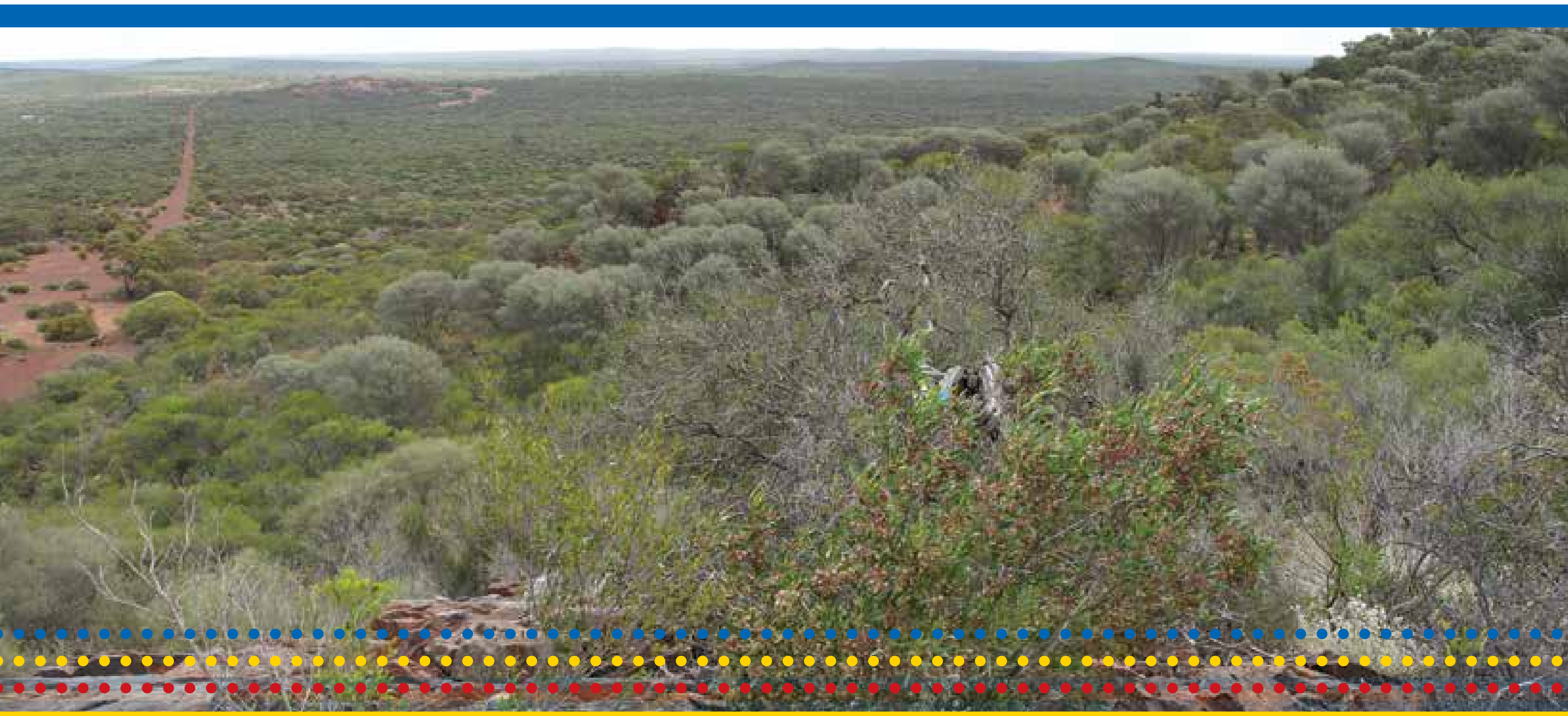
Sinosteel Midwest Corporation Limited
Blue Hills Mungada East Expansion



Public Environmental Review

August 2016

DOCUMENT TRACKING

Item	Detail
Project Name	Blue Hills Expansion PER
Project Number	442
Project Manager	Phillipa Tompson
Prepared by	Phillipa Tompson
Reviewed by	Warren McGrath, Benjamin Casillas-Smith
Approved by	Benjamin Casillas-Smith
Approved by client	Stuart Griffiths
Status	FINAL
Version Number	8
Last saved on	9 August 2016

This report should be cited as 'Eco Logical Australia (2016). *Blue Hills Mungada East Expansion Public Environmental Review*. Prepared for Sinosteel Midwest Corporation.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Sinosteel Midwest Corporation.

Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

Sinosteel Midwest Corporation Ltd (SMC) is proposing to expand its existing Koolanooka/Blue Hills Mungada Direct Shipping Ore Project approximately 220 kilometres south-east of Geraldton in the Midwest region of Western Australia. In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) document has been prepared which describes this proposal and its likely effects on the environment. The PER document is available for a public review period of six weeks from **Monday 15 August 2016 closing on Tuesday 27 September 2016.**

Where to get copies of this document

Comments from government agencies and the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Printed and CD copies of this document may be obtained from:

Peter Jones,
3rd Floor,
7 Rheola Street, West Perth
08 9429 4888
pjones@smcl.com.au

Hard copies of the document cost $10 (including postage); CDs will be provided free of charge.

The PER may also be accessed through the proponent's website at: www.smcl.com.au/OurEnvironment/Approvals/BlueHillsPER.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approaches. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged with electronic submissions being acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*, and may be quoted in full or in part in the report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER document or on specific elements. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER document;
- if you discuss different sections of the PER document, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: **Tuesday 27 September 2016**

The EPA prefers submissions to be made at: https://consultation.epa.wa.gov.au

Alternatively, submissions can be

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, EAST PERTH WA 6892; or
- delivered to the Environmental Protection Authority, Level 8, The Atrium, 168 St Georges Terrace, Perth.

If you have any questions on how to make a submission, please ring the Office of the Environmental Protection Authority on 6145 0800.

Executive summary

Introduction

This Public Environmental Review (PER) document has been prepared to present the potential environmental impacts of the proposed Blue Hills Mungada East Expansion Project (the Proposal). The Proponent for the Proposal is Sinosteel Midwest Corporation Limited (SMC). The Proposal is an expansion of the Blue Hills component (Blue Hills mine) of SMC's existing Koolanooka/Blue Hills Mungada Direct Shipping Ore Project (DSO Project). The Proposal is located within SMC's tenements M59/595 and M59/596 in the Midwest region of Western Australia (WA), within the Shire of Perenjori (Figure ES1). The closest towns are Perenjori and Morawa, which are 65 kilometres (km) south and 85 km west of the Proposal respectively. The largest regional town, Geraldton, is 220 km north-west of the Proposal. The Proposal is expected to produce an additional 4.4 million tonnes (Mt) of haematite iron ore over approximately three years and will extend the life of the DSO Project from five to eight years.

DSO Project summary

The existing DSO Project includes:

- mining, crushing and screening of iron ore from three pits:
  - one existing pit at the Koolanooka component (the Koolanooka mine), approximately 160 km south-east of Geraldton;
  - two existing pits at the Blue Hills mine, named Mungada East and Mungada West pits, located approximately 60 km east of the Koolanooka mine; and
- transport of ore to the Geraldton Port.

Operations commenced at the Koolanooka mine in April 2010, with mining and crushing ceasing in April 2013. A total of 98% of the Koolanooka mine has since been subject to rehabilitation works, with the balance planned to be completed in 2018. Mining at the Blue Hills mine commenced in July 2013, with first production in September 2013. Currently, the Blue Hills mine is in care and maintenance, while SMC awaits environmental approval to extend mining operations.

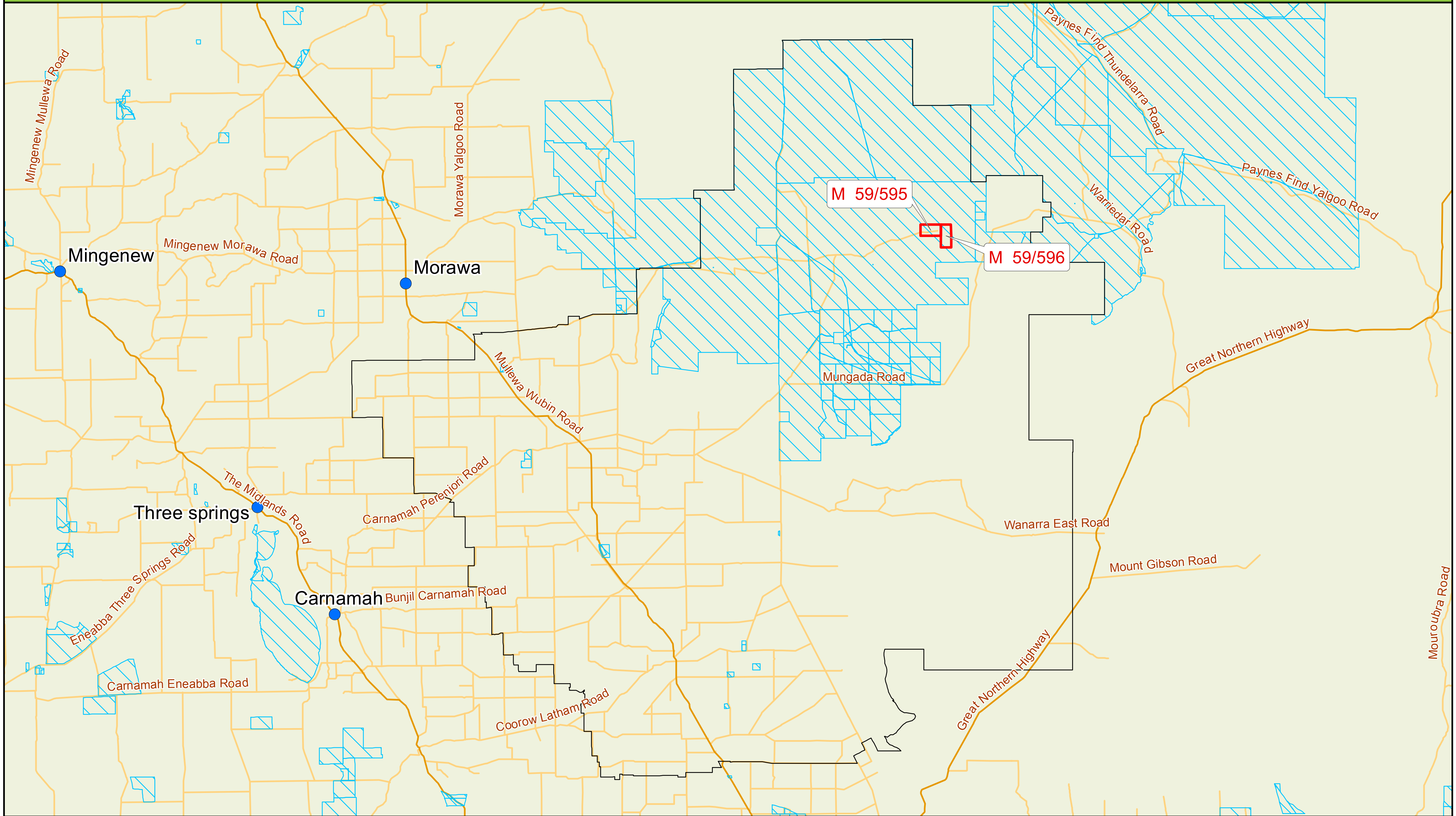
Description of the Proposal

The Proposal involves the construction and operation of a new mine pit adjacent to the existing approved Mungada East pit, a waste rock dump, processing infrastructure, haul roads and an access road (Figure ES2). Ore from the proposed mine pit will be processed using the proposed processing infrastructure. Most of the waste rock from the proposed mine pit will be utilised to backfill the existing Mungada East pit (which would otherwise not occur), and the remainder will be stored in the proposed waste rock dump.

