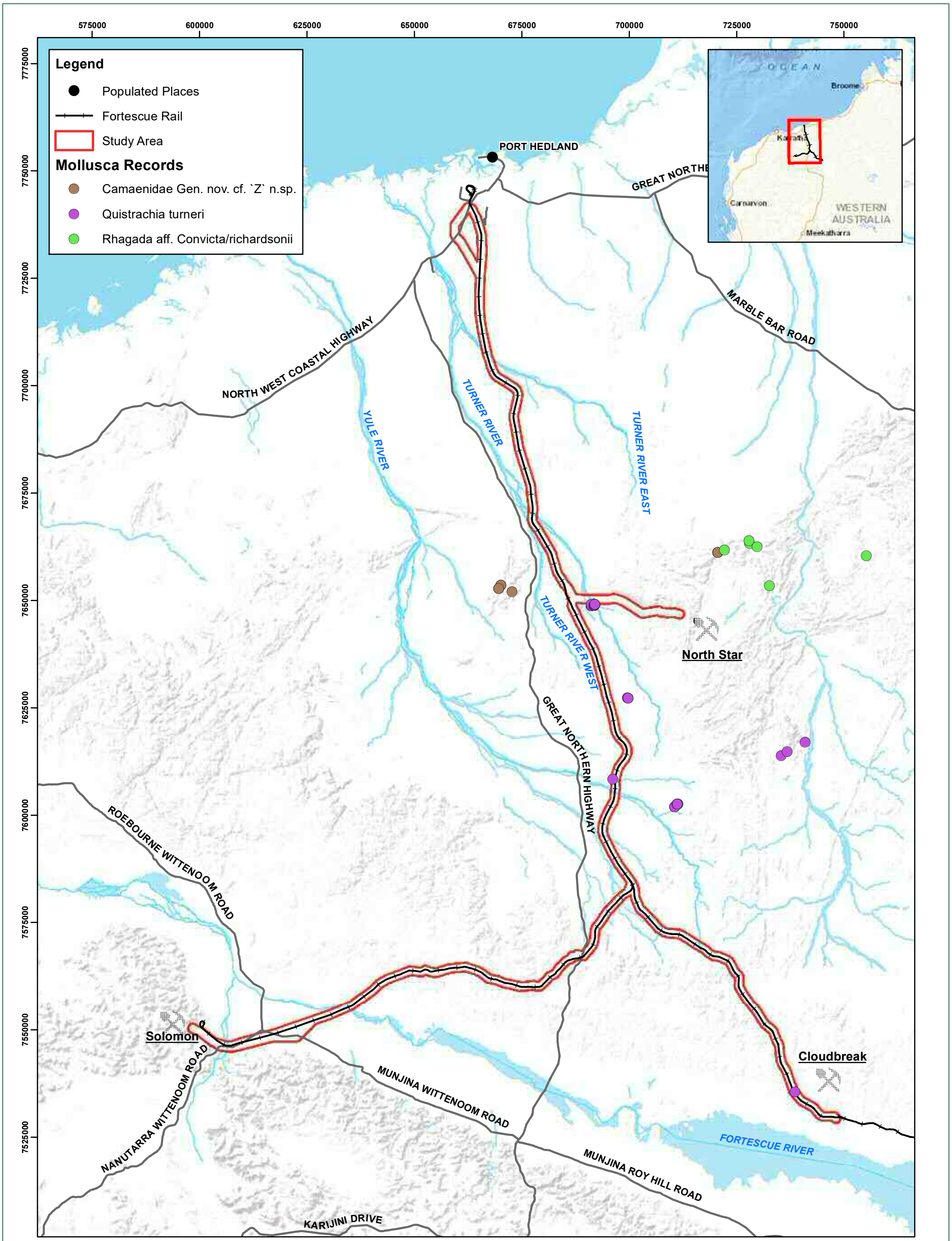
Absolute Scale: 1:360,000 @ A3

LOCATION OF ARACHNID DATABASE RECORDS

DRAWN: C.PARKER
DATE: 27/09/2018

FIGURE 6.2

Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 20 40 Km

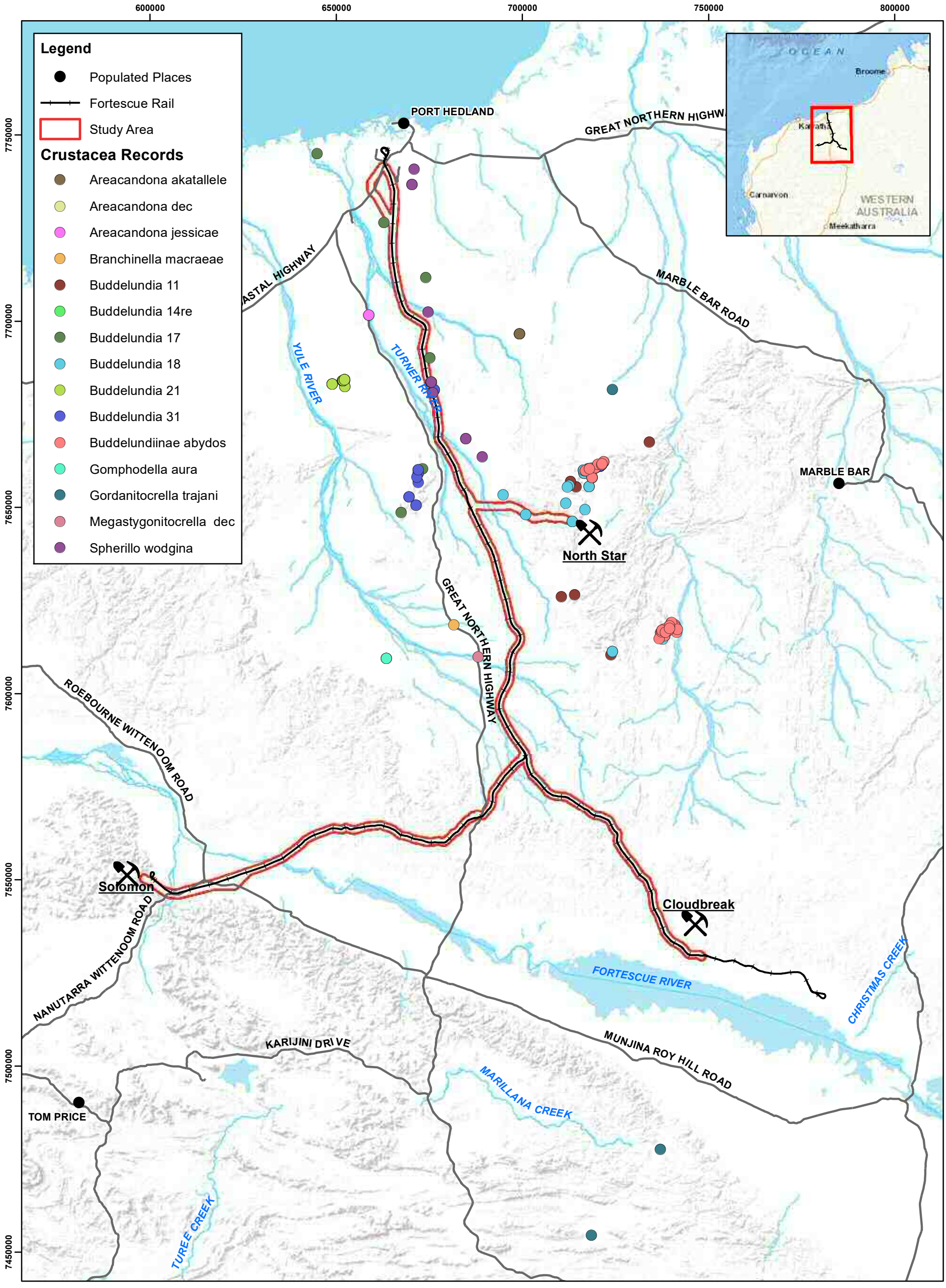
Absolute Scale: 1:825,000 @ A3

LOCATION OF MOLLUSCA DATABASE RECORDS

DRAWN: C.PARKER
DATE: 12/10/2018

FIGURE 6.3

Spectrum ECOLOGY



Service Layer Credits: Geoscience Australia, Sources: Esri, USGS, NOAA

N

System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

0 25 50 Km

Absolute Scale: 1:1,000,000 @ A3

LOCATION OF CRUSTACEA DATABASE RECORDS

DRAWN: C.PARKER
DATE: 12/10/2018

FIGURE 6.4

Spectrum ECOLOGY

7. REFERENCES

Allen, G. R., Midgley, S. H. and Allen, M. (2002) *Field guide to the freshwater fishes of Australia*. Perth, Western Australia: Western Australian Museum.

Anstee, S. D., Roberts, J. D. and Shea, J. E. (1997) 'Social Structure and patterns of Movement of the Western Pebble-mound Mouse, Pseudomys chapmani, at Marandoo, Western Australia', *Wildlife Research*, 24, pp. 295–305.

Armstrong, K. N. (2001) 'The roost habitat and distribution of the orange leaf-nosed bat, Rhinonicteris aurantius, in the Pilbara region of Western Australia.', *Wildlife Research*, 28, pp. 95–104.

Armstrong, K. N. (2003) *The bats that time forgot: the Orange Leaf-nosed Bat Rhinonicteris aurantius (Gray, 1845) (Microchiroptera: Hipposideridae) in the Pilbara region of Western Australia.* The University of Western Australia, Department of Animal Biology.

Armstrong, K. N. (2006) 'Resolving the correct nomenclature of the orange leaf-nosed bat Rhinonicteris aurantia (Gray, 1845) (Hipposideridae).', *Australian Mammalogy*, 28, pp. 125–130.

Armstrong, K. N. and Anstee, S. D. (2000) 'The ghost bat in the pilbara: 100 years on.', *Australian Mammalogy*, 22, pp. 93–101.

Astron (2015) *Poondano Iron Ore Project. Fauna Monitoring Program July 2015. Prepared for Mineral Resources Limited*.

ATA Environmental (2007) *Assessment of Conservation Significant Vertebrate Fauna for the Proposed Rail Corridor and Associated Borrow Pits. Volume 1. Fortescue Metals Group (FMG) Pty Ltd*.

Bamford Consulting (2005a) *Fauna survey of proposed Iron Ore Mine, Cloud Break. Fortescue Metals Group*.

Bamford Consulting (2005b) *Survey for the Night Parrot Pezoporus occidentalis in the Cloud Break Project Area, Fortescue Metals Group.*

Bamford Consulting (2006) *Survey for the Night Parrot Pezoporus occidentalis in the Cloud Break Project Area, Fortescue Metals Group.*

Bamford Consulting (2007) *Survey for the Night Parrot Pezoporus occidentalis in the Cloud Break Project Area, Fortescue Metals Goup.*

Bamford Consulting (2008) *Fauna Assesment of BC Iron Nullagine Iron Ore Project. Prepared for BC Iron by Bamford Consulting Ecologists, Kingsley.*

Bamford Consulting (2009) *Report on September 2008 search for the Night parrot. A Fortescue Metals Group Project.*

Bamford Consulting (2010a) *BC Iron Nullagine Iron Ore Project. Northern Quoll (Dasyurus hallucatus) Monitoring Programme Stage 1 September 2010.*

Bamford Consulting (2010b) *Fortescue Metals Group. Targeted Fauna Assessment of the Rail Duplication.*

Bamford Consulting (2010c) *Report on December 2009 search for the Night Parrot. A Fortescue Metals Group Project.*

Bamford Consulting (2011) *Report on 2010 search for the Night Parrot. A Fortescue Metals Group Project*.

Bamford Consulting (2012) *2011/2012 Night Parrot Survey Summary Report. A Fortescue Metals Group Project.*

Bamford, M. *et al.* (2008) *Migratory shorebirds of the East Asian-Australasian Flyway: population estimates and internationally important sites*, *Wetlands International*.

Barrientos, R. *et al.* (2011) 'Meta-Analysis of the Effectiveness of Marked Wire in Reducing Avian Collisions with Power Lines.', *Conservation Biology*, 25(5), pp. 893–903.

Barrientos, R. *et al.* (2012) 'Wire marking results in a small but significant reduction in avian mortality at power lines: a BACI designed study', *PLoS ONE*, 7(3), p. e32569.

Bevanger, K. (1994) 'Bird interactions with utility structures: collision and electrocution, causes and mitigating measures.', *Ibis*, 136(4), pp. 412–425.

Biologic (2015) *Orebody 32 East AWT (Above Water Table) Terrestrial Short-Range Endemic Fauna Environmental Impact Assessment. BHP Billiton Iron Ore PTY Ltd*.

Biota (2005) *Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas. Prepeared for Fortescue Metals Group (FMG).*

Biota Environmental Services (2004) *Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor. Fortescue Metals Group.*

Bird Life Australia (2012) 'Peregrine Falcon'.

Boles, W. E. (1999) 'Avian prey of the Australian Ghost bat Macroderma gigas (Microchiptera: Megadermatidae): prey characteristics and damage from predation', *Australian Zoologist*, 31(1), pp. 82–91.

Chace, J. F. and Walsh, J. J. (2006) 'Urban effects on native avifauna: a review.', *Landscape Urban Planning*, 74, pp. 46–69.

Chen, X., Dickman, C. R. and Thompson, M. B. (1998) 'Diet of the Mulgara, Dasycercus cristicauda (Marsupialia: Dasyuridae), in the Simpson Desert, central Australia.', *Wildlife Research*, 25, pp. 233–242.

Churchill, S. (2009) *Australian Bats*. 2nd Editio. Allen & Unwin.

Coffey Environments (2011) *Targeted Surveys Northern Quolls, Mulgara and Pilbara Olive Python – Solomon Rail Project. Report for Fortescue Metals Group*.

Department of Environment and Conservation (2012) *Fauna Profiles. Bilby Macrotis lagotis.* Available at: https://www.dpaw.wa.gov.au/images/documents/conservation-management/pests-diseases/bilby_2012.pdf.

Department of Mines and Petroleum (2013) *Clearing Permit Decision Report. BHP Billiton Iron ore Pty Ltd. Bing Siding to Walla Siding.*

Department of Parks and Wildlife (2017) *Interim guideline for preliminary surveys of night parrot (Pezoporus occidentalis) in Western Australia.*

Department of Parks and Wildlife (2018) *NatureMap: Mapping Western Australia's Biodiversity. Department of Parks and Wildlife.* Available at: https://naturemap.dpaw.wa.gov.au/.

Department of the Environment (2018a) *Species Profile and Threats Database. Dasyurus hallucatus — Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu]*. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=331 (Accessed: 17 September 2018).

Department of the Environment (2018b) *Species Profile and Threats Database. Macrotis lagotis - Greater Bilby*. Available at: http://www.environment.gov.au/sprat (Accessed: 19 September 2018).

Department of the Environment (2018c) *Species Profile and Threats Database. Rhinonicteris aurantia (Pilbara form) - Pilbara Leaf-nosed Bat*. Available at: http://www.environment.gov.au/biodiversity/threatened/species/bats.html. (Accessed: 17 September 2018).

Department of the Environment and Energy (2018a) *Species Profile and Threats Database. Actitis hypoleucos — Common Sandpiper*. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59309.

Department of the Environment and Energy (2018b) *Species Profile and Threats Database. Ctenotus angusticeps — Northwestern Coastal Ctenotus, Airlie Island Ctenotus*. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=25937.

Department of the Environment and Energy (2018c) *Species Profile and Threats Database. Tringa glareola - Wood Sandpiper*. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=829.

Department of the Environment and Energy (2018d) *Species Profile and Threats Database. Tringa nebularia — Common Greenshank*. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=832.

Drewitt, A. L. and Langston, R. H. W. (2006) 'Assessing the impacts of wind farms on Birds.', *Ibis*, 148, pp. 29–42.

Dunlop, J. (2017) *Pilbara Northern Quoll Research Program. Annual Report 2016. Department of Parks and Wildlife, Perth.*

Dunlop, J., Rayner, K. and Doherty, T. S. (2017) 'Dietary flexibility in small carnivores: a case study on the endangered northern quoll, Dasyurus hallucatus', *Journal of Mammalogy*, 98(3), pp. 858–866.

Dwyer, R. J. F., Harness, R. E. and Donohue, K. (2014) 'Predictive Model of Avian Electrocution Risk on Overhead Power Lines.', *Conservation Biology*, 28(1), pp. 159–168.

van Dyck, S. and Strahan, R. (2008) *The Mammals of Australia (Third Edition)*. Sydney: Reed New Holland.

Ecologia Environment (2011a) *Cloudbreak Level 2 Terrestrial Vertebrate Fauna Assessment . Unpublished report for Fortescue Metals Group*.

Ecologia Environment (2011b) *Cloudbreak Short-range endemic Invertebrate Survey. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2011c) *Proposed Yeelirrie Development. Short-range Endemic Invertebrate Baseline Survey. Unpublished report for URS Australia Pty Ltd.*

Ecologia Environment (2012a) *Canning Basin Pipeline and Drawdown Area. Vertebrate and Short Range Endemic Invertebrate Survey. Unpublished report for Fortescue Metals Group*.

Ecologia Environment (2012b) *Central Pilbara Project: Mine. Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2012c) *North Star Project. Level 2 Terrestrial Vertebrate Fauna Assessment. Fortescue Metals Group Ltd*.

Ecologia Environment (2013) *Solomon Iron Ore Project - Rail. Conservation Significant Fauna Monitoring 2012. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2014a) *Additional Rail Infrastructure Project. Conservation Significant Fauna*

Monitoring Program. Fortescue Metals Group Limited.

Ecologia Environment (2014b) *Hamersley Line Project Conservation Significant Fauna report 2014. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2014c) *Investigator Project: Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group*.

Ecologia Environment (2014d) *North Star Hematite Project. EPBC Listed Threatened Fauna Monitoring Report 2014. Unpublished Report for Fortescue Metals Group/Ironbridge*.

Ecologia Environment (2014e) *Solomon Hub. Short Range Endemic Invertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2014f) *Solomon Hub Project. Terrestrial Fauna Assessment. Unpublished report for Fortesue Metals Group.*

Ecologia Environment (2014g) *Solomon Mine Annual Conservation Significant Fauna Monitoring Report 2013. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2014h) *Solomon Rail Annual Monitoring. Conservation Significant Fauna Monitoring Report 2013. Unpublished report for Fortescue Metals Group*.

Ecologia Environment (2015a) *Additional Rail Infrastructure Project. Conservation Significant Fauna Monitoring 2013/2014. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2015b) *Additional Rail Infrastructure Project Conservation Significant Fauna Monitoring Annual Report 2014/2015. Unpublished report for Fortescue Metals Group.*

Ecologia Environment (2015c) *Solomon Mine Annual Conservation Significant Fauna Monitoring Report 2014/2015. Unpublished report for Fortescue Metals Group.*

Ecoscape (Australia) (2015) *North Star Pilbara Olive Python monitoring 2015. Unpublished report for Fortescue Metals Group.*

Ecoscape (Australia) (2016a) *Cape Preston Northern Quoll Reconnaissance Survey. CITIC Pacific Mining Management.*

Ecoscape (Australia) (2016b) *Cape Preston Northern Quoll Targeted Survey. CITIC Pacific Mining Management*.

Ecoscape (Australia) (2016c) *Conservation Significant Fauna Monitoring 2015/2016 - Operations. Unpublished report for Fortescue Metals Group.*

Ecoscape (Australia) (2016d) *North Star Conservation Significant Fauna monitoring 2015/2016. Unpublished report for Fortescue Metals Group.*

Ecoscape (Australia) (2017a) *Conservation Significant Fauna Monitoring 2016/2017. Unpublished report for Fortescue Metals Group.*

Ecoscape (Australia) (2017b) *Conservation Significant Fauna Monitoring 2016/2017. Unpublished report for Fortescue Metals Group*.

Ecoscape (Australia) (2017c) *Eliwana Project: Consolidated Vertebrate Fauna. Fortescue Metals Group.*

Ecoscape (Australia) (2017d) *Vegetation and Fauna Habitat Mapping of the Northern Tenement Area, Cloudbreak. Unpublished report for Fortescue Metals Group*.

Ecoscape (Australia) (2018) *Conservation Significant Fauna Monitoring 2017/2018. Unpublished report for Fortescue metals group*.

Ellis, R. (2010) 'Pilbara Olive Python Liasis olivaceus barroni. A (sub)species overview. Presentation at the Pilbara Olive Python workshop', in.

ENV Australia (2009) *Outer Harbour Development, Fauna Assessment. Report for Fortescue Metals Group*.

Environmental Protection Authority (2016) *Technical Guidance - Terrestrial Fauna Surveys*. Perth, Western Australia.

Erickson, W. P., Johnson, G. D. and Young, D. P. (2005) *A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collision*.

Fortescue Metals Group (2005) *Night Parrot (Pezoporus occidentalis) Management Plan. Pilbara Iron Ore Project*.

Frost, D. (2008) 'The use of "flight diverters" reduces mute swan Cygnus olor collision with power lines at Abberton Reservoir, Essex, England', *Conservation Evidence*, 5, pp. 83–91.

Garnett, S. *et al.* (1993) 'Notes on Live Night Parrot Sightings in North-western Queensland', *Emu*, 93, pp. 292–296.

Garnett, S. T., Szabo, J. and Dutson, G. (2011) *The Action Plan for Australian Birds 2010*. Melbourne.

GHD (2015) *North Star Mine. Pilbara Leaf-nosed Bat roost habitat survey. Unpublished report for Fortescue Metals Group/Ironbridge*.

Government of Western Australia (2018) *Long-tailed Dunnart Sminthopsis longicaudata. WA Museum Collections & Research*.

Greatwich, B. (2017) 'Night Parrot in Western Australia', *Western Australian Bird Notes*, 162, p. 4.

Hall, L. *et al.* (1997) 'The importance of abandoned mines as habitat for bats', in Hale, P. and Lamb, D. (eds) *Conervation Outside Nature Reserves,*. Centre for Conservation Biology, University of Queensland, Brisbane., pp. 326–334.

Harvey, M. (2002) 'Short-range endemism among the Australian fauna: some examples from nonmarine environments', *Invertebrate Systematics*, 16, pp. 555–570.

Hill, R. S. E. (1994) *History of Australian Vegetation: Cretaceous to Recent*. Cambridge University Press, Cambridge, UK.

Hoyle, S. D., Pople, A. . and Toop, G. J. (2001) 'Mark-recapture may reveal more about ecology than about population trends: Demography of a threatened ghost bat (Macroderma gigas) population.', *Australian Ecology*, 26, pp. 80–92.

Jackett, N. A. *et al.* (2017) 'A nesting record and vocalisations of the Night Parrot Pezoporus occidentalis from the East Murchison, Western Australia.', *Australian Field Ornithology*, 34, pp. 144–150. Available at: http://dx.doi.org/10.20938/afo34144150.

Jenkins, A. R., Smallie, J. J. and Diamond, M. (2010) 'Avian collisions with power lines: a global review of causes and mitigation with a South African perspective.', *Bird Conservation International*, 20(3), pp. 263–278.

Kutt, A. S. and Kemp, J. E. (2005) 'Distribution, habitat and conservation status of Leggadina lakedownensis (Rodentia: Muridae) in Queensland.', *Australian Zoologist*, 33(2), pp. 258–264.

Luzenski, J. *et al.* (2016) 'Collision avoidance by migrating raptors encountering a new electric power transmission line.', *The Condor*, 118(2), p. 402.

Main, B. Y. (1996) 'Terrestrial invertebrates in south-west Australian forests: the role of relict species and habitats in reserve design', *Journal of the Royal Society of Western Australia*, 79, pp. 277–280.

Main, B. Y. (1999) 'Biological anachronisms among trapdoor spiders reflect Australias environmental changes since the Mesozoic', in Ponder, W. and Lunney, D. (eds) *The Other 99%. Transactions of the Royal Zoological Society of New South Wales*. Mosman, 2088.

Maryan, B. *et al.* (2013) *Status of the Airlie Island Ctenotus, Ctenotus angusticeps (Lacertilia: Scincidae), with notes on distribution, habitat and genetic variation*, *The Western Australian Naturalist*.

McDougall, A. *et al.* (2009) 'Another piece in an Australian ornithological puzzle - a second Night Parrot is found dead in Queensland', *Emu*, 109, pp. 198–203.

Menkhorst, P. W. and Knight, F. (2001) *A Field Guide to the Mammals of Australia*.

Meunier, J. M., Verheyden, C. and Jouventin, P. (2000) 'Use of roadsides by diurnal raptors in agricultural landscapes', *Biological Conservation*, 92, pp. 291–298.

Morelli, F. *et al.* (2014) 'Can roads, railways and related structures have positive effects on birds?- A review, Transportation Research Part D.', *ISSN*, 30, pp. 21–31.

Murphy, R. K. *et al.* (2009) 'Effectiveness of avian collision averters in preventing migratory bird mortality from powerline strikes in the central Platte River, Nebraska', *Final Report to the US Fish and Wildlife Service, Grand Island, Nebraska, USA*.

Murphy, S. *et al.* (2018) *Night Parrot surveys at Fortescue Marsh, Western Australia: Habitat analyses, survey review and recommendations. Report to Fortescue Metals Group, February 2018.*

Murphy, S. A. *et al.* (2015) *A review of night parrot (Pezoporus occidentalis) biology and the identification of research priorities.*

Murphy, S. A., Silcock, J., *et al.* (2017) 'Movements and habitat use of the night parrot Pezoporus occidentalis in south-western Queensland.', *Australian Ecology*, 42, pp. 858–868. Available at: doi:10.1111/aec.12508.

Murphy, S. A., Austin, J. J., *et al.* (2017a) 'Observations on breeding Night Parrots (Pezoporus occidentalis) in western Queensland.', *The Emu - Austral Ornithology*, pp. 1–7. Available at: 10.1080/01584197.2017.1292404.

Murphy, S. A., Austin, J. J., *et al.* (2017b) 'Observations on breeding Night Parrots (Pezoporus occidentalis) in western Queensland.', *The Emu - Austral Ornithology*, pp. 1–7.

Oakwood, M. (2008) 'Northern Quoll Dasyurus hallucatus', in Van Dyck, S. & R. S. (ed.) *The Mammals of Australia*. 3rd Editio. Sydney, NSW: Reed New Holland, pp. 57–59.

Olson, P. D. and Olson, J. (1986) 'Distribution, status, movements and breeding of the Grey Falcon Falco hypoleucos', *Emu*, 86, pp. 47–51.

Outback Ecology (2013) *Fortescue Metals Group Ltd Proposed Gas Pipeline Targeted Threatened Fauna Survey.*

Pavey, C. (2006) *National Recovery Plan for the Greater Bilby Macrotis lagotis.*

Pearse, A. T., Brandt, D. A. and Krapu, G. L. (2016) 'Wintering Sandhill Crane exposure to wind energy development in the central and southern Great Plains, USA.', *The Condor*, 118(2), pp. 391–401.

Pearson, D. (2003) 'Giant Pythons of the Pilbara', *Landscope*, 19(1), pp. 32–39.

Pettigrew, J. D. *et al.* (1986) 'The Australian Ghost Bat, Macroderma gigas, at Pine Creek, Northern Territory', *Macroderma*, 2(1), pp. 8–19.

Pettigrew, J. D. *et al.* (1988) 'Peak density and distribution of ganglion cells in the retinae of microchiropteran bats: Implications for visual acuity', *Brain, Behaviour and Evolution*, 32, pp. 39–56.

Ponder, W. F. and Colgan, D. J. (2002) 'What makes a narrow-range taxon? Insights from Australian freshwater snails.', *Invertebrate Systematics*, 16.

Schoenjahn, J. (2010) 'Field Identification of the Grey Falcon Falco hypoleucos', *Australian Field Ornithology*, 27, pp. 49–58.

Schoenjahn, J. (2011) 'How scarce is the Grey Falcon?', *Boobook*, 29(1), pp. 24–25.

Schoenjahn, J. (2013) 'A hot environment and one type of prey: investigating why the Grey Falcon (Falco hypoleucos) is Australia's rarest falcon.', *Emu*, 113(1), pp. 19–25.

Schulz, M. and Menkhorst, K. (1986) 'Roost Preferences of Cave-Dwelling Bats at Pine Creek, Northern Territory.', *Macroderma*, 2(1), pp. 2–7.

Short, J. and Turner, B. (1991) 'Distributuion and Abundance of the Spectacled Hare-wallabies and Euros on Barrow Island, Western Australia', *Wildlife Research*, 18, pp. 421–429.

Simpson, K. and Day, N. (2004) *Field Guide to the Birds of Australia*. 7th Editio. Camberwell, Victoria: Penguin Group.

Smith, J. A. and Dwyer, R. J. F. (2016) 'Avian interactions with renewable energy infrastructure: An Update.', *The Condor*, 118(2), pp. 411–423.

Toop, G. J. (1985) 'Habitat requirements, survival strategies and ecology of the ghost bat, Macroderma gigas Dobson, (Microchiptera Megadermatidae) in central coastal Queensland.', *Macroderma*, 1, pp. 37–41.

Turpin, J. and Ford, S. (2011) *A second mainland population of Ctenotus angusticeps (Lacertilia: Scincidae) from Port Hedland, Western Australia, with notes on habitat*, *Herpetofauna*.

Wilson, S. and Swan, G. (2017) *A Complete Guide to Reptiles of Australia*. 5th Editio. Sydney, NSW: New Holland Publishers.

Woolley, P. A., Haslem, A. and Westerman, M. (2013) 'Past and present distribution of Dasycercus: toward a better understanding of the identity of specimens in cave deposits and the conservation status of the currently recognised species D. blythi and D. cristicaud (Marsupialia: Dasyuridae)', *Australian Journal of Zoology*, 61, pp. 281–290.

Worthington Wilmer, J. *et al.* (2008) 'Extreme population structuring in the threatened ghost bat, Macroderma gigas: evidence from mitochondrial DNA.', *Biological Sciences*, 257, pp. 193–198.

Yee, M. L. (2008) 'Testing the effectiveness of an avian flight diverter for reducing avian collisions with distribution power lines in the Sacramento Valley, California', *California. California Energy Commission. Downloaded from www. energy. ca. gov/2007publications/CEC-500-2007-122/CEC-500-2007-122. PDF on*, 15(02), p. 2010.

Appendix 1: Regional SRE Invertebrate Fauna Species

Table 7.1: WAM Database Search Results

Taxa Group	Species name	Site recorded	SRE status
Crustacea			
Thamnocephalidae	*Branchinella macraeae*	Creek Pool Off NW Coastal, Edgina Creek (Port Hedland)	SRE
Ameriridae	*Gordanitocrella trajani*	Pilbara	SRE
	Megastygoniocrella dec	Pilbara	SRE
Armadilidae	*Buddelundia* 11	Abydos, Wodgina, Mt Webber, North Star	SRE
	Buddelundia 14re	Wodgina	SRE
	Buddelundia 17	Wodgina, Port Hedland, Central Pilbara Project	SRE
	Buddelundia 18	Abydos, Wodgina, North Star, Mt Webber	SRE
	Buddelundia 21	Mt Dove	SRE
	Buddelundia 31	Mt Dove, Wodgina, Abydos	SRE
	Buddelundia abydos	Abydos, Mt Webber	SRE
	Spherillo wodgina	Wodgina, Port Hedland	SRE
Candonidae	*Areacandona akatallele*	Spring Bore (Pilbara)	SRE
	Areacandona dec	Dunny Bore (Pilbara)	SRE
	Areacandona jessicae	Turner River West	SRE
Limnocytheridae	*Gomphodella aura*	Yule River (Yandeyarra Reserve)	SRE
Arachnids			
Mygalomorphae			
Nemesidea	*Aname* 'MYG001' group	Wodgina, Abydos	Potential SRE
	Aname 'MYG034'	22km SSE of Wodgina	Potential SRE
	Aname 'MYG099'	Woodstock Station	Potential SRE
	Aname 'MYG0372-DNA'	15km NE of Wodgina	Potential SRE
	Aname 'sp. 1'	Woodstock Station	Potential SRE
	Aname 'sp. 3'	Woodstock Station	Potential SRE
	Aname mellosa	Abydos, Mt Webber, North Star	Potential SRE
Arthropoda			
Paradoxosomatidae	*Antichiropus* 'DIP005'	Abydos, Wodgina	Potential SRE
	Antichiropus 'DIP028'	Wodgina	Potential SRE
	Antichiropus 'DIP033'	Wodgina	Potential SRE
	Antichiropus 'DIP037'	Wodgina, Dresser Mining Centre	Potential SRE
Polyxenidae	*Unixenus* 'mjoebergi complex'	Mt Dove	Potential SRE

Taxa Group	Species name	Site recorded	SRE status
Pseudoscorpiones			
Atemnidae	*Oratemnus* 'PSE018'	Wodgina	Potential SRE
	Oratemnus 'PSE060'	BHP Rail 80km SSE of Port Hedland	Potential SRE
Cheiridiidae	*`PSEAAB`* sp.	Wogina	Potential SRE
	Apocheiridium sp.	Wodgina and surrounding	Potential SRE
Chernetidae	*Troglochernes* 'sp.nov.001'	Mt Dove	Potential SRE
Chthoniidae	*Austrochthonius* 'pilbara'	Wodgina and surrounding	Potential SRE
	Tyrannochthonius 'sp. AB A'	Abydos	Potential SRE
	Tyrannochthonius 'sp. nov.near aridus'	Abydos, Mt Dove	Potential SRE
Garypidae	*Synsphyronus* 'PSE008'	Roy Hill	Potential SRE
	Synsphyronus 'PSE012'	BHP Rail, 100km S of Port Hedland	Potential SRE
	Synsphyronus 'PSE094, long chelal hand'	BHP Rail, 50km S of Port Hedland	Potential SRE
	Synsphyronus heptatrichus	Wodgina	Potential SRE
Hyidae	*Indohya* 'PSE002'	Mt Dove, Wodgina, Abydos	Potential SRE
Olpiidae	'Genus 7/4'	Wodgina and surrounding	Potential SRE
	'PSEAAA'	Mt Dove, Wodgina	Potential SRE
	Austrohorus '8/4'	115km S of Port Hedland	Potential SRE
	Austrohorus 'sp. 8/2'	Mt Dove, Wodgina	Potential SRE
	Austrohorus 'sp. 8/3'	Abydos, Wodgina	Potential SRE
	Beierolpium '8/4 lge'	North Star, Wodgina	Potential SRE
	Beierolpium '8/4'	Mt Dove	Potential SRE
	Beierolpium 'sp 8/2'	Near Wodgina	Potential SRE
	Beierolpium 'sp 8/3'	Abydos, near Wodgina	Potential SRE
	Beierolpium 'sp. indet. (juvenile 6/2) lge'	Mt Dove	Potential SRE
	Beierolpium 'sp. indet. (juvenile 6/2) small'	Mt Dove	Potential SRE
	Indolpium 'long chelal hand'	Wodgina	Potential SRE
Sternophoridae	*Afrosternophorus* sp.	Mt Dove, Wodgina	Potential SRE
Cryptopidae	*Cryptops* 'sp. indet'	Woodstock Station	Potential SRE
	Cryptops 'sp. MN'	Yandi Mine site	Potential SRE
Scorpiones			
Buthidae	*Lychas* 'sp. 1'	Wodgina and surrounding	Potential SRE
	Lychas 'sp. 2'	Wodgina	Potential SRE
	Lychas 'sp. 4'	Wodgina and surrounding	Potential SRE
	Lychas 'sp. 6'	Near Wodgina	Potential SRE

Taxa Group	Species name	Site recorded	SRE status
Urodacidae	*Urodacus* 'sp.1'	Hope Downs	Potential SRE
	Urodacus 'sp.2'	Near Wodgina, Hope Downs	Potential SRE
	Urodacus 'sp.5'	Near Wdgina	Potential SRE
	Urodacus 'sp.9'	Near Wodgina	Potential SRE
	Urodacus 'sp. Pilbara 8'	Abydos, Wodgina	Potential SRE
Molluscs			
Arthropoda	Rhagada 'Sulphur Springs'	Biota record: Sulphur Springs (Panorama Project)	Potential SRE
Camaenidae	Gen.nov. cf.'Z'n.sp.	Wodgina, Abydos, Skull Spring	Potential SRE
	Quistrachia turneri	Gallery Hill, Port Hedland, Gallery Hill, K Pool Wodgina, Marble Bar, Woodstock	Potential SRE
	Rhagada aff. Convicta/richardsonii	Marble Bar	Potential SRE