BHP Billiton Iron Ore

Draft Impact Assessment Report

Pilbara Strategic Assessment

March 2016

Document Control

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This Draft Impact Assessment Report has been prepared for submission to the Federal Department of the Environment for the purpose of the Minister for the Environment making a determination regarding whether to approve BHP Billiton Iron Ore's Proposal under the *Environment Protection and Biodiversity Conservation Act 1999*. This Draft Impact Assessment Report has been developed for this purpose only, and no one other than the Department of the Environment or the Minister should rely on the information contained in this Draft Impact Assessment Report to make any decision.

In preparing this Draft Impact Assessment Report, BHP Billiton Iron Ore has relied on information provided by specialist consultants, government agencies and other third parties available during preparation.

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NOTE ON CURRENCY

Where possible, the contents of this Draft Impact Assessment Report are up to date as at 16 March 2016.

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Document Abbreviations

Abbreviation	Meaning
AHD	Australian height datum
BoM	Bureau of Meteorology
SIP	Social Investment Program
CIA	cumulative impact assessment
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DotE	Department of the Environment
DoW	Department of Water (Western Australia)
DPaW	Department of Parks and Wildlife (Western Australia)
DSEWPaC	Department of Sustainability, Environment, Water, Populations and Communities (now DotE)
EHU	ecohydrological unit
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986 (WA)*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
FIFO	fly-in, fly-out
FY	financial year
GIS	geographic information system
ha	hectare
IAR	Impact Assessment Report
IBRA	Interim Biogeographic Regionalisation for Australia
km	kilometre
ML	mega litre
MNES	matter of national environmental significance
MNES Program	Matters of National Environmental Significance Program
Mt	million tonnes
Mtpa	million tonnes per annum
MW	megawatt
NGO	non-government organisation
OSA	overburden storage area
PER	public environmental review
PMST	Protected Matters Search Tool

Abbreviation	Meaning
SPRAT	Species Profile and Threats Database
TEC	threatened ecological community
TSSC	Threatened Species Scientific Committee
WC Act	*Wildlife Conservation Act 1950* (WA)

Document Definitions

Term	Definition
action	As defined in Chapter 8 Part 23 Division 1 Subdivision A of the EPBC Act.
Agreement, the	the agreement dated 18 September 2012 between the Commonwealth Minister for the Environment and BHP Billiton Iron Ore for the strategic assessment of the impacts of the Proposal on MNES and attached at Appendix A.
asset	An economic resource within the Strategic Assessment Area. Examples include mining tenure with an identified resource, an operating mine, or infrastructure such as rail or processing infrastructure.
Assurance Plan	An Implementation Plan that provides further detail on the processes described in this MNES Program, including management of Specified Protected Matters, stakeholder engagement, reporting and auditing requirements and governance arrangements.
BHP Billiton Limited	the ultimate parent company of BHP Billiton Iron Ore.
BHP Billiton Iron Ore	BHP Billiton Iron Ore Pty Ltd, as manager and agent for and on behalf of BHP Billiton Minerals Pty Ltd, BHP Iron Ore (Jimblebar) Pty Ltd, United Iron Pty Ltd, the participants of the Mount Goldsworthy Joint Venture, Mount Newman Joint Venture and Yandi Joint Venture.
BHP Billiton Iron Ore Strategic Assessment	The BHP Billiton Iron Ore Strategic Assessment encompasses the Company's possible future development for mining and support infrastructure over the next 100 years within the geographic extent of the Strategic Assessment Area. Shortened to 'the Proposal'.
Controlled Action	An action that would otherwise be prohibited without approval under Part 9 of the EPBC Act.
Controlling Provision	As defined in Part 7 Division 1 Section 67 of the EPBC Act.
derived proposal	Part of the state strategic environmental assessment process for the Proposal. The derived proposal is a second step that is required to implement parts of the Proposal under Section 39B of the state *Environmental Protection Act 1986*.
ecohydrological unit	A landscape element with broadly consistent and distinctive ecohydrological attributes.
ecologically sustainable development	In this Draft IAR, the principle of ecologically sustainable development has been defined as 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased' (Ecologically Sustainable

Term	Definition
	Development Steering Committee 1992).
Endorsed MNES Program	An MNES Program that has been endorsed by the Minister for the Environment and can be implemented.
Full Conceptual Development Scenario	The conceptual direct disturbance footprint for the development of all current BHP Billiton Iron Ore mining tenures within the Strategic Assessment Area.
future operation	In the context of the Strategic Assessment, this term includes new mines and expansions, together with supporting infrastructure including (but not limited to) rail lines, accommodation villages and roads.
Implementation Plans	Specifically the Assurance Plan and Offsets Plan, which are designed to support the implementation of this MNES Program
landscape	A spatially heterogeneous area, scaled relative to the process of interest; within landscapes, it is usually possible to define a series of different ecosystems, landforms, habitats and natural or manmade features.
local	Pertaining to a discrete area and its immediate vicinity (as opposed to the whole Strategic Assessment Area or the whole bioregion).
local scale	At the scale of a local activity, e.g. the zone of impact of a particular activity. Used to differentiate between regional-scale impacts (i.e. impacts at the scale of the bioregion or the entire distribution of a species) and impacts at the scale of a particular operation (e.g. an existing or future mine).
Material Action	An activity that is considered likely to have an impact on a MNES that is greater than the thresholds defined for a Specified Protected Matter in the Assurance Plan.
matters of national environmental significance (MNES)	Matters of national environmental significance under Part 3 of the EPBC Act.
Mining Operation	A location of mining activities on BHP Billiton Iron Ore tenure. The mining operation may contain one or more processing hubs within it, depending on the mining strategy.
MNES Management Outcome	A measurable level of performance for the management of MNES Impacts that are a result of implementation of Material Actions applicable under this MNES Program.
Proposal	Means BHP Billiton Iron Ore's proposal for future operations within the Strategic Assessment Area as described in Section 3.
Public Environmental Review - Strategic Proposal	The document prepared under the EP Act that outlines the potential impacts of the Proposal on environmental factors and the management strategies to address potential impacts. It is assessed by the Western Australian EPA in considering whether the Proposal is environmentally acceptable.
regional scale	At the scale of the region. Used to differentiate between local-scale impacts (i.e. at the scale of an existing or future mine) and impacts at a broader scale.
region	Pertaining to a vast area (e.g. an entire IBRA bioregion as opposed to a specific locality).

Term	Definition
run-of-mine	The unprocessed ore that results from blasting. The run-of-mine will often require crushing and may require further processing (e.g. beneficiation) prior to being suitable for transport to port.
Specified Protected Matters	MNES that have potential to be impacted significantly by the Proposal.
Strategic Assessment Area	The geographical extent of the assessment and boundaries within which the Proposal may be implemented, as depicted in Figure 1.
strategic environmental assessment	A generic term for landscape-scale evaluations of the environmental impacts of multiple actions across a broad region; also called strategic assessment.
value	Any particular benefit or use of the environment that is important for a healthy ecosystem or for public benefit. Values are often not readily quantifiable and may be difficult to directly monitor, measure or assess.
Validation Framework	The framework described in Section 8.6.2.

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EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) has been operating in the Pilbara for over 50 years and proposes to continue developing mines and infrastructure within and around its existing Pilbara operations over the long term. The proposed future activities include development of new mines and infrastructure and expansion of existing mines and infrastructure (the Proposal) are the subject of this assessment. BHP Billiton Iron Ore envisages that the Proposal will be implemented over a long timeframe, with a maximum time limit of 130 years.

The proposed future development activities that are the subject of this Proposal include the development of new iron ore mines and associated infrastructure and the expansion of existing iron ore mines and associated infrastructure within a defined Strategic Assessment Area (Figure ES1). The strategic assessment process is conducted under Part 10 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Strategic assessments provide an alternative to project-by-project impact assessment under Part 9 of the EPBC Act and examine proposed developments at a broader landscape scale and timeframe in relation to the requirements of the EPBC Act, taking into consideration impacts on matters of national environmental significance (MNES).

The EPBC Act is the Commonwealth government's key environmental legislation with regard to environmental impact assessment. On 18 September 2012, BHP Billiton Iron Ore entered into an Agreement (Appendix 1) with the Commonwealth Minister for the Environment under section 146 of the EPBC Act. The Agreement pertains to the development of a strategic assessment for the potential impacts of the Proposal on MNES. BHP Billiton Iron Ore's decision to pursue a strategic assessment approach under the EPBC Act has the following benefits:

- The early consideration of environmental issues, including MNES, providing the ability to influence design and management of future project developments;
- The ability to consider direct, indirect and cumulative impacts to MNES of more than one future action;
- Greater certainty for local communities regarding the maximum extent of cumulative impacts and greater confidence in future development;
- An increased surety for BHP Billiton Iron Ore that its proposed environmental management approaches will result in appropriate management of impacts to MNES;
- A standardised and consistent approach across operations, with environmental and economic benefits;
- A long-term approach to environmental management, focusing on environmental outcomes and allowing adaptive management; and
- Greater efficiencies in the environmental approvals process for the community, government and BHP Billiton Iron Ore.

Three key documents form the basis of the Commonwealth strategic environmental assessment under the EPBC Act (note there is also a separate state assessment under the Western Australian *Environmental Protection Act 1986*):

- The Agreement between BHP Billiton Iron Ore and the Commonwealth Minister for the Environment under section 146 of the EPBC Act;

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Figure ES1 Boundary of the Strategic Assessment Area and Proposal Tenure

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- The Draft MNES Program, which identifies the key commitments and undertakings of BHP Billiton Iron Ore for the protection and management of Controlling Provisions (relevant MNES) under the EPBC Act (BHP Billiton Iron Ore 2016); and
- This Draft Impact Assessment Report (Draft IAR), which provides details of the potential impacts from the implementation of the Proposal on MNES.

The purposes of the Impact Assessment Report are to assess potential impacts to MNES as a result of implementation of the Proposal and to enable the Commonwealth Minister for the Environment to make a decision on whether to endorse the Draft MNES Program. This Impact Assessment Report presents the results of the impact assessment undertaken for the Proposal and evaluates the potential impacts given BHP Billiton Iron Ore commitments detailed within the Draft MNES Program. The strategic assessment process is summarised in Figure ES2.

A search undertaken using the Department of the Environment's Protected Matters Search Tool identified MNES that may be present in the Strategic Assessment Area (Table ES1). Of the MNES within the Strategic Assessment Area, only listed threatened species and listed migratory species are considered to be Controlling Provisions for the Proposal.

Table ES1: Controlling Provisions of the Proposal

MNES Protected under EPBC Act	Controlling Provisions
World Heritage Properties	No
National Heritage Places	No
Wetlands of International Importance (Ramsar Wetlands)	No
Great Barrier Reef Marine Park	No
Commonwealth Marine Areas	No
Listed Threatened Species and Communities	Yes
Listed Migratory Species	Yes
Nuclear Actions	No
Protection of water resources from coal seam gas development and large coal mining development	No
Protection of the environment from actions involving Commonwealth land	No
Protection of Commonwealth heritage places outside the Australian jurisdiction	No
Protection of the environment from Commonwealth actions	No

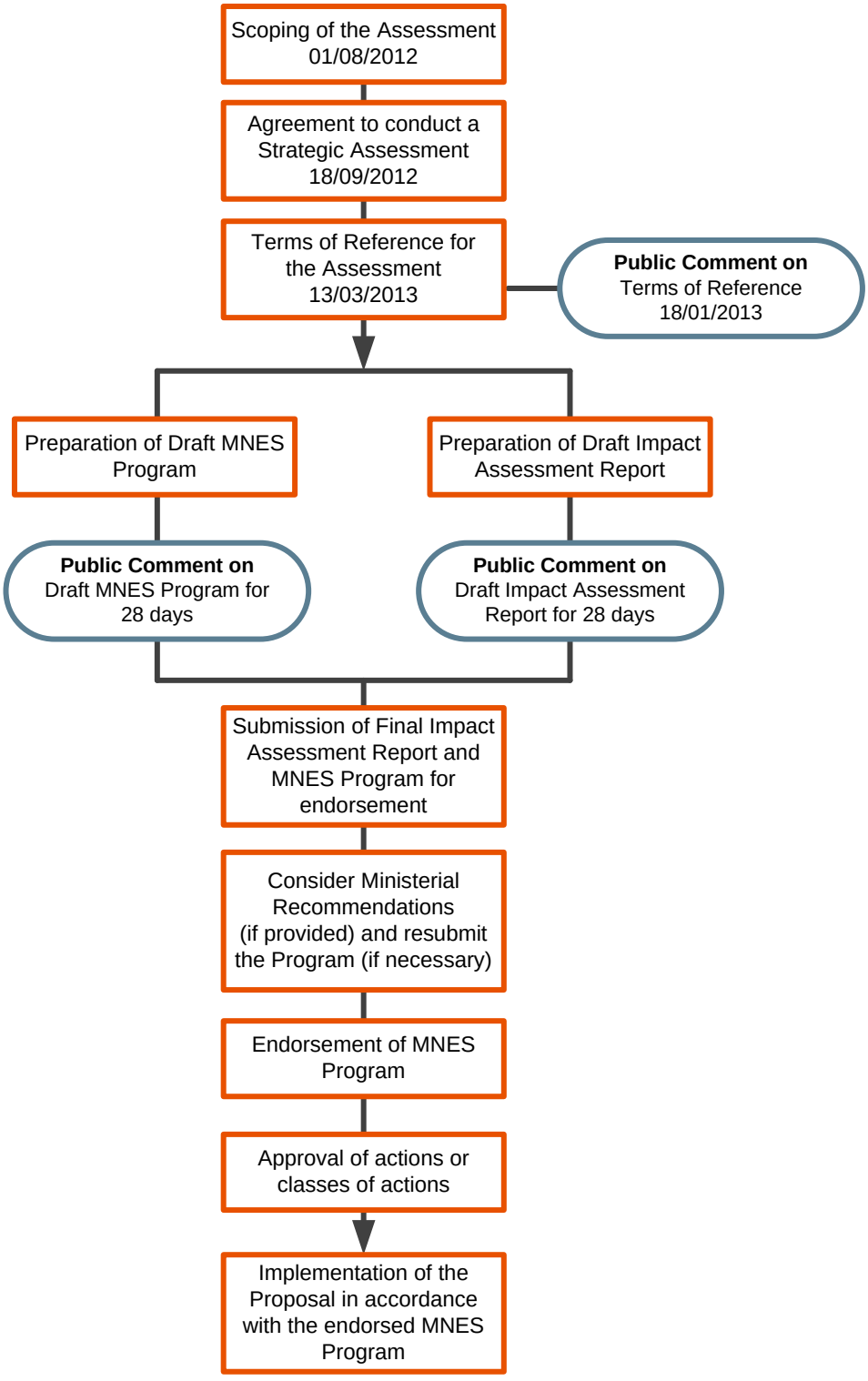


Figure ES2: The Commonwealth strategic assessment process

A screening assessment was conducted on the Controlling Provisions to determine those threatened species, ecological communities and migratory species that had potential to be impacted significantly by the Proposal, referred to as Specified Protected Matters. The screening assessment (Appendix 3) resulted in five threatened species being identified as Specified Protected Matters as listed below:

- Northern quoll;
- Greater bilby;
- Pilbara leaf-nosed bat;
- Pilbara olive python; and
- Hamersley lepidium.

A comprehensive impact assessment was carried out at a regional scale to quantify and assess the potential for significant impacts (direct, indirect and cumulative) from implementation of the Proposal on the Specified Protected Matters. The impact assessment was informed by a range of inputs, including modelling, published scientific information, and regulatory guidance for MNES. An independent peer review team was also engaged to critique and improve the methods and interpretation of key documents. This Draft IAR considers the following impacts to the Specified Protected Matters:

- Direct impacts: a direct result of an activity. For example, clearing of vegetation and removal of overburden prior to mining directly results in the loss of habitat;
- Indirect impacts: a result facilitated but not directly caused by an activity. For example, lowering of the water table in wetlands from dewatering activities at a mine in a hydrologically connected aquifer;
- Local impacts: impacts at the scale of a local activity, e.g. the zone of impact of a particular activity or a particular operation (e.g. an existing or future mine);
- Regional impacts: impacts at the scale of the bioregion or of the entire distribution of a species; and
- Cumulative impacts: the aggregate impacts (both direct and indirect) on a given receptor, ecosystem, or population centre of past, present and reasonably foreseeable future activities as a result of both BHP Billiton Iron Ore and third-party operations.

Sources of potential impacts or threatening processes and the nature and extent of those potential impacts and processes have been assessed for each of the Specified Protected Matters. A summary of species' ecology and the cumulative impact assessment findings for the five Specified Protected Matters are provided in Table ES2.

BHP Billiton Iron Ore recognises that over the life of the Proposal there is potential for change to occur to the relevant Controlling Provisions and as such, the Draft MNES Program provides a process to address future listing events. In addition, BHP Billiton Iron Ore has voluntarily undertaken an impact assessment of wetlands of international importance and national heritage places as features within the Strategic Assessment Area that may have potential to become listed as MNES during implementation of the Proposal.

BHP Billiton Iron Ore has also noted the recent inclusion of the ghost bat (*Macroderma gigas*) in the Finalised Priority Assessment list. In light of its possible listing under the Act, an assessment of potential impacts to this species has also been included in this Draft IAR.

A summary of the impact assessment to potential future wetlands of international importance and national heritage places, and the ghost bat is provided in Table ES3.

Table ES2: Impact assessment summary for Specified Protected Matters

Northern Quoll (EPBC Act: Endangered)
Description: The northern quoll is the smallest and most arboreal of the four Australian quoll species (van Dyck & Strahan 2008). The northern quoll has undergone a dramatic range contraction since European settlement, including a 75% reduction in distribution during the 20th century. In the Pilbara, northern quoll distribution is bounded in the north, east and south by the Great Sandy Desert, Gibson Desert and Little Sandy Deserts (DotE 2014a).
Results and Conclusion: Eco Logical (2015a) modelled the habitat preference (the probability of that species being located in certain habitats) for the northern quoll using 518 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) was strongly associated with rugged hills, ranges and outcrops in the north and northeast of the Pilbara bioregion, as opposed to areas in the central and southern areas of the Pilbara bioregion. It was acknowledged, however, that the model may have potentially under predicted in the higher elevation ranges in the southern part of the Strategic Assessment Area (Eco Logical 2014a). The cumulative impact assessment (Appendix 4) model predicts a potential increase of 504 ha to Habitat Rank 4 (highest probability of potential habitat) for the northern quoll as a result of the Full Conceptual Development Scenario. This increase in modelled Habitat Rank 4 is partially due to the predicted level of existing impacts (from mining, pastoral activities, etc.) potentially being high (91% in the current scenario) and the assumption that all BHP Billiton Iron Ore mines and infrastructure would be closed by the time the Full Conceptual Development Scenario is implemented, thereby removing indirect impacts such as fauna mortality associated with roads and trains. Although the model indicates a potential increase in preferred northern quoll habitat at a regional level, BHP Billiton Iron Ore considers this prediction to be indicative only and recognises that this prediction could change in the future as a result of changes to threats, such as the introduction of cane toads to the Pilbara. In addition to the regional modelling approach, BHP Billiton Iron Ore also conducted an impact assessment based on northern quoll species records. The records data were obtained from the Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. Based on the species records data, 4% of the known records within the Strategic Assessment Area are predicted to be impacted cumulatively by iron ore mining in the Pilbara. The data show that the majority of the impact is from BHP Billiton Iron Ore. There are few records within the Full Conceptual Development Scenario footprint; therefore at this stage the species is considered to be at low risk from the Proposal. BHP Billiton Iron Ore considers that impacts to the northern quoll from the Proposal will be managed to an acceptable level given the above findings and BHP Billiton Iron Ore's commitments in the MNES Program to: • Develop a MNES Management Outcome for the northern quoll prior to implementation; • Validate impacts to the northern quoll at a local scale; and • Apply the mitigation hierarchy (avoid impact first, then mitigate impact, then, as a last resort, offset significant residual impact) for predicted impacts to the northern quoll. Peer review comments on the species viability for the northern quoll are provided in Appendix 5.

Greater Bilby (EPBC Act: Vulnerable)
Description: The greater bilby is a small nocturnal burrowing marsupial that is restricted to the arid regions of central Australia. In the Pilbara bioregion, the greater bilby exists in the Hamersley Range area, along the Fortescue River and northeast to Shay Gap (Pavey 2006a). The extent of occurrence for the greater bilby is thought to have remained relatively stable over the last 20 years. However, given the remote distribution of this species, it is likely that the current distribution is inadequately mapped (DotE 2014b). The density of greater bilby populations is currently unknown, but the total population size is estimated to be around 5,000 to 10,000 in Western Australia (Friend et al. 2008).
Results and Conclusion: Eco Logical (2015a) modelled the habitat preference (the probability of that species being located in certain habitats) for the greater bilby using 21 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) was strongly associated with hotter regions in the eastern part of the Strategic Assessment Area. Within this range, lower, less rocky areas were identified as higher potential greater bilby habitat. Most greater bilby records were from the north-eastern part of the Pilbara, with most records occurring along the existing rail line within the Strategic Assessment Area. The cumulative impact assessment model (Appendix 4) predicts a potential decrease of 114 ha to Habitat Rank 4 (highest probability of potential habitat) for the greater bilby as a result the Full Conceptual Development Scenario. This area of potential impact from the Proposal represents less than 1% of the area modelled as Habitat Rank 4 within the Pilbara bioregion. In addition to the regional modelling approach, BHP Billiton Iron Ore also conducted an impact assessment based on greater bilby species records. The records data were obtained from the Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. Based on the species records data, 2.3% of the known records within the Strategic Assessment Area are predicted to be impacted cumulatively by iron ore mining in the Pilbara. The data show that all of the potential impact is from BHP Billiton Iron Ore. Given that the majority of records occur outside the Pilbara and only two occur in the Full Conceptual Development Scenario, the cumulative risk to this species is considered low. BHP Billiton Iron Ore considers that impacts to the greater bilby from the Proposal will be managed to an acceptable level given the above findings and BHP Billiton Iron Ore's commitments in the MNES Program to: • Develop a MNES Management Outcome for the greater bilby prior to implementation; • Validate impacts to the greater bilby at a local scale; and • Apply the mitigation hierarchy (avoid impact first, then mitigate impact, then, as a last resort, offset significant residual impact) for predicted impacts to the greater bilby. Peer review comments on the species viability for the greater bilby are provided in Appendix 5.

Pilbara Leaf-nosed Bat (EPBC Act: Vulnerable)

Description: The Pilbara leaf-nosed bat occurs over an approximate area of 120 million ha (Eco Logical 2014c) and is restricted to the Pilbara bioregion of Western Australia. Armstrong (2001) suggests that there may be three discrete subpopulations – George Range, Hamersley Range and Upper Gascoyne – separated by extensive flat areas restricting gene flow. Individual colonies vary in size from 10 individuals to 20,000 individuals, although the latter is exceptional (e.g. Armstrong 2001; Ecologia Environment 2005, 2006a, 2006b). The total number of Pilbara leaf-nosed bats is currently unknown due to difficulties in counting individuals (Eco Logical 2014c). An assessment of data by Bullen (2013) indicates 24 maternal or day roosts occur across the Pilbara.

Results and Conclusion: Eco Logical (2015a) modelled the habitat preference (the probability of that species being located in certain habitats) for the Pilbara leaf-nosed bat using 137 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) occurs in the central-east of the Pilbara bioregion.

The cumulative impact assessment model (Appendix 4) predicts a potential decrease of 6,275 ha to Habitat Rank 4 (highest probability of potential habitat) for the Pilbara leaf-nosed bat as a result the Full Conceptual Development Scenario. This area of potential impact from the Proposal represents less than 1% of the area modelled as Habitat Rank 4 within the Pilbara bioregion. BHP Billiton Iron Ore recognises that, although the modelled potential impact is considered relatively minor at a regional scale, the Pilbara leaf-nosed bat has specific habitat requirements that may not have been captured at a regional scale, and thus management at a local scale is important.

In addition to the regional modelling approach, BHP Billiton Iron Ore also conducted an impact assessment based on Pilbara leaf-nosed bat species records. The records data were obtained from the Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. Based on the species records data, 7.7 % of the known records within the Strategic Assessment Area are predicted to impacted cumulatively by iron ore mining in the Pilbara. The data show that the potential impact is from both BHP Billiton Iron Ore and reasonably foreseeable third party mines. Based on surveys to date, there have been no significant roosts for this species identified in BHP Billiton Iron Ore tenure; therefore at this stage this species is considered to be at low risk from the Full Conceptual Development Scenario.

BHP Billiton Iron Ore considers that impacts to the Pilbara leaf-nosed bat from the Proposal will be managed to an acceptable level given the above findings and BHP Billiton Iron Ore's commitments in the MNES Program to:

- Develop a MNES Management Outcome for the Pilbara leaf-nosed bat prior to implementation;
- Validate impacts to the Pilbara leaf-nosed bat at a local scale; and
- Apply the mitigation hierarchy (avoid impact first, then mitigate impact, then, as a last resort, offset significant residual impact) for predicted impacts to the Pilbara leaf-nosed bat.

Peer review comments on the species viability for the Pilbara leaf-nosed bat are provided in Appendix 5.

Pilbara Olive Python (EPBC Act: Vulnerable)

Description: The Pilbara olive python is described by DotE (2014c) as being restricted to ranges within the Pilbara bioregion, although an isolated population is thought to occur south on Mount Augustus in the Gascoyne region (Bush & Maryan 2011), and additional records exist in the north-eastern Carnarvon region. Within the Pilbara bioregion, the species has been recorded from the Hamersley Range, Dampier Archipelago, Pannawonica, Millstream, Tom Price, Burrup Peninsula, and 70 km east of Port Hedland (DotE 2014c). The species is also known from riparian areas along the Fortescue River (Doughty et al. 2011).

Pilbara olive pythons are known to occupy a distinct home range ranging from 85 to 450 ha and to move around frequently within their home range (Pearson 2003).

Results and Conclusion: Eco Logical (2015a) modelled the habitat preference (the probability of that species being located in certain habitats) for the Pilbara olive python using 75 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) was most heavily concentrated in the ranges of the southern and central areas of the Pilbara bioregion; however, preferred habitat was also predicted in association with river plains in the north and the ranges and outcrops of the eastern part of the Pilbara bioregion.

The cumulative impact assessment model (Appendix 4) predicts a potential decrease of 1,344 ha to Habitat Rank 4 (highest probability of potential habitat) for the Pilbara olive python as a result of the Full Conceptual Development Scenario. This area of potential impact from the Proposal represents less than 1% of the area modelled as Habitat Rank 4 within the Pilbara bioregion.

In addition to the regional modelling approach, BHP Billiton Iron Ore also conducted an impact assessment based on Pilbara olive python species records. The records data were obtained from the Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. Based on the species records data, 22% of the known records within the Strategic Assessment Area are predicted to be impacted cumulatively by iron ore mining in the Pilbara. The data show that the majority of the impact is from BHP Billiton Iron Ore. It is a cryptic species that is difficult to specifically target during fauna surveys (DotE, 2008), so this number is unlikely to represent its abundance and distribution within the Pilbara. There is currently no population estimate for the Pilbara olive python although it is believed to have sizable populations in areas (e.g. the Burrup Peninsula), and some of these are restricted from threatening processes (Pearson 2003). Cumulative impact to this species is considered to be moderate.

BHP Billiton Iron Ore considers that impacts to the Pilbara olive python will be managed to an acceptable level given the above findings and BHP Billiton Iron Ore's commitments in the MNES Program to:

- Develop a MNES Management Outcome for the Pilbara olive python prior to implementation;
- Validate impacts to the Pilbara olive python at a local scale; and
- Apply the mitigation hierarchy (avoid impact first, then mitigate impact, then, as a last resort, offset significant residual impact) for predicted impacts to the Pilbara olive python.

Peer review comments on the species viability for the Pilbara olive python are provided in Appendix 5.

Hamersley Lepidium (EPBC Act: Vulnerable)
Description: Hamersley lepidium is a short-lived perennial herb or shrub growing up to 0.4 m high. The species is endemic to the Pilbara bioregion of Western Australia and has a scattered distribution in populations ranging from a few individuals to several hundred individuals. The majority of populations occur in the Hamersley subregion, extending into the southernmost edge of the Fortescue Plains subregion of the Pilbara bioregion. There is also a disjunct population approximately 125 km northeast of the other populations in the Chichester subregion (DPaW 2013).
Results and Conclusion: Eco Logical (2015a) modelled the habitat preference (the probability of that species being located in certain habitats) for Hamersley lepidium using 616 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) was associated with higher elevations and cooler temperatures and that the majority of preferred habitat was concentrated in the central-south of the Pilbara bioregion. Recorded locations of Hamersley lepidium are well-aligned to the preferred habitat model, occurring in the southern Pilbara bioregion (central area of the Strategic Assessment Area). The cumulative impact assessment model (Appendix 4) predicts a potential decrease of 30,959 ha to Habitat Rank 4 (highest probability of potential habitat) for the Hamersley lepidium as a result of the Full Conceptual Development Scenario. This area of potential impact from the Proposal represents less than 4% of the area modelled as Habitat Rank 4 within the Pilbara bioregion. In addition to the regional modelling approach, BHP Billiton Iron Ore also conducted an impact assessment based on Hamersley lepidium species records. The records data were obtained from the Department of Parks and Wildlife in December 2015. Based on the species records data, 15.3 % of the known records within the Strategic Assessment Area are predicted to be impacted cumulatively by iron ore mining in the Pilbara. The data show that the majority of the potential impact is from BHP Billiton Iron Ore, however the risk to this species is considered low due to the increasing frequency at which this taxon is being recorded. This species is regarded as common across the southeast Pilbara region and well represented in Karijini National Park. BHP Billiton Iron Ore considers that significant impacts to this species are unlikely given the widespread distribution of the species. Further, the Hamersley lepidium has been observed to be a pioneer species where disturbance, such as clearing and road construction, has increased the short-term presence of the species in an area. BHP Billiton Iron Ore considers that impacts to the Hamersley lepidium can be managed to an acceptable level given the above findings and BHP Billiton Iron Ore's commitments in the MNES Program to: • Develop a MNES Management Outcome for the Hamersley lepidium prior to implementation; • Validate impacts to the Hamersley lepidium at a local scale; and • Apply the mitigation hierarchy (avoid impact first, then mitigate impact, then, as a last resort, offset significant residual impact) for predicted impacts to the Hamersley lepidium. Peer review comments on the species viability for Hamersley lepidium are provided in Appendix 5.

Table ES3: Impact assessment summary for potential future MNES listings

Potential future wetlands of international importance
Description: There are currently no wetlands of international importance within the Strategic Assessment Area. However, it is possible that future listing events may result in some wetlands of national importance being 'uplisted' to wetlands of international importance during the life of the MNES Program. The Directory of Important Wetlands (DotE 2015a) lists the following wetlands within the Strategic Assessment Area: • Fortescue Marsh; • Karijini (Hamersley Range) Gorges; and • Mt Bruce coolibah-lignum flats. The above wetlands are considered to be potential future wetlands of international importance for the purposes of the assessment.
Results and Conclusion: BHP Billiton Iron Ore (2015) undertook a detailed Ecohydrological Change Assessment (Appendix 6) to assess the potential for changes to surface and groundwater associated with implementation of the Proposal in relation to key water sensitive features. Under the Full Conceptual Development Scenario, BHP Billiton Iron Ore mining operations have been implemented in all mining areas, in addition to existing BHP Billiton Iron Ore and third party iron ore operations. The findings of this study have been used to inform the assessment on potential wetlands of international importance, the outcomes of which are discussed below. • Fortescue Marsh: The model indicates that without mitigation, a high change potential to groundwater within a localised area at the southern fringe of Fortescue Marsh under the Full Conceptual Development Scenario. The majority of the Marsh area (approximately 99%) remains unaffected by drawdown. There is moderate potential without mitigation for ecohydrological change to surface water availability considering the cumulative effects of BHP Billiton Iron Ore and third-party operations, based on the reduction in the catchment area of the Marsh exceeding 5%. The model also indicates that there is also potential for saline intrusion. All of the modelled results are without mitigation in place. BHP Billiton Iron Ore considers that the potential impacts to Fortescue Marsh predicted from implementation of the Proposal can be managed to an acceptable level within the implementation of proven mitigation measures. • Karijini (Hamersley Range) Gorges: Hydrochemical analysis of the gorge waters suggests that the pools are supported by local aquifers that are hydrologically disconnected from the regional groundwater resources (Hedley 2009). The nearest proposed BHP Billiton Iron Ore mining operation is over 18 km to the southeast of the Karijini (Hamersley Range) Gorges. Given that the gorges are hydrologically disconnected from the regional groundwater resources and are supported by local aquifers, BHP Billiton Iron Ore considers the potential impact from implementing the Proposal to be negligible (Appendix 6). • Mt Bruce coolibah-lignum flats: This priority ecological community is likely to have ecohydrological similarities to the Coondewanna Flats (an internally draining basin), as the woodland vegetation community has a likely dependence on stored soil water derived from runoff. The Proposal will not result in any ecohydrological change to the community, as it is ecohydrologically disconnected from any current or proposed BHP Billiton Iron Ore mining areas (Appendix 6).

Potential future national heritage places
Description: There are no national heritage places within the Strategic Assessment Area; however the Abydos Woodstock Protected Area was nominated for listing in 2011. The site is located north of BHP Billiton Iron Ore's mining tenure, but the Company's existing rail lines (along with two other mining company rail lines) traverse the nominated area.
Results and Conclusion: In 1987, Anthropological Consultant Rory O'Connor conducted surveys across the Abydos Woodstock area to identify sites of cultural significance. In 2008, Anthropologist Kim Barber conducted an additional ethnographic survey along the BHP Billiton Iron Ore rail corridor through Abydos Woodstock on behalf of the Native Title groups. One site of ethnographic significance was identified in the corridor. After further consultation with the relevant Native Title groups, BHP Billiton Iron Ore amended it mainline rail alignment to avoid this site. In 2010, BHP Billiton Iron Ore contracted Archaeological consultants WARU to conduct a detailed archaeological survey, 200 metres either side of the existing 80m BHP Billiton Iron Ore rail corridor. All archaeological sites were identified, mapped and recorded in detail and extensive consultation was undertaken with the relevant Native Title groups and Yamatji Marlpa Aboriginal Corporation (YMAC) over the following two years with the intention of identifying an expanded corridor alignment that did not impact on sites of cultural or historical significance. In one place this involved narrowing the corridor and changing the alignment. This work was undertaken in the context of YMAC moving towards lodging a nomination of Abydos Woodstock for a National Heritage Listing on behalf of the Native Title groups. If that occurred, the 480m rail corridor (200m either side of the existing 80m rail lease) would be excluded from any future listing. From the above, BHP Billiton Iron Ore considers that should the Abydos Woodstock Protected Area become listed as a National Heritage Place under the EPBC Act in the future, implementation of the Proposal would not result in any impact to this area.
Potential future listing event – ghost bats
Description: The ghost bat is the largest microbat in Australia and the second largest in the world (DotE 2015d). In the Pilbara region, the species occurs in all four sub-regions, and was recorded in 21 of the 24 areas surveyed by DPaW during the Pilbara Biological Survey (2002-2007; see McKenzie & Bullen, 2009). The largest populations occur within the Chichester sub-region, where known populations are largely restricted to disused mines. The ghost bat (Macroderma gigas) was included on the Finalised Priority Assessment List on 1 October 2015. The Finalised Priority Assessment List (FPAL) is the list of nominated species, ecological communities and key threatening processes that have been approved for assessment by the Minister responsible for the EPBC Act (the Minister) for a particular assessment year (1 October – 30 September).
Results and Conclusion: BHP Billiton Iron Ore conducted a review of ghost bat records from the company's database and publicly available data supplied by Western

Australian Department of Parks and Wildlife (DPaW) and Western Australian museum in December 2015 and January 2016 respectively. The review identified 1,028 records for ghost bat, of which 465 occurred within the Strategic Assessment Area. 175 records are predicted to be impacted by iron ore mining (reasonable foreseeable third party and BHP Billiton Iron Ore Full Conceptual Development) in the Pilbara. The data show that the majority of the potential impact is from BHP Billiton Iron Ore.

The largest colonies in the Pilbara occur outside the Strategic Assessment Area where they roost in abandoned mines. Colonies within the Strategic Assessment Area are much smaller, and available data suggest that they likely depend on a number of roosts within their range. Ghost bat populations in the Chichester subregion, which occur outside of the Strategic Assessment Area, are considered significant; and if impacted by habitat loss (due to collapse or reworking of mine adits) or from the arrival of cane toads, those populations within the Strategic Assessment Area will become more important regionally.

BHP Billiton Iron Ore recognises that the ghost bat will require considered management during implementation of the Proposal. Should the ghost bat be listed as an MNES it would be considered as a Specified Protected Matter and as such, BHP Billiton Iron Ore's commitments in the MNES Program would apply. The MNES Program contains a commitment to develop an Assurance Plan and Offsets Plan. The Assurance Plan would include a MNES Management Outcome specific to the ghost bat, which must be met through avoidance and mitigation measures. If after avoidance and mitigation measures have been applied and significant residual impacts are predicted to occur, the offsets would be applied in line with the Offsets Plan.

The MNES Program also contains a Validation Framework (described in Section 8.6.2), which includes a commitment to review baseline data and site-specific information such as the proposed footprint and indirect impacts predicted to the Specified Protected Matter. This Validation Framework provides a robust process to consider new information in regards to ghost bat roost significance on a case-by-case basis during implementation of the Proposal.

BHP Billiton Iron Ore considers that the potential impacts of the Proposal on the ghost bat will be managed to an acceptable level; given the commitments and processes contained in the MNES Program that can be applied to the ghost bat in the event that the species is listed as an MNES.

The management framework that will be applied to implementation of the Proposal is a combination of corporate governance (such as the Company Charter, which outlines the Company strategy, values and success criteria) and specific commitments identified in the Draft MNES Program (BHP Billiton Iron Ore 2016). The Draft MNES Program outlines the processes that BHP Billiton Iron Ore will follow to ensure that impacts to MNES can be managed to an acceptable level throughout the life of the Proposal. Key to the management framework is the commitment to develop an Assurance Plan and an Offsets Plan (known as the Implementation Plans) following endorsement of the MNES Program. The Minister may consider these Implementation Plans in approving actions or classes of actions under the MNES Program.

The Draft MNES Program contains a key non-statutory process step, known as Notice of Intent to Proceed, which occurs prior to undertaking any action that may have material impacts on the Specified Protected Matters, referred to as a Material Action. The Notice of Intent to Proceed is a document issued to the Department of the Environment (DotE) or equivalent department that demonstrates that a preferential mitigation hierarchy of ‘avoid, mitigate, offset’ can be effectively applied to achieve the MNES Management Outcomes (specific, measureable performance outcomes for the Specified Protected Matters) specified in the Assurance Plan. Impacts will be validated at a regional and local scale using contemporary, relevant data to inform the application of the mitigation hierarchy. Processes for ongoing auditing, monitoring, corrective action and reporting on MNES Management Outcomes are also provided as part of the MNES Program.

Based on the analysis of potential cumulative impacts to the Specified Protected Matters described in this Draft IAR, and the clear management processes and commitments provided in the Draft MNES Program, BHP Billiton Iron Ore considers that the Proposal will not have a significant impact on MNES and that objects of the EPBC Act will be met.

1 INTRODUCTION

BHP Billiton is among the world's largest producers of major commodities, including coal, copper, iron ore, nickel and uranium, and has substantial interests in oil and gas. BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore), one of BHP Billiton's businesses, has been developing mines and infrastructure in the Pilbara since the 1960s (Plate 1). BHP Billiton Iron Ore's existing mining operations include Newman, Yandi, Mining Area C and Jimblebar, together producing approximately 270 million tonnes per annum (Mtpa) of iron ore, which is transported via rail to Port Hedland for export.

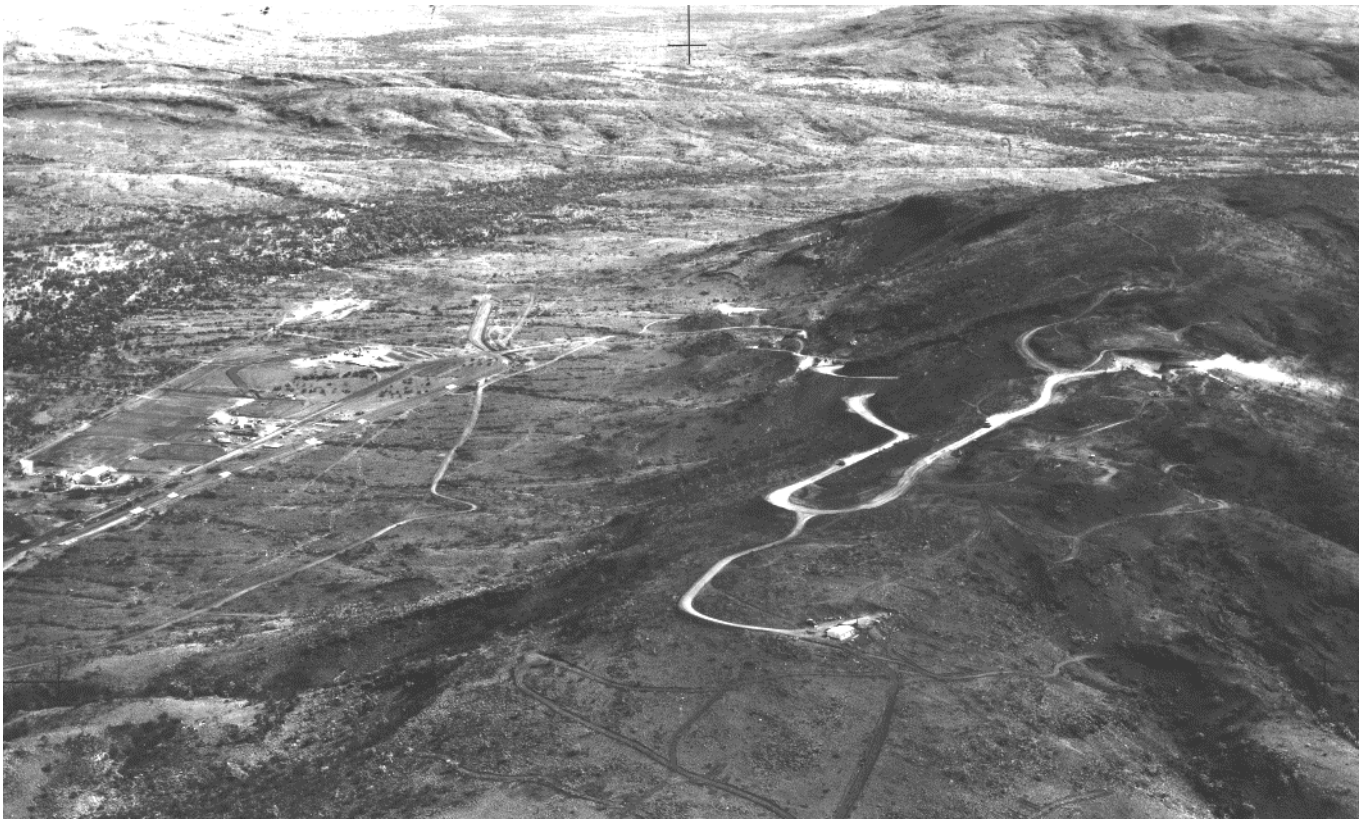


Photo: BHP Billiton Iron Ore

Plate 1: Mount Whaleback operations 1968

BHP Billiton Iron Ore Pty Ltd proposes to continue developing mines and infrastructure within and around its existing Pilbara operations over the long term. The proposed future activities include development of new mines and infrastructure and expansion of existing mines and infrastructure (the Proposal) are the subject of this assessment. Subject to market conditions, BHP Billiton Iron Ore envisages that the Proposal will be developed over a long timeframe, within a defined area known as the Strategic Assessment Area (Figure 1).

Given its long history of iron ore mining and environmental management in the Pilbara, BHP Billiton Iron Ore is well placed to use its experience and environmental knowledge to undertake a regional and strategic approach to environmental impact assessment.

Figure 1 Boundary of the Strategic Assessment Area and Proposal Tenure

DATE: 21/01/2016
DRAWN: BHP Billiton Iron Ore Environmental Approvals

On 18 September 2012, BHP Billiton Iron Ore entered into an agreement with the Commonwealth Minister for the Environment under section 146 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to undertake a strategic assessment of the impacts of a plan, policy or program for mining iron ore in the Pilbara region, Western Australia (see Appendix 1). Since this time, BHP Billiton Iron Ore has been working in consultation with the Commonwealth Government to deliver this Strategic Assessment.

This Draft Impact Assessment Report (Draft IAR) for the Proposal is one of two key documents that comprise the Commonwealth Strategic Assessment. The Draft IAR assesses the potential impacts of the Proposal to matters of national environmental significance (MNES), considering the commitments that BHP Billiton Iron Ore has made to manage impacts to MNES to an acceptable level. These commitments are contained within a second document, the Draft MNES Program (BHP Billiton Iron Ore 2016). Once the Draft MNES Program is endorsed by the Commonwealth Minister for the Environment, BHP Billiton Iron Ore will be bound to meet these commitments for the duration of the Proposal implementation. Thus, this Draft IAR should be read in conjunction with the Draft MNES Program.

BHP Billiton Iron Ore is also undertaking a separate strategic environmental assessment under the Western Australian *Environmental Protection Act 1986* (EP Act) for environmental factors considered at a state level.

1.1 Strategic Environmental Assessment

Strategic environmental assessments (often referred to as strategic assessments) are landscape-scale evaluations of the environmental impacts of multiple actions across a broad region. They differ from project-by-project assessments, which look at individual actions within a narrower, local environmental context (such as the construction and operation of a single iron ore mine in a specific location). In this document, *region* is used in the context of a vast area (for example, the entire Pilbara). This is distinct from *local,* which is used to indicate a more confined, specific area (for example, a single mine or piece of infrastructure). The Proposal provides for the assessment of potential impacts from multiple mines and supporting infrastructure across the Pilbara over the long term. Benefits of a strategic assessment include:

- The early consideration of environmental issues, including relevant matters of national environmental significance (MNES), providing the ability to influence design and management of future project developments;
- Broadening the technical assessment from a local to landscape scale
- The ability to consider direct, indirect and potential cumulative impacts of more than one future action to MNES;
- Greater certainty for local communities regarding the maximum extent of potential cumulative impacts and greater confidence in future developments;
- An increased surety for BHP Billiton Iron Ore that its proposed environmental management approaches will result in appropriate management of potential impacts to MNES;
- A standardised and consistent approach across operations with environmental and economic benefits;
- A long-term approach to environmental management, focusing on environmental outcomes and allowing adaptive management; and
- Greater efficiencies in the environmental approvals process for the community, government and BHP Billiton Iron Ore.

Commonwealth and state governments recognise the benefit of proponents undertaking strategic assessments (Commonwealth of Australia 2013; EPA 2012). Several strategic assessments have been pursued by proponents in Australia under both state and Commonwealth legislation, and the concept of strategic assessment has been proven for large-scale infrastructure projects with a longer-term development horizon (e.g., Molonglo Valley Plan (Australian Capital Territory), Western Sydney Growth Centres Strategic Assessment (New South Wales), Midlands Water Scheme Strategic Assessment (Tasmania) and Melbourne's Urban Growth Boundary Strategic Assessment (Victoria)). BHP Billiton Iron Ore has recognised the potential benefits and has prepared strategic assessments under both State and Commonwealth legislation.

1.1.1 COMMONWEALTH STRATEGIC ASSESSMENT

Strategic assessments are conducted under Part 10 of the EPBC Act. They provide an alternative to mine-by-mine impact assessments and examine proposed developments at a broader landscape scale in relation to the requirements of the EPBC Act. The department (currently the Commonwealth Department of the Environment) administers the strategic assessment provisions of the EPBC Act and provides advice to the Commonwealth Minister for the Environment throughout the process.

As the Proposal is being formally assessed under the EPBC Act, it is considered a Controlled Action (section 67 of the EPBC Act). A Controlled Action is an action that would otherwise be prohibited without approval under Part 9 of the EPBC Act. The approval is provided by the Minister's endorsement of this Draft IAR and the supporting Draft MNES Program and subsequent approval of an action or class of actions.

1.1.2 WESTERN AUSTRALIAN STATE STRATEGIC PROPOSAL

There is also an equivalent strategic assessment process at the state level under the EP Act. The state process is conducted in two phases. Phase one involves preparation of a public environmental review document (PER) for the Proposal. The PER is assessed by the Environmental Protection Authority (EPA), and subject to the assessment outcomes, the State Minister for Environment has the option to approve the Proposal by issuing a Ministerial Statement. Once approval has been granted, phase two involves consideration of individual future proposals within the scope of the Proposal.

BHP Billiton Iron Ore will refer individual proposals to the EPA and request that the EPA declare each of the referred proposals to be a derived proposal. When a future proposal is referred, the EPA considers it to be a Derived Proposal if:

- The proposal was identified in the strategic proposal that has been assessed by the EPA; and
- The Ministerial Statement for the strategic proposal allows the proposal to be implemented, subject to any conditions.

The EPA may refuse to declare the referred proposal a Derived Proposal if it considers that:

- The environmental issues raised by the referred proposal were not adequately assessed in the strategic proposal;
- There is significant new or additional information that justifies the reassessment of the issues raised by the referred proposal; or
- There has been a significant change in the relevant environmental factors since the strategic proposal was assessed.

The EPA will assess whether or not the implementation conditions relating to the Strategic Proposal apply to the Derived Proposal. Where the EPA decides to declare a referred proposal to be a Derived Proposal, it

publishes the reasons for the declaration on the EPA website. A notice is issued to the proponent of the Derived Proposal allowing implementation of the proposal, and the notice will specify which conditions would apply. If the EPA refuses to declare a referred proposal to be a deferred proposal, it may require the referred proposal to be subject to further environmental impact assessment pursuant to Part IV of the EP Act.

1.2 Proponent Details

The proponent for the Proposal is BHP Billiton Iron Ore Pty Ltd for and on behalf of the Joint Venture Participants. The key contact for the Proposal is:

Project Manager – EPBC Strategic Assessment

BHP Billiton Iron Ore

125 St Georges Terrace

PERTH Western Australia 6000

Telephone: 08 6224 4444

Email: pilbarastrategicassessment@bhpbilliton.com

1.3 Structure of this Report

This Draft IAR is structured as follows:

1. Introduction – describes BHP Billiton Iron Ore's history and the strategic environmental assessments being undertaken at a State and Commonwealth level.
2. Strategic Assessment and Approvals Process – describes the Strategic Assessment process and how this relates to other legislation and the key documents that form this Strategic Assessment. It also describes the peer review process and stakeholder consultation undertaken during the development of these documents.
3. Scope of the Proposal – outlines the scope of the Proposal, which mirrors the scope outlined in the MNES Program and provides additional conceptual detail about typical iron ore mining.
4. Existing Environment – describes the environment in which the Proposal will be implemented and which may be relevant to MNES, including the biological environment and biophysical elements such as fire history, climate and land use.
5. Impact Assessment – describes the scope of the impact assessment, the impact assessment inputs and the results of the impacts to the Specified Protected Matters (MNES that are considered relevant to the Proposal at this time).
6. Assessment of Potential Future MNES Listings – Assesses those matters that occur within the Strategic Assessment Area that are considered to have potential to be listed as MNES during the life of the Proposal, which is 120 years. These potential future MNES are wetlands of international importance, national heritage places and a future listing event for ghost bats.
7. Socio-economic Environment – describes the socio-economic environment in which the Proposal will be implemented and provides an impact analysis of the potential impacts associated with the Proposal.
8. Management Framework – describes the Corporate governance context for BHP Billiton, a description of Aboriginal heritage management, how BHP Billiton Iron Ore will address the principles of ecologically

sustainable development, how adaptive management and consideration of the mitigation hierarchy has been embedded in the MNES Program, and management measures specific to the MNES Program.

9. Endorsement Criteria – demonstrates how BHP Billiton Iron Ore has complied with the endorsement criteria for the Strategic Assessment as per Clause 9 of the Agreement between BHP Billiton Iron Ore and the Commonwealth Government of Australia. The Agreement provides the Terms of Reference for the MNES Program and the IAR.
10. References – provides references used throughout the IAR.

This Draft IAR includes case studies and call-out boxes throughout that demonstrate or illustrate concepts, examples or projects. They are designed to facilitate an understanding of and provide context to the main body of the report.

2 STRATEGIC ASSESSMENT AND APPROVAL PROCESS

2.1 Strategic Assessment Process and Other Legislation

The EPBC Act is the Commonwealth Government's key piece of legislation for environmental impact assessment. Part 3 of the EPBC Act sets out MNES, which are:

- World heritage values of a declared World Heritage property (section 12 and section 15A);
- Heritage values of a national heritage place (section 15B and section 15C);
- Wetlands of international importance (section 16 and section 17B);
- Listed threatened species and ecological communities (section 18 and section 18A);
- Listed migratory species (section 20 and section 20A);
- Commonwealth marine areas (section 23 and section 24A);
- Protection of the environment from actions involving Commonwealth land (section 26 and 27A);
- Commonwealth heritage places outside the Australian jurisdiction (section 27B and section 27C);
- Protection of the environment from Commonwealth actions (section 28);
- Protection of water resources from coal seam gas development and large coal mining development (section 24D and section 24E);
- Protection of the environment from nuclear actions (section 21 and section 22A); and
- The Great Barrier Reef Marine Park (section 24B and section 24C).

Strategic assessments are conducted under Part 10 of the EPBC Act. They provide an alternative to mine-by-mine impact assessments and examine proposed developments at a broader landscape scale in relation to the requirements of the EPBC Act. Strategic assessments are designed to facilitate a collaborative process that delivers positive environmental outcomes and allows the Minister to assess the proponent's proposed framework for the management of MNES.

The jurisdiction of the Commonwealth strategic assessment process is limited to MNES. Approval can only be granted if the Minister considers that the proponent has adequately identified and addressed potential impacts to MNES, addressed requirements set out in the Agreement (described further in Section 2.2) and provided for any modifications recommended by the Minister. At a broad level, the strategic assessment process occurs in two stages:

- Assessment and endorsement of a 'policy, plan or program' (the MNES Program); and
- Approval of actions (or classes of actions) associated with the Program that will occur over time.

The EPBC Act prohibits certain actions from being taken in relation to MNES without approval under Part 9 of the EPBC Act. Such actions are called 'controlled actions'. The MNES to which controlled actions relate are called 'controlling provisions' (Box 1).

Box 1: Controlling Provisions

A controlling provision is a provision of Part 3 of the EPBC Act which prohibits the taking of an action in respect of that provision without approval under Part 9 of the EPBC Act. The controlling provisions that are relevant to the Proposal are section 18 (listed threatened species and communities) and section 20 (listed migratory species). See further at Section 5.1 of this document.

BHP Billiton Iron Ore will be approved to take controlled actions in relation to controlling provisions under the Proposal where:

- The Minister has endorsed the Draft MNES Program under Part 10 of the EPBC Act; and
- The Minister has approved the taking of an action or class of actions identified in the Draft MNES Program in accordance with section 146B of the EPBC Act.

The Draft MNES Program identifies the controlling provisions relevant to the Proposal.

A range of Commonwealth and State legislation, policies, strategies and plans (referred to as key legislation and guidance) applies to the Proposal. This Draft IAR and the Draft MNES Program has been developed in accordance with key environmental legislation and guidance where relevant, and provides a validation framework which includes a process to consider contemporary guidance. Further information of the MNES Program is provided in Section 8.6, and consideration of key legislation and guidance is provided in Appendix 2.

The environmental assessment and approval process that applies to strategic assessments under the EPBC Act is provided in Figure 2. A description of the key documents is provided in Section 2.2.

2.2 Key Assessment Documents

The Proposal comprises three key documents:

- The Agreement between BHP Billiton Iron Ore and the Commonwealth Minister for the Environment under section 146 of the EPBC Act (Appendix 1);
- The Draft MNES Program (BHP Billiton Iron Ore 2016), which identifies the key commitments and undertakings of BHP Billiton Iron Ore for the protection and management of Controlling Provisions under the EPBC Act; and
- This Draft IAR, which provides details of the potential impacts of the implementation of the Proposal.

The Agreement was made publicly available for comment from 17 November 2012 to 18 January 2013.

This Draft IAR presents the findings of the environmental impact assessment undertaken to evaluate the potential impacts to MNES from the implementation of the Proposal. The Draft IAR will be considered by the Minister when deciding whether to endorse the Draft MNES Program.

MNES that have potential to be impacted significantly through implementation of the Proposal are known as Specified Protected Matters. This Draft IAR considers the following impacts to the Specified Protected Matters:

- Direct impacts: a direct result of an activity. For example, clearing of vegetation and removal of overburden prior to mining directly results in the loss of habitat.
- Indirect impacts: a result facilitated but not directly caused by an activity. For example, lowering of the water table in wetlands from dewatering activities at a mine in a hydrologically connected aquifer.

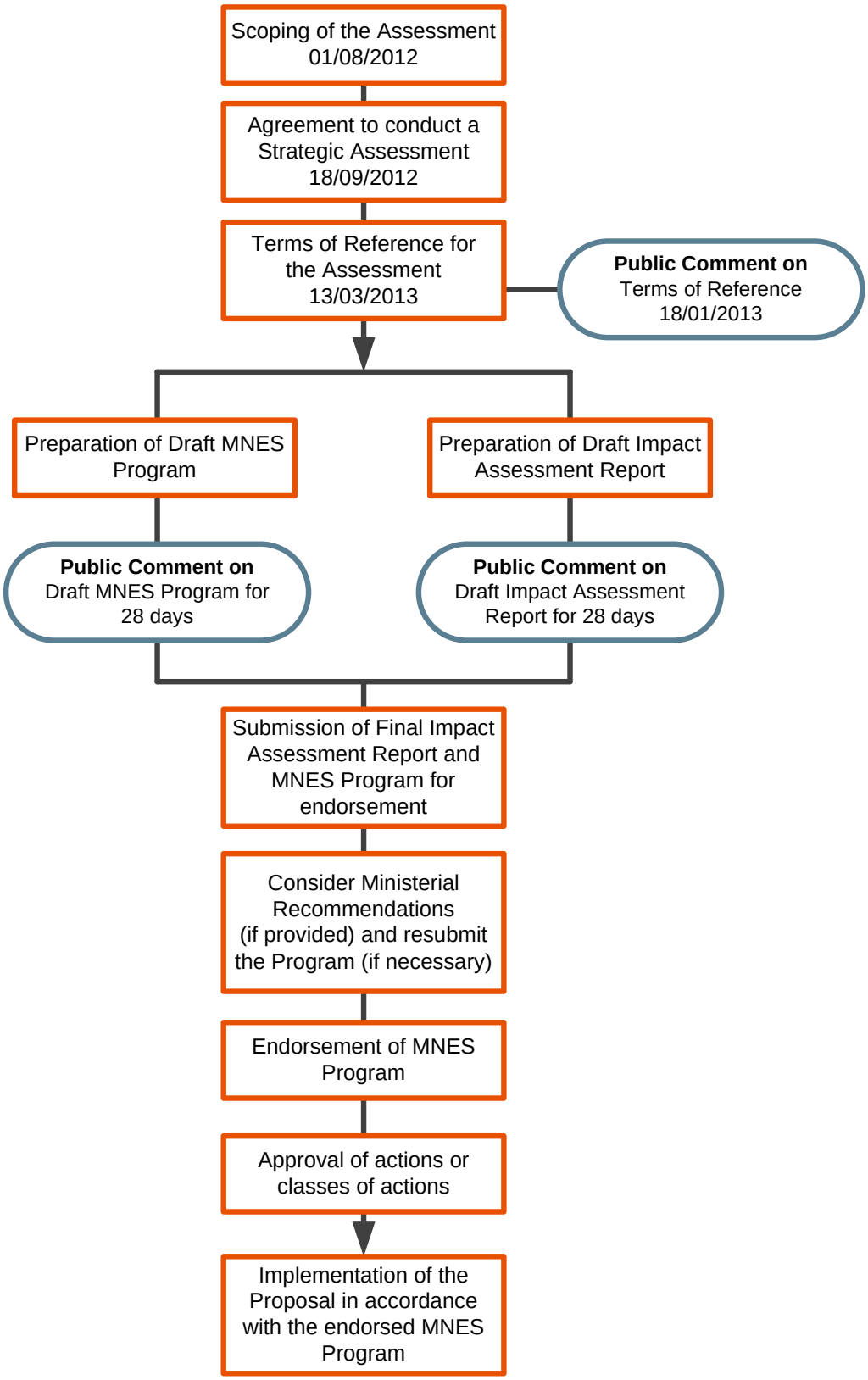


Figure 2: The Commonwealth strategic assessment process

- Local impacts: impacts at the scale of a local activity, e.g. the zone of impact of a particular activity or a particular operation (e.g. an existing or future mine).
- Regional impacts: impacts at the scale of the bioregion or of the entire distribution of a species.
- Cumulative impacts: the aggregate impacts (both direct and indirect) on a given receptor, ecosystem, or population centre of past, present and reasonably foreseeable future activities as a result of both BHP Billiton Iron Ore and third-party operations.

BHP Billiton Iron Ore has responsibilities under the MNES Program, which has been developed to meet the objects of the EPBC Act. BHP Billiton Iron Ore is also required to satisfy the Endorsement Criteria outlined in the Agreement (Appendix 1) between BHP Billiton Iron Ore and the Commonwealth. The MNES Program identifies the key commitments and undertakings of BHP Billiton Iron Ore for the protection and management of MNES protected under the EPBC Act. Specifically, the MNES Program:

- Describes the 'policy, plan or program' as required pursuant to Part 10 of the EPBC Act and the Agreement;
- Demonstrates how the MNES Program will ensure that the Proposal will be implemented in a manner consistent with the EPBC Act;
- Outlines the commitments and processes that BHP Billiton Iron Ore will undertake to meet EPBC Act requirements;
- Provides the basis for ministerial endorsement of the MNES Program pursuant to the Agreement; and
- Provides the basis for ministerial approval of actions and classes of actions that are required to implement the Proposal and that will be undertaken in accordance with the Endorsed MNES Program.

The Draft MNES Program has been developed in accordance with *A Guide to Undertaking Strategic Assessments* (Commonwealth of Australia 2013) and is the result of consultation between BHP Billiton Iron Ore and the DotE.

Key to the implementation of the Endorsed MNES Program is BHP Billiton Iron Ore's commitment to develop an Assurance Plan and Offsets Plan and prior to implementing a Material Action. A Material Action is an activity that is considered likely to have an impact on a MNES, and determined by specific thresholds. The process for determining these thresholds will be described in an Assurance Plan (see Section 8.6.1 for further detail).

The Draft MNES Program includes a Validation Framework to ensure that potential impacts to MNES are managed to an acceptable level through the application of the mitigation hierarchy (firstly avoid, then mitigate, and, if ultimately required, offset). The acceptability of impacts to Specified Protected Matters will be informed by MNES Management Outcomes (specific, measureable performance outcomes for the Specified Protected Matters) provided in the Assurance Plan, which is updated every five years.

Part of the Validation Framework is a key non-statutory process step known as Notice of Intent to Proceed, which occurs prior to a Material Action being taken under the Endorsed MNES Program and the Class of Actions approval. The Notice of Intent to Proceed is a document that BHP Billiton Iron Ore will issue to the DotE or equivalent department, which details the location and activity that will be undertaken in implementing the Material Action and a demonstration that BHP Billiton Iron Ore will comply with the MNES Program (via the Implementation Plans) in taking the Material Action. Processes for ongoing auditing, monitoring, corrective action and reporting on MNES Management Outcomes are also provided in the MNES Program. Key components of the MNES Program are described further in Section 8.6.

This Draft IAR has been developed so that, together with the Draft MNES Program, the Proposal will meet the Terms of Reference in the Agreement (Appendix 1) for the Minister to make a decision on whether to endorse the MNES Program.

2.3 Peer Review Process

An external panel of peer reviewers was engaged to critique and provide advice on the technical work underpinning the Proposal. Members of the Peer Review Panel were selected based on experience and reputation to provide independent advice across a range of technical and strategic content that supports the Draft MNES Program and this Draft IAR. Specifically, the peer reviewers were engaged to:

- Provide guidance and ensure the strategic assessment process is robust and transparent;
- Provide input as to the adequacy of studies, including the cumulative impact assessment (CIA) (Eco Logical 2015b), that has informed this Draft IAR;
- Provide input on the impact assessment interpretation, including modelling;
- Provide independent expertise and input into the state and Commonwealth strategic environmental assessment processes;
- Provide input on the suitability of management measures proposed within the Draft MNES Program; and
- Provide guidance on the Draft MNES Program and the Draft IAR in meeting the requirements of the EPBC Act, including the Agreement (Appendix 1).

The peer reviewers that participated in review of the strategic assessment documentation are listed in Table 1.

Table 1: Proposal peer review panel

Membership	Expertise relevant to the Proposal
Dr Larry Canter (USA)[1]	Cumulative impact assessment and global perspective on best practice
Mr. Warren Tacey	Regulatory experience and local context
Dr Chris Moran	Cumulative impact assessment modelling approach
Dr Mike Bamford	Northern quoll
Dr Rick Southgate	Greater bilby
Dr Mark Fitzgerald	Pilbara olive python
Dr Kyle Armstrong	Pilbara leaf-nosed bat
Dr Eddie van Etten	Hamersley lepidium
Dr Doug Brown	Hydrology[2]
Dr Libby Mattiske	Ecohydrology[2], regulatory experience and local context

1. Dr Canter was involved during the formative stages of the strategic assessment to provide high-level, strategic guidance on cumulative impact assessment.
2. Hydrology and ecohydrology assessments were an input into the cumulative impact assessment model for Specified Protected Matters, and the assessment of potential future wetlands of international significance.

2.4 Stakeholder and Community Engagement

BHP Billiton Iron Ore undertakes regular and ongoing stakeholder engagement as part of its core business activities. BHP Billiton's Community Group Level Document sets out the Company's approved mandate and minimum performance requirements for community engagement (BHP Billiton 2015). BHP Billiton aims to facilitate regular, open and honest dialogue to understand expectations, concerns and interests of stakeholders and incorporate them into business planning to help build strong, mutually beneficial relationships.

During development of the Proposal over the past three years, BHP Billiton Iron Ore has undertaken targeted stakeholder and community engagement based on interest and proximity to the project location. A summary of the key stakeholders identified for the Proposal is provided in Table 2.

BHP Billiton Iron Ore has also committed within the Draft MNES Program to undertake stakeholder engagement activities during implementation of the MNES Program.

Table 2: Proposal key stakeholders

Stakeholder Group	Key Representatives or Members
Commonwealth Government	
Ministers	Minister for the Environment (Decision Making Authority for the Proposal)
Departments	Department of the Environment (formerly DSEWPaC)
Commonwealth Members	Key Commonwealth Members, WA Commonwealth Members, WA Senators
State Government	
WA Ministers	Premier, Minister for State Development Minister for Environment; Heritage Minister for Mines and Petroleum Minister for Water Minister for Regional Development; Lands Other ministers as required
Government-owned Corporations and Organisations	Pilbara Development Commission
Opposition	Leader of the Opposition; Shadow Ministers; other relevant members
Elected Representatives	Member for Pilbara Members for Mining and Pastoral Region

Stakeholder Group	Key Representatives or Members
Agencies and Departments	Department of Environment Regulation Department of Parks and Wildlife Department of Aboriginal Affairs Department of Mines and Petroleum Department of Planning Department of Premier and Cabinet Department of Regional Development Department for State Development Department of Transport Department of Water Office of the Environmental Protection Authority / EPA Port Hedland Port Authority
Local Government	
Local Organisations	Pilbara Regional Council
Towns and Shires	Town of Port Hedland Shire of East Pilbara Shire of Ashburton
Community	
Community Groups and Associations	Newman Community Consultative Group Port Hedland Community Consultative Group Newman Visitor Centre
Local Residents	Newman community Port Hedland community Jigalong and other Indigenous communities
Traditional Owners, Native Title Claimants, and Representative Bodies	Banjima Native Title Aboriginal Corporation (BNTAC) Banjima Implementation Committee Kariyarra people Karlka Nyiyaparli Aboriginal Corporation Nyiyaparli Implementation Committee Ngarlawangga people Palyku people Yinhawangka Aboriginal Corporation Yinhawangka Implementation Committee Yamatji Marlpa Aboriginal Corporation (YMAC)
Non-Government Organisations (NGOs)	
Environment NGOs	Care for Hedland Environmental Association CSIRO Conservation Council of Western Australia Gondwanalink Greening Australia Rangelands Natural Resource Management Group Wildflower Society of Western Australia

Stakeholder Group	Key Representatives or Members
Industry	
Peak Bodies	Chamber of Minerals and Energy Newman Chamber of Commerce and Industry Port Hedland Chamber of Commerce and Industry
Industry Association	Association of Mining and Exploration Companies
Landholders	
Landholders	Pastoral lease holders and managers
Media	
News Media	National, state and local news media (particularly, *The Australian*, *The West Australian*, *Pilbara Echo*, *North West Telegraph*)

3 SCOPE OF THE PROPOSAL

This chapter defines the scope of the Proposal, in particular the spatial limit of the Proposal (the Strategic Assessment Area) and the activities proposed.

3.1 Approval Holder

The MNES Program applies to:

- all activities (Section 3.3) associated with assets of BHP Billiton Iron Ore within the Strategic Assessment Area (Section 3.2) except those in Section 3.4; and
- all activities (Section 3.3) associated with assets divested by BHP Billiton Iron Ore for which a Notice of Intent to Proceed has been issued to the Department or determined not to be a Material Action (Section 8.6.2).

The MNES Program outlines a process that applies to divestment of assets to other owners within the scope of the Proposal.

3.2 The Strategic Assessment Area

The Strategic Assessment Area has been defined to encompass future operations within existing BHP Billiton Iron Ore tenure, as well as potential future tenure. The boundary of the Strategic Assessment Area is shown in Figure 1.

3.3 Actions and Class of Actions within the Scope

Subject to express exclusions outlined in Section 3.4, proposed activities undertaken within the boundary of the Strategic Assessment Area (as shown in Figure 1) that are considered within the scope of the Proposal include:

- all activities directly or indirectly associated with the development of new iron ore mines and associated infrastructure within the Strategic Assessment Area.
- all activities directly or indirectly associated with the expansion of existing iron ore mines and associated infrastructure and their use within the Strategic Assessment Area.
- all activities associated with decommissioning, rehabilitation and/or closure of an iron ore mine issued with a Notice of Intent to Proceed within the Strategic Assessment Area.

These activities may be implemented anywhere within the Strategic Assessment Area, subject to the exclusions in Section 3.4 and compliance with the MNES Program.

BHP Billiton Iron Ore is committed to limiting the direct disturbance footprint within the Strategic Assessment Area to a maximum of 110,000 ha excluding those matters in Section 3.4. This is the upper limit of disturbance for all actions implemented in accordance with the MNES Program. The MNES Program does not apply to any direct disturbance activity that occurs beyond 110,000 ha.

The Draft IAR considers the potential direct, indirect and cumulative impacts to the Specified Protected Matters as a result of the above actions or class of actions within scope. Potential indirect impacts resulting from secondary actions (actions that are not within the scope of the Proposal but that may be reasonably associated with the Proposal) are addressed in Section 5.5.

3.4 Exclusions from the Scope

Approval is not being sought for the following activities within the Strategic Assessment Area:

- activities in any existing National Park, including Karijini National Park, as shown on Figure 1; and
- activities associated with any existing BHP Billiton Iron Ore operations and infrastructure that has been previously approved.

Activities north of 26 km rail-chainage mark, including BHP Billiton Iron Ore's existing operations at Port Hedland and the Goldsworthy rail line from Port Hedland to and including Yarrie, do not occur within the Strategic Assessment Area.

3.5 Typical Iron Ore Mining

This section describes the types of activities and infrastructure characteristics of BHP Billiton Iron Ore's Pilbara iron ore mines to describe the conceptual basis used to determine potential impacts associated with the Proposal. The components of a typical mining operation approved under the Proposal may include additional developments and/or activities. Irrespective of the development and activity that occurs, BHP Billiton Iron Ore will work towards the MNES Program objective for activities within its control.

3.5.1 PRECONSTRUCTION: CLEARING AND GROUND DISTURBANCE

The clearing of vegetation and preliminary earthworks are usually early steps in the development of a new mine or piece of supporting infrastructure. Land disturbance is currently managed in accordance with a standard BHP Billiton Iron Ore land disturbance procedure Box 2.

This process will continue into the future, either in its current form or via an equivalent standard operating procedure that will be developed to manage disturbance. The current procedure is designed to manage environmental, heritage, land tenure and legal commitments prior to and during land clearing. The procedure is the mechanism whereby project-specific technical and professional advice, such as topsoil management measures, can be captured and implemented.

Box 2: BHP Billiton Iron Ore's standard procedure for ground-disturbing activities

BHP Billiton Iron Ore uses a standard operating procedure to manage all ground-disturbing activities and thus identify and manage environmental, Aboriginal heritage, land access and legal commitments prior to and during land clearing. The standard operating procedure provides a mechanism for the consideration of technical and professional advice. The objectives of the standard operating procedure are to:

- identify the significant environmental, Aboriginal heritage and land access aspects of BHP Billiton Iron Ore operations;
- ensure that, through appropriate management, BHP Billiton Iron Ore's project activities comply with all legislative and regulatory requirements, industry standards and codes of practice;
- minimise the number and nature of incidents related to environmental, Aboriginal heritage and land access

and thus improve the environmental performance of BHP Billiton Iron Ore;

- provide improved planning and management at BHP Billiton Iron Ore's projects and operations; and
- ensure that requirements of long-term planning, in particular closure and final rehabilitation, are taken into account at the planning stage.

BHP Billiton Iron Ore currently uses an electronic workflow process linked to a GIS to approve all new land clearing on site. The electronic system is accessible by all employees via the BHP Billiton Iron Ore portal homepage on the corporate intranet and is used by employees conducting site-based planning activities. The standard operating procedure is backed by a strong governance team and dedicated competency-based training.

3.5.2 CONSTRUCTION ACTIVITIES

The anticipated construction phase for a typical mining operation is approximately 30 months. The construction phase would generally involve land clearing and bulk earthworks, installation of infrastructure and prestripping activities in preparation for mining.

Key activities include construction of laydown areas, borrow pits, roads, concrete batch plant, non-processing infrastructure, power and water distribution facilities, primary crushing facilities, ore handling plant, stockyard, train load-out facilities, overland conveyors and the rail loop. Towards the end of the mine construction phase, major infrastructure components (e.g. the ore handling plant) would be tested and commissioned.

Clearing of vegetation is usually required (although not always in the case of an expansion of existing operations). Cleared vegetation and soils are stockpiled for later use in rehabilitation activities around the site to aid in the return of vegetation and creation of fauna habitat.

The construction phase includes prestripping the first pit. Ore encountered during prestrip may be preferentially stockpiled on the primary crusher run-of-mine pads or on approved disturbance areas until the ore handling plant is commissioned. Overburden is used for construction purposes (preferentially to opening borrow pits) or stockpiled within overburden storage areas (OSAs).

3.5.3 MINING OPERATIONS

MINING DESCRIPTION

Mine Planning

Individual mine plans will be developed based on detailed resource definition, market conditions and the interaction of the mine as part of BHP Billiton Iron Ore's integrated Pilbara mining operations.

Mining Method

Mining would likely follow conventional open-cut iron ore mining methods used in the Pilbara (Figure 3 and Plate 2). Future technological advances (e.g. continuous mining) may result in changes to contemporary mining methods.

The general method involves the mining of ore and overburden using conventional drill, blast, load and haul. Following blasting, the unprocessed, broken ore (the run-of-mine) and overburden could be loaded by hydraulic excavators or front-end loaders to dump trucks. Ore may be transported to run-of-mine pads for primary crushing or may be placed in low-grade ore stockpiles. Overburden could be either retained within the pit for use as in-fill or removed from the pit area to out-of-pit OSAs.

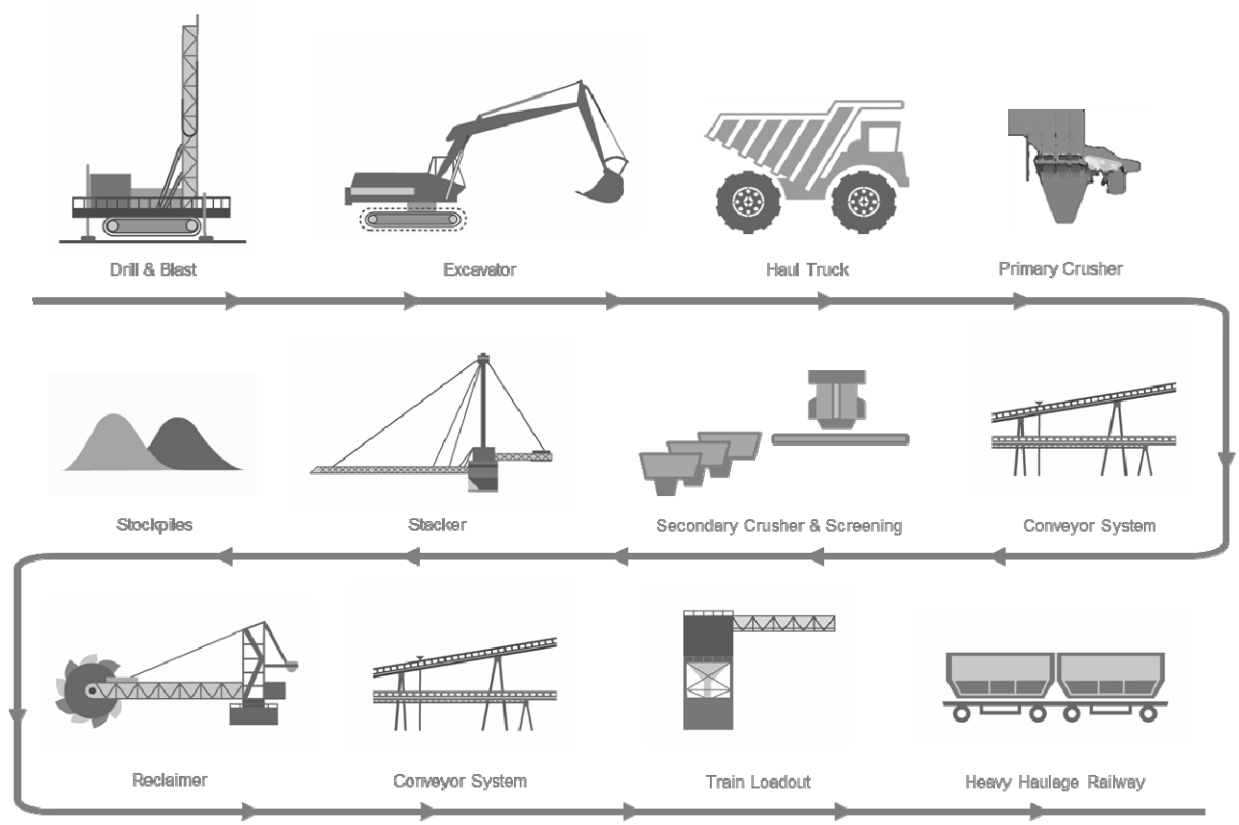


Figure 3: Components of a typical mining operation

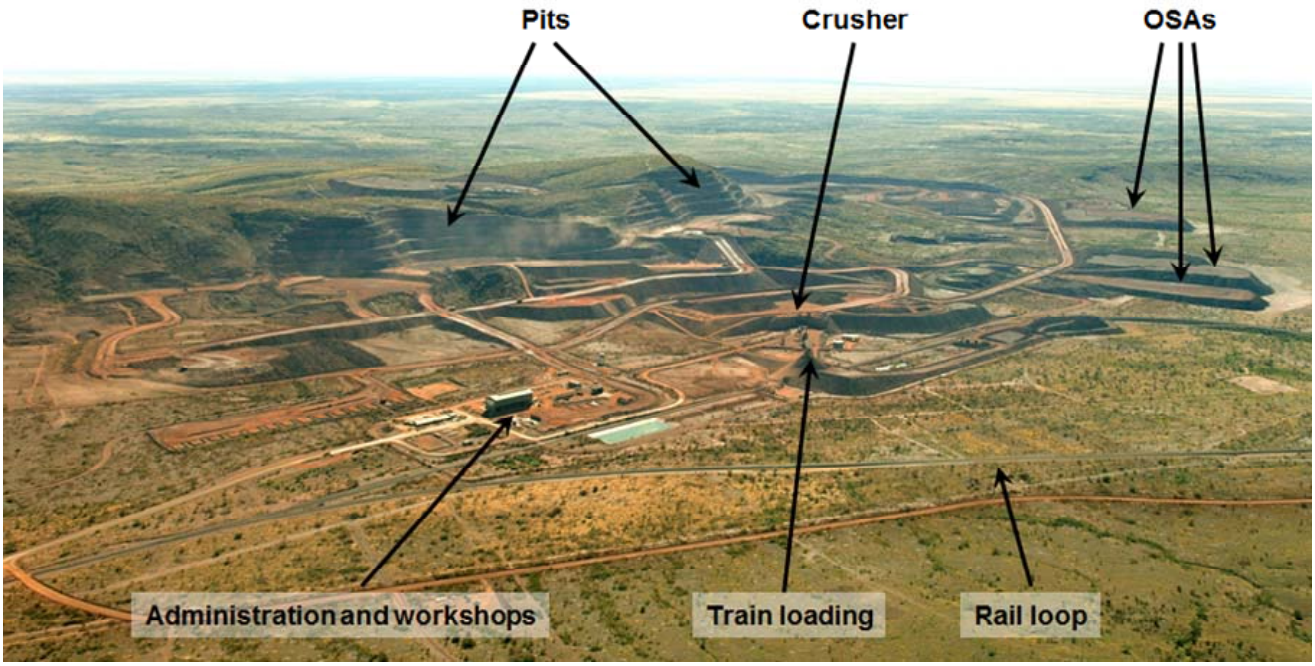


Photo: BHP Billiton Iron Ore

Plate 2: Mine layout overview

Open pits will be selectively mined in accordance with the site mine plan. Mining will generally occur both above and below the water table. Mining operations could be conducted for up to 24 hours per day, seven days per week.

Blasting

Pit benches will be drilled and blasted to the required depth. The number of holes and the quantity and type of explosives will be adjusted to suit the rock conditions and design objectives of the blasts. Based on current practices, the main explosives will be ammonium nitrate fuel oil and bulk blasting emulsion products. Future technological advances may result in changes to contemporary blasting methods.

Mine Fleet

The mobile mining fleet may comprise haul trucks (Plate 3), excavators, front-end loaders, drill rigs and ancillary vehicles, including dozers, water carts and graders. The actual type and number of mobile mining fleet vehicles will vary during the mine life, depending on such factors as the number and location of open mining areas, mining rate, and ore and overburden characteristics.

Photo: BHP Billiton Iron Ore

Plate 3: Haul truck

Mine Dewatering

To access ore below the water table, production bores and in-pit sumps may be used to dewater the open pits. The dewatering pumping rates are likely to fluctuate in response to aquifer characteristics, the mine plan,

operational water demands and weather conditions. In-pit pumping, conducted seasonally to remove incidental stormwater, may be used in addition to the dewatering pumping.

Abstracted water may be required for such activities as dust suppression, mine water supply and environmental purposes. Options for disposal of excess water include managed aquifer recharge, surface discharge and water sharing with other nearby mines or agreed end-users. Management options will be detailed in a regional water management plan. Dewatering of pits ahead of mining may also be required, depending on their depth to groundwater.

Overburden Storage

Storage of overburden is required from the prestrip period of construction throughout operations. OSAs are shaped as mining progresses and remain in place at closure as part of the final landform. Overburden from operational pits could be used to in-fill mined-out portions of the pits where mine scheduling allows. These are referred to as in-pit OSAs. Where this is not possible, the overburden could be placed in out-of-pit OSAs. OSAs will be constructed to a site-specific defined maximum height.

Preliminary construction designs would generally be benches and berms. Final batter slopes are unlikely to be greater than approximately 20 degrees. Final OSA designs would be informed by ongoing materials characterisation and rehabilitation programs.

ORE PROCESSING, STOCKPILING AND TRANSPORT

Mined ore would be hauled from the open pits to the nearest primary crushing facilities. Overland conveyors are one option to transport the ore from the primary crushers to a coarse ore stockpile, located adjacent to the centralised ore handling plant. After crushing and screening, ore could be conveyed to a stockyard located near the train load-out facilities from where it would be loaded onto trains for transport to BHP Billiton Iron Ore's Port Hedland port facilities.

Primary Crushers and Overland Conveyors

The primary crushers would generally be located adjacent to the open pits. Haul trucks could then feed ore into the run-of-mine bin located over the crusher. The crushed ore could then be fed onto the overland conveyor system linking the primary crushers to the coarse ore stockpile.

Ore Handling Plant

The coarse ore stockpile would generally receive ore from one or more primary crushers and may be located adjacent to the ore handling plant (Plate 4). The ore handling plant may comprise scalping screening, product screening and secondary crushing units. Ore would be crushed and screened to fines (ore crushed to around 6 mm in size) or lump (around 6 to 30 mm in size) 'products'.

Some ore may be classified as 'low grade' due to impurities and may be transported to low-grade ore stockpiles for beneficiation. The beneficiation process may involve washing the low-grade ore to remove impurities to achieve customer specifications. Tailings material generated by this process would be stored in a tailings storage facility.

Ore Stacking, Reclaiming and Loading

Generally, two ore stacking circuits (lump and fines) would receive ore from the ore handling plant and discharge it onto separate stockpiles via luffing or slewing stackers (Plate 5). Ore could be reclaimed from the stockyard using a bucketwheel reclaimer and then be discharged via the train load-out feed conveyor to the train load-out bin. The train load-out may consist of a mass flow bin located on a single rail loop. Both lump and fines material could be loaded through the bin, which would generally be designed to fully empty between products.

Photo: BHP Billiton Iron Ore

Plate 4: Typical ore handling plant

Photo: BHP Billiton Iron Ore

Plate 5: Stockpile with stacker and reclaimer

Ore Transport (Rail)

Operations are anticipated to utilise the existing rail network (Plate 6), as well as new spur lines and potential additional parallel expansions to the existing alignments to transport processed ore to port facilities for export. Ore would be loaded onto trains at the train load-out facilities at each typical mining operation and transported off-site.

Photo: BHP Billiton Iron Ore

Plate 6: BHP Billiton Iron Ore rail infrastructure

3.5.4 NON-PROCESS INFRASTRUCTURE, SERVICES AND FACILITIES

ADMINISTRATION, WORKSHOP AND AUXILIARY FACILITIES

Administration Buildings

The administration buildings would provide air-conditioned offices and facilities for administration and operational staff. The buildings are likely to be a conventional modular transportable design.

Workshops and Other Areas

Workshop and warehouse buildings and associated hardstand areas may be installed to provide fixed plant and mobile equipment maintenance facilities, hydrocarbon storage, heavy and light vehicle wash down areas, and laydown areas for equipment and consumable storage. A sample preparation and laboratory building may also be installed.

A mine access security gatehouse, concrete batch plant, communication facilities and turkey's-nest dams would typically be required within the mine site.

Accommodation

Dedicated worker accommodation may be constructed to service one or more mining operations. The accommodation is typically single-person rooms with common administration, medical, dining, recreation and laundry facilities. Accommodation could be for 300 to over 1,500 people.

Roads

Future mine access roads would connect new or expanded mines to the existing road network. Intra-mine roads would include a network of heavy-vehicle haul roads and light-vehicle access roads and tracks.

Power

Power is likely to be supplied to most typical mining operations (though not necessarily all) by the existing BHP Billiton Iron Ore Pilbara power grid, which is connected to the Newman gas-fired power station. Power requirements for process and non-process infrastructure may be distributed from a centralised substation and switchyard. Power from the substation could be transferred by either overhead or underground cable where necessary. Power during construction may be supplied by temporary on-site diesel generators. Future technological advances may result in alternate power supply sources if they become available and are feasible.

ENVIRONMENTALLY HAZARDOUS GOODS AND MATERIALS

Potential environmentally hazardous and dangerous goods that may be transported, handled and disposed of include but are not limited to diesel, oils and lubricants, coolant, detergents, paints and explosives. Mining may also expose potentially acid-forming material that will require appropriate assessment, handling and management.

Fuel and Hydrocarbon Storage

The typical mining operation assumes a diesel-based transport system for the purpose of the impact assessment. The bulk fuel requirements may be transported to site via train and decanted at a dedicated fuel unloading facility located adjacent to the rail spur.

The main on-site diesel fuel storage tanks would generally be located in the non-processing infrastructure area. Oil, lubricant and coolant storage tanks and facilities may also be installed in this area. All hydrocarbon storage areas would be designed and constructed in accordance with relevant Australian standards.

Future improvements to current diesel-based technologies may result in alternate energy sources or consumption efficiencies.

Explosive Storage

Current blasting technology involves the use of ammonium nitrate fuel oil. Separate explosive storage areas would be located within the mining operation. Explosive storage areas (whether for ammonium nitrate fuel oil or a future technology) would be designed and constructed in accordance with relevant Australian standards.

3.5.5 WASTE MANAGEMENT

Waste materials at a future operation would generally include sewage and effluent, scrap metal, non-metal scrap (e.g. piping, plastic, fibreglass or wood), general refuse, putrescible wastes, tyres, conveyor belts and packaging wastes.

Generally, on-site landfill facilities would be used for the disposal of putrescible and inert waste. Controlled wastes would be collected and transported off site for disposal at a licensed facility in accordance with the Environmental Protection (Controlled Waste) Regulations 2004 or compliance requirements appropriate at the time.

Based on current technology, a typical mining operation may utilise a centralised wastewater treatment plant with lined evaporation ponds for the processing of domestic sewage and wastewater. An irrigation field or other disposal option may also be used. Smaller package wastewater treatment plants and evaporation ponds may also be installed. Solids removed from the wastewater treatment plants would be carted to treated sewage drying beds.

All waste would be managed in accordance with the Environmental Protection Regulations 1987 or future relevant legislation.

3.5.6 WATER MANAGEMENT

WATER DEMAND AND SUPPLY

Water may be required for a combination of potable uses, construction, ore conditioning, dust suppression and other operational purposes. Potable water supply may be sourced from bores established within or near to the project area. A water treatment plant may be installed, if necessary, to treat the water to potable standard.

Water abstracted through dewatering of the deposits would be preferentially used to meet mine water demands. Should there be discrete periods where mine dewatering rates are insufficient to meet the raw water demand; alternative water supplies may be accessed. Potential alternative water sources may include excess water from other mines in the region or water from borefields established in nearby iron ore deposits or local aquifer systems.

The construction of bores, abstraction of water and its use will be managed under the Country Areas Water Supply (Clearing Licence) Regulations 1981, Country Areas Water Supply By-laws 1957 and Rights in Water and Irrigation Regulations 2000 or future relevant legislation.

SURPLUS WATER MANAGEMENT

Various options for managing the surplus water generated during mine dewatering may be considered. The method of surplus water management would depend on the outcome of further technical investigations and feasibility studies. BHP Billiton Iron Ore also supports, in principle, water-sharing agreements, provided this option is economically, socially and environmentally acceptable and in line with approval conditions.

DRAINAGE AND STORMWATER MANAGEMENT

The objective of the water management system during operations is to manage all potentially contaminated water generated within the project area, while diverting all other surface water around infrastructure, landforms and open pits areas, where practicable.

Drainage across the project area may be managed using diversion channels, protective bunds around open pits, OSAs or specifically engineered infrastructure. Based on current practice, drainage may be designed to convey surface waters generated by events of up to a 1:100-year average recurrence interval rainfall event.

All major plant and facilities would generally be constructed at an elevation above or protected against a 1:20-year average recurrence interval flood level as a minimum. On-site drainage designs would be used to ensure stormwater within infrastructure areas is appropriately managed. Infrastructure such as roads and the rail loop would be constructed with culverts or another suitable method to manage water flows.

Potentially contaminated water (e.g. washdown water) would be contained and treated before being reused or discharged.

Water pumped from open pit sumps may be directed to nearby sedimentation basins prior to being used for operational purposes or released. Seasonal stormwater may need to be discharged directly to the surrounding environment should the pit pumping rate exceed the design capacity of the sedimentation basins.

3.5.7 CLOSURE AND DECOMMISSIONING

Mine closure and decommissioning requires consideration and planning of:

- earthworks
- surface treatments
- rehabilitation; and

- site contamination

Rehabilitation earthworks aim to re-profile the land surface to create landforms that are consistent with the surrounding landscape, within the constraints imposed by the physical nature of the materials. This may further require surface water management which could include the construction of compacted bunds along the crest of the overburden storage area to prevent surface water runoff.

To facilitate stability and revegetation potential, a number of surface treatments may be used, depending on the size and nature of the area. Typical treatments may consist of one or more of the following:

- deep ripping of compacted surfaces;
- selective application of topsoil material (or alternative growth media) to provide a medium to support plant growth;
- surveyed contour ripping or scarifying of surfaces following the application of soils to maximise water infiltration and enhance revegetation success; and
- selective placement of logs or smaller woody debris and/or boulders (if available) across the re-profiled surface and/or constructing rocky cliff features (where potential exists) to provide additional habitat areas for fauna species recorded prior to mining.

Typically revegetation will use local provenance native seed (from the local area, but as a minimum from within 100 km of the rehabilitation site) consistent with vegetation associations and native species recorded in the mine area prior to mining. To promote vegetation density, species diversity and plant age heterogeneity, additional seeding (in subsequent years) is typically conducted if required.

In areas where the potential for soil contamination is identified, assessment is typically managed in accordance with legislative requirements including sampling/analysis and remediation/management.

4 EXISTING ENVIRONMENT

This chapter presents a high-level overview of the existing environment in the Pilbara region with a focus on the Strategic Assessment Area. Current knowledge of the Strategic Assessment Area and data relevant to the Proposal includes BHP Billiton Iron Ore's data; other Pilbara proponents' survey data; and data generated by scientists, researchers and regulators within the region. BHP Billiton Iron Ore has been operating in the Pilbara for over 50 years and has a wealth of environmental and social information that has been used in the development of this Draft IAR.

More detailed descriptions of characteristics of the environment applicable to the Specified Protected Matters are provided in Section 5.3.

4.1 Bioregional Context

The Interim Biogeographic Regionalisation for Australia (IBRA) (DSEWPaC 2012a) recognises 89 distinct bioregions in Australia based on climate, geology, landform, native vegetation and species information. BHP Billiton Iron Ore's current granted mining tenures fall within the Pilbara bioregion. A small proportion of the Strategic Assessment Area falls outside the Pilbara bioregion, extending south into the Gascoyne and east into the Little Sandy Desert bioregions.

The bioregions and subregions within the Strategic Assessment Area are listed in Table 3 and are shown in Figure 4. Each of the bioregions and subregions are discussed briefly below.

Table 3: Bioregions and subregions of the Strategic Assessment Area

Bioregion	Subregion	Proportion of the Strategic Assessment Area
Pilbara	Chichester (PIL1)	14%
	Fortescue (PIL2)	21%
	Hamersley (PIL3)	43%
	Roebourne (PIL 4)	<1%
Gascoyne	Ashburton (GAS1)	7%
	Augustus (GAS3)	14%
Little Sandy Desert	Trainor (LSD2)	1%

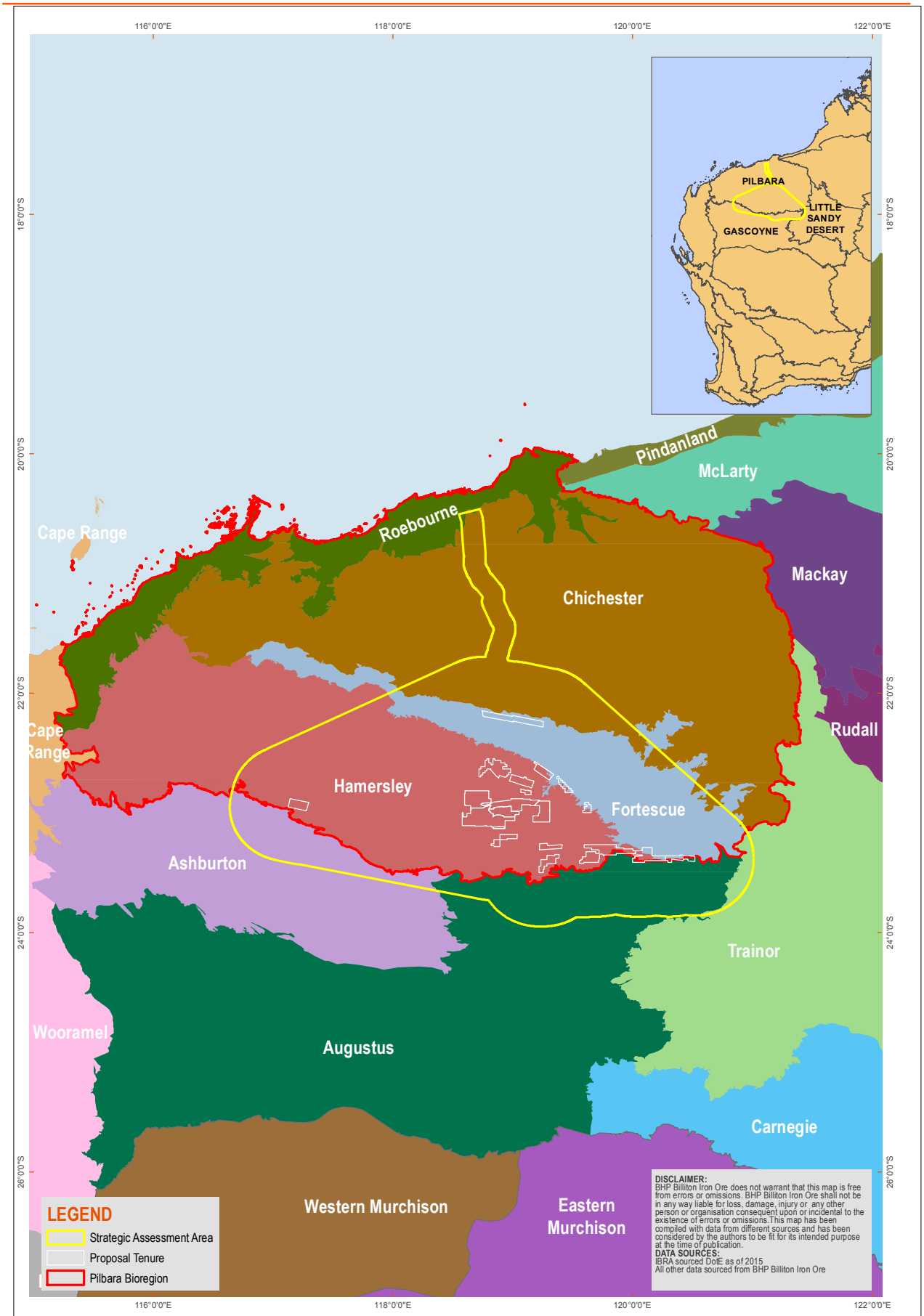


Figure 4 Biogeographic subregions across the Strategic Assessment Area

4.1.1 PILBARA BIOREGION

The Pilbara bioregion, which is where the majority of the Proposal will be implemented, is composed of four subregions: Hamersley, Fortescue, Chichester and Roebourne. The Roebourne subregion does not overlap the Strategic Assessment Area. The Pilbara bioregion is an area of approximately 178,000,000 ha within the Pilbara Craton.

The Pilbara Craton comprises a portion of the ancient continental Western Shield that dominates the geology of Western Australia, with active drainage occurring in the Fortescue, De Grey and Ashburton river systems (CALM 2003). Vegetation consists predominantly of mulga low woodlands or snappy gum over bunch and hummock grasses (Bastin & ACRIS Management Committee 2008) covering red deep sands and sandy red earths (Tille 2006). Climatic conditions are semi-desert tropical, with an average rainfall of 300 mm, falling mainly in summer cyclonic events (CALM 2003).

The Pilbara bioregion is characterised by biodiversity levels that are considered to be among the richest in the world. Geological, altitudinal and climatic diversity is potentially related to the high level of observed species diversity and endemism across the bioregion, which has subsequently been recognised by the DotE and others as one of Australia's 15 biodiversity hotspots (DotE 2014d). This distinct heterogeneity is related to its transitional location between the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions and to the range of geological, altitudinal and climatic elements that influence the region. The combination of geophysical factors yields a high diversity of floral and faunal habitats occupied by biological communities of similarly high diversity and high levels of regional endemism.

The Hamersley subregion (PIL3) of the Pilbara bioregion is 5,634,727 ha in area (DotE 2012) and is a mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges of basalt, shale and dolerite (Kendrick 2001a) (Plate 7). Mulga low woodland over bunch grasses on fine-textured soils dominate in valley floors, while on the skeletal soils of the ranges snappy gum (*Eucalyptus leucophloia*) over *Triodia brizoides* predominate (Kendrick 2001a; Garnett & Crowley 2000). Drainage is typically into either the Fortescue River to the north, the Ashburton River to the south, or the Robe River to the west (Kendrick 2001a).

Photo: BHP Billiton Iron Ore

Plate 7: Hills and drainages common within the Hamersley subregion

The Fortescue Plains subregion (PIL2) is located north and east of the Hamersley subregion and is 1,951,435 ha in size (DotE 2012). The subregion is characterised by alluvial plains and river frontages. Extensive salt marsh, mulga-bunch grass, and short grass communities occur on alluvial plains in the east (Kendrick 2001b). River gum woodlands fringe the drainage lines. This is the northern limit of mulga *(Acacia aneura*). An extensive calcrete aquifer (originating within a palaeodrainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of river gum and cajuput woodlands.

The Chichester subregion (PIL1) forms the northern part of the Pilbara Craton, has an area of 8,374,728 ha (DotE 2012) and is the largest subregion of the Pilbara bioregion. Basalt plains divided by Archaean granite include substantial areas of basaltic ranges. *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands characterise the shrub-steppe of the plains with tree-steppes of *Eucalyptus leucophloia* found on the ranges. The subregion's semi-desert tropical climate receives approximately 300 mm of annual rainfall (Kendrick & Mckenzie 2001).

4.1.2 GASCOYNE BIOREGION

The Gascoyne bioregion spans an area of approximately 18,000,000 ha (DotE 2012) and comprises three subregions: Ashburton, Augustus and Carnegie (CALM 2003); the latter does not overlap the Strategic Assessment t Area. The geology of the region ranges from shales, sandstones and conglomerates of the Ashburton Basin to sandstone, shale and carbonates of the north-western and south-eastern parts of the Bangemall Basin. The Ashburton and Gascoyne river systems and the headwaters of the Fortescue River form broad flat valleys, separated by rugged low Proterozoic sedimentary and granite ranges. Shallow earthy loams over hardpan on the plains give rise to open mulga/snakewood low woodlands with mulga scrub and *Eremophila* shrublands found on the shallow stony loams of the ranges. Hummock grass is found extensively throughout the region. The bioregion's arid climate experiences bimodal rainfall, with tropical monsoon influences in some areas (CALM 2003).

Centres of endemism and high diversity within the Gascoyne bioregion consist of *Eremophila* species on Landor Station; *Ctenophorus yinnietharra* on granites on Yinnietharra Station; *Lerista stictopleura* around the base of Mount Augustus; and troglobitic communities in calcrete aquifers associated with palaeodrainage lines (Desmond et al. 2001). It is also likely that subterranean aquatic fauna within calcrete aquifers are centres of endemism within the bioregion (Desmond et al. 2001).

The Augustus subregion (GAS3) is the largest of the Gascoyne subregions, spanning 9,669,571 ha (DotE 2012). Drainage is provided primarily by the Gascoyne river system, assisted by the headwaters of the Ashburton and Fortescue rivers. Large areas of alluvial valley-fill deposits feature in the subregion with mulga parkland growing on the plains and mulga woodland with *Triodia* occurring on the rises (Desmond et al. 2001).

The Ashburton subregion (GAS1) is largely mountainous with areas of broad flat valleys (Kendrick 2001c). Covering an area of 3,687,030 ha (DotE 2012), it is the smallest subregion of the Gascoyne bioregion. The area has a high diversity of *Eremophila* species. A diverse stygofaunal crustacean fauna occurs in calcrete areas.

4.1.3 LITTLE SANDY DESERT BIOREGION

The Little Sandy Desert bioregion is an area of approximately 11,090,000 ha and consists of two subregions: Rudall and Trainor (DotE 2012); only Trainor subregion is included in the Strategic Assessment Area. Red Quaternary dune fields and Proterozoic sandstone ranges characterise the region, with Savory Creek and Rudall River providing near-permanent wetlands along their courses (CALM 2003). Acacias, *Aluta maisonneuvei* and grevilleas form a shrub steppe, with *Triodia* species found on hummock grassland covering

the red sandy desert and rocky hills of the region. River gums and bunch grasslands can be found in association with the ranges. The bioregion's arid climate experiences episodic summer rainfall.

The Little Sandy Desert bioregion contains a high diversity of arid-zone reptiles, especially *Ctenotus* and *Lerista* species, and of plant species from the *Acacia* and *Goodenia* genera. Centres of endemism may include the palaeodrainage lines associated with Lake Disappointment; however, this is yet to be investigated (Cowan & Kendrick 2001). Lake Disappointment is located outside the Strategic Assessment Area.

The Trainor subregion (LSD2) forms the majority of the Little Sandy Desert bioregion, covering an area of 10,098,580 ha (DotE 2012) and is underlain by a Neoproterozoic sedimentary basement (Officer Basin). The area has dispersed shrub-steppe over *Triodia basedowii* on stony hills with eucalypt and coolibah communities and bunch grasslands on alluvial deposits and drainage lines associated with ranges (Cowan & Kendrick 2001).

4.2 Soil and Landforms

The Strategic Assessment Area occurs within the Hamersley Plateaux Zone of the Fortescue Province of the Western Region of the soil-landscape zones of Western Australia (Tille 2006). The dominant landform features within this zone are rocky ranges and hills and stony plains (Plate 8). Rugged hills, ridges, dissected plateaux and mountains occur on the basalt, banded iron formation and sandstone of the Hamersley Basin, the most notable examples being the Chichester and Hamersley ranges. The Strategic Assessment Area lies within the central Hamersley Range, which, together with the Ophthalmia Range, comprises the majority of the Hamersley Plateau. As the Strategic Assessment Area spans several hundred square kilometres, landforms vary considerably across the area.

Photo: 360 Environmental

Plate 8: View down into the Fortescue Valley from the Hamersley Plateau

Parts of the Strategic Assessment Area are composed of deeply dissected high ridges and hills aligned southeast to northwest. The highest areas of relief occur along the western boundary. The ridges are dissected by numerous large gorges and gullies. Many of the gorges in the Strategic Assessment Area have steep sides,

overhangs and outcropping, with vegetation mostly concentrated in drainage channels. The major drainage in the Marillana area occurs to the southeast towards Weeli Wolli Creek, which then flows into the Fortescue Valley further north. Low linear dunes occur on plains in the eastern sector of the Strategic Assessment Area.

Much of the landscape in the central portion of the Strategic Assessment Area is typified by heavily weathered, roughly parallel ridgelines and dissecting valleys. The surfaces of these ridges are generally covered in skeletal soils with areas of exposed rock. The main landscape features within this area are the Jirrpalpur Range in the north and Mount Robinson along the southern limit. The Jirrpalpur Range comprises long strike ridges and hills rising up to 300 m above the surrounding plains. It is topographically lower than the Packsaddle Range to the north and is part of the Marra Mamba Iron Formation. Mount Robinson is the highest point in the western part of the Strategic Assessment Area, rising to 1,158 m Australian height datum (AHD) (see Plate 9). Other notable peaks within the Strategic Assessment Area include the Governor (1,051 m AHD; see Plate 10) and the highest point in Western Australia, Mount Meharry (1,250 m AHD).

Photo: Biologic

Plate 9: Hamersley subregion – Mount Robinson

Photo: 360 Environmental

Plate 10: The Governor

Soils throughout the Strategic Assessment Area are generally stony and shallow, with large areas of no soil cover. Sparse vegetation cover on the ranges and the force of heavy summer rains transport large amounts of soil from the ranges down into the valleys. This results in shallow or non-existent soil cover on the ranges; hence, vegetation types in these areas are generally correlated to geology rather than soils (Beard 1975). The hill slopes support uniform medium- or fine-textured soils consisting of loams and sands that are generally shallow and stony and lack nutrients. On the plains, soils are better developed and deeper, represented most commonly as hard alkaline red loams. A layer of quartz and jaspilite gravel may cover the surface in some areas. The soils in the major drainage channels are alluvial sands with banks formed by a combination of alluvial sands and duplex soils. Minor drainage channels consist primarily of duplex soils. In drainage lines, the vegetation type is influenced by superficial deposits, as well as by the presence of surface water and groundwater.

4.3 Biological Environment

Over the last decade, BHP Billiton Iron Ore has commissioned more than 350 biological studies within the Strategic Assessment Area. The information from these studies has been collated and used to inform this impact assessment report. Although the Jinidi Iron Ore Project, which is located within the Strategic Assessment Area, has been assessed under the EPBC Act and is excluded from the scope of the Proposal, Case Study 1 provides an example of the Company's approach to collecting biological data to inform environmental management and this Draft IAR.

Case Study 1: Summary of botanical baseline surveys for the Jinidi project

Jinidi was approved as an individual project under the EPBC Act in September 2012, and is not included within the scope of the Proposal. The studies to support the impact assessment provide a useful example of the level of detail that is available on BHP Billiton Iron Ore's tenure and the level of information that is available to be used as part of the Validation Framework (described in Section 8.6.2).

Photo: BHP Billiton Iron Ore.
Lepidium catapycnon

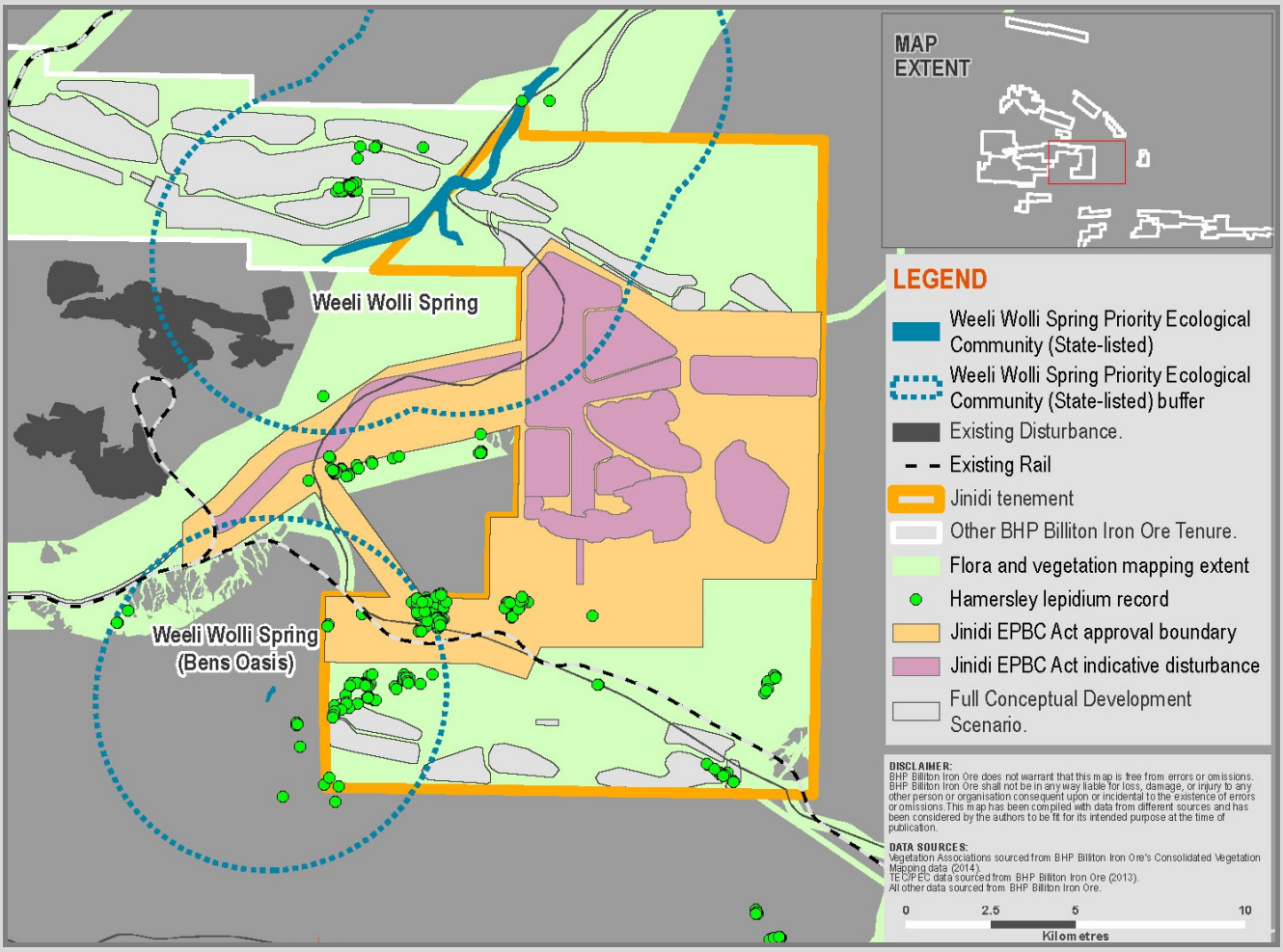
Flora and vegetation surveys commissioned by BHP Billiton Iron Ore generally use desktop analysis and systematic and opportunistic sampling, as well as targeted searches for conservation-significant flora, to determine the baseline characteristics of a project area. These methods are in line with the Western Australian EPA's Guidance Statement No. 51 (EPA 2004), as well as other relevant EPA position statements.

At least eight flora and vegetation (and supporting) surveys have been undertaken since 2005 (together with an earlier survey in 1984) within the Jinidi tenement, while at least nine other regional surveys have also been reviewed for contextual information. This information has been consolidated into the regional flora and vegetation dataset, the coverage of which is shown in the figure below.

The results from the various flora and vegetation surveys have indicated that the Specified Protected Matter Hamersley lepidium (*Lepidium catapycnon*) (pictured), is located within and outside of the Jinidi tenement. This species is also

considered Priority 4 flora under the Western Australian WC Act.

Hamersley lepidium has not been identified to date within the approved disturbance areas under the EPBC Act in September 2012; however some records are located within the Full Conceptual Development Scenario. BHP Billiton Iron Ore will use this information as part of the Validation Framework to ensure that new actions are consistent with the MNES Management Outcomes at the local scale and over the life of the Proposal.



Flora and vegetation features relative to the Jinidi tenement

4.3.1 FLORA AND VEGETATION

The flora and vegetation of the Pilbara bioregion is broadly dominated by *Acacia* shrublands over *Triodia* grasslands, although eucalyptus is also a conspicuous element of the vegetation (van Vreeswyk et al. 2004). However, the distribution of vegetation types, as well as the levels of diversity and endemicity, reflects the complexity of the available habitats.

The predominant vegetation formations of the Chichester and Hamersley plateaux are tree and shrub steppe (hummock grassland) communities with emergent eucalypts and acacia shrubs over *Triodia* hummock grasses. Mulga (*Acacia aneura*) communities occur in valleys, and short bunch grasslands occur on alluvial plains (van Vreeswyk et al. 2004). The granitic sand plains of the Chichester subregion are vegetated with shrub steppe of *Acacia inaequilatera*. In the southwest of the Hamersley subregion, a sparse shrub steppe of snakewood

occupies drainage flood plains and heavy clay soils. The north side of the Fortescue Plains subregion is characterised by patches of short bunch grassland and groved mulga. The extensive Fortescue salt marsh supports halophytic low shrublands of saltbush, bluebush and samphire. To the east of the Roy Hill homestead, there is an area of coolibah trees over bunch grassland (van Vreeswyk et al. 2004). Flora species protected under the EPBC Act that have been recorded within the region include:

- Hamersley lepidium (*Lepidium catapycnon*) listed as Vulnerable under the EPBC Act. Hamersley lepidium is typically found on stony hillslopes of the Hamersley Range (Onshore Environmental 2012); and
- mountain thryptomene (*Thryptomene wittweri*) listed as Vulnerable under the EPBC Act. Mountain Thryptomene typically inhabits steep slopes, rock scree and breakaways near the summits of prominent hills. Plants are often found in the open, growing from ledges and fissures along rock faces and walls (Brown et al. 1998).

The Pilbara region contains a relatively small number of invasive flora species when compared to other regions of Australia. Of the total flora taxa known to occur in the Pilbara, only 6% is non-native. Although the percentage of introduced flora species is relatively low in the Pilbara region, data from Keighery (2010) demonstrated that the number of weed species increased by 20% from 2004 to 2010, mostly due to intentional introductions as fodder plants for the pastoral industry or as garden and amenity plantings. The following weeds are able to grow in many habitats in the Pilbara, often becoming dominant (Keighery 2010):

- ruby dock (*Acetosa vesicaria*);
- kapok bush (*Aerva javanica*);
- Mexican poppy (*Argemone ochroleuca*);
- buffel grass (*Cenchrus ciliaris*);
- birdwood grass (*Cenchrus setiger*);
- feathertop Rhodes grass (*Chloris virgata*);
- indigofera (*Indigofera oblongifolia*);
- spiked malvastrum (*Malvastrum americanum*); and
- Prosopis species (*mesquite*).

The most common species recorded by Keighery (2010) was buffel grass.

4.3.2 TERRESTRIAL VERTEBRATE FAUNA

The vertebrate fauna of the bioregion comprises avifauna, mammals and herpetofauna. The avifauna of the region, while rich, is considered to be seasonally variable and relatively ubiquitous across the landscape. Mammalian fauna has declined during the 150 years since European colonisation. Twelve mammal species of the 41 originally occurring in the Pilbara are now regionally extinct, and a further two persist only on coastal islands (Gibson & MacKenzie 2009).The remaining taxa are dominated by species with mean adult body weights of less than 35 g (McKenzie & Burbidge 2002). Herpetofauna (frogs and reptiles) composition at the regional scale appears to have persisted despite changes associated with European settlement, including pastoralism, changed fire regimes, weeds, introduced animals, mining and infrastructure (Doughty et al. 2011).

The generally uniform nature of avifauna distributions across the habitats of the Pilbara potentially indicates that the intrusion of European activities into the environment is unlikely to have affected birds. However,

Burbidge et al. (2010) highlighted the importance of human impacts on particularly sensitive areas of riparian vegetation, while also noting that this habitat has limited spatial extent.

Much recent taxonomic work has identified a multitude of new species in groups including geckos and skinks, many of which occupy far smaller areas of distribution than was attributed to the polytypic taxa from which they have been extracted (Pepper et al. 2013a; Pepper et al. 2013b). In the case of both mammals and herpetofauna, their persistence likely depends on the maintenance of the full range of habitats known from the Pilbara.

A number of non-native fauna species have been introduced, or have migrated to, the Pilbara region. These include grazing fauna such as donkeys, horses, goats, cattle, pigs and camels, as well as predators like cats, wild dogs and the European fox (Carwardine et al. 2014). Cane toads are currently an irregular, episodic arrival in the region (Carwardine et al. 2014). Several threat abatement plans exist for non-native fauna species, including the European red fox, feral cats and unmanaged goats.

4.4 Hydrology

The hydrology of the Pilbara is marked by infrequent, high-intensity rainfall events associated with cyclonic rainfall and long, dry periods with high evaporation rates. Thus, the hydrology of the Pilbara is one of extremes, ranging from drought to major floods; and water is a highly variable resource (DoW 2010a) (Plate 11).

Photos: BHP Billiton Iron Ore

Plate 11: Watercourses in the Strategic Assessment Area

While there are few quantitative studies of the landscape water balance in the Pilbara, BHP Billiton Iron Ore has developed ecohydrological conceptualisations for four regions in the Strategic Assessment Area: Fortescue Marsh, Marillana Creek, Central Pilbara and Eastern Pilbara regions (Golder Associates 2014; MWH 2014b; RPS 2014a; RPS 2014b). As part of these investigations, landscape areas of the Strategic Assessment Area were partitioned into ecohydrological units (EHUs) and broad-scale ecohydrological factors were described.

Five ecohydrological factors were derived to classify EHUs in the region, namely landscapes and surface types, surface drainage patterns and processes, groundwater and surface water interactions, vegetation characteristics, and wetland habitats and occurrence. These broad-scale factors were then used to classify nine EHUs within the Strategic Assessment Area. These are summarised as follows:

- EHU 1: Upland areas - hills, mountains, plateaux;

- EHU 2: Upland areas - dissected slopes and plains, downgradient from EHU1;
- EHU 3: Upland areas - drainage floors within EHUs 1 and 2 that accumulate surface flows from upgradient;
- EHU 4: Upland areas - channel systems of higher order streams that dissect EHU 1 and EHU 2;
- EHU 5: Lowland sandplains - landform characterised by level or gently undulating plains up to 10 km in extent;
- EHU 6: Lowland alluvial plains - broad depositional plains of low relief;
- EHU 7: Lowland calcrete plains- plains of low relief generally bordering major drainage tracts and termini;
- EHU 8: Lowland major channels systems and associated floodplains; and
- EHU 9: Lowland areas - drainage termini in the form of ephemeral lakes, claypans and bounded flats.

These EHUs were distinguished on the basis of the dominant water balance processes operating within them, for example infiltration, surface drainage, and groundwater recharge and discharge. Each of these water balance elements is influenced by a complex array of factors, many of which may be interdependent (Figure 5).

The EHUs were classified into four upland units, including surface water source units (EHUS 1 and 2) and transitional units (EHUs 3 and 4) and five lowland units, including transitional units (EHUs 5, 6 and 7) and receiving units (EHUs 8 and 9). These EHUs have been spatially defined using various datasets and have been used to support and provide context for environmental impact assessment.

4.5 Aboriginal Heritage

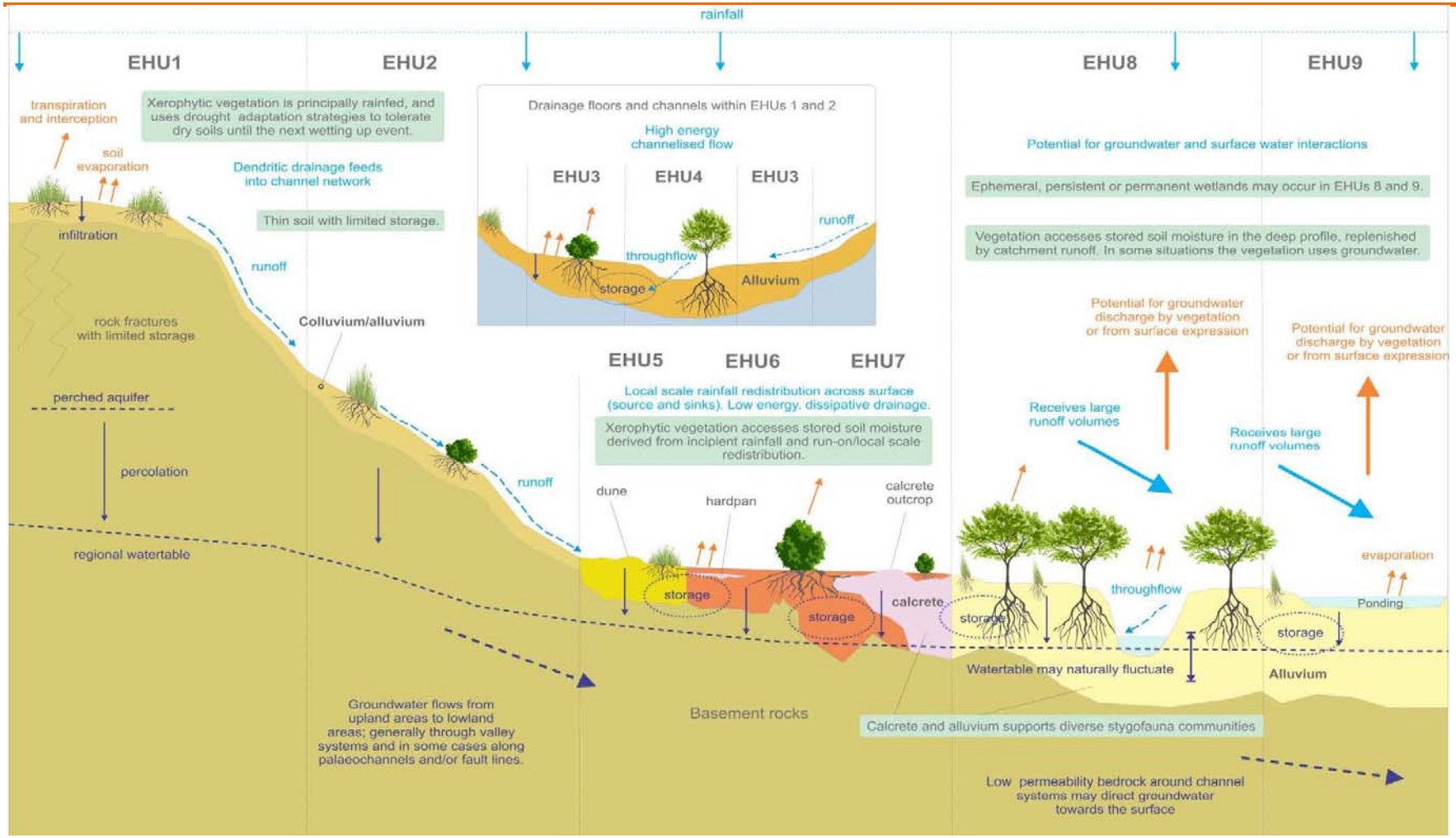
The Pilbara region hosts a prolific number of Aboriginal rock engravings, some of the most well-known being on the Burrup Peninsula (outside of the Strategic Assessment Area). Similar engravings also occur within the Strategic Assessment Area. BHP Billiton Iron Ore has conducted large-scale archaeological and ethnographic surveys to identify places of cultural significance. Those surveys are ongoing and undertaken with participation by the relevant Traditional Owners of the area as described further in Section 8.2.

There are also numerous Aboriginal reserves within the Strategic Assessment Area, such as Ethel Creek and the Weeli Wolli area. These Aboriginal reserves are Crown land set aside for public purposes, including hospitals, schools, conservation of plants and animals, national parks, recreation, and the use of Aboriginal people (DIA 2010).

No National Heritage Places currently occur within the Strategic Assessment Area. Potential future National Heritage Places of Aboriginal heritage significance are considered in Section 6.2.

4.6 European Heritage

In Western Australia, the *Heritage of Western Australia Act 1990* makes provision for the preservation of places of historic significance. Under the Act, places identified as meeting the criteria outlined in section 47 of the Act are placed on the State Register of Heritage Places. Places of Commonwealth heritage significance are protected under Part 15 of the EPBC Act.



Source: MWH (2014)

Figure 5: Overview of ecohydrological units

European settlement of the Pilbara region began in the 1860s (van Vreeswyk et al. 2004), with pastoralism dominating the region for the next 100 years with European settlers arriving with livestock to establish sheep stations. Many of the European heritage sites in the Pilbara region relate to these historic pastoral stations, natural features (such as pools) and town sites.

The Inherit Database (Heritage Council of WA 2015) indicates that there are over 90 heritage places in the Shire of East Pilbara. In the Newman area many of these relate to Stations, pools (Weeli Wolli Pool, Ophthalmia Dam), historic mining (Mt Whaleback Mine) and around Newman (St Joseph's Catholic Church, Boomerang Grandstand).

There are no National Heritage Places within the Strategic Assessment Area. Future potential National Heritage Places are discussed further in Section 6.2**.**

4.7 Climate

4.7.1 EXISTING CONDITIONS AND HISTORICAL TRENDS

The climate of the Pilbara is influenced both by maritime and continental air masses and is described as semi-arid to arid (Department of Planning 2009; Australian Natural Resources Atlas 2009). See Figure 1 and Figure 4 for the location of key towns and bioregional boundaries discussed in this paragraph. The climate of the Little Sandy Desert and Gascoyne bioregions is arid with episodic summer rainfall (Cowan & Kendrick 2001). The Gascoyne bioregion also receives winter rainfall (CALM 2003), with some parts subject to tropical monsoonal influences (Kendrick 2001a). Port Hedland (north of the Strategic Assessment Area) lies within the Roebourne subregion with an arid-tropical climate, experiencing variable rainfall, predominantly in summer, and significant cyclonic activity annually (Kendrick & Stanley 2001).

The Bureau of Meteorology (BoM) data for temperature statistics since 1996 at the Newman Aero weather station shows that high mean maximum temperatures, often just under 40ºC, are characteristic between November and February, while the mean winter monthly minimum is 6.2ºC in June (BoM 2014). Mean annual rainfall in Newman is 319 mm.

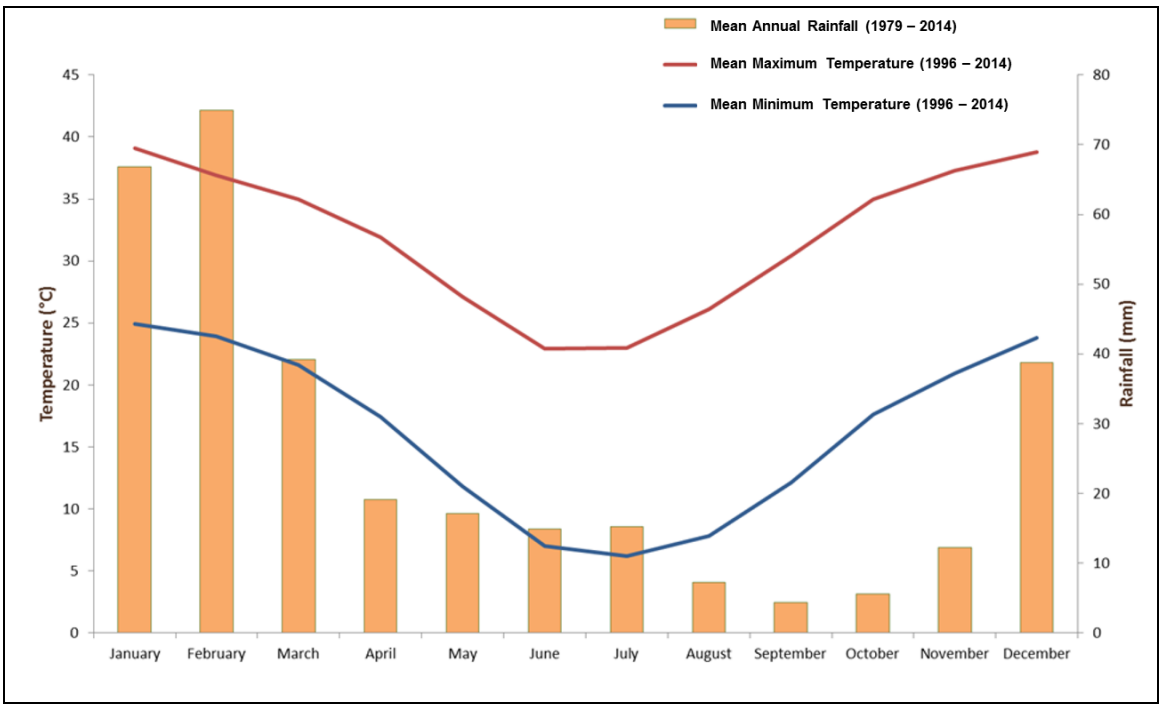
Figure 6 shows climate data since 1996. Temperature ranges are larger inland, away from the tempering effects of the Indian Ocean and onshore coastal winds. Figure 7 provides an indication of inter-annual variability changes over the short term in the region, using data from BoM recorded at Newman Aero.

4.7.2 CLIMATE CHANGE

Climate projections for the Pilbara have been studied in detail by CSIRO (Loechel et al. 2011; Charles et al. 2013; Watterson et al. 2015). The CSIRO *Interim Report Hydroclimate of the Pilbara: Past, Present and Future* (Charles et al. 2013) describes how the future climate will evolve in response to enhanced concentrations of atmospheric greenhouse gases.

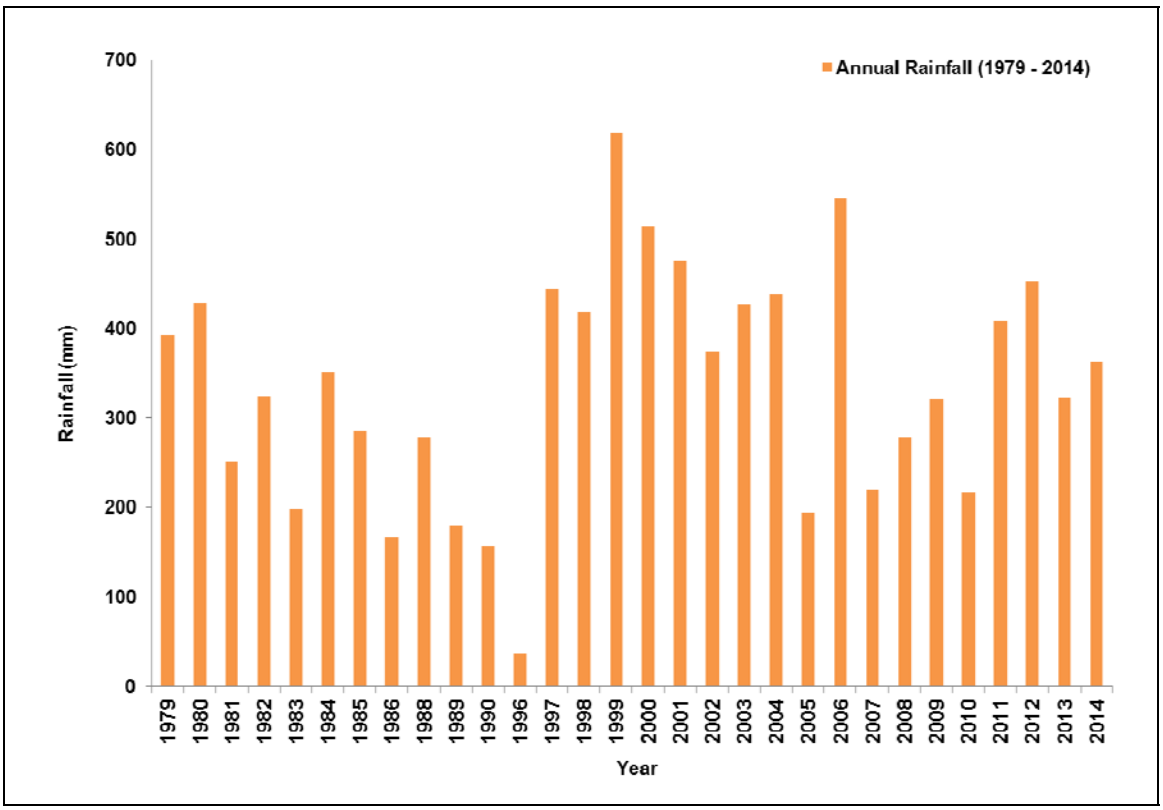
With regards to projected annual rainfall, the models produced a large range of results, with some indicating a decrease in rainfall and others an increase in rainfall. In general, the high emission scenario resulted in a dryer climate in comparison to existing and lower emission scenarios. The median results showed that future climate rainfall projections to 2050 do not vary by more than five percent from current levels.

The Charles et al. (2013) report looked at the global frequency of tropical cyclones, suggesting that they will either decrease or remain essentially unchanged owing to greenhouse warming. Modelling carried out on Australian tropical cyclones indicates an approximate 100 km southward shift in genesis and decay regions of cyclones, as well as an increase in wind speed, rainfall intensity and integrated kinetic energy.



Source: Adapted from BoM (2014).

Figure 6: Monthly climate statistics for Newman Airport



Source: Adapted from BoM (2014).

Figure 7: Annual rainfall 1972 to 2013 for Newman Airport

These indications suggest that the intensity of cyclonic rainfall in the Pilbara is likely to increase within the timeframes of the Proposal. It is worth noting that thunderstorm intensity, which is important for regular runoff events, was not modelled by Charles et al. (2013).

CSIRO projections suggest that both mining companies and the local communities will need to adapt practices to improve water use efficiency and to cope in the hotter extremes. Dunlop et al. (2012) suggest that one probable impact of climate change is alteration to vegetation structure in response to a reduction in the availability of water. In addition to the temperature and rainfall projections described in the report, it is also projected that the severity of extreme weather events or storms could increase, including an increase in the strength of tropical cyclones impacting the Pilbara. An increase in tropical cyclone intensity not only increases the degree of destruction at the centre of the cyclone but may also increase the geographic area over which cyclonic winds and downstream flooding occurs.

4.8 Fire Regimes

Within Australia's natural environment, fire plays an important role in land management to achieve management objectives ranging from land clearance for primary production to biodiversity conservation and human safety (Whelan et al. 2006). Fire can also occur naturally as a result of lightning and plays a central role in ecosystem changes and landscape modifications (Whelan 1995). The behaviour and impacts of fire are varied, depending on weather conditions, fuel loads and distribution, and suppression activities. Changes to fire regimes can include frequency, intensity, seasonality and type (Whelan et al. 2006).

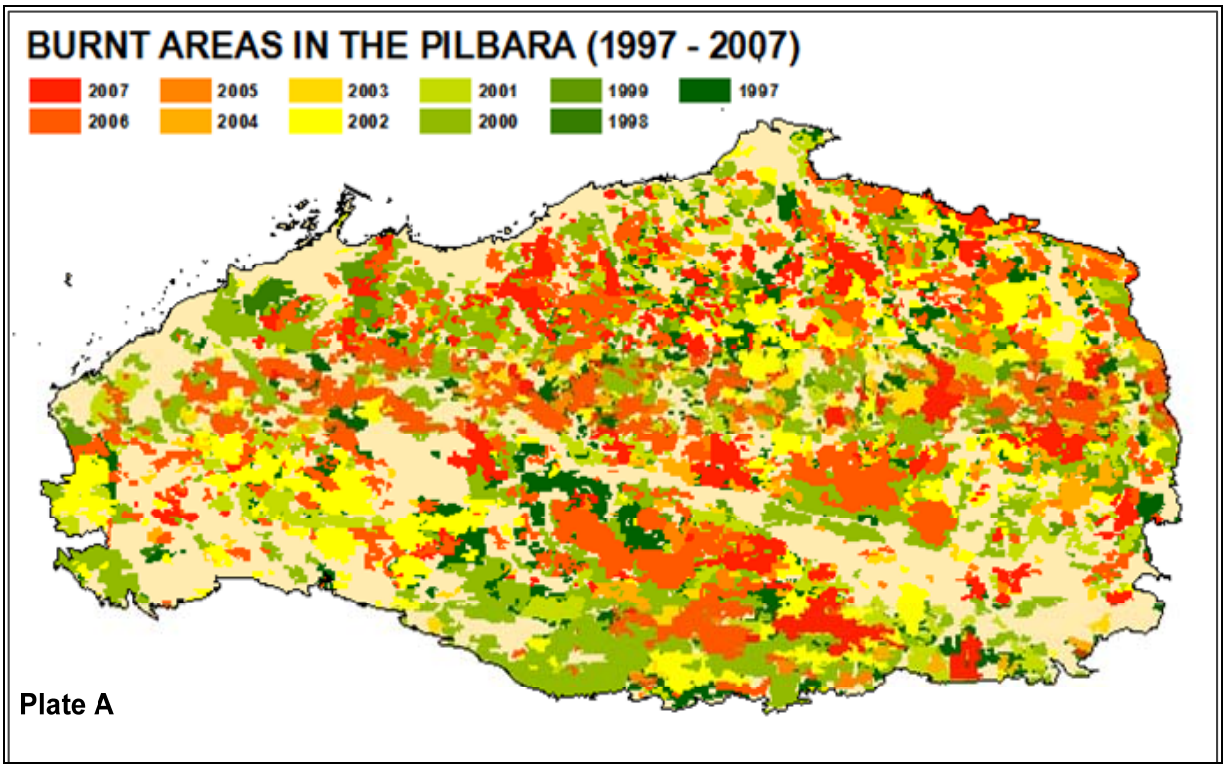
The pattern of fire occurrence in arid Australia has also changed over time, both temporally and spatially, with smaller-scale Aboriginal burning practices occurring less frequently and giving way to larger-scale wildfires that burn out of control across large areas of the western deserts of Western Australia (Southgate & Carthew 2006; Southgate & Carthew 2007; Pavey 2006b). Data for fires in the Pilbara are scarce; however it appears that there is no particular trend or pattern in fire regimes and also that, over time, it might reasonably be expected that the majority of the land in the Pilbara will be subjected to a fire (EPA 2006).

Figure 8 shows the pattern of burnt areas in the Pilbara over 10 years between 1997 and 2007. Plate B and C provide a snapshot of burnt areas for the years 2000 and 2005 respectively. These snapshots serve to demonstrate the variability of the fire regime in the Pilbara, with Plate B showing substantially greater burnt area coverage when compared to Plate C.

4.9 Tenure and Land Use

Within the Pilbara region, land use is divided into eight tenure types (Table 4). Unallocated crown land forms the majority of the land in the Pilbara region, followed by pastoral leases. Table 4 shows the area of each land tenure types in the Pilbara and also demonstrates that tenures can overlap, which explains why the value for 'total land tenure' is greater than 'total Pilbara land area'. To provide context, the total area of BHP Billiton Iron Ore's mining tenures relevant to the Proposal (see Figure 1) is also shown in Table 4 in italics. The dominant land uses in the Pilbara region are:

- pastoralism;
- conservation;
- mining;
- agriculture; and
- tourism



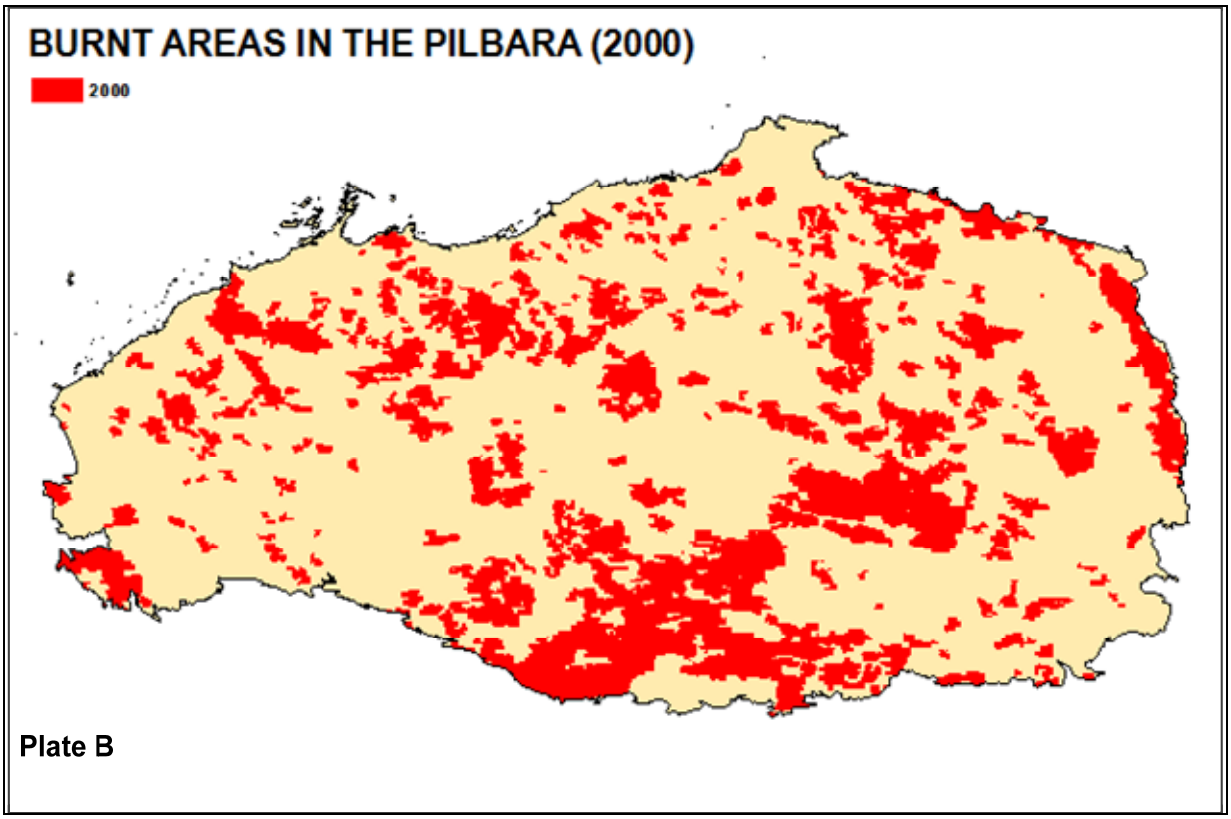


Figure 8: Pattern of burnt areas in the Pilbara (1997 to 2007)

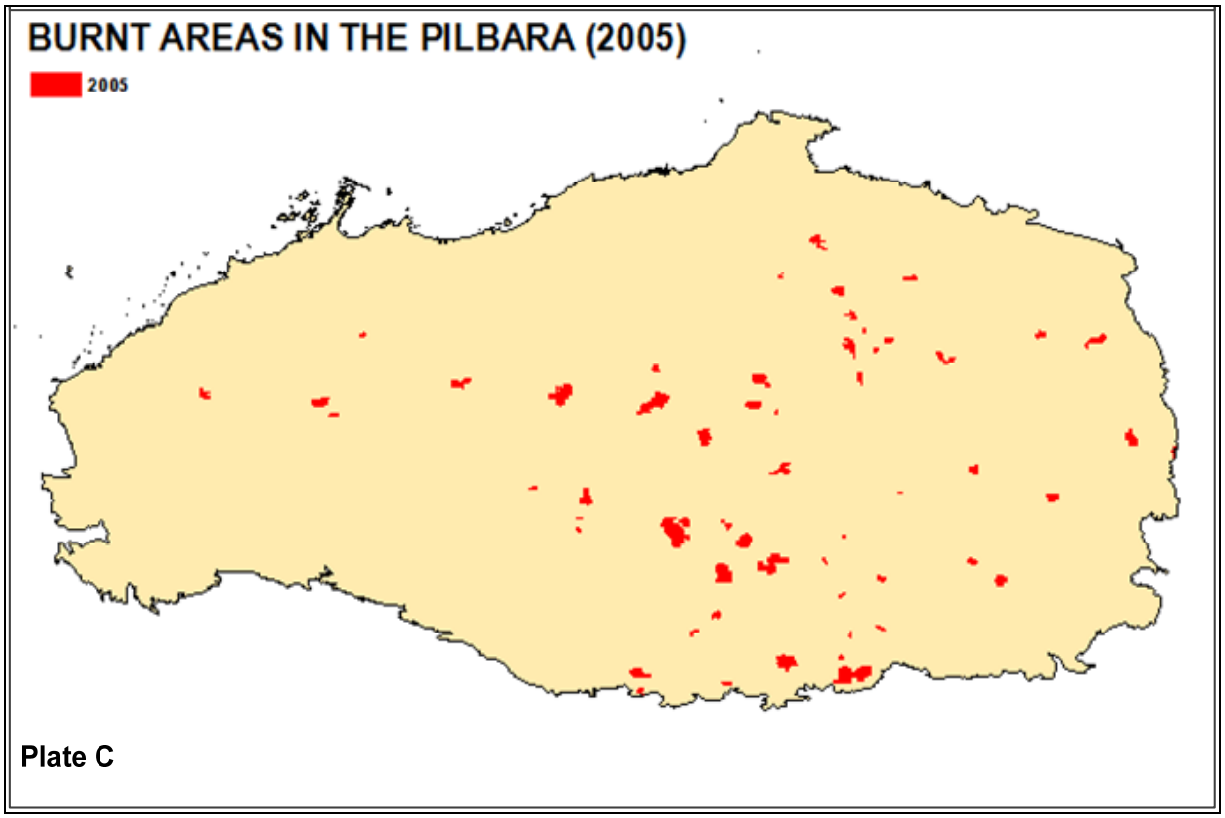


Figure 8: Pattern of burnt areas in the Pilbara (1997 to 2007) (cont'd)

The above land use types are discussed below. Although population centres are not a dominant land use in the Pilbara region, they are important to the Pilbara landscape and also discussed.

Table 4: Summary of Pilbara land tenure types

LAND TENURE TYPE	AREA (HA)
Unallocated crown land	49,591,800
Pastoral leases	16,684,600
Aboriginal land (e.g. leases, reserves, land use agreements)	8,605,400
National parks and conservation reserves	3,369,500
Mining tenements (*Area of current BHP Billiton Iron Ore mining tenures relevant to the Proposal provided in brackets)*	3,208,500 (*335,629*)
Population centres or townships	45,200
Strategic industrial sites (e.g. industrial estates)	4,400
Total land tenure (overlaps included)	81,509,400
Total Pilbara land area*	**50,789,600**

Source: Department of Planning (2009).
* Different to the Pilbara Bioregion

4.9.1 PASTORALISM

Pastoralism has been an extensive land use, and important industry, in the Pilbara region since the early twentieth century (SLWA 2010). Pastoral activities involve the free-range grazing of stock over vast areas of land.

Up until the 1970's sheep as well as cattle were the stock favoured by pastoralists, however feeder cattle (for live export or slaughter export trade) is now the predominant stock run by the majority pastoralists in the Pilbara region (SLWA 2010). As of 2012, the Pilbara pastoral industry was valued at $52 Million (DRD 2015).

Photo: 360 Environmental

Plate 12: Cattle graze large tracts of the Pilbara bioregion

4.9.2 CONSERVATION

Land reserved for conservation purposes amounts to approximately 7% of the total area of the Pilbara region, with the major reserves being Karijini and Millstream-Chichester National Parks. These Parks are supplemented by lesser conservation estates such as Cane River and Meentheena Conservation Parks. Wetlands of national importance include Karijini (Hamersley Range) gorges, Mount Bruce coolabah-lignum flats and Fortescue Marsh.

4.9.3 MINING

The Pilbara is a globally significant mining and energy region boasting a wealth of resource endowments (Pilbara Development Commission 2015). Mining and energy production accounted for 78% ($33 billion) of the total value of exports from the region in 2012-2013 (DRD 2015) and provides employment to approximately 18,500 people in the Pilbara (Pilbara Development Commission 2015).

Iron ore is the primary commodity mined in the region and the vast majority of Australia's iron ore comes from the Pilbara (>90%) (DRD 2015). There are at least 25 iron ore mines currently operating in the Pilbara, the majority of which are located around the towns of Newman and Tom Price (DMP 2014). These mines collectively contribute to the export of more than 500 Mtpa, which is railed or trucked from the mines to one of three port facilities located at Port Hedland, Cape Lambert and Karratha (DMP 2014, DRD 2015).

In addition to iron ore, manganese, gold, silver and copper are also mined in the Pilbara, though to a much lesser extent (DRD 2015).

4.9.4 AGRICULTURE

Irrigated agricultural land uses occur within the Pilbara at a localised, small scale; and there is limited potential for irrigation expansion owing to the aridity of the Pilbara environment (Carwardine et al. 2014). However, the Pilbara remains of interest to the state government, which is investing resources in to the development of irrigated agricultural schemes using surplus mine water.

4.9.5 TOURISM

The Pilbara is increasingly recognised for its natural values; thus, the region has experienced an increase in tourism. Tourism plays an important role in the Pilbara economy by supporting diversification of the economy (Pilbara Development Commission 2014).

An annual visitor expenditure of over $360 million benefits small, locally owned businesses in the accommodation, food services and other retail sectors (Pilbara Development Commission 2014). The main tourist attraction in the Pilbara is the natural environment, although industrial and cultural or heritage attractions exist. Natural environment tourist attractions in the Pilbara include:

- national parks;
- gorges, pools and swimming holes (many of which are in national parks);
- islands and marine attractions;
- coastal or beach destinations; and
- outstanding landscapes and isolation (Pilbara Development Commission 2014).

Many of the natural attractions are world class and can compete effectively (in terms of the experience) with numerous locations across Australia. Most of these attractions provide a unique experience that can distinguish the Pilbara clearly from other regions in Australia (Pilbara Development Commission 2014). Tourism within conservation estates in the Pilbara is regulated by DPaW; however, tourism undertaken within other tenure and at entry points (e.g. roads and off-road tracks) is not easily regulated and therefore has the potential to result in adverse environmental impacts (Carwardine et al. 2014).

4.9.6 POPULATION CENTRES

The Pilbara region is a large, sparsely populated region with the main population centres being the City of Karratha, Port Hedland and Newman (DRD 2015). The majority of established centres have been developed to support the resource sector, with other significant towns including Tom Price and Paraburdoo.

Population growth has been predominantly driven by the expansion of the resources sector in the region with total population increasing from approximately 43,000 in 2003 to 67,500 in 2015 in-line with the rapid expansion in the resource sector over that time (DRD 2015).

5 IMPACT ASSESSMENT

This chapter presents an impact assessment for MNES within the Strategic Assessment Area, as determined by the outcomes of a screening assessment (refer to Appendix 3).

The following definitions apply to this chapter:

- Direct impacts are a direct result of an activity. For example, clearing of vegetation and removal of overburden prior to mining can directly result in the loss of habitat.
- Indirect impacts are facilitated, but not directly caused, by an activity. For example, clearing of vegetation can facilitate dust generation from cleared surfaces under specific weather conditions; in this case, dust is a direct result of wind rather than a direct result of clearing.
- Cumulative impacts can generally be defined as the total impact (both direct and indirect) on a given receptor (a species, ecosystem or human community). Cumulative impacts are the aggregate impacts of past, present and reasonably foreseeable future impacts of mining and non-mining activities.

5.1 Scope of the Impact Assessment

A search of the Strategic Assessment Area (plus a 100-km buffer) was undertaken using the EPBC Act Protected Matters Search Tool (PMST) to identify MNES that may be present in the area according to DotE data.

Table 5 presents the results of the PMST Report produced on 29 July 2015 (Appendix 3) and whether or not the MNES is applicable to the Proposal. MNES that have the potential to occur within the Strategic Assessment Area based on the PMST Report are considered as Controlling Provisions for the Proposal.

Table 5: Controlling Provisions of the Proposal based on the PMST Report

MNES	Result of PMST Search	Controlling Provisions
World Heritage Properties	No World Heritage Properties occur within the Strategic Assessment Area. The nearest World Heritage Area is the Ningaloo Coast, which is located approximately 300 km west of the Strategic Assessment Area.	No
National Heritage Places	There are no National Heritage Places within the Strategic Assessment Area. Potential future national heritage places are considered in Section 6.2.	No
Wetlands of International Importance (Ramsar Wetlands)	No Wetlands of International Importance are currently listed within the Strategic Assessment Area. The nearest wetland of international importance is Eighty Mile Beach, which is located approximately 440 km north-northeast of the Strategic Assessment Area. Potential for future wetlands of international importance are considered in Section 6.1.	No

MNES	Result of PMST Search	Controlling Provisions
Great Barrier Reef Marine Park	The Strategic Assessment Area located over 3,000 km from the Great Barrier Reef.	No
Commonwealth Marine Areas	No Commonwealth Marine Areas occur within the Strategic Assessment Area. The nearest Commonwealth Marine Area is the Exclusive Economic Zone and Territorial Sea located approximately 30 km to the north of the Strategic Assessment Area (north of Port Hedland).	No
Listed Threatened Species and Communities	15 terrestrial listed threatened species were identified; a screening assessment was conducted (Appendix 3) and five species were determined to be Specified Protected Matters. An assessment of potential impacts to the Specified Protected Matters is provided in Section 5.3. No threatened ecological communities occur in the Strategic Assessment Area. The nearest listed threatened ecological community (the endangered monsoon vine thickets on the coastal sand dunes of Dampier Peninsula) is located approximately 550 km north and east of the Strategic Assessment Area and outside the Pilbara bioregion.	Yes
Listed Migratory Species	45 migratory species were identified; and a screening assessment was conducted (Appendix 3). No migratory species were considered to be Specified Protected Matters at this time, however a precautionary approach has been taken and listed migratory species has been included as a controlling provision.	Yes
Nuclear Actions	BHP Billiton Iron Ore does not propose to undertake any nuclear actions as part of the Proposal.	No
Protection of water resources from coal seam gas development and large coal mining development	BHP Billiton Iron Ore does not propose to undertake any coal seam gas or large coal mining development as part of the Strategic Assessment Area.	No
Protection of the environment from actions involving Commonwealth land	Commonwealth land is present within the townships of Newman and Tom Price; however, BHP Billiton Iron Ore does not propose to undertake any actions within Commonwealth land as part of the Proposal, and thus no impact is expected.	No
Protection of Commonwealth heritage places outside the Australian jurisdiction	Not within the scope of the Proposal	No
Protection of the environment from Commonwealth actions	Not within scope of the Proposal	No

Based on these two Controlling Provisions, a screening assessment was undertaken to identify which species were relevant to the Proposal (Appendix 3). The following species were considered to be Specified Protected Matters, requiring detailed impact assessment:

- northern quoll (*Dasyurus hallucatus*);
- greater bilby (*Macrotis lagotis*);
- Pilbara leaf-nosed bat (*Rhinonicteris aurantia*);
- Pilbara olive python (*Liasis olivaceus barroni*); and

- Hamersley lepidium (*Lepidium catapycnon*).

The inputs to the impact assessment for the Specified Protected Matters are described in Section 5.2 and the results of the impact assessment are described in Section 5.3.

5.2 Impact Assessment Inputs for the Specified Protected Matters

This Draft IAR identifies and assesses the nature and extent of potential impacts to the Specified Protected Matters as a result of the future implementation of the Proposal. The impact assessment has been informed by a number of key inputs as shown in Figure 9 and described below.

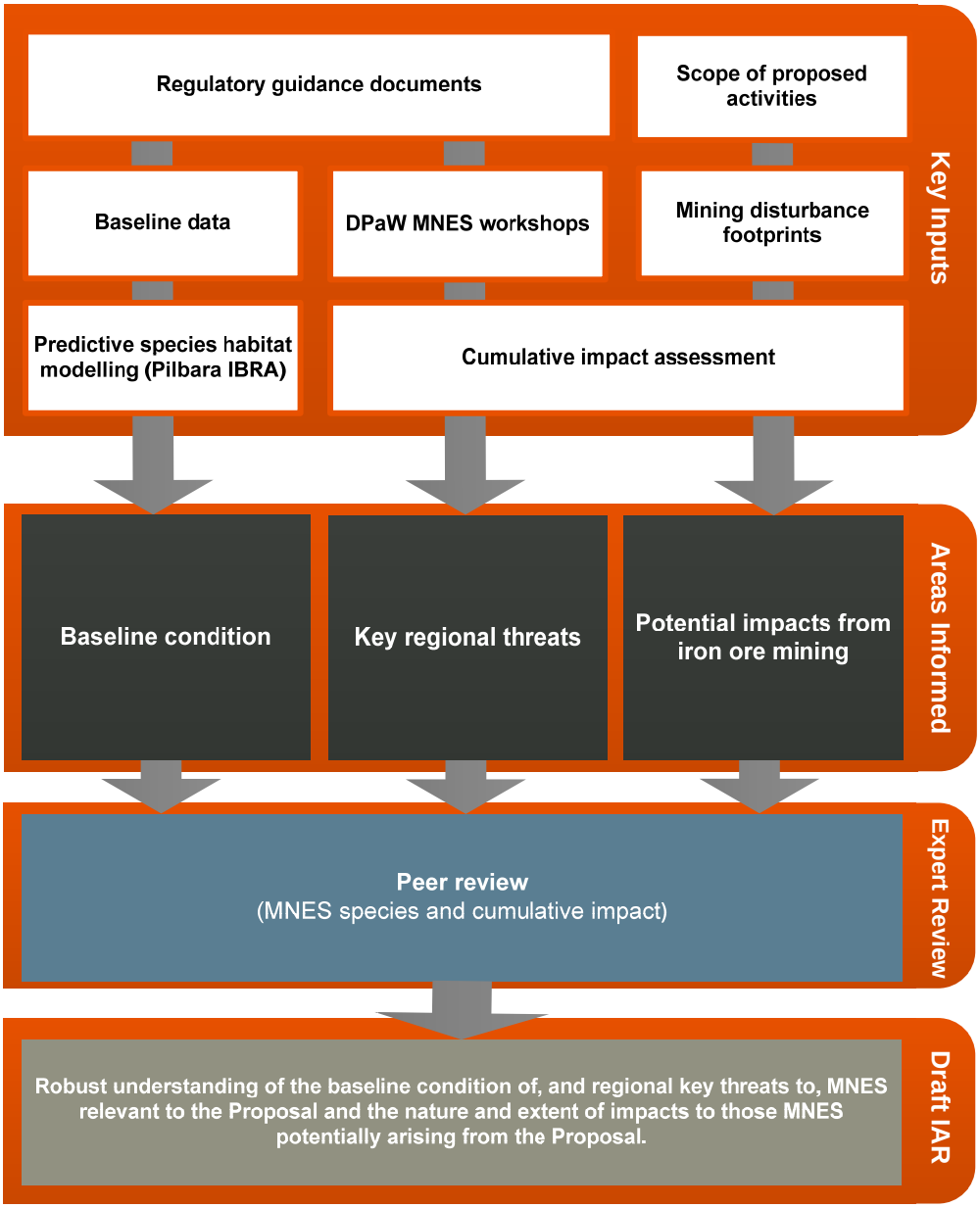


Figure 9: Key inputs into this Draft IAR

5.2.1 SCOPE OF PROPOSED ACTIVITIES

The scope of the Proposal is described in Chapter 3. The activities described for typical iron ore mine (provided in Section 3.5) are used as a basis for the impact assessment in this Draft IAR. For example, activities such as dewatering or mine voids and transport of ore via rail are considered within the impact assessment.

5.2.2 MINING DISTURBANCE FOOTPRINTS

To support the quantitative component of the impact assessment, several disturbance footprints were considered. These included existing disturbance from existing BHP Billiton Iron Ore and third-party iron ore mines, reasonably foreseeable third-party developments associated with iron ore mining and the footprint for the BHP Billiton Iron Ore's Full Conceptual Development Scenario of the Proposal.

As shown in Figure 10, the Proposal's existing disturbance scenario is based on the following:

- Existing BHP Billiton Iron Ore mining operations. Yandi, Mining Area C, Newman (including mines at Mount Whaleback and Eastern Ridge), Jimblebar (including Wheelarra) and their associated rail infrastructure. The disturbance represented the extent of ground disturbance to date and may be less than that approved under existing environmental approvals;
- Existing third-party iron ore operations[1.] Existing third-party operations included:
    - Rio Tinto's (including joint ventures with Hamersley Iron, Hamersley HMS and Robe River Mining Co.) Brockman Syncline 4, Hope Downs 1, Hope Downs 4, Marandoo, Mount Tom Price, West Angelas, Western Turner Syncline Section 10 and Yandicoogina (including Junction Central, Junction SE, and Junction SW and Oxbow); and
    - Fortescue Metals Group's Cloudbreak and Christmas Creek.
- Existing non-mining impacts. A review of available datasets determined that the Geoscience Australia Global Map 2001 (1:1,000,000) dataset was the best publicly available source of data for the CIA. Data for roads, power lines, airfields, railway yards, human settlements and built-up areas were obtained from this dataset.

Figure 11 shows the disturbance footprints used for the Full Conceptual Development Scenario and reasonably foreseeable third party iron ore disturbance. These future scenarios are conceptual only and designed as a tool for assessment of the potential impacts of the Proposal. The conceptual footprints for these future development scenarios are based on the following:

BHP Billiton Iron Ore current and future operations. Caramulla, Coondiner, Gurinbiddy, Jimblebar, Jinidi, Marillana, Mindy, Mining Area C, Ministers North, Mudlark Well, Munjina/Upper Marillana, Newman, Ophthalmia/Prairie Downs, Rocklea, Roy Hill, South Flank, Tandanya and Yandi;

[1] Existing third-party operations considered were those that had been approved and were underway as at June 2012 (the time of referral of the Proposal under the EP Act), within a 50km buffer of Proposal tenure. Note that Rio Tinto's Nammuldi Silvergrass Mine and FMG's Solomon Iron Ore Mine were not included as an input into the CIA as they are located more than 50 km away from BHP Billiton Iron Ore mining tenures, and was not considered likely contribute to potential cumulative impacts from BHP Billiton Iron Ore's operations.

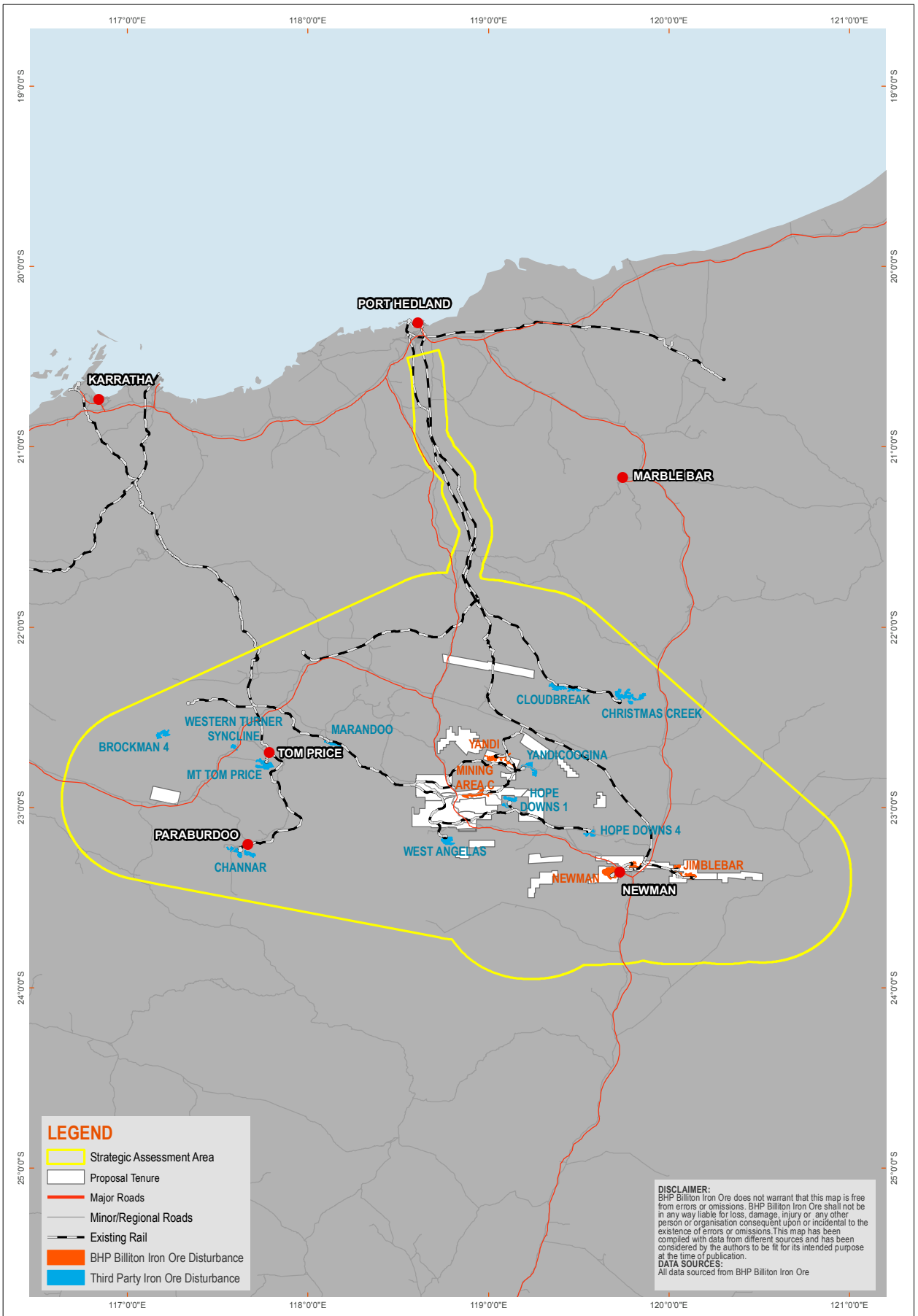


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Figure 10 Existing Disturbance Footprint

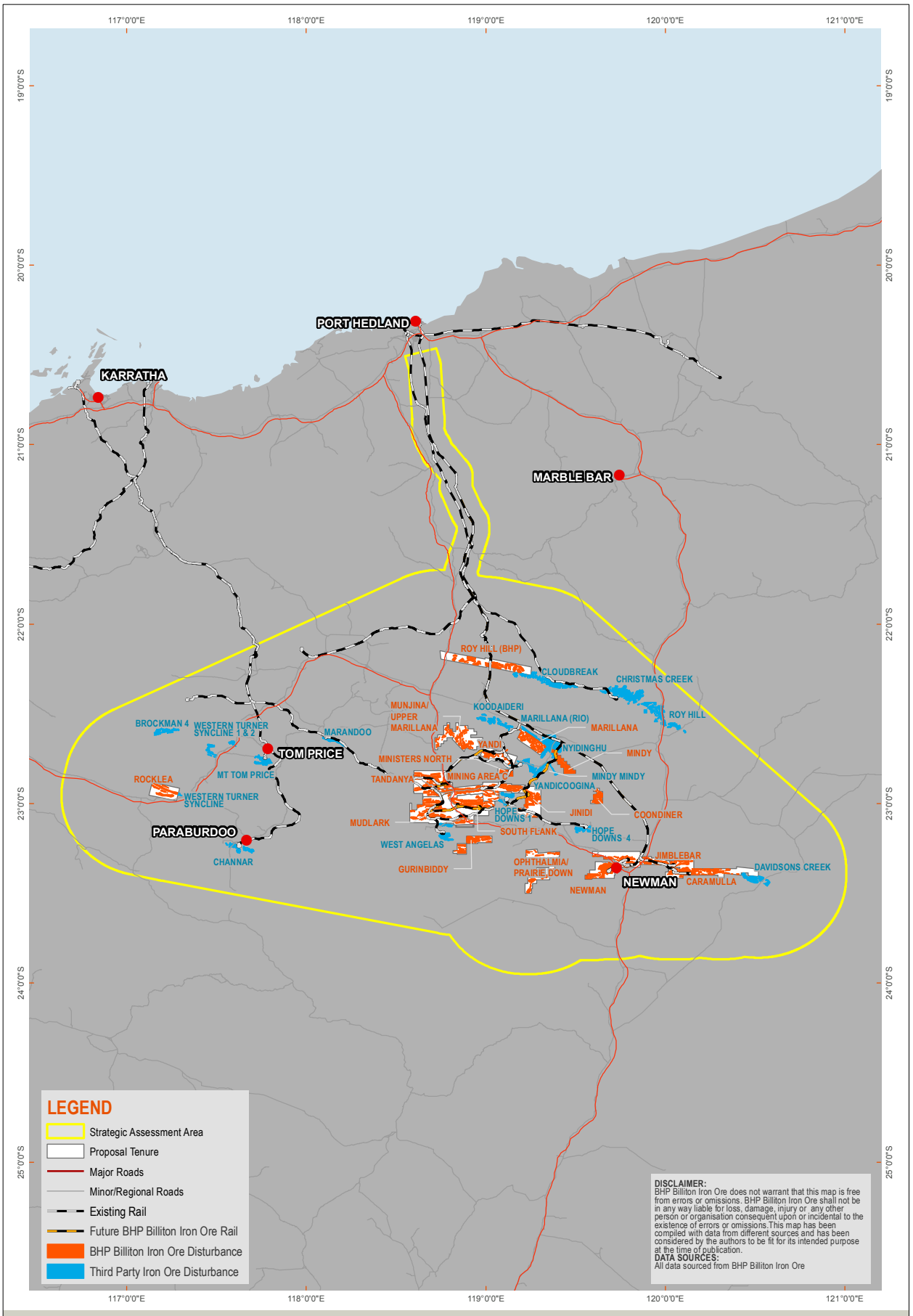

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Figure 11 BHP Billiton Iron Ore Full Development Scenario and Reasonably Foreseeable Third Party Disturbance Footprint

- Reasonably foreseeable future third-party iron ore operations derived from publicly available data for projects referred or approved by the EPA. It included projects or components of projects already approved but not yet implemented or only partially implemented and projects referred to the EPA as at September 2014[2]. The disturbance footprint does not take into account any expansions that third-party operators may propose to undertake in the future, where this information is not publicly available. The following reasonably foreseeable third-party operations were included in the Full Conceptual Development Scenario:
    - Rio Tinto's (including joint ventures with Hamersley Iron, Hamersley HMS and Robe River Mining Co.) Brockman Syncline 4, Hope Downs 1, Hope Downs 4, Koodaideri, Marandoo, West Angelas, Western Turner Syncline, Western Turner Syncline Stage 2, Yandicoogina (Junction SE; Junction SW and Oxbow, Pocket and Billiard South);
    - Fortescue Metal Group's Cloudbreak, Christmas Creek, Mindy Mindy and Nyidinghu;
    - Atlas Iron's Davidson's Creek;
    - Australian Premium Iron Management's Hardey;
    - Iron Ore Holdings' Iron Valley;
    - Brockman Resources' Marillana; and
    - Hancock Prospecting's Roy Hill Stage 1 and Roy Hill Stage 2[3].

Assumptions regarding level of disturbance for existing and future non-mining impacts are described in Section 5.2.7.

5.2.3 REGULATORY GUIDANCE DOCUMENTS

Available regulatory guidance documents were referenced during development of this Draft IAR and were used to inform the key threats used in the CIA model. Key references are listed in Table 6. Key threats are summarised for each of the Specified Protected Matters in Section 5.3.

5.2.4 DPAW WORKSHOPS 2013

In 2013, DPaW held a series of workshops in collaboration with industry, research experts, the Commonwealth DotE and relevant stakeholders, on the current status of and threats to a selected group of MNES in the Pilbara. This included focus on four of the species relevant to the Proposal: greater bilby, northern quoll, Pilbara leaf-nosed bat and Pilbara olive python. Hamersley lepidium was not included in the series of workshops.

Specifically, the DPaW workshops highlighted climate change, cumulative impacts, feral predators, and human interactions, as well as impacts associated with mining, as key threats to the MNES species. Key threats identified for each of the species from these workshops are discussed under each Specified Protected Matter in Section 5.3.

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[2] Future third-party operations considered were those within a 50km buffer of Proposal tenure that had been referred or approved as at September 2014 but not commenced. BHP Billiton Iron Ore is aware of other iron ore projects referred since that cut-off date however considers that these additional disturbance areas unlikely to change the outcomes of the cumulative impact assessment.

[3] Since the completion of the CIA model, the Handcock Prospecting Roy Hill mine has commenced operation. Whilst the mine has not been included in the assessment of existing third-party iron ore operations, it has been fully considered in the Full Conceptual Development Scenario.

Table 6: Regulatory guidance that has informed Specified Protected Matter key threats

Specified Protected Matters	Relevant References
Northern quoll	• Species National recovery plan (Hill & Ward 2010) • Species Profile and Threat Database (SPRAT 2014a)
Greater bilby	• Species National recovery plan (Pavey 2006a) • Species Profile and Threat Database (SPRAT 2014b) • Species matter-expert literature (Southgate 2013)
Pilbara leaf-nosed bat	Species Profile and Threat Database (SPRAT 2014e)
Pilbara olive python	• Species Profile and Threat Database (SPRAT 2014c) • Species conservation advice (TSSC 2008c)
Hamersley lepidium	Species Profile and Threat Database (SPRAT 2014f)

5.2.5 BASELINE DATA

BHP Billiton Iron Ore has commissioned over 350 individual baseline reports over the last decade. Supporting studies have been undertaken by BHP Billiton Iron Ore internal specialists and by a wide consultancy base. This wealth of baseline knowledge supports BHP Billiton Iron Ore's confidence in the rigour and robustness of the strategic assessment undertaken and the effectiveness of its management approach in managing potential impacts of the Proposal to an acceptable level. In addition to BHP Billiton Iron Ore baseline data, an extensive review of publicly available data was collated and included in this Draft IAR.

Publicly available data and baseline data have been used as a key input in the predictive habitat species modelling (described in Section 5.2.4). In addition to the modelled approach, BHP Billiton Iron Ore has used data obtained in December 2015 and January 2016 to expand on the modelled approach by assessing the species records impacted by BHP Billiton Iron Ore's and reasonably foreseeable third part mining developments.

5.2.6 PREDICTIVE SPECIES HABITAT MODELLING

Predictive species habitat modelling was undertaken by Eco Logical (2015a) for the Specified Protected Matters for this Draft IAR. The primary objective was to model potential species habitat based on the relationships identified between spatial patterns in environmental variables favoured by the species and the locations of recorded species observations. The modelling was undertaken to complement the existing data records and to provide a regional context in which to consider the potential impacts of the Proposal.

In the preparation of the predictive spatial habitat modelling, 1,493 species' records (for the Specified Protected Matters) were utilised in conjunction with spatial datasets, such as topography, terrain, climate, hydrology, landscape and vegetation, describing the landscape.

Relationships between records of species observations and spatial datasets were statistically analysed and inputs and outputs were evaluated by expert ecologists for each targeted species. Statistical analysis software (S-Plus), a GIS (ArcGIS/ArcView), and purpose-built software (GRASP) were utilised. Numerous models were undertaken for each target species, and each model was evaluated by assessing the predicted distribution of species habitat, validation and cross-validation statistics, and the contribution of the variables (or predictors) to final models. Following this assessment, the model that represented the strongest and most realistic predictors was selected. These final models were validated and then assessed for reliability. A summary of outcomes of the species habitat modelling for each species is outlined below:

- northern quoll: strongly associated with rugged hills, ranges and outcrops in the northern part of the Pilbara bioregion; however, may have been under predicted in the southern part;

- greater bilby: strongly associated with hotter regions of the eastern part of the Pilbara bioregion, with lower, flatter and sandier areas identified as higher potential habitat;
- Pilbara leaf-nosed bat: suitable habitat predicted beyond recorded distribution in the Hamersley Range and east Pilbara; however, cave microclimate requirements are limiting factor;
- Pilbara olive python: potential relationship to hills and ranges, river plains, and low- to mid-level topographic positions; and
- Hamersley lepidium: confined distribution in the Hamersley Range in the southern part of the Pilbara bioregion.

5.2.7 CUMULATIVE IMPACT ASSESSMENT

CUMULATIVE IMPACT ASSESSMENT FOR THE SPECIFIED PROTECTED MATTERS

BHP Billiton Iron Ore undertook a cumulative impact assessment for the Proposal as one of the inputs into this Draft IAR (Eco Logical 2015b) (Appendix 4). The cumulative impact assessment is a first of its kind for the Pilbara. In the absence of definitive regulatory guidance in the area of cumulative impact assessment, BHP Billiton Iron Ore has made use of available data and drawn on expert opinion (i.e. leading experts in the subject) to develop the methods used to achieve results that are as scientifically robust as reasonably possible. BHP Billiton Iron Ore considers this level of scientific robustness as a firm basis to assess the impacts discussed in this IAR and inform the management framework Chapter 8.

The cumulative impact assessment is an appropriate tool for the Strategic Assessment in the context of a regional approach to impact assessment. The objectives of the impact assessment were to:

- Present a baseline of habitat suitability for each of the five Specified Protected Matters in the Pilbara bioregion, from which potential cumulative impact increases could be measured;
- Quantify the potential cumulative impacts to habitat suitability of both existing non-mining land use and activities and iron ore projects operating and proposed in the Pilbara bioregion based on the typical mining operation described in Section 3.5; using a conservative approach without the inclusion of management and mitigation measures;
- Determine the proportion of potential cumulative impact attributable to BHP Billiton Iron Ore's Proposal; and
- Assess the implications of the potential cumulative impact attributable to BHP Billiton Iron Ore's Proposal in the context of the total potential cumulative impact and the ecology of each Specified Protected Matter.

The impact assessment was undertaken across the Pilbara bioregion and considered the Specified Protected Matters. The assessment was undertaken quantitatively where possible and was based on changes in the spatial extent of the modelled habitat of each species. The key conceptual steps in the impact assessment process are shown in Figure 12.

The impact assessment considered a range of potential impacts and how these may combine in a cumulative manner. The sources of potential impacts considered were the Proposal; existing mining projects, non-mining activities and land use for which data were available (i.e. grazing intensity); and reasonably foreseeable future third-party iron ore projects. Only iron ore projects were included because iron ore mining is considered to be the most dominant mining activity within the Strategic Assessment Area and most likely to contribute to cumulative impacts on Specified Protected Matters relative to the Proposal.

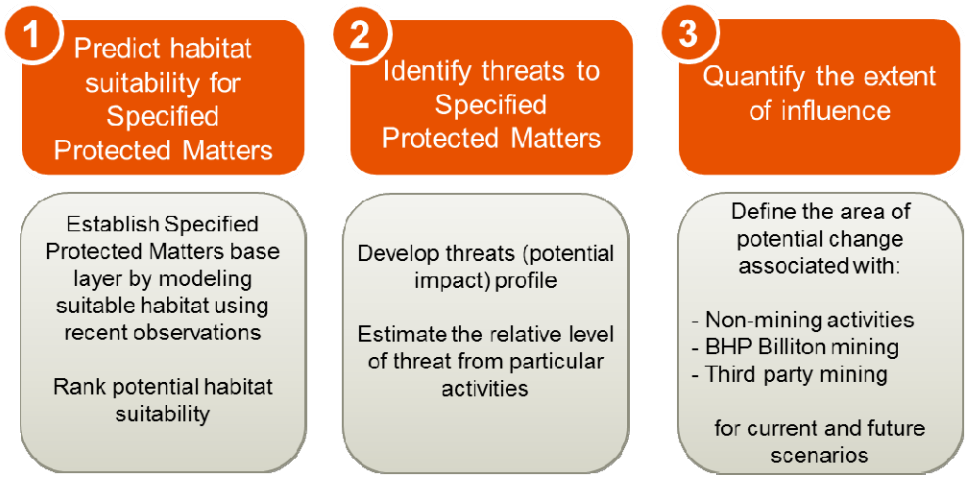


Figure 12: Key stages of the impact assessment process

Relevant potential impacts were determined on a case-by-case basis according to the attributes, values and likely sensitivity to different types of impact for each MNES (Eco Logical 2015b). Relevant potential impacts to MNES were informed by the outcomes of workshops facilitated by DPaW in 2013, described is Section 5.2.3.

Future non-mining impacts such as changes to non-mining land uses, changes to fire regimes and introduction of cane toads were not included in the model, because of the level of uncertainty associated with these impacts. Similarly, climate change predictions were considered to be too uncertain to include a modelled output within the impact assessment; however these impacts are discussed as relevant for each of the Specified Protected Matters.

Potential impacts in the impact assessment were applied to each habitat model as spatial layers using numerical values to represent the potential effect of qualitative judgements of each impact. Application of potential impacts as numerical values in this way affected habitat suitability through multiplication of the impact value by the underlying species habitat model value when the spatial layers were overlaid on each other (Eco Logical 2015b) (Box 3).

In the CIA, a potential impact of 100% was applied as the potential effect of habitat removal and for other impacts expected to reduce habitat suitability to virtually zero. This level of potential impact was applied to potential impacts that had been classified as ‘High’. Similarly, potential impacts of 50% and 20% were applied for potential impacts classified as ‘Medium’ and ‘Low’ respectively (Eco Logical 2015b).

Habitat suitability for each MNES was categorised into four habitat ranks as follows:

- Habitat Rank 4: Highest probability of potential habitat suitability (model value 70% to 100%);
- Habitat Rank 3: Model value 30% to 70%;
- Habitat Rank 2: Model value 10% to 30%; and
- Habitat Rank 1: Lowest probability of potential habitat (model value zero to 10%).

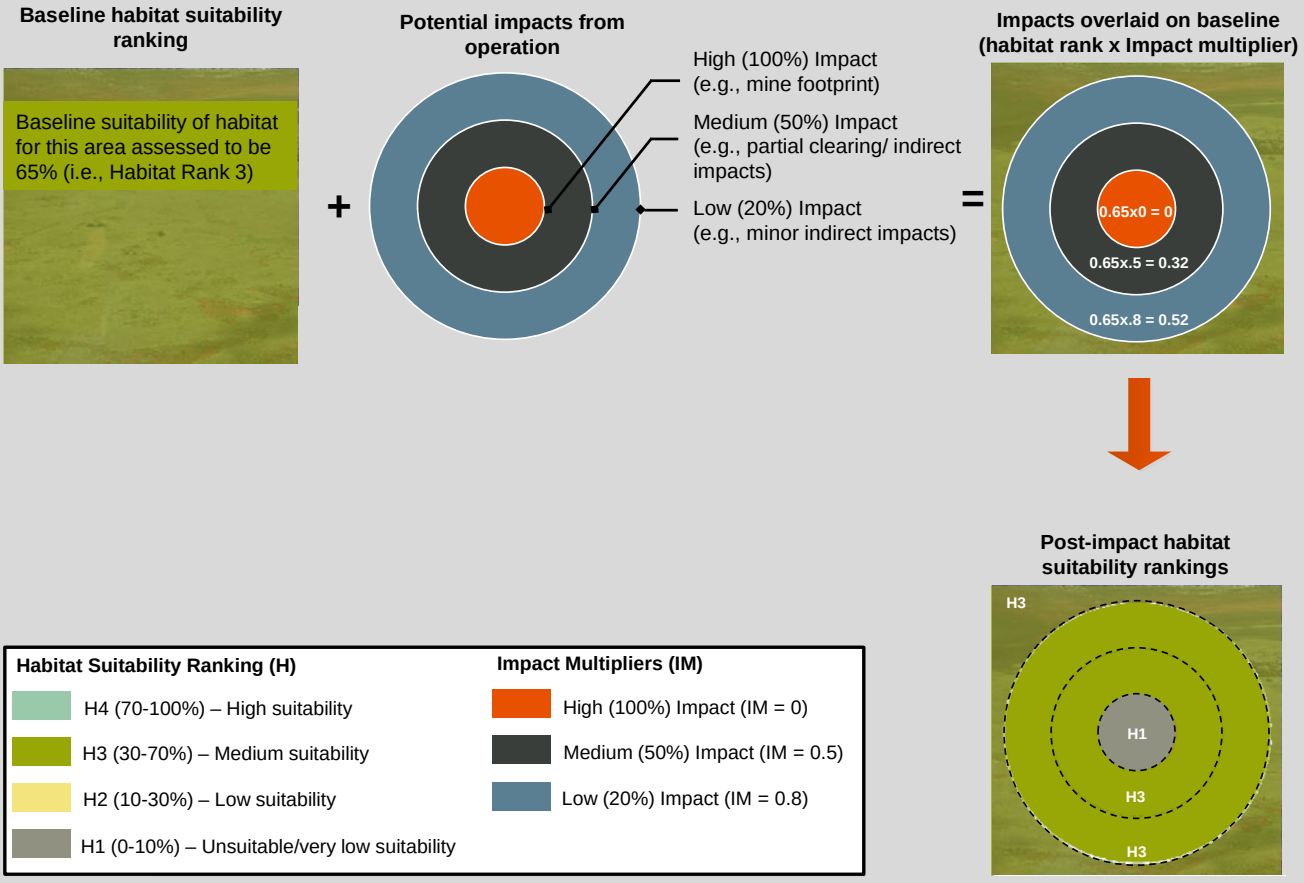
In the CIA, spatial layers were generated separately to account for the potential effect of each impact on its own (independent of other impacts) and then consolidated into an ‘all impacts’ spatial layer for each CIA scenario (Eco Logical 2015b). Operationally, the spatial layers for potential impacts effect change in habitat suitability through multiplication of the impact value by the underlying species habitat model value, when the spatial layers are overlaid on each other in a GIS program (Eco Logical 2015b).

Box 3: Example of how potential impacts were calculated

For potential impact spatial layers representing High (100% impact), Medium (50% impact) and Low (20% impact) impacts respectively, the effect on a particular location in the landscape with a starting species habitat model value of 65% (Habitat Rank 3) would be as follows:

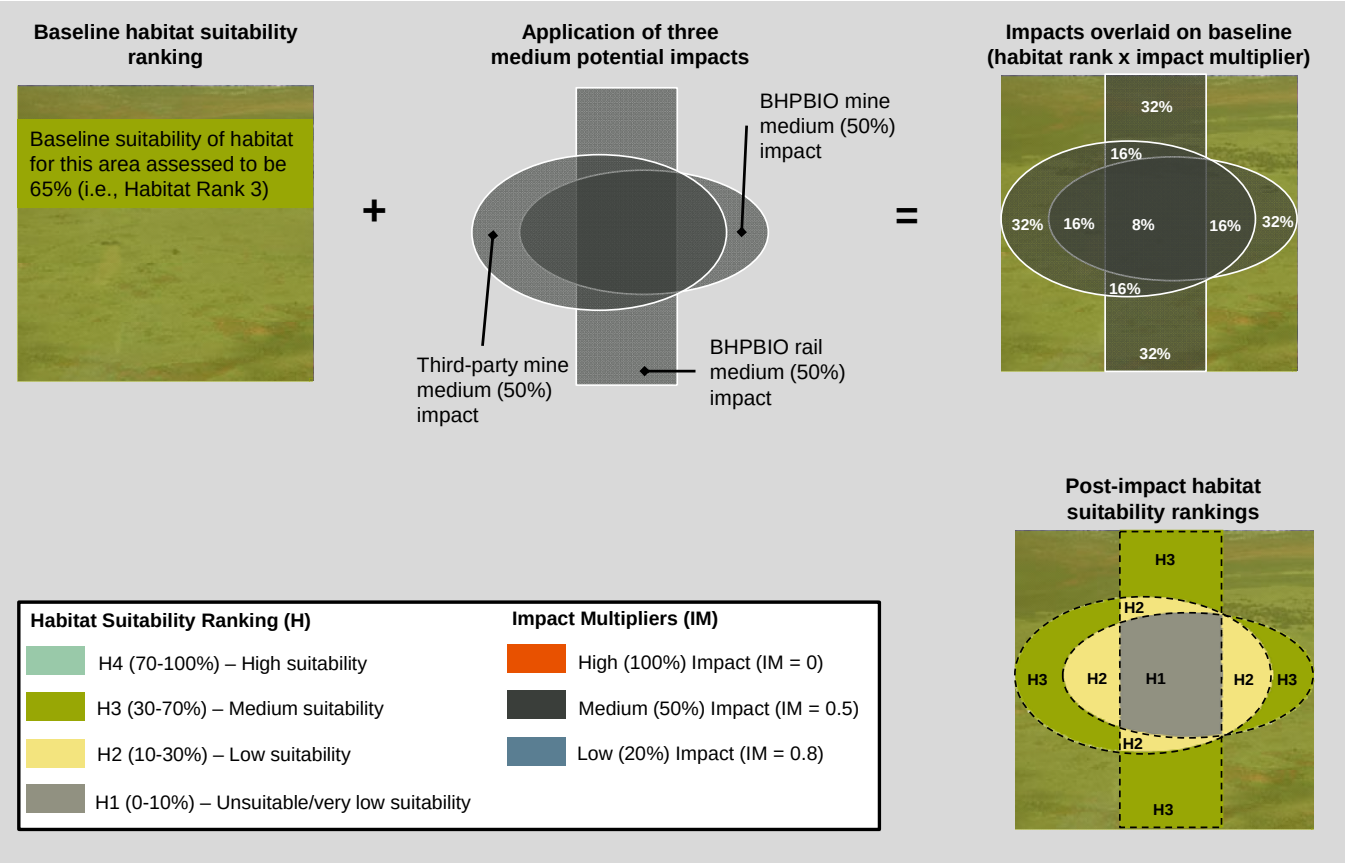
- High (100%) impact: 0.65 (starting habitat model value; Habitat Rank 3) x 0.00 (impact multiplier) = 0.00 (resulting habitat model value; Habitat Rank 1);
- Medium (50%) impact: 0.65 (starting habitat model value; Habitat Rank 3) x 0.50 (impact multiplier) = 0.32 (resulting habitat model value; Habitat Rank 3); and
- Low (20%) impact: 0.65 (starting habitat model value; Habitat Rank 3) x 0.80 (impact multiplier) = 0.52 (resulting habitat model value; Habitat Rank 3).

In the example provided, the application of both low and medium level impacts to Habitat Rank 3 result in the same habitat rank. This is because Habitat Rank 3 is a broad model value range, from 30% to 70%. It should be noted that the model represents coarse values only and is considered fit-for-purpose at a regional scale.



As another example, if three Medium impact spatial layers were overlaid at the same point in the landscape (again, with a starting species habitat model value of 65%; Habitat Rank 3), the effect on habitat suitability would be as follows:

Three Medium (50%) impacts: 0.65 (starting habitat model value; Habitat Rank 3) x 0.50 (impact value 1) x 0.50 (impact value 2) x 0.50 (impact value 3) = 0.08 (resulting habitat model value; Habitat Rank 1).



Source: Ecological (2015b)

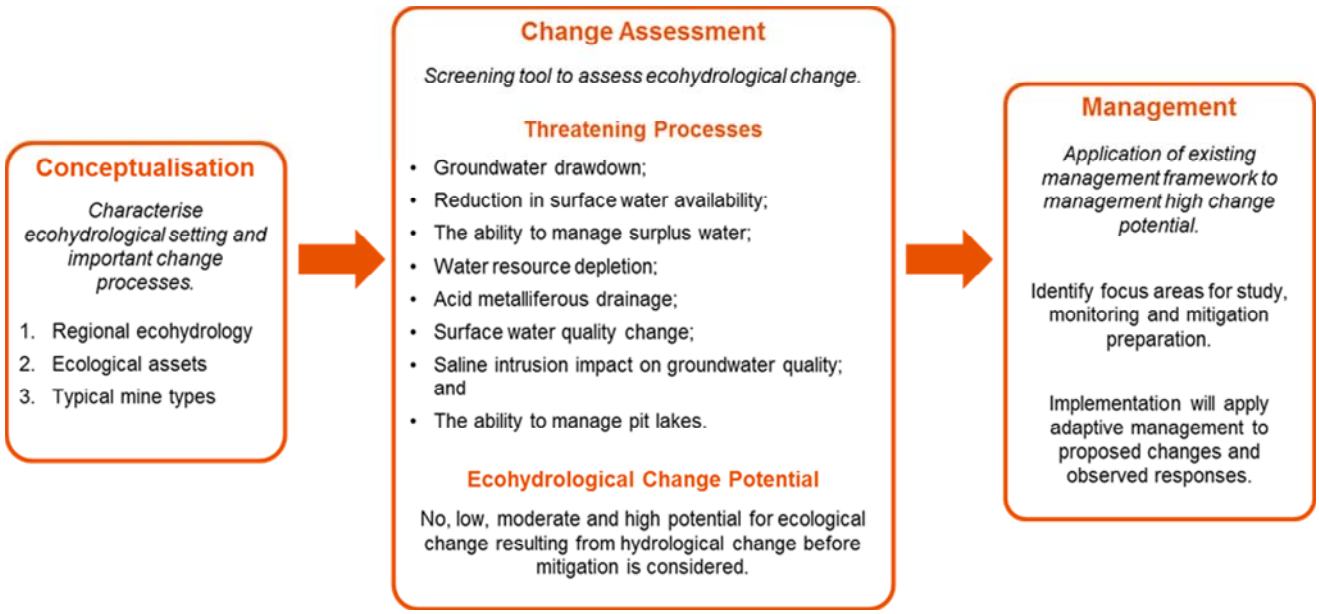
ECOHYDROLOGICAL CHANGE ASSESSMENT

The ecohydrological change assessment was included in the overall CIA. It describes the potential hydrological change for surface water and groundwater associated with the Proposal (BHP Billiton Iron Ore 2015), providing an assessment of potential impacts of the Proposal on groundwater and surface water in the region. For the purpose of the assessment, hydrological change refers to modifications to groundwater and surface water regimes caused by the activities of BHP Billiton Iron Ore and third parties, and ecohydrological change refers to measurable change in ecosystem structure, function or biodiversity resulting from hydrological change.

BHP Billiton Iron Ore ecohydrological conceptualisations provide a basis for the assessment of potential environmental impacts due to hydrological change as a result of the Company's and third-party future operations. The ecohydrological conceptualisation integrates knowledge of hydrological and ecological systems and processes in Pilbara landscapes.

The ecohydrological change assessment process is shown in Figure 13.

The basis of the assessment was to conceptually characterise the hydrological regime of the Pilbara landscapes, with a focus on understanding the connectivity between water resources and major ecosystem components. Ecological assets were identified and classified, with assets considered to have a high level of hydrological dependency and connectivity deemed 'ecohydrological receptors'.



Source: BHP Billiton Iron Ore (2015)

Figure 13: Stepwise method used in the ecohydrological change assessment

The assessment study area was divided into four regions based on major catchment boundaries: Eastern Pilbara, Central Pilbara, Marillana Creek, and Fortescue Marsh. The ecohydrological change assessment outlined the potential for the Proposal to influence the hydrological regime of landscapes and ecohydrological receptors for both development scenarios considered in the Draft IAR – Existing Development and the Full Conceptual Development Scenario.

The ecohydrological change assessment was used as a key input into the CIA on the Specified Protected Matters. A detailed evaluation was undertaken for each of the identified ecohydrological receptors, including Fortescue Marsh, which has been considered under Chapter 6 as a potential future MNES.

5.3 Specified Protected Matters

5.3.1 NORTHERN QUOLL (*DASYURUS HALLUCATUS*)

SPECIES DESCRIPTION AND CONSERVATION STATUS

The northern quoll is the smallest and most arboreal of the four Australian quoll species; is brown with white spots on its back, rump and head; and has a pointy snout (van Dyck & Strahan 2008) (Plate 13).

The species is listed as Endangered under the EPBC Act and as Schedule 1 (species considered rare or likely to become extinct) under the Western Australian WC Act. The listing of the northern quoll by the Commonwealth government was largely predicated on the dramatic decline of populations of the species, particularly in Queensland and the Northern Territory, as a result of toxic ingestions associated with the spread of the cane toad (*Rhinella marina*) (TSSC 2005). When the northern quoll was listed, cane toads were absent from Western Australia and therefore were not considered to have contributed to a decline in northern quoll numbers from the western part of the species' range. Currently, although cane toads are present in the north-eastern parts of Western Australia (the Kimberley), they are yet to reach the Pilbara. However, recent predictive modelling indicates that cane toads will spread from the Kimberley to the Pilbara through a narrow coastal band

(Tingley et al 2013); and there is at least one record of a cane toad from a Pilbara mine site (Government of Western Australia 2015).

Photo: BHP Billiton Iron Ore

Plate 13: Northern quoll

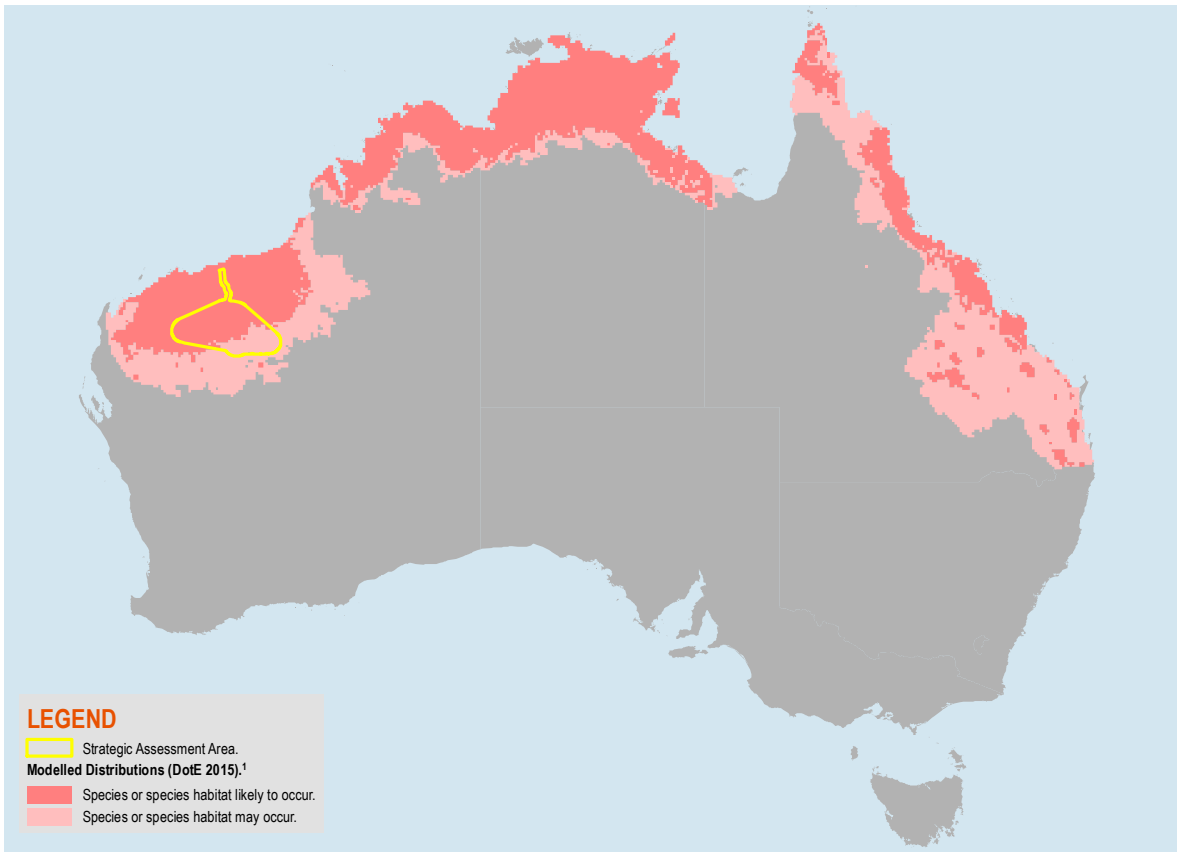
SPECIES DISTRIBUTION

The northern quoll has undergone a dramatic range contraction since European settlement, including a 75% reduction in distribution during the 20th century (Braithwaite & Griffiths 1994). The current distribution is discontinuous across northern Australia, restricted to six main areas, including the Pilbara, Kimberley, Northern Territory and Queensland (three centres) and a number of islands along the north and west coasts (DotE 2014a; Hill & Ward 2010). In the Pilbara, the northern quoll's distribution is bounded in the north, east and south by the Great Sandy Desert, Gibson Desert and Little Sandy Desert (DotE 2014a). The species distribution for the northern quoll is shown in Figure 14.

ECOLOGY

Northern quolls are both terrestrial and arboreal; and although mostly nocturnal, they may be active during the day during the mating season (van Dyck & Strahan 2008). Northern quolls are opportunistic omnivores, consuming a wide range of invertebrates and small vertebrates. They also feed on fruit and are known to feed on carrion and human refuse (van Dyck & Strahan 2008). The species is known to forage over several kilometres, particularly on spinifex plains adjacent to rocky refuge habitat. Foraging habitat is considered to be any habitat within 2 km of rocky habitat within the modelled distribution of the species (DotE 2014a).

Much of the published work on the ecology of the northern quoll comes from studies undertaken across northern Australia, particularly from the Top End of the Northern Territory and from the Kimberley in Western Australia (Begg 1981; Schmitt et al. 1989; Braithwaite & Griffiths 1994; Oakwood 2000). These studies report that reproduction occurs annually, with females breeding during their first year with an average litter size of six to seven. Almost all males die after the mating period in their first year, which ranges from May through to July (Begg 1981; Schmitt et al. 1989; Oakwood 2000). In the Pilbara, mating occurs in July or August and the young are born in August or September (Cook 2013; Woinarski et al. 2014).



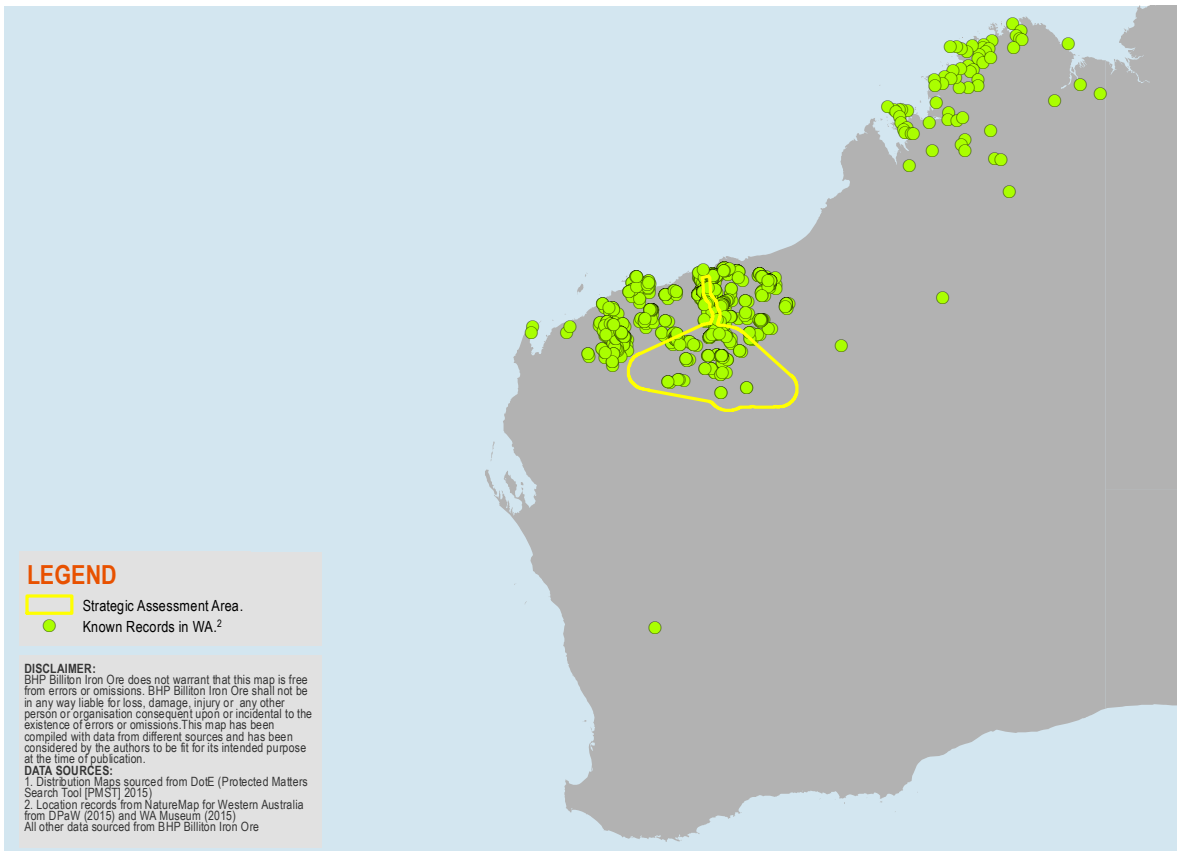


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Figure 14 Northern quoll distribution relative to the Strategic Assessment Area

Several studies from Kakadu National Park and the Kimberley have investigated the home range size of the northern quoll (Begg 1981; Oakwood 2002; Cook 2010), and it ranges from 35 ha for females to 84 ha for males from Kakadu National Park (Oakwood 2002) and 7 ha for females to 64 ha for males from the Kimberley (Cook 2010). In the Pilbara, King (1989) recorded a large variation in home ranges for the northern quoll, with female home range size between 75 ha and 443 ha, and male home range size between 5 ha and 1,109 ha. It is important to note that this was based on a limited number of radio tracking fixes (maximum of 18) and on a limited number of individuals (King 1989).

HABITAT

The northern quoll occurs in a wide range of habitats, usually in eucalypt forests and woodlands, but it is most abundant in rocky areas (Begg 1981; Bradley et al. 1987; Schmitt et al. 1989). Rocky habitats have been identified by Hill and Ward (2010) and Oakwood (2000) as critical to the survival of the species, as they can support higher densities of northern quoll dens and refuge sites. Northern quoll dens are most often made in rock crevices, with surrounding vegetation used for foraging and dispersal (TSSC 2005; Cook 2010). Less often, the species may den in tree holes, logs, termite mounds or goanna burrows, and the den is usually only occupied by an individual (Oakwood 2002).

Rocky water courses, such as gorges and creek systems, are also known to be important habitats; and breeding success of the northern quoll is reportedly even higher in animals that secure a den close to water courses (Oakwood 2000). In the Pilbara, the northern quoll prefers rocky environments, such as iron stone ridges, basalt mesas, granite outcrops, and gorges and other rocky habitats, particularly for denning (Biota 2009; Eco Logical 2014a). It will forage widely over several kilometres, particularly on spinifex plains adjacent to rocky habitats (King 1989; Eco Logical 2014a).

The northern quoll also occurs around mine sites, human dwellings and campgrounds where it scavenges on human refuse, high concentrations of insects around lights, or road kill (Oakwood 2008) and shelters among mining infrastructure, such as buildings, waste rock dumps, laydown areas, vehicles, machinery and scrap metal piles (Oates & Johnson 2013). Predicted habitat modelling for the northern quoll was strongly associated with rugged hills, ranges and outcrops in the northern region of the Strategic Assessment Area; however, habitat was potentially under predicted in the higher elevation ranges in the southern part of the Pilbara bioregion (Eco Logical 2014a). Eco Logical (2014a) suggests that habitat areas in the north and northeast of the Pilbara bioregion are considered core habitat for the northern quoll. The main body of the Strategic Assessment Area is located a minimum of 50 km south of identified core habitat and has a low probability for core habitat (Eco Logical 2014a).

IMPACT ASSESSMENT

The northern quoll is found throughout the Pilbara and is known to occur in areas covered by Strategic Assessment Area; however, the modelling undertaken by Eco Logical suggests that the highest suitable habitat for the northern quoll occurs outside the Hamersley subregion. The distribution of preferred habitat based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 15. Since the development of this model, publicly available data has been updated and these data have been included in Figure 15. The additional records are consistent with the modelled habitat preference across the Pilbara. The additional records also demonstrate the type of new information that will be used throughout implementation of the Proposal as part of the Validation Framework and adaptive management (refer to Chapter 8).

The presence of mining operations and transport corridors within areas and habitats that are considered suitable for the northern quoll suggests that there may be an impact to the species. While the northern quoll is distributed across the Strategic Assessment Area and the Pilbara, there are fewer records in the southern Pilbara (see Figure 15).

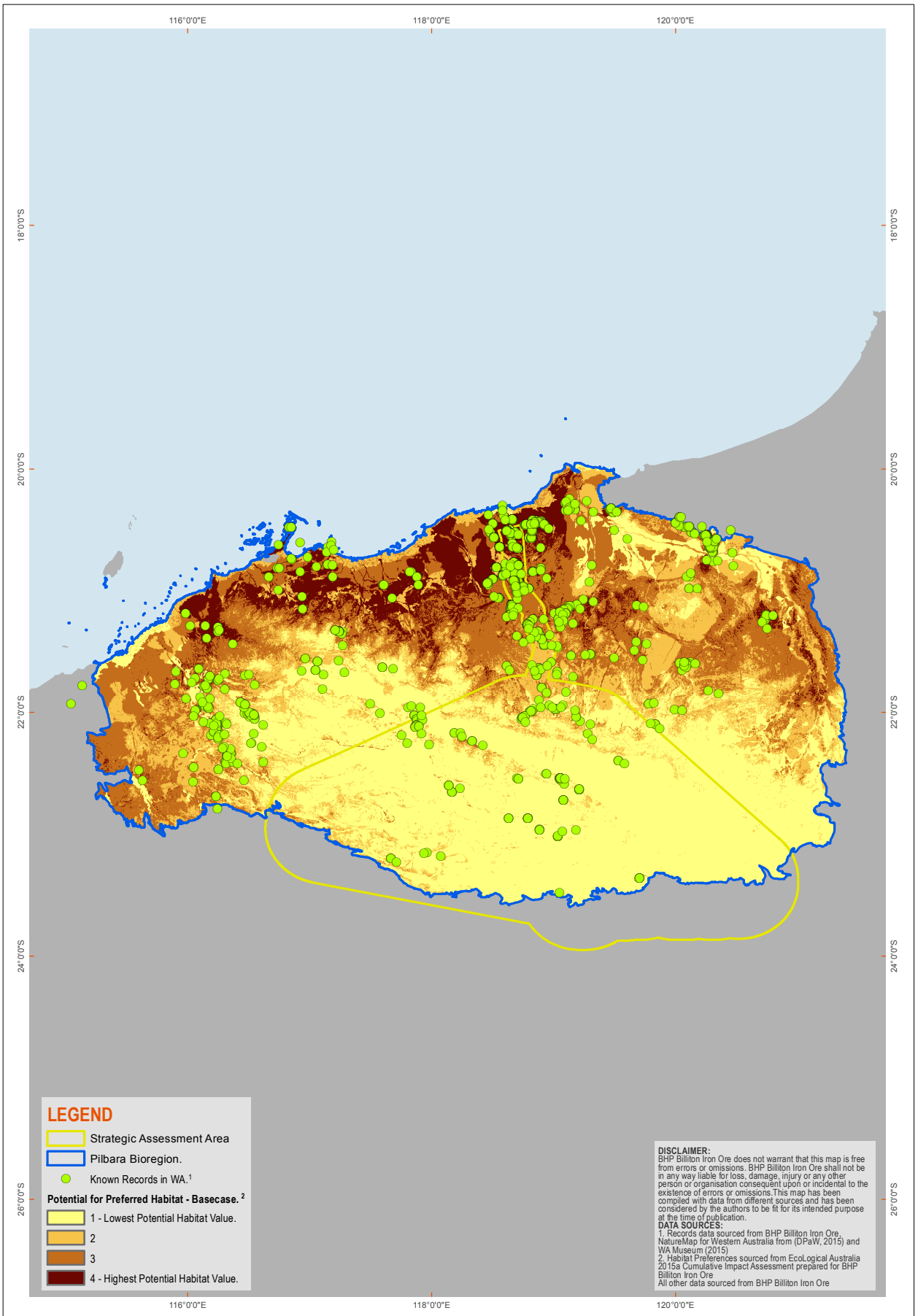

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Figure 15 Modelled distribution of preferred habitat for the northern quoll

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The majority of recent records in Strategic Assessment Area are from the rail line corridor and not in BHP Billiton Iron Ore tenure in the southern section of the Strategic Assessment Area, where there are approximately 10 records in the databases (NatureMap and BHP Billiton Iron Ore fauna database) (see Figure 18). Numerous fauna surveys (approximately 135) have been undertaken in BHP Billiton Iron Ore tenure with very few records.

Dr Mike Bamford, one of the peer reviewers for the CIA, focused on the work and text presented for the northern quoll. Dr Bamford provided a schematic distribution map for the northern quoll indicating alternative locations based on extensive survey experience and knowledge of the literature and the ecology of the northern quoll (Figure 16). Dr Bamford's northern quoll distribution map is well aligned with the modelled output of preferred habitat presented in Figure 15.

Key Threats to the Northern Quoll

Known and perceived threats to the northern quoll are identified in the Commonwealth Species Profile and Threats (SPRAT) database (DotE 2014b), the national recovery plan for the species (Hill & Ward 2010) and the northern quoll workshop facilitated by DPaW (as described in Section 5.2.4).

From the review of this information, the key threats to the northern quoll in the Pilbara region have been identified as:

- removal and fragmentation of habitat due to land clearing;
- degradation of habitat as a result of grazing pressure;
- degradation of habitat due to inappropriate fire regimes;
- predation and competition from non-native species;
- mortality from collision with road and/or rail traffic;
- emission of noise and light;
- climate change; and
- mining development.

These threats are described below and graphically represented in the conceptual threats model shown in Figure 17. The model shows the relative ranking of the threats to the northern quoll and also identifies which threats were quantitatively assessed in the CIA.

The cane toad is a potential threat to northern quolls, due to mortal, toxic effects following ingestion of the toads. While the cane toad's predicted future occurrence in the Pilbara is recognised, the interactions with and impacts to wildlife are complex, and there are limited data available to extrapolate potential future impacts of the cane toad within the Pilbara (Eco Logical 2015b). Therefore, the potential impacts of future effects of the cane toad on the northern quoll were not applied in the CIA modelling (or shown in Figure 17), but they are given consideration below.

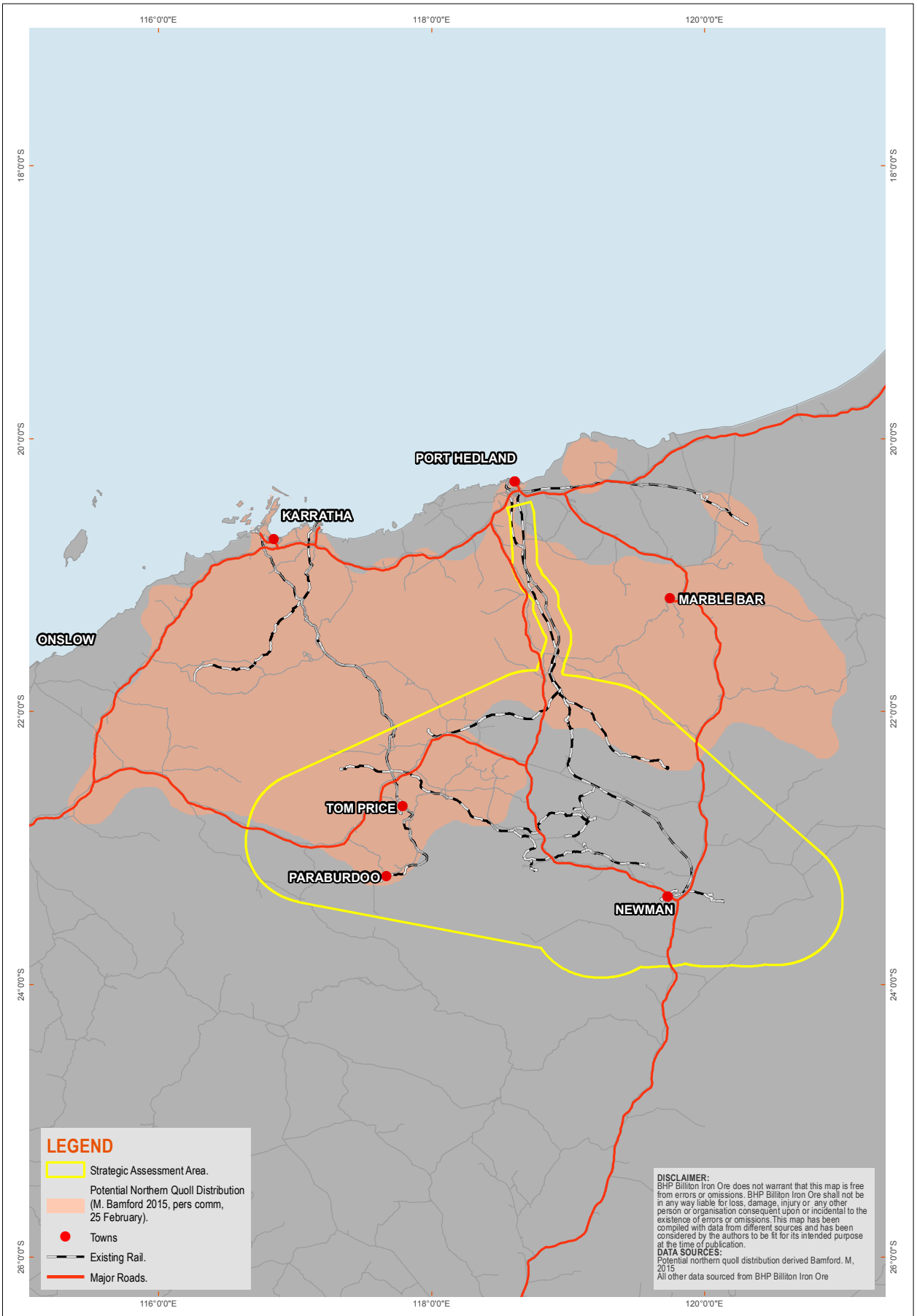

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Figure 16 Alternative distribution for the northern quoll

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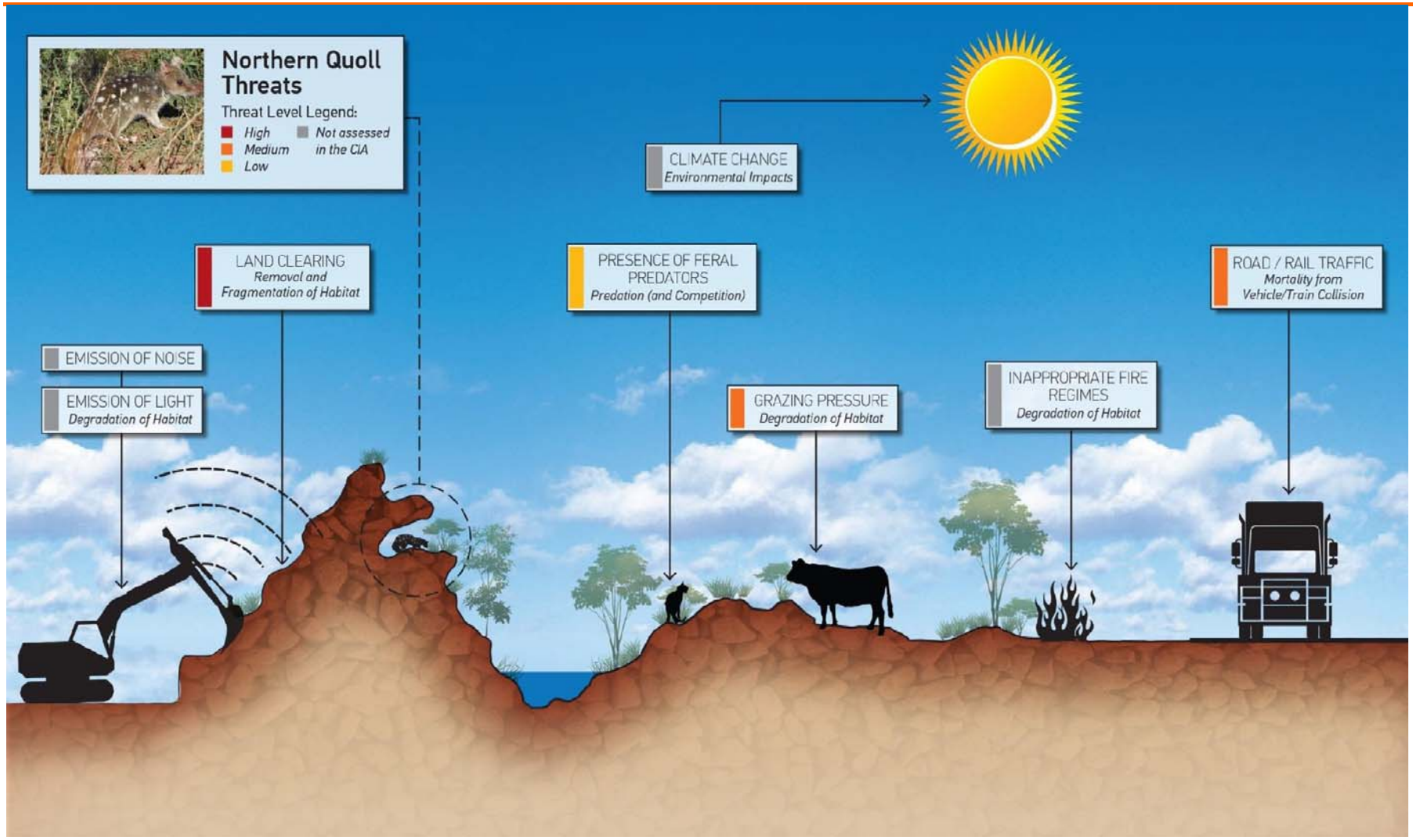

Figure 17: Conceptual diagram of key threats for the northern quoll

Removal and Fragmentation of Habitat Due to Land Clearing

The removal of northern quoll habitat may result in the loss of denning and foraging habitat, consequently causing a reduction in its distribution in the Pilbara bioregion. Furthermore, the removal of habitat may displace individuals, affect reproduction and result in mortality or extinction of local populations. This may also result in the isolation of populations, causing reduced gene flow; and increased predation by or competition with feral animals. At a bioregional level, the removal of habitat is recognised as having the greatest potential impact; consequently, the removal of habitat, should it occur, is rated as High in the CIA modelling (Eco Logical 2015b).

In the Strategic Assessment Area, records of the northern quoll primarily occur within granite outcrops or tors adjacent to BHP Billiton Iron Ore's railway line in the Chichester subregion (see Figure 18). These populations are most likely important for the persistence of northern quolls in the region and to allow gene flow between populations.

Records within BHP Billiton Iron Ore mining tenure in the Hamersley subregion are limited to a small number of scats and records of individual juvenile or male animals (see Figure 14), which were possibly dispersing from key denning habitat at the time. Based on BHP Billiton Iron Ore survey data, fauna habitats within BHP Billiton Iron Ore mining tenure, particularly in the Strategic Assessment Area, do not appear to support a large or persistent population of northern quolls. The northern quoll does utilise highly disturbed areas; however, this occurs only when other resources are present, such as food and shelter. Habitat fragmentation could isolate northern quoll populations, reduce genetic connectivity across affected areas and increase the risk of local extinctions; however, this would only occur in areas where there is significant clearing of vegetation (e.g. for mines and transport corridors), and this scale of clearing is more likely to occur in the southern part of the Strategic Assessment Area where there are very few northern quoll records (see Figure 14). Habitat fragmentation could reduce landscape permeability for this species. A reproductive strategy of male semelparity (characterised by a single reproductive episode before death) in some populations makes the northern quoll particularly susceptible to local extinctions following isolation of populations by habitat fragmentation (Hill & Ward 2010). The majority of northern quoll records in the vicinity of the Strategic Assessment Area occur adjacent to the Newman to Port Hedland rail line in the northern section of the Strategic Assessment Area. A study by Creese (2012) that examined the use of BHP Billiton Iron Ore rail culverts by fauna found that the northern quoll was the most commonly recorded fauna species using these culverts, with 59 records (from a total of 332 records from 39 species). These rail lines have been in use for approximately 50 years, and there are still significant populations of northern quolls adjacent to them.

Potential impacts to the northern quoll from fragmentation of habitat are rated from Low to High in the CIA, with the rating dependent on the size of the patch that is fragmented (Eco Logical 2015b).

Degradation of Habitat as a Result of Grazing Pressure

Increased cattle stocking rates are considered a threat to the northern quoll in Western Australia (DotE 2013b). Grazing may alter habitat for the northern quoll by reducing ground layer cover and in some cases increasing shrub cover by promoting vegetation thickening and weed invasion (Hill & Ward 2010). Loss of cover may increase the vulnerability of the species to predation, but it also increases exposure of vertebrate prey (Hill & Ward 2010). Further, cattle grazing and presence (ground disturbance) is likely to change the nature of fire (e.g. intensity and extent) based on the effect cattle can have on low strata vegetation, including the potential for introduction or spread of weeds with high fuel loads. The interaction of grazing pressure and fire may act to compound negative effects on the northern quoll; however, this was not considered in the application of the potential impacts of grazing (Eco Logical 2015b).

Habitat suitability is expected to reduce as habitat condition is degraded and prey becomes less abundant as grazing pressure increases. The impact of grazing was applied to the northern quoll from a spatial layer for grazing pressure developed for the Pilbara bioregion by Eco Logical (2015a). The grazing pressure layer

categorised areas as either zero, low, medium or high grazing pressure based on land system data (which contain a 'Pastoral Potential' spatial attribute; land systems are characterised according to vegetation types, substrate and landscape characteristics (van Vreeswyk et al. 2004) and distance to water (Eco Logical 2015b). Potential impacts from grazing to the northern quoll are rated from Low to Medium in the CIA, with this being dependent on the level of grazing.

Degradation of Habitat due to Inappropriate Fire Regimes

The detrimental impact of inappropriate fire regimes (frequent and hot) on northern quolls is likely to be a result of changes in habitat structure and floristics (McKenzie et al. 2007). Burning that is too frequent may reduce the abundance of food if there is insufficient time to allow prey species, mostly invertebrates, to complete their life cycles (Hill & Ward 2010), although this appears to be less applicable to the northern quoll. For example, a radio-tracking study in Kakadu National Park in the Northern Territory found no decline in body weight or condition after fire, and Woinarski et al. (2004) found that northern quolls were more abundant in sites burnt annually, compared with sites that had not been burnt for 23 years, on a property in outer Darwin. It is concluded that the opportunistic nature of the northern quoll diet makes them less vulnerable to starvation and their vertebrate prey are probably more exposed and easier to catch after fire (Oakwood 2000).

It is unclear whether fire influences breeding success in the northern quoll; a study in Kakadu National Park found that breeding was delayed by one month, and the mean number of young leaving the pouch per female was lower after fire (Begg 1981), whereas a later study in Kakadu National Park (undertaken over a longer period) found no evidence that the timing of breeding or the number of young leaving the pouch was affected by fire (Oakwood 2000).

The season, frequency, extent and severity of fires are all likely to be key factors influencing northern quoll populations. The greatest threat posed by fire, however, is probably the increased risk of predation on northern quolls after removal of cover. When fire has removed the ground cover, northern quolls are more vulnerable to predators, such as dingoes, cats and raptors (Oakwood 2004). This may particularly be the case in habitats without rocky outcrops where northern quolls rely on tree hollows or hollow logs for daytime shelter, as fire will reduce the availability of hollow logs (Williams et al. 1999).

Note that all of the above studies have been undertaken in the Northern Territory where climate and the habitats that the northern quoll once occurred in (prior to the arrival of the cane toad) are very different to the Pilbara; consequently, may not be representative of the impact of inappropriate fire regimes on the northern quoll in the Pilbara.

With regard to reasonably foreseeable future impacts of fire, the effect of mining and non-mining activities on alteration of fire impacts is unclear and likely to be influenced primarily by assumptions of fire management and fire response. For this reason, the impact to the northern quoll from inappropriate fire regimes was not included in the CIA.

Predation and Competition from Non-Native Species

Feral predators may compete with the northern quoll for food or may prey on it (DotE 2014a). Although the significance of this threat to the northern quoll is yet to be assessed, feral predators have significantly affected other species of quoll, including the western quoll and spotted-tailed quoll. Both cats and foxes are present in the Pilbara.

In parts of the eastern Pilbara, along with western and coastal areas, the current distribution of the northern quoll overlaps with that of the fox (Hill & Ward 2010); and competition with and predation by the fox may be contributing to the decline of the northern quoll in this part of its range.

Feral predators do occur throughout the Pilbara generally, including remote areas away from human settlement, such as those areas surrounding mine activities. Feral predators are considered likely to occur in

greater numbers near areas of human settlement (such as towns and mine camps) as a result of increased opportunities for food and near roads as a result of facilitated movement (e.g. Andrews 1990; Brown et al. 2006; Lach & Thomas 2008; Mahon et al. 1998). As a result, potential impacts of predation in the CIA were related to proximity to human settlements and roads or tracks (and to power lines under the assumption that power lines have an associated access track), with distances relating to the home ranges of feral predators.

Mortality from Collision with Road and/or Rail Traffic

Mortality from collision with vehicles or trains is considered as an impact because the northern quoll is an opportunistic forager (Hill & Ward 2010) and may forage on roads and rail lines and scavenge on roadkill (DotE 2014a). Consequently, there is a risk of mortality from vehicle or train strike.

There are limited data for roadkill rates for the northern quoll and spatial and temporal factors that may drive the incidence of roadkill (such as the presence of hills adjacent to roads or rail, traffic densities, traffic speed, or northern quoll densities) have not been documented. Potential impacts from mortality from collision with vehicles or trains to the northern quoll is rated from Low to Medium in the CIA, with this being dependent on the distance to roads and rail.

Emission of Noise and Light

The Proposal will increase noise and light in the vicinity of mining operations. Noise and light has been documented to affect some fauna (e.g. Larkin et al. 1996), however the extent to which the northern quoll may be affected by noise or light is not well understood and assessing impacts of degradation of habitat through increased noise and light in terms of its frequency, intensity and extent is difficult. For example, an animal may respond differently to rare and short term light disturbance compared with ongoing light disturbance. The introduction of artificial light could affect the species given that it is largely nocturnal, with potential to affect movement and behaviour thereby impacting foraging and mating activity (Beier 2006). In some instances, artificial light may increase foraging activity due to providing a higher abundance of food resources (e.g. lights attracting insects) (Larkin et al. 1996). Due to the range of possible effects that noise and light could have on the northern quoll, these threats were not modelled in the CIA and are not considered further in this Draft IAR.

Climate Change

Climate change is recognised as a key threat to the northern quoll (DotE 2014a). Predicted changes to climatic conditions in the Pilbara (as described in Section 4.7.2) may impact northern quoll populations by causing modification, loss or fragmentation of key habitat or by exacerbating other threats such as increasing the frequency and intensity of fires and further mediating the invasion of introduced species (Dunlop et al. 2012).

Preliminary analysis and modelling of potential effects as a result of recognised predicted climate change estimates was undertaken during the development of the CIA; however, the level of uncertainty associated with the modelling outcomes was considered to limit its interpretation in relation to cumulative impacts in the Pilbara and it was subsequently excluded from the CIA.

Mining Development

The threat posed to the northern quoll from mining development is predominantly from the direct and indirect impacts to habitat, the introduction/attraction of non-native species and vehicle collisions, the details of which are described within the other key threat sections above.

Potential impacts (primarily for mine and transport infrastructure) to the northern quoll will change over time and are likely to be of lower significance in the southern section of the Strategic Assessment Area (given few records) but, in general, will likely consist of habitat loss and fragmentation during the preconstruction phase and mortality from collisions with vehicles and trains during the operational phase. During closure, there is the

potential for northern quolls to return to previously occupied areas as landforms and vegetation are returned and rehabilitated.

Lethal Toxic Ingestion of Cane Toads

The northern quoll is vulnerable to lethal toxic ingestion of cane toad toxin, and this is considered the main threat to northern quoll populations outside the Pilbara (Oakwood 2003; Hill & Ward 2010). The future predicted spread of the cane toad into the Pilbara bioregion may have comparable negative impacts to the northern quoll as observed in other areas of northern Australia. Some models predict that the cane toad's distribution will spread to include the Pilbara via the narrow coastal strip but that this spread will be dependent on artificial water bodies in this narrow strip (Tingley et al. 2013); however, introduction via vehicles or equipment has also occurred (Government of Western Australia, 2015).

Recovery and Conservation Management Priorities for the Northern Quoll

The draft National Recovery Plan for the Northern Quoll (Hill & Ward 2009) aims to minimise the rate of decline of the northern quoll in Australia, such that viable populations remain in each of the major regions of distribution into the future.

The nine main objectives of the draft plan include:

- protect northern quoll populations on offshore islands from invasion and establishment of cane toads, cate and other potential invasive species.
- foster the recovery of northern quoll sub-populations in areas where the species has survived alongside cane toads.
- halt declines in areas not yet colonised by cane toads.
- halt declines in areas recently colonised by cane toads.
- maintain secure populations and source animals for future reintroductions/introductions, if they become appropriate.
- reduce the risk of northern quoll populations being impacted by disease.
- reduce the impact of pastoral land management practices on Northern Quolls.
- raise public awareness of the plight of northern quoll and the need for biosecurity of islands and Western Australia.

Some specific actions identified include continue research into the susceptibility of the northern quoll to cane toad poisoning, investigate factors causing declines in northern quoll populations not yet affected by cane toads, continue studies of whether there is a genetic basis for differences in susceptibility of northern quolls to cane toad toxins, development and, where required, implementation of a strategy for rapid-response control of cane toad or feral cat outbreaks on offshore islands occupied by northern quolls.

BHP Billiton Iron Ore has committed to considering contemporary guidance (such as threat abatements plans) as part of the Validation Framework provided within the MNES Program. The Validation Framework is discussed further in Section 8.6.2.

Extent of Potential and Cumulative Impacts to the Northern Quoll

Eco Logical (2015b) modelled the habitat preference (the probability of that species being located in certain habitats) for the northern quoll using 518 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat

Rank 4) was strongly associated with rugged hills, ranges and outcrops in the north and northeast of the Pilbara bioregion, as opposed to areas in the central and southern areas of the Pilbara bioregion.

Table 7 shows the area and proportion of the Pilbara bioregion of habitat suitability from 1 to 4, with Habitat Rank 1 being the lowest probability of potential habitat and Habitat Rank 4 being the highest probability of potential habitat. These areas represent the base case habitat suitability for the northern quoll.

Table 7: Classification and ranking applied to the northern quoll habitat model

Model Value	Habitat Rank	Habitat Suitability	Modelled Area (ha) in Pilbara Bioregion
70-100%	4	Highest probability of potential habitat	1,552,321 (9%)
30-70%	3	↓	4,497,928 (25%)
10-30%	2		3,822,101 (21%)
0-10%	1	Lowest probability of potential habitat	7,920,267 (45%)

Source: Eco Logical (2015b).

The extent of potential impacts to the northern quoll were developed and modelled in the CIA (Eco Logical) and assigned to different categories:

- Existing impacts (this includes existing mining and non-mining impacts);
- Future third-party mines (potential impacts from reasonably foreseeable future third-party iron ore mines, described in Section 5.2.2 and shown in Figure 18); and
- Full Conceptual Development Scenario (this includes potential impacts from the Proposal described in Section 5.2.2 and shown in Figure 18).

The potential cumulative impact is all of the above impacts combined.

The CIA model indicated a potential cumulative impact of 1.4 million hectares (91%) to the most suitable modelled habitat (Habitat Rank 4 - highest probability of potential habitat). Existing impacts (e.g. grazing pressure and human settlement) were the main contributors to this impact (Table 8 and Box 4).

Table 8: Cumulative effects assessment for potential cumulative impacts to the northern quoll (expressed as a percentage and in hectares of Habitat Rank 4)

Specified Protected Matter	Base Case[1]	Existing Impacts	Reasonably foreseeable third party development	BHP Billiton Iron Ore Full Conceptual Development Scenario	Potential Cumulative Impact
Northern quoll	1,552,321 ha	-1,411,805 ha (-91%)	-1 ha (<-1%)	504 ha (<1%)	-1,411,302 ha (-91%)

1. Base Case means area of modelled Habitat Rank 4 within the Pilbara bioregion.
Source: Eco Logical (2015b).

The model indicates that there is a relatively small increase of 504 ha (once existing impacts are considered) in potential impact to Habitat Rank 4 (highest probability of potential habitat) for the northern quoll when all future operations within the scope of the Proposal are included (Eco Logical 2015b). This is due to the removal of some indirect impacts within the Full Conceptual Development Scenario upon closure, such as fauna mortality from collision with roads and trains.

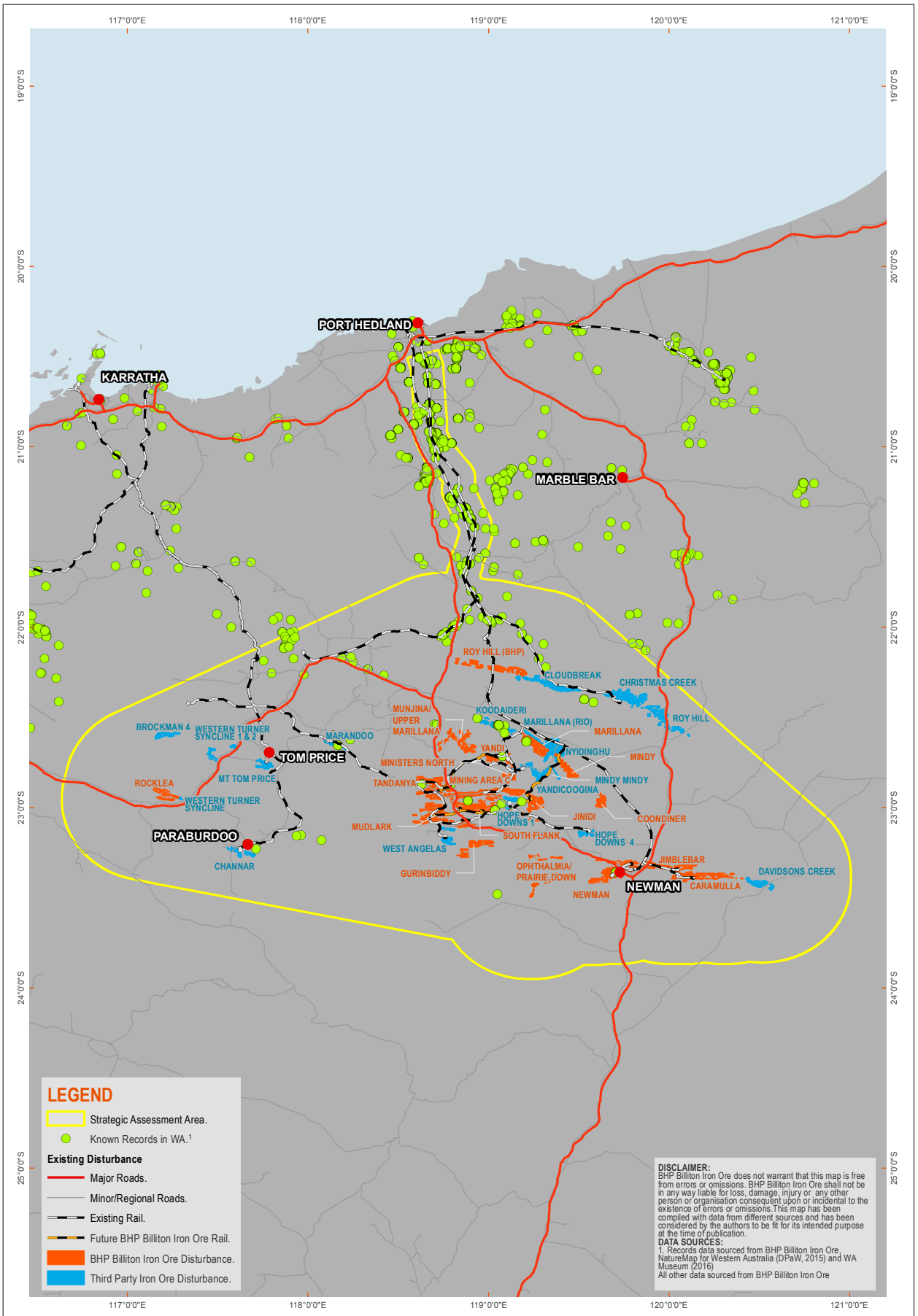

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Figure 18 Northern quoll distribution records and Full Conceptual Development Scenario

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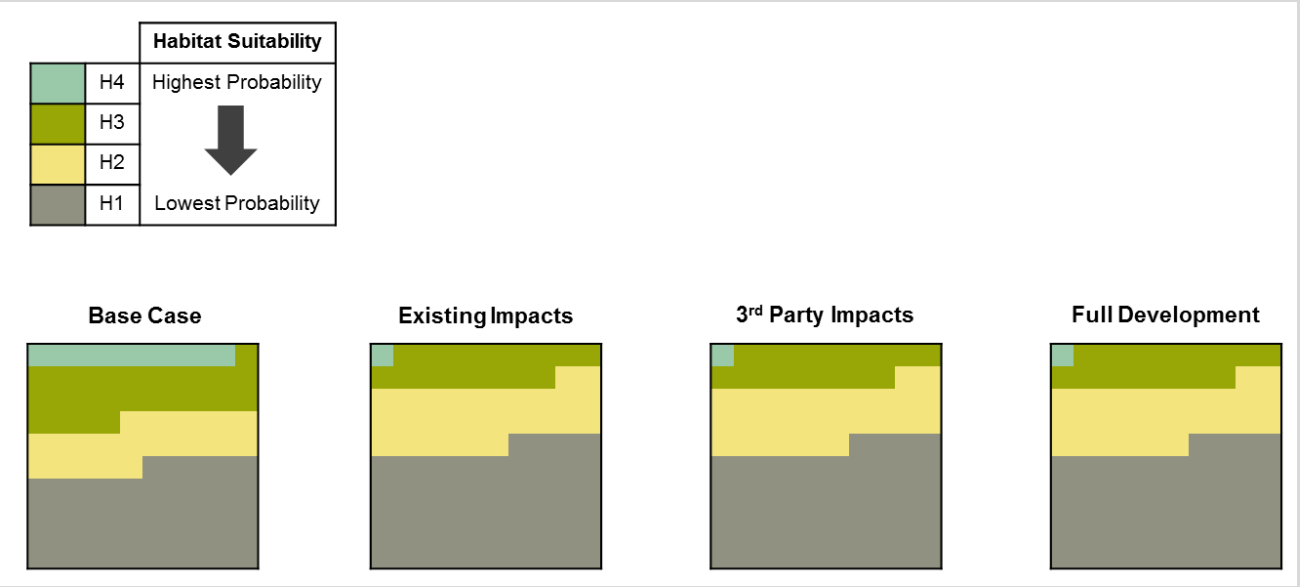
Other indirect impacts such as ecohydrological change were included in the Full Conceptual Development Scenario.

Although the model indicates a potential increase in preferred northern quoll habitat at a regional level, BHP Billiton Iron Ore considers this prediction to be indicative only and recognises that the Proposal will potentially contribute to cumulative impacts to the northern quoll in the Pilbara bioregion. Further, the predicted 504 ha increase in Habitat Rank 4 could change in the future as a result of changes to threats such as the introduction of cane toads to the Pilbara. Nevertheless, it should be noted that existing impacts are largely related to land use (e.g. grazing pressure) in the region, and impacts (at the regional scale) due to mining are comparatively small. At the local level of an existing or future operation, this impact could be reversed in some cases. BHP Billiton Iron Ore has measures in place to validate and mitigate potential impacts to the northern quoll (Chapter 8).

Box 4: Visualisation of numerical CIA results for the northern quoll

A visualisation of the relative change in each of the habitat types is shown in Figure 26. Each box represents 100% of the modelled area (the Pilbara) and shows the relative proportion of each habitat suitability class under each of the modelled scenarios:
- Base case
- Base case + existing impacts
- Base case + existing impacts + third-party impacts
- Base case + existing impacts + third-party impacts + BHP Billiton Iron Ore Full Conceptual Development Scenario impacts

For the northern quoll, existing mining, infrastructure and pastoral impacts have reduced the proportion of both Habitat Rank 4 (H4) and Habitat Rank 3 (H3) habitat classes from the base case (from approximately 10% to 1% for H4 and from approximately 25% to 17% for H3), with a corresponding increase in the proportion of Habitat Rank 2 (H2) and Habitat Rank 1 (H1). The addition of both third-party and BHP Billiton Iron Ore Full Conceptual Development Scenario potential impacts do not materially change these relative proportions.



Visual representation of changes to habitat ranks for the northern quoll

To further assess impacts to northern quoll from iron ore mining in the Pilbara, BHP Billiton Iron Ore conducted an impact assessment based on northern quoll species records. The records data were obtained from the Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. The results are presented in Table 9.

Table 9: Impact assessment to northern quoll based on species records

Total known records	Records within Strategic Assessment Area	Existing		Future		Cumulative impact (total records impacted and % of SAA records)
		Third Party	BHP Billiton Iron Ore	Third party Reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	
3638	403	0	13	1	15	16 (4 %)

Based on the species records data, 4 % of the known records within the Strategic Assessment Area are predicted to be impacted by iron ore mining in the Pilbara. The data show that the majority of the impact is from BHP Billiton Iron Ore.

The Pilbara population of the northern quoll may become more important to conservation with time as the cane toad moves across the Kimberley, causing local extinctions and a potential severe decline in the population (based on impacts to quolls in Queensland and the Northern Territory). Some models (e.g. Tingley et al. 2013) predict that the cane toad's distribution will spread into the Pilbara via the narrow coastal strip, but others predict that the cane toad will not cross into the Pilbara due to large areas with no standing water between the Kimberley and Pilbara regions. There is one major road (the Great Northern Highway) into the Pilbara from northern Australia, and there has been a recent record of a cane toad being introduced to the Pilbara, presumably via a vehicle (Government of Western Australia 2015). Mining activities may speed up the cane toad's natural progression or may extend its distribution and persistence due to the presence of artificial water bodies (e.g. dams, turkey's nests, waste water treatment plants and pit lakes).

Potential impacts to the northern quoll as a result of the Full Conceptual Development Scenario are not considered to be significant at the regional scale given that there is a negligible impact on the most preferred habitat (Habitat Rank 4) from the Proposal. Peer review comments for the northern quoll cumulative impact assessment model are provided in Appendix 5. There are few records within the Full Conceptual Development Scenario footprint; therefore at this stage the species is considered to be at low risk from the Proposal. Impacts to the northern quoll at a local scale will be validated on a case-by-case basis through processes described in the Validation Framework, where key inputs such as engineering design and contemporary guidance will be taken into account in decision-making before taking a Material Action. The Validation Framework is described further in Section 8.6.2.

Other key threats that were not modelled in the CIA for the northern quoll included inappropriate fire regimes and climate change. The reasons for not including these in the CIA are discussed in the consideration of potential impacts to the northern quoll above. BHP Billiton Iron Ore considers that the Proposal is unlikely to impact upon climate change or fire regimes as these are largely independent of and would not be exacerbated by the Proposal.

The Draft MNES Program (BHP Billiton Iron Ore 2016) includes commitments to consider and manage as part of its adaptive management approach any material future changes to the environment, including climate change and environmental change (e.g., presence of cane toads). Further, BHP Billiton Iron Ore has committed to applying the mitigation hierarchy (avoid, mitigate and, as a last resort, offset) to manage its potential impacts

to the Specified Protected Matters, including the northern quoll. Further information regarding the commitments made in the Draft MNES Program is provided in Chapter 8.

BHP Billiton Iron Ore considers that the potential impacts to the northern quoll from implementation of the Proposal are not likely to be significant, given the negligible modelled impact predicted to northern quoll habitat from future reasonably foreseeable third-party mining operations and the BHP Billiton Iron Ore Full Conceptual Development Scenario. BHP Billiton Iron Ore's commitments in the Draft MNES Program to validate these potential impacts, manage future change and apply the mitigation hierarchy ensure that impacts to the northern quoll will be managed to an acceptable level during the life of the Proposal.

5.3.2 GREATER BILBY (*MACROTIS LAGOTIS*)

SPECIES DESCRIPTION AND CONSERVATION STATUS

The greater bilby (*Macrotis lagotis*) is the only surviving member of the family Thylacomyidae, with the lesser bilby (*Macrotis leucura*) considered extinct in the 1960s (Johnson 2008). The greater bilby is a small nocturnal burrowing marsupial that is restricted to the arid regions of central Australia (Plate 14). It is rabbit-sized with large ears, a long pointed snout and a black tail with a white tip. It has long, grey fur over most of the body and white to cream on the belly (van Dyck & Strahan 2008). It has two unclawed toes and three stoutly clawed toes that enable it to burrow effectively. The greater bilby is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act.

Photo: Bruce Greatwich

Plate 14: Greater bilby

SPECIES DISTRIBUTION

The greater bilby once occurred across most of the arid and semi-arid regions of the Australian mainland, south of about latitude 18°S (Johnson 2008; Friend et al. 2008). The greater bilby's range has significantly contracted since European settlement, and it now remains patchily distributed through the Tanami Desert in the Northern Territory and west to Broome and south to Warburton in Western Australia. There are isolated populations north of Birdsville in southwestern Queensland and northeast of Alice Springs in the Northern Territory (Johnson 2008). The species distribution for the greater bilby is shown in Figure 19.

The greater bilby was common throughout most of its range until the early 1900s when there was a sudden and widespread collapse (Abbott 2001; Johnson 2008). This collapse and range contraction has been attributed to predation from cats and foxes, habitat destruction from introduced herbivores and changed fire regimes. Feral cats have been linked to the reduced success of reintroduced populations (Pavey 2006b).

Within the Pilbara bioregion, the greater bilby exists along the Fortescue River and northeast to Shay Gap (Pavey 2006a). The extent of occurrence for the greater bilby is thought to have remained relatively stable over the last 20 years.

There are disjunct populations of the greater bilby throughout Western Australia, including in the Gibson Desert, southwestern Kimberley, inland areas of the Pilbara and northern Great Sandy Desert. However, given the remote distribution of this species, it is likely that the current distribution is inadequately mapped (DotE 2014b). Within the Pilbara bioregion, most records come from the eastern half of the bioregion, although there are a small number of records in the western and northern parts. The greater bilby's total population size is estimated to be around 5,000 to 10,000 in Western Australia (Friend et al. 2008).

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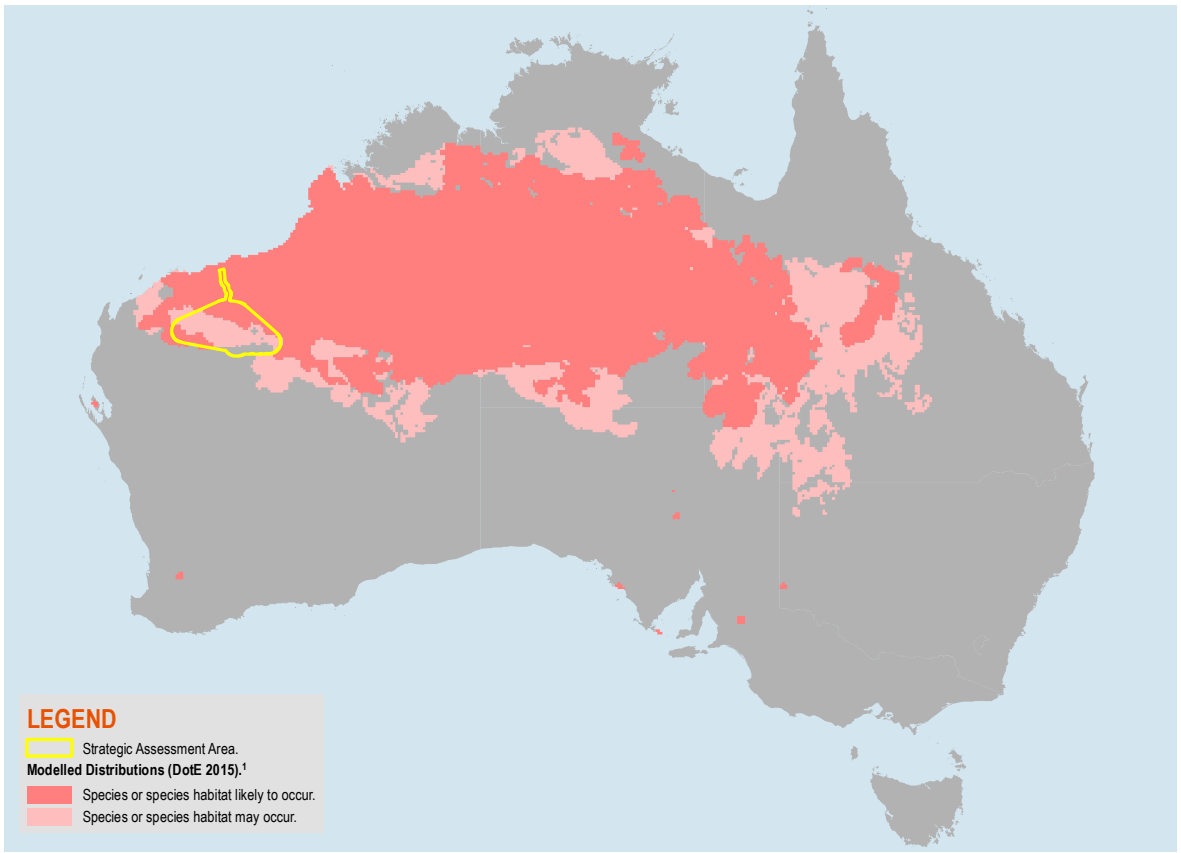
The greater bilby is a dietary generalist and feeds on seeds, bulbs, fruits, fungi and invertebrates, such as termites, ants, beetles and grasshoppers (Southgate & Carthew 2006). The species is able to take advantage of a wide range of seasonally available food resources (Eco Logical 2014b). The greater bilby forages after twilight, typically moving up to 7 km in search of food (Moseby & O'Donnell 2003). It is primarily insectivorous in the warmer months and granivorous in the cooler months (Bice & Moseby 2008). Fire-promoted seed is also consumed by the greater bilby (Southgate & Carthew 2006).

The greater bilby can reach a density of 12 to 16 individuals per square kilometre in optimal habitat; however, a density of one to two animals per square kilometre is more typical (Pavey 2006b). Bilbies are mostly solitary and are relatively mobile, moving between scattered burrows that can be more than 1 km apart (Moseby & O'Donnell 2003; Southgate et al. 2005). The male greater bilby can also move up to 5 km between burrows on consecutive nights (Southgate et al. 2007). The greater bilby is a powerful digger and constructs gently spiralling burrow systems that may be 3 m long and up to 1.8 m deep (van Dyck & Strahan 2008). The greater bilby will use several active burrows in its home range on consecutive nights and will utilise the same burrows infrequently (Southgate 2013).

Breeding habitat is restricted to areas with soil properties that can support suitable burrowing construction (DotE 2014b). The female greater bilby becomes sexually mature at the age of six months, with a short gestation period (14 days) and period of lactation (Southgate & Possingham 1995). Breeding can occur throughout the year, with the female greater bilby producing up to four litters per year.



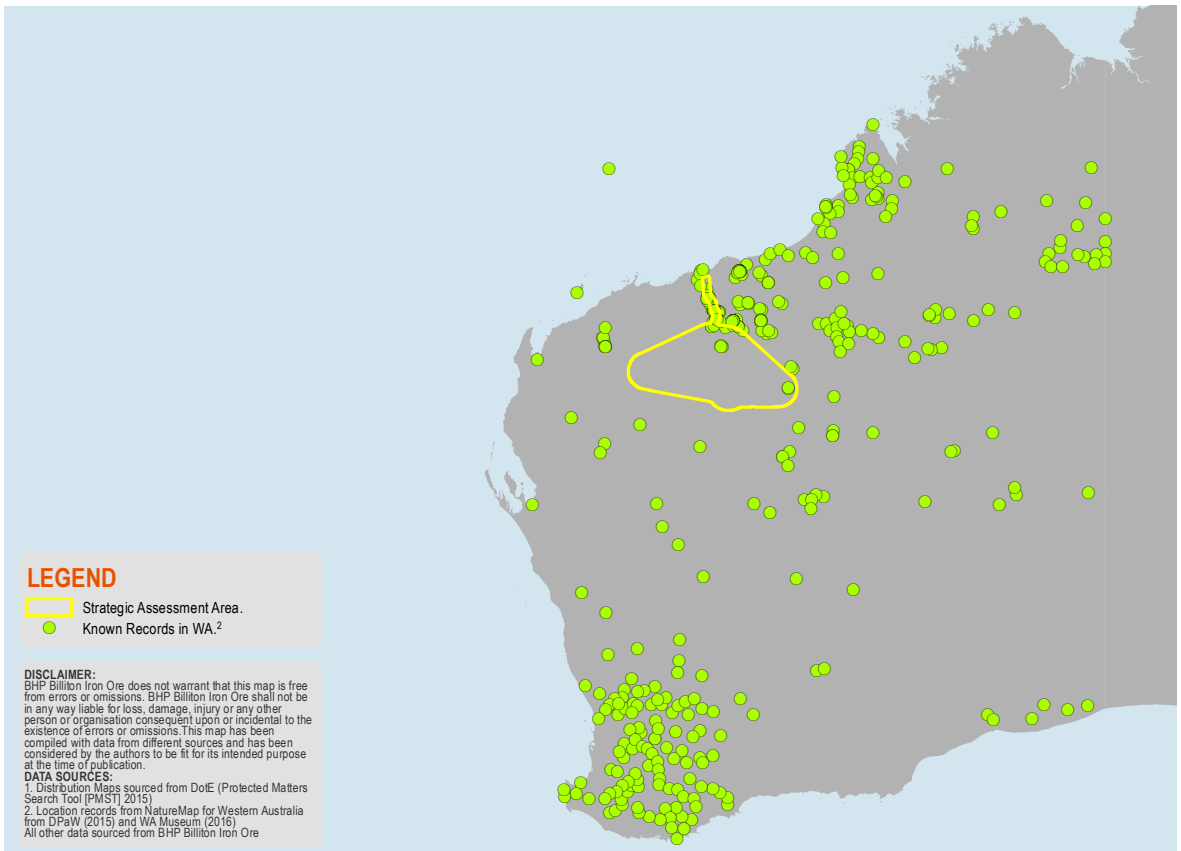


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Figure 19 Distribution of the greater bilby relative to the Strategic Assessment Area

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HABITAT

Across its current distribution, the greater bilby occupies a variety of habitats that include Mitchell grass and stony downs country of cracking clays, the desert sandplains and dune fields sometimes containing laterite, with hummock grassland (spinifex) and massive red earths with *Acacia* shrubland (Southgate 1990b; Southgate et al. 2007; Johnson 2008; Greatwich 2013). The presence of the greater bilby is strongly associated with substrate type as it is generally restricted to areas that contain suitable burrowing habitat, such as sandy loam plains, alluvial creeks, dunes and sand ridges (DotE 2014b). Swale habitat and sand plains in between dunes are less suitable as they are often too hard for burrow construction (Moseby & O'Donnell 2003). Laterite or rock features and drainage or calcrete substrates are important for the greater bilby as they provide habitat that supports shrubs with root-dwelling larvae, which is an important food source (DotE 2014b). Laterite and rock feature substrates also contain spinifex hummocks, which tend to be fairly uniform and discrete and to provide corridors or runways that enable easier movement for foraging (Southgate et al. 2007). Home ranges for the greater bilby can be between 18 ha (for females) and 320 ha (for males) and can shift approximately 15 km over three months (Southgate 2013).

The greater bilby shows a strong association with areas of higher rainfall and temperatures, which may be due to higher plant and food production; and these areas also coincide with areas less tolerated by feral predators, such as the fox (DotE 2014b). Both cats and foxes are present in the Pilbara.

In limited parts of the greater bilby's range, fire may be an important factor in improving the habitat favourability for the species. The occurrence of the greater bilby has been associated with close proximity to recently burnt (less than one year ago) habitat in a study done in the Tanami Desert (Southgate et al. 2007). *Panicum australiensis*, a post-fire ephemeral grass, is suggested as a significant part of the diet of the greater bilby in spinifex habitats (Southgate & Carthew 2007). However, fire occurrences may also contribute to the species' decline as a result of habitat destruction; and there is also a lack of data from the Pilbara to suggest that fire would affect greater bilby occurrences in the same way as in Southgate and Carthew's 2007 study in the Tanami Desert.

Modelled greater bilby habitat was strongly associated with hotter regions of the eastern part of the Pilbara bioregion (Eco Logical 2014b). Within this range, lower, less rocky areas were identified as higher potential habitat.

IMPACT ASSESSMENT

Based on the greater bilby habitat preferences for sandy soil types and previous records of the greater bilby, it is not likely that there will be a significant impact to the species from the proposed mining areas within the Strategic Assessment Area. Mining areas are largely composed of rocky terrain with harder loamy substrates, skeletal soils and where stony mantles are predominant (van Vreeswyk et al. 2004).

The most preferred greater bilby habitat (Habitat Rank 4) is situated in the northern sections of the Pilbara region (Figure 20). The Strategic Assessment Area intersects these preferred habitat areas where the existing rail corridor is located. Since the development of this model, publicly available data has been updated and these data have been included in Figure 20. The additional records are consistent with the modelled habitat preference across the Pilbara. The additional records also demonstrate the type of new information that will be used throughout implementation of the Proposal as part of the Validation Framework and adaptive management (refer to Chapter 8). Most greater bilby records come from the north eastern part of the Pilbara, and the many records occur in the rail corridor (Figure 20). This is likely due to sampling bias associated with the BHP Billiton Iron Ore data.

A study undertaken in 2012 found that the greater bilby used rail culverts (Creese 2012), which suggests that mitigation measures in place are working to maintain habitat connectivity along the existing rail line.

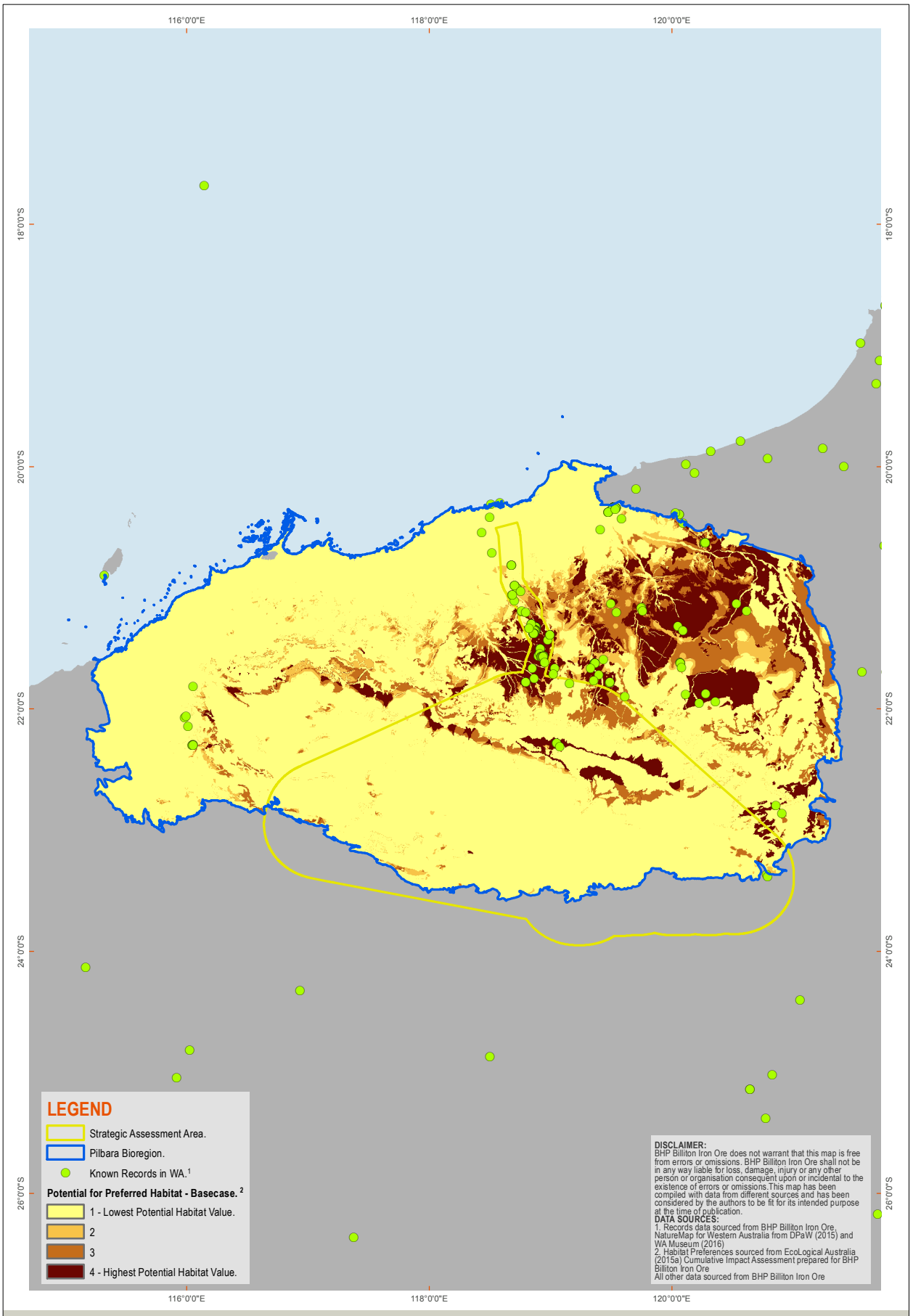

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Figure 20 Modelled distribution of preferred habitat for the greater bilby

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Key Threats to the Greater Bilby

Known and perceived threats to the greater bilby are identified in the SPRAT database (DotE 2014b), the national recovery plan for the species (Pavey 2006a) and the greater bilby workshop facilitated by facilitated by DPaW (as described in Section 5.2.4).

From the review of this information, the key threats to the greater bilby in the Pilbara region have been identified as:

- removal and fragmentation of habitat due to land clearing;
- degradation of habitat as a result of grazing pressure;
- degradation of habitat due to inappropriate fire regimes;
- predation and competition from non-native species;
- mortality from collision with road and/or rail traffic;
- emission of noise and light;
- climate change; and
- mining development.

These threats are described below and graphically represented in the conceptual threats model shown in Figure 21. The model shows the relative ranking of the threats to the greater bilby and also identifies which threats were quantitatively assessed in the CIA.

Removal and Fragmentation of Habitat due to Land Clearing

The removal of habitat may result in the loss of active burrows and habitat suitable for burrowing, as well as habitat suitable for foraging and dispersal. This may reduce the species' distribution, which may be compounded by other threats (Pavey 2006a, 2006b). Removal of habitat may also displace individuals, which can jeopardise reproduction potential and therefore local population viability, and can increase predation by or competition with feral animals (Pavey 2006a, b). Removal of habitat was rated as High impact: areas where habitat was removed were assigned a High (100%) level of potential impact as habitat would become unsuitable in these areas (assuming clearing is permanent); areas where habitat was not removed were unchanged (Eco Logical 2015b).

Greater bilby habitat fragmentation could reduce genetic connectivity and the potential for physical dispersal across affected areas and could increase the risk of local extinctions. A patch is considered a discrete area used by individuals of a species to breed or obtain other resources. Mining and linear infrastructure have the potential to fragment greater bilby habitat if clearing reduces habitat connectivity or if infrastructure presents an obstacle to movement or dispersal.

Potential impacts to the greater bilby from fragmentation of habitat were rated from Low to High in the CIA (Eco Logical 2015b), with habitat fragmentation considered in terms of minimum patch size: the area required for the species to maintain a viable population. The minimum patch size was determined based on reported greater bilby mobility and assumptions of viable population density. The DPaW workshop held in October 2013 noted that one piece of research suggested that an area of 50,000 ha is required to maintain a viable population (Sustainable Consulting 2013b). In contrast, based on a minimum estimate of 40 individuals for a viable population (from studies completed for reintroduced populations, (AATB 2008, Pertuisel 2010)) and on a population density of one to three individuals per 100 ha (from a predator-free fenced environment (Moseby & O'Donnell 2003; AATB 2008)), an area of approximately 1,300 to 4,000 ha would be required.

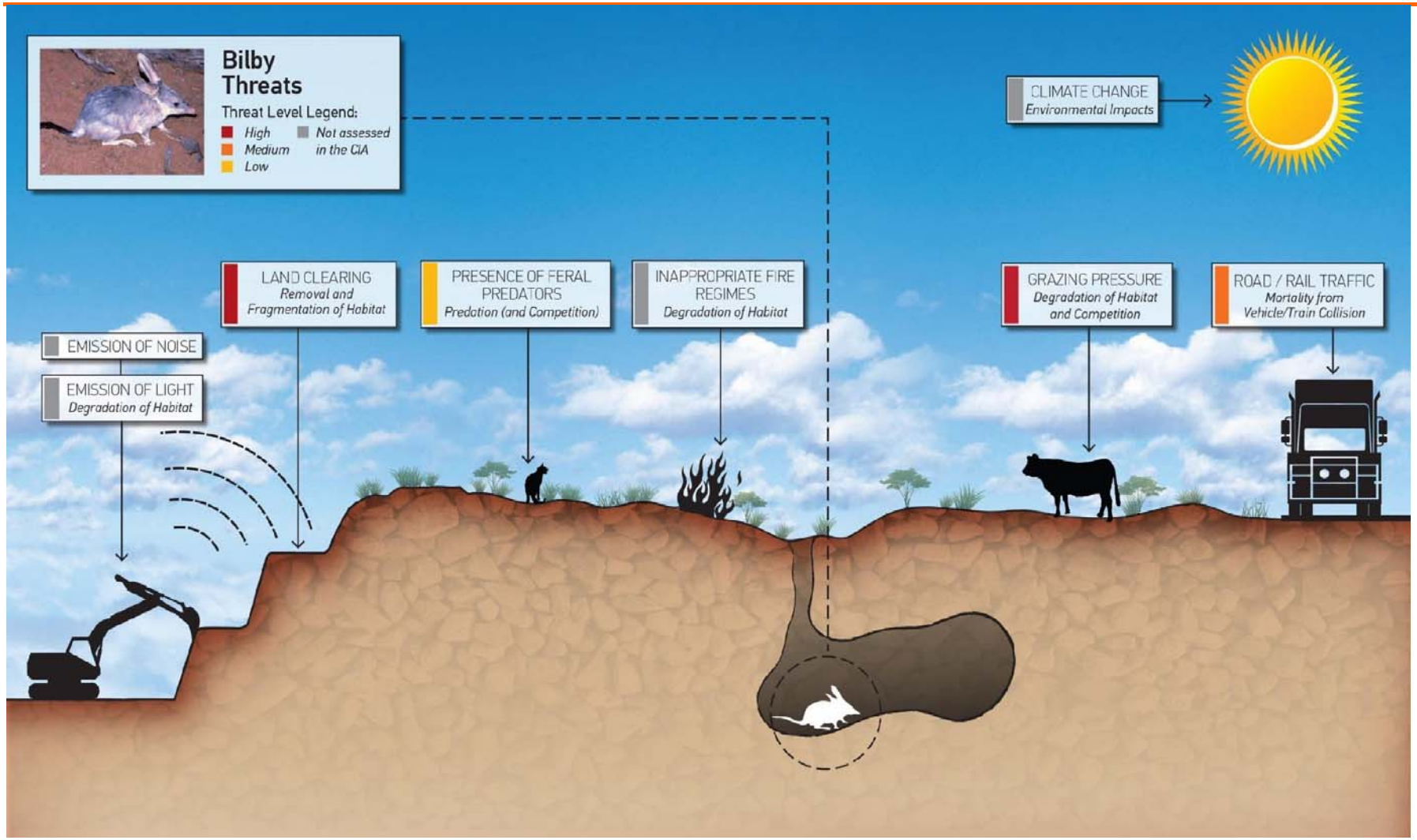


Figure 21: Conceptual diagram of key threats for the greater bilby

A rounded value of 3,000 ha was used in this assessment. Habitat fragmentation was considered to have occurred when patch size was reduced below 3,000 ha; impacts were assumed to increase with decreasing patch size below this threshold.

Degradation of Habitat as a Result of Grazing Pressure

Introduced herbivores, such as cattle and camels, present a threat to the greater bilby through physical damage to soil structure, competition for preferred grass or food species, and reduction in termite and ant abundance due to reduced grass seed biomass from grazing (SKM 2012). The distribution of the greater bilby is negatively correlated with pastoral land, although it appears the species is able to survive in low densities within grazed areas (Southgate et al. 2007; SKM 2012). Further, cattle grazing and presence (ground disturbance) is likely to change the nature of fire (e.g. intensity and extent) based on the effect cattle can have on low strata vegetation, including the potential for introduction or spread of weeds with high fuel loads. The interaction of grazing pressure and fire may compound negative effects on the greater bilby; however, this was not directly considered in the application of the potential impacts of grazing.

Impacts of grazing pressure were considered Low, Medium or High depending on the locations within the landscapes expected to be infrequently, moderately or heavily grazed respectively. Habitat suitability is expected to reduce as habitat condition is degraded and prey becomes less abundant as grazing pressure increases.

Degradation of Habitat due to Inappropriate Fire Regimes

Inappropriate fire regimes were excluded from the CIA (Eco Logical 2015b). While it is recognised that fire scar mapping is available for the Pilbara, such fire scar mapping provides only the approximate date and area of fires and does not necessarily describe the fire regime (which is a complex of many interacting factors) or inform about changes in regime (which may require decades of data to detect) (van Etten, E., pers. comm., 23 March 2015). In addition, the response of species to different elements of the fire regime and to changes in regime is largely unknown and difficult to predict (van Etten, E., pers. comm., 23 March 2015). The effect of fire on each species is complex and can be positive or negative in different situations. Consequently, the impact of fire was not applied in the CIA due to lack of data for season, frequency and extent of fires across the Pilbara, all of which may play a key role in influencing greater bilby habitat suitability in the Pilbara bioregion (DotE 2014b).

With regard to reasonably foreseeable future impacts of fire, the effect of mining and non-mining activities on alteration of fire impacts is unclear and likely to be influenced primarily by assumptions of fire management and fire response. For this reason, the impact to the greater bilby from inappropriate fire regimes was not included in the CIA.

The potential effect of weeds was considered for inclusion in the CIA, as weeds contribute to habitat degradation and alteration of fire regimes (Adair & Groves 1998). Some introduced grasses have high fuel loads, which increase the intensity and frequency of fires (Hill & Ward 2010). Weeds can suppress or outcompete native flora species that form part of the diet of the greater bilby. Yalka or bush onion (*Cyperus bulbosus*) is an important food plant for the greater bilby and is currently threatened by the introduced couch grass (*Cynodon dactylon*) in some parts of its range (Parks and Wildlife Commission of the Northern Territory 1998). By altering the vegetation community composition through competitive recruitment or modified fire regimes, weeds have the ability to alter habitat suitability for the greater bilby. However, as weeds have not been listed as a key threatening process to the greater bilby by the DotE (2014b) nor in the national recovery plan for the species (Pavey 2006a), they have been excluded from the CIA for the greater bilby.

Predation and Competition from Non-Native Species

The occurrence of feral predators, in particular the fox, was previously considered the main threatening process to the greater bilby as it caused a significant decline in greater bilby populations across southwestern Australia (DotE 2014b). The historic decline and the current areas of occurrence of the greater bilby correlate well with the spread and current distribution of the fox (DotE 2014b). The extent to which the fox affects Pilbara populations of the greater bilby is currently not well understood.

Other feral predators, such as the feral cat, are also known to prey on the greater bilby and have caused some populations to decline (e.g. at Lorna Glen, close to the geographic centre of Western Australia and straddling the boundary between the Murchison and Gascoyne bioregions, Pertuisel (2010)). Dingoes may also prey on the greater bilby but are more likely to improve habitat suitability for the species by preying on cats and rabbits and displacing foxes (Southgate et al. 2007).

While there is likely to be some level of predation throughout the Pilbara generally, feral predators are considered likely to occur in greater numbers near areas of human settlement (such as towns and mine camps) as a result of increased opportunities for food and near roads as a result of facilitated movement (e.g. Andrews 1990; Brown et al. 2006; Lach & Thomas 2008; Mahon et al. 1998; May & Norton 1996). The increased spatial and temporal availability of free water from mining activities (for example, due to increased surface water discharge into water bodies, dust suppression, or creation of pit lakes upon mine closure) can also result in feral predator populations that are more resilient and persistent, with greater home ranges (Department of Environment and Heritage Protection 2012). Thus, impacts of predation incorporated in the CIA were related to proximity to human settlements and roads or tracks (and to power lines under the assumption that power lines have an associated access track), with distances relating to the home ranges of feral predators.

Impacts from predation on the greater bilby were rated as Low in the CIA, with feral predators being considered likely to occur in greater numbers near areas of human settlement and roads (Eco Logical 2015b).

There is strong evidence that competition with rabbits for food resources (and potentially burrow resources) is a major threatening process to the greater bilby, with greater bilby distribution correlating to areas where rabbits are now absent or in low abundance (SKM 2012).

Mortality from Collision with Road and/or Rail Traffic

There are limited data for roadkill rates for the greater bilby, although data exist for mortality on haul roads and public roads in the Northern Territory. Haul roads and railways may be a significant cause of greater bilby mortality at a local scale due to the combination of vehicles operating throughout the night (when the greater bilby is most active) and in locations where roads or rail lines are adjacent to suitable greater bilby habitat.

Mortality from collision with vehicles was considered in the CIA (Eco Logical 2015b) as, where road and rail infrastructure occurs in proximity to greater bilby habitat, greater bilby deaths can be attributed to associated vehicle movements (Pavey 2006b). Potential impacts of road and rail mortality were estimated as Low to Medium depending on the proximity of roads or rail to potential greater bilby habitat; collisions were considered to potentially affect greater bilby habitat suitability at a distance of up to 500 m (Low impact), with the greatest effect being within 50 m (Medium impact). In the application of the potential impact of mortality from collision with vehicles, the use of the spatial layer for roads was limited to ‘highly trafficked roads’.

Noise and Light

The Proposal will increase noise and light in the vicinity of mining operations. Noise and light has been documented to affect some fauna (e.g. Larkin et al. 1996), however the extent to which the greater bilby may be affected by noise or light is not well understood and assessing impacts of degradation of habitat through increased noise and light in terms of its frequency, intensity and extent is difficult. For example, an animal may respond differently to rare and short term light disturbance compared with ongoing light disturbance. The

introduction of artificial light could affect the species given that it is largely nocturnal, with potential to affect movement and behaviour thereby impacting foraging and mating activity (Beier 2006). In some instances, artificial light may increase foraging activity due to providing a higher abundance of food resources (e.g. lights attracting insects) (Larkin et al. 1996). Due to the range of possible effects that noise and light could have on the greater bilby, these threats were not modelled in the CIA and are not considered further in this Draft IAR.

Climate Change

Climate change is recognised as a threat to the greater bilby (DotE 2014b). Potential impacts of climate change to the species include habitat loss, modification or degradation. These impacts are related to increased frequency and intensity of fires, increase in climatic extremes, increased invasion of introduced species and vegetation structural and compositional change (Dunlop et al. 2012).

Climate change can also impact the greater bilby by increasing the incidence of extreme weather conditions, in particular, prolonged droughts and periods of high rainfall. Physiological research indicates that the greater bilby is only partly adapted to arid environments, placing it at risk of local extinction during severe droughts (Pavey 2006b). Animals from a Queensland population exhibited a negative energy balance during one summer of a two-year study (Gibson & Hume 2000). The unpredictability of food availability in arid environments indicates that the greater bilby may experience severe physiological stress during periods of food shortage throughout its current range. Such conditions would severely limit population growth rates and may explain the disappearance of colonies following prolonged drought (Pavey 2006b). Other research in the Tanami Desert has demonstrated that the greater bilby was positively associated with higher rainfall (Southgate et al. 2007).

Preliminary analysis and modelling of potential effects as a result of recognised predicted climate change estimates was undertaken during the development of the CIA; however, the level of uncertainty associated with the modelling outcomes was considered to limit its interpretation in relation to cumulative impacts in the Pilbara and climate change was not considered further in the CIA.

Prolonged drought and high rainfall, being closely linked to climate change, was not specifically modelled in the CIA due to the level of uncertainty associated with predicting these processes in the future. It is considered that the greater bilby would likely be able to adapt to changes in rainfall; however, the resilience of the species may be affected by additional pressures, such as inappropriate fire regimes, habitat fragmentation and predation.

Mining Development

The greatest potential direct impact of mining operations is the destruction and degradation of greater bilby habitat. Although mining operations impact on a relatively small area of the potential habitat available to the greater bilby in the Northern Territory and Western Australia, the location of mines adjacent to palaeodrainage systems, which appear to be important habitat areas for the greater bilby (e.g. Paltridge & Southgate 2001), may have an impact on regional populations in the long term.

Other developments, such as the rail and major roads, occur within greater bilby habitat (Pavey 2006b). Construction of these other developments through greater bilby habitat has potential to introduce a number of negative indirect consequences, such as predation (Pavey 2006b).

Potential impacts from mining development have been included in the CIA through the consideration of removal of habitat and mortality from collision with vehicles.

Recovery and Conservation Management Priorities for the Greater Bilby

The National Recovery Plan (Pavey 2006) aims to achieve two major objectives; improve and at least maintain the national conservation status of the greater bilby over the duration of the Plan; and achieve an accurate

assessment of distribution, trends in occurrence, and successfully reduce the impacts of key threatening processes. Recovery actions recommended by the National Recovery Plan (Pavey 2006) include:

- Reduce fox and cat numbers at reintroduction sites and key wild populations where greater bilbies are in decline.
- Ensure that captive populations of the greater bilby continue to be managed effectively for reintroduction purposes, and to continue management of greater bilby populations that have been reintroduced into the wild or that occur within predator-proof fences within the former range.
- Ensure that an effective and uniform monitoring methodology is developed and refined. This methodology should be used to interpret changes in greater bilby occurrence within and across sites.
- Continue to monitor occurrence and relative abundance trends of the Queensland greater bilby population.
- Monitor trends in occurrence of greater bilby populations in Western Australia and the Northern Territory.
- Monitor trends in abundance and occurrence of the greater bilby at each reintroduction site, and measure the impacts of threatening processes on greater bilby populations at reintroduction sites.

BHP Billiton Iron Ore has committed to considering contemporary guidance (such as threat abatements plans) as part of the Validation Framework provided within the MNES Program. The Validation Framework is discussed further in Section 8.6.2.

Extent of Potential and Cumulative Impacts to the Greater Bilby

Eco Logical (2015b) modelled the habitat preference (the probability of that species being located in certain habitats) for the greater bilby using 21 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) was strongly associated with hotter regions in the eastern part of the Strategic Assessment Area. Within this range, lower, less rocky areas were identified as higher potential greater bilby habitat.

Table 10 shows the area and proportion of the Pilbara bioregion of habitat suitability from 1 to 4, with Habitat Rank 1 being the lowest probability of potential habitat and Habitat Rank 4 being the highest probability of potential habitat. The distribution of preferred habitat based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 20.

Table 10: Classification and ranking applied to the greater bilby habitat model

Model Value	Habitat Rank	Habitat Suitability	Area (ha) in Pilbara Bioregion
70-100%	4	Highest probability of potential habitat	1,751,623 (10%)
30-70%	3	↓	1,513,018 (9%)
10-30%	2		877,696 (5%)
0-10%	1	Lowest probability of potential habitat	13,650,278 (77%)

Source: Eco Logical (2015b).

The extent of potential impacts to the greater bilby were developed and modelled in the CIA (Eco Logical 2015b) and assigned to different categories:

- Existing impacts (this includes existing mining and non-mining impacts);
- Future third-party mines (potential impacts from reasonably foreseeable future third-party iron ore mines, described in Section 5.2.2 and shown in Figure 22); and
- Full Conceptual Development Scenario (this includes potential impacts from the Proposal, described in Section 5.2.2 and shown in Figure 22).

The potential cumulative impact is all of the above impacts combined.

The CIA model indicated a potential cumulative impact of 1.6 million hectares (94%) to the most suitable modelled habitat (Habitat Rank 4 - highest probability of potential habitat). Existing impacts were the main contributors to this impact (Table 11 and Box 5).

Table 11: Cumulative effects assessment for potential cumulative impacts to the greater bilby (expressed as area and proportion of Habitat Rank 4)

Specified Protected Matter	Base Case[1]	Existing Impacts	Reasonably foreseeable third party development	BHP Billiton Iron Ore Full Conceptual Development Scenario	Potential Cumulative Impact
Greater bilby	1,751,623 ha	-1,639,332 ha (-94%)	0 ha (0%)	-114 ha (<-1%)	-1,639,446 ha (-94%)

1. Base Case means area of modelled Habitat Rank 4 within the Pilbara bioregion.
Source: Eco Logical (2015b).

The CIA model for the greater bilby identified over 1,751,623 ha of the most suitable habitat within the Pilbara bioregion. The model suggested that existing impacts have already resulted in a substantial decrease of approximately 1.6 million hectares (94% of its habitat in the Pilbara bioregion) in greater bilby habitat suitability relative to the base case (Table 11). The model indicated that these existing impacts have occurred primarily in the central part of the Pilbara bioregion. Within the Strategic Assessment Area, these existing impacts have primarily occurred in areas surrounding the Fortescue Marsh and in areas of high habitat suitability in close proximity to Karijini Drive, within Karijini National Park. Existing impacts have also occurred along the Great Northern Highway and the BHP Billiton Iron Ore mainline rail corridor.

To further assess impacts to greater bilby from iron ore mining in the Pilbara, BHP Billiton Iron Ore conducted an impact assessment based on species records. The records data were obtained from the Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. The results are presented in Table 12.

Based on the species records data, on 2.3 % of the known records within the Strategic Assessment Area are predicted to be impacted by iron ore mining in the Pilbara. The data show that all of the potential impact is from BHP Billiton Iron Ore.

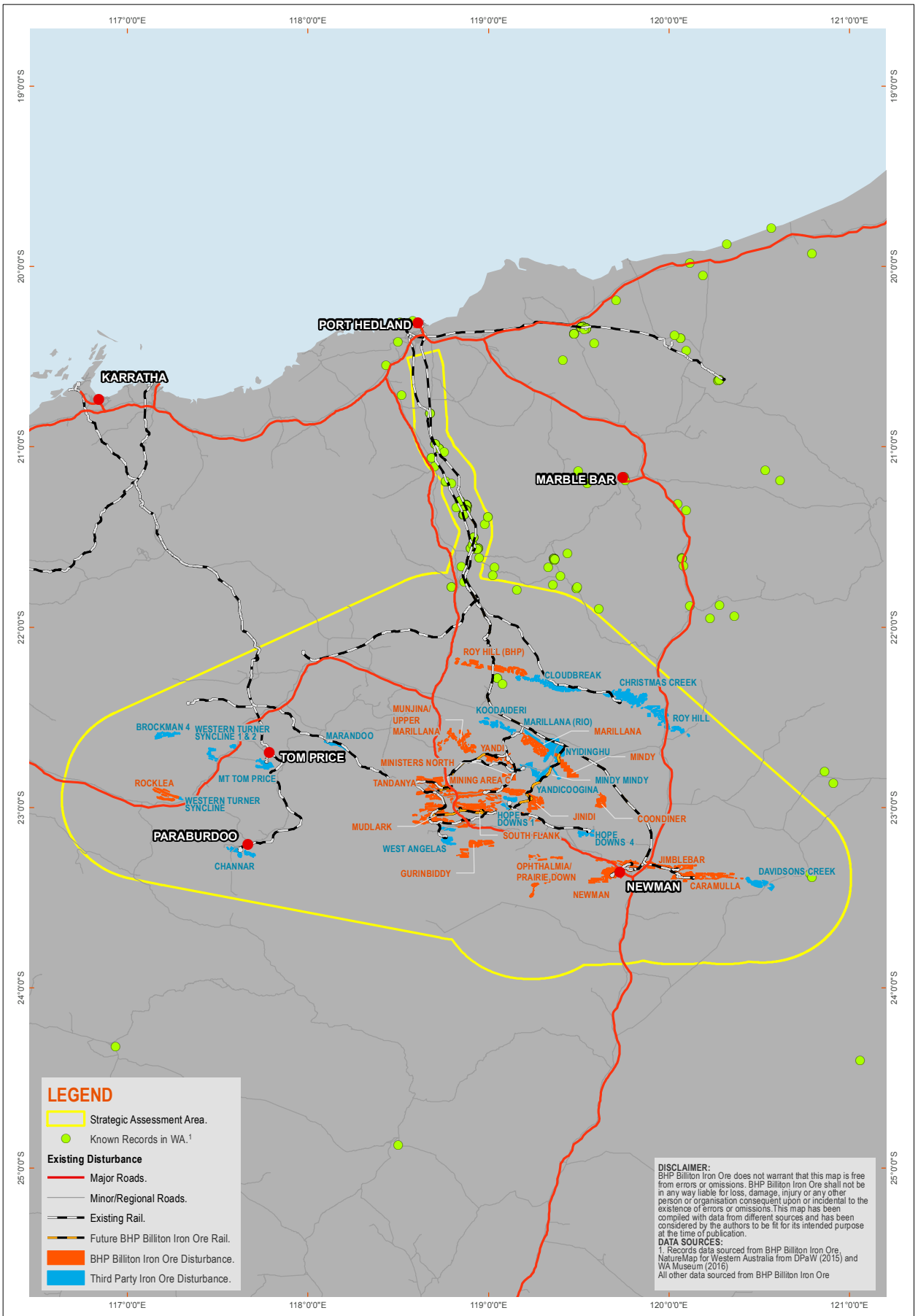


Figure 22 Greater bilby distribution records and Full Conceptual Development Scenario

Table 12: Impact assessment to greater bilby based on species records

Total known records	Records within Strategic Assessment Area	Existing		Future		Cumulative impact (total records impacted and % of SAA records)
		Third Party	BHP Billiton Iron Ore	Third Party Reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	
2522	131	0	3	0	3	3 (2.3%)

Box 5: Visualisation of numerical CIA results for the greater bilby

A visualisation of the relative change in each of the habitat types is shown below. Each box represents 100% of the modelled area (the Pilbara) and shows the relative proportion of each habitat suitability class under each of the modelled scenarios:

- Base case
- Base case + existing impacts
- Base case + existing impacts + third-party impacts
- Base case + existing impacts + third-party impacts + BHP Billiton Iron Ore Full Conceptual Development Scenario impacts

From the greater bilby modelling, existing mining, infrastructure and pastoral impacts have modified the proportion of both Habitat Ranking 4 (H4) and Habitat Ranking 3 (H3) habitat classes from the base case (from approximately 10% to less than 1% for H4 and approximately 9% to 8% for H3), with a corresponding increase in the proportion of Habitat Ranking 2 (H2) and Habitat Ranking 1 (H1). The addition of both third-party and BHP Billiton Iron Ore Full Conceptual Development Scenario potential impacts do not materially change these relative proportions.

Visual representation of changes to habitat ranks for the greater bilby

The distribution of the greater bilby is negatively correlated with pastoral land; however, it appears the species is able to survive in low densities within grazed areas (Southgate et al. 2007; SKM 2012). It should be noted that, although there are limitations associated with estimating impacts due to habitat degradation from grazing pressure, these impact findings are in line with other literature on key threats in the Pilbara, such as Carwardine et. al. (2014).

Potential impacts to the greater bilby as a result of the Proposal's Full Conceptual Development Scenario are not considered to be significant at the regional scale given that less than 1 % of the most preferred habitat (Habitat Rank 4) will be potentially impacted by the Proposal. Peer review comments for the greater bilby cumulative impact assessment model are provided in Appendix 5. Given that the majority of records occur outside the Pilbara and only two occur in the Full Conceptual Development Scenario, the cumulative risk to this species is considered low. Impacts to the greater bilby at a local scale will be determined on a case-by-case basis through processes described in the Validation Framework, where key inputs such as engineering design and contemporary guidance will be taken into account in decision-making before taking a Material Action. The Validation Framework is described further in Section 8.6.2.

Other key threats that were not modelled in the CIA for the greater bilby included inappropriate fire regimes and climate change. The reasons for not including these in the CIA are discussed in the consideration of potential impacts to the greater bilby above. BHP Billiton Iron Ore considers that the Proposal is unlikely to impact upon climate change or fire regimes as these are largely independent of and would not be exacerbated by the Proposal.

The Draft MNES Program (BHP Billiton Iron Ore 2016) includes commitments to consider and manage as part of its adaptive management approach any material future changes to the environment, including climate change and environmental change (e.g., changes in land degradation associated with grazing pressure). Further, BHP Billiton Iron Ore has committed to applying the mitigation hierarchy (avoid, mitigate and, as a last resort, offset) to manage its potential impacts to the Specified Protected Matters, including the greater bilby. Further information regarding the commitments made in the Draft MNES Program is provided in Chapter 8.

BHP Billiton Iron Ore considers that the potential impacts to the greater bilby from implementation of the Proposal are not likely to be significant, given the negligible modelled impact predicted to greater bilby habitat from future reasonably foreseeable third-party mining operations and the BHP Billiton Iron Ore Full Conceptual Development Scenario. BHP Billiton Iron Ore's commitments in the Draft MNES Program to validate these potential impacts, manage future change and apply the mitigation hierarchy ensure that impacts to the greater bilby will be managed to an acceptable level during the life of the Proposal.

5.3.3 PILBARA LEAF-NOSED BAT (*RHINONICTERIS AURANTIA*)

SPECIES DESCRIPTION AND CONSERVATION STATUS

The Pilbara leaf-nosed bat belongs to the family Hipposideridae and is a geographically isolated form of the orange leaf-nosed bat. The species was listed under Commonwealth legislation in 2001 due to its geographic isolation, small population size and a predicted reduction in numbers as a result of direct loss of roosting habitat (DotE 2014e). The Pilbara leaf-nosed bat is a moderate-sized bat with relatively small ears and a fleshy nose-leaf structure surrounding the nostrils (Plate 15). The fur is most often bright orange, and the wings are dark brown; but brown, yellow, and white individuals are also known (Churchill 2008); paler bats are likely to be older. The species differs from other members of its family in having an elaborate, rounded and scalloped nose-leaf. The Pilbara leaf-nosed bat is listed as Vulnerable under the EPBC Act and 'Schedule 1' under the WC Act.

SPECIES DISTRIBUTION

The Pilbara leaf-nosed bat occurs over an approximate area of 120 million hectares (Eco Logical 2014c) and is restricted to the Pilbara region of Western Australia (DotE 2014e). Armstrong (2001) suggests that there may be three discrete subpopulations – George Range, Hamersley Range and Upper Gascoyne – separated by extensive flat areas restricting gene flow. The subpopulations can be further separated into individual colonies, which vary in size from 10 individuals to 20,000 individuals, although the latter is exceptional (e.g. Armstrong 2001; Ecologia Environment 2005, 2006a, 2006b). The total number of Pilbara leaf-nosed bats is currently unknown due to difficulties in counting individuals (Eco Logical 2014c).

Photo: Stewart Ford

Plate 15: Pilbara leaf-nosed bat

An assessment of data by Bullen (2013) indicates 24 maternal or day roosts occur across the Pilbara, many of which are not identified by the DotE (2014e). The species distribution for the Pilbara leaf-nosed bat is shown in Figure 23.

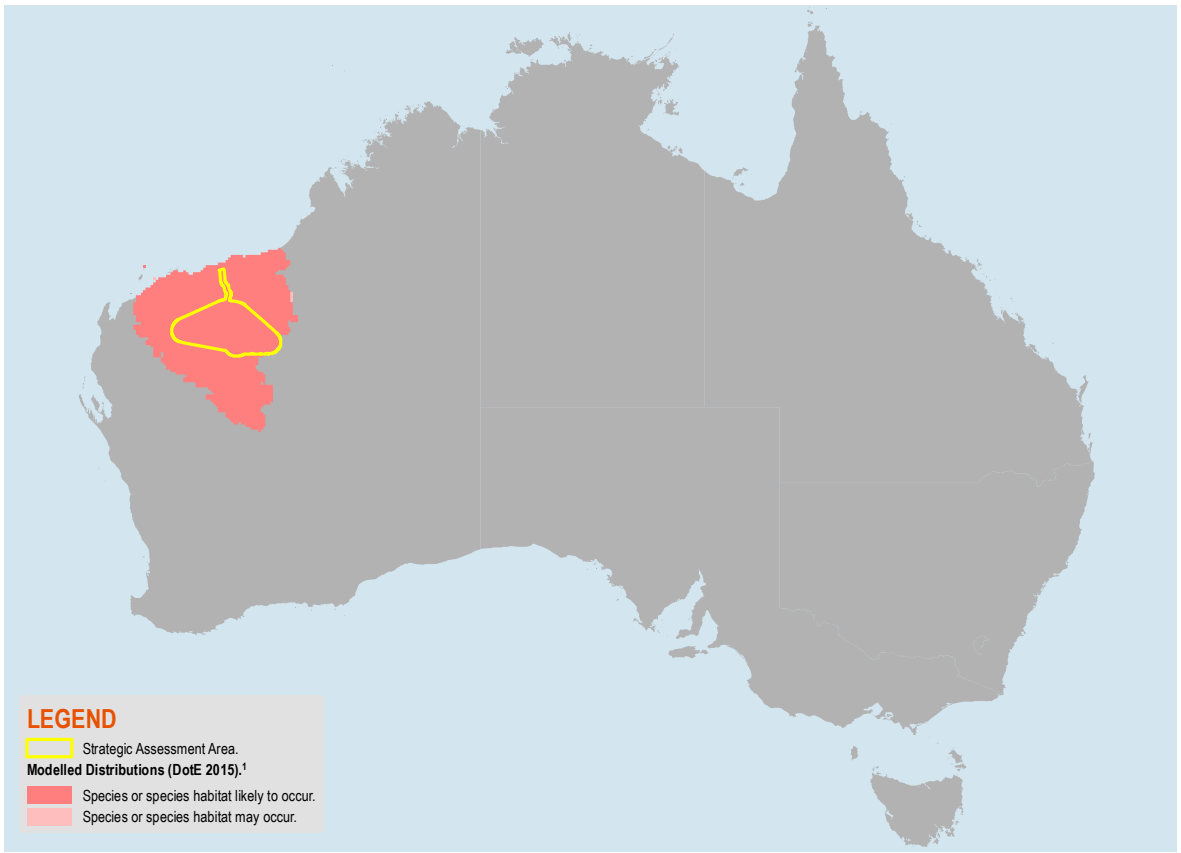
ECOLOGY

The Pilbara leaf-nosed bat is an opportunistic insectivore, and throughout the year its prey consists primarily of moths and beetles (Woinarski et al. 2014). Unlike other leaf-nosed bats, the Pilbara leaf-nosed bat is a high-energy bat that uses rapid flight and abrupt turns to catch prey at 18 to 22 km/hr. It cannot enter torpor and thus must feed every night (McKenzie & Bullen 2013). The energetic requirements of the species are unknown. However, females are likely to have different metabolic needs during breeding and non-breeding seasons (McKenzie & Bullen 2013).

Females of the species become reproductively mature at seven months, while males become reproductively mature at 16 to 18 months (DotE 2014e; McKenzie & Bullen 2013). Pairs mate in July, and females give birth to a single young in late December to early January. Young are weaned by the end of February (Churchill 2008). Longevity of this species is unknown but is predicted to be similar to that of closely related bats of equivalent size, approximately 10 years (DotE 2014e).

HABITAT

The Pilbara leaf-nosed bat can forage in any habitat provided insect biomass is sufficiently high (McKenzie & Bullen 2013). The foraging range of the Pilbara leaf-nosed bat is unknown; however, it is assumed that bats have a maximum nightly foraging range of 10 km from their roost (DotE 2014e). The Pilbara leaf-nosed bat forages over open vegetation, including:



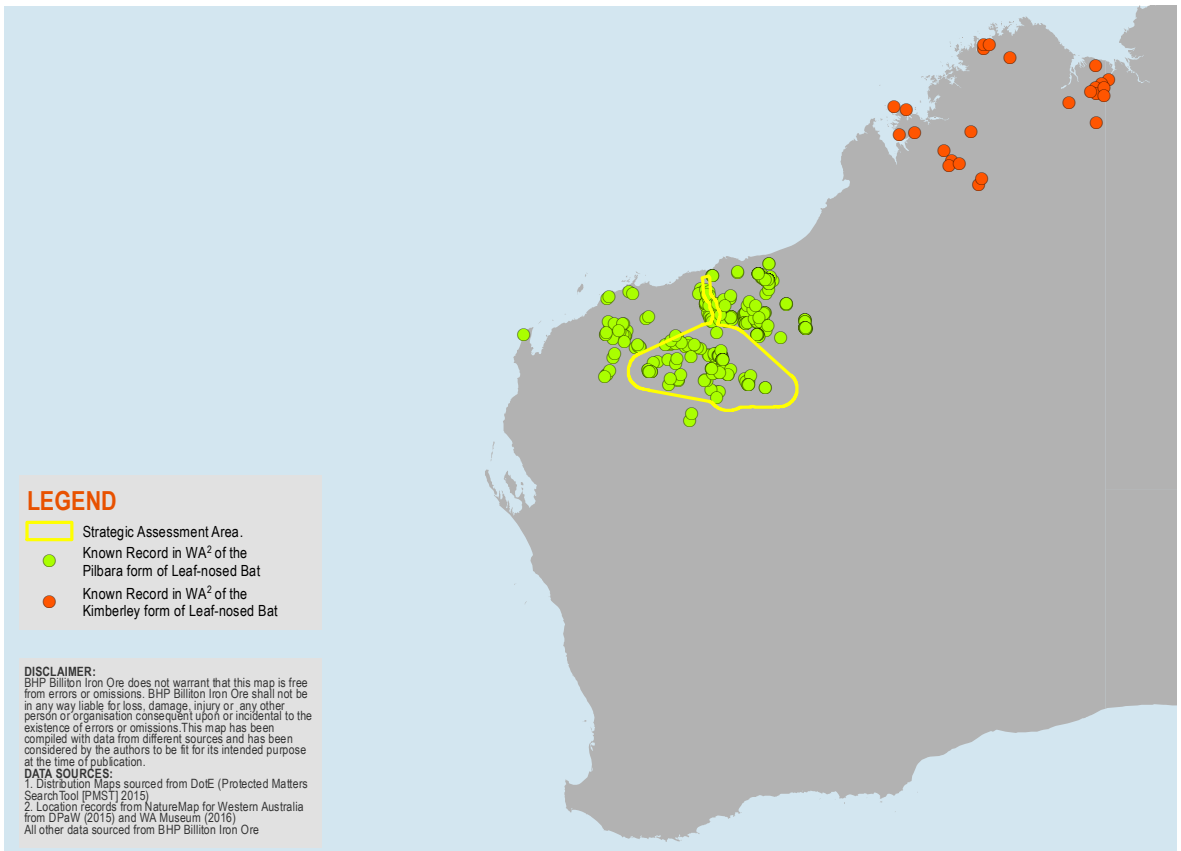


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Figure 23 Distribution of the Pilbara leaf-nosed bat relative to the Strategic Assessment Area

- *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks;
- small watercourses among granite boulder terrain;
- pools and low shrubs in ironstone gorges; and
- low shrubs and around pools in gravelly watercourses with *Melaleuca leucodendron* (Bullen & McKenzie 2002).

The Pilbara leaf-nosed bat is a poor thermoregulator, exhibiting evaporative water loss of more than double that of other bats (Churchill 2008). Therefore, its persistence in the Pilbara depends heavily on the presence of physiologically benign, humid and temperature-stable caves and disused mines, which it uses as roosts. These microhabitats generally occur deep within rocky hills or underground where humidity is often maintained via ephemeral pools or waterfalls at the cave or mine entrance or by groundwater when deeper. Armstrong (2001) suggests that the presence of seeps and groundwater pools are the most important factor in determining roost suitability.

The Pilbara leaf-nosed bat often shares roosts with the ghost bat (*Macroderma gigas*), Finlayson's cave bat (*Vespadelus finlaysoni*) and common sheath-tailed bat (*Taphzous georgianus*) (DotE 2014e). Seasonal movements have not been studied to date although it is assumed that bats can move distances of up to 60 km easily between mines (Armstrong 2001) although not necessarily overnight. Roosts can be maternity, diurnal or nocturnal; diurnal and nocturnal roosts allow the species to extend their foraging range (Bullen 2013).

IMPACT ASSESSMENT

Roosting requirements for the Pilbara leaf-nosed bat are extremely specific. Their foraging requirements are much less specific; they are likely to forage across a relatively high proportion of the Strategic Assessment Area within set distances from day roosts. Mining activity is unlikely to cause significant impact to the foraging habitat of the species, unless the habitat is removed or degraded within 10 km of a known roosting location, as this distance is thought to be the nightly flight range (Armstrong, pers. comm. 24 March 2015, in Woinarski et al. 2014).

The distribution of preferred habitat based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 24. Records of the Pilbara leaf-nosed bat occur across the Strategic Assessment Area, including in the rail line corridor; however, the majority are from the central areas. Since the development of this model, publicly available data has been updated and these data have been included in Figure 24. The additional records are consistent with the modelled habitat preference across the Pilbara. The additional records also demonstrate the type of new information that will be used throughout implementation of the Proposal as part of the Validation Framework and adaptive management (refer to Chapter 8).

BHP Billiton Iron Ore's Full Conceptual Development Scenario is largely located within habitat that may contain roosting sites for this species, i.e. rocky escarpment. Due to the highly specialised roosting requirements of the species, any alteration to a roost site or area within the vicinity of a day or maternity roost site will potentially have an impact on the Pilbara leaf-nosed bat. However, because roosting requirements are so specific, the distribution of the Pilbara leaf-nosed bat is not considered uniform across the region. Pilbara leaf-nosed bat surveys have been undertaken across most BHP Billiton Iron Ore's mining tenure, and no significant roosts have been discovered, with the exception of roosts at Goldsworthy (in the northeast of the Pilbara bioregion), which are not included in the Strategic Assessment Area.

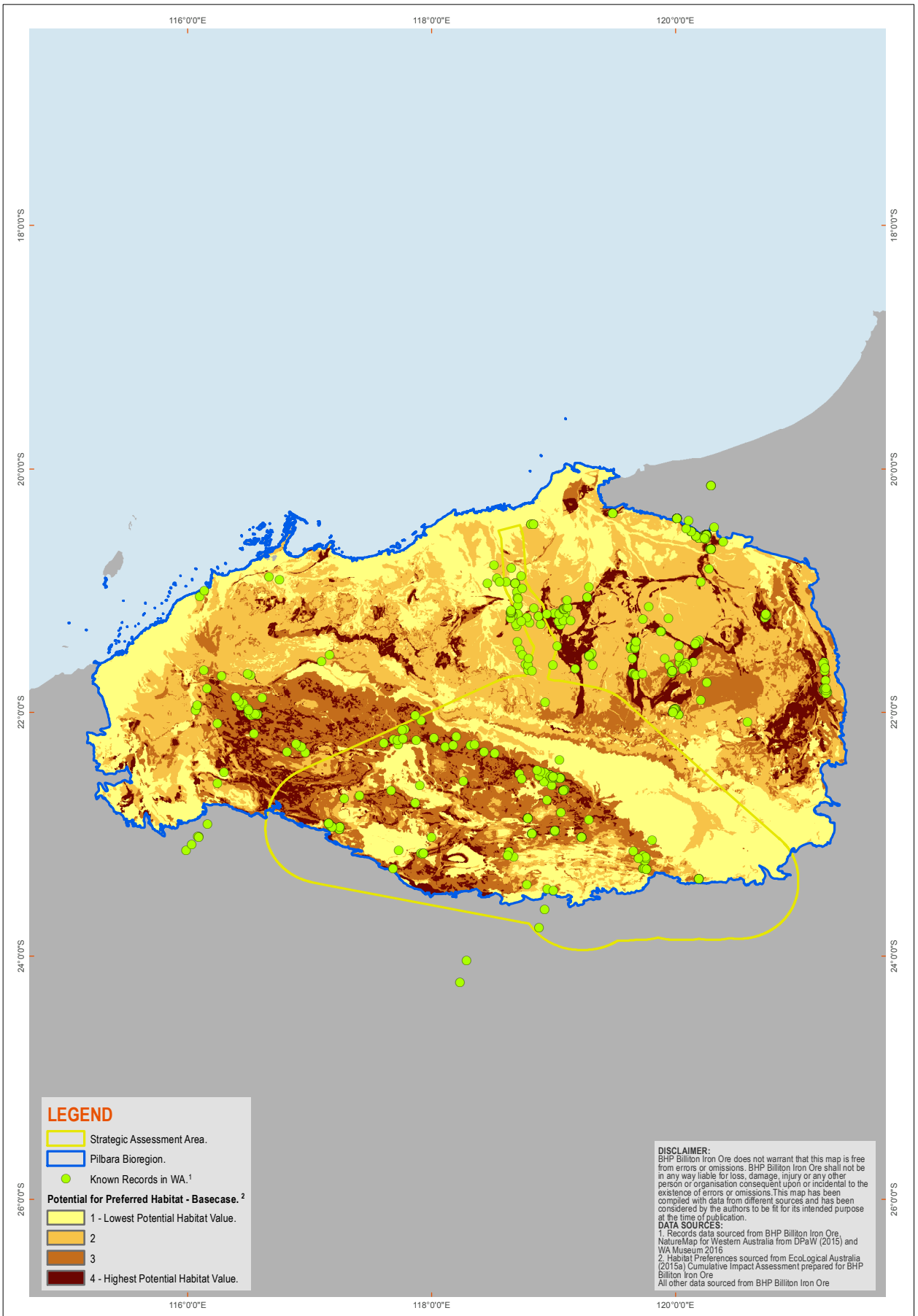

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Figure 24 Modelled distribution of preferred habitat for the Pilbara leaf-nosed bat

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Key Threats to the Pilbara Leaf-nosed Bat

Known and perceived threats to the Pilbara leaf-nosed bat are identified in the Commonwealth Species Profile and Threats (SPRAT) database (DotE 2014e) and the Pilbara leaf-nosed bat workshop facilitated by DPaW (as described in Section 5.2.4). From the review of this information, the key threats to the Pilbara leaf-nosed bat in the Pilbara region have been identified as:

- removal of habitat due to land clearing;
- degradation of habitat due to hydrological change;
- disturbance of natural roosts (e.g., from noise, light or vibration);
- mortality from collision with road and/or rail traffic;
- climate change; and
- mining development.

These threats are described below and graphically represented in the conceptual threats model shown in Figure 25. The model shows the relative ranking of the threats to the Pilbara leaf-nosed bat and also identifies which threats were quantitatively assessed in the CIA.

Removal of Habitat due to Land Clearing

The removal or loss of suitable roosting habitat is a key threat to the Pilbara leaf-nosed bat and includes natural roosts, such as underground caves, as well as artificial roosts, such as disused mine shafts and horizontal adits. Loss of roosting habitat can occur in many ways, such as collapse or flooding of disused mines, as well as mining activities, such as open cutting of underground mines, exploration drilling and blasting (Eco Logical 2015b). It can result in mortality of individuals present when the roost collapses or is sealed or destroyed or due to heat and water loss by individuals that attempt to locate alternative roosting habitat or that relocate to roosting habitat with less suitable microclimatic conditions. The potential loss of foraging habitat is also a threat to the Pilbara leaf-nosed bat, albeit one that is considered less significant than loss of suitable roosting habitat as the species can forage in any habitat provided insect biomass is sufficiently high (McKenzie & Bullen 2013). Accordingly, removal of day-roosting habitat was rated as High potential impact in the CIA (Eco Logical 2015b).

Loss (evacuation) of suitable roosts due to human entry of roosts and capture of bats, e.g. for scientific research or environmental monitoring programs, is not likely to be significantly influenced by the Proposal and is instead a key threat that should be noted in the planning and implementation of scientific research and environmental monitoring programs (Eco Logical 2015b). The potential impact of human disturbance was not applied in the CIA modelling, particularly given this threat's limited potential for impact or any impact associated with the Proposal.

The potential loss of foraging habitat is considered a threat to the Pilbara leaf-nosed bat, albeit one that is considered less significant than loss of suitable roosting habitat as the species can forage in any habitat provided insect biomass is sufficiently high (McKenzie and Bullen 2013).

Degradation of Habitat due to Hydrological Change

Hydrological change may affect the Pilbara leaf-nosed bat via reduced available surface water, which supports the species' prey (insects) and most likely also is a source of drinking water. The occurrence of pools of water is a critical component of the Pilbara leaf-nosed bat's foraging habitat (Armstrong 2001). There is no documented information on the importance of surface drinking water for the Pilbara leaf-nosed bat; however, anecdotal accounts from field observations suggest that this species requires surface water for drinking, and water sources in proximity to day roost caves are therefore likely to be important (Armstrong 2013).

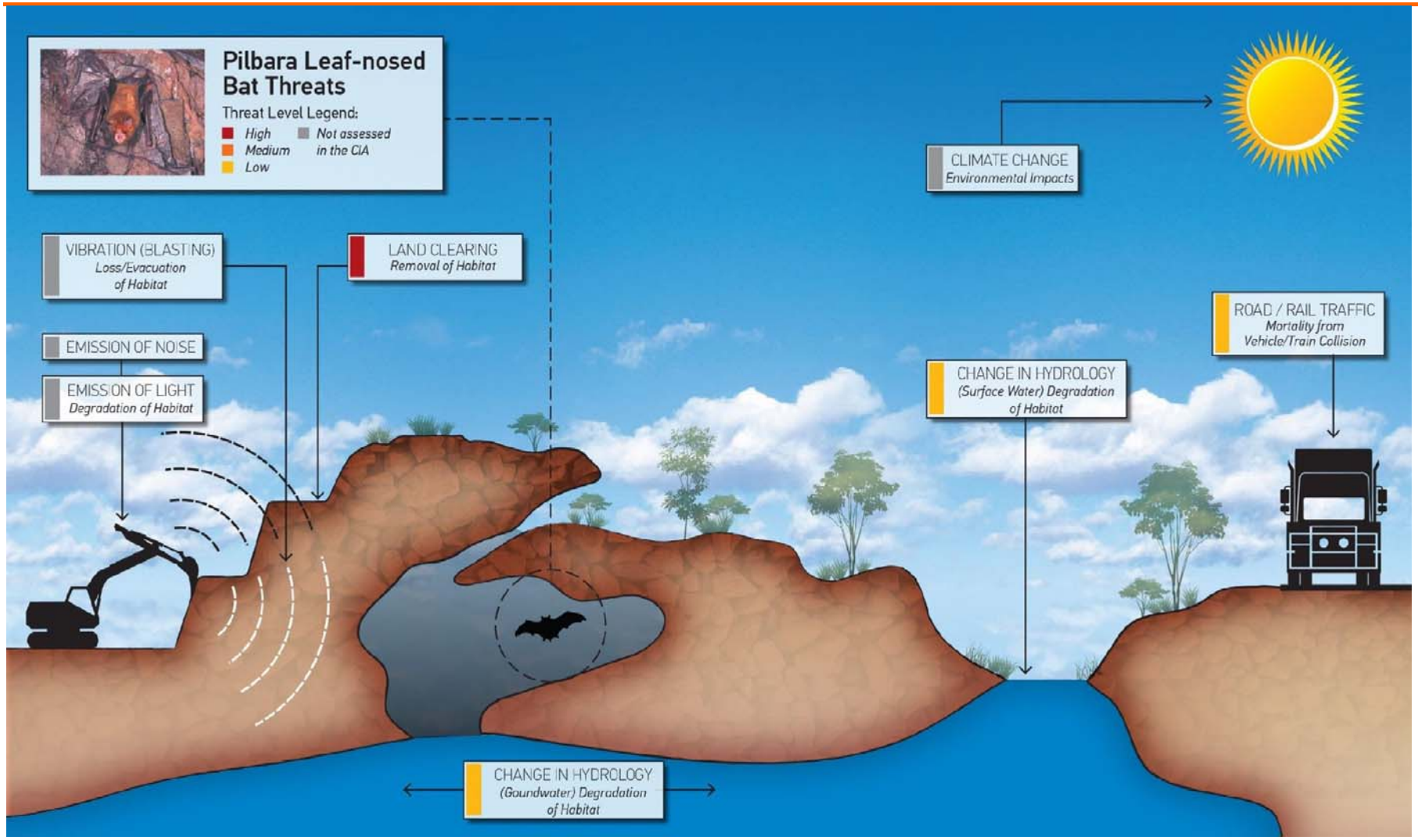

Figure 25: Conceptual diagram of key threats for the Pilbara leaf-nosed bat

Published data are not available on the maximum distance that the Pilbara leaf-nosed bat will fly from its day roost cave before it requires water; however, based on a foraging range of 10 km from a roost, the species is likely to require at least one drinking water source within this range. Water sources closer to the roost may be more critical than water sources further away. Surface water pools that provide drinking and feeding habitat for the Pilbara leaf-nosed bat may be derived from surface runoff or spring seepage following rainfall or may be groundwater-fed. Therefore, changes to both surface water and groundwater regimes may alter the suitability of foraging habitat for the species (Eco Logical 2015b).

Changes to groundwater regimes may also affect the species' roosting habitat if changes to the groundwater table affect the humidity of the roost. Armstrong (2001) suggests the presence of seeps or groundwater pools is the most important factor in determining roost suitability; groundwater is considered important to maintain stable temperature and high humidity regimes of roost caves, and Pilbara leaf-nosed bat roosts are often associated with groundwater seeps (Armstrong 2001; DotE 2014e).

Reduced groundwater supply, e.g. due to mine pit dewatering, may reduce roost humidity, potentially to a point where the roost is no longer inhabitable by the species (DotE 2014e). Potential impacts to the Pilbara leaf-nosed bat from changes in hydrology and hydrogeology were included in the CIA (described further in Section 5.2.7) Potential impacts to the Pilbara leaf-nosed bat from changes to groundwater and surface water is rated Low in the CIA (Eco Logical 2015b).

Disturbance of Natural Roosts

Light, noise and vibration emissions have the potential to adversely impact Pilbara leaf-nose bat populations via the disturbance of natural roosts.

The Proposal will increase noise and light in the vicinity of mining operations, which may affect natural roosts if located in close proximity. Noise and light has been documented to affect some fauna (e.g. Larkin et al. 1996), however the extent to which the Pilbara leaf-nosed bat may be affected by noise or light is not well understood and assessing impacts of degradation of habitat through increased noise and light in terms of its frequency, intensity and extent is difficult. Artificial light may affect the species through interruption to normal nocturnal foraging behaviour, or through direct mortality (e.g. due to collision with vehicles, fences and other structures, or entanglement with objects such as barbed wire; Jones 2000; Stone et al. 2009) if individuals are attracted to artificially-lit area to feed on flying insects drawn to the lights at night. For example, a study in the United Kingdom demonstrated that artificially increased light levels significantly delayed bat emergence from roosts and disturbed their use of commuting routes, both of which reduced available foraging time (Murphy et al. 2009). Due to the range of possible effects that noise and light could have on the Pilbara leaf-nosed bat, these threats were not modelled in the CIA and are not considered further in this Draft IAR.

The DotE (2013b) states that 'blasting in any structure is likely to cause evacuation of the Pilbara leaf-nosed bat' from its roost; however, it is not stated whether such evacuation would be as a result of vibration, noise, or some other factor (Eco Logical 2015b). A recent comprehensive trial conducted by Rio Tinto suggests blasting is not likely to be a significant source of disturbance to the Pilbara leaf-nosed bat if appropriate measures are in place (including a buffer if required). The trial was completed in October 2013 and documented the behavioural response of the Pilbara leaf-nosed bat to blasting and vibration disturbance at Rio Tinto's proposed Koodaideri iron ore mine, located approximately 110 km west-northwest of Newman (Biota 2013; Rio Tinto 2013). The trial involved the use of explosive charges of incrementally increasing intensity and proximity to an underground roost located at the proposed Koodaideri mining area, which supported a Pilbara leaf-nosed bat colony comprising over 430 individuals (Eco Logical 2015b). Results of the trial were related to measures of behavioural response in the resident bats during daylight hours, when the Pilbara leaf-nosed bat is largely quiescent. The nominal threshold vibration level of 10 millimetres per second peak particle velocity adopted in the trial (based primarily on available standards for humans) was exceeded at the roost by one of the six trial blasts; however, there was no evidence that any of the blasts significantly disturbed the colony as none of the

blasts resulted in most, or all, bats taking flight within the underground roost (Biota 2013; Rio Tinto 2013). On this basis, vibration from blasting was excluded from the CIA modelling (Eco Logical 2015b).

Mortality from Collision with Vehicles or Trains

The Pilbara leaf-nosed bat is often observed foraging along roads at night (Churchill 2008). Its foraging height of less than 3 m makes it vulnerable to collision with cars, and many records of the species are of road kills (DotE 2014e). The species displays a curiosity for light sources and may be attracted to headlights (Armstrong 2013). Intermittent incidences of mortality from collision with vehicles are unlikely to significantly affect the population size of the Pilbara leaf-nosed bat; however, an increase in the number of roads or a larger volume of traffic may contribute to local decline in areas near roosting or foraging sites (DotE 2014e; Eco Logical 2015b).

There is a lack of data for roadkill rates for the Pilbara leaf-nosed bat; spatio-temporal factors that may drive the incidence of roadkill (such as the occurrence of roosts adjacent to roads or rail, traffic densities, traffic speed, or Pilbara leaf-nosed bat densities) have not been documented. However, the probability of a collision resulting in roadkill is likely to increase in locations closer to roads or rail lines. Collisions were considered to potentially affect Pilbara leaf-nosed bat habitat suitability at a distance of up to 500 m. Potential impacts to the Pilbara leaf-nosed bat from collision with vehicles or trains is rated Low in the CIA (Eco Logical 2015b).

Climate Change

The impacts of climate change on the Pilbara leaf-nosed bat have not been described in detail (DotE 2014e), however the effects of climate change on hydrological regimes in the Pilbara has the potential to impact habitat suitability. The level of uncertainty associated with current climate modelling outcomes was considered to limit its interpretation in relation to cumulative impacts in the Pilbara. While the predicted changes in average rainfall in the Pilbara are generally considered uncertain, the predicted increases of rainfall variability are more accepted. As the inter-annual rainfall variability in the Pilbara is already very high to extreme, the native species of plants this region can be considered well adapted to such fluctuations.

Preliminary analysis and modelling of potential effects as a result of recognised predicted climate change estimates was undertaken during the development of the CIA; however, the level of uncertainty associated with the modelling outcomes was considered to limit its interpretation in relation to cumulative impacts in the Pilbara.

Mining development

Potential impacts from mining development to the Pilbara leaf-nosed bat will change over time but in general will likely consist of habitat loss (habitat here primarily refers to daytime roosting) during the construction phase and mortality from collisions with vehicles or trains during the operational phase.

Changes in hydrology and hydrogeology during the operational phase have the potential to impact surface water (pools of water) which the Pilbara leaf-nosed bat requires for drinking and which supports its prey (insects). Changes to groundwater regimes may also affect the species' roosting habitat if changes to the groundwater table affect the humidity of the roost. Note, impacts from habitat fragmentation and degradation are described in the sections describing impacts associated with habitat loss or degradation of roosting sites and degradation or reduction in foraging habitat.

Sealing or destroying old mine shafts and horizontal adits during site rehabilitation could result in loss of suitable roost habitat and in mortality if bats are present when the structure is sealed or destroyed. This would be addressed as a result of site-specific rehabilitation and closure planning for relevant sites, rather than part of this Proposal; consequently, this was not applied as part of the CIA (Eco Logical 2015b). To date, there have been no adits recorded on BHP Billiton Iron Ore tenure that support a population of Pilbara leaf-nosed bats.

Recovery and Conservation Management Priorities for the Pilbara Leaf-nosed Bat

Recovery objectives and management and research actions for the Pilbara leaf-nosed bat were outlined in the Action Plan for Australian Bats (McKenzie et al. 1999) with the primary recovery objectives being:

- Protect known Pilbara colonies and/or translocate them if necessary.
- Ascertain if colonies in natural roosts in the Barlee Range Nature Reserve are declining.
- Locate and protect natural breeding roost sites in the Pilbara region.

Conservation Advice (DotE, 2016) for the Pilbara leaf-nosed bat lists the following priority conservation actions to stop the decline of and, or support the recovery of the species:

- Discover new occurrences by conducting field surveys for environmental assessments using acceptable methods and equipment to maximise potential for locating and confirming new occurrences;
- Discover new roosts by conducting target searches for environmental assessments, to determine whether critical roosting habitat coincides with development interests;
- Confirm diurnal roosts to determine their importance to the Pilbara leaf-nosed bat;
- Protect roosts, in including confirmed and suspected diurnal roost sites, particularly those occupied permanently and used for breeding;
- Monitor the population using robust and non-invasive methods to understand changes in usage across seasons and at breeding time;
- Assess and protect foraging habitat by retaining and preserving an adequate extent of observed or predicted high value foraging habitat near critical roost habitats to support the persistence of any existing colony and their continued use of roosts;
- Develop and support coordinated research with the involvement of qualified biologists to better understand the occurrence, population size and ecological requirements of the species in a regional and population-wide context;
- Encourage submission of occurrence data to Department of Parks and Wildlife;
- Suitably control public access to all known roost sites on both private and public lands;
- Implement a separate regional management plan, linked to a dynamic database that provides information on occurrence and roosting context to local developments.

The Conservation Advice also notes national conservation objectives and information and research priorities for the species.

BHP Billiton Iron Ore has committed to considering contemporary guidance as part of the Validation Framework provided within the MNES Program. The Validation Framework is discussed further in Section 8.6.2.

Extent of Potential and Cumulative Impacts to the Pilbara Leaf-nosed Bat

Eco Logical (2015b) modelled the habitat preference (the probability of that species being located in certain habitats) for the Pilbara leaf-nosed bat using 137 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) occurs in the central-east of the Pilbara bioregion.

Table 13 shows the area and proportion of the Pilbara bioregion of habitat suitability from 1 to 4, with Habitat Rank 1 being the lowest probability of potential habitat and Habitat Rank 4 being the highest probability of

potential habitat. The distribution of preferred habitat based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 24.

The extent of potential impacts to the Pilbara leaf-nosed bat were developed and modelled in the CIA (Eco Logical 2015b) and assigned to different categories:

- Existing impacts (this includes existing mining and non-mining impacts);
- Future third-party mines (potential impacts from reasonably foreseeable future third-party iron ore mines, described in Section 5.2.2 and shown in Figure 26); and
- Full Conceptual Development Scenario (this includes potential impacts from the Proposal, described in Section 5.2.2 and shown in Figure 26).

The potential cumulative impact is all of the above impacts combined.

Table 13: Classification and ranking applied to the Pilbara leaf-nosed bat habitat model

Model Value	Habitat Rank	Habitat Suitability	Area (ha) in Pilbara bioregion
70-100%	4	Highest probability of potential habitat	1,623,283 (9%)
30-70%	3	↓	4,233,754 (24%)
10-30%	2		6,569,572 (37%)
0-10%	1	Lowest probability of potential habitat	5,372,377 (30%)

Source: Eco Logical (2015b).

The CIA model indicated a potential cumulative impact of 38,952 hectares (2%) to the most suitable modelled habitat (Habitat Rank 4 - highest probability of potential habitat). Existing impacts were the main contributors to this impact (Table 14 and Box 6).

Table 14: Cumulative effects assessment for potential cumulative impacts to the Pilbara leaf-nosed bat (expressed as area and proportion of Habitat Rank 4)

Specified Protected Matter	Base Case[1]	Existing Impacts	Third party reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	Potential Cumulative Impact
Pilbara leaf-nosed bat	1,623,238 ha	-27,676 ha (-2%)	-5,001 ha (<-1%)	-6,275 ha (<-1%)	-38,952 ha (-2%)

1. Base Case means area of modelled Habitat Rank 4 within the Pilbara bioregion.
Source: Eco Logical (2015b).

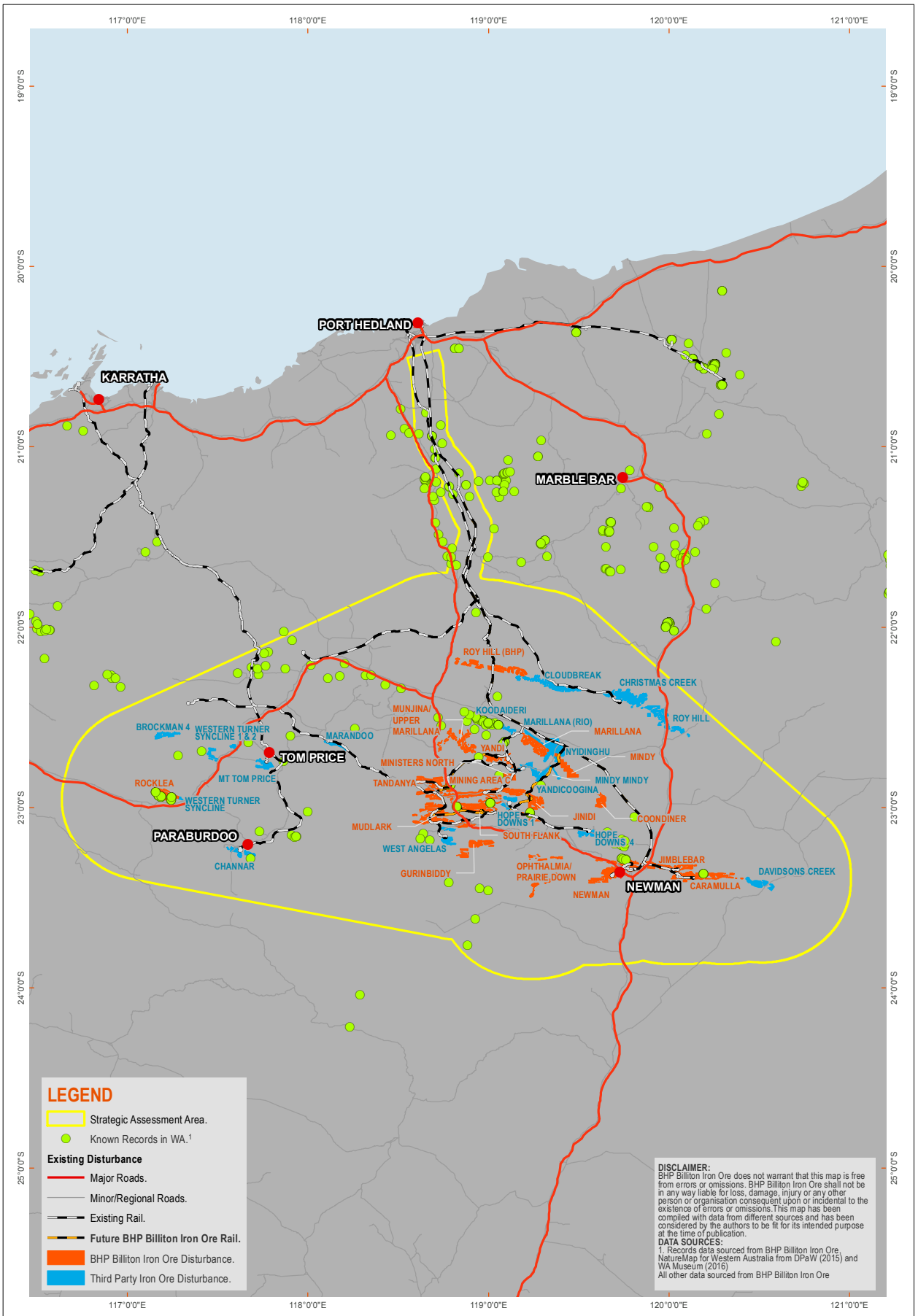

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Figure 26 Pilbara leaf-nosed bat distribution records and Full Conceptual Development Scenario

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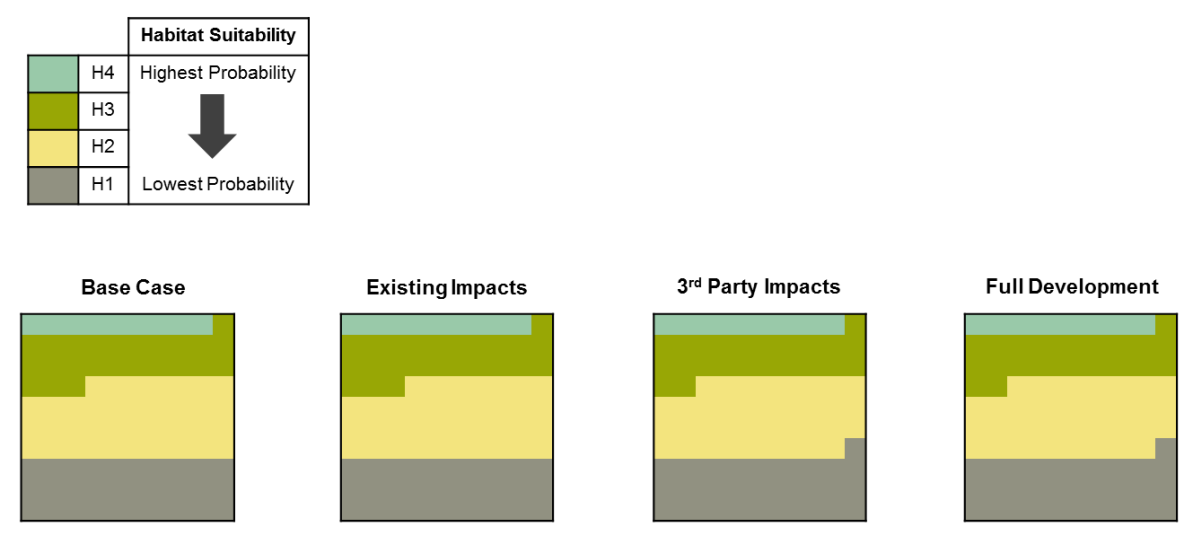
Box 6: Visualisation of numerical CIA results for the Pilbara leaf-nosed bat

A visualisation of the relative change in each of the habitat types is shown below. Each box represents 100% of the modelled area (the Pilbara) and shows the relative proportion of each habitat suitability class under each of the modelled scenarios:

- Base case
- Base case + existing impacts
- Base case + existing impacts + third-party impacts
- Base case + existing impacts + third-party impacts + BHP Billiton Iron Ore Full Conceptual Development Scenario impacts

At the regional level, the Pilbara leaf-nosed bat modelled impacts of the existing mining, infrastructure and pastoral activities have not materially changed the proportion of either Habitat Rank 4 (H4) or Habitat Rank 3 (H3) habitat classes from the base case. The addition of both third-party and BHP Billiton Iron Ore Full Conceptual Development Scenario impacts only slightly changes these relative proportions, with a corresponding decrease in H3 from approximately 13% to 12% and a corresponding 1% increase in Habitat Rank 1 (H1). Based on this result, potential impacts to the Pilbara leaf-nosed bat as a result of the Proposal's Full Conceptual Development Scenario are not considered to be significant at the regional scale.



Visual representation of changes to habitat ranks for the Pilbara leaf-nosed bat

The CIA model for the Pilbara leaf-nosed bat predicted over 1,623,238 ha of the most suitable habitat within the Pilbara bioregion. The model suggested that existing impacts have already resulted in a decrease of approximately 27,676 hectares (2% of its most suitable habitat in the Pilbara bioregion) in Pilbara leaf-nosed bat habitat suitability relative to the base case (Table 14). The model indicated that these existing impacts have occurred in isolated locations throughout the Pilbara bioregion. Within the Strategic Assessment Area, these existing impacts have primarily occurred in areas surrounding Newman and in some areas of the Hamersley Range. Impacts from third party iron ore mining and BHP Billiton Iron Ore future mining operations are predicted to be 5,001 ha and 6,275 ha respectively, which each represent less than 1% of the total most suitable habitat.

To further assess impacts to Pilbara leaf-nosed bat from iron ore mining in the Pilbara, BHP Billiton Iron Ore conducted an impact assessment based on species records. The records data were obtained from the

Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. The results are presented in Table 15.

Table 15: Impact assessment to Pilbara leaf-nosed bat based on species records

Total known records	Records within Strategic Assessment Area	Existing		Future		Cumulative impact (total records impacted and % of SAA records)
		Third Party	BHP Billiton Iron Ore	Third party Reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	
389	117	0	0	4	5	9 (7.7%)

Based on the species records data, 7.7% of the known records within the Strategic Assessment Area are predicted to be impacted by iron ore mining in the Pilbara. The data show the potential impact is from both BHP Billiton Iron Ore and reasonably foreseeable third party iron ore mines. This species is restricted to the Pilbara region of Western Australia. Three distinct subpopulations occur: the eastern Pilbara mines and granite, the Hamersley Range, and the Upper Gascoyne. The Pilbara leaf-nosed bat is restricted to caves and horizontal mine shafts with stable, warm and humid microclimates and occurs over a wide area with relatively few records within the Full Conceptual Development Scenario footprint. There is a significant roost known from Rio Tinto's Koodaideri project (EPA, 2014b). Based on surveys to date, there have been no significant roosts for this species identified in BHP Billiton Iron Ore tenure, however this species prefers habitats that occur within mining tenure and it is susceptibility to mining related impacts.

While the modelled potential impact is considered relatively minor at the regional scale, Woinarski et al. (2014) identified habitat loss based on mining, potentially leading to loss of roost sites in caves and old mine adits, as having a severe consequence in the medium term and possibly a catastrophic one in the longer term. Further to this, McKenzie and Bullen (2012) state that, while there is no evidence that the Pilbara leaf-nosed bat population has declined or that its area of occupancy has contracted, the Pilbara leaf-nosed bat is vulnerable due to the natural roosts known in the Pilbara being confined to banded ironstone strata that may be mined. According to McKenzie and Bullen (2012), unconstrained mining, without intervention and regionally focused management, will reduce the population by more than 30% over the next 15 years.

Potential impacts to the Pilbara leaf-nosed bat as a result of the Proposal's Full Conceptual Development Scenario are not considered to be significant at the regional scale given that less than 1% of the most preferred habitat (Habitat Rank 4) will be potentially impacted by the Proposal. Peer review comments for the Pilbara leaf-nosed bat cumulative impact assessment model are provided in Appendix 5. Based on surveys to date, there have been no significant roosts for this species identified in BHP Billiton Iron Ore tenure; therefore at this stage this species is considered to be at low risk from the Full Conceptual Development Scenario. Impacts to the Pilbara leaf-nosed bat at a local scale will be validated on a case-by-case basis through processes described in the Validation Framework, where key inputs such as engineering design and contemporary guidance will be taken into account in decision-making before taking a Material Action. The Validation Framework is described further in Section 8.6.2.

Other key threats that were not modelled in the CIA for the Pilbara leaf-nosed bat included climate change. The reason for not including climate change in the CIA is discussed in the consideration of potential impacts to the Pilbara leaf-nosed bat above. BHP Billiton Iron Ore considers that the Proposal is unlikely to impact upon climate change as it is largely independent of and would not be exacerbated significantly by the Proposal.

The Draft MNES Program (BHP Billiton Iron Ore 2016) includes commitments to consider and manage as part of its adaptive management approach any material future changes to the environment; including climate change and environmental change (e.g., change in availability of foraging habitat). Further, BHP Billiton Iron Ore has committed to applying the mitigation hierarchy (avoid, mitigate and, as a last resort, offset) to manage its impacts to the Specified Protected Matters, including the Pilbara leaf-nosed bat. Further information regarding the commitments made in the Draft MNES Program is provided in Chapter 8.

BHP Billiton Iron Ore considers that the potential impacts to the Pilbara leaf-nosed bat from implementation of the Proposal are not likely to be significant, given the negligible modelled impact predicted to Pilbara leaf-nosed bat habitat from future reasonably foreseeable third-party mining operations and the BHP Billiton Iron Ore Full Conceptual Development Scenario. BHP Billiton Iron Ore's commitments in the Draft MNES Program to validate these potential impacts, manage future change and apply the mitigation hierarchy ensures that impacts to the Pilbara leaf-nosed bat will be managed to an acceptable level during the life of the Proposal.

5.3.4 PILBARA OLIVE PYTHON (*LIASIS OLIVACEUS BARRONI*)

SPECIES DESCRIPTION AND CONSERVATION STATUS

The Pilbara olive python is a terrestrial snake in the Pythonidae family. It is a large, dark olive, yellowish brown to olive brown python with white to cream ventral surfaces (DotE, 2014c) (Plate 16).

The species can grow to 4.5 m in length but is more commonly encountered at 2.5 m (Pearson 2003). Two subspecies of the olive python are recognised. Apart from its more southerly distribution in Western Australia, the Pilbara subspecies can be differentiated from the Kimberley subspecies by fewer mid-body scale rows and more ventral scale rows (Smith 1981). The Pilbara olive python is listed as Vulnerable under the EPBC Act and 'Schedule 1' under the WC Act.

Photo: Ruchira Somaweera and Belinda Barnett

Plate 16: Pilbara olive python

SPECIES DISTRIBUTION

The Pilbara olive python is described by the DotE (2014c) as being restricted to ranges within the Pilbara bioregion, although an apparently isolated population occurs south on Mount Augustus in the Gascoyne bioregion (Bush & Maryan 2011) and additional records exist in the north-eastern Carnarvon bioregion). Within the Pilbara bioregion, the species has been recorded from the Hamersley Range, Dampier Archipelago, Pannawonica, Millstream, Tom Price, Burrup Peninsula, and 70 km east of Port Hedland (DotE 2014e); the species is also known from riparian areas along the Fortescue River (Doughty et al. 2011). The species distribution for the Pilbara olive python is shown in Figure 27.

ECOLOGY

The Pilbara olive python is adept at swimming, utilising water holes to hunt; and its diet includes rock wallabies, small euros, fruit bats, and birds. Juveniles are thought to eat reptiles, frogs, small mammals and small birds (Pearson 2003). Breeding occurs from June to August, with males moving long distances (up to 4 km) in search of females (Pearson 2003). Males and females often move into shelter, such as a cave, and remain together for up to three weeks. Eggs are laid in October, in nests under large slabs of rock well away from water, and hatch around January (Pearson 2003).

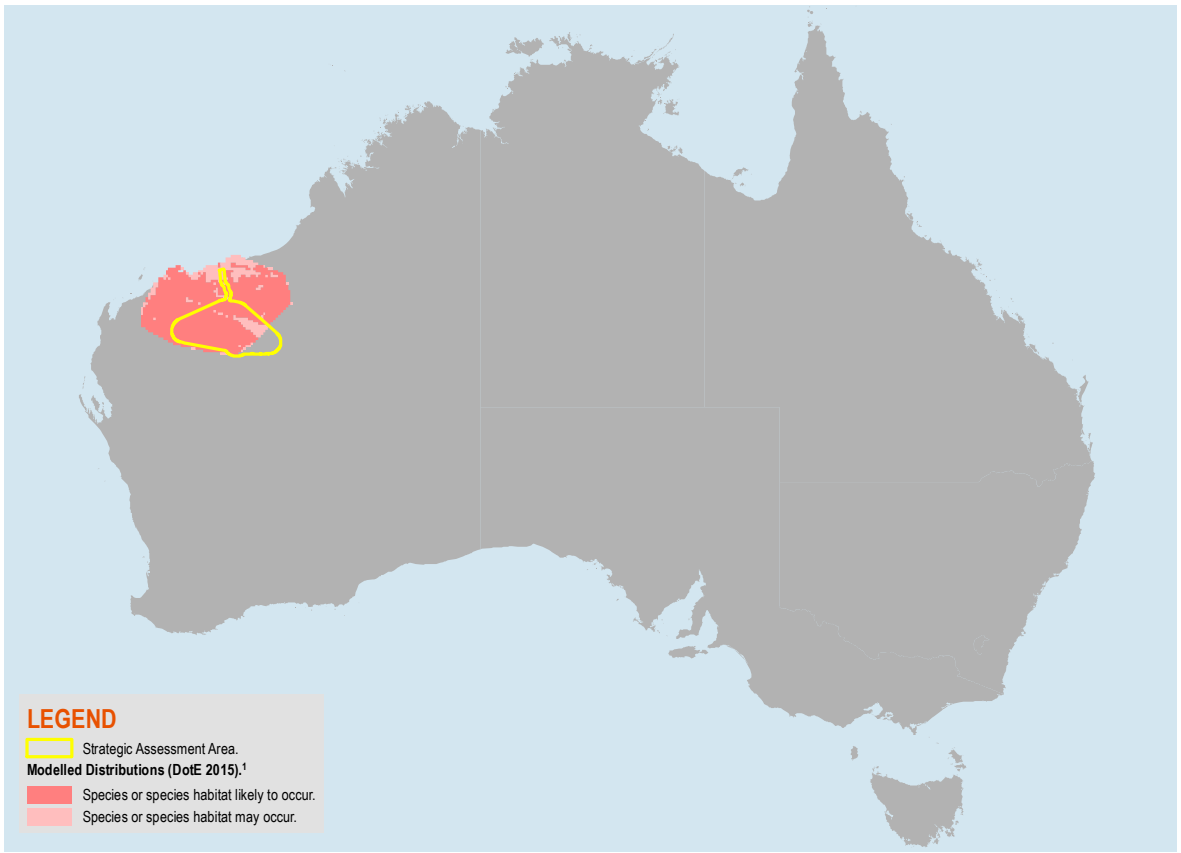
HABITAT

The Pilbara olive python has a strong preference for riparian habitats during warmer months when hunting for prey but utilises rocky habitats at other times of the year (Doughty et al. 2011). Waterholes and billabongs form an important component of the python's habitat, as it is able to ambush prey species that come to drink (Pearson 2003; DotE 2014c). The Pilbara olive python attains relatively high densities along the paperbark- and river red gum-lined billabongs of the Fortescue River (Pearson 2003), as well as other major creeks and rivers throughout its Pilbara range. It is also known from around permanent pools and mesas of the Robe River valley and the Millstream spring system (Rio Tinto 2011). At Tom Price, the Pilbara olive python has been observed around sewage ponds and a recreational lake (Pearson 2003) and has also been found sheltering in railway embankments (DotE 2014e).

Outside of warmer months, the Pilbara olive python occupies rocky habitats, such as escarpments, mesas, overburden heaps (at Pannawonica), and caves and gorges (Doughty et al. 2011). It is often found on top of or underneath rocks or sheltering under spinifex (Tutt et al. 2004). Pilbara olive pythons are known to occupy a distinct home range ranging from 85 to 450 ha and to move around frequently within its home range (Pearson 2003). Potential habitat predicted by Eco Logical (2014d) was most heavily concentrated in the ranges of the southern and central areas of the Pilbara bioregion; however potential habitat was also predicted in association with river plains in the north and the ranges and outcrops of the east.

IMPACT ASSESSMENT

Iron ore mining activities typically occur in rocky habitats, which means that these activities can impact on the suitability of habitat for the Pilbara olive python as it prefers rocky habitats (Cogger 2014). The distribution of preferred habitat based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 28. Since the development of this model, publicly available data has been updated and these data have been included in Figure 28. The additional records are consistent with the modelled habitat preference across the Pilbara. The additional records also demonstrate the type of new information that will be used throughout implementation of the Proposal as part of the Validation Framework and adaptive management (refer to Chapter 8).



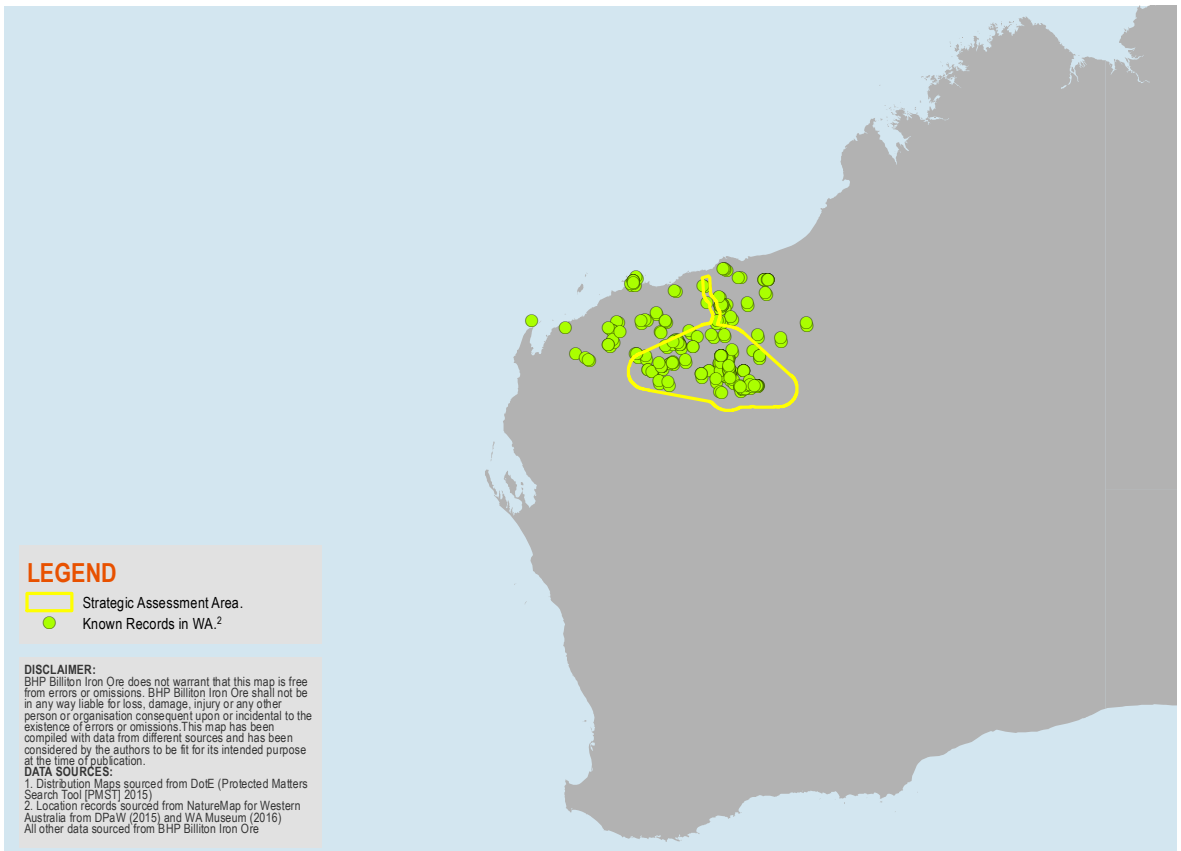


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Figure 27 Distribution of the Pilbara olive python relative to the Strategic Assessment Area

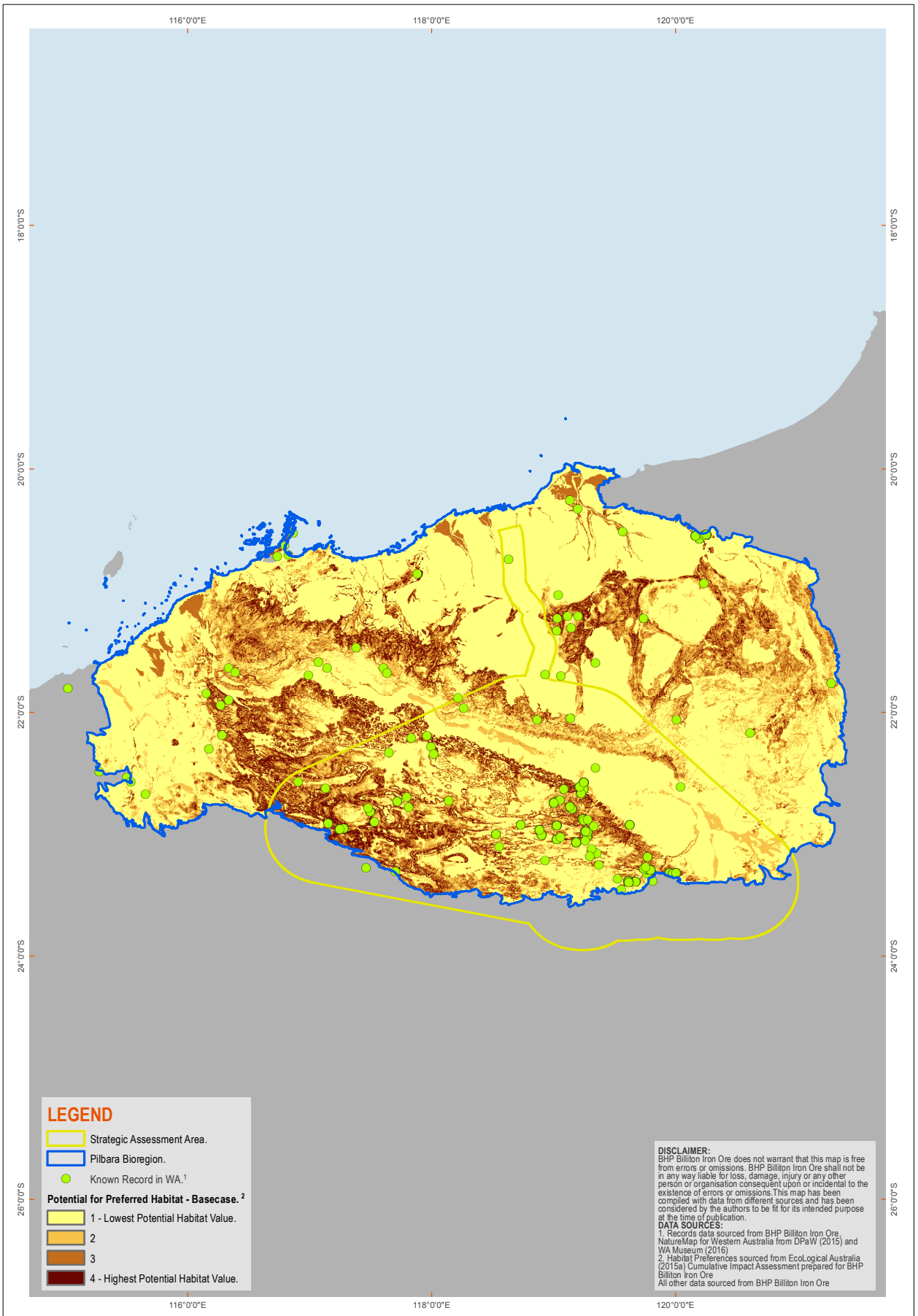

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Figure 28 Modelled distribution of preferred habitat for the Pilbara olive python

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There are numerous records of the Pilbara olive python in the Pilbara and in the Strategic Assessment Area. However, most of the records in the databases (NatureMap and BHP Billiton Iron Ore fauna database) occur in the southern Pilbara, with many records coming from the central area of the Strategic Assessment Area (see Figure 28). There are only two records in the rail corridor section of the Strategic Assessment Area.

Key Threats to the Pilbara Olive Python

Known and perceived threats to the Pilbara olive python are identified in the Commonwealth Species Profile and Threats (SPRAT) database (DotE 2014c), conservation advice the species (TSSC 2008a) and the Pilbara olive python workshop facilitated by DPaW (as described in Section 5.2.4).

From the review of this information, the key threats to the Pilbara olive python in the Pilbara region have been identified as:

- removal and fragmentation of habitat due to land clearing;
- degradation of habitat as a result of grazing pressure;
- degradation of habitat due to hydrological change;
- degradation of habitat due to inappropriate fire regimes;
- predation and competition from non-native species;
- mortality from collision with road and/or rail traffic;
- emission of noise and light;
- climate change; and
- mining development.

These threats are described below and graphically represented in the conceptual threats model shown in Figure 29. The model shows the relative ranking of the threats to the Pilbara olive python and also identifies which threats were quantitatively assessed in the CIA.

Removal and Fragmentation of Habitat due to Land Clearing

The removal of habitat may result in the loss of breeding and foraging habitat and lead to a reduction in the species' distribution and population size. Removal of habitat was rated as a High impact in the CIA (Eco Logical 2015b). The Pilbara olive python has been observed to use artificial water sources, such as the Tom Price sewage treatment ponds and recreational lakes, along with overburden heaps and railway embankments at the Mesa J Iron Ore Mine near Pannawonica (Pearson 2003). The Pilbara olive python may therefore still be able to utilise highly disturbed areas where suitable habitat features are present; however, as a conservative approach was taken in the CIA, potential habitat utilisation in cleared areas was not considered (Eco Logical 2015b).

Habitat fragmentation could isolate Pilbara olive python populations, reduce genetic connectivity across affected areas and increase the risk of local extinctions. Mining and linear infrastructure (roads and rail) have the potential to fragment Pilbara olive python habitat if clearing reduces habitat connectivity or if infrastructure presents an obstacle to movement or dispersal.

Consideration of the Pilbara olive python's habitat requirements in the warmer months is important in the context of habitat fragmentation as, during these times, the Pilbara olive python has a strong preference for riparian habitats (Doughty et al. 2011). Habitat quality is also strongly influenced by the presence of waterholes and billabongs (Pearson 2003; DotE 2014c). Habitat fragmentation was considered in terms of minimum patch size: the area required for the species to maintain a viable population.

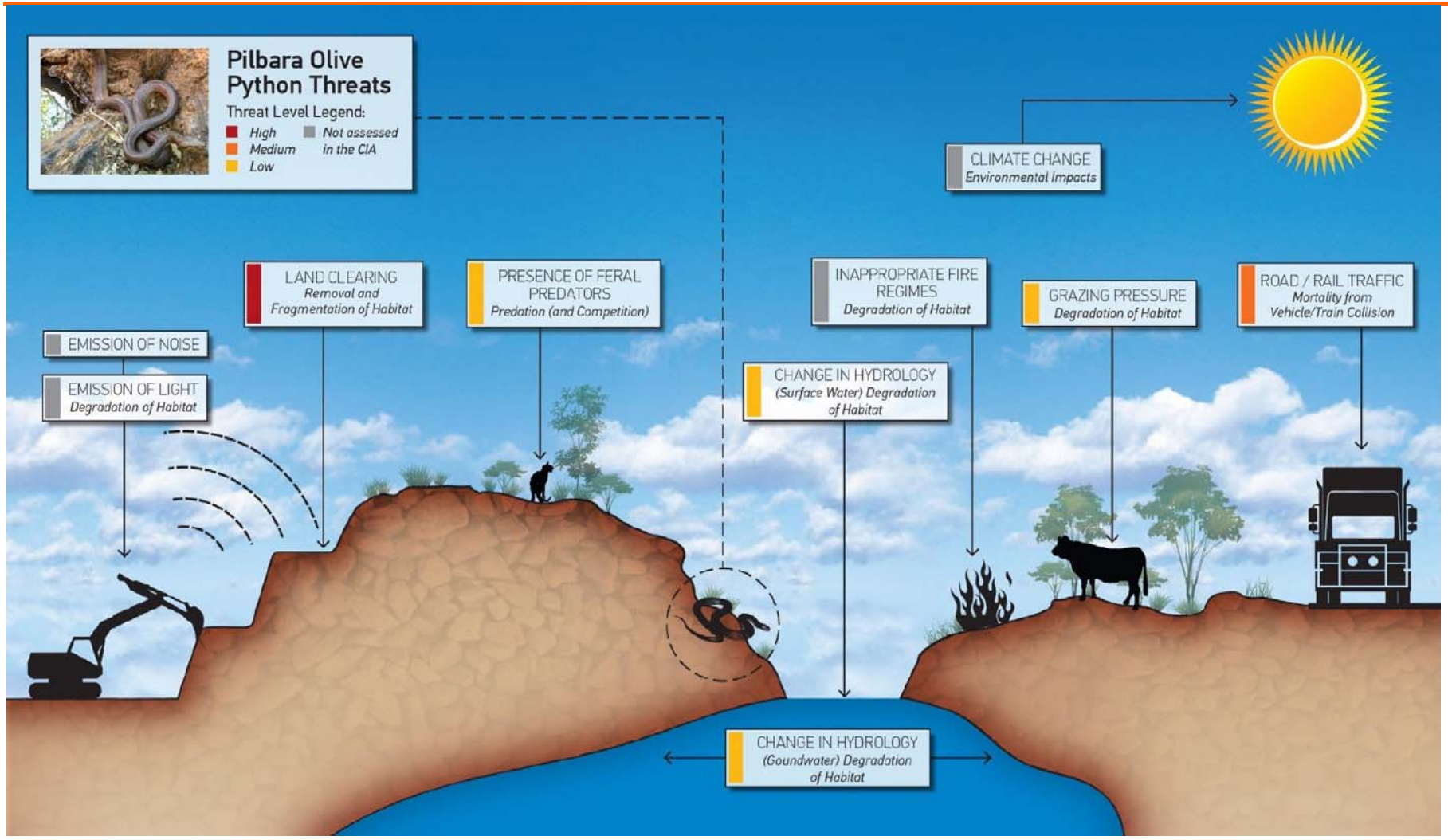


Figure 29: Conceptual diagram of key threats for the Pilbara olive python

The minimum patch size was determined based on information from the SPRAT database, which states that the Pilbara olive python's home range may be as large as 450 ha (DotE 2014c). Habitat fragmentation was considered to have occurred when patch size was reduced below 450 ha; impacts were assumed to increase with decreasing patch size below this threshold (Eco Logical 2015b). Consequently, potential impacts to the Pilbara olive python from fragmentation of habitat are rated from Low to High in the CIA (Eco Logical 2015b), with this dependent on the size of the patch that is fragmented.

Degradation of Habitat as a result of Grazing Pressure

Increased cattle stocking rates may alter habitat for the Pilbara olive python and its prey by reducing ground cover and in some cases increasing shrub cover by promoting vegetation thickening and weed invasion, e.g. as discussed for the northern quoll by Hill and Ward (2010); quolls are a known food source for the Pilbara olive python (e.g. TSSC 2008a). Loss of cover may also increase the vulnerability of the Pilbara olive python to predation, juveniles in particular. Further, cattle grazing and presence (ground disturbance) is likely to change the nature of fire (e.g. intensity and extent) based on the effect cattle can have on low strata vegetation, including the potential for introduction or spread of weeds with high fuel loads. The interaction of grazing pressure and fire may act to compound negative effects on the Pilbara olive python; however, this was not considered in the application of the potential impacts of grazing (Eco Logical 2015b). Habitat suitability is expected to reduce as grazing pressure increases and the likelihood of Pilbara olive python predation increases and prey becomes scarcer. The impact of grazing was applied to the Pilbara olive python from a spatial layer for grazing pressure developed for the Pilbara bioregion by ELA (Eco Logical 2015b). The grazing pressure layer categorised areas as either zero, low, medium or high grazing pressure based on land system data (land systems are characterised according to vegetation types, substrate and landscape characteristics (van Vreeswyk et al. 2004)) and distance to water (Eco Logical 2015b). Potential impacts to the Pilbara olive python from grazing were considered Low in the CIA (Eco Logical 2015b).

Degradation of Habitat due to Hydrological Change

Changes in natural surface water flows and quality and potential impacts to groundwater through mining activities may affect the Pilbara olive python via impacts to the species' foraging habitat. The Pilbara olive python is known to occur in riparian habitats, waterholes and billabongs where it ambushes prey attracted to the water (Pearson 2003; Doughty et al. 2011; DotE 2014c). In relation to mining activities, pit dewatering and extraction of groundwater may lead to a decline in the water level or to drying of waterholes, thereby leading to a loss of foraging habitat. The Pilbara olive python may be affected by groundwater drawdown through reduced availability of groundwater-fed surface water and through interception of surface runoff and a reduced catchment area directing runoff to water bodies. Potential impacts to the Pilbara olive python were estimated based on BHP Billiton Iron Ore (2015) groundwater and surface water change potential. Potential impacts to the Pilbara olive python were considered Low for groundwater drawdown and surface water availability in the CIA (Eco Logical 2015b).

Degradation of Habitat due to Inappropriate Fire Regimes

Inappropriate fire regimes were excluded from the CIA (Eco Logical 2015b). While it is recognised that fire scar mapping is available for the Pilbara, such fire scar mapping provides only the approximate date and area of fires and does not necessarily describe the fire regime (which is a complex of many interacting factors) or inform about changes in regime (which may require decades of data to detect) (van Etten, E., pers. comm., 23 March 2015). In addition, the response of species to different elements of the fire regime and to changes in regime is largely unknown and difficult to predict (van Etten, E., pers. comm., 23 March 2015). The effect of fire on each species is complex and can be positive or negative in different situations. Consequently, the impact of fire was not applied in the CIA due to lack of data for season, frequency and extent of fires across the Pilbara, all of which may play a key role in influencing Pilbara olive python habitat suitability in the Pilbara bioregion (DotE 2014c).

With regard to reasonably foreseeable future impacts of fire, the effect of mining and non-mining activities on alteration of fire impacts is unclear and likely to be influenced primarily by assumptions of fire management and fire response. For this reason, the impact to the Pilbara olive python from inappropriate fire regimes was not included in the CIA.

Predation and Competition from Non-Native Species

Feral predators of the Pilbara olive python include the cat and dingo (DotE 2014c; Ellis 2013; Sustainable Consulting 2013d). Feral predators may play a role in the decline of the Pilbara olive python through predation, particularly of juveniles, as well as predation of the Pilbara olive python's food sources (such as quolls and rock-wallabies) (TSSC 2008a; Ellis 2013; Pearson 2013b; DotE 2014c).

While there is likely to be some level of predation throughout the Pilbara, feral predators are considered likely to occur in greater numbers near areas of human settlement (such as towns and mine camps) as a result of increased opportunities for food and near roads as a result of facilitated movement (e.g. Andrews 1990; Mahon et al. 1998; Brown et al. 2006; Lach & Thomas 2008). Thus, impacts of predation were related to proximity to human settlements and roads or tracks (and to power lines under the assumption that power lines have an associated access track), with distances relating to the home ranges of feral predators (Eco Logical 2015b).

The home range of feral cats was estimated by Johnstone et al. (2013) as approximately 1,000 ha, which equates to a radius of approximately 1.8 km, assuming a circular area. Based on this and other studies, a conservative proximity of 2 km to human settlements or roads was used as the basis for predation impacts (Eco Logical 2015b). Potential impacts to the Pilbara olive python from predation are rated Low in the CIA.

Mortality from Collision with Road and/or Rail Traffic

Rail and road networks possibly increase the chance of Pilbara olive python mortality. Vehicle strikes are likely to occur as the Pilbara olive python moves across roads between shelters and forage sites and especially when males are in search of females in the breeding season (Eco Logical 2015b). There is a lack of road mortality literature specific to the Pilbara olive python, or other reptiles in the Pilbara bioregion; however, studies on other species of snakes have been undertaken elsewhere. A study undertaken in the McDonnell Ranges (central Australia) found that road-kill snakes made up 9% of all snakes encountered, suggesting that road mortality did not inflict substantial damage on that region's snake fauna (McDonald 2012). As part of the same study, McDonald et al. (2011) examined the ecology of Stimson's python (*Antaresia stimsoni*) and, while doing so, found that 10% of the Stimson's pythons he encountered were road kills.

Impacts of road and rail mortality were estimated based on the proximity of roads and rail to potential Pilbara olive python habitat. Collisions were considered to potentially affect Pilbara olive python habitat suitability at a distance of up to 500 m, with the greatest effect being within 50 m. Consequently, potential impacts to the Pilbara olive python from collision with vehicles or trains is rated Low to Medium in the CIA (Eco Logical 2015b), with this being dependent on distance from rail and roads.

Emission of Noise and Light

The Proposal will increase noise and light in the vicinity of mining operations. Noise and light has been documented to affect some fauna (e.g. Larkin et al. 1996), however the extent to which the Pilbara olive python may be affected by noise or light is not well understood and assessing impacts of degradation of habitat through increased noise and light in terms of its frequency, intensity and extent is difficult. For example, an animal may respond differently to rare and short term light disturbance compared with ongoing light disturbance. The introduction of artificial light could affect the Pilbara olive python given that it is active during both the day and night, and so would prey on nocturnal fauna that may be affected by artificial light. Movements and behaviour of the Pilbara olive python and/or its prey could be altered, as individuals could become disoriented by artificial light, resulting in changes in foraging success and reduced fitness, and increased

likelihood of predation. In some instances, artificial light may increase foraging activity due to providing a higher abundance of food resources (e.g. lights attracting insects) (Larkin et al. 1996). Due to the range of possible effects that noise and light could have on the Pilbara olive python, these threats were not modelled in the CIA and are not considered further in this Draft IAR.

Climate Change

Climate change is recognised as a key threat to the Pilbara olive python (DotE 2014a). Predicted changes to climatic conditions in the Pilbara (as described in Section 4.7.2) may impact Pilbara olive python populations by causing modification, loss or fragmentation of key habitat, particularly through its influence on hydrological regimes in Pilbara. Other impacts may arise through the exacerbating effect climate change may have on other threats, i.e., increasing the frequency and intensity of fires and further mediating the invasion of introduced species (Dunlop et al. 2012).

Preliminary analysis and modelling of potential effects as a result of recognised predicted climate change estimates was undertaken during the development of the CIA; however, the level of uncertainty associated with the modelling outcomes was considered to limit its interpretation in relation to cumulative impacts in the Pilbara and was therefore not assessed.

Mining development

Potential impacts for mining development to the Pilbara olive python will change over time and are more likely to occur in the southern part of the Strategic Assessment Area (given there is more suitable habitat) but in general will likely consist of habitat loss and fragmentation during the construction phase. During operations, predation and mortality from collisions with vehicles and trains, habitat degradation (changes in natural surface water flows and quality, as well as impacts to groundwater, through mining activities) are the most likely potential impacts.

Recovery and Conservation Management Priorities for the Pilbara Olive Python

The limiting of free water at mining sites and increased road signage around roads with increased usage at development areas has been recommended to limit negative interactions between the Pilbara olive python, their prey and humans (Tutt et al 2002).

BHP Billiton Iron Ore has committed to considering contemporary guidance (such as threat abatements plans) as part of the Validation Framework provided within the MNES Program. The Validation Framework is discussed further in Section 8.6.2.

Extent of Potential and Cumulative Impacts to the Pilbara Olive Python

Eco Logical (2015b) modelled the habitat preference (the probability of that species being located in certain habitats) for the Pilbara olive python using 75 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) was most heavily concentrated in the ranges of the southern and central areas of the Pilbara bioregion; however, preferred habitat was also predicted in association with river plains in the north and the ranges and outcrops of the eastern part of the Pilbara bioregion.

Table 14 shows the area and proportion of the Pilbara bioregion of habitat suitability from 1 to 4, with Habitat Rank 1 being the lowest probability of potential habitat and Habitat Rank 4 being the highest probability of potential habitat. The distribution of preferred habitat based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 28.

Table 16: Classification and ranking applied to the Pilbara olive python habitat model

Model Value	Habitat Rank	Habitat Suitability	Area (ha) and proportion (%) of the Pilbara Bioregion
70-100%	4	Highest probability of potential habitat	1,126,500 (6%)
30-70%	3	↓	2,948,403 (17%)
10-30%	2		3,100,368 (17%)
0-10%	1	Lowest probability of potential habitat	10,609,870 (60%)

Source: Eco Logical (2015b).

The extent of potential impacts to the Pilbara olive python were developed and modelled in the CIA (Eco Logical 2015b) and assigned to different categories:

- Existing impacts (this includes existing mining and non-mining impacts);
- Future third-party mines (potential impacts from reasonably foreseeable future third-party iron ore mines, described in Section 5.2.2 and shown in Figure 30); and
- Full Development Scenario (this includes potential impacts from the Proposal Full Conceptual Development Scenario, described in Section 5.2.2 and shown in Figure 30).

The potential cumulative impact is all of the above impacts combined.

The CIA model indicated a potential cumulative impact of 841,000 ha (75%) to the most suitable modelled habitat (Habitat Rank 4 - highest probability of potential habitat). Existing impacts were the main contributors to this impact (Table 17 and Box 7).

Table 17: Cumulative effects assessment for potential cumulative impacts to the Pilbara olive python (expressed as area and proportion of Habitat Rank 4)

Specified Protected Matter	Base Case[1]	Existing Impacts	Third party reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	Potential Cumulative Impact
Pilbara olive python	1,126,500 ha	-74% (-837,414 ha)	<-1% (-2,305 ha)	<-1% (-1,344 ha)	-75% (-841,062 ha)

1. Base Case means area of modelled Habitat Rank 4 within the Pilbara bioregion.
Source: Eco Logical (2015b).

The model suggests that there is only a 1% increase (based on existing impacts) in potential impact to Habitat Rank 4 (highest probability of potential habitat) for the Pilbara olive python when all future operations within the scope of the Proposal are included (Eco Logical 2015b). The Full Conceptual Development Scenario may result in a slight decrease in impacts to Habitat Rank 4 for the Pilbara olive python when compared to existing impacts.

To further assess impacts to Pilbara olive python from iron ore mining in the Pilbara, BHP Billiton Iron Ore conducted an impact assessment based on species records. The records data were obtained from the Department of Parks and Wildlife and Western Australian Museum in December 2015 and January 2016 respectively. The results are presented in Table 18.

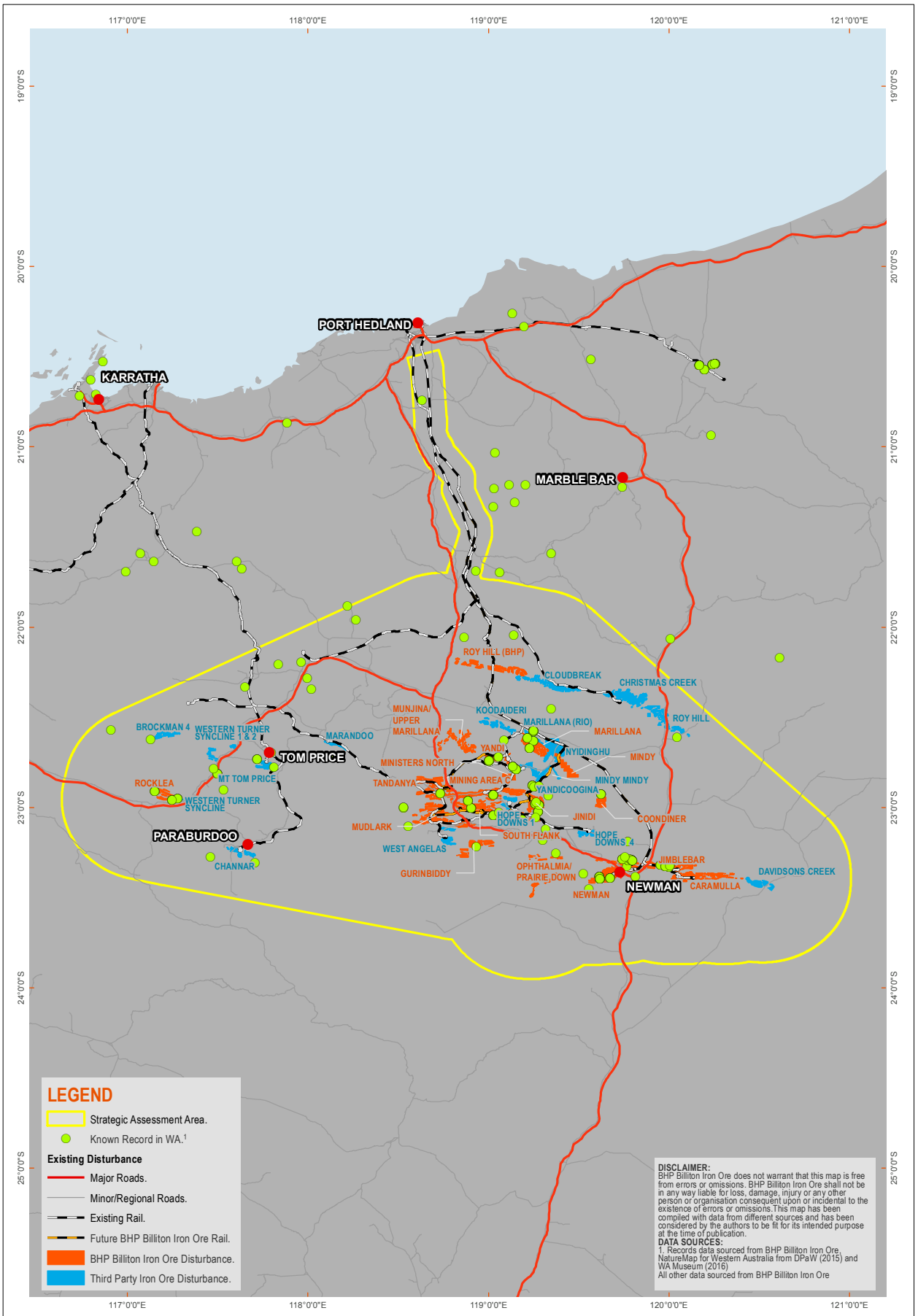


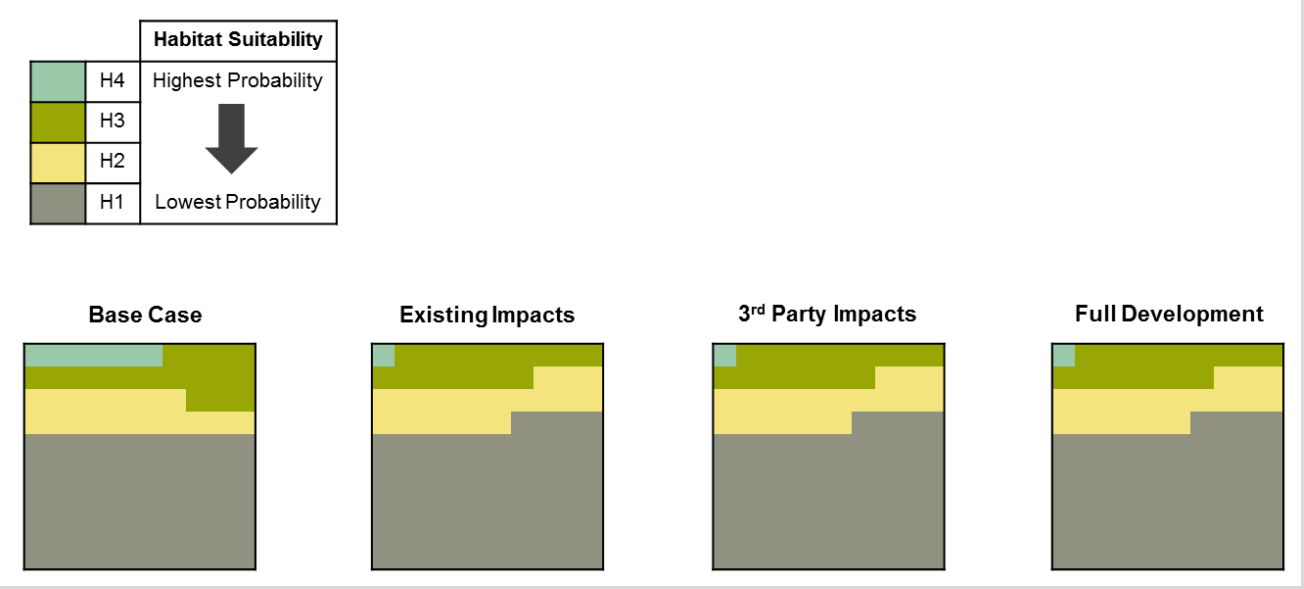
Figure 30 Pilbara olive python distribution records and Full Conceptual Development Scenario

Box 7: Visualisation of numerical CIA results for the Pilbara olive python

A visualisation of the relative change in each of the habitat types is shown below. Each box represents 100% of the modelled area (the Pilbara) and shows the relative proportion of each habitat suitability class under each of the modelled scenarios:

- Base case
- Base case + existing impacts
- Base case + existing impacts + third-party impacts
- Base case + existing impacts + third-party impacts + BHP Billiton Iron Ore Full Conceptual Development Scenario impacts

From the Pilbara olive python modelling, existing mining, infrastructure and pastoral impacts have modified the proportion of both Habitat Rank 4 (H4) and Habitat Rank 3 (H3) habitat classes from the base case (from approximately 6% to less than 1% for H4 and from approximately 17% to 16% for H3), with a corresponding increase in the proportion of Habitat Rank 2 (H2) and Habitat Rank 1 (H1). The addition of both third-party and BHP Billiton Iron Ore Full Conceptual Development Scenario potential impacts do not significantly change these relative proportions.



Visual representation of changes to habitat ranks for the Pilbara olive python

Table 18: Impact assessment to Pilbara olive python based on species records

Total known records	Records within Strategic Assessment Area	Existing		Future		Cumulative impact (total records impacted and % of SAA records)
		Third Party	BHP Billiton Iron Ore	Third party reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	
187	117	1	3	1	25	26 (22.2%)

Based on the species records data, 22.2% of the known records within the Strategic Assessment Area are predicted to be impacted by iron ore mining in the Pilbara. It is a cryptic species that is difficult to specifically target during fauna surveys (DotE, 2008), so this number is unlikely to represent its abundance and distribution within the Pilbara. There is currently no population estimate for the Pilbara olive python although it is believed to have sizable populations in areas (e.g. the Burrup Peninsula), and some of these are restricted from threatening processes (Pearson 2003).

The Pilbara olive python has a strong preference for riparian habitats during warmer months when hunting for prey but utilises rocky habitats at other times of the year (Doughty et al. 2011). Waterholes and billabongs form an important component of the python's habitat, as it is able to ambush prey species that come to drink (Pearson 2003; DotE 2014c). Outside of warmer months, the Pilbara olive python occupies rocky habitats, such as escarpments, mesas, overburden heaps (at Pannawonica), and caves and gorges (Doughty et al. 2011). A large proportion of its habitat is conserved in Karijini National Park (Pearson 1993).

Potential impacts to the Pilbara olive python as a result of the Full Conceptual Development Scenario indicate that impacts are not likely to be significant at the regional scale given that less than 1% of the highest potentially suitable habitat will be potentially impacted. Peer review comments for the Pilbara olive python cumulative impact assessment model are provided in Appendix 5. The impact assessment provided in Table 18 indicates that, based on species records, a moderate impact will occur. BHP Billiton Iron Ore recognises that impacts to this species will require considered management during implementation of the Proposal. Impacts to the Pilbara olive python at a local scale will be validated on a case-by-case basis through processes described in the Validation Framework, where key inputs such as engineering design and contemporary guidance will be taken into account in decision-making before taking a Material Action. The Validation Framework is described further in Section 8.6.2. An example of the mitigation hierarchy being applied to the Pilbara olive python to achieve an acceptable outcome is provided in Case Study 8 within Section 8.4.

Inappropriate fire regimes were considered to be a relevant threat; however it was not modelled in the CIA for the Pilbara olive python. Any impacts associated with inappropriate fire regimes would occur largely independent of and would not be exacerbated by the Proposal. Any assessment of potential impacts from fire is also likely to be heavily influenced by assumptions of fire management and fire response.

The Draft MNES Program (BHP Billiton Iron Ore 2016) includes commitments to consider and manage as part of its adaptive management approach any material future changes to the environment. Further, BHP Billiton Iron Ore has committed to applying the mitigation hierarchy (avoid, mitigate and, as a last resort, offset) to manage its impacts to the Specified Protected Matters, including the Pilbara olive python. Further information regarding the commitments made in the Draft MNES Program is provided in Chapter 8.

BHP Billiton Iron Ore considers that the potential impacts to the Pilbara olive python from implementation of the Proposal can be managed to an acceptable level, noting that although the modelled cumulative impact to the most suitable habitat for Pilbara olive python habitat is low, impacts to known species records are potentially significant. BHP Billiton Iron Ore's commitments in the Draft MNES Program to validate these potential impacts, manage future change and apply the mitigation hierarchy ensures that impacts to the Pilbara olive python will be managed to an acceptable level during the life of the Proposal.

5.3.5 HAMERSLEY LEPIDIUM (*LEPIDIUM CATAPYCNON*)

SPECIES DESCRIPTION AND CONSERVATION STATUS

Hamersley lepidium is a rounded, short-lived perennial herb or shrub, growing up to 40 cm high, with numerous stems that zigzag markedly between the leaf nodes (Brown et al. 1998; Hewson 1981) (Plate 18). The leaves are small, 4 cm long by 2 mm wide, linear and terete, succulent-like and papillose (having minute projections on the surface) (Hewson 1981). Flowers are white with four sepals and six stamens, and individual flowers grow

up to 6 mm long and form a dense terminal raceme (Hewson 1981, 1982). The fruit is winged and papillose (Brown et al. 1998; Hewson 1981). *Lepidium catapycnon* has recently been delisted from the WC Act, and at a state level is considered a Priority 4 species.

Photo: Onshore Environmental

Plate 17: Hamersley lepidium

SPECIES DISTRIBUTION

The Hamersley lepidium is endemic to the Pilbara, occurring in scattered locations of the Hamersley Range (Brown et al. 1998) (Figure 31). The species is recorded from the Newman, Wittenoom, Weeli Wolli Creek and West Angelas areas (DotE 2014f). Recent work by Onshore Environmental (2014) has suggested that 2011 data from a Department of Environment and Conservation database identifies a total of 32 populations. Onshore Environmental (2012) states that the species' distribution covers approximately 21,736 km^2 in an area stretching roughly between the towns of Newman, Nullagine and Tom Price in the Pilbara.

Onshore Environmental (2013a) confirmed the presence of eight populations comprising approximately 1,345 plants in Karijini National Park. The survey was not exhaustive, and Onshore Environmental (2013a) concluded there is a high probability that additional populations occur within similar landforms within the park.

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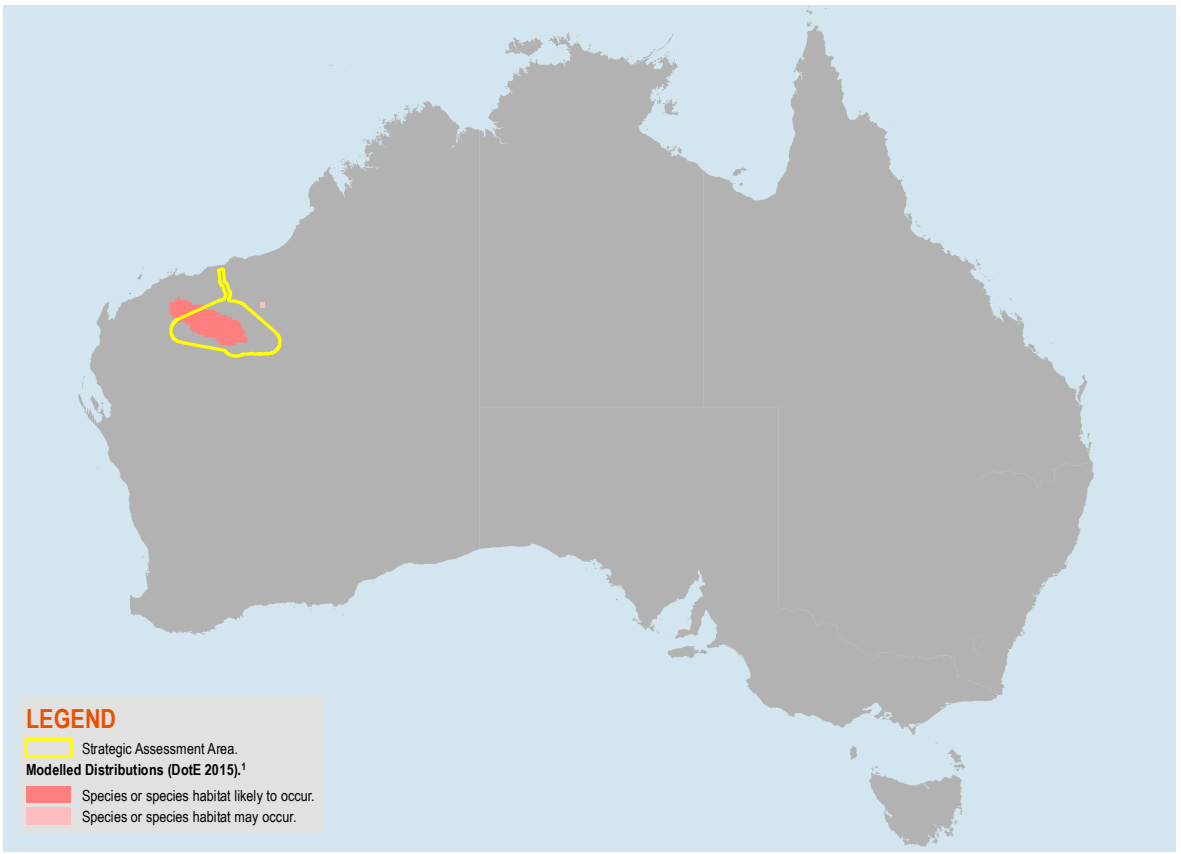
The life cycle is that of a pioneer ephemeral, with flowering from August to January (Brown et al. 1998). Seed maturation time may vary depending on the flowering periods and conditions; mature seed used for a germination trial by Cochrane (2000) was collected in November. Time to reproductive maturity is not known for the species, although it is likely to vary according to conditions.

HABITAT

Hamersley lepidium prefers steep upper breakaway slopes of mesa hills (Onshore Environmental 2013a). Within these areas, it occurs on hill hummock grasslands and open woodland hilly areas on skeletal red or brown and gritty soils particularly on south facing slopes (Brown et al. 1998). Hamersley lepidium has also been associated with disturbance, being recorded on road verges and cuttings (Hewson 1981), and is described by DotE (2014f) as a disturbance opportunist. The species is commonly associated with such species as snappy gum (*Eucalyptus leucophloia*), telopea (*Eucalyptus xerothermica*), blue mallee (*Eucalyptus gamophylla*), limestone spinifex (*Triodia wiseana*), hard spinifex (*Triodia basedowii*), two-veined wattle (*Acacia bivenosa*), Hill's tabletop wattle (*Acacia hilliana*), and black gidgee (*Acacia pruinocarpa*) (Brown et al. 1998). Hamersley lepidium has been recorded near Tom Price, growing on the lower slopes of Mount Nameless on steep south-facing shaly hill slopes (Biota 2007).

Hamersley lepidium has been identified as a pioneer species that responds rapidly to disturbance, in particular fire, but has also been recorded growing in undisturbed hummock grasslands at some sites (Onshore Environmental 2012).

Most known populations of Hamersley lepidium occur on mining tenements, which leads to a perception that the main threat to the species is mining; however, this is likely to be a function of the high level of survey effort on mining tenements relative to other areas. Specific mining activities include road works as many populations are on or adjacent to frequently graded mining and exploration roads (Brown et al. 1998). As it is a pioneer species, it is likely that the Hamersley lepidium thrives in disturbed mining and exploration environments, until it is replaced by successional species. Predictive habitat modelling by Eco Logical (2015a) suggested that broad extents are likely to be associated with higher elevations and cooler temperatures. Potential habitat for the Hamersley lepidium was in general agreement with the confined distribution encountered with this species in the Hamersley Range in the southern part of the Strategic Assessment Area.



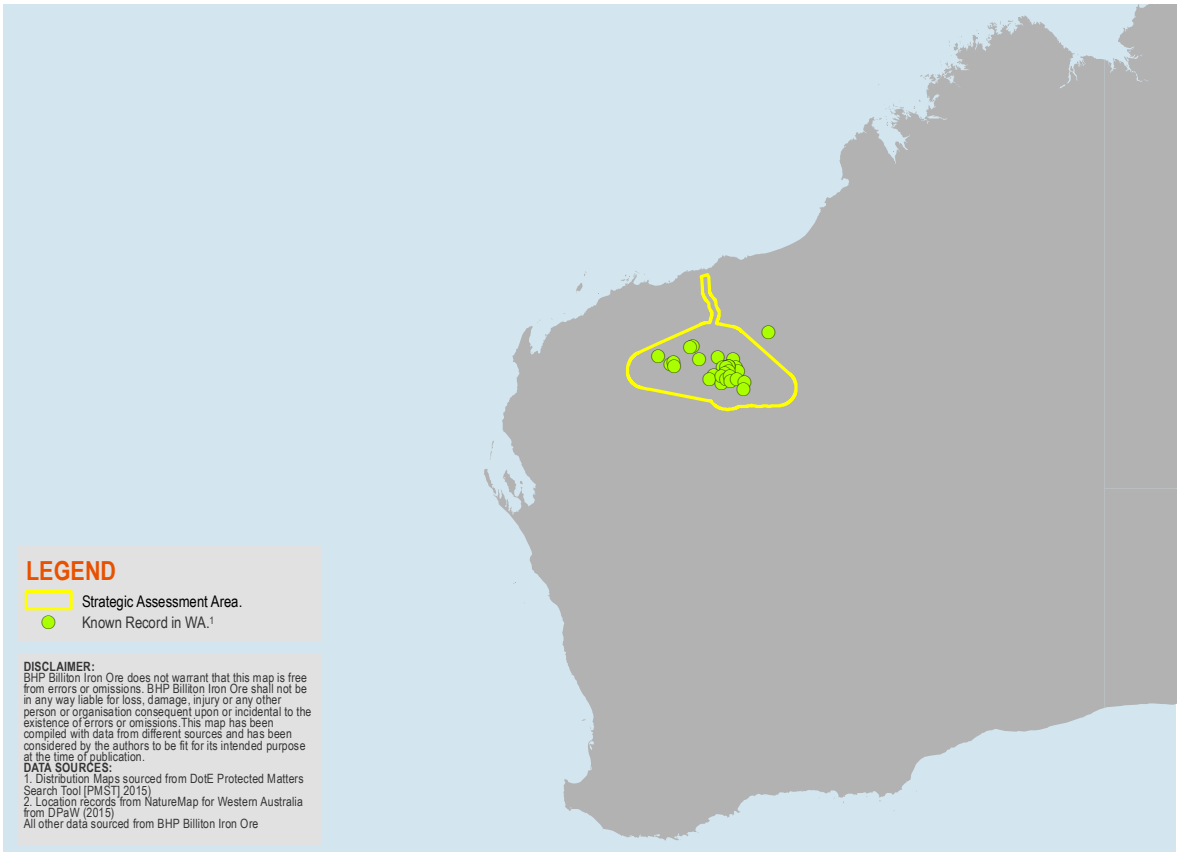


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Figure 31 Distribution of Hamersley lepidium relative to the Strategic Assessment Area

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IMPACT ASSESSMENT

The distribution of preferred habitat for the Hamersley lepidium based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 32. Since the development of this model, publicly available data has been updated and these data have been included in Figure 32. The additional records are consistent with the modelled habitat preference across the Pilbara. The additional records also demonstrate the type of new information that will be used throughout implementation of the Proposal as part of the Validation Framework and adaptive management (refer to Chapter 8).

There are many records of the Hamersley lepidium in the Pilbara and in the Strategic Assessment Area. However, most of the records in the databases (NatureMap and BHP Billiton Iron Ore flora database) occur in the southern Pilbara (apart from one record), with the majority of records occurring in the central part of the Strategic Assessment Area (see Figure 44). There are no records in the rail corridor section of the Strategic Assessment Area (see Figure 45).

Potential Impacts to the Hamersley Lepidium

Known and perceived threats to the Hamersley lepidium are identified in the Commonwealth Species Profile and Threats (SPRAT) database (DotE 2014f).

From the review of this information, the key threats to the Hamersley lepidium in the Pilbara region have been identified as:

- removal of habitat due to land clearing;
- competition from non-native species; and
- climate change.

These threats are described below and graphically represented in the conceptual threats model shown in Figure 33. The model shows the relative ranking of the threats to the Hamersley lepidium and also identifies which threats were quantitatively assessed in the CIA.

The effect of fire regimes is also a key threat to the survival of Hamersley lepidium (van Etten 2015, pers. comm., 23 March 2015).

Removal of Habitat due to Land Clearing

Land clearing is a key threat to Hamersley lepidium (DotE 2014f). As many populations of Hamersley lepidium are recorded on mining tenure, land clearing particularly associated with mining is considered to be a key threat to the species. However, this is likely to be due at least in part to the high level of survey effort on mining tenements relative to other areas. Vegetation clearing associated with mining and mining-related activities, as well as other activities that occur in the species' preferred habitat, may remove Hamersley Lepidium habitat and individuals.

Hamersley lepidium is generally considered to be a short-lived disturbance opportunist that requires disturbance events to recruit from soil-stored seed (Brown et al. 1998, Onshore Environmental 2013b,c). Localised disturbance could be of benefit to Hamersley lepidium where soil seed banks are present, whereas more severe or extensive ground disturbance (such as the removal of topsoil from relatively large areas) has the potential to remove individuals (or seeds) or small or localised populations. The species has been recorded along roads and tracks created for mining purposes (Brown et al. 1998; Hewson 1981); however, the balance between habitat removal (e.g. for a mining pit) and the beneficial edge effect of habitat creation is likely to be swayed in the negative for the species; therefore, clearing was applied as a High impact in the model.

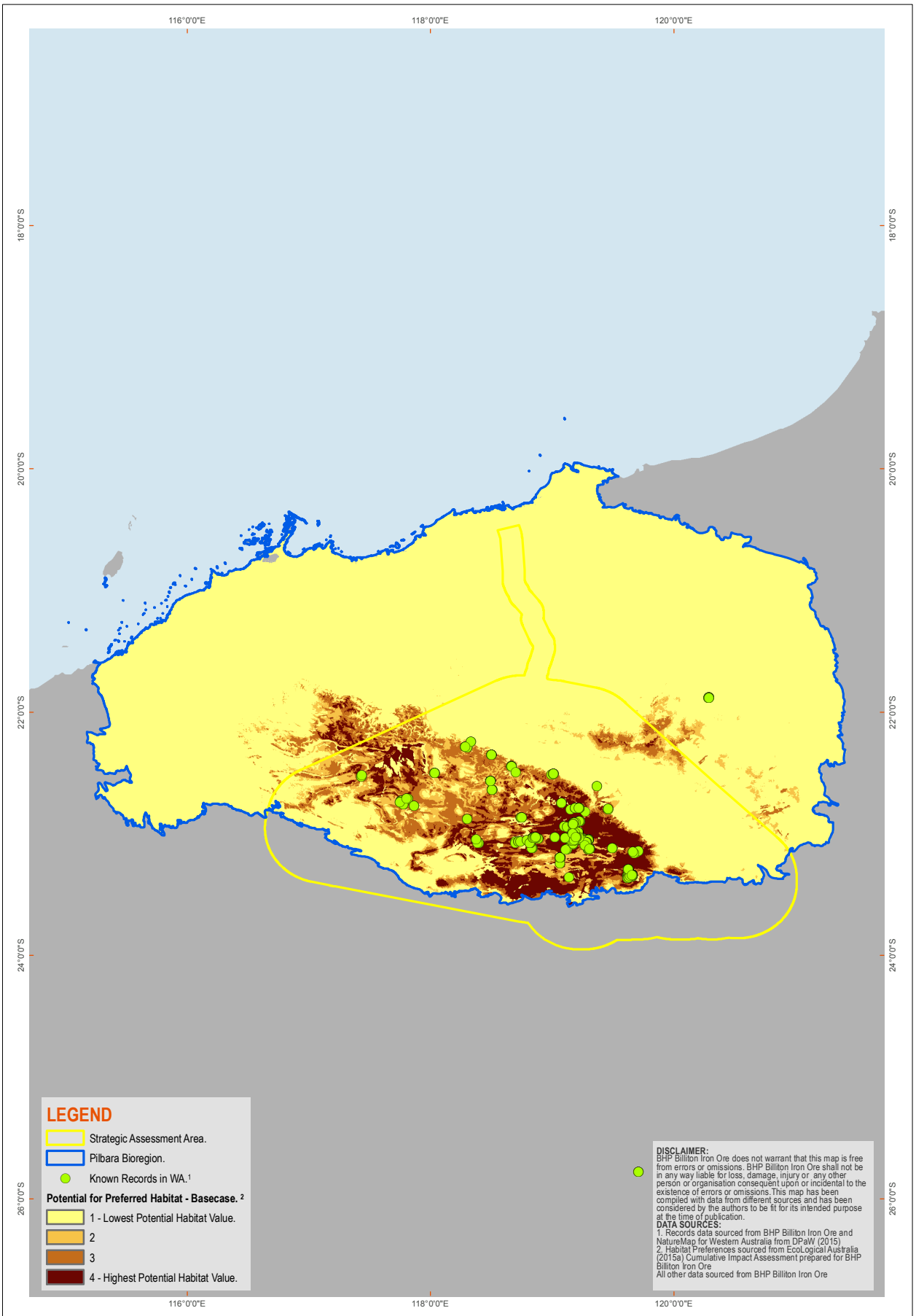

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Figure 32 Modelled distribution of preferred habitat for the Hamersley lepidium

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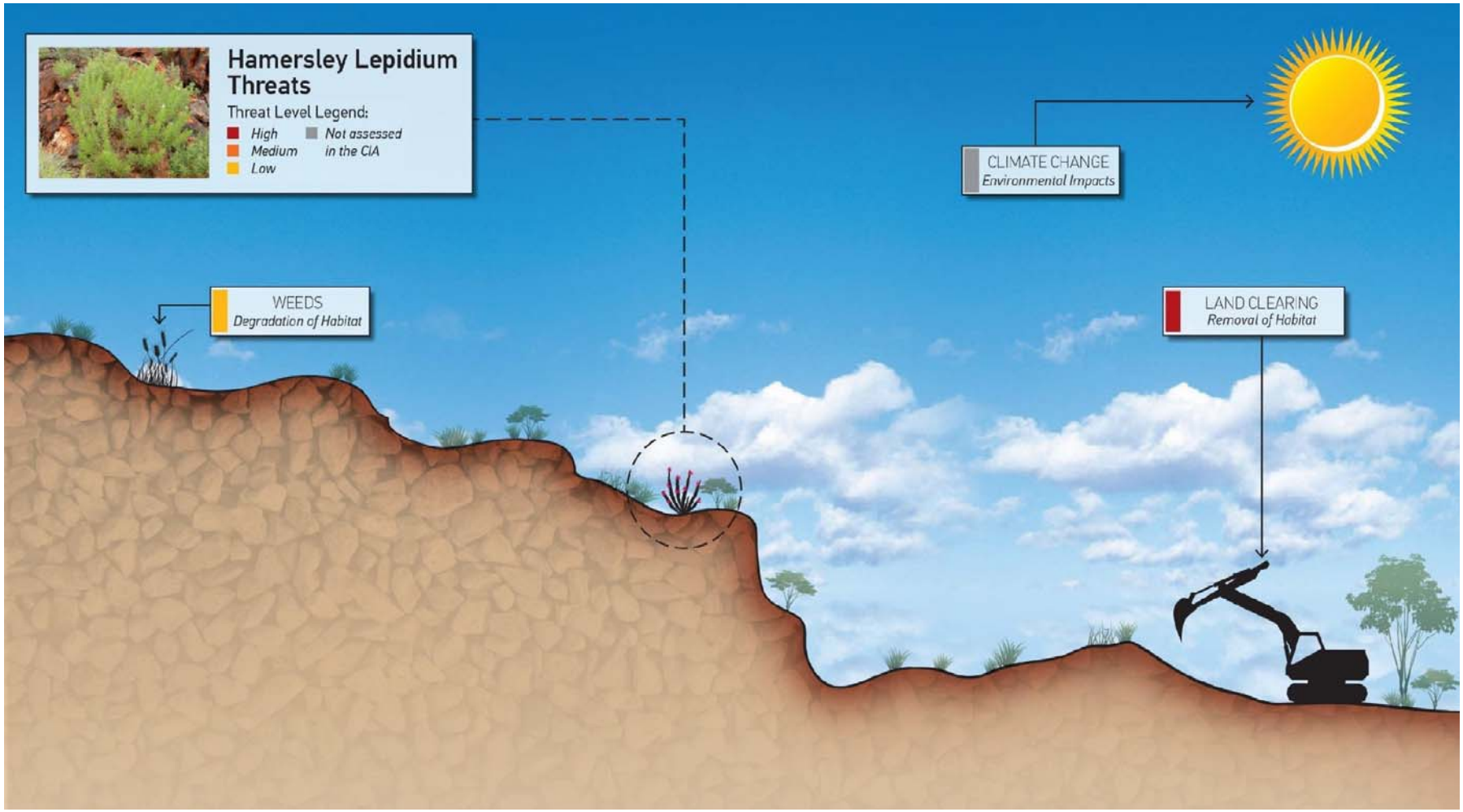

Figure 33: Conceptual diagram of key threats for the Hamersley lepidium

Potential impacts to the Hamersley lepidium will change over time but are likely to occur in the southern part of the Strategic Assessment Area (based on the majority of current records) and will likely consist of removal of habitat during the preconstruction phase and degradation of habitat during the operational phase from mining and other developments where land clearing is required.

Competition with Non-Native Species

Ruby dock is an invasive weed found throughout arid Australia that grows on disturbed sites, for example roads, gravel pits and railway lines, as well as creek lines (CALM 1999). Invasion of ruby dock is listed as one of the main potential threats to Hamersley lepidium (DotE 2014f). This is due to competition with ruby dock preventing establishment of Hamersley lepidium in some areas (Mattiske & Associates 1994). Other weeds, such as buffel grass (*Cenchrus ciliaris*) and kapok bush (*Aerva javanica*), may also threaten the species as they can form large infestations in the Pilbara and potentially prevent the establishment of Hamersley lepidium.

Climate Change

The widespread, landscape-scale potential impacts of predicted future climate change may impact the Hamersley lepidium. Given that the successful establishment of Hamersley lepidium is likely to be driven by the frequency, timing and volume of rainfall, Hamersley lepidium may be affected by changes in rainfall associated with future climate change. However, the level of uncertainty associated with current climate modelling outcomes was considered to limit its interpretation in relation to cumulative impacts in the Pilbara. While the predicted changes in average rainfall in the Pilbara are generally considered uncertain, the predicted increases of rainfall variability are more accepted. As the inter-annual rainfall variability in the Pilbara is already very high to extreme, the native species of plants this region can be considered well adapted to such fluctuations.

Degradation of Habitat due to Inappropriate Fire Regimes

The effect of fire regimes is also a key threat to the survival of Hamersley lepidium (van Etten 2015, pers. comm., 23 March 2015); however, the impact of fire was not applied in the CIA (Eco Logical 2015b) due to lack of data for season, frequency and extent of fires across the Pilbara. While it is recognised that fire scar mapping is available for the Pilbara, the mapping provides only the approximate date and area of fires and does not necessarily describe the fire regime (which is a complex of many interacting factors) or inform about changes in regime (which may require decades of data to detect) (van Etten 2015, pers. comm., 23 March 2015). In addition, the response of Hamersley lepidium to different elements of the fire regime and to changes in regime is largely unknown and difficult to predict (van Etten 2015, pers. comm., 23 March 2015).

Historically, lightning and burning by Aboriginal people were the main causes of fire in spinifex-dominated grasslands. In more recent times, most fires are started by lightning, although human-caused ignitions are significant near settlements, on pastoral leases and along travel routes (Burrows et al. 2006). The fire risks associated with mining in the Pilbara are currently managed, primarily due to safety concerns, through a number of existing fire management plans and fire response plans by BHP Billiton Iron Ore and others. Naturally occurring fires, especially those associated with lightning strike, are unlikely to be exacerbated by the Proposal. Fires in close proximity to mining infrastructure may be controlled to provide safety and protect assets.

With regard to reasonably foreseeable future impacts of fire, the effect of mining and non-mining activities on alteration of fire impacts is unclear and likely to be influenced primarily by assumptions of fire management and fire response. For this reason, the impact to Hamersley lepidium from inappropriate fire regimes was not included in the CIA.

Recovery and Conservation Management Priorities for Hamersley lepidium

There is no recovery plan available for the Hamersley lepidium. BHP Billiton Iron Ore has committed to considering contemporary guidance (such as threat abatements plans) as part of the Validation Framework provided within the MNES Program. The Validation Framework is discussed further in Section 8.6.2.

Extent of Potential and Cumulative Impacts to Hamersley Lepidium

Eco Logical (2015b) modelled the habitat preference (the probability of that species being located in certain habitats) for Hamersley lepidium using 616 species records from publicly available and BHP Billiton Iron Ore data. The model indicated that preferred habitat (representing the highest probability of potential habitat, Habitat Rank 4) was associated with higher elevations and cooler temperatures and that the majority of preferred habitat was concentrated in the central-south of the Pilbara bioregion.

Table 19 shows the area and proportion of the Pilbara bioregion of habitat suitability from 1 to 4, with Habitat Rank 1 being the lowest probability of potential habitat and Habitat Rank 4 being the highest probability of potential habitat. The distribution of preferred habitat based on modelling undertaken for the Proposal by Eco Logical (2015a) is shown in Figure 32.

Table 19: Classification and ranking applied to the Hamersley lepidium habitat model

Model Value	Habitat Rank	Habitat Suitability	Area (ha) in the Pilbara Bioregion
70-100%	4	Highest probability of potential habitat	871,770 (5%)
30-70%	3	↓	1,191,995 (7%)
10-30%	2		957,475 (5%)
0-10%	1	Lowest probability of potential habitat	14,771,377 (83%)

Source: Eco Logical (2015b).

The extent of potential impacts to the Hamersley lepidium were developed and modelled in the CIA (Eco Logical 2015b) and assigned to different categories:

- Existing impacts (this includes existing mining and non-mining impacts);
- Future third-party mines (potential impacts from reasonably foreseeable future third-party iron ore mines, described in Section 5.2.2 and shown in Figure 34); and
- Full Conceptual Development Scenario (this includes potential impacts from the Proposal, described in Section 5.2.2 and shown in Figure 34).

The potential cumulative impact is all of the above impacts combined.

The CIA model indicated a potential cumulative impact of 61,286 hectares (7%) to the most suitable modelled habitat (Habitat Rank 4 - highest probability of potential habitat). The BHP Billiton Iron Ore Full Conceptual Development Scenario impacts were the main contributor to this impact (Table 20 and Box 8) (Eco Logical 2015b). Management of potential impacts from the Proposal are discussed further below.

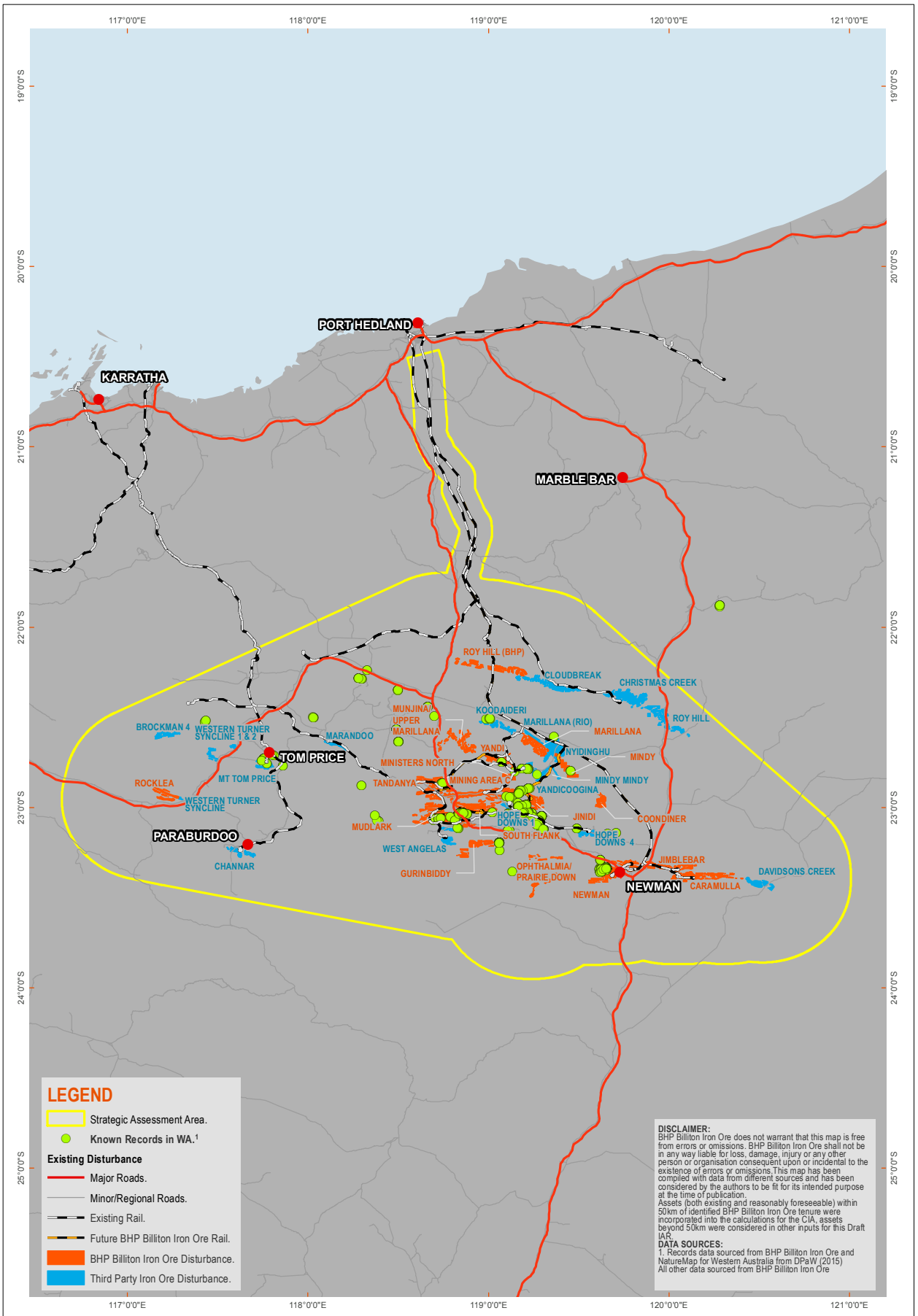

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Figure 34 Hamersley lepidium distribution records and Full Conceptual Development Scenario

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Table 20: Cumulative effects assessment for potential cumulative impacts to Hamersley lepidium (expressed as area and proportion of Habitat Rank 4)

Specified Protected Matter	Base Case[1]	Existing Impacts	Third party reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	Potential Cumulative Impact
Hamersley lepidium	871,770 ha	-26,987 ha (-3%)	-3,340 ha (<-1%)	-30,959 ha (- 4%)	-61,286 ha (-7%)

1. Base Case means area of modelled Habitat Rank 4 within the Pilbara bioregion.
Source: Eco Logical (2015b).

Box 8: Visualisation of numerical CIA results for the Hamersley lepidium

A visualisation of the relative change in each of the habitat types is shown below. Each box represents 100% of the modelled area (the Pilbara) and shows the relative proportion of each habitat suitability class under each of the modelled scenarios:

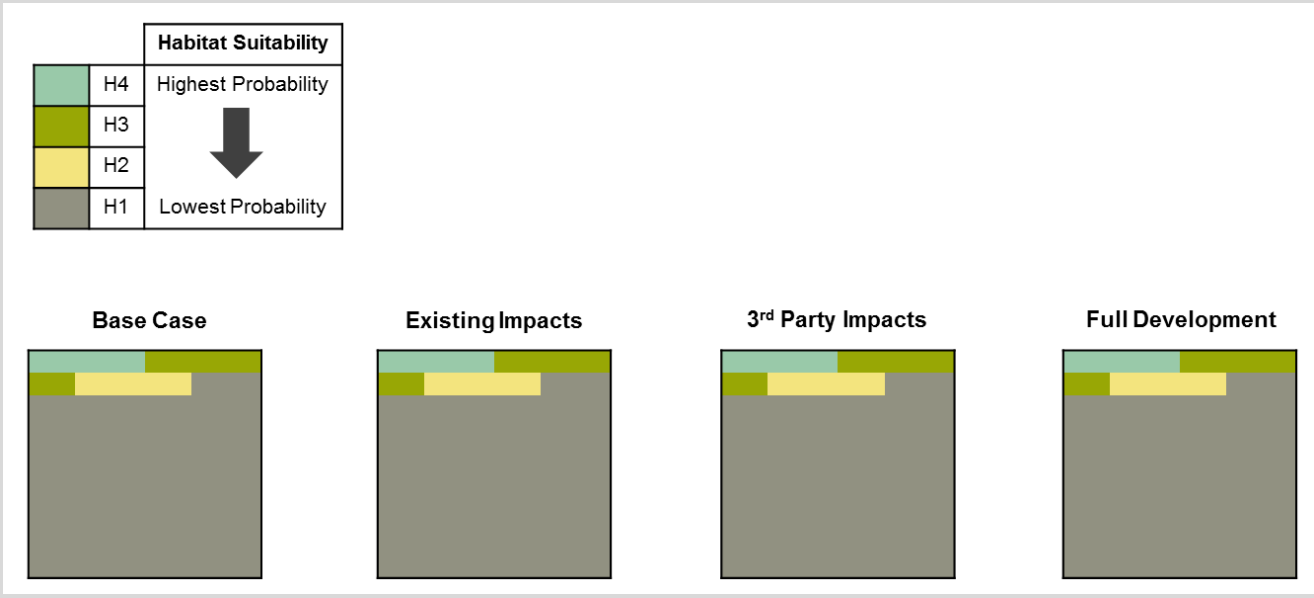
- Base case

- Base case + existing impacts

- Base case + existing impacts + third-party impacts

- Base case + existing impacts + third-party impacts + BHP Billiton Iron Ore Full Conceptual Development Scenario impacts

From the Hamersley lepidium modelling, changes to the overall relative proportions of the four habitat classes do not change by more than 1% at a regional scale. The addition of existing, third-party and BHP Billiton Iron Ore Full Conceptual Development Scenario impacts do not materially change these relative proportions.



Visual representation of changes to habitat ranks for the Hamersley lepidium

The model indicates that the implementation of the Proposal's Full Conceptual Development Scenario will decrease the availability of Habitat Rank 4 by approximately 4% (30,959 ha) contributing to a potential cumulative impact of 7% (61,286 ha). While this loss of preferred habitat may appear to be large in absolute terms, when the widespread distribution is taken into context the loss of habitat can be considered relatively small. An assessment of potential impacts based on the habitat model is somewhat complicated by the Hamersley lepidium being a pioneer species. Disturbance, such as clearing and construction of roads, can increase the short-term presence of the species in an area.

To further assess impacts to Hamersley lepidium from iron ore mining in the Pilbara, BHP Billiton Iron Ore conducted an impact assessment based on species records. The records data were obtained from the Department of Parks and Wildlife in December 2015. The results are presented in Table 21.

Table 21: Impact assessment to Hamersley lepidium based on species records

Total known records	Records within Strategic Assessment Area	Existing		Future		Cumulative impact (total records impacted and % of SAA records)
		Third Party	BHP Billiton Iron Ore	Third party reasonably foreseeable development	BHP Billiton Iron Ore Full Conceptual Development Scenario	
1108	1102	1	24	5	165	170 (15.3%)

Based on the species records data, 15.3% of the known records within the Strategic Assessment Area are predicted to be impacted by iron ore mining in the Pilbara. The data show the majority of the impact is from BHP Billiton Iron Ore. This species is broadly distributed between the Pilbara towns of Newman, Nullagine and Wittenoom. The total area of extent approximates 21,736 km^2 with eight known populations occurring within Karijini National Park. Increasing numbers of populations of *Lepidium catapycnon* have been recorded on BHP Billiton Iron Ore tenure, including Newman, Mining Area C, South Flank, Jinidi, Yandi, Marillana, and Mindy. At a state level, the conservation ranking for *Lepidium catapycnon* has recently been downgraded from Threatened (under the WC Act) to Priority 4 in response to the increasing frequency at which this taxon is being found. It is regarded as being relatively common across the southeast Pilbara region and well represented within Karijini National Park.

While mining was identified as the key threat to Hamersley lepidium due to most known populations occurring on or adjacent to tracks on mining tenements (DEC 2008), more recent surveys have identified new populations outside of mining tenements, including eight new populations within Karijini National Park (Onshore Environmental 2013a). The apparent restricted nature of Hamersley lepidium to mining tenements is likely to be reflective of the numerous surveys associated with baseline flora and vegetation surveys of mining tenements. This is evident with recent surveys by Onshore Environmental at several mining tenements significantly increasing the known distribution of Hamersley lepidium (Onshore Environmental 2013b,c).

The occurrence of Hamersley lepidium on or adjacent to tracks is likely due to Hamersley lepidium being a pioneer species that responds rapidly to disturbance (Onshore Environmental 2013b,c) rather than tracks being aligned with existing populations. While mining is likely to cause disturbance, the level at which it occurs will determine the degree of impact it will have on Hamersley lepidium at a local level.

The weed ruby dock also responds to disturbance, so it is likely that mining will further increase the spread ruby dock and reduce habitat suitability for Hamersley lepidium. In a joint project with DPaW in Karratha, Kings Park and Botanic Garden is currently undertaking research and development of integrated controls for ruby dock in the Pilbara.

Potential impacts to the Hamersley lepidium as a result of the Proposal's Full Conceptual Development Scenario are not considered to be significant at the regional scale. Peer review comments for the Hamersley lepidium cumulative impact assessment model are provided in Appendix 5. Based on known species records, the potential cumulative impact to Hamersley lepidium records within the Strategic Assessment Area is predicted to be 15.3%. However, the risk to this species is considered low due to the increasing frequency at which this taxon is being recorded. This species is regarded as common across the southeast Pilbara region and well represented in Karijini National Park. Impacts to Hamersley lepidium at a local scale will be validated on a case-by-case basis through processes described in the Validation Framework, where key inputs such as engineering design and contemporary guidance will be taken into account in decision-making before taking a Material Action. The Validation Framework is described further in Section 8.6.2.

Inappropriate fire regimes were not modelled in the CIA for the Hamersley lepidium due because it is difficult to predict future fire patterns on a regional scale. Similarly, climate change was not modelled in the CIA. BHP Billiton Iron Ore considers that the Proposal is unlikely to impact upon climate change or fire regimes as these are largely independent of and would not be exacerbated by the Proposal.

The Draft MNES Program (BHP Billiton Iron Ore 2016) includes commitments to consider and manage as part of its adaptive management approach any material future changes to the environment that affect Hamersley lepidium. Further, BHP Billiton Iron Ore has committed to applying the mitigation hierarchy (avoid, mitigate and, as a last resort, offset) to manage its potential impacts to the Specified Protected Matters, including the Hamersley lepidium. Further information regarding the commitments made in the Draft MNES Program is provided in Chapter 8.

BHP Billiton Iron Ore considers that the potential impacts to the Hamersley lepidium from implementation of the Proposal are not likely to be significant, given the negligible modelled impact predicted to Hamersley lepidium habitat from future reasonably foreseeable third-party mining operations and the BHP Billiton Iron Ore Full Conceptual Development Scenario. BHP Billiton Iron Ore's commitments in the Draft MNES Program to validate these potential impacts, manage future change and apply the mitigation hierarchy ensures that impacts to the Hamersley lepidium will be managed to an acceptable level during the life of the Proposal.

5.4 Limitations and Assumptions Related to the Impact Assessment

This section describes the limitations and assumptions made in conducting the impact assessment, and provides a discussion on materiality to the assessment. There is a distinction between scientific uncertainty and uncertainty due to an assessment being based on inadequate or insufficient information. Scientific uncertainty is not always avoidable; however the precautionary principle can be applied to ensure that measures to prevent degradation to the environment where there are threats of serious or irreversible environmental damage are not postponed and to ensure that MNES Objectives are met. BHP Billiton Iron Ore considers that the quantitative and qualitative information used for this Draft IAR to be appropriate for the assessing the potential impacts of the Proposal, which has long timeframes and regional geographical scale associated with it.

Inputs into the impact assessment, as described in Section 5.1, included:

- Disturbance footprints;
- DPaW workshops;
- Predictive species habitat modelling;
- Ecohydrological change assessment; and

- CIA.

These inputs are a combination of analytical (quantitative) and factual (qualitative) 'tools' that have allowed BHP Billiton Iron Ore to undertake an informed, comprehensive and broad-scale assessment of potential impacts to the MNES as a result of the implementation of the Proposal. The CIA model does not include every key threat or impact to the five Specified Protected Matters because some aspects have a high level of uncertainty associated with it. Uncertainties associated with potential impact are documented in each of the impact assessment's inputs and discussed within the relevant sections. BHP Billiton Iron Ore considers the breadth of inputs used, together with further interpretation and discussion and peer review input, has resulted in a technically robust and appropriate impact assessment.

Certain assumptions have been made for the purpose of this Draft IAR so as to be in a position to assess potential impacts at a regional scale rather than on a project-by-project basis. This is particularly relevant for disturbance footprint assumptions, where exact disturbance footprints (e.g. for pits and OSAs) were estimated rather than accurately defined, because project specifics are not yet known. Estimations were based on BHP Billiton Iron Ore's working knowledge of clearing requirements, mine planning and design. While BHP Billiton Iron Ore recognises that this may introduce a degree of inaccuracy, the information is used in the broader context of the Pilbara landscape; it is not going to be used to estimate impacts at the local scale. Similarly, rail alignments were indicative only; again this is not considered to be a significant limitation in the context of a regional strategic assessment. It is important to remember that, for a regional assessment, a more broad-scale approach is both necessary and appropriate; site specifics are not the focus at the regional scale of a strategic assessment; they are incorporated at the local level when design detail is known and the Endorsed MNES Program is implemented.

To test the uncertainty associated with the CIA, Ecological (2015b) undertook a sensitivity analysis, discussed in Case Study 2.

Case Study 2: Sensitivity analysis on the magnitude of potential impacts

The CIA (Ecological 2015b) (further described in Section 5.2.7) included the development and GIS application of a range of potential impacts to MNES related to mining operations and infrastructure. The CIA then allocated levels of potential impact within the Strategic Assessment Area from the implementation of the Proposal, taking into consideration expected spatial extent of impacts, target species vulnerability and species threat level based on prior expert knowledge and scientific literature.

As a result of the subjective judgement associated with determining the magnitude and extent of potential impacts, uncertainty within the modelling process was identified as a potential limitation. To assess the significance of the uncertainty, a sensitivity analysis was conducted to test how robust the model was in terms of the assignment of potential impact levels and the effect on outcomes of small to significant changes to these impact levels. This sensitivity analysis, described below, demonstrates that limitations associated with subjective judgements in the model run are not significant and that it is generally robust and fit for purpose at the regional scale.

One of the five Specified Protected Matters, the Pilbara olive python, was selected for use with one impact scenario (Scenario 1 - Existing Impacts) to test a range of different impact levels associated with values used in the CIA for impacts associated with habitat fragmentation and predation. This involved:

- The development of a Sensitivity Base Case to demonstrate the baseline habitat model used in the overall CIA with same impact levels involved consideration of removal and fragmentation of habitat and predation;
- Modifications from the Sensitivity Base Case to increase the levels of potential impact from the

Sensitivity Base Case; and

- Calculation of degree of change between the Sensitivity Base Case and Alternatives 1 to 3

The results are presented below.

Results for the Pilbara olive python between the Sensitivity Base Case and Alternatives 1 to 3 for Habitat Rank 4 (most valuable habitat for a given species) reduced the amount of available habitat by 3.2% and were uniform across Alternatives 1 to 3 (see Table 28). The alterations across Alternatives 1 to 3 increased the amount of Habitat Rank 1 (least valuable habitat) by a maximum of 2.6%.

The findings of the sensitivity analysis indicate that, despite increases in potential impact levels, some of which were significant (e.g. more than doubling the level of predation), the result was marginal in comparison to the levels in the Sensitivity Base Case and the CIA analysis overall. Overall, therefore, the model is not considered sensitive to changes in impact level and is thus robust and appropriate for use. The sensitivity analysis suggests that the model outputs are relatively insensitive to assumptions about the degree of impact from indirect factors in the assessment.

Values used in the sensitivity analysis for the Sensitivity Base Case and Alternatives 1 to 3

Impact		Level of potential Impact to Pilbara Olive Python Habitat Suitability			
		Sensitivity Base Case	Alternative 1 (+10% Impact)	Alternative 2 (+20% Impact)	Alternative 3 (increased Spread between Levels)
Removal of habitat	Clearing footprint	100%	100%	100%	100%
Fragmentation of habitat	>450 ha	0%	0%	0%	0%
	200-450 ha	20%	30%	40%	30%
	100-200 ha	50%	60%	70%	70%
	<100 ha	100%	100%	100%	100%
Predation	>2 km	0%	0%	0%	0%
	0-2 km	20%	30%	40%	50%

Source: Eco Logical (2015b).

Area of each habitat rank in the Sensitivity Base Case and Alternatives 1 to 3

Habitat Rank	Area (ha) (% Change Compared to Sensitivity Base Case)			
	Sensitivity Base Case	Alternative 1	Alternative 2	Alternative 3
1	10,786,084 ha	10,880,918 ha (+0.9%)	10,956,991 ha (+1.6%)	11,066,474 ha (+2.6%)
2	3,131,353 ha	3,102,433 ha (-0.9%)	3,101,982 ha (-0.9%)	3,089,947 ha (-1.3%)
3	2,843,581 ha	2,810,750 ha (-1.2%)	2,735,127 ha (-3.8%)	2,637,679 ha (-7.2%)
4	1,024,123 ha	991,041 ha (-3.2%)	991,041 ha (-3.2%)	991,041 ha (-3.2%)

Source: Eco Logical (2015b).

5.5 Indirect Impacts from Secondary Actions

BHP Billiton Iron Ore has also considered potential indirect impacts of secondary actions associated with implementation of the Proposal. Secondary actions are those that are not directly related to the scope of the Proposal but that may arise as a result of development undertaken for the Proposal. Consideration of these indirect impacts was undertaken to understand the broader potential implications of the Proposal.

In considering indirect impacts, BHP Billiton Iron Ore identified that its port operations at Port Hedland may require changes to throughput volumes as a result of the implementation of the Proposal. Changes to throughput volumes would therefore be a secondary action.

Port operations consist of iron ore receiving, processing, stockpiling and ship loading at Finucane Island (west) and Nelson Point (east), located on opposite sides of the Port Hedland Inner Harbour. Over the life of the Proposal, there may be actions or classes of actions that could contribute to an increase in iron ore throughput and that may require upgrades of existing port infrastructure and the potential expansion of BHP Billiton Iron Ore's existing port operations.

In 2012, BHP Billiton Iron Ore received approval from the then Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)[4] and the Western Australian EPA for its proposed Outer Harbour project in Port Hedland (EPBC Referral 2008/4159 and Ministerial Statement 890). This approval allowed for the development of additional jetties and berths outside the existing harbour.

In early 2013, BHP Billiton Iron Ore announced that the Outer Harbour development will be deferred beyond its short-term planning horizon as its focuses on maximising the potential capacity from the Inner Harbour and capitalising on infrastructure from previous investment. While BHP Billiton Iron Ore's dual harbour strategy includes both development of the Outer Harbour and optimising the Inner Harbour, development of the Outer Harbour project is not currently expected in the short term.

In considering the potential indirect impacts from future secondary actions, BHP Billiton Iron Ore has examined reasonably foreseeable growth scenarios for its port operations. Currently, the most likely port development scenario includes further expansion of BHP Billiton Iron Ore's Inner Harbour infrastructure followed (if required) by development of an Outer Harbour. The reasonably foreseeable secondary actions that could arise from this scenario include:

- Increased throughput, including shipping movements (e.g. existing infrastructure);
- Upgrades or expansion of existing infrastructure (e.g. Inner Harbour); and
- Development of new infrastructure (e.g. Outer Harbour).

The reasonably foreseeable potential impacts from these secondary actions include:

- Change in dust emissions;
- Change in noise emissions;
- Change to terrestrial flora;
- Dredging related impacts to marine flora and fauna;
- Impacts to marine fauna from ship movements;

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- Changes in water use;
- Impacts to terrestrial fauna;
- Change in greenhouse gas emissions;
- Spills / contamination; and
- Social impacts (traffic, amenity etc.).

For BHP Billiton Iron Ore's future port operations, a number of potential indirect impacts that may arise from the Proposal have been considered through existing approvals. These include approvals that are in place for BHP Billiton Iron Ore's proposed Outer Harbour development and upgrades to existing Inner Harbour infrastructure.

The environmental impacts expected to arise from the proposed Outer Harbour development have previously been assessed through state and Commonwealth legislative processes and include dredging, shipping movements, dust and social impacts. Where changes may be proposed in future to BHP Billiton Iron Ore's approved Outer Harbour development, BHP Billiton Iron Ore will review these changes and where necessary seek amendments to existing approvals or new approvals as required.

The extent of changes to BHP Billiton Iron Ore's Inner Harbour infrastructure is expected to be confined to the existing operating footprints on Nelson Point and Finucane Island. Where a change in the footprint is anticipated (e.g. additional marine infrastructure), BHP Billiton Iron Ore will seek the necessary changes to existing environmental approvals or, where required, seek new approvals under relevant state and Commonwealth legislation.

The primary environmental impacts anticipated from any future increase in throughput from BHP Billiton Iron Ore's Inner Harbour infrastructure relate to potential changes in dust and noise emissions. BHP Billiton Iron Ore will continue to work with the relevant government agencies and the community to manage dust and noise emissions from its operations and will continue to seek the necessary environmental approvals.

Based on the above, BHP Billiton Iron Ore considers that potential indirect impacts from implementation of the Proposal outside the Strategic Assessment Area have been identified and have either been adequately addressed through existing approvals or will be assessed through future approvals where required.

6 ASSESSMENT OF POTENTIAL FUTURE MNES LISTINGS

As discussed in Chapter 3, the life of the Proposal is 120 years. During this time, BHP Billiton Iron Ore recognises that there is potential for changes to Controlling Provisions relevant to the Proposal. The Draft MNES Program provides a process to address listing events in the future (refer to Section 8.6).

In recognition of the potential for future listing events, BHP Billiton Iron Ore has voluntarily undertaken an impact assessment of features within the Strategic Assessment Area that may have potential to become listed as MNES during implementation of the Proposal. In consultation with the DotE, BHP Billiton Iron Ore has considered MNES with potential to be listed as:

- Wetlands of international importance
- National heritage places

In addition to the above, BHP Billiton Iron Ore has noted the recent inclusion of the ghost bat (*Macroderma gigas*) in the Finalised Priority Assessment list. In light of its possible listing under the Act, an assessment of potential impacts on this species has also been included in the IAR.

6.1 Potential Future Wetlands of International Importance

As described within Section 4.4, there are currently no wetlands of international importance within the Strategic Assessment Area. However, it is possible that future listing events may result in some wetlands of national importance being 'uplisted' to wetlands of international importance during the life of the MNES Program.

The Directory of Important Wetlands (DotE 2015a) lists the following wetlands within the Strategic Assessment Area:

- Fortescue Marsh;
- Karijini (Hamersley Range) Gorges; and
- Mt Bruce coolibah-lignum flats.

The locations of these wetlands are shown on Figure 35.

BHP Billiton Iron Ore (2015) undertook a detailed Ecohydrological Change Assessment (Appendix 6) to assess the potential for changes to surface and groundwater associated with implementation of the Proposal in relation to key water sensitive features. This study is described further in Section 5.2.7. The findings of this study have been used to inform this assessment on potential wetlands of international importance, which are discussed under sections 6.1.1 to 6.1.3.

6.1.1 FORTESCUE MARSH

LANDSCAPE CONTEXT

BHP Billiton Iron Ore has developed ecohydrological conceptual models (ECM) for four project areas in the central Pilbara region: Fortescue Marsh, Marillana, Central Pilbara Hub and Eastern Pilbara Hub respectively. The ECMs integrate knowledge of hydrological and ecological systems and processes in Pilbara landscapes.

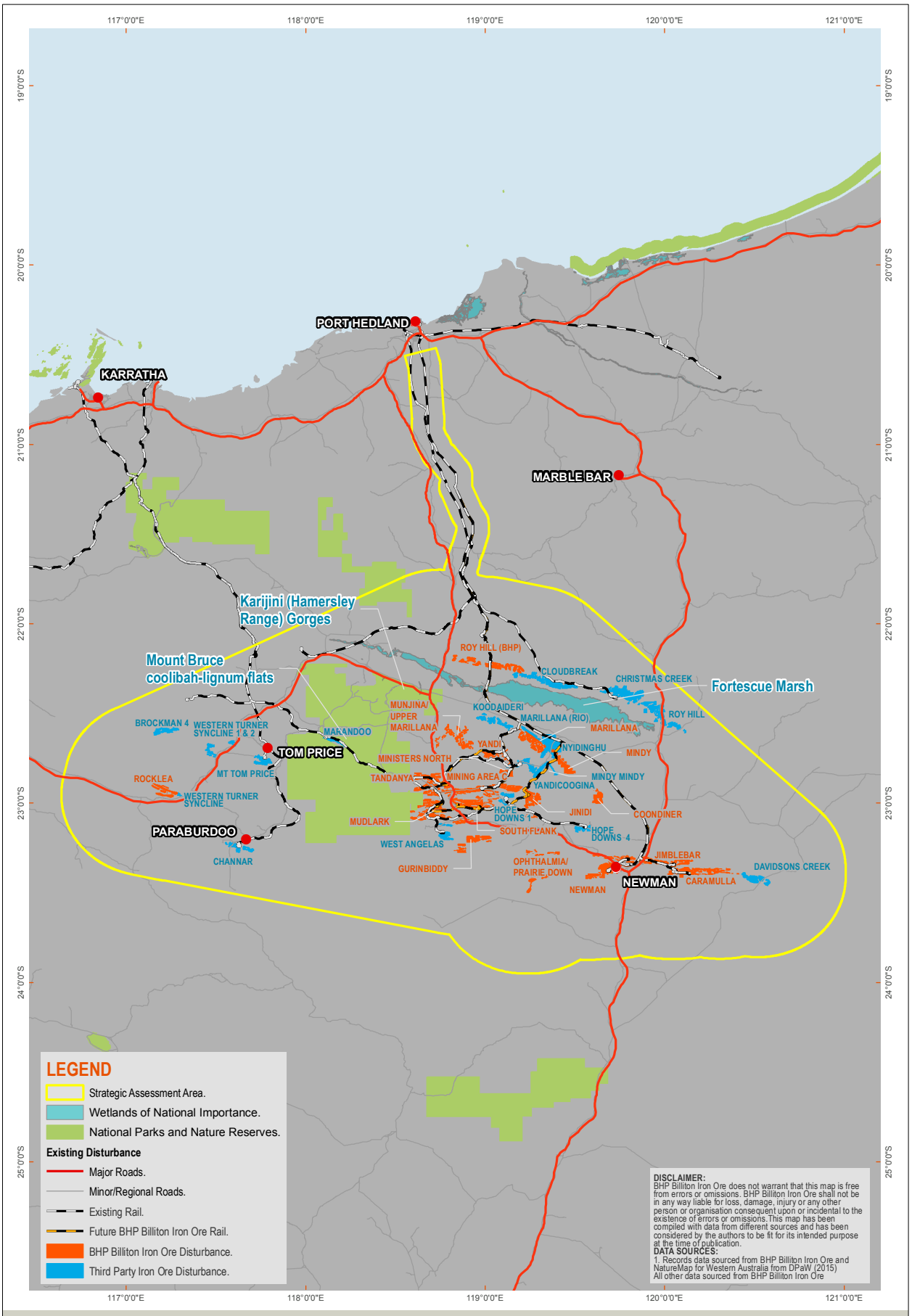

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Figure 35 Wetlands of national importance relative to the Full Development Scenario and future third party footprints

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As part of the ECM development process, the landscapes of BHP Billiton Iron Ore's project areas were partitioned into a series of ecohydrological units (EHUs) defined as 'landscape elements with broadly consistent and distinctive ecohydrological attributes'. A conceptualisation of the EHUs is provided in Figure 36.

Based on the ecohydrological conceptualisation, the Marsh is classified as EHU 9. It is surrounded by alluvial plains (EHU 6) of the Fortescue River Valley, and some areas of calcrete plain (EHU 7) along its southern margin. A number of major creek systems (EHU 8) contribute surface flow into the Marsh with the most important being the Upper Fortescue River and Weeli Wolli Creek. A diagram illustrating the EHUs across the Pilbara is provided in Section 4.4.

The Fortescue Marsh is a brackish to saline, endorheic wetland within the drainage terminus of the Upper Fortescue River. It is a unique regional-scale landscape feature, extending for about 100 km along the Fortescue Valley with a width of between 3 and 10 km. The boundary of the Marsh is broadly defined by the Marsh Land System (van Vreeswyk et al., 2004). Bed levels in the Marsh lie between 400 m and 405 m AHD with fringing samphire vegetation typically extending to about 407 to 408 m AHD.

The Marsh is episodically inundated following large rainfall, surface water runoff and streamflow events. Analysis of flood levels and high resolution topographical data indicates that the Marsh waterbody segregates into eastern and western basins. Floodwaters may persist for several months providing breeding and foraging habitat for waterbirds and other biota. Surface waterbodies in the Marsh rapidly evaporate leading to salt accumulation. Beneath the Marsh, the groundwater is hypersaline.

The Marsh has a history of pastoral land use since the late 19th century and is still accessed by roaming cattle. Large portions of the Marsh have been identified for transition into conservation tenure and management following the expiry of overlapping pastoral leases in mid-2015.

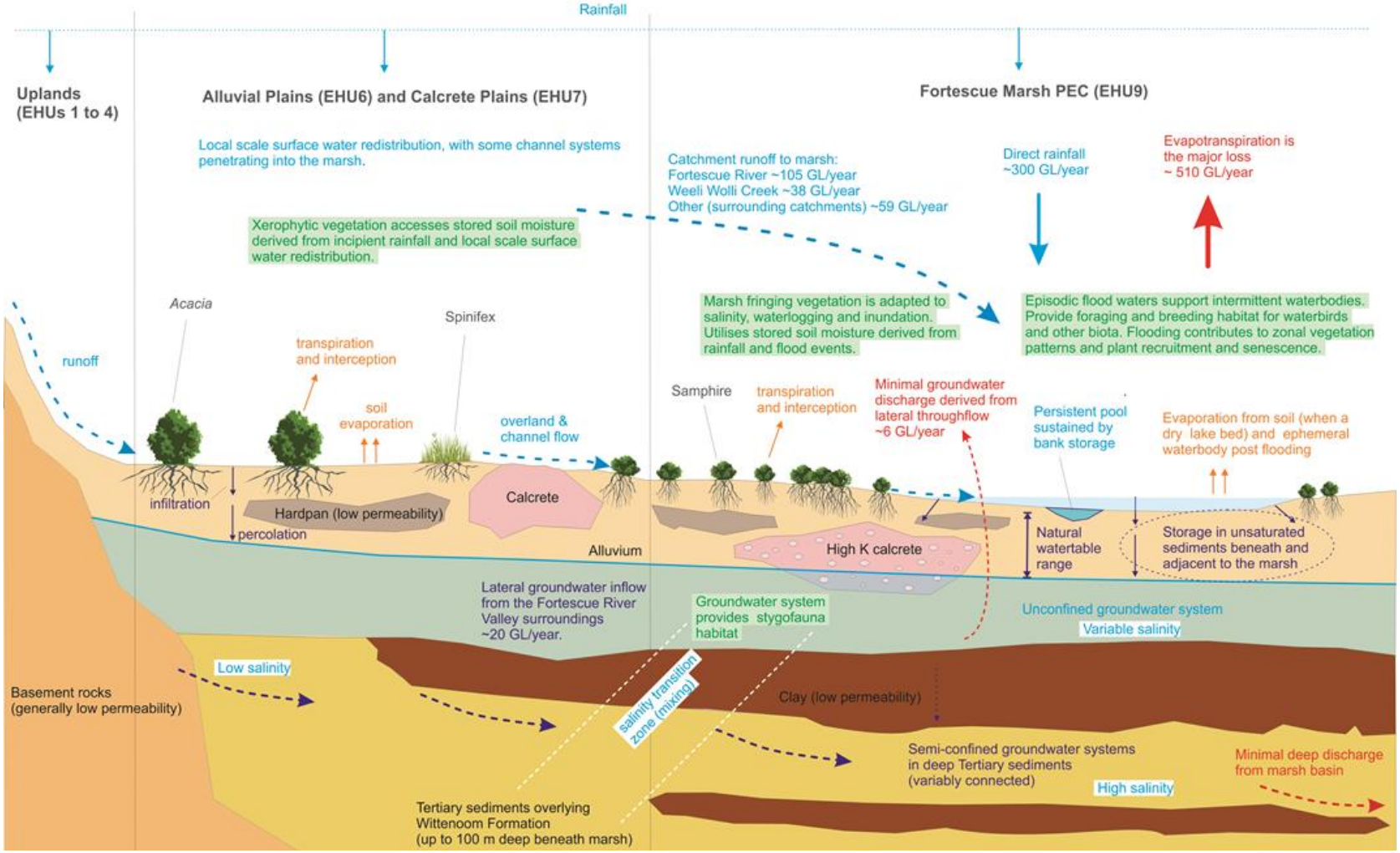
The Marsh has a wide range of environmental values and is classified as a wetland of national importance within the Directory of Important Wetlands in Australia (Ref. WA066).

ECOHYDROLOGICAL CONCEPTUALISATION

An ecohydrological conceptualisation of the Marsh is provided in Figure 36 with the key aspects being:

Surface and groundwater systems

- Surface water inflows to the Marsh are largely contributed by the Fortescue River and Weeli Wolli Creek, accounting for about 52% and 19% of mean annual inflows respectively. Catchment areas for these major drainages extend outside the Strategic Assessment Area. The remaining inflow (29%) derives from smaller catchments that report directly into the Marsh.
- Flooding is generally associated with cyclonic rainfall and runoff in the summer months, with large-scale inundation events estimated to occur every five to seven years on average. Inundation of the eastern and western basins may be different for smaller events; however, large-scale inundation extends across both basins.
- Surface ponding is facilitated by the presence of relatively low permeability clay and silcrete/calcrete hardpans in the surficial sediments. Higher permeability zones within these sediments may provide pathways for the infiltration of floodwater into the shallow groundwater system.
- A shallow, unconfined aquifer is present in the surficial sediments. Groundwater levels range between 2 and 4 m below ground level with the shallow watertable being influenced by a combination of flooding events, groundwater inflow and evapotranspiration. Soil moisture in the shallow, often unsaturated alluvium, of the Marsh is replenished by rainfall and surface water inflows. During flooding events, localised groundwater mounds may develop for a short time.



Source: MWH (2014)

Figure 36: Ecohydrological conceptualisation for Fortescue Marsh

- Beneath the surficial sediments, there are clayey aquitard and calcrete horizons of the Oakover Formation throughout the Tertiary detrital aquifer. These horizons provide vertical barriers and lateral pathways for groundwater flow that may influence groundwater recharge and discharge processes. There is limited lateral groundwater flow towards the Marsh from the margins of the Fortescue River Valley under low hydraulic gradients.
- The Marsh water balance is dominated by surface water contribution. Major flooding events have potential to contribute up to 100 gigalitres (GL) that enable the refilling of the unsaturated zone and lead to the creation of large areas of ponded water.
- On average, approximately 200 GL/yr surface water flows into the Fortescue Marsh. Inflow volumes vary widely with the median inflows of 61 GL/yr and the maximum annual inflow of more than 1400 GL/yr.
- Large-scale inundation events, associated with cyclonic rainfall, occur about once in five to seven years, during which more than 20% of the Marsh is inundated. The maximum recorded flooding extent occurred in April 2000 which inundated 985 km^2 (50%) of the Marsh.
- Groundwater contribution is estimated at 40 GL/yr with the main groundwater throughflow occurring from the Chichester Ranges (20 GL/yr) and Upper Fortescue River (8 to 10 GL/yr). Most of this contributing water is considered to be lost via direct evaporation from impounded waterbodies and the Marsh surface, capillary evaporation through the marsh bed, and potentially evapotranspiration from vegetated surfaces during the period between floods (interfloods).

Ecosystem components

- The interior of the Marsh comprises sparsely vegetated clay flats within a series of low elevation flood basins. Vegetation recruitment may occur during dry phases; however, the frequency and depth of inundation events is a constraint to long-term vegetation persistence.
- Fringing the lake bed extent are unique samphire vegetation communities including a number of rare flora taxa. Species zonation is evident and considered to be a function of the combined stresses of seasonal drought, soil salinity, waterlogging and inundation. Structural complexity is provided by patches of lignum shrubland (*Duma florulenta* and *Muellerolimon salicorniaceum*), grassland areas dominated by Eragrostis and Eriachne species, and Melaleuca woodlands (*M. glomerata and M. lasiandra*). The Melaleuca woodlands in particular may be important for providing roosting and nesting sites for waterbirds.
- Samphire vegetation communities exhibit conservative water use behaviour, and are most likely reliant on pulses of fresh water associated with floods and stored soil moisture. The flooding regime is likely to be a major factor influencing samphire recruitment and mortality.
- The Marsh habitat may contribute to the foraging range of fauna of conservation significance (i.e. Bilby, Northern Quoll, Mulgara and Night Parrot).
- The Marsh supports aquatic invertebrate assemblages of conservation interest including species known only to be present in the Marsh; however, little is known of the ecological requirements of these taxa.
- The Marsh has not been sampled for stygofauna owing to a lack of bores located within the Marsh. However; subterranean fauna communities in areas adjacent to the Marsh are relatively poorly developed when compared with other Pilbara localities.

- A number of persistent pools, known as Yintas, are present on the northern fringe and associated with drainage channels from Chichester Range and the inflow of the upper Fortescue River. These may be sustained by storage in the surrounding alluvium following flood events and provide possible refugia for some aquatic fauna species during inter-floods.

CHANGE ASSESSMENT

Management Response

BHP Billiton Iron Ore has in place a regional water management strategy to plan for and manage surface water and groundwater impacts during the planning and design, operational and closure phases of mining. With respect to each identified threatening process, the change assessment provides a regional scale evaluation for the potential for altered surface water and groundwater regimes to cause ecohydrological change at Fortescue Marsh during implementation of the Proposal. The following ecohydrological change potential categories have been adopted for the assessment:

- Low change potential – where the effect of hydrological change caused by mining activities on landscape elements or ecological assets is unlikely to be significant;
- Moderate change potential - where the effect of hydrological change caused by mining activities on landscape elements or ecological assets may be significant in the absence of BHP Billiton Iron Ore's normal business management practices, but is unlikely to be when those practices are employed; and
- High change potential - where the effect of hydrological change caused by mining activities on landscape elements or ecological receptors may require a more targeted management approach. Management options developed under the regional water management strategy may be required to avoid or minimise environmental impacts.

The change assessment is necessarily precautionary and takes into account knowledge limitations and uncertainties. It complements BHP Billiton Iron Ore's adaptive management approach (see Section 8.4), by helping to inform studies and investigations that will improve knowledge and refine the assessment findings prior to implementing an action or class of actions. This includes the validation of thresholds and trigger values for the management of ecohydrological receptors.

Baseline scenario

There are no existing BHP Billiton Iron Ore operations interacting with the Marsh; however several third party mines are located around the periphery of the Marsh. This includes active mining at the Cloudbreak and Christmas Creek mining areas located along the northern fringe, as well as construction activities at the Roy Hill mining area on the northeast fringe. The nature and significance of threatening processes relevant for the Marsh under the baseline scenario are summarised as follows:

- Groundwater drawdown - No change potential at the receptor; on the basis that the Cloudbreak and Christmas Creek mining areas are conditioned to maintain groundwater levels at the Marsh fringe through managed aquifer recharge under the respective EP Act approvals.
- Surface water availability - Negligible change potential; on the basis that aggregate mining disturbance affects <5% of the catchment area of the receptor. However, a higher degree of catchment area reduction in small drainages between the Cloudbreak and Christmas Creek mining areas and the receptor may contribute to increased change potential at a localised scale proximal to these drainages.
- Surplus water - No change potential at the receptor; on the basis that the Cloudbreak and Christmas Creek mining areas are conditioned to maintain groundwater levels at the Marsh fringe through managed aquifer recharge under the EP Act.

- Saline intrusion - Negligible change potential; on the basis that the Cloudbreak and Christmas Creek mining areas are conditioned to manage saline intrusion under the EP Act.
- Acid metalliferous drainage potential – unable to be assessed for third party operations.
- Surface water quality - unable to be assessed for third party operations.

Full Conceptual Development Scenario

Under the Full Conceptual Development Scenario, BHP Billiton Iron Ore mining operations have been implemented in all mining areas. The nature and significance of threatening processes relevant for the Fortescue Marsh include:

- Groundwater drawdown - High potential for ecohydrological change restricted to a localised area at the southern fringe of the Marsh, associated with groundwater drawdown from BHP Billiton Iron Ore's Marillana mining area. The majority of the Marsh area (approximately 99%) remains unaffected by drawdown. Groundwater drawdown for BHP Billiton Iron Ore's Roy Hill, Mindy and Coondiner mining areas are likely to be distant from the Marsh; although, there may be localised areas subject to high change potential associated with areas proximal to the Mindy and Coondiner Creeks. With respect to third-party operations, areas with high potential for ecohydrological change are restricted to a small zone subject to cumulative drawdown from multiple projects influencing the southern fringe of the Marsh.
- Surface water availability - There is moderate potential for ecohydrological change considering the cumulative effects of BHP Billiton Iron Ore and third-party operations, based on the reduction in the catchment area of the Marsh exceeding 5%. The lower Weeli Wolli Creek is subject to potential change being influenced by operations along the southern fringing of the Fortescue River Valley, as well as operations further upgradient along Marillana Creek and beyond Weeli Wolli Spring. Change potential associated with the BHP Billiton Iron Ore's Marillana mining area is moderate within local drainages and high along the lower Weeli Wolli Creek through to the Marsh. Change potential associated with the Mindy and Coondiner mining area is low to moderate within local drainages, but reduces to either low or negligible towards the southeast of the Marsh. Change potential associated with BHP Billiton Iron Ore's Roy Hill mining area is low within local drainages, but there are several creeks subject to high change potential that drain into the northwest portion of the Marsh.
- Surplus water - High change potential; on the basis that BHP Billiton Iron Ore's Marillana and Mindy mining areas have periods of large surplus water and the assumption that no mitigation is in place. The Coondiner and Roy Hill mining areas are forecast to have only a minor water surplus for short durations, and therefore have low change potential with respect to surplus water.
- Saline intrusion - Potential for change; based on groundwater drawdown from the Marillana, Mindy and Roy Hill mining areas potentially extending to the saltwater interface within the Fortescue River Valley groundwater system.
- Surface water quality - Negligible change potential. Surface water quality is maintained via the implementation of normal business surface water management practices.

Based on the above findings, BHP Billiton Iron Ore considers that the potential impacts to Fortescue Marsh predicted from implementation of the Proposal can be managed to an acceptable level (Appendix 6).

6.1.2 KARIJINI (HAMERSLEY RANGE) GORGES

LANDSCAPE CONTEXT

The Karijini (Hamersley Range) Gorges are a series of permanent spring-fed pools in the narrow rugged gorges of the Karijini National Park's north east. These pools include (from the south-east) Munjina, Dales, Yampire and Kalamina gorges, a complex of linked gorges (Joffre, Hancock, Weano, Red and Knox) and parts of Hamersley Gorge and Range Gorge. The creeks in the gorges flow into the Fortescue River.

The gorges are situated in the Pilbara Craton, the rugged Hamersley Range trends north-west to south-east with an escarpment rising to a general height of approximately 900 m above sea level and a maximum of 1245 m above sea level at Mt. Meharry (the highest peak in Western Australia) on the plateau to the south. Gorges have formed where drainage lines have exploited cracks and fissures in the surface. Streams funnel through the gorges onto the broad Fortescue Plain.

The Karijini (Hamersley Range) Gorges have a wide range of environmental values and is classified as a wetland of national importance within the Directory of Important Wetlands in Australia (Ref. WA067). The gorges provide a refuge for disjunct flora and rare fauna; permanent water supplies in an otherwise arid environment. There is also evidence of occupation by ancestors of the Banjima, Innawonga and Kurrama Aboriginal people dates back more than 20,000 years. There are paintings in several of the gorges. (DotE 2015b).

ECOHYDROLOGICAL CONCEPTUALISATION

The permanent pools that are associated with deeply incised creeks and gorges in the northern portion of the Karijini National Park occur within EHUs 3 and 4. The gorges constitute a unique landform type that is not encountered in the Proposal tenure. The pools form through seasonal surface water inundation and local groundwater discharge from the low permeability Brockman Formation (Hedley 2009). The generalised gorge morphology includes spring discharge at the gorge head, steep sided walls which are predominantly dry (non-leaking) and a low discharge stream at its base. There is minimal alluvium development within the gorges. Hydrochemical analysis of the gorge waters suggests that the pools are supported by local aquifers that are hydrologically disconnected from the regional groundwater resources (Hedley 2009).

CHANGE ASSESSMENT

The nearest proposed BHP Billiton Iron Ore mining operation is over 18 km to the southeast of the Karijini (Hamersley Range) Gorges. Given that the gorges are hydrologically disconnected from the regional groundwater resources and are supported by local aquifers, BHP Billiton Iron Ore considers the potential impact from implementing the Proposal to be negligible (Appendix 6).

6.1.3 MOUNT BRUCE COOLIBAH-LIGNUM FLATS

LANDSCAPE CONTEXT

The Mt Bruce Coolibah-Lignum Flats are located approximately 8 km southeast of Mount Bruce in Karijini National Park (see Figure 35).

The flats occur in a valley that is surrounded by peaks of the Hamersley Range and mapped as the Wannamunna Land System (EHU 6) by van Vreeswyk et al (2004).

The *Eucalyptus victrix* woodlands on the Mt Bruce Flats are classified as the 'Coolibah woodland over lignum and silky browntop (*Eulalia aurea*)' priority ecological community (DPaW 2014). The wetland landform that supports this vegetation consists of red cracking clays within run-on zones and is listed in the Directory of

Important Wetlands of Australia (Ref. WA113). Recognised threats to the priority ecological community include dewatering, grazing, and clearing associated with infrastructure corridors (DPaW 2014).

ECOHYDROLOGICAL CONCEPTUALISATION

The Mt Bruce Coolibah-Lignum Flats are likely to have ecohydrological similarities to the Coondewanna Flats, which is located adjacent to the east of Karijini National Park. Coondewanna Flats is an internally-draining catchment that includes the ephemeral (seasonal) Lake Robinson. The woodland vegetation community has a likely dependence on stored soil water derived from runoff.

CHANGE ASSESSMENT

The Proposal will not result in any ecohydrological change to the woodland vegetation community, as the priority ecological community is ecohydrologically disconnected from any current or proposed BHP Billiton Iron Ore mining areas (Appendix 6).

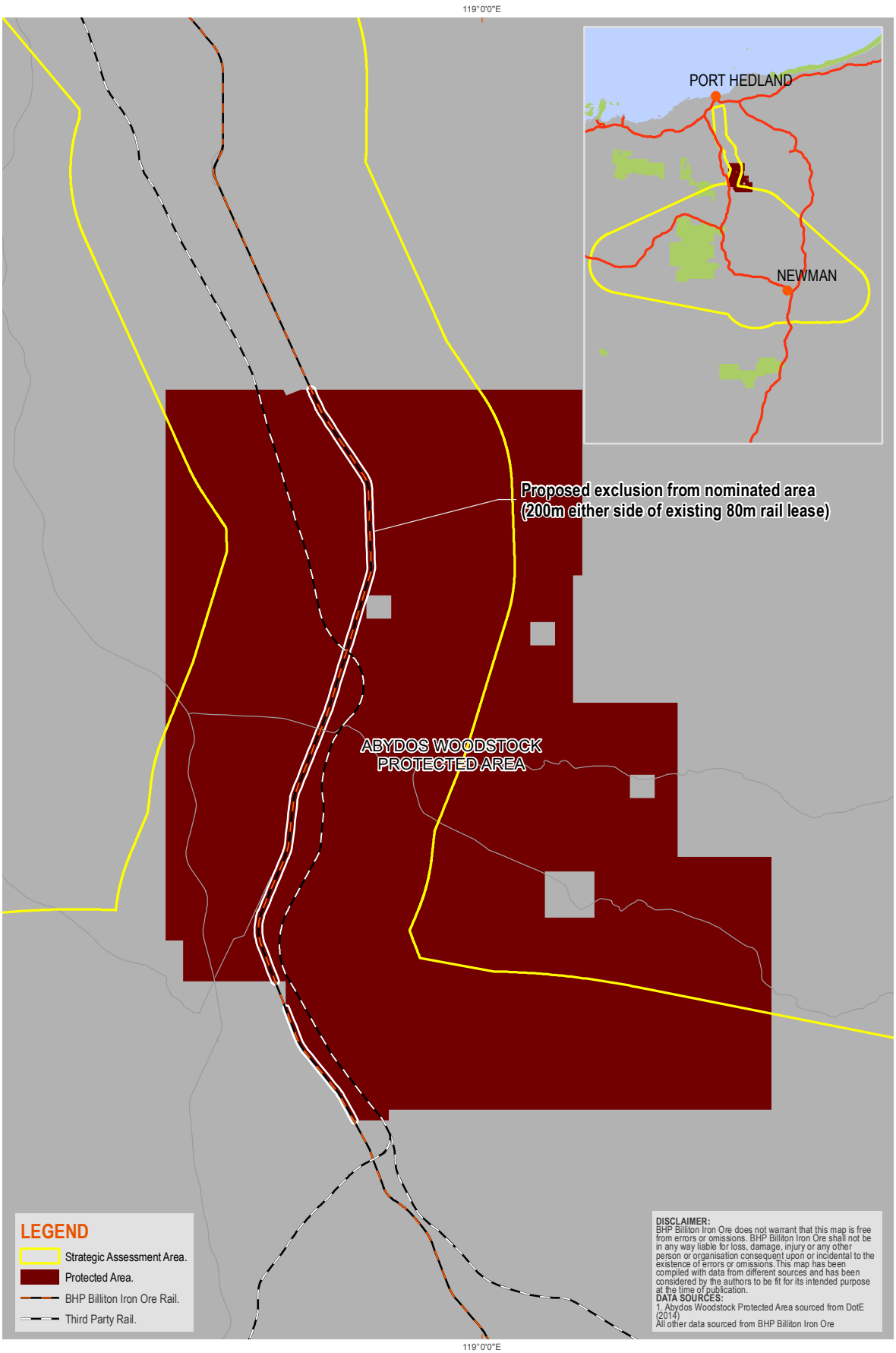
6.2 Potential Future National Heritage Places

Aboriginal people have lived in the Pilbara region for more than 40,000 years. As a consequence of this extended period of occupation combined with the natural environment, the Pilbara region is rich in Aboriginal cultural heritage. BHP Billiton Iron Ore has conducted large scale archaeological and ethnographic surveys to identify places of cultural significance on or around its tenure. Those surveys are generally undertaken with participation by the relevant Traditional Owners of the area. During these surveys, which are ongoing, a large number of archaeological and ethnographic sites have been identified. These sites are managed internally by a sophisticated spatial heritage information management system to ensure the spatial attributes of these sites are included in the planning stages of any project. It is BHP Billiton Iron Ore's aim to minimise any impact on culturally significant sites. Heritage protocols, cultural heritage management plans and cultural material management plans are in place guiding the process to achieve this goal. Management of Aboriginal heritage is described further in Section 8.2.

While there are no national heritage places within the Strategic Assessment Area, the Abydos Woodstock Protected Area was nominated for listing in 2011. The site is located north of BHP Billiton Iron Ore's mining tenure, but the Company's existing rail lines (along with two other mining company rail lines) traverse the nominated area (Figure 37).

In 1987, Anthropological Consultant Rory O'Connor conducted surveys across the Abydos Woodstock area to identify sites of cultural significance. In 2008, Anthropologist Kim Barber conducted an additional ethnographic survey along the BHP Billiton Iron Ore rail corridor through Abydos Woodstock on behalf of the Native Title groups. One site of ethnographic significance was identified in the corridor. After further consultation with the relevant Native Title groups, BHP Billiton Iron Ore amended the track alignment to avoid this site.

In 2010, BHP Billiton Iron Ore contracted Archaeological consultants WARU to conduct a detailed archaeological survey, 200 metres either side of the existing 80m BHP Billiton Iron Ore rail corridor. All archaeological sites were identified, mapped and recorded in detail and extensive consultation was undertaken with the relevant Native Title groups and Yamatji Marlpa Aboriginal Corporation (YMAC) over the following two years with the intention of identifying an expanded corridor alignment that did not impact on sites of cultural or historical significance. In one place this involved narrowing the corridor and changing the alignment. This work was undertaken in the context of YMAC moving towards lodging a nomination of Abydos Woodstock for a National Heritage Listing on behalf of the Native Title groups. If that occurred, the 480m rail corridor (200m either side of the existing 80m rail lease) would be excluded from any future listing.



Pilbara Strategic Assessment

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Figure 37 Abydos Woodstock Protected Area

DATE: 27/01/2016
DRAWN: BHP Billiton Iron Ore
Environmental Approvals

From the above, BHP Billiton Iron Ore considers that should the Abydos Woodstock Protected Area become listed as a National Heritage Place under the EPBC Act in the future, implementation of the Proposal would not result in any impact to this area.

Other sites on the Register of the National Estate archive (DotE 2015b) within or partially within the Strategic Assessment Area, but not nominated to be listed as National Heritage Places, are:

- Woongarra Gorge Area, Paraburdoo (reference 18747)
- Hamersley Range National Park (1977 boundary) Munjina - Roy Hill Rd (reference 10129)
- Mungaroona Range Nature Reserve (ref 10065)
- Knossos Geological Site, Port Hedland - Newman Railway Line (reference 18289)
- Abydos - Woodstock Art Sites (reference 10061)
- “Indigenous Place” (reference 16192)
- “Indigenous Place” (reference 16193)

All of the above places are outside of the existing and proposed disturbance areas; therefore no impact to these areas is expected as a result of the Proposal.

Further information on BHP Billiton Iron Ore’s approach to heritage is provided in Section 8.2.

6.3 Potential Future Listing Event – Ghost Bats (*Macroderma gigas*)

The Agreement (Appendix 1) requires BHP Billiton Iron Ore to consider MNES that may be listed prior to the class of actions approval. The ghost bat (*Macroderma gigas*) was included on the Finalised Priority Assessment List on 1 October 2015. The Finalised Priority Assessment List (FPAL) is the list of nominated species, ecological communities and key threatening processes that have been approved for assessment by the Minister responsible for the EPBC Act (the Minister) for a particular assessment year (1 October – 30 September). These have a statutory timeframe in which the assessment must be completed (DotE 2015). Although the timeframe for assessment is not until 30 Sept 2017, the requirements of the Commonwealth Strategic Assessment terms of reference are to include a species profile and an assessment of the nature and extent of impacts to the species, because it is considered potentially eligible for listing prior to the class of actions approval.

The criteria used to determine if a species warrants protection under the EPBC Act include species:

- which have undergone, are suspected to have undergone or are likely to undergo a significant reduction in numbers in the immediate future;
- who’s geographic distribution is precarious for the survival of the species and is limited or worse;
- who’s estimated total number of mature individuals is limited or worse; and
- who’s estimated total number of mature individuals continue to decline at a substantial rate or worse, or
- who’s number is likely to continue to decline and its geographic distribution is precarious for its survival;
- who’s estimated total number of mature individuals is low or worse; and
- who’s probability of extinction in the wild is at least 10% in the medium-term future, 20% in the near future or 50 % in the immediate future.

This section presents an impact assessment of the ghost bat, in the event that this species is listed as an MNES prior to the Minister granting an approval of an action or classes of action. If listed, the ghost bat would be considered a Specified Protected Matter for future updates of the Assurance Plan, described in Section 8.6.1.

6.3.1 SPECIES DESCRIPTION AND CONSERVATION STATUS

The ghost bat is the largest microchiropteran bat in Australia, with a head and body length of 10-13 cm and a forearm length of 10-11 cm. It is Australia's only carnivorous bat. Its fur is light to dark grey above and paler below. It has long ears which are joined together, large eyes, a simple noseleaf and no tail (Richards et al. 2008).

The species was evaluated in a Recovery Outline published in The Action Plan for Australian Bats (Duncan et al. 1999). The 2012 Action Plan for Australian Mammals (Woinarski et al., 2014) lists this species as Vulnerable C1, based on the relatively small population size (<10,000 animals), and an estimating continuing decline of >10 % in 24 years (3 generations). In the Pilbara, its maternity roosts are restricted to abandoned open cut mines that are now collapsing or being open cut, or natural caves that occur in banded ironstone that are the focus of current and future mining and exploration activities. It is also listed as Vulnerable C1 under the IUCN Red List.

6.3.2 SPECIES DISTRIBUTION

Ghost bats occur across most of northern Australia; however, the relatively recent contraction of the distribution in central Australia has left the Pilbara population of ghost bats isolated by extensive sandy deserts (Worthington-Wilmer et al. 1994). Worthington-Wilmer (2012) considers that only 14 maternity roosts are known in Australia.

In the Pilbara region, the species occurs in all four sub-regions, and was recorded in 21 of the 24 areas surveyed by DPaW during the Pilbara Biological Survey (2002-2007; see McKenzie & Bullen, 2009). The largest populations occur within the Chichester sub-region, where known populations are largely restricted to disused mines. The largest colonies occur around Bamboo Creek, Marble Bar and Nullagine, with the largest population occurring in natural caves occurring in the vicinity of BHP Billiton Iron Ore's Goldsworthy operations (outside both the Strategic Assessment Area and the Proposal scope). In the Hamersley subregion, populations are more widespread, but are much smaller in size (Figure 38). There are few abandoned mines in this sub-region, and those that have been sampled have shown little evidence of ghost bat presence (e.g. Koodaideri (Biota 2011) and Hashimoto (Specialised Zoological 2009).

A recent population estimate has been given as less than 10,000 individuals (Woinarski et al. 2014), with the Pilbara population comprising between 1,800 and 2,400 individuals (Biologic and Bat Call WA 2014).

6.3.3 ECOLOGY

The ghost bat is Australia's only strictly carnivorous bat, predating on frogs, lizards, birds, small terrestrial mammals, other bats and large insects (Van Dyck & Strahan 2008). Ghost bats forage in a wide range of habitats, whereas habitat for roost sites is more specific. Abandoned horizontal mine tunnels comprise a significant portion of the known ghost bat roost sites (Woinarski et al. 2014).

Ghost bats disperse widely when not breeding but concentrate around maternity roosts in July and August when mating takes place. Births occur in September and October; the young begin to fly at 7 weeks and are completely weaned by the March following their birth.

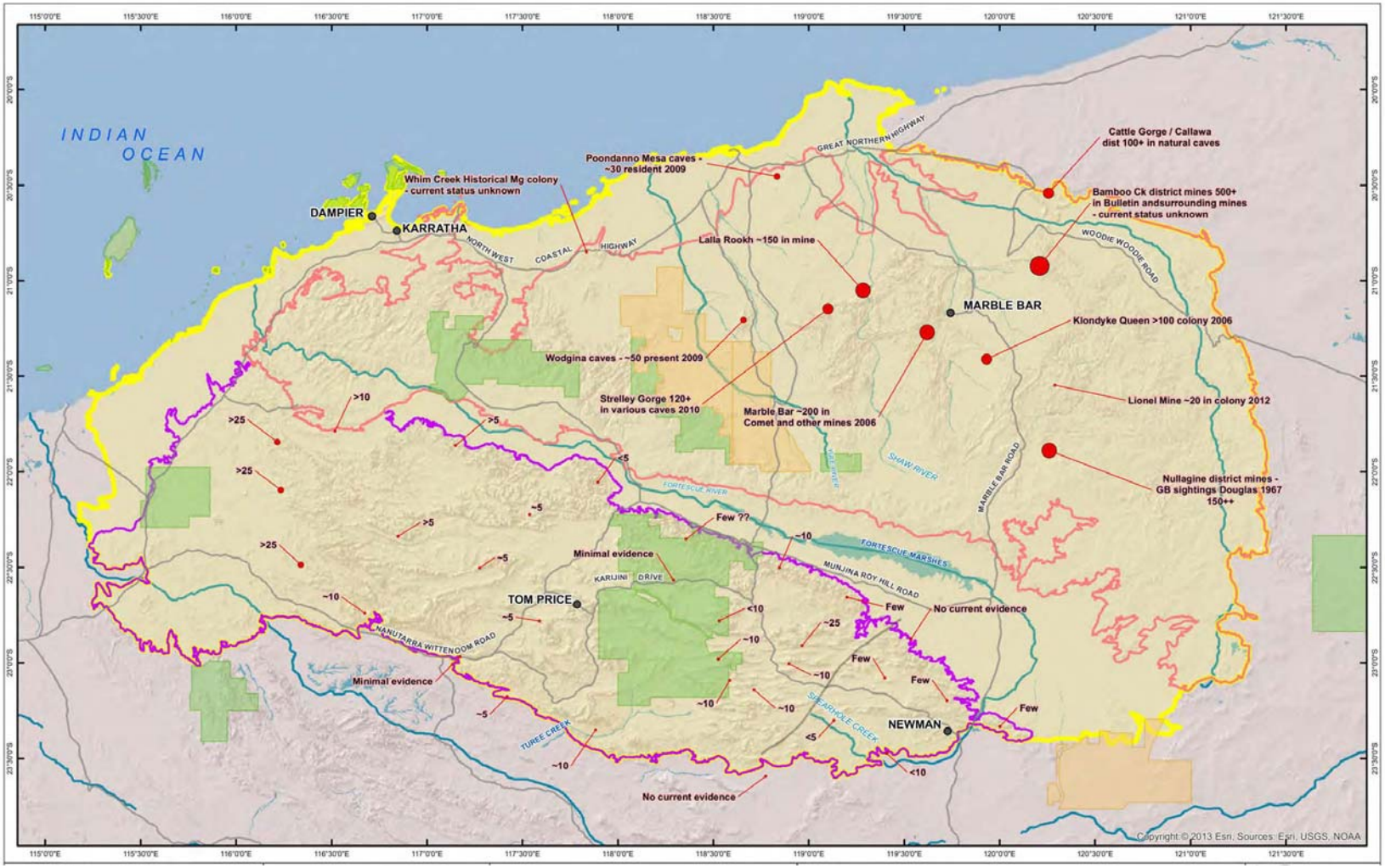


Figure 38: Graphical representation of the 2014 population estimate for the ghost bat in the Pilbara.

Genetic studies indicate that there is a high degree of female philopatry at natal roosts (tendency to return to its home area or birthplace), with gene flow mediated by male movement (Worthington-Wilmer et al. 1994). Because of this, the loss of maternity sites that contain breeding females has the potential to reduce the area of occupancy significantly.

6.3.4 HABITAT

The distribution of ghost bats in the Pilbara is dictated by the presence of suitable roosting sites, either natural caves or man-made mines and adits. Natural roosts generally comprise deep, complex caves beneath bluffs or low rounded hills composed of marra mamba or Brockman Iron Formation, or in granite tors (Armstrong & Anstee 2000). Armstrong and Anstee (2000) further noted that most caves used by ghost bats in bluffs have narrow entrances, generally less than 0.5 m^2, that opened into larger chambers. The bats moved between a number of caves, both seasonally and as dictated by weather changes. During the breeding season, female ghost bats congregate into maternity roosts during pregnancy and lactation (Hutson et al., 2001). Most maternity sites appear to require multiple entranced caves (L. Hall pers. comm. in McKenzie & Hall 2008). Presence of maternity roosts in the Pilbara is discussed further in Section 6.3.5. At night whilst feeding, bats may use shallow caves or overhangs to rest or whilst consuming prey.

6.3.5 IMPACT ASSESSMENT

BHP Billiton Iron Ore conducted a review of ghost bat records from the company's database and publicly available data supplied by Western Australian Department of Parks and Wildlife (DPaW) and Western Australian museum in December 2015 and January 2016 respectively. The review identified 1,028 records for ghost bat, of which 465 occurred within the Strategic Assessment Area. 175 records are predicted to be impacted by iron ore mining (reasonable foreseeable third party and BHP Billiton Iron Ore Full Conceptual Development) in the Pilbara. The data show that the majority of the potential impact is from BHP Billiton Iron Ore. No distinction between types of records was available within the data. It is likely that most of the locations have been recorded from bat call detectors and therefore may not necessarily reflect the location of roosts. Further, this number may be biased towards records on mining tenure due to the large amount of survey work undertaken by biological consulting companies for environmental approvals. Nevertheless, the data do demonstrate that this species is commonly recorded and are consistent with the findings of McKenzie & Bullen (2009).

As described in Section 6.3.2, the ghost bat occurs in all four Pilbara subregions, but within these subregions it occurs as clustered populations, particularly where large populations roost in abandoned mines and adits in the Chichester subregion (see Figure 38). Based on data available as of 2014, Biologic and Bat Call WA (2014) estimated the Pilbara population to be between 1,800 and 2,400 individuals, with the Chichester population comprising most of these (Chichester population estimated at 1,500 to 2,000 individuals; Hamersley population estimated at 300 to 400).

A recent national estimate for Australia was given as less than 10,000, and this is expected to decline at a rate of more than 10% over the next 24 years (three generations)(Woinarski et al. 2014). At a national level, this species' persistence is under threat due to habitat loss and fragmentation, climate change and mortality due to interactions with infrastructure (Woinarski et al. 2014), and there is recent evidence that it may also be impacted by consumption of cane toads (Purtill 2014). Given this, all populations of this species are considered to be of conservation value, particularly those that occur at or beyond the limit of the cane toad's estimated future distribution in the Pilbara or those that will facilitate a shift in distribution with changing climate.

A population of ghost bats occurs within BHP Billiton Iron Ore's tenements east of Karijini National Park (in the vicinity of BHP Billiton Iron Ore's existing Mining Area C operation), and there is evidence of breeding occurring

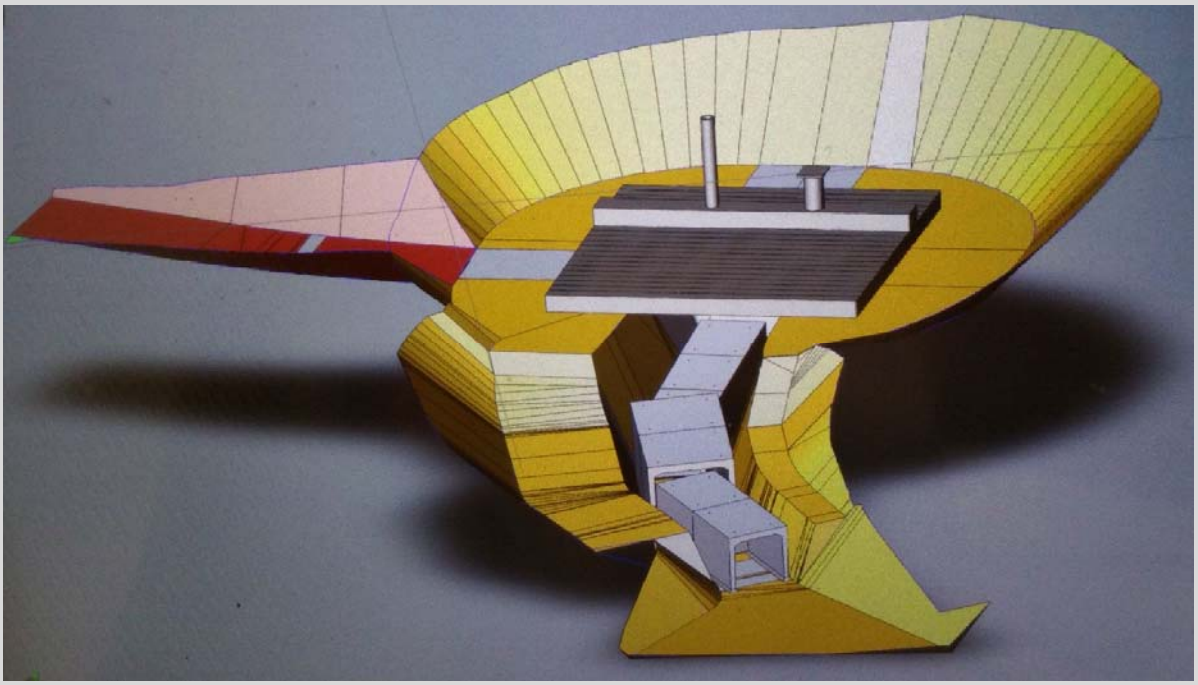
in this area (at Rio Tinto's West Angelas tenure (Armstrong & Anstee 2000) and BHP Billiton Iron Ore's South Flank tenure. There are few known records of breeding in the Hamersley Range, so the presence of a breeding colony in this area is considered to be significant at a local (population) and subregional (Hamersley) level. Unlike the large maternity roosts that occur in the Chichester subregion (e.g. the Klondyke Queen mine, which supports over 100 ghost bats), the colonies in this area are small, numbering up to 20 individuals. The largest colonies in the Pilbara occur outside the Strategic Assessment Area where they roost in abandoned mines. Colonies within the Project Definition Boundary are much smaller, and available data suggest that they likely depend on a number of roosts within their range.

BHP Billiton Iron Ore is currently funding studies to better understand the ecology of ghost bats in this area (see Case Study 3).

Case Study 3: Understanding ghost bat roosting requirements in the vicinity of Mining Area C

Nine terrestrial fauna surveys have been undertaken to date within the vicinity of BHP Billiton Iron Ore's Mining Area C operations, including two targeted bat surveys, during which no ghost bats had been recorded. In 2009 and 2010, Biologic (2011) assessed the presence of ghost bat in the area based on visual searches of caves and documenting the presence of scats or middens. During this survey, 20 caves were recorded that showed evidence of ghost bat use, and a further 19 caves were identified that contained suitable habitat for this species.

Removal of roosting habitat from this area is likely to have an impact on local populations of ghost bats, so BHP Billiton Iron Ore is currently funding studies to better understand the ecology of ghost bats in this area and in particular their use of day and maternity roosts, which appears to differ from those larger roosts in the northern Pilbara and other areas across the Kimberley and Northern Territory that have been the subject of detailed studies (e.g. Boles 1999; Tidemann et al. 1985; Schulz & Menkhorst 1986). In conjunction with regional bat experts, BHP Billiton Iron Ore has recently designed and constructed an artificial roost to mitigate impacts to ghost bats (shown in figure below).



Ghost bat roost design

The roost has been designed to prevent predation of ghost bats and includes a main roosting chamber and second intermediate roosting chamber. The roost has been constructed using concrete culverts and structural integrity is engineered for an excess of 200 years. The design also includes a monitoring chute at the roof of the cave to enable non-invasive monitoring to be undertaken to detect the ghost bat's use of the artificial roost. The opening to the completed roost is shown below. It is intended that the monitoring data are made available.

Completed artificial ghost bat roost constructed in the vicinity of Mining Area C

Ghost bat populations in the Chichester subregion are considered significant; and if impacted by habitat loss (due to collapse or reworking of mine adits) or from the arrival of cane toads, those populations within the Strategic Assessment Area will become more important regionally.

BHP Billiton Iron Ore recognises that the ghost bat will require considered management during implementation of the Proposal. Should the ghost bat be listed as an MNES it would be considered as a Specified Protected Matter and as such, BHP Billiton Iron Ore's commitments in the MNES Program would apply. The MNES Program contains a commitment to develop an Assurance Plan and Offsets Plan; these plans are described further in Section 8.6.1. The Assurance Plan would include a MNES Management Outcome specific to the ghost bat, which must be met through avoidance and mitigation measures. If after avoidance and mitigation measures have been applied and significant residual impacts are predicted to occur, offsets would be applied.

The MNES Program also contains a Validation Framework (described in Section 8.6.2), which includes a commitment to review baseline data and site-specific information such as the proposed footprint and indirect impacts predicted to the Specified Protected Matter. This Validation Framework provides a robust process to consider new information in regards to ghost bat roost significance on a case-by-case basis during implementation of the Proposal.

BHP Billiton Iron Ore considers that the potential impacts of the Proposal on the ghost bat will be managed to an acceptable level; given the commitments and processes contained in the MNES Program that can be applied to the ghost bat in the event that the species is listed as an MNES.

7 SOCIO-ECONOMIC ENVIRONMENT

7.1 Introduction

In addition to its natural and heritage values, the Pilbara is possibly best known for its economic contribution to Australia, particularly from mining and gas production. Key industries in the Pilbara are mining, construction, liquefied natural gas (LNG) and agriculture; with two of Australia's largest ports by tonnage located at Dampier and Port Hedland. The region is also a popular tourism destination during the winter months.

The Pilbara government region comprises four local government authorities; the Shires of Ashburton and East Pilbara, the City of Karratha and the Town of Port Hedland. The major towns of the Pilbara include Port Hedland, South Hedland, Karratha, Onslow, Newman, Tom Price and Marble Bar (Figure 1). A significant number of Indigenous communities are also present in the Pilbara, along with such historic towns such as Cossack, pastoral stations and localities that date back to an early pastoral and pearling era. The majority of BHP Billiton Iron Ore's mining tenure within the Proposal are located within the Shire of East Pilbara and in proximity to Newman.

While the Pilbara supports a wide range of industries and businesses, by export value approximately 98% of goods and services are contributed by mining, construction and manufacturing (Pilbara Development Commission 2015a). In the 2011 census, over 35% of respondents in the region indicated they were employed in the mining sector and another 16% indicated they were employed in the construction industry (ABS 2011).

7.2 Pilbara Communities

As a result of the location of BHP Billiton Iron Ore's operations, the main communities that the Company interacts with are Port Hedland, Newman and some of the remote Indigenous communities that are close to the Company's operations. BHP Billiton Iron Ore has a long established program of regular and ongoing engagement with these communities, which are discussed further in Section 7.3.

Over the last 15 years, the Pilbara region has experienced sustained population growth reflecting the expansion of mining and gas development in the region. The regional population has grown from approximately 40,000 people in 2001 to nearly 68,000 by 2014, an increase of over 70% (Pilbara Development Commission 2015b).

7.2.1 PORT HEDLAND

Port Hedland is a town of nearly 15,000 permanent residents located to the north of the Strategic Assessment Area. In addition to this permanent population, approximately 5,000 transient workers (including fly in – fly out (FIFO)), and tourists are accommodated within the Port Hedland area. Port Hedland is the largest bulk handling port in the world, shipping a total tonnage of 446 Mt in 2014/15 (Pilbara Port Authority 2015). Iron ore makes up over 98% of this total.

In addition to the rapid population growth over the last 10 years, Port Hedland has also experienced a highly transient population. At the 2011 census, only 51% of respondents indicated their address was the same as the previous year and only 32% had their usual place of residence in Port Hedland 5 years previously (ABS 2011).

Over 25% indicated they worked in the mining industry, with nearly 16% in construction and over 7% in health care and social assistance.

Weekly incomes in the Pilbara reflect the higher wages for the mining and construction sectors, with nearly 12% of respondents recording a weekly income of $1,500 to $1,999 and just over 30% stated they were in the top band of $2,000 or more per week. Over 22% of respondents did not state their income (ABS 2011).

Aboriginal and Torres Strait Islanders make up nearly 14.8% of Port Hedland residents and this is considerably higher than the State average of 3.1% (ABS 2011).

7.2.2 NEWMAN

With a resident population of around 5,500, Newman is the largest town in the Shire of East Pilbara. The town was established in the 1960s by the Mount Newman Mining Company to accommodate workers mining the iron ore deposits at nearby Mount Whaleback.

Newman's population is characterised by a high degree of transience. It is estimated that around 5,000 FIFO workers live in and around Newman, giving a total combined population of around 10,500 in 2013. Similar to Port Hedland, only 21% of respondents to the 2011 census had the same place of residence five years ago (ABS 2011). Over 56% indicated they worked in the mining industry and nearly 9% said they worked in construction.

The labour force participation rate is particularly high in Newman, with nearly all males aged 25 years and over participating at the time of the last census. The unemployment rate was very low in Newman in 2011 at 2.3% or almost half the statewide unemployment rate of 4.7% (ABS 2011). This was indicative of a local labour shortage in Newman at the time. Since this period of low unemployment, unemployment rates in Western Australia have increased from approximately 2.6% and 4% for men and women respectively in mid-2012 to 6.8% and 6% in June 2015, seasonally adjusted (ABS 2015).

7.2.3 EAST PILBARA REMOTE ABORIGINAL COMMUNITIES

The Shire of East Pilbara covers an area larger than the State of Victoria. Although sparsely populated. The Shire contains a number of remote Indigenous communities including Jigalong, Goodabinya (near Marble Bar), Irrungadji (near Nullagine), Kunawarritji (otherwise known as Well 33), Parnngurr (Cotton Creek), Punmu, Warralong and Yandeyarra.

The communities have populations of between 56 and 300 people. Residents are mainly Indigenous with strong cultural links and traditions. Jigalong is located within the Strategic Assessment Area.

7.2.4 REGIONAL PLANNING OBJECTIVES

Pilbara Cities was established in April 2010 by the Western Australian State Government to address the issues associated with significant growth in the region. It aimed to fulfil the vision of building the population of Karratha and Port Hedland into cities of 50,000 people and Newman to 15,000 people by 2035, with other Pilbara towns growing into more attractive, sustainable local communities.

The Pilbara Development Commission identified a number of consequences as a result of rapid population growth over recent years:

- Housing is less affordable due to unmet demand;
- Infrastructure upgrades or expansion are not keeping pace with growth;

- Small business numbers have declined partly due to rising costs;
- Education and health services are below expectations;
- Community services facilities are aging and inadequate; and
- Sense of community is in decline, adversely impacted by workforce FIFO rosters and 12 hour shifts.

Some of these consequences have lessened with the slowing of mining and construction activity in 2014 and 2015. For example, advertised average housing prices and property rentals in Port Hedland and Newman are currently the lowest for seven to eight years (Pilbara Development Commission 2015c).

7.3 Traditional Owners / Native Title Groups

BHP Billiton Iron Ore engages with Traditional Owner and Native Title Groups within the Strategic Assessment Area as part of the Company's heritage management throughout project planning and implementation, as described in Section 8.2. This is then enhanced through BHP Billiton Iron Ore's ongoing programme of negotiating broad based land access agreements. These agreements seek to establish long term relationships and provide the framework for managing native title, heritage and environmental issues both now and into the future.

Consultation with the Native Title Groups identified as key stakeholders has been a critical component in the development of this draft IAR. Consultation has been undertaken with groups whose land is directly physically impacted by the Proposal and will also be undertaken with Aboriginal communities that are in proximity to the Proposal. Traditional Owners or Native Title claimants identified as key stakeholders within the Strategic Assessment Area include the:

- Kariyarra people;
- Nyiyaparli people;
- Palyku people;
- Banjima people;
- Ngarlawangga people; and
- Yinhawangka people.

Initial consultation on the Strategic Assessment addressed issues such as:

- What is the Strategic Assessment?
- Why are we doing it?
- What will it cover?
- How long will it take?
- What happens for future proposals.

A summary of this consultation to date is provided in Table 22.

Table 22: Summary of Traditional Owner consultation to date

Consultation date	Topics covered
Nyiyaparli Group	
12 September 2012	General Strategic Assessment overview (presentation).
27 March 2013	Written Strategic Assessment update regarding progress to date – focus upon process. Presentation on water management.
12 September 2013	Written Strategic Assessment update re progress to date - focus upon process.
13 March 2014	General Strategic Assessment overview (presentation).
18 September 2014	Written Strategic Assessment update re progress to date - focus upon process.
30 January 2014	BHP Billiton Iron Ore environment team meeting with Nyiyaparli. Regional closure and rehabilitation approach. Current approvals. General discussion on the Strategic Assessment.
1 April 2015	Site visit to a working mine to looked at closure and rehabilitation.
14 April 2015	Introduced the proposal for an independent environmental consultant to assist Traditional Owner groups with Strategic Assessment documents. Presented on Strategic Assessment with focus on what the Strategic Assessment is, potential flora and fauna and visual impacts. Presented on water management.
10 June 2015	Presentation to discuss current approvals and key findings. Confirmation of the engagement of the independent environmental consultant. Update on the status of the Strategic Assessment.
19 August 2015	Presentation of key Strategic Assessment findings by an independent environmental consultant as part of a process to identify key environmental issues of concern to Traditional Owners.
12 October 2015	Presentation to discuss current approvals and key findings. Update on the status of the Strategic Assessment.
17 November 2015	Presentation by BHP Billiton Iron Ore on key environmental issues raised at the meeting on 19 August 2015. Separate discussions with the independent environmental consultant on BHP Billiton Iron Ore's response.

Consultation date	Topics covered
Yinhawangka Group	
3 November 2014	Presentation on water management. Presentation on Strategic Assessment.
27 August 2015	Presentation on water management. Presentation on Strategic Assessment. Presentation of key Strategic Assessment findings by an independent environmental consultant as part of a process to identify key environmental issues of concern to Traditional Owners.
21 October 2015	Presentation by BHP Billiton Iron Ore on key environmental issues raised at the meeting on 27 August 2015. Separate discussions with the independent environmental consultant on BHP Billiton Iron Ore's response.
Ngarlawangga Group	
28 August 2015	Presentation on Strategic Assessment. Presentation of key Strategic Assessment findings by an independent environmental consultant as part of a process to identify key environmental issues of concern to Traditional Owners
14 October 2015	Presentation by BHP Billiton Iron Ore on key environmental issues raised at the meeting on 28 August 2015. Separate discussions with the independent environmental consultant on BHP Billiton Iron Ore's response.
10 December 2015	Presentation by BHP Billiton Iron Ore on its response to additional issues raised following the meeting on 14 October 2015. Separate discussions with the independent environmental consultant on BHP Billiton Iron Ore's response.
Banjima Group	
2 December 2014	Presentation on water management. Presentation on Strategic Assessment.
23 September 2015	Presentation on Strategic Assessment. Presentation of key Strategic Assessment findings by an independent environmental consultant as part of a process to identify key environmental issues of concern to Traditional Owners
Palyku Group	
16 November 2015	Presentation of key Strategic Assessment findings by an independent environmental consultant as part of a process to identify key environmental issues of concern to Traditional Owners: • Overview of the process for Strategic Assessment. • What is being proposed? • Work done by BHP Billiton Iron Ore so far. • The predicted impacts.

Consultation date	Topics covered
Kariyarra Group	
12 November 2015	Presentation on Strategic Assessment. Presentation of key Strategic Assessment findings by an independent environmental consultant as part of a process to identify key environmental issues of concern to Traditional Owners.

This consultation is ongoing and will continue throughout planning and implementation of the Proposal.

7.4 Tourism

The Pilbara contains three national parks: Millstream-Chichester, Karlamilyi (Ruddell River) and Karijini - and contains some of the oldest geology in the world including the oldest known fossilised stromatolites estimated to be 3.45 billion years old. The Pilbara region offers outdoor recreation including such activities as camping, boating and fishing in some beautiful and remote landscapes.

Tourism in the Pilbara attracts over 212,000 leisure visitors each year and injects $362 million into the local economy (Pilbara Development Commission 2014). Key visitor attractions include:

- natural attractions (e.g. national parks, landscapes, islands, beaches);
- cultural and heritage attractions (e.g. Aboriginal culture, historic rock art, earliest signs of life, art galleries, original settlements, events); and
- industrial tourism (e.g. mine, harbour and industrial assets).

7.5 Economic Benefits from Iron Ore Mining

Australia currently produces more than 700 Mt of iron ore a year. This generates approximately $54 billion in export revenue for Australia ensuring iron ore is Australia's largest export earner and a major contributor to the Australian economy (Office of the Chief Economist 2015).

In the decade from 2005 to 2014, which included a period of historically high prices, revenue of the major Australian iron ore producers totalled more than $430 billion. In the next decade, even with no production growth and prices at much lower levels, a higher production base is predicted to generate more than $600 billion in revenue, which will be shared between suppliers, governments and investors (Minerals Council of Australia 2015).

The Pilbara contributes 90% of Australia's iron ore exports and currently produces 85% of Australia's LNG (Pilbara Regional Council 2014) and contributes 17.5% of Western Australia's and 2.8% of Australia's economic activity. The region will play a key strategic role in the future growth of expanding economies of China, India and South-east Asia, providing 45% of global iron ore exports. Gross regional product per capita for the Pilbara is more than six times the state level and more than 10 times the national level at $690,000.

7.6 Socio-economic Assessment

7.6.1 TYPES OF SOCIO-ECONOMIC IMPACTS

BHP Billiton Iron Ore's ongoing engagement with the community has identified areas of potential impacts and opportunities for future investment. Understanding the type of impact and the Company's responsibility in relation to each impact is critical to informing mitigation and enhancement strategies. Impacts generally fall into one of two categories: direct and indirect.

Direct Impacts: Those social impacts that are a direct consequence of operations and construction activity. The Company typically has a responsibility to directly mitigate or manage these impacts. Examples include:

- Mine and related traffic;
- Utility requirements;
- Workforce;
- Aesthetics and visual impacts;
- Native Title and Cultural Heritage; and
- Quality of living – dust and noise.

Indirect Impacts: The impacts that result from the increased economic and other activity a project creates in a region. These impacts are a function of progress creating a need for greater capacity and resourcing (i.e. cost of living, local government capacity, health services, recreational facilities, land supply). Thus, responsibility to fund the increased demand on the services, facilities and infrastructure is ideally shared with government and others. Where the quantum of impact is cumulative from other projects or organisations the responsibility should also be shared. Where there is low capacity to respond locally or there are impacts on the costs of operations, such as cost of land, the Company might choose to also contribute. Examples include:

- Land and accommodation;
- Community support services;
- Cost of living;
- Economic diversity;
- Community engagement in planning;
- Crime, safety and antisocial behaviour;
- Education;
- Air transport services;
- Retail and entertainment;
- Access to health services;
- Emergency medical services; and
- Recreation and leisure areas.

In some cases an opportunity arises from those impacts where the Company's presence can create clear positive results through sound investment and management. These are impacts where there are opportunities for building a social licence to operate or a project legacy by focusing on already present or systemic issues. In

remote and regional towns - where there is often a need for economic diversification, inadequate provision of health, education and community services, a lack of Indigenous employment and enterprise - operations such as BHP Billiton Iron Ore can make significantly positive contributions that build the operations' social licence to operate and achieve significant, enduring, positive outcomes for the community.

The mitigation of both direct and indirect impacts can reduce project costs. For example:

- Local workforce capacity may be built by investments in education and training as well as support of Indigenous enterprises;
- Local economies and support industries may be strengthened by local contracting policies;
- Staff turnover may be reduced through investments resulting in higher quality of life (education, recreation facilities, and services); and
- Project approvals may be expedited through stakeholder satisfaction in the Company's contributions to local community infrastructure and other investments.

7.6.2 REGIONAL SOCIO-ECONOMIC IMPACT ANALYSIS

BHP Billiton Iron Ore regularly undertakes social impact analysis consistent with the Company's corporate standards. The Company considers a range of indicators to inform internal decision making in relation to the communities in which it operates. As BHP Billiton Iron Ore has been operating in the Pilbara for over 50 years, it has developed an understanding of existing and potential impacts as a result of its operations. The most recent social analysis was undertaken in 2013.

Ongoing engagement with these communities provides the Company insight into community concerns, which in turn help it to effectively manage social impacts and opportunities. Furthermore, the extensive investments via BHP Billiton Iron Ore's SIP promote strong and resilient communities and indicate a firm commitment by the Company to corporate social responsibility. Through ongoing social analysis, social investments through our Social Investment Program, and based on feedback received from the ABS census statistics, BHP Billiton aims to integrate both long-term and short-term social considerations into decision-making processes.

Overall the 2013 Social Impact and Opportunity Assessment assessed BHP Billiton as having a net positive impact on the local communities in which it operates through the creation of jobs, economic development and social investment.

There were, however, some issues identified for these local communities through the 2013 analysis which are listed below.

Port Hedland

- Dust, noise and land use in the West End.
- Land and accommodation availability and affordability.
- Capacity and resilience of non-mining sector organisations and small businesses.
- Traffic management and potentially increasing number of train movements.

Newman

- Land and accommodation availability and affordability.
- FIFO workforce – integration with residents and use of the airport.
- Lack of retail and commercial space.

- Capacity of non-mining sector organisations and economic diversification.
- Access to health – development of the hospital.

Wider Pilbara

- Native Title considerations
- Operational impacts on cultural heritage
- Housing and educational attainment, health, income and employment for local Indigenous people.

BHP Billiton manages its social and economic impacts through a number of strategies including:

- Direct management of impacts.
- Investing in social and community programs through the annual Social Investment Program (SIP).
- Engaging and collaborating with key stakeholders in our local communities on a regular basis regarding issues of mutual concern.

The SIP is an integral part of the BHP Billiton Iron Ore's approach to sharing socio-economic benefits and managing social impact. It is also recognised that issues and impacts in communities change overtime. For example, in 2013 when the last Social Impact and Opportunity Assessment was undertaken the cost of land and accommodation in Port Hedland and Newman was still a significant issue. The housing market in these communities has now softened. Recognising this, the Company's strategies need to be continually adapted to reflect these changing conditions.

Over the last five years, our voluntary community investment was more than $200 million which has delivered significant benefits across the SIP's three investment areas – Strong Communities, Indigenous Development and Education Enrichment.

Examples of projects completed as part of focused mitigation or as part of our voluntary community investment include:

- A key participant in the Port Hedland dust health risk assessment.
- The Wallwork Road Bridge was officially opened in May 2014. The new four lane road overpass has reduced the impacts of rail crossings on traffic flow between South Hedland and Port Hedland by eliminating the rail crossing and separating rail traffic from road traffic. BHP Billiton Iron Ore contributed $24 million to the $32 million project.
- Ngala Community Parenting Workshops - early parenting support provider Ngala aims to provide access to support services for families with young children and the wider community in Newman and Port Hedland.
- In partnership with YMCA Perth, BHP Billiton Iron Ore contributed $5 million toward the construction of a 20 unit accommodation development in South Hedland. The new accommodation will consist of two and three bedroom units. The development will provide secure, affordable accommodation for YMCA early learning staff and other not for- profit service workers in Port Hedland. The Mirnutharntu Maya (living to learn) Employment Related Accommodation Facility in South Hedland was completed in June 2014. Mirnutharntu Maya provides affordable accommodation for apprentices and trainees in the Pilbara, with priority given to young Western Australians of Indigenous descent.
- Murdoch Drive Developments South Hedland (Stage One). In October 2013, BHP Billiton WA Iron Ore commenced construction of 84 single storey houses (of 3, 4 and 5 bedroom and 2 bathroom configurations).

- $30 million investment for a new retail facility in the town of Newman, to be developed as part of an innovative community partnership with St Bartholomew's House (St Bart's). The new retail facility will provide residents with a range of retail and dining options which may include a supermarket, discount department store and cafe. Under a unique partnership model, St Bart's will use profits from the retail facility to provide ongoing support to the Newman community as well as create a Community Trust that will provide small grants for local community projects.
- BHP Billiton contributed $1.3 million toward the construction of six short stay accommodation units at the Newman Visitor Centre.
- BHP Billiton WA Iron Ore has proudly invested in a unique three year $3 million Indigenous conservation and land management training program with partners Greening Australia in conjunction with Kanyirninpa Jukurrpa and The Nature Conservancy. The program will assist in providing formal recognition for land management expertise being practised by the Martu and help to build a foundation for further education, training and employment.
- BHP Billiton WA Iron Ore is committed to supporting quality health care for all Western Australians, and since 2004 we have partnered with Royal Flying Doctor Services (RFDS) Western Operations to deliver a range of services to the State. In October 2013, we commenced a new partnership with RFDS supporting the Aeromedical Aircraft Replacement program. We have committed $4.5 million towards the purchase of four new PC12 Pilatus aircrafts.
- BHP Billiton WA Iron Ore's $4.8 million five-year partnership with Mission Australia supports the delivery of its Connected: Classroom to Career Program.
- An investment of $555,000 in the Newman Senior High School Trade Training Centre, which will enable students to complete their Certificate II in Engineering (Metal & Fabrication) develop strong trade based literacy and numeracy skills, a strong work ethic and work readiness.
- BHP Billiton BHP Billiton WA Iron Ore contributed $80,000 to the Newman St John Ambulance service for a 'Kit Servicing Vehicle' containing a portable storeroom to restock first aid kits on site and to sell new complete kits to the community. This investment will also enable increased first aid training in remote indigenous communities, providing essential skills and equipment to help in a medical emergency.
- To assist in the attraction and retention of general practitioners to service Port Hedland's growing community, we have partnered with the Town of Port Hedland and the Royalties for Regions program to construct executive style houses reserved for general practitioners to live in Port Hedland. A total of 10 houses for general practioners have now been completed through a successful $6.5 million project to which the Company contributed $4.25 million.
- In March 2015, BHP Billiton WA Iron Ore announced its $8 million contribution toward the $11 million expansion of the Youth Involvement Council's Lawson Street Youth Centre in South Hedland. The increased service space, facilities and operational efficiency that comes from the new site is estimated to increase engagement across all programs by over 100 young people per month.
- BHP Billiton have contributed a total of $7.5 million since 2011 to support the refurbishment of Hedland Senior High School, which has added vibrancy to the high school, offering students a level of facilities comparable to their metropolitan counterparts
- South Hedland Youth Space, Australia's largest Skate Park opened in South Hedland in February 2015. BHP Billiton WA Iron Ore supported the construction of this recreation facility by contributing $2.3 million of the total $3.8 million project cost.

- BHP Billiton has spent over $75 million to date on the construction of the Murdoch Drive development in South Hedland, with continued work on the establishment of parks and recreation areas for resident use.
- Through our agreements, the Company is seeking to make considerable contributions to Traditional Owners groups with the objective of delivering sustainable multi-generational benefits. BHP Billiton WA Iron Ore has negotiated, and continues to negotiate, agreements with Traditional Owner groups. These agreements are designed to enable the development of natural resources, while delivering sustainable support for the Pilbara Indigenous communities.
- During the financial year 2014 we procured close to $100 million worth of goods and services from Indigenous businesses. This procurement has come from a variety of sectors including cultural awareness training, building and construction, civil and earthworks, ground works, dust suppression, electrical, labour hire and waste management.

Case Study 4: Education through the Graham (Polly) Farmer Foundation

BHP Billiton Iron Ore supports the Graham (Polly) Farmer Foundation's Follow the Dream program in our host communities of Port Hedland and Newman, and locations in the Perth metropolitan area. The support extends to the primary education level Martu Education Centre in Newman, and the Maths and Science Centre of Excellence in South Hedland. These programs combined are currently supporting 242 Aboriginal and Torres Strait Islander students.

In Port Hedland and Newman alone, by the end of 2014, 116 students had graduated from the Follow the Dream program since its inception in 2003. By the end of 2013:

- 30 % of graduates had gone on to university either directly or through completing a bridging course.
- 52 % of graduates went on to TAFE, a traineeship or an apprenticeship.
- 18 % of graduates went into direct employment.

A number of program graduates have also gone on to employment with BHP Billiton Iron Ore, either as apprentices, trainees or into direct employment.

Photo: BHP Billiton Iron Ore
Graham (Polly) Farmer Foundation's Follow the Dream program

The Foundation's programs are now successfully replicated across Australia in 26 communities in Western Australia, South Australia, the Northern Territory and New South Wales. More than 635 Aboriginal and Torres Strait Islander students have graduated from the program and currently there are around 1,000 Aboriginal and Torres Strait Islander students participating in one of the Foundation's 31 programs. Other BHP Billiton assets including Olympic Dam and Mt Arthur Coal support the Foundation's programs in their respective host communities.

8 MANAGEMENT FRAMEWORK

This chapter outlines the management framework within which the Endorsed MNES Program will be delivered, including BHP Billiton's corporate requirements and BHP Billiton Iron Ore's commitments detailed within the Draft MNES Program. While not all of the content of this chapter forms part of the Draft MNES Program, these corporate requirements provide an additional level of assurance about the successful delivery of the Endorsed MNES Program objectives.

8.1 BHP Billiton Corporate Governance

All BHP Billiton activities, including BHP Billiton Iron Ore activities in Western Australia, operate under the Company Charter (Box 9), which outlines the Company's strategy, values and success criteria. Central to BHP Billiton Iron Ore's environmental management approach are the minimum mandatory requirements contained within the BHP Billiton Environment Group Level Document. These requirements align with BHP Billiton's management of risk and enhance the emphasis on the hierarchy of controls to avoid, minimise and offset direct, indirect and cumulative impacts within the Company's area of influence. The Environment Group Level Document requires BHP Billiton Iron Ore to set target environmental outcomes for land, biodiversity, water resources and air and to prevent or minimise greenhouse gas emissions, including in project design. Where unacceptable impacts to important biodiversity and ecosystems remain, the Company is required to consider compensatory actions to address significant residual impacts. The Company also pursues national and international conservation opportunities that will deliver long-term environmental benefits.

BHP Billiton Iron Ore is an industry leader in providing research advancements in the knowledge of Pilbara species distribution and attributes. In early 2013, a steering committee was established to progress the development of the Western Australian Biodiversity Science Institute (WABSI). BHP Billiton is a key funding provider and contributor to this initiative. The institute has committed to promoting significant improvements in current knowledge and management practices for Western Australia's terrestrial biodiversity, focusing on research planning, multi-sector research collaboration; and business and implementation planning.

BHP Billiton Iron Ore further contributes to the scientific community and the Pilbara environment through the support and funding of research projects and other environmental initiatives. Key examples of environmental initiatives undertaken in the 2014 financial year are listed below:

- Pilbara Seed Atlas supports research targeted at increasing knowledge about the ecology of and seed management practices for Pilbara species;
- The Pilbara leaf-nosed bat genetic research into population linkages of this species in the Pilbara; and
- WAMinals, which is a research program that supports invertebrate taxonomic information available to the public through the Western Australian Museum.

Box 9: BHP Billiton Charter

bhpbilliton
resourcing the future

Our Charter

We are BHP Billiton, a leading global resources company.

Our purpose is to create long-term shareholder value through the discovery, acquisition, development and marketing of natural resources.

Our strategy is to own and operate large, long-life, low-cost, expandable, upstream assets diversified by commodity, geography and market.

Our Values

Sustainability
Putting health and safety first, being environmentally responsible and supporting our communities.

Integrity
Doing what is right and doing what we say we will do.

Respect
Embracing openness, trust, teamwork, diversity and relationships that are mutually beneficial.

Performance
Achieving superior business results by stretching our capabilities.

Simplicity
Focusing our efforts on the things that matter most.

Accountability
Defining and accepting responsibility and delivering on our commitments.

We are successful when:

Our people start each day with a sense of purpose and end the day with a sense of accomplishment.
Our communities, customers and suppliers value their relationships with us.
Our asset portfolio is world-class and sustainably developed.
Our operational discipline and financial strength enables our future growth.
Our shareholders receive a superior return on their investment.

Andrew Mackenzie
Chief Executive Officer

The following sections outline key elements of the management approach key to the implementation of the Proposal. These sections are supported by case studies to demonstrate the existing application of these elements and how they are driving environmental outcomes within BHP Billiton Iron Ore operations.

8.2 Management of Aboriginal Heritage

BHP Billiton Iron Ore is well placed to understand and manage the potential impacts to heritage values, having conducted large scale archaeological and ethnographic surveys to identify places of cultural significance. These surveys are undertaken with the Native Title Groups of the area and are embedded in the Company's heritage management throughout project planning and implementation.

BHP Billiton Iron Ore is committed to meeting the requirements of the WA *Aboriginal Heritage Act 1972* and the EPBC Act to respect Aboriginal heritage and will continue to consult with Traditional Owners and other stakeholders regarding any proposed activities that have the potential to impact heritage values. Consultation with Native Title Groups is described in Section 8.2.

BHP Billiton Iron Ore conducts its operations in accordance with a standard set of heritage principles. These principles are based on international conventions, regulatory processes, community expectations and industry standards. BHP Billiton Iron Ore:

- conducts its operations in accordance with all state and Commonwealth heritage legislation;
- recognises that Aboriginal people have an intrinsic link to land, culture and heritage;
- works cooperatively with Aboriginal communities to jointly identify, record and manage heritage sites;
- conducts archaeological and ethnographic surveys to identify and record significant heritage sites prior to undertaking land disturbance activities;
- keeps an active register of all significant heritage sites situated on its tenure;
- integrates its heritage management processes into standard business planning and project cycles and Native Title agreements where applicable;
- has an internal land management procedure to ensure compliance with legal and community commitments;
- is committed to minimising impacts to significant heritage sites through consultation and planning;
- manages cultural objects in accordance with protocols outlined in a cultural materials management plan; and
- actively promotes Aboriginal culture through community-based heritage projects and academic research.

In order to manage and protect Aboriginal heritage in compliance with the WA Aboriginal Heritage Act, the EPBC Act and the above principles, BHP Billiton Iron Ore utilises strict internal processes and procedures implemented by dedicated Heritage and geographic information systems (GIS) teams. Within surveyed areas, BHP Billiton Iron Ore documents the spatial location of each heritage place and, where practical, adopts engineering solutions to avoid them. If any heritage site cannot practically be avoided, the Company seeks to consult with the relevant Native Title Group and apply for approval from the Minister for Aboriginal Affairs under Section 18 of the Aboriginal Heritage Act before the site is disturbed.

BHP Billiton Iron Ore also has in place an internal procedure to internally manage conditions associated with all ground disturbing activities and ensures compliance to environmental, Aboriginal heritage, land tenure, legal

commitments and regulatory requirements. The procedure provides a mechanism for the heritage specialists within the Heritage and GIS team to provide technical and professional advice regarding cultural heritage management of sites including protection requirements to ensure compliance with the Aboriginal Heritage Act and the relevant Native Title Agreements.

BHP Billiton Iron Ore has entered into a claim-wide agreement with the Nyiyaparli Native Title group and the Banjima Native Title group; these agreements provide certainty about future tenure requirements beyond the existing lease and mining operations in the areas. As part of these agreements, BHP Billiton Iron Ore and the Native Title groups have agreed to specific cultural heritage commitments in relation to the management of heritage sites, including the recognition, mapping and capture of places of ethnographic importance (referred to as 'confidential areas'). BHP Billiton Iron Ore will not seek to impact these confidential areas under future actions or classes of actions in line with its obligations under the agreement while the agreement is in force.

BHP Billiton Iron Ore is currently working towards similar agreements with the Kariyarra and Yinhawangka Native Title groups, which will also include confidential areas. Additional discussions relating to the compilation of project agreements are currently being negotiated with numerous registered Native Title groups through the Pilbara.

BHP Billiton Iron Ore's heritage management protocols described above and ongoing consultation with Native Title Groups will ensure that potential impacts to heritage sites associated with the Proposal will continue to be managed to an acceptable level well into the future.

8.3 Ecologically Sustainable Development

The Commonwealth Government suggests the following definition of ecologically sustainable development (Ecologically Sustainable Development Steering Committee 1992):

> *using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.*

This essentially means that Australia should be striving to meet contemporary development needs while conserving its ecosystems for the benefit for future generations. Due to the long-term nature of the Proposal, success in achieving ecologically sustainable development requires BHP Billiton Iron Ore to consider how environmental resources are managed in a way that maintains (or even improves) their range, variety and quality while exploiting target resources to develop industry and generate employment. This section of the Draft IAR demonstrates how the following principles of ecologically sustainable development have been applied in the Draft MNES Program:

- Integration Principle: Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
- Precautionary Principle: If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- Principle of Intergenerational Equity: The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for future generations;
- Biodiversity Principle: Conservation of biological diversity and ecological integrity should be a fundamental consideration in planning; and
- Valuation Principle: Improved valuation, pricing and incentive mechanisms should be promoted.

8.3.1 INTEGRATION PRINCIPLE

The integration principle requires that impact assessment and decision-making processes should effectively integrate both long-term and short-term economic, environmental and social considerations that are equitable. The Draft MNES Program meets this principle by outlining processes that apply to the Proposal in the short and long term. BHP Billiton Iron Ore's commitment in the Draft MNES Program to continue to undertake stakeholder engagement during implementation of the Proposal will ensure that economic and social considerations are transparent and equitable. The Assurance Plan will define MNES Management Outcomes and mitigation measures to support these, which will ensure that environmental considerations are taken into account in decision-making processes in the short and long term.

8.3.2 PRECAUTIONARY PRINCIPLE

The EPBC Act requires the Minister to consider the precautionary principle, which states that a lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage.

This Draft IAR has been prepared using the best available information across the Strategic Assessment Area, however during implementation of the Proposal, knowledge of the Pilbara environment and the key species assessed is likely to develop further.

The Validation Framework described in Section 8.6.1 is designed to ensure that future changes to contemporary guidance and information (such as changes in threats to MNES over time) are considered as BHP Billiton Iron Ore prepares to implement a project (i.e. take a Material Action). This Validation Framework is used to inform the application of the mitigation hierarchy (avoid, mitigate and offset) to ensure that MNES Objectives are met. The mitigation hierarchy has been and will continue to be implemented to ensure, as far as practicable, that impacts are first avoided, then mitigated and finally offset if significant residual impacts are unavoidable.

8.3.3 PRINCIPLE OF INTERGENERATIONAL EQUITY

The principle of intergenerational equity states that the present generation should ensure that the health, diversity, and productivity of the environment is maintained or enhanced for the benefit of future generations. The Draft MNES Program provides for intergenerational equity through the development and implementation of the Assurance Plan, which will contain MNES Management Outcomes that contribute to the MNES Objectives identified in the Draft MNES Program. BHP Billiton Iron Ore's commitment in the Draft MNES Program to continue to undertake stakeholder engagement during implementation of the Proposal will ensure that future generations will be considered in decision-making as part of adaptive management.

8.3.4 BIODIVERSITY PRINCIPLE

The biodiversity principle requires that the conservation of biological diversity and ecological integrity be a fundamental consideration in impact assessment and decision-making. The Draft MNES Program provides a description of activities that may occur in implementing the Proposal. This Draft IAR has been prepared using the best available information to understand potential future impacts to Specified Protected Matters (Section 5.3) and identifies current MNES potentially impacted by the Proposal. Broad-scale investigations have provided background information on the biological and physical environment to support the assessment of risks to MNES and the identification of appropriate management measures (defined within the Assurance Plan). Chapter 5 presents the full range of potential threats to Specified Protected Matters.

BHP Billiton Iron Ore will use the Validation Framework for decision-making, thereby ensuring that conservation of biodiversity and ecological integrity are considered during implementation of the Proposal.

8.3.5 VALUATION PRINCIPLE

The valuation principle requires that improved valuation, pricing and incentive mechanisms should be promoted. BHP Billiton Iron Ore has considered the quantum of impact to MNES and the full costs and benefits of implementing the Proposal. The Draft MNES Program outlines the validation process that occurs at the time that BHP Billiton Iron Ore prepares to undertake a Material Action. This validation process uses site-specific information, such as updated baseline data and detailed mine planning information, to refine the quantum of impact. This site specific information informs decision-making regarding application of the mitigation hierarchy (avoid, mitigate, offset) to meet the MNES Management Outcomes defined in the Assurance Plan.

8.4 Adaptive Management

BHP Billiton Iron Ore acknowledges that, due to the geographical and temporal scale of the Proposal, managing potential change is important to ensure that impacts to MNES are managed to an acceptable level. BHP Billiton Iron Ore will apply an adaptive management approach (outlined in Figure 39) to manage this future change as set out in the Draft MNES Program, discussed further in Section 8.6. This approach allows for changes to MNES and changes in management standards or approach to be incorporated into MNES management. Future changes may include:

- Listing events under the EPBC Act;
- Changes to such guidance as threat abatement plans, conservation advice, recovery plans, or equivalent guidance material; and
- Changes in the environment, including climate change and ecological threats (e.g. cane toads).

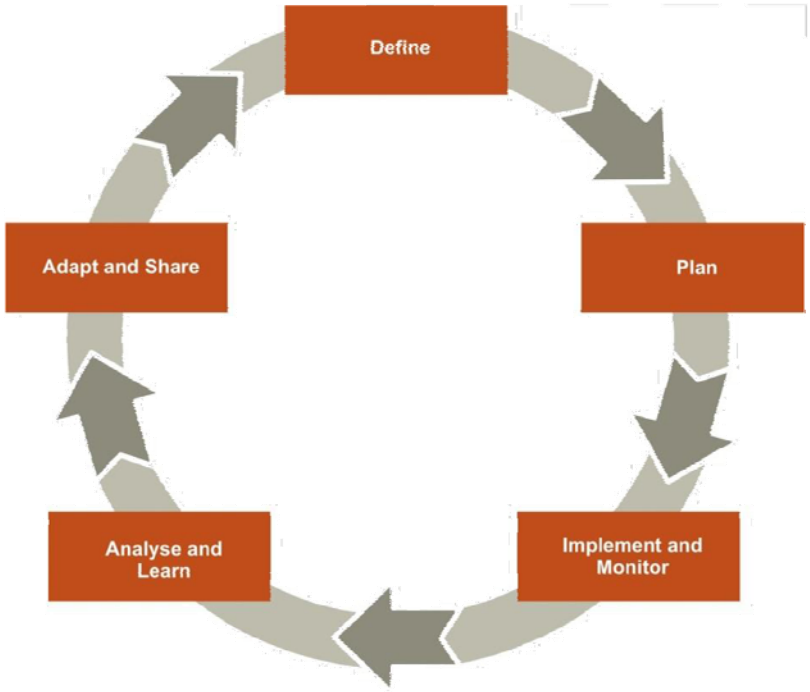


Figure 39: BHP Billiton Iron Ore's adaptive management approach

BHP Billiton Iron Ore's adaptive management approach consists of the following key steps:

1. Define: Impacts to Specified Protected Matters from Material Actions will be validated through the Validation Framework described in the MNES Program and in Section 8.6.2. This will include:
    a. a review of whether the Material Action is within the scope of the MNES Program;
    b. the relevant Specified Protected Matters for the Material Action;
    c. a review of contemporary guidance and information, including environmental change;
    d. evaluation of impact assessment data to ensure that it is fit-for purpose to determine impacts; and
    e. application of the mitigation hierarchy to ensure that impacts will be managed to an acceptable level.
2. Plan: All Material Actions will be informed by Step 1 (Define) and the application of the mitigation hierarchy described in Section 8.5. Planning may include the modification of the scope of the action (such as mine design or scheduling) to avoid or manage impacts to the Specified Protected Matters;
3. Implement and Monitor: MNES Management Outcomes with appropriate performance criteria (targets, thresholds and triggers) will be defined in the Implementation Plans (Assurance Plan and Offsets Plan) described in Section 8.6.1. During implementation of the Material Action these performance criteria will be monitored to track performance against the MNES Management Outcomes;
4. Analyse and Learn: Monitoring results will be analysed to understand effectiveness of mitigation measures to meet the MNES Management Outcomes. Additionally, audits will be conducted as outlined in Section 8.6.3 to determine compliance with the Endorsed MNES Program. BHP Billiton Iron Ore's performance will also undertake performance audits as part of a 5 yearly review of the Assurance plan, to ensure that MNES Management Outcomes are meeting the MNES Program Objective, described further in Section 8.6.1. BHP Billiton Iron Ore has also committed within the MNES Program to undertaking stakeholder engagement and providing key documents for public review throughout implementation of the Proposal, which will inform key learnings; and
5. Adapt and Share: The MNES Program contains a commitment to update the Assurance Plan every 5 years to address the key learnings described in Step 4. The Assurance Plan is a key document that will be made publicly available for comment. In addition, BHP Billiton Iron Ore may adapt management measures during the implementation of a Material Action to ensure that MNES Management Outcomes continue to be met. Key learnings will be implemented across other Material actions where applicable and published where appropriate.

Case studies 4 and 5 are provided below to demonstrate adaptive management for existing BHP Billiton Iron Ore operations.

Case Study 5: Active management of a key water asset within the Strategic Assessment Area

This case study presents an example of the implementation of BHP Billiton Iron Ore's Regional Water Management Strategy at Ethel Gorge for the purpose of applying an adaptive management approach when assessing and managing potential impacts on ecological receptors caused by mining-related changes to the groundwater and surface water regime.

Ethel Gorge is located on the Fortescue River about 15 km northeast of Newman and downstream of the confluence of several creeks. The Ophthalmia aquifer hosts the Ethel Gorge stygobiont community, which is considered to be a threatened ecological community (TEC) within Western Australia (but not under the EPBC

Act). The TEC contains an abundant and diverse stygofauna community. The Ethel Gorge area also supports riparian woodland vegetation communities, which may be groundwater-dependent.

BHP Billiton Iron Ore has a mining lease over Ethel Gorge and owns and operates the Ophthalmia Borefield, which is an important water supply for the Newman town site and surrounding mining operations. BHP Billiton Iron Ore also owns the Ophthalmia Dam, a purposely designed managed aquifer recharge structure, located about 3 km upstream of Ethel Gorge.

Adaptive water resource management for Ethel Gorge has involved the following steps:

1. Define Ethel Gorge values: these are commercial, social and environmental;
2. Describe the hydrological conditions: develop a conceptual flow model and establish baseline, historical stresses and variance;
3. Predict hydrological change, with and without controls;
4. Apply adaptive management to evaluate management options and practicable and feasible alternatives and to set thresholds;
5. Implement management and monitor response based on monitoring zones; and
6. Review and adapt: adjust water management controls.

Change Assessment: Operational

Numerical modelling suggests that groundwater levels can be sustained throughout the Ophthalmia aquifer, which implies no significant potential impacts on either the stygofauna community or riparian vegetation associated with groundwater drawdown resulting from the Proposal. The modelling demonstrates that drawdown in the Ophthalmia aquifer would be offset by leakage from the Ophthalmia Dam and infiltration along the recharge ponds. The numerical model also suggests that rising groundwater levels, caused by increased infiltration from the discharge of surplus water to Ophthalmia Dam and associated infiltration infrastructure will remain within the historical range.

The water and salt balance modelling shows that, for the majority of the Ophthalmia aquifer and the majority of climatic and operating conditions, salinity concentrations will remain within the historical ranges recorded between 1977 and 2014. However, salinity concentrations could increase to about 30% above historical maximum ranges under lower-than-normal rainfall conditions (RPS 2014a).

The operating strategy of the dam is predicted to exert a strong influence on groundwater salinity concentrations. In particular, salinity concentrations could be 70% above historical maximum ranges if water is released from the dam during non-flooding periods. Available scientific knowledge suggests that many stygofauna species can tolerate a variable salinity regime (Halse et al. 2014). However, less resilient species may be vulnerable to salinity increases beyond the range of natural variability. Riparian vegetation communities are considered unlikely to be significantly affected by increases in groundwater salinity concentrations, as the vegetation principally relies on soil moisture in the vadose zone. Progressive technical studies are required to address these uncertainties within the framework of BHP Billiton Iron Ore's adaptive management approach. A precautionary approach that considers historical ranges rather than species' tolerance and adaptability has been adopted for this case study.

The increase in groundwater salinity is likely to be within the tolerance thresholds of the stygofauna community. There is also no significant risk of potential impacts on riparian vegetation communities associated with groundwater salinity increases associated with the implementation of the Proposal mine schedule. This outcome is, however, dependent on the adoption of an appropriate operating strategy for the Ophthalmia Dam.

The findings are sensitive to the hydraulic connection uncertainties and surplus dewatering discharge rate, which require validation.

Change Assessment: Closure

The modelling suggests that groundwater levels in the Ophthalmia aquifer will recover within a matter of years (rather than decades) after cessation of groundwater abstraction, which implies no significant potential impacts on the Ethel Gorge stygofauna community and riparian vegetation. The apparent hydraulic disconnection between the mine pits and the Ethel Gorge groundwater system suggests that the closure strategy of the open pits will have no significant effect on groundwater levels in the Ophthalmia aquifer. However, the degree of hydraulic disconnection will need to be validated.

Monitoring, Review and Corrective Action

BHP Billiton Iron Ore operates a groundwater and surface water monitoring program in the Ethel Gorge project area and also monitors the health of the Ethel Gorge stygofauna community and riparian vegetation. Water monitoring observations are included in BHP Billiton Iron Ore's annual aquifer reviews, and data on stygofauna and riparian vegetation monitoring are included in its annual environmental reviews.

Both preventive and corrective controls are currently in place to manage water levels and salinity concentrations. The preventive measures entail returning excess dewatering water back to the aquifer by means of discharge to the Ophthalmia Dam and recharge ponds. Where implemented, the effectiveness of mitigation measures will be evaluated and optimised using predictive modelling. This approach will ensure that residual risks to ecological receptors are minimised throughout the implementation of the Proposal.

BHP Billiton Iron Ore's history of managing the aquifer and dam to date demonstrates implementation of an adaptive management approach that effectively manages potential impacts on ecological receptors caused by mining-related changes to the groundwater and surface water regime.

Case Study 6: How increased knowledge and an adaptive approach has improved management of the northern quoll

The northern quoll has been recorded at BHP Billiton Iron Ore's Goldsworthy mine site, and along BHP Billiton Iron Ore's railway lines. There are also occasional records from tenements within the vicinity of the Mining Area C and Yandi mines. Numerous studies have either been commissioned or supported by BHP Billiton Iron Ore that contribute to regional knowledge of the species. These include various targeted northern quoll surveys, and behavioural, genetic and monitoring studies that have resulted in improvements to BHP Billiton Iron Ore's management of impacts to the northern quoll (Biologic 2010; Ecologia 2010; Spencer et al. 2013, BHP Billiton Iron Ore, 2011). Three of these are described in more detail below.

A general fauna survey and targeted northern quoll habitat survey were undertaken in preparation for rail expansion at Mooka Siding, in which evidence of several resident northern quoll populations was found (Biologic 2010; Ecologia 2010). As a result of the results of the surveys, prior to clearing within 50 metres of identified northern quoll denning sites, BHP Billiton Iron Ore committed to relocating any individuals found to in nearby habitat deemed suitable by the Department of Environment and Conservation (now DPaW). Radio collars were also fitted to the relocated individuals, and record was made of the relocation site and date in accordance with an approved clearing permit from the Department of Mines and Petroleum.

A Northern Quoll Ecology and Demography Study was commissioned to document the ecology and demography of the species in the Pilbara (BHP Billiton Iron Ore 2011). This was important because the majority of studies undertaken at that time were based in the Kimberley, Northern Territory or Eastern states. The study

examined whether there were differences in ecology or demography between northern quoll populations occurring in disturbed sites versus undisturbed sites. The study was undertaken by the Department of Environment and Conservation at Goldsworthy and along the mainline rail. Targeted outcomes for the study were as follows:

- To determine if disturbance relating to mine and infrastructure in the Pilbara has a detrimental impact on northern quolls;
- To obtain a better understanding of northern quoll populations within the Pilbara, which is designed to assist in mitigation of impacts to and management of the species;
- To provide information to the Department of Environment and Conservation and other mining companies to assist with management of the species in the Pilbara; and
- To provide information that will assist BHP Billiton Iron Ore with rehabilitation and closure (BHP Billiton Iron Ore 2011).

Linear infrastructure, such as railway lines, may adversely impact fauna populations through fragmentation of habitat. A rail culvert study (Creese 2012) funded by BHP Billiton Iron Ore used remote cameras to examine whether railway lines create a barrier to fauna movement in the Pilbara, and whether fauna utilise/ or move through culverts in the Pilbara. Through this study, the potential of culverts to ameliorate the impacts of habitat fragmentation has been explored. It was found that rail culverts do facilitate the movement of fauna under the railway; during the study, a total of 45 species were recorded from by motion sensor cameras, sand pads and track pads located within culverts (Creese 2012). These included 13 reptile, 19 bird species and 13 mammals of which 11 were native. The most frequently recorded species were mammals and included 59 records of the northern quoll (Creese 2012). Culverts that are placed to facilitate the general movement of fauna in the Pilbara could be placed at various locations, within different fauna habitat types.

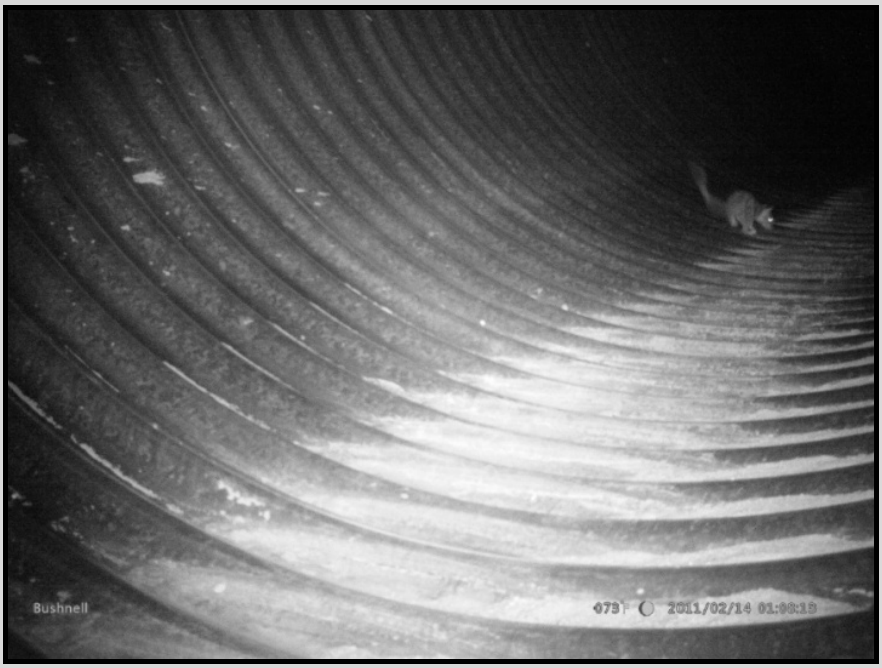


Photo: Sonja Creese

Northern quoll in a rail culvert

Increased knowledge gained from research such as this provides an opportunity at the planning and design stage to place rail culverts in habitats that are associated with conservation significant species. Rail culverts have the potential to facilitate the natural movements of species, especially MNES like the northern quoll, across the landscape and minimise the likelihood of mortality due to vehicle collision (Creese 2012).

Studies such as those described above contribute to a broader understanding and increased knowledge of the northern quoll's ecology and distribution in the Pilbara and are examples of how, through the use of both general and targeted fauna surveys, BHP Billiton Iron Ore can design management controls to avoid (or minimise) impacts and effectively manage MNES more generally.

8.5 Mitigation Hierarchy

The Draft MNES Program outlines a process to apply the mitigation hierarchy for environmental management, which is to avoid, mitigate and, as a last resort, offset significant residual impacts to MNES. The mitigation hierarchy is embedded in BHP Billiton Iron Ore's Validation Framework, which considers the potential impacts of Material Actions to the Specified Protected Matters. Where reasonably practicable, BHP Billiton Iron Ore will employ its best endeavours to avoid impacts to Specified Protected Matters. Where impacts to Specified Protected Matters cannot be completely avoided, impacts will be mitigated as far as reasonably practicable. If all significant impacts cannot be avoided or mitigated to an acceptable level (i.e. significant residual impact is likely to occur), offsets will be applied.

The MNES Program contains a commitment to develop Implementation Plans (Assurance Plan and Offsets Plan) prior to taking an action under the Endorsed MNES Program. The Assurance Plan (described in Section 8.6.1) will include MNES Management Outcomes for each Specified Protected Matter. If impacts from Material Actions taken under Program cannot be entirely avoided and mitigated then offsets will be applied as defined in the Offsets Plan (described further in Section 8.6.1). The Validation Framework (described in Section 8.6.2) embeds the mitigation hierarchy in planning and decision-making by ensuring that avoidance, mitigation and offset measures are considered prior to taking a Material Action.

BHP Billiton Iron Ore routinely applies the mitigation hierarchy across its existing mining operations as detailed in Case Study 6 and Case Study 8.

Case Study 7: Implementation of the Mitigation Hierarchy – Orebody 31

This case study demonstrates implementation of management options from planning to the project approvals phase to avoid, mitigate and offset potential impacts. BHP Billiton Iron Ore proposes to develop and operate a new iron ore deposit at Orebody 31, located approximately 40 km east of Newman. BHP Billiton Iron Ore has operated in the vicinity of the Newman area for over 50 years. Numerous studies have been carried out to support a number of projects and future operations in the Pilbara region, including studies in the vicinity of Orebody 31. BHP Billiton Iron Ore used its knowledge of the environment, together with an understanding of the environmental impact assessment process in the Pilbara region, to undertake an internal risk assessment.

BHP Billiton Iron Ore implemented the following tasks through the development and approvals phase of Orebody 31; this has led to a reduction in inherent impacts to the environment. A summary of the studies, impact assessment, mitigation controls and significant residual impacts to flora and vegetation is provided below.

Among other studies, BHP Billiton Iron Ore commissioned flora and vegetation surveys (Onshore Environmental 2015) that identified:

- Mulga (*Acacia aptaneura*) present as an upper-storey vegetation component: may have local conservation significance due to its sensitivity to disturbance to sheet flow;
- The south-eastern sector of the disturbance footprint is capable of supporting groundwater-dependent vegetation and contains species within a drainage line, *Eucalyptus victrix*, that could be at risk from groundwater drawdown; and
- Four conservation significant taxa have been recorded: *Acacia* sp. East Fortescue (J. Bull and D. Roberts ONS A 27.01) (Priority 1), *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (Priority 3), *Goodenia nuda* (Priority 4) and *Acacia clelandii* (range extension).

Under the original design concept, inherent impacts on flora and vegetation were identified for Orebody 31. BHP Billiton Iron Ore implemented a number of design changes and management controls to reduce the severity of impacts. These controls were consistent with the mitigation hierarchy and included measures to avoid and mitigate potential impacts before considering offsets. A selection of the mitigation measures that were applied include:

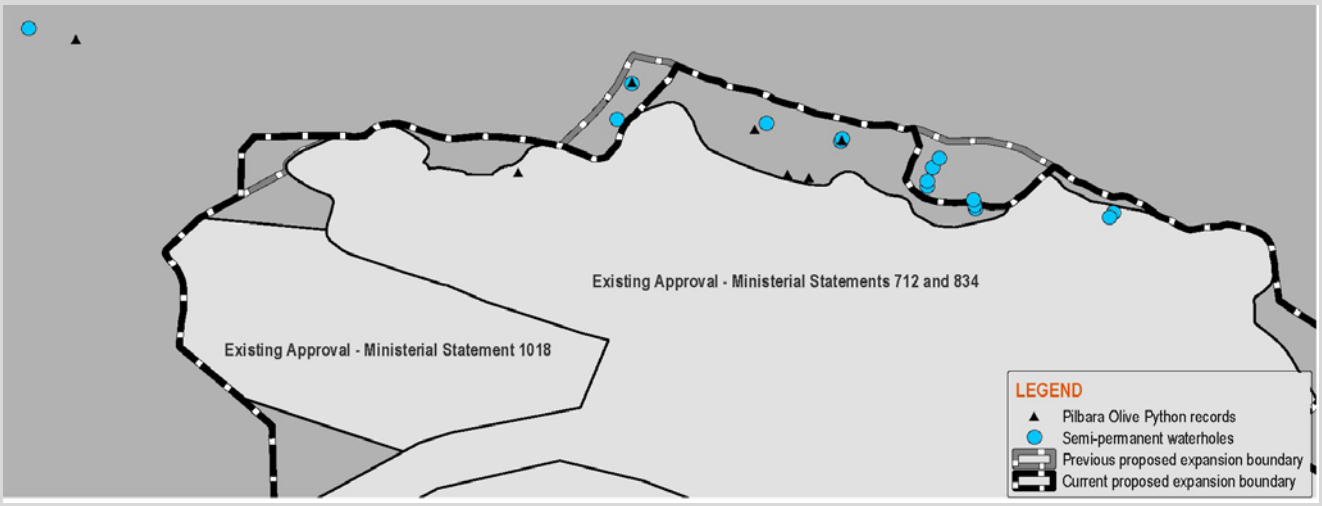
- Use of existing infrastructure and facilities at the adjacent Orebody 18 Mine Hub to reduce Orebody 31's disturbance area by 25% compared with on the original concept design;
- Modification of Orebody 31's footprint to avoid the majority of identified habitat containing *Acacia* sp. East Fortescue by modifying the OSA design;
- Modification of the disturbance area boundary to avoid the majority of identified habitat containing *Triodi*a sp. Mt Ella (M.E. Trudgen 12739);
- Modification of the development envelope boundary to avoid the majority of vegetation that has been rated as 'excellent' condition; and
- A commitment to monitor the health of conservation significant flora or vegetation adjacent to dust sources, including OSAs.

The overall outcome demonstrates how BHP Billiton Iron Ore's existing management processes can be applied to reduce impacts on environmental aspects to meet regulatory objectives. Through design changes and a number of footprint minimisation initiatives, the implementation of Orebody 31 has reduced the initial extent of clearing by 25%, reduced impacts to *Acacia* sp. East Fortescue to 13.48% of known recordings and clearing of *Triodia* sp. Mt Ella from 50 plants to 7.

Case Study 8: Implementation of the Mitigation Hierarchy – Pilbara olive pythons at Eastern Ridge

BHP Billiton Iron Ore's Eastern Ridge operation is within the Newman mining hub. The operation is currently undergoing an approvals amendment process for expansion of the mine. During a survey to support a currently proposed expansion, a number of semi-permanent waterbodies were identified (see figure below) that provide habitat for Pilbara olive pythons, and this species was recorded from the area over multiple years, including from a number of these waterbodies. Removal of all of these waterbodies was considered to have an unacceptable impact to the local population of Pilbara olive pythons, and so the proposed development footprint was revised to avoid removal of some of these habitats (BHP Billiton Iron Ore 2015).

BHP Billiton Iron Ore has also put in place mitigation measures to ensure that these habitats are not impacted during operations through indirect impacts such as surface water change.



Avoidance of semi-permanent waterholes at Eastern Ridge

8.6 MNES Program

The MNES Program is a document that accompanies this Draft IAR and sets out BHP Billiton Iron Ore's commitments to implement the Proposal in a manner that meets the requirements of the EPBC Act. Once endorsed by the Minister, the MNES Program will apply to any action taken as part of the Proposal over its 120-year timeframe. Flexibility and transparency has been built into the Program through:

- Commitment to develop of Implementation Plans (the Assurance Plan and the Offsets Plan), that will be required for the Ministers approval of an action or class of actions;
- The Validation Framework, which is required to be undertaken by BHP Billiton Iron Ore prior to taking any action associated with the Proposal; and
- Processes for auditing, reporting and corrective action if required. The MNES Program includes a commitment to update the Implementation Plans every five years.

These elements of the MNES Program are discussed further in sections 8.6.1 to 8.6.3 below.

The MNES Program will have effect for 120 years from the date of the Approval. The Validation Framework will only have initial effect for 30 years from the date of the Approval. The Validation Framework may operate for two subsequent 30 year periods, subject to considerations in relation to new listings events as detailed in the MNES Program.

8.6.1 IMPLEMENTATION PLANS

ASSURANCE PLAN

BHP Billiton Iron Ore has committed to developing an Assurance Plan prior to taking an action associated with the Proposal. The Assurance Plan may be considered as part of the Minister's decision to approve an action or class of actions. The purpose of the Assurance Plan is to define the MNES management hierarchy, monitoring, reporting and auditing requirements, and governance processes that will be implemented to ensure that all actions are undertaken in accordance with the MNES Program. The Assurance Plan will be reviewed every 5 years and submitted to the DotE for approval.

The Assurance Plan will contain:

- A process to identify Material Actions, including criteria and/or examples. A Material Action is an action that may have material impacts on the Specified Protected Matters;
- MNES Management Outcomes, which are measurable, specific and relevant to the Specified Protected Matters potentially impacted by Material Action. The MNES Management Outcomes will be developed using relevant sources of baseline data or other information, including recovery plans, threat abatements plans and approved conservation advices;
- Performance indicators, including triggers, thresholds and/or targets that will be used to track compliance and performance against each MNES Management Outcome. These performance indicators will be measurable, auditable and appropriate for each Specified Protected Matter;
- Adaptive management and corrective action to manage events in which monitoring indicates that MNES Management Outcomes are not likely to be met, or where it is anticipated that MNES Management Outcomes are not considered likely to continue to support the MNES Program Objective (see Box 10);
- A process for data management and sharing of data;
- Details of compliance audit and reporting aligned with Section 8.6.3;
- Performance audit, adaptive management and corrective action process to demonstrate that the MNES Management Outcomes are being met;
- Details of regular and ongoing stakeholder engagement, including a process for maintaining records of stakeholder engagement outcomes and how these will be addressed where relevant to the management of the Specified Protected Matters;
- Key communication points with the DotE, including the Notice of Intent to Proceed, and notification of commencement and completion of the Material Action; and
- Governance arrangements to deliver the above.

The Assurance Plan will be supported by BHP Billiton Iron Ore regional plans, site specific plans and standard operating procedures where necessary to meet the MNES Management Outcomes. The Offsets Plan, described below, supports the Assurance Plan by delivering offsets for significant residual impacts where required to meet the MNES Management Outcomes.

Box 10: MNES Program Objective and MNES Management Outcomes

The Commonwealth Government has identified environmental objectives for all MNES in the Department's Standards for Accreditation of Environmental Approvals under the EPBC Act (2014). BHP Billiton Iron Ore proposes to support those objectives through implementation of the MNES Program. Specifically, BHP Billiton Iron Ore's MNES Program objective is to implement the Proposal in a manner that aligns with the Commonwealth objectives for MNES, which are provided in the table below.

MNES Management Outcomes will be defined for each Specified Protected Matter within the Assurance Plan, and will align with the Commonwealth objectives. These MNES Management Outcomes will be specific environmental outcomes for the Strategic Assessment Area and will reflect BHP Billiton Iron Ore's influence and focus on the drivers within its control.

MNES that are Applicable Controlling Provisions	Commonwealth Objective
Listed threatened species and ecological communities	The survival and conservation status of listed species and ecological communities is promoted and enhanced, including through the conservation of habitat critical to the survival of a species or community and other measures contained in any recovery plans, threat abatement plans or conservation advices.
Listed migratory species	The survival and conservation status of migratory species and their critical habitat is promoted and enhanced, consistent with Australia's international obligations.

OFFSETS PLAN

Background

The Proposal provides a unique opportunity for BHP Billiton Iron Ore to deliver offsets that have strategic benefits (over a larger area and a longer timeframe), are coordinated and are developed to address regional- or landscape-scale residual impacts and threatening processes. This is particularly relevant for offsets in the Pilbara, where underlying tenure can mean that traditional land acquisitions are generally not a viable offset alternative (EPA 2014):

> *For the extensive land use zone of the State where land is almost exclusively Crown land overlain by pastoral leases and mining provinces, a different approach is needed as there is almost no opportunity for land acquisition to occur.*

Contemporary environmental offset guidance in Australia focuses primarily on individual project offsets and offers little incentive for alignment with other offsets proposed or being implemented within a region. Some recent examples in Australia have tried to be more proactive in coordinating regional outcomes, such as the Galilee Basin Offset Strategy (Department of Environment and Heritage Protection 2013) and the Western Australian Environmental Offsets Guidelines (EPA 2014), which respectively seek:

> *to support the strategic location of offsets in areas where the range of values to be lost from potential development occur. These 'offset investment hubs' will be used to manage and protect those values to ensure long-term environmental outcomes at the wider landscape scale.*

> *[to use] a strategic approach, such as a fund, [as] a solution to overcome land use tenure issues by providing a coordination mechanism to implement offsets across a range of land tenures. This type of approach may be suitable to apply in the extensive land use zone*

The challenges for delivery of offsets in the Pilbara are recognised in both the contemporary offset guidance from the DotE and the EPA. Both also recognise that different offset solutions may be appropriate to strategic assessments; for example (DSEWPaC 2012b):

> *Proposed new strategic assessments may consider alternative metrics other than the Offset assessment guide (e.g. if a jurisdiction has developed a metric tailored to their needs) provided the principles of this policy are met*.

Based on the implementation of the Full Conceptual Development Scenario, BHP Billiton Iron Ore expects to have a maximum additional direct disturbance impact of approximately 110,000 ha. This potential impact will be reduced through the application of the mitigation hierarchy, including rehabilitation.

Regional Offset Considerations

The EPA has proposed the establishment of a strategic conservation initiative for the Pilbara as a mechanism to pool offset funds to achieve broad-scale biodiversity conservation outcomes (EPA 2014). The initiative would align with Western Australia's Environmental Offsets Policy to focus offsets on longer-term strategic outcomes. The initiative is currently being referred to as the Pilbara Strategic Conservation Initiative (the Initiative), and the EPA has recently commenced a series of stakeholder workshops to assist in the development of the Initiative's objectives, approach, governance and offset metrics.

A series of Pilbara threatened species workshops conducted at DPaW (during 2013 and 2014) and a subsequent study undertaken by CSIRO (Carwardine et al. 2014) confirmed the key threatening processes to species, including MNES, and to the overall ecology of the Pilbara. CSIRO found that the top three most cost-effective strategies to manage key threatening processes to species for the Pilbara are (Carwardine et al. 2014):

1. Management of feral ungulates;
2. Provision of sanctuaries; and
3. Cat management.

There has been considerable success in the development and implementation of conservation and offset initiatives to address these threats in the Pilbara, including on-ground programs undertaken by Rangelands NRM (Pilbara Corridors Project) and Greening Australia (Aboriginal Landcare Education Program). These programs have included feral animal control, weed control, and land use management and have been undertaken in conjunction with land managers in the Pilbara, including pastoralists and Aboriginal groups.

Offset Approach

The Draft MNES Program includes a commitment by BHP Billiton Iron Ore to develop and implement an Offsets Plan for the Proposal. The Offsets Plan will be prepared in line with guiding principles outlined in the MNES Program. The Offsets Plan will contain:

- Specific MNES Management Outcomes to be achieved. These will either be the same as or complement those detailed in the Assurance Plan;
- An estimate of the potential residual impact (after avoidance and mitigation is applied) if the full extent of the Proposal is implemented (i.e., the maximum quantum of the offset);
- A method to convert the above potential residual impact to an adequate and measureable offset for the relevant MNES;
- A process to apply and track offsets over time including identification and prioritisation of offsets;
- Monitoring, reporting, adaptive management process for changing offsets identification and priorities and evaluation mechanisms;
- Timeframes and responsibilities for implementation;
- Funding schedule and financial arrangements; and
- Governance arrangements to deliver the above.

BHP Billiton Iron Ore will implement offsets for any Material Action for which potential significant impacts cannot be completely avoided or mitigated to meet the MNES Management Outcomes for Specified Protected Matters, defined in the Assurance Plan. As described in Section 8.6.2, the requirement for offsets will be determined using a Validation Framework and provided in Notice of Intent to Proceed to the DotE.

The Offset Plan will focus on the delivery of individual or regional offsets in line with the incremental implementation of new actions or class of actions.

Measures to offset potential impacts to Specified Protected Matters may include both direct and indirect offsets such as on-ground management of non-mining threats (e.g. feral animal control), research into ecology or threats relating to MNES, or creation or enhancement of habitat. These measures will align with threat abatement plans, recovery plans, conservation advices and other relevant policy statements to ensure that a coordinated approach is taken. Further detail on measures to offsets potential impacts to the Specified Protected Matters will be provided in the Offsets Plan.

BHP Billiton Iron Ore considers the Initiative as a key potential option through which it could meet its environmental offset obligations for the Proposal. However, the Initiative has yet to be endorsed by the Western Australian Government or industry and the mechanics and governance of the Initiative are still in development. BHP Billiton Iron Ore will reserve commitment to the Initiative until such time as these governance arrangements are in place. In lieu of the Initiative, BHP Billiton Iron Ore will develop and implement individual offsets which meet the requirements of the Assurance Plan as detailed above.

The preferred offsets approach (the Initiative or an alternative Offsets Plan) will be confirmed at the time that offsets are required to be implemented as determined by the Validation Framework. BHP Billiton Iron Ore considers this approach to be appropriate given the evolving policy context in Western Australia, and its endeavours to implement an Offsets Plan that meets the needs of the state and Commonwealth requirements to ensure both alignment and consistency in approach.

8.6.2 VALIDATION FRAMEWORK

This Draft IAR presents a comprehensive environmental impact assessment in order to provide the Minister with appropriate information to support the endorsement of the MNES Program. This Draft IAR presents an assessment of potential impacts from implementation of the Proposal on the Specified Protected Matters. The IAR is an assessment as at 2016 and at the broad whole of Strategic Assessment Area scale, so the assessment validation process is required to ensure that new actions are consistent with the MNES Management Outcomes at the local scale and over the lifetime of the program.

The Validation Framework identifies, through a Material Action test, those actions that require BHP Billiton Iron Ore to prepare a Notice of Intent to Proceed to be issued to the Department prior to undertaking the Material Action. The Notice of Intent to Proceed is a document that provides assurance to the Department that all actions taken under the MNES Program are consistent with the MNES Management Outcomes for each Specified Protected Matter.

The Validation Framework includes:

- A process to identify whether the action is a Material Action or not a Material Action as described above;
- Verification that the Material Action is within the scope of the MNES Program and the actions or classes of actions approved by the Minister;
- Consideration of contemporary guidance and information, such as threat abatement plans, conservation advice and recovery plans;

- Evaluation of baseline and impact assessment data, including updates that are required in line with conservation guidance and information if required and site-specified information such as proposed footprint, project life and indirect impacts;
- Validation that BHP Billiton Iron Ore can meet the MNES Management Outcomes specified in the Assurance Plan through application of the mitigation hierarchy, including quantification of significant residual potential impact on which to base offsets following avoidance and mitigation measures; and
- Targeted stakeholder engagement on the outcomes of the above and processes for making key documents publicly available for comment.

The Validation Framework contains a key non-statutory process step, known as Notice of Intent to Proceed, which occurs prior to undertaking any action that may have material impacts on the Specified Protected Matters. The Notice of Intent to Proceed is a document issued to the DotE or equivalent department that details the location and activity that will be undertaken in implementing the Material Action, and a statement that the Material Action complies with the MNES Program, which is demonstrated by implementing the Validation Framework.

A worked example of the proposed Validation Framework and how it links to the Implementation Plans described in Section 8.6.1 is provided in Case Study 8.

Case Study 9: An example of the implementation of the proposed Validation Framework

In this hypothetical example set in 2025, BHP Billiton Iron Ore proposes to develop *Mine X*. The following outlines the steps that would be undertaken under the Assurance Plan prior to the submission of a Notice of Intent to Proceed. A hypothetical example has been used to illustrate this process based on the proposed Validation Framework detailed in the draft MNES Program. The example assumes certain thresholds, indicators and triggers for the Specified Protected Matters. These will form part of the Assurance Plan which has not yet been approved by the Minister.

In this example, the Assurance Plan specifies Management Outcomes for the Pilbara olive python which aim to ensure the long term persistence/viability of important populations potentially impacted by BHP Billiton Iron Ore's operations. The indicators and trigger values for this outcome are that there is no more than a 10% reduction in an important population or critical habitat.

1. **Is the Action Material?**

The first step is for BHP Billiton Iron Ore to determine whether the Action is a Material Action in relation to the Specified Protected Matters listed in the Assurance Plan. Based on the Assurance Plan, the Material Action threshold is the presence of preferred (or known) habitat or the presence of the Specified Protected Matter within the area of the proposed action.

For *Mine X*, preferred habitat for the Pilbara olive python is known to occur within the area of the proposal. Records exist for sightings of the python within gorge/gully habitat on parts of the site. As such, the proposed *Mine X* is a Material Action.

2. **Is the Action within scope?**

The second step is for BHP Billiton Iron Ore to determine whether *Mine X* is within the scope of the MNES Program. This involves confirmation that the Material Action:

- Is within the Strategic Assessment Area; and
- Is within the scope of the proposal as defined in Section 3 of the MNES Program.

In this example, *Mine X* is both within the Strategic Assessment Area and the scope of the MNES Program.

3. Validate the potential impacts to Specified Matters

Having identified a Specified Protected Matter, BHP Billiton Iron Ore undertakes a series of steps to validate the potential impacts to the Pilbara olive python. A review of listing advice and current guidance (including a Threat Abatement Plan, Conservation Advice and Recovery Plan) identifies that a new field survey methodology is recommended.

BHP Billiton Iron Ore also reviews the existing baseline data for the project area. Given the outdated survey methods previously used for Pilbara olive python, a targeted survey for the python is justified using the new approach detailed in the current guidance. Based on this targeted survey and the earlier baseline information, preferred habitat (gorge/gully) mapping for the python is updated and will be used as the basis of the validation.

The proposed mine plan is now considered in the context of this baseline environmental information. From the proposed mine plan, 150 ha out of a total of 200 ha of the preferred gorge/gully habitat will be directly impacted by a section of mine pit and one of the proposed OSAs. For the purpose of this example, this large area of habitat is considered to support an important population which extends beyond the boundaries of the project area.

The mitigation hierarchy is then applied to the plan to examine if these impacts can be avoided or reduced. In discussion with mine planners, it is agreed that by progressively infilling the main pit during mining, the need for the impacting OSA is negated. As such, 140 ha of disturbance to the gorge/gully habitat is avoided. It is not possible to avoid the impacts from the mine pit without significantly impacting the viability of the mine.

Impacts from changes to surface water flows into the remaining gorge/gully habitat can be mitigated by surface water diversion around the pit. The result is only a minor change to surface flows through the gorge/gully habitat.

By applying the mitigation hierarchy, the residual impact on the Pilbara olive python is the loss of 10 ha of preferred habitat which represents a 5% impact on preferred habitat within the project area. This level of impact meets the MNES Management Outcome.

In this example, a residual 5% impact on preferred habitat within a project area is not considered significant and as such, the requirement for an environmental offset is not triggered.

The above information is included in the draft Notice of Intent to Proceed.

4. Targeted stakeholder engagement

Based on the modified mine plan, BHP Billiton Iron Ore prepares a draft Notice of Intent to Proceed and undertakes targeted stakeholder engagement with the following in addition to the Department of the Environment:

- Western Australian Environmental Protection Authority
- Western Australian Department of Parks and Wildlife
- Relevant Traditional Owners
- Newman Community Consultative Group
- Those stakeholders on the register of interested parties

BHP Billiton Iron Ore advises the above parties of the proposed submission, including a description of

proposed activities of the proposed action, potential impacts on the Specified Protected Matters and the proposed management approach. As part of this consultation, the draft Notice of Intent to Proceed would be made available on BHP Billiton Iron Ore's website for 28 days.

As a result of this stakeholder engagement, BHP Billiton Iron Ore incorporates disturbance buffer zones around gorge/gully habitat to minimise the risk of unintentional impacts.

5. Issue Notice of Intent to Proceed

Based on the above modified proposal, BHP Billiton Iron Ore revises and issues a Notice of Intent to Proceed to the DotE as detailed in the Assurance Plan.

8.6.3 REPORTING, AUDITING AND CORRECTIVE ACTION

REPORTING

Reporting requirements during implementation of the Proposal will be defined in the Assurance Plan (see Section 8.6.1). Reporting will primarily occur through annual reports and five yearly reports.

The Draft MNES Program contains specific requirements for the content of the annual report. These are:

- Material Actions under the MNES Program;
- Progress of all Material Actions;
- Progress in applying the avoidance, mitigation and, if relevant, offsets for each Material Action;
- Progress in achieving the MNES Management Outcomes; and
- Deviations from the MNES Program or from information contained in a Notice of Intent to Proceed for a Material Action.

BHP Billiton Iron Ore is required to provide an explanation of the importance of any deviation in terms of impacts on Specified Protected Matters, along with corrective action taken.

BHP Billiton Iron Ore will also produce a five-yearly report that contains the outcomes of a five yearly review of the Assurance Plan (described further in Section 8.6.1). The five yearly review will focus on the performance of the MNES Management Outcomes defined in the Assurance Plan, and whether the implementation of the Assurance Plan and Offsets Plan is achieving the requirements of the Endorsed MNES Program. The review will inform adaptive management and potentially prompt the updating of relevant Implementation Plans to maintain or improve performance.

AUDITING AND CORRECTIVE ACTION

Auditing arrangements specific to the Proposal will be implemented in accordance with the Assurance Plan (see Section 8.6.1). The Draft MNES Program contains specific requirements to identify and implement any corrective action required to achieve the MNES Management Outcomes in the Assurance Plan. For any deviation that has materially impacted or may materially impact any Specified Protected Matter greater than the level of impact expected without the deviation, the Approval Holder will:

1. take corrective action in respect to the deviation;
2. Within 30 business days of becoming aware of the deviation, notify the DotE in writing of the deviation; the corrective action taken or to be taken; and should corrective action be taken, the outcome of that corrective action;

   The DotE will advise BHP Billiton Iron Ore that either:

- The deviation is minor or trivial and that the corrective action taken or to be taken is satisfactory or no further corrective action is required; or
- The deviation requires further corrective action.

BHP Billiton Iron Ore routinely undertakes audits of its existing operations (and implements corrective actions if required) and has systems and processes in place to meet the MNES Program requirements.

9 ENDORSEMENT CRITERIA

For the Draft MNES Program to be endorsed, the Minister must be satisfied that the EPBC Act outcomes can be achieved through implementation of the Program. Clause 9 of the Agreement (see Appendix 1) outlines the Endorsement Criteria for the Strategic Assessment. Table 23 demonstrates how BHP Billiton Iron Ore has met the criteria.

Table 23: Demonstration of compliance with Commonwealth Endorsement Criteria defined in Clause 9 of the Agreement

Clause	Endorsement Criteria	Demonstrated Compliance with Endorsement Criteria
9.1	When deciding whether to endorse the MNES Program, the Minister must be satisfied that the Impact Assessment Report adequately addresses the impacts to which the Agreement relates, and that any recommendations by the Minister to modify the MNES Program have been responded to appropriately.	In preparing this Draft IAR, BHP Billiton Iron Ore has undertaken a detailed and robust assessment of the potential impacts from implementation of the Proposal in accordance with the Draft MNES Program. This assessment has included: • A comprehensive evaluation of the Controlling Provisions relevant to the Proposal over the proposed life of the Draft MNES Program. • Identification of the actions and classes of actions that may be undertaken in implementing the Proposal. The scope of the Proposal has been clearly defined based on BHP Billiton Iron Ore's operational tenure within a defined Strategic Assessment Area. Identification of likely actions was based on a thorough understanding of the Proposal based on over 50 years' operational experience in the Pilbara. • Identification of the preferred habitat for the Specified Protected Matters based on BHP Billiton Iron Ore's extensive biological survey data and the development of statistical predictive models to provide regional context. Identification of habitat preferences and key threatening processes was informed by contemporary reports prepared by CSIRO and the Western Australian DPaW and were peer reviewed by species experts • Quantification of potential impacts to each of the Specified Protected Matters. This has included the development of a conceptual direct disturbance footprint, which formed the basis of the impact assessment. The conceptual footprint included all current BHP Billiton Iron Ore operational tenures and reasonably foreseeable third-party mining operations within the Strategic Assessment Area. This is the first time that a comprehensive direct disturbance footprint of this nature has been developed within the Pilbara. • The development of a spatially based CIA model, which enabled quantification of the potential impacts on Specified Protected Matters arising from the implementation of the Proposal. This is the first time such an approach has been undertaken in the Pilbara and is a step change in the analytical approach to cumulative impacts within Australia. The model has included both direct and indirect impacts specific to each Specified Protected Matter.

Clause	Endorsement Criteria	Demonstrated Compliance with Endorsement Criteria
		• Peer review of the method and findings of the CIA by relevant species experts, who have confirmed the validity of the approach. • An impact assessment of reasonably foreseeable third party mining footprints and BHP Billiton Iron Ore's Full Conceptual Development Scenario footprint on publicly available species records. The records data were obtained from using data obtained from Department of Parks and Wildlife in December 2015 and Western Australian Museum in January 2016. • Incorporation within the Draft MNES Program of an Assurance Plan, which embeds the application of the mitigation hierarchy and adaptive management within BHP Billiton Iron Ore's project planning and operations. The plan is based on the development of specific outcomes, indicators and thresholds for each of the Specified Protected Matters.
9.2	In determining whether or not to endorse the MNES Program, the Minister will have regard to the extent to which the MNES Program meets the objects of the EPBC Act. In particular, that it:	
	(a) Protects the environment, especially those aspects of the environment that are MNES;	The CIA has identified that the implementation of the Program will not have a potential significant impact on the Specified Protected Matters relevant to the Proposal and that, through implementation of the MNES Program, future operations can meet the objects of the EPBC Act. This outcome is consistent with the findings of workshops on selected MNES species undertaken by DPaW (in 2013) and the identification of key threatening processes on species within the Pilbara undertaken by CSIRO (Carwardine et al. 2014). CSIRO identified the conservation strategies with the greatest benefit as being fire management and research, cat management and research, and feral ungulate and domestic herbivore management. Regardless of these findings, BHP Billiton Iron Ore is committed to minimising its impacts on the environment in which it operates and has consequently developed a management approach that moves away from site-based management to the application of a landscape-scale management approach. The Draft MNES Program includes the commitment to develop an Offsets Plan and an Assurance Plan, each of which embeds the implementation of the mitigation hierarchy and adaptive management within the Proposal. The Notice of Intent to Proceed will provide assurance to the Minister that these processes have been applied as required by the Endorsed MNES Program.
	(b) Promotes ecologically sustainable development through the conservation and ecologically sustainable use of natural resources;	Section 8.3 of the Draft IAR details how the Draft MNES Program meets the principles of ecologically sustainable development, being: • Integration Principle; • Precautionary Principle; • Principle of Intergenerational Equity; and • Biodiversity Principle.

Clause	Endorsement Criteria	Demonstrated Compliance with Endorsement Criteria
		• Valuation Principle The Draft IAR and the Draft MNES Program together provide assurance that the potential impacts from the Proposal are acceptable at the time of assessment and that the processes embedded in the Draft MNES Program will ensure that the impacts remain acceptable for the life of the Proposal.
	(c) Promotes the conservation of biodiversity;	The Assurance Plan will identify MNES Management Outcomes for each of the Specified Protected Matters. These outcomes demonstrate how BHP Billiton Iron Ore will meet the MNES Program Objective, which is to implement the Proposal in a manner that aligns with the Commonwealth objectives for MNES for each relevant Controlling Provision. Embedding these specific objectives in the management of the Specified Protected Matters, along with an adaptive management approach, ensures that BHP Billiton Iron Ore will continue to sustain the biodiversity conservation values protected by the EPBC Act.
	(d) Provides for the protection and conservation of heritage;	BHP Billiton Iron Ore has developed and is continuing to implement comprehensive agreements with the Traditional Owners on whose determination or claim areas it operates. These agreements include protection of the key cultural and heritage values within the region. BHP Billiton Iron Ore has also had a long history of working with Traditional Owners to assess, document and manage archaeological sites across its tenements. This mutually agreed approach is embedded in existing and future comprehensive agreements. In terms of European heritage, many of the European heritage sites in the Pilbara region relate to these historic pastoral stations, natural features (such as pools) and town sites. BHP Billiton Iron Ore manages these places where relevant on a case by case basis.
	(e) Promotes a cooperative approach to the protection and management of the environment; and	The Assurance Plan and Offsets Plan will form the basis of BHP Billiton Iron Ore's regional approach to management of the natural environment, including Specified Protected Matters. The commitments within the Endorsed MNES Program will ensure that BHP Billiton Iron Ore considers contemporary guidance over the life of the Proposal and that the application of adaptive management will be undertaken with the approval of the Department of the Environment. BHP Billiton Iron Ore has a long history of cooperative interaction with regulatory agency, university, research institute, community and NGO stakeholders. The Assurance Plan and the adaptive management approach that it is embedded within provide an ideal platform to maintain this cooperative approach.
	(f) Assists in the co-operative implementation of Australia's international environmental responsibilities.	The Draft IAR has considered all Controlling Provisions that may be relevant to the implementation of the Proposal, and the Draft MNES Program has been developed accordingly. Implementation of the Endorsed MNES Program will consequently contribute to implementation of international environmental responsibilities.

Clause	Endorsement Criteria	Demonstrated Compliance with Endorsement Criteria
9.3	Without limiting the matters the Minister may consider when making the decision whether or not to endorse the MNES Program, the Minister will consider the manner in which the Program:	
	(a) Identifies direct, indirect and cumulative impacts on MNES;	The Draft IAR has detailed the evaluation of relevant Controlling Provisions and identification of Specified Protected Matters. On this basis, BHP Billiton Iron Ore has undertaken a CIA that has specifically assessed potential direct, indirect and cumulative impacts on each key species to demonstrate the potential impacts from implementation of the Proposal. The Draft IAR has also specifically considered the potential for indirect impacts outside the Strategic Assessment Area.
	(b) Avoids impacts on MNES; (c) Mitigates the impacts on MNES; (d) Offsets the impacts on MNES;	The Draft MNES Program details the application of the mitigation hierarchy and how it will be applied in the implementation of the Proposal. Further, the submission of the Notice of Intent to Proceed will document how the hierarchy has been applied for each action or class of actions.
	(e) Contributes to the enhancement of the existing environment and management of existing threats; and	The Draft IAR has identified key threatening processes for each MNES and addressed the implications of implementing the Proposal with these threats in mind. Where these threats arise as a result of the Proposal, BHP Billiton Iron Ore has proposed an outcome-based regional management approach to ensure that the environmental impacts on Specified Protected Matters are acceptable. The Draft MNES Program details a process for development of outcomes for each Specified Protected Matters to guide BHP Billiton Iron Ore's management of actions or classes of actions. Through the implementation of the mitigation hierarchy, BHP Billiton Iron Ore seeks to not only minimise impacts on the environment but, where possible, also enhance environmental values through the implementation of environmental offsets.
	(f) Demonstrates adaption to reasonable climate change scenarios.	The Draft IAR has identified the potential impacts from climate change on implementation of the Proposal. Further, the adaptive management approach contained in MNES Program will specifically address modification of management to allow for climate change over the life of the Proposal.
9.4	Commitments in the MNES Program must be adequately resourced throughout its life. The MNES Program must demonstrate an effective system of adaptive management that addresses uncertainty and contingency management as well as procedures for monitoring, independent auditing and	BHP Billiton Iron Ore has been operating in the Pilbara for over 50 years and has access to a substantial resource capable of sustaining the business for at least another 50 to 100 years. Maintaining our social license to operate is critical to sustaining these operations over this period. Adaptive management is an embedded component of both the Draft MNES Program. The Draft MNES Program recognises that there will be change over time and that BHP Billiton Iron Ore will modify its environmental management practices to reflect contemporary science and regulatory guidance. The Assurance Plan outlined in the Draft MNES Program clearly sets out how BHP Billiton Iron Ore will meet its monitoring, auditing and reporting obligations

Clause	Endorsement Criteria	Demonstrated Compliance with Endorsement Criteria
	public reporting on implementation.	over the life of the Proposal.
9.5	The MNES Program must address all of the above matters for it to be considered for endorsement by the Minister in accordance with the EPBC Act.	BHP Billiton Iron Ore considers that, between the Draft IAR and Draft MNES Program, all the matters to be considered by the Minister to endorse the Program have been met.

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