Workforce accommodation facilities at the nearby Karara mine site will be utilised for the Proposal workforce. Supporting infrastructure at the Blue Hills mine will be utilised for all other requirements. This includes:

- office, workshop, warehouse and magazine buildings;
- power and water supplies (no increase is required for the Proposal); and
- communications infrastructure.

Figure ES1: Regional location



Legend

- Towns
- SMC Blue Hills Tenure
- Shire of Perenjori
- Former leasehold - (Parks and Wildlife Managed Lands)
- Major Road
- Minor Road

Datum/Projection: GDA 1994 MGA Zone 50

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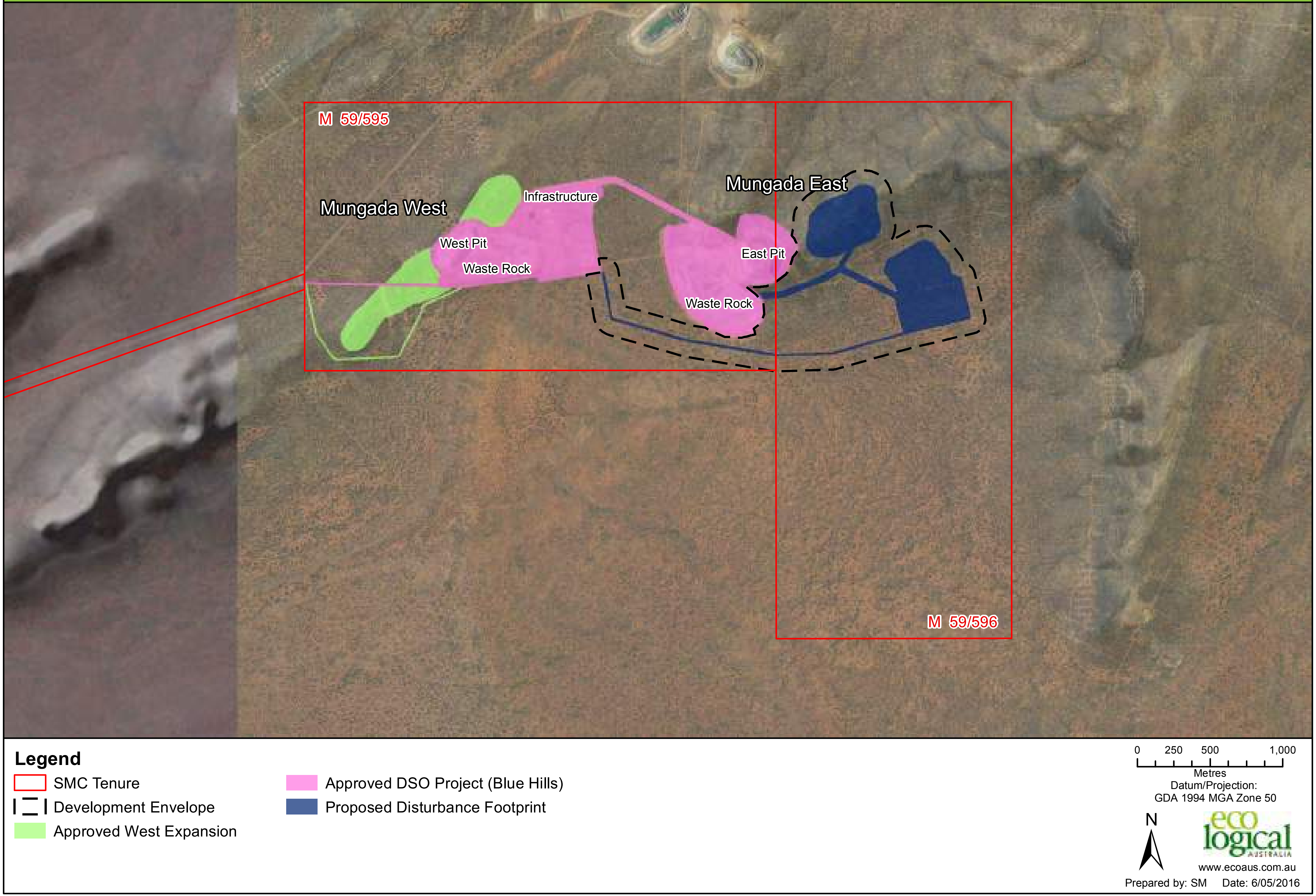
Prepared by: SM Date: 22/04/2016

Figure ES2: SMC Blue Hills operations



The key characteristics of the Proposal are presented in Table ES1 in accordance with the Environmental Protection Authority (EPA) Environmental Assessment Guideline (EAG) No. 1 – Defining the key characteristics of a proposal. The Proposal will result in the clearing of up to 53.5 ha of native vegetation on and adjacent to the Mungada Ridge within a 172.5 ha development envelope.

Table ES1: Key characteristics of the Proposal

Summary of the Proposal		
Proposal title	Blue Hills Mungada East Expansion Project	
Proponent name	Sinosteel Midwest Corporation Limited	
Short description	The Proposal is to construct and operate one open-cut hematite iron ore mine pit and associated mine waste rock dump, processing infrastructure, haul roads and access road. The Proposal is located approximately 65 km north-east of Perenjori in the Midwest region of Western Australia.	
Physical Elements		
Element	Location	Proposed Extent
Mine pit and pit abandonment bund area	Figure ES1	Clearing of no more than 18.6 ha within a 172.5 ha development envelope
Waste rock dump	Figure ES1	Clearing of no more than 11 ha within a 172.5 ha development envelope
Supporting infrastructure (processing)	Figure ES1	Clearing of no more than 11.3 ha within a 172.5 ha development envelope
Haul roads and access road	Figure ES1	Clearing of no more than 12.6 ha within a 172.5 ha development envelope
Operational Elements		
Element	Location	Proposed Extent
Waste material	Figure ES1	Approximately 13.5 million tonnes of waste rock[1] – the majority used to backfill the existing Mungada East pit and the remainder disposed of to the proposed waste rock dump and the existing Mungada East waste rock dump.

[1] The estimated amount of waste material to be produced from the Proposal was incorrectly stated as 1.6 Mt in the Environmental Scoping Document (ESD) for the Proposal. The correct amount is 13.5 Mt. The 1.6 Mt stated in the ESD was the amount of waste rock estimated to be disposed of to the proposed waste rock dump. The disturbance footprint of the proposed waste rock dump has not increased from the area stated in the ESD (11 ha), as a large percentage of the waste produced from the proposed mine pit will be used to backfill the existing Mungada East pit.

Assessment process

A proposal to expand the existing Mungada East and Mungada West pits was referred for assessment to the WA EPA under Section 38 of the *Environmental Protection Act 1986* (WA) (EP Act) in September 2013. In April 2014, the EPA provided preliminary advice that the Mungada East component of the proposed expansion was considered environmentally unacceptable and recommended an Assessment on Proponent Information (API) category B (environmentally unacceptable) level of assessment. The EPA undertook consultation with SMC regarding the proposed expansion and, in June 2014, SMC requested that the proposed expansion of the Mungada West pit be removed from the proposal. The approval of the Mungada West component of the proposed expansion was then sought separately through an application under Section 45C of the EP Act. This application was made in August 2014 and approved in December 2014.

In its report to the Minister for Environment on the proposed expansion of the Mungada East pit (EPA Report 1532), which was released in November 2014, the EPA concluded that the proposed expansion could not be managed to meet its objectives for the landforms factor and was environmentally unacceptable and should not be implemented. Following consideration of appeals and with particular regard to further assessment of the landforms factor being considered appropriate, the Minister for Environment remitted the proposal back to the EPA in April 2015 pursuant to Section 101(1)(d)(i) of the EP Act and directed that the EPA assess the proposal under a PER level of assessment. Assessment of the proposal (this Proposal) is now being undertaken by way of a PER in accordance with the procedures set out in the Environmental Impact Assessment Administrative Procedures 2012 of the EP Act, and sections 40 to 48 of the EP Act.

The EPA issued an Environmental Scoping Document (ESD) for the Proposal in July 2015. The ESD provides an outline of the preliminary key environmental factors, a description of the scope of the assessment of the Proposal and an indicative timeline for the assessment process.

The primary purpose of this PER document is to present an assessment of the potential environmental impacts of the Proposal in accordance with the ESD.

The EPA identified seven preliminary key environmental factors relevant to the Proposal that require detailed consideration by SMC. These preliminary key environmental factors were:

- Landforms;
- Flora and vegetation;
- Terrestrial fauna;
- Subterranean fauna;
- Amenity;
- Offsets (integrating factor); and
- Rehabilitation and decommissioning (integrating factor).

The EPA identified other environmental factors that it considered relevant to the Proposal. These were hydrological processes, inland waters environmental quality, and heritage.

Landforms

The EPA released Environmental Protection Bulletin (EPB) No. 23: Guidance on the EPA Landforms factor in July 2015. The bulletin states landforms are a component of the landscape and their defining feature is described as the combination of geology (composition) and morphology (form). The EPA has defined key criteria to be applied as the basis for determining the significance of a landform in the context of an environmental impact assessment (EIA). The key criteria include variety, integrity, ecological importance, scientific importance and rarity.

The landform associated with the Proposal is Mungada Ridge, in the Blue Hills Range, which is one of a number of banded iron formation (BIF) ranges of the Yilgarn Craton. There are two key areas in the Yilgarn Craton where BIF landforms occur: the south-west cluster known as the

Mungada/Karara/Koolanooka region (in which Mungada Ridge occurs) and the south-east cluster known as the Mount Manning region. The BIF ranges in both regions are identified as having high biodiversity conservation values in the Strategic Review of Banded Iron Formation Ranges of the Midwest and Goldfields (DEC and DoIR 2007).

In order to assess the potential impacts of the Proposal on Mungada Ridge, the EPA identified three contexts in the ESD in which to consider the affected landform: the landform itself (Mungada Ridge), the local assessment unit (LAU; Blue Hills Range) and the regional context (the Mungada/Karara/Koolanooka region).

Mungada Ridge is one of 31 BIF landforms in the LAU and one of 362 BIF landforms in the Mungada/Karara/Koolanooka region. Mungada Ridge is the largest (685 ha), highest (510 metres Australian Height Datum (mAHD)) and steepest (up to 20 degrees) BIF landform in the LAU and is one of a small number of very large, high and steep BIF landforms in the Mungada/Karara/Koolanooka region (although it is not the largest, highest, nor steepest landform in the region). Mungada Ridge is unique in that it is the only one of the relatively few large, high and steep BIF landforms in the region that is distinctly crescent-shaped. While unusual, the distinct crescent shape of Mungada Ridge is not known, nor believed to influence the ecological or scientific importance of the landform.

Like most of the BIF landforms in the LAU, Mungada Ridge is not completely intact; 8.4% of Mungada Ridge has been affected by existing disturbance (4.9% from mining and infrastructure and 3.5% from exploration activities). A total of 26.5% of the total area of BIF landforms in the LAU has been affected by existing disturbance (24.8% from mining and infrastructure and 1.7% from exploration activities), and of the 362 BIF landforms in the Mungada/Karara/Koolanooka region, 46 are associated with existing disturbance. A number of conservation significant flora and fauna values occur on Mungada Ridge, including significant flora and fauna species, and the Priority 1 Priority Ecological Community (PEC) 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)'. Although none are endemic to the ridge, two conservation significant flora species, *Acacia woodmaniorum* (Threatened) and *Lepidosperma* sp. Blue Hills (Priority 1), are endemic to the local area and have the majority of their known records located on the ridge.

Mining and excavation earthworks associated with the proposed pit, pit abandonment bund and haul roads on the landform are the only aspects of the Proposal which may potentially affect Mungada Ridge. The potential direct and indirect impacts of erosion and instability are unlikely to significantly impact the landform as they will be mitigated through surface water management and geotechnical design measures.

After application of mitigation and management, the residual impact to the Mungada Ridge landform will be the proposed mine pit and pit abandonment bund remaining as structural impacts on the landform, covering approximately 18.6 ha. The proposed haul roads and access road will alter the landform temporarily; these will be rehabilitated upon closure of the Proposal and will therefore alter the surface of the landform only for the duration of construction and operations.

The permanent impact associated with the proposed mine pit and pit abandonment bund will be restricted to the western, lower-lying area of Mungada Ridge. The highest elevation in the proposed disturbance footprint on the ridge is 442.7 mAHD and the steepest slope 12.4 degrees. The most prominent (highest and steepest) areas of the ridge are >500 mAHD and 15-20 degrees and will not be affected by the Proposal. The crescent shape of Mungada Ridge will also not be affected by the Proposal. The vast majority of the Mungada Ridge landform and its more distinctive attributes (height, slope, shape and size) will remain in the landscape. Therefore, the Proposal will not significantly affect the variety of landforms present in the LAU or the Mungada/Karara/Koolanooka region.

Mungada Ridge is not considered an 'intact' landform as it has already been altered by Western Mining operations in the 1960's and subsequent expansions by SMC for the Mungada East pit and waste rock dump. Existing disturbance on Mungada Ridge comprises 57.5 ha, which represents 8.4% of the landform. The Proposal will affect 22 ha of the ridge (3.4 ha of which is associated with roads and will be rehabilitated upon closure), which will increase the total disturbance on Mungada Ridge from 57.5 ha (8.4%) to 79.5 ha (11.6%).

The management measures proposed are considered to be standard practice and are therefore both feasible and achievable. These measures will minimise the potential indirect impacts to the landform. The Proposal is considered to be consistent with the EPA's objective for the landforms factor. After implementation of the Proposal, 88.4% of the ridge would remain undisturbed. Furthermore, once the proportion of Mungada Ridge affected by exploration (23.9 ha, the majority of which is on Karara Mining's tenements) is rehabilitated the undisturbed or restored area of Mungada Ridge would increase to 91.8%.

Flora and vegetation

Seven vegetation associations have been mapped in the development envelope, six of which are considered to be of high local significance and one of moderate local significance:

- *ElWL* (1): *Eucalyptus* Woodland (High local significance);
- MSL (2): Mixed Shrubland (Moderate local significance);
- *ArAtSL* (4): *Acacia* Shrubland (High local significance);
- MSL (7): Mixed Shrubland (High local significance);
- MSL (8): Mixed Shrubland (High local significance);
- MSL (9): Mixed Shrubland (High local significance); and
- *AsArSL* (11): *Acacia* Shrubland (High local significance).

The condition of most of the vegetation in the development envelope (88%) was mapped as Excellent with some areas mapped as Good (10%). The remainder (2%) has been previously cleared.

The development envelope does not intersect any Threatened Ecological Communities (TECs), but does intersect the Priority 1 PEC 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)'.

One threatened flora species listed as Threatened, Vulnerable under the *Wildlife Conservation Act 1950* (WA) (WC Act): *Acacia woodmaniorum*. No other threatened flora species listed under the WC Act or EPBC Act has been recorded in the development envelope; however, potential habitat for one other threatened flora species, *Stylidium scintillans* (Vulnerable; WC Act), does occur. Potential habitat for *Acacia woodmaniorum* and *Stylidium scintillans* was ranked and modelled within the Blue Hills Impact Assessment Area (an area covering 73,579 ha and encompassing Karara Mining Limited's Karara, Blue Hills North, Terrapod and Hinge approved project footprints, as well as SMC's approved project footprints).

Ten Priority flora species have been recorded in the development envelope:

- *Acacia karina* (Priority 1);
- *Acacia subsessilis* (Priority 3);
- *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (Priority 3);
- *Drummondita fulva* (Priority 3);
- *Gunniopsis divisa* (Priority 3);
- *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1);

- *Micromyrtus acuta* (Priority 3);
- *Micromyrtus trudgenii* (Priority 3);
- *Persoonia pentasticha* (Priority 3); and
- *Rhodanthe collina* (Priority 3).

Potential habitat for *Lepidosperma* sp. Blue Hills was ranked and modelled within the Blue Hills Impact Assessment Area. All but three of these 10 Priority flora species (*Calotis* sp. Perrinvale Station [R.J. Cranfield 7096], *Gunniopsis divisa*, and *Persoonia pentasticha*) are considered to be regional endemics (restricted to an area within a 100 km radius).

Potential impacts associated with the Proposal in relation to flora and vegetation values include clearing of native vegetation; indirect impacts due to alterations and disruptions to surface water flows, dust, fragmentation and changes in microclimate; introduction and/or spread of weeds; and altered fire regimes. After considering the application of avoidance, minimisation and mitigation (including rehabilitation and restoration) measures, the following key residual impacts on vegetation and flora are predicted:

- clearing of approximately 52 ha of vegetation in Good to Excellent condition across six vegetation associations of high local conservation significance and one vegetation association of moderate local conservation significance;
- clearing of approximately 21.4 ha of vegetation within the boundary of the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC, representing 0.3% of the mapped area of the PEC;
- removal of 2,634 individuals of *Acacia woodmaniorum* (Threatened – Vulnerable), representing 25% of the number of individuals within tenements M59/595 and M59/596 and 10% of the number of individuals within the Tallering sub-region and WA. The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat modelled for *Acacia woodmaniorum*, which represents approximately 41% of the extent modelled in the development envelope and 1.5% of the extent modelled within the Blue Hills Impact Assessment Area;
- removal of two individuals of *Acacia karina* (Priority 1), representing 4% of the number of individuals within tenements M59/595 and M59/596 and less than 1% of the number of individuals within the Tallering sub-region;
- removal of 669 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1), representing 29% of the number of individuals within tenements M59/595 and M59/596 and 12% of the number of individuals within the Tallering sub-region and WA. The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat for *Lepidosperma* sp. Blue Hills, which represents approximately 41% of the extent modelled within the development envelope and 1.3% of the extent modelled within the Blue Hills Impact Assessment Area; and
- removal of 5,832 individuals of eight Priority 3 species, representing up to 24% of each species' sub-regional population.

SMC considers residual impacts can be restricted to those described and offsets can be applied such that the EPA objective for flora and vegetation is met.

Terrestrial fauna

Four terrestrial fauna habitats have been mapped in the development envelope: Rocky ridge with steep slopes, Low slopes with dense *Acacia* shrubs, Eucalypt woodland plain with *Acacia* shrubs, and *Acacia* shrubland plain. These habitats are not restricted to the development envelope and are considered typical of the surrounding region.

A total of 28 native mammal species, 181 bird species, 80 reptile species, and eight amphibian species have been recorded, or have the potential to occur in the development envelope. Three conservation significant vertebrate fauna species have been recorded in the development envelope:

- Malleefowl (*Leipoa ocellata*) – Vulnerable (*Environment Protection and Biodiversity Conservation Act 1999* [Cwth; EPBC Act]) and Critically Endangered (WC Act);
- Peregrine Falcon (*Falco peregrinus*) – Other Specially Protected Fauna (WC Act); and
- Gilled Slender Blue-tongue (*Cyclodomorphus branchialis*) – Vulnerable (WC Act).

The key potential impact to fauna is the clearing of up to 52 ha of fauna habitat. This includes removal of five inactive Malleefowl mounds. Malleefowl have been commonly recorded across the Midwest region indicating that suitable habitat occurs extensively outside the development envelope and viable breeding populations occur across the region. Although Malleefowl habitat will be cleared as part of the Proposal, only a relatively small proportion of the available habitat in the vicinity and regionally will be affected. Habitat clearing will be restricted to the development envelope and will be the minimum necessary for safe construction and operation of the Proposal. The Proposal is not expected to significantly impact the Peregrine Falcon as no nest sites have been recorded in the development envelope and it is likely that the species would only use the area opportunistically as part of broader foraging activity. The Proposal is unlikely to significantly impact the Gilled Slender Blue-tongue given the species' broad distribution.

One confirmed Short Range Endemic (SRE) species has been recorded in the development envelope: the Shield-backed Trapdoor Spider, *Idiosoma nigrum* (Vulnerable – EPBC Act, Vulnerable – WC Act). However, the Western Australian Museum (WAM) recently provided advice (WAM 2016) that based on molecular and morphological data, the *Idiosoma* records from the Blue Hills Range were not considered to be *Idiosoma nigrum*; instead, these specimens are classified as *Idiosoma* 'MYG018'. Nevertheless, the records of *Idiosoma* 'MYG018' are currently treated as *Idiosoma nigrum* by the Department of Parks and Wildlife (DPaW). Until the new taxonomic arrangement is recognised by DPaW, all records from the Blue Hills area previously identified as *Idiosoma nigrum* or *Idiosoma* 'MYG018' are referred to as *Idiosoma nigrum* and a confirmed SRE, and treated as thus throughout this PER document. In addition to *Idiosoma nigrum*, two potential SRE species and one species of 'unknown' SRE status have also been recorded in the development envelope. All taxa have been recorded outside the development envelope.

There will be a loss of potential SRE fauna habitat of 52 ha. A total of 25 of the 84 burrows of *Idiosoma nigrum* recorded in the development envelope are located within the proposed disturbance footprint. The low population density of *Idiosoma nigrum* at the Blue Hills mine and the extent of available habitat beyond the development envelope suggest it is unlikely the removal of habitat and burrows of *Idiosoma nigrum* as a result of the Proposal will significantly impact the species. The local population mortality within the proposed disturbance footprint during clearing and the loss of potential habitat in the proposed disturbance footprint is unlikely to significantly impact potential and 'unknown' SRE species recorded or potentially occurring in the development envelope.

SMC considers that it can restrict residual impacts to those described and manage the Proposal such that the EPA objective can be met without further mitigation in the form of specific offsets being required for terrestrial fauna.

Subterranean fauna

Potential impacts to stygofauna are considered to be negligible given there is no suitable habitat in the development envelope and dewatering of the pit will not be required for implementation of the Proposal.

Prospective habitat for troglofauna is present within the BIF in some, but not all, parts of the proposed mine pit extending from relatively shallow depths (<8 m) through to deeper strata. One potentially troglobitic species has been recorded within the proposed mine pit. All specimens recorded were juveniles belonging to the hemipteran family Meenoplidae and could not be identified to species. The specimens are considered likely to be troglophilic (with surface occurrence in one life stage, although mostly subterranean) rather than troglobitic (with all life stages being subterranean).

The excavation of ore from the proposed mine pit will result in the direct removal of troglofauna habitat. The troglofauna habitat present in the development envelope extends for approximately 10 km in a south-west to north-east direction along a fault line and represents a large expanse of continuous prospective habitat around the proposed pit with few, if any, potential spatial barriers to dispersal. The proposed pit comprises <1% of this habitat and the spatial extent of habitat loss from excavation of the proposed mine pit is therefore considered to be negligible.

Excavation of troglofauna habitat will be restricted to the area of the proposed mine pit, limiting the geographic extent of potential impacts. Maintenance of surface water quality in the development envelope will provide mitigation of potential indirect impacts to subterranean fauna from ground disturbance, stockpiling and surface contamination. SMC considers that it can restrict residual impacts to those described and manage the Proposal such that the EPA objective can be met without further mitigation in the form of specific offsets being required for subterranean fauna.

Amenity

A Visual Landscape Evaluation (VLE) was conducted for the Proposal to provide baseline information on landscape values of the proposed disturbance footprint and surrounding areas (within 50 km). The general character of the proposed disturbance footprint and surrounding areas is of a natural landscape that is a densely vegetated scrub plain interspersed with woodland vegetation. Landscape features include rolling hills and peaks and expansive salt lake systems. Infrastructure, such as transmission towers, has been installed within the landscape, but does not dominate the overall character. Broad acre agriculture occurs approximately 35 km to the south-west of the proposed disturbance footprint.

The impact of the Proposal was assessed via a Visual Impact Assessment (VIA) conducted from a variety of view locations within 50 km of the proposed disturbance footprint. The future plans to promote particular areas of the Karara complex (within which the Proposal is located) as a tourism-conservation-recreation destination, were also considered in the VIA. From two of the view locations (John Forrest Lookout and Lochada Road) a potential visual impact was identified, but was assessed as unlikely due the distance of the view location from the proposed disturbance footprint, shared visual characteristics (line and form) with the surrounding landscape and both view locations having a low level of public sensitivity. The VIA concluded that, for most of the landscape within 50 km of the proposed disturbance footprint, the Proposal will not have a visual impact on the surrounding landscape due to:

- vegetation screening along travel routes;
- landform screening along travel routes east of the development envelope; and
- the distance of the proposed disturbance footprint to key view locations.

DPaW is proposing to develop a walk trail around the eastern portion of Mungada Ridge. From the conceptual walk trail, the Proposal will be partially visible however is generally unlikely to be noticeable after rehabilitation. Some of the pit wall of the proposed pit may be visible where it extends above the proposed 2 m high bund that will surround the pit once rehabilitated. The waste rock dump, haul roads and infrastructure area will be rehabilitated with local endemic species and should therefore blend with the surrounding landscape.

Rehabilitation and decommissioning

A Mine Closure Plan has been prepared for the Proposal. The long-term goal for the Proposal is to ensure land disturbed by mining activities remains undisturbed from secondary impacts in the future, and that all disturbed areas are rehabilitated to as close as possible to the natural surroundings. The closure and rehabilitation objectives for the Proposal are to ensure land disturbed by SMC's mining activities is:

- safe to humans and wildlife;
- non-polluting;
- geotechnically and erosionally stable;
- self-sustaining with minimal maintenance required post-closure;
- ecologically similar to the pre-mining environment, incorporating local native plant taxa and fauna habitat;
- visually compatible with the surrounding natural landscape;
- suitable for agreed post-mining land uses; and
- compliant with the requirements of SMC's statutory approvals.

Indicative closure completion criteria have been developed for the Proposal with a view to refine these based on rehabilitation monitoring and trials during the life of the mine:

- all waste is removed and disposed of appropriately;
- at final closure, all project infrastructure has been decommissioned and taken off site;
- erosion from built landforms is similar (frequency of rills, rate of sediment yield) to naturally occurring colluvial slopes in the development envelope;
- geotechnical stability of the pit and dump slopes has an acceptable factor of safety under the worst case scenario;
- groundwater contaminant concentrations do not exceed Groundwater Investigation Levels as stated in the National Environmental Protection Measure (NEPM);
- if initial site baseline groundwater surveys indicate higher levels than NEPM investigation levels, post-mining water quality do not exceed pre-mining contaminant concentrations by more than two standard deviations;
- safety/abandonment bunds are in place;
- soil bulk density and infiltration capacity in upper 0.5 m of rehabilitated surface are comparable to pre-mining conditions;
- topsoil is stored for use during rehabilitation;
- waste rock dumps blend in with the surroundings and reduce the visual impact of the mine;
- within five years post-closure, flora and vegetation has been re-established as far as practicable; and
- within five years post-closure, weed coverage represents no more than in undisturbed nearby areas or less than 10%, whichever is the lesser.

The total waste that will be produced from the Proposal is approximately 13.5 Mt. Approximately 74% of this will be used to backfill the existing Mungada East pit. Approximately 22% will be disposed of to the existing Mungada East waste rock dump. The remaining 4% will be disposed of to the proposed new waste rock dump to the south-east of the proposed mine pit. The proposed waste rock dump has been designed such that its maximum elevation will be below the highest point on the natural ridge line.

Drainage systems will minimise the risk of contamination of natural water courses and groundwater. Suitable surface water drainage will be incorporated to limit seepage into the waste rock dump and reduce erosion of the slopes.

Sulphur concentrations (and the risk of acid formation) and acid neutralising capacity within ore grade and waste rock samples from the proposed mine pit have been assessed as generally low to very low. The risk of waste rock forming saline drainage or containing dispersive sodic clays is rated as very low, as is the risk of production of metalliferous drainage containing metals from stockpiles of ore or waste rock landforms.

Topsoil from the development envelope is considered to have suitable chemical properties for use in rehabilitation. SMC has implemented research trials at its existing operations at the Blue Hills and Koolanooka mines to determine the restoration requirements of its operations. The research trials are a collaboration with the Kings Park Botanic Gardens and Parks Authority. SMC will conduct rehabilitation and restoration with a view to return the post-mining land use to reflect the environmental values of the surrounding landscape.

Closure for the Proposal has been structured around a number of domains, each of which has been assigned closure implementation strategies. Rehabilitation will be conducted progressively where possible, and as such, final closure works are not anticipated to exceed 12 months from closure. Monitoring will be conducted annually and will continue for at least five years post-closure to demonstrate the acceptable health of rehabilitated vegetation communities.

Implementation of the Proposal is expected to produce the following long-term outcomes for the development envelope:

- the development envelope is non-polluting and safe to humans and wildlife;
- areas disturbed for waste landforms are geotechnically and erosionally stable, visually compatible with the surrounding natural landscape, and ecologically similar to the pre-mining environment;
- areas disturbed for mining and infrastructure are rehabilitated to a condition compatible with the post-mining land use following decommissioning; and
- land disturbed by the proposed mining activities remains undisturbed from secondary impact in the future.

Offsets

The proposed mine plan and design represents the outcome of a process of avoidance and minimisation of potential environmental impacts. During a preliminary environmental review, major modifications were made to reduce potential impacts. Of particular note, the extent of the proposed mining disturbance footprint on Mungada Ridge was reduced. The ridge is recognised as supporting higher conservation values than surrounding areas.

The modifications to the mine plan included:

- relocation of the proposed waste rock dump further away from the proposed mine pit and off Mungada Ridge;
- realignment of the proposed haul roads to reduce disturbance on Mungada Ridge; and
- backfill of the existing Mungada East pit with waste rock to be excavated from the proposed mine pit.

This process of avoidance and minimisation of potential impact to more significant areas has resulted in a reduction of impacts to a number of key values.

Measures to mitigate potential residual direct or indirect impacts include specific design measures, engineering controls, operational procedures and progressive rehabilitation aimed at restoring the maximum environmental value that is reasonably practicable given a modified landform.

The significance model from the WA Environmental Offsets Guidelines has been used to assess residual impacts and evaluate rationale for the application of offsets. Following the implementation of the mitigation hierarchy, residual impacts to terrestrial and subterranean fauna (both direct and indirect) and residual impacts to non-biodiversity impacts (in this case landforms and amenity) are not considered to be significant. As such, no offsets are considered necessary for these factors.

In the case of flora and vegetation, after applying the significance model from the WA Environmental Offsets Guidelines to residual impacts, the following residual impacts are considered significant impacts requiring an offset, or potentially significant impacts which may require an offset:

- ‘Significant residual impacts that will require an offset’:
    - removal of 2,634 individuals of *Acacia woodmaniorum* representing 25% of the number of individuals within tenements M59/595 and M59/596 and 10% of the number of individuals within the Tallering sub-region and WA;
- ‘Significant residual impacts that may require an offset’:
    - clearing of 669 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1), representing 29% of the number of individuals within tenements M59/595 and M59/596 and 12% of the number of individuals within the Tallering sub-region and WA.

In light of these residual impacts offsets are proposed for both *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. SMC proposes that its main offset consists of a re-establishment program to be undertaken that ultimately seeks to increase the populations of these flora and prospects of long-term survival of these species. As part of this offset, research and trials to inform best-practice rehabilitation specific to these species will be undertaken through a recently confirmed five year ARC research program. Components of both programs would include seed collection, trials to improve germination and establishment techniques, identification of potential habitat sites and translocation of seedlings. The replacement of approximately 3,413 *Acacia woodmaniorum* and 837 *Lepidosperma* sp. Blue Hills would be undertaken to completely offset the losses of individuals of these species as a result of implementation of the Proposal.

SMC proposes that its additional offset consists of on-ground management of portions of Mungada Ridge outside existing operations and the proposed development envelope and within tenements M59/595 and M59/596 (the Management Area), which provide habitat for approximately 5,563 individuals of *Acacia woodmaniorum* and 1,587 individuals of *Lepidosperma* sp. Blue Hills. On-ground management is considered likely to be of benefit to both species by reducing threatening processes and thereby averting the future loss of key environmental values.

SMC considers the EPA’s objective for this integrating factor will be achieved through the implementation of the proposed offsets to counterbalance the significant residual impacts identified for the Proposal, in this case being the removal of 2,634 individuals of *Acacia woodmaniorum* and 669 individuals of *Lepidosperma* sp. Blue Hills. The proposed offset is designed to replace those removed and reduce the risk of loss of individuals of these species outside the proposed disturbance footprint from threatening processes other than mining to increase the overall populations of these flora.

SMC will work with the EPA, in consultation with DPaW, in finalising the proposed environmental offset, counterbalancing as far as practicable significant residual impacts likely after consideration of efforts to avoid, minimise and mitigate impacts.

Other factors

Hydrological processes and inland waters environmental quality

There are no major rivers or creeks within or surrounding the development envelope. Surface water drainage occurs predominately through overland sheet flow. The proposed mine pit will extend to a maximum depth of 112 m below ground level and will not intersect groundwater; drill holes sampled in the proposed mine pit area have been drilled to 132 m below ground level and have not intersected groundwater. The surface water that drains from the Blue Hills range discharges southwards to a low-lying wetland basin that is surface water-dependent. Drainage structures will be designed and constructed to ensure minimal alteration to existing surface drainage patterns, and disturbance areas will be designed for minimal impact on surface drainage as far as practicable.

No impacts to groundwater quantity or quality are expected as dewatering is not required for the Proposal. It is anticipated that water requirements for the DSO Project operations will remain unchanged as a result of the implementation of the Proposal. All groundwater abstraction will be in accordance with the existing licence conditions issued under the *Rights in Water and Irrigation Act 1914* (WA).

After mitigation and management measures have been applied, the potential impacts to hydrogeological regimes and the environmental quality of groundwater and surface water as a result of the Proposal are not considered to be significant. Any potential impacts can be managed by the measures proposed and under other statutory processes, such as the *Rights in Water and Irrigation Act 1914* (WA).

Heritage

There are no sites of European heritage significance within or nearby the development envelope. The Blue Hills tenements have one registered Native Title Claimant Group: the *Widi* Mob. There are no 'Registered Aboriginal Sites' within the development envelope; however, three registered Aboriginal 'Other Heritage Places' occur within the development envelope. Two of these places are artefact scatters and one is the Blue Hills area. Disturbance of these three sites to facilitate construction and operation of the Proposal is unavoidable. The Proposal will require salvage and removal of the two artefact scatter sites and will partially affect Blue Hills. An application to disturb the Other Heritage Places was approved on 12 February 2016 under Section 18 of the *Aboriginal Heritage Act 1972* (WA) (Aboriginal Heritage Act). Disturbance will be in accordance with the provisions of the Aboriginal Heritage Act and will have the consent of the Traditional Owners. SMC will maintain ongoing consultation with Aboriginal stakeholders over the life of the Proposal.

SMC has prepared an Aboriginal Heritage Management Plan (AHMP) to ensure its staff and contractors understand the general requirements and management of heritage sites. The AHMP documents the management of all significant Aboriginal heritage sites within the development envelope. In particular, the AHMP contains measures in accordance with Section 17 of the Aboriginal Heritage Act to prevent the excavation, destruction, damage, concealment, or alteration of any Aboriginal site, and the possession, custody or control of any object on or under an Aboriginal site, unless authorised to do so under Section 16 or Section 18 of the Aboriginal Heritage Act.

Environmental management

SMC has an overarching Environmental Policy that promotes the company's objective to develop resources while also protecting and preserving the environment. SMC accepts responsibility for the impacts their operations have on the environment, and is committed to eliminate, mitigate, reduce, manage or offset these impacts.

Management controls to be implemented as part of the Proposal to ensure preliminary key environmental factors are managed as described in the PER document include measures and/or actions contained within the EMP, the Closure Plan and the AHMP. Management measures specific to the Proposal are outlined in this PER document and the EMP.

SMC has identified the regulatory controls that will ensure environmental values are protected during implementation of the Proposal. The key controls are:

- environmental conditions in any Statement issued by the WA Minister for Environment allowing the Proposal to be implemented;
- conditions relating to the rate and volume of groundwater extraction in accordance with the existing Licence to take Water #GWL159255(1) issued by the Department of Water;
- conditions of any Works Approval or Licence issued by the Department of Environment Regulation; and
- conditions of any Program of Works or Mining Proposal approvals issued by the Department of Mines and Petroleum.

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Abbreviations

Abbreviation	Description
Aboriginal Heritage Act	*Aboriginal Heritage Act 1972* (WA)
ABS	Australian Bureau of Statistics
ACMC	Aboriginal Cultural Materials Committee
AHD	Australian Height Datum
AHMP	Aboriginal Heritage Management Plan
AMD	Acid and metalliferous drainage
API	Assessment on Proponent Information
ARC	Australian Research Council
BGPA	Kings Park Botanic Gardens and Parks Authority
BIF	Banded iron formation
CALM	Department of Conservation and Land Management
CPL	CALM Purchased Lease
DAA	Department of Aboriginal Affairs
DAFWA	Department of Agriculture and Food WA
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DEWHA	Department of Environment, Water, Heritage and the Arts
DMA	Decision-making authority
DMP	Department of Mines and Petroleum
DoW	Department of Water
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
DSO	Direct shipping ore
DSO Project	Koolanooka/Blue Hills Mungada Direct Shipping Ore Project
EAG	Environmental Assessment Guideline
EIA	Environmental impact assessment
EMP	Environmental Management Plan
EP Act	*Environmental Protection Act 1986 (WA)*
EPA	Environmental Protection Authority
EPB	Environmental Protection Bulletin

Abbreviation	Description
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwth)
ESD	Environmental Scoping Document
FCT	Floristic Community Type
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
kg	Kilogram
kL	Kilolitre
km	Kilometre
kW	Kilowatt
L	Litre
LAU	Local assessment unit
LCT	Landscape Character Type
LCU	Landscape Character Unit
m	Metre
mAHD	Metres Australian Height Datum
MCA	Minerals Council of Australia
mg	Milligram
mm	Millimetre
Mm^3	Million cubic metres
MMP	Malleefowl Management Plan
MNES	Matter of National Environmental Significance
MS	Ministerial Statement
Mt	Million tonnes
Mtpa	Million tonnes per annum
NEPM	National Environment Protection Measure
NAF	Non-acid forming
OEPA	Office of the Environmental Protection Authority
P	Priority
PAF	Potentially acid forming
PEC	Priority Ecological Community
PER	Public Environmental Review
SMC	Sinosteel Midwest Corporation Limited
SRE	Short Range Endemic

Abbreviation	Description
TEC	Threatened Ecological Community
VIA	Visual Impact Assessment
VLE	Visual Landscape Evaluation
VMO	Visual management objective
WA	Western Australia
WAPC	Western Australian Planning Commission
WC Act	*Wildlife Conservation Act 1950* (WA)

Part 1 Introduction

This Part introduces and outlines the Proposal and the environmental impact assessment process together with the legislative context in which the Proposal being assessed.

1 Overview

Sinosteel Midwest Corporation Ltd (SMC) is proposing to expand its existing Koolanooka/Blue Hills Mungada Direct Shipping Ore Project (DSO Project), which is approximately 220 kilometres (km) south-east of Geraldton in the Midwest region of Western Australia (WA) (Figure 1). The proposed Blue Hills Mungada East Expansion Project (the Proposal) involves the construction and operation of a single new mine pit, one waste rock dump, processing infrastructure, associated haul roads and an access road. Ore will continue to be trucked to the existing facilities at Geraldton Port.

The Proposal will result in the clearing of up to 53.5 hectares (ha) of native vegetation (proposed disturbance footprint) on and adjacent to Mungada Ridge within a 172.5 ha development envelope. The Proposal is expected to produce an additional 4.4 million tonnes (Mt) of haematite iron ore over approximately three years. The Proposal will extend the life of the DSO Project from five to eight years.

1.1 Proponent

SMC is the proponent for the Proposal. SMC also owns, operates and manages the existing DSO Project.

All correspondence pertaining to this Public Environmental Review (PER) document should be directed to:

Community Relations
Sinosteel Midwest Corporation Ltd
3rd Floor, 7 Rheola Street
West Perth WA 6005
T: 08 9429 4888
F: 08 9226 3388
E: communityrelations@smcl.com.au

1.2 Purpose and scope of the Public Environmental Review

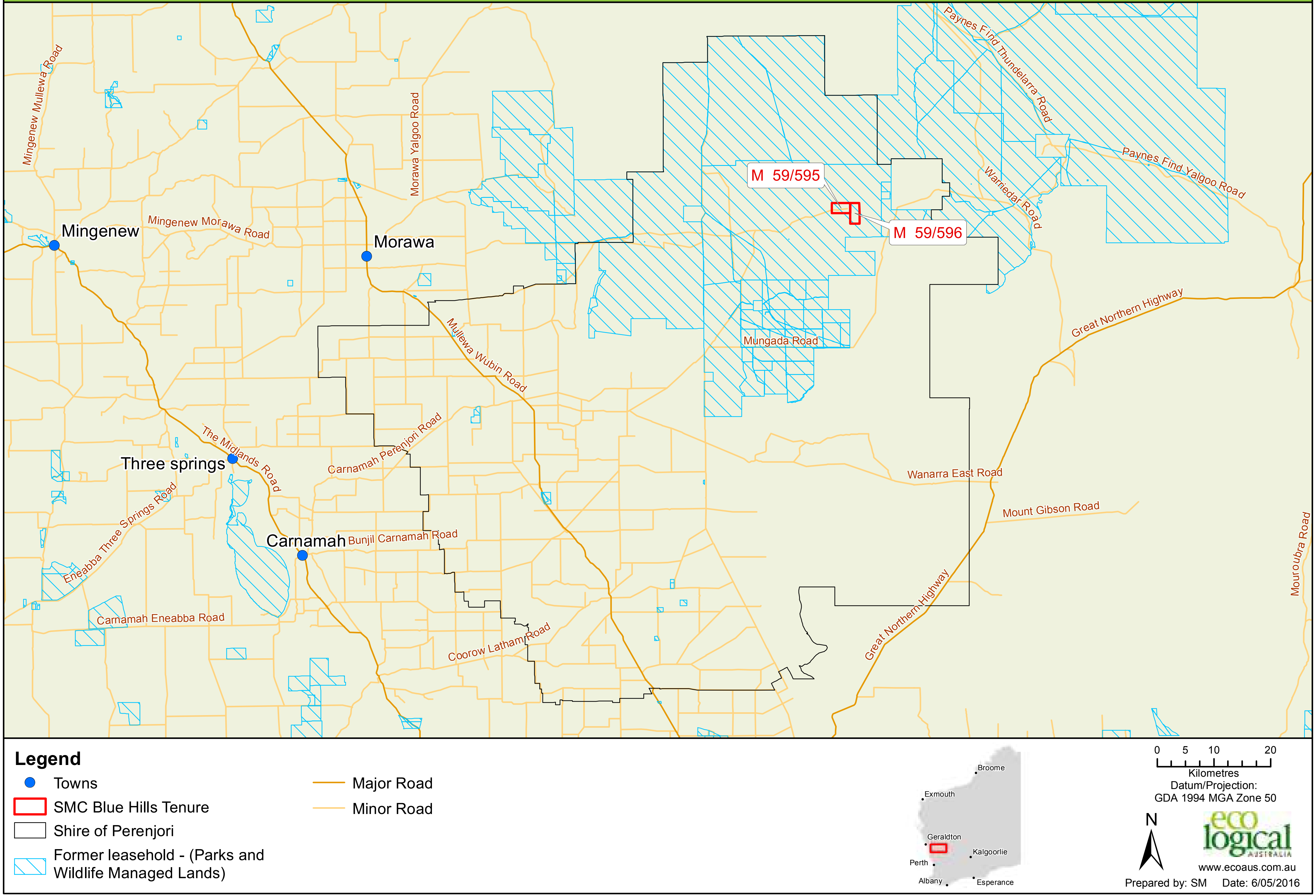
This PER document has been prepared in accordance with the Environmental Impact Assessment Administrative Procedures 2012 of the *Environmental Protection Act 1986* (WA) (EP Act), administered by the WA Environmental Protection Authority (EPA).

The purpose of this PER document is to present an environmental review of the principle components of the Proposal, and a detailed impact assessment and description of proposed environmental management measures for relevant environmental aspects in accordance with the scope outlined in the Environmental Scoping Document (ESD). This PER document is subject to a six week public review period.

This PER document considers the construction, operations and closure phases of the Proposal, and includes:

- a description of the relevant features of the existing environment within the development envelope containing the proposed disturbance footprint and surrounding areas as appropriate;
- a detailed description of the Proposal;
- a description of the approach taken for the environmental impact assessment including stakeholder engagement and consultation;
- a factor-by-factor assessment of the potential environmental impact of the Proposal; and
- a description of key proposed environmental management measures.

Figure 1: Regional location



2 Proposal background

2.1 DSO Project overview

SMC operates several iron ore projects in the Midwest region of WA, including the DSO Project. The existing DSO Project includes:

- mining, crushing and screening of ore from three pits:
  - one existing pit at the Koolanooka component (the Koolanooka mine), approximately 160 km south-east of Geraldton;
  - two existing pits at the Blue Hills component (the Blue Hills mine), named Mungada East and Mungada West pits, located approximately 60 km east of the Koolanooka mine; and
- transport of ore to the Geraldton Port.

The Blue Hills mine is located on Karara Station, a former pastoral lease purchased along with the Lochada, Kadji and Warriedar stations to form a combined proposed Conservation Park approximately 310,000 ha in size. The formal reservation of the purchased leases under the *Land Administration Act 1997* (WA) is in progress. In the interim, properties are being managed under an agreement between the Department of Parks and Wildlife (DPaW) and the Department of Lands (DPaW 2013).

The DSO Project was originally referred for assessment under the EP Act in April 2007 and was assessed at the level of PER. In its original report and recommendations, the EPA advised that it considered mining of Mungada Ridge environmentally unacceptable; indicating that mining at Mungada East could not be managed to meet the EPA's objectives in relation to the conservation of biodiversity and ecological integrity (EPA 2009a). Key issues identified related to impacts on flora and vegetation, fauna, landscape and recreational values, and rehabilitation and mine closure. Following the provision of additional information relevant to these factors during the subsequent appeals process, Ministerial approval for the DSO Project was granted in November 2009 by way of Ministerial Statement (MS) 811. Additional expansions of pits and infrastructure at the Blue Hills mine have been approved under Section 45C of the EP Act and MS 811 has been amended accordingly.

Operations commenced at the Koolanooka mine in April 2010, with mining and crushing ceasing in April 2013. A total of 98% of the Koolanooka mine has since been subject to rehabilitation works, with the balance to be completed in 2018.

Mining at the Blue Hills mine commenced in July 2013, with first production in September 2013. The approved mine schedule is for a three year operational period. Currently, the Blue Hills mine is in care and maintenance, while SMC awaits environmental approval to extend mining operations.

2.2 Proposal approvals process to date

A proposal to expand the existing Mungada East and Mungada West pits was referred for assessment under Section 38 the EP Act in September 2013. In April 2014, the EPA provided preliminary advice that the Mungada East component of the proposed expansion was considered environmentally unacceptable and recommended an Assessment on Proponent Information (API) category B (environmentally unacceptable) level of assessment. The EPA undertook consultation with SMC regarding the proposed expansion and, in June 2014, SMC requested that the proposed expansion of the Mungada West pit be removed from the proposal. The approval of the Mungada West component of the proposed expansion was then sought separately through an application under Section 45C of the EP Act. This application was made in August 2014 and approved in December 2014.

In its report to the Minister for Environment on the proposed expansion of the Mungada East pit (EPA Report 1532), which was released in November 2014, the EPA concluded that the proposed expansion could not be managed to meet its objectives for Landforms and was environmentally unacceptable and should not be implemented. Following consideration of appeals and with particular regard to further assessment of Landforms being considered appropriate, the Minister for Environment remitted the proposal back to the EPA in April 2015 pursuant to Section 101(1)(d)(i) of the EP Act and directed that the EPA assess the proposal under a PER level of assessment. Assessment of the proposal (this Proposal) is now being undertaken by way of a PER in accordance with the procedures set out in the EPA's Administrative Procedures and sections 40 to 48 of the EP Act.

2.2.1 Application of key preliminary environmental factors

Subsequent to the conclusion by the EPA that the Proposal was environmentally unacceptable, SMC commissioned a 'benchmarking review' of other resource projects that have previously been considered by the EPA. The purpose of the benchmarking review was to determine whether the Proposal had been appropriately considered and assessed. The intention of the review was to provide a comparative and objective assessment of the environmental issues for each project, the factors considered by the EPA and provide justification that a PER level of assessment is appropriate in relation to the potential impacts of the Proposal (Talis 2015). It was not a critique of the EPA administrative process nor was it to provide an opinion on the outcome of the assessments.

The review found that, under the EPA's current environmental impact assessment regime, there appears to be some inconsistency in the manner in which factors are applied, and in some cases assessed, across various projects, particularly those occurring in areas with significant environmental values (Talis 2015). This was particularly apparent in the application of the Landforms factor (Talis 2015).

During the preparation of this PER document, the OEPA has been upfront during consultation with SMC that the application of the Landforms factor in environmental impact assessment (EIA) is not as well defined as it is for other factors, and requires further development. This in terms of the level and type of information required to be presented in EIA documentation by proponents. As a result, the EPA recently released Environmental Protection Bulletin (EPB) 23: Guidance on the EPA Landforms factor (EPA 2015a). The purpose of the bulletin is to communicate how the Landforms factor is considered by the EPA in the EIA process and aims to provide proponents with some high level guidance on the EPA's objective for the Landforms factor to consider when developing their proposal or scheme.

SMC understands this PER is one of the first to have been prepared using EPB 23 as a guide for the assessment of whether the EPA's objective for the Landforms factor can be met with regard to implementation of the Proposal.

2.3 Location

The Proposal is located in the Midwest region of WA, within the Shire of Perenjori (Figure 1). The closest towns are Perenjori and Morawa, which are approximately 65 km south and 85 km west of the Proposal respectively. The largest regional town is Geraldton, approximately 220 km west of the Proposal.

2.4 Mungada Ridge

The landform associated with the Proposal is Mungada Ridge in the Blue Hills Range, which is one of a number of BIF ranges in the Yilgarn Craton. There are two key areas in the Yilgarn Craton where BIF landforms occur: the south-west cluster known as the Mungada/Karara/Koolanooka region (containing Mungada Ridge) and the south-east cluster known as the Mount Manning region. Due to their unique geology, soils and relative isolation, the BIF landforms of the Yilgarn Craton are considered to be of significant biodiversity value (DEC 2007).

A number of attributes (relating to size, height, steepness/relief) of Mungada Ridge make it one of the more prominent BIF landforms in the Mungada/Karara/Koolanooka region. These attributes, along with a number of conservation significant flora and fauna values and restricted vegetation types, contribute to its relative significance in the region. In determining whether to proceed with this Proposal, and considering the EPA's previous advice on Mungada Ridge, SMC has undertaken detailed analysis of the Ridge's values. In doing so, it has identified that Mungada Ridge is not unique and its features are shared with a number of other BIF landforms. It is noted that Mungada Ridge is not the largest, highest, nor steepest landform in the region. Of the vegetation types and conservation significant flora and fauna that occur, none are strictly endemic to the ridge. A detailed analysis and description of the significance of Mungada Ridge is provided in Section 13.2.3.

2.5 Proposal rationale and benefits

Iron ore remains the State's largest sector in terms of value accounting for $54 billion or 71% of total mineral sales in 2014-15 (Department of Mines and Petroleum [DMP] 2015). New and expanding mining projects are necessary to maintain ongoing benefits to the WA economy from iron ore exports. The value of WA's mineral and petroleum industry was $99.5 billion in 2014-15, representing a fall of 19% from 2013-14's record of $122 billion.

The Proposal will enable operations at the Blue Hills mine to continue beyond the expected three year mine life at a mining rate of approximately 1.5 million tonnes per annum (Mtpa). The advantages of scale, ore quality, and existing infrastructure (approved for development) make the Proposal a highly desirable option for continuing SMC's operations, with consequent benefits for the local and wider community.

Implementation of the Proposal will generate royalties and taxation payments for both the State and the Commonwealth governments. The Proposal will also enable an operational workforce to be maintained beyond the lifespan of the existing mine and will provide ongoing opportunities for local businesses and communities. SMC has previously received strong community support for the development of the Blue Hills mine. Furthermore, SMC has a sound record of successful environmental management at Blue Hills and Koolanooka. This provides confidence that the implementation of the Proposal will be undertaken by an experienced proponent with demonstrated success in environmental management.

2.6 Alternatives considered

SMC recognises the environmental values of the Blue Hills area and, as part of its management approach, has developed and pursued alternative mine plans to optimise the proposed mining footprint. The current mine plan is the result of a planning process aimed at avoiding and minimising environmental impacts. Major modifications were made to reduce potential environmental impacts. In particular, the extent of the mining footprint located on Mungada Ridge, which supports higher conservation values than areas off the ridge, was significantly reduced. This was achieved by relocating the proposed waste rock dump off the ridge and outside of the Priority Ecological Community (PEC) occurring there, despite resulting in significant higher cost for haulage within the development envelope.

2.6.1 No development option

The 'do nothing' alternative would result in the loss of economic, social and employment opportunities (particularly within the Midwest region) and the loss of potential for future development of SMC's business. The development of overseas projects, or projects in other regions, to meet the world's demand for iron ore will result in the loss of associated benefits to Morawa, Perenjori and other communities in the Midwest region of WA. The Proposal would result in the continuation of an existing operation, which brings with it efficiencies and confidence in the outcomes, more so than compared to a 'greenfields' development.

Part 2 Description of the Proposal

This Part describes the Proposal as intended to be implemented, including information on the design and scheduling of the Proposal.

3 Development overview

3.1 Existing operations

Existing operations at the Blue Hills mine involve extracting haematite ore from two pits, Mungada East pit and Mungada West pit (Figure 2). The development of these pits involved the expansion of historic mine pits (remnants of mining at Blue Hills between 1960 and 1970). Waste from the pits is deposited into two waste rock dumps, one adjacent to the existing Mungada East pit and one adjacent to the existing Mungada West pit. A semi-mobile dry crushing and screening plant operates adjacent to the Mungada West waste rock dump, which blends and processes the ore into lump and fine products at a rate of up to 2 Mtpa. High grade haematite ore is transported by road from the crushing plant at the Blue Hills mine to either the nearby Karara mine (to be loaded onto a train) or trucked directly to the SMC's storage and ship loading shed at the Geraldton Port.

Supporting infrastructure at the Blue Hills mine includes an office, workshop, warehouse and magazine buildings, power and water supplies and communications infrastructure. The production of DSO lump and fine fractions, using dry crushing and screening, requires limited water use. Daily water use of approximately 1,200 kilolitres (kL) is required at the Blue Hills mine for haul road dust suppression and other mining activities. Water required for mine operations is sourced from existing local bores.

Electrical power required for the crushing and screening circuit and associated infrastructure at the Blue Hills mine is approximately 500-1,000 kilowatts (kW). This is below the threshold requiring licensing and is supplied by portable diesel fuelled power generators, maintained and operated by contractors. Diesel for the generators is stored in in double-skinned fuel tanks.

The Blue Hills mine workforce will be accommodated at the nearby Karara mine site.

3.2 The Proposal

The Proposal involves the construction and operation of a new mine pit adjacent to the existing Mungada East pit, one waste rock dump, processing infrastructure (for crushing and screening), associated haul roads and an access road (Figure 3). Ore from the proposed mine pit will be processed using the new processing infrastructure. Most of the waste rock from the proposed mine pit will be utilised to backfill the existing Mungada East pit (which would otherwise not occur), and the remainder will be stored in a new waste rock dump.

The original proposed location of the waste rock dump is shown in Figure 4. This element of the Proposal was relocated in the current mine plan in order to minimise the extent of the proposed disturbance footprint located on Mungada Ridge and within the PEC (refer to Section 2.6), which supports higher conservation values than surrounding areas.

3.3 Key characteristics

The key characteristics of the Proposal are presented in Table 1 in accordance with EPA Environmental Assessment Guideline (EAG) No. 1 – Defining the key characteristics of a proposal (EPA 2012a). The Proposal will result in the clearing of up to 53.5 ha of native vegetation on and adjacent to Mungada Ridge within a 172.5 ha development envelope. A total of 22 ha of clearing will occur on the Mungada Ridge landform, with the remainder to occur outside the ridge boundary.

The disturbance footprint of all elements of the Proposal will be contained within the development envelope (Figure 3) and will not exceed the prescribed clearing limits (Table 1). Conceptual locations for individual elements of the Proposal are shown in Figure 3.

Table 1: Key characteristics of the Proposal

Summary of the Proposal		
Proposal title	Blue Hills Mungada East Expansion Project	
Proponent name	Sinosteel Midwest Corporation Limited	
Short description	The Proposal is to construct and operate one open-cut hematite iron ore mine pit and associated mine waste rock dump, processing infrastructure, haul roads and access road. The Proposal is located approximately 65 km north-east of Perenjori in the Midwest region of WA.	
Physical Elements		
Element	Location	Proposed Extent
Mine pit and pit abandonment bund area	Figure 3	Clearing of no more than 18.6 ha within a 172.5 ha development envelope
Waste rock dump	Figure 3	Clearing of no more than 11 ha within a 172.5 ha development envelope
Supporting infrastructure (processing)	Figure 3	Clearing of no more than 11.3 ha within a 172.5 ha development envelope
Haul roads and access road	Figure 3	Clearing of no more than 12.6 ha within a 172.5 ha development envelope
Operational Elements		
Element	Location	Proposed Extent
Waste material	Figure 3	Approximately 13.5 million tonnes of waste rock[1] – the majority used to backfill the existing Mungada East pit and the remainder disposed of to the proposed waste rock dump and the existing Mungada East waste rock dump.

[1] The estimated amount of waste material to be produced from the Proposal was incorrectly stated as 1.6 Mt in the Environmental Scoping Document (ESD) for the Proposal. The correct amount is 13.5 Mt. The 1.6 Mt stated in the ESD was the amount of waste rock estimated to be disposed of to the proposed waste rock dump. The disturbance footprint of the proposed waste rock dump has not increased from the area stated in the ESD (11 ha), as a large percentage of the waste produced from the proposed mine pit will be used to backfill the existing Mungada East pit.

Figure 2: SMC Blue Hills operations

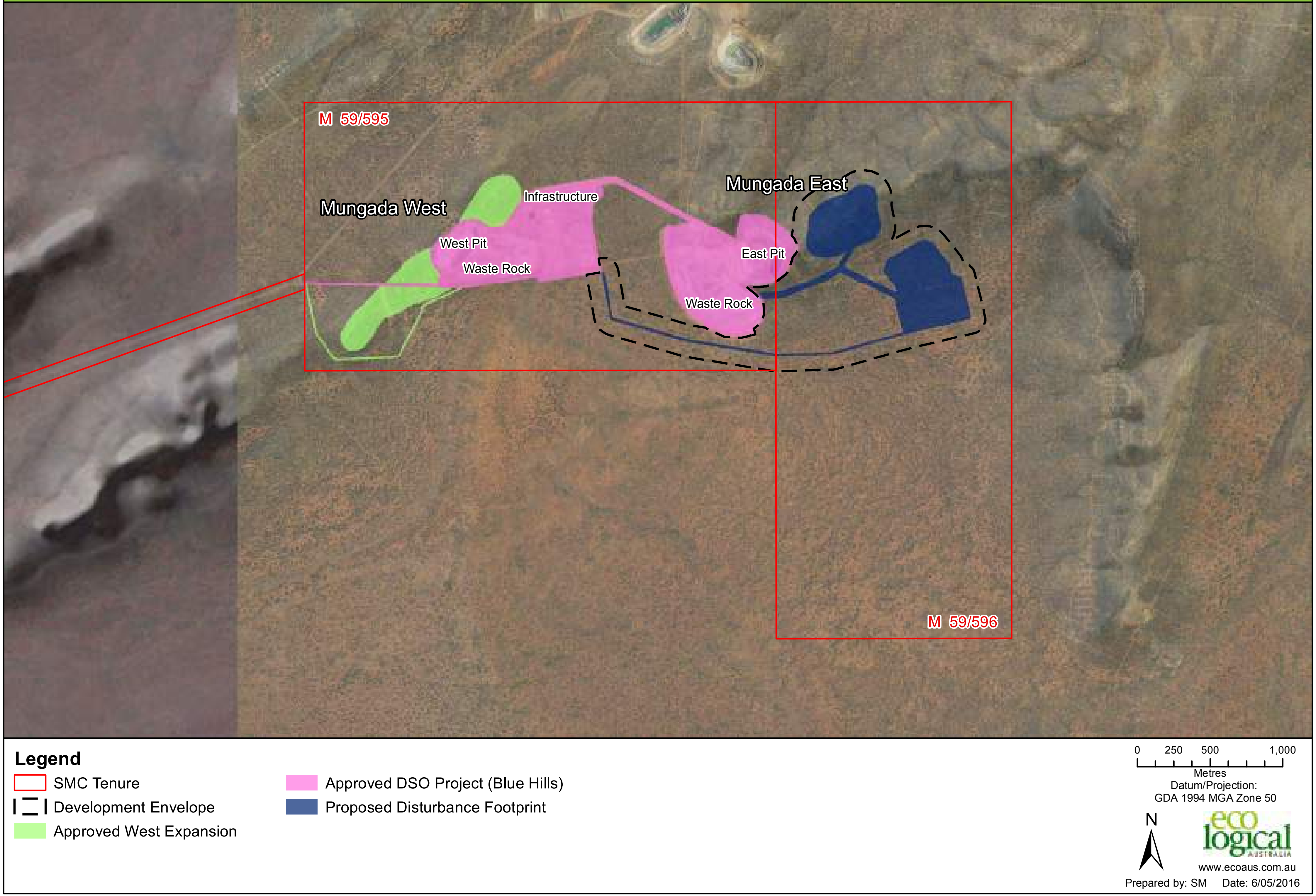


Figure 3: Proposal layout

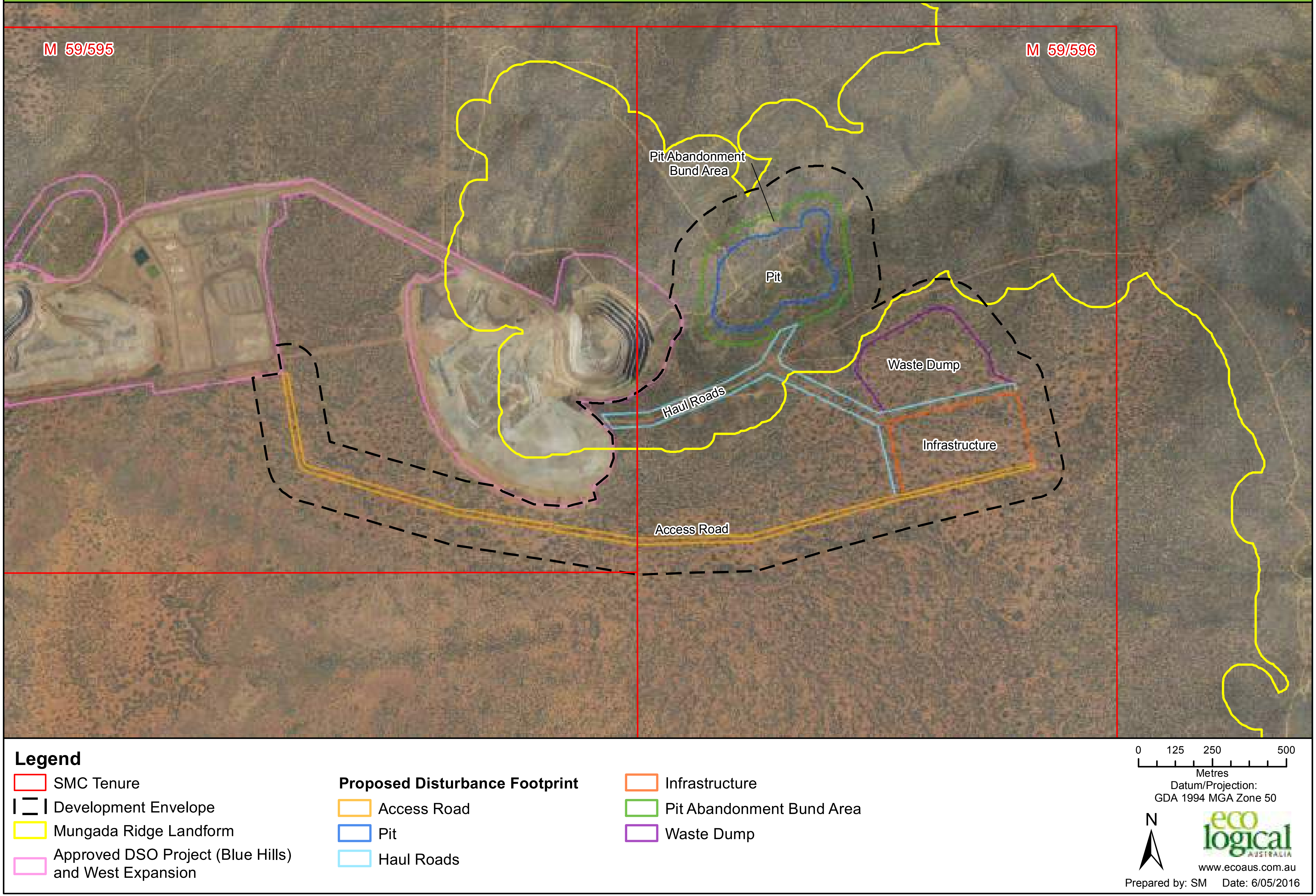
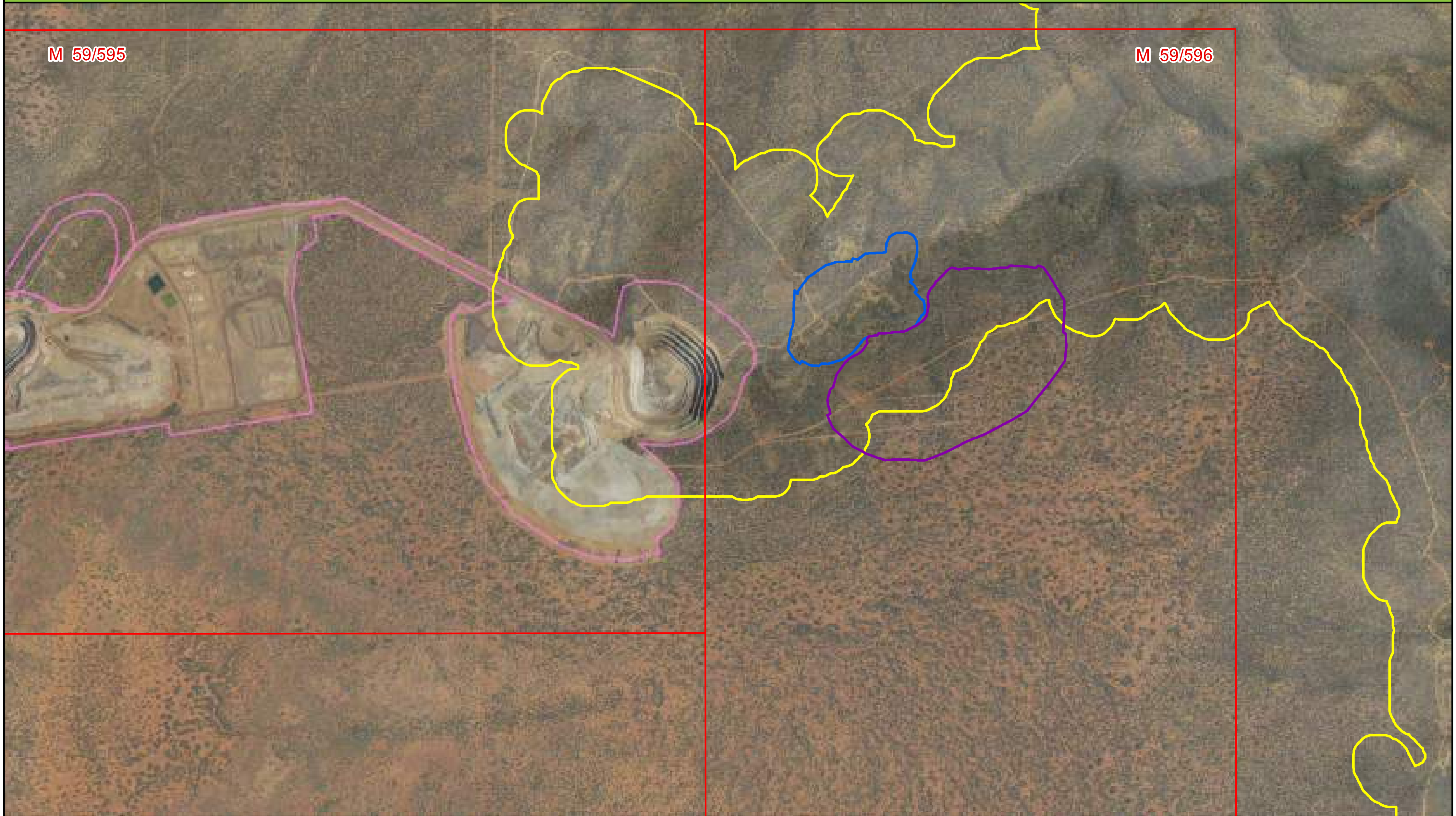


Figure 4: Initial proposal layout



Legend

- SMC Tenure
- Mungada Ridge Landform
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Pit
- Proposed Waste Dump (Initial Location)

4 Proposal description

4.1 Development of the mining operation

4.1.1 Ground disturbance and clearing

The Proposal will require the clearing of up to 53.5 ha of native vegetation. Topsoil and vegetation will be stripped and stockpiled in dedicated areas for later use in rehabilitation. Topsoil will be placed onto areas as soon as they are ready for revegetation to minimise the long term stockpiling of topsoil. Designated topsoil stockpiles will be placed within the existing approved stockpile areas for the DSO Project (MS 811). Topsoil stockpiling will occur in small volumes given that soil profiles in the region naturally contain only a thin topsoil horizon.

4.1.2 Surface water diversions

There are no major waterways requiring modification or diversion to facilitate construction and operation of the Proposal. Localised modification of surface sheetflow paths will be necessary to protect mine infrastructure from flood risks. Culverts, crossings, and roadside drainage will be installed along the proposed haul and access road.

Control of interactions between natural surface water drainage, mining operations, and waste rock dumps will be managed through standard practices, which typically include a series of diversion bunds, levees, drains, silt traps and in-pit sumps.

4.1.3 Mining and processing

Conventional open pit mining techniques will be employed for the Proposal. These will involve drilling, blasting, excavation, stockpiling, crushing, loading and hauling. The proposed Mungada East Extension pit and pit abandonment bund will require vegetation clearing of no more than 18.6 ha.

Ore from the proposed mine pit will be unable to be processed using the existing plant location, due to the long distance between the proposed mine pit and the plant. New processing infrastructure is proposed to be constructed to process ore from the proposed mine pit. This will require vegetation clearing of no more than 11.3 ha. Processed ore will be stored at the existing stockpile storage area near the existing Mungada West pit and transported to Geraldton Port.

4.1.4 Waste material

Approximately 13.5 Mt of waste material will be produced through implementation of the Proposal. The estimated amount of waste material to be produced from the Proposal was incorrectly stated as 1.6 Mt in the ESD for the Proposal. The correct amount is 13.5 Mt. The 1.6 Mt stated in the ESD was the amount of waste rock estimated to be disposed of to the proposed waste rock dump. The disturbance footprint of the proposed waste rock dump has not increased from the area stated in the ESD (11 ha), as a large percentage (approximately 74%) of the waste produced from the proposed mine pit will be used to backfill the existing Mungada East pit. The majority of the remaining material (22%) will be disposed of to the proposed waste rock dump to the south-east of the proposed mine pit. This will require vegetation clearing of no more than 11 ha. The remaining 4% will be disposed of to the existing Mungada East waste rock dump.

4.2 Mine support facilities and other infrastructure

4.2.1 Access and haul roads

A new 2.8 km long access road is proposed to connect the Proposal to the existing Blue Hills mine. The access road will be constructed to the south of the existing Mungada East pit and waste rock dump and will run from the existing Blue Hills mine haul road to the proposed processing infrastructure.

Two new haul roads will be required to facilitate movement of ore from the proposed mine pit. The first will be constructed between the existing Mungada East pit and the proposed mine pit to facilitate backfilling of the existing Mungada East pit. The second, a transport haul road, will connect the first haul road to the proposed processing infrastructure and waste rock dump. The proposed haul roads will total approximately 1.8 km in length. The proposed haul roads have been aligned with areas of existing tracks where possible to minimise the amount of vegetation clearing required.

Together, the proposed access road and haul roads will require vegetation clearing of no more than 12.6 ha.

4.2.2 Infrastructure and consumables

No additional infrastructure or consumables will be required, as existing support infrastructure, water and power supply will be used to support the Proposal. Power and water requirements will remain consistent with current use as the mining rate will not be increased.

4.3 Schedule

The Proposal is in the very early stages of development and a mining schedule has not yet been confirmed. Details and dates of proposed commencement and completion will be determined closer to development.

Part 3 Overview of existing environment

This Part provides an overview of the relevant features of the existing environment. A more detailed description of preliminary key environmental factors together with the potential impact of the Proposal and relevant key management measures is presented in Part 5.

5 Physical environment

5.1 Climate

The Midwest is semi-arid, with hot summers (October to April) and mild to cool winters (May to September). The highest average monthly rainfall occurs between May and July. The combination of high wind speeds in summer months and high temperatures results in elevated evaporation rates. Prevailing ambient dust levels are extremely high in these conditions. The closest official Bureau of Meteorology (BoM) weather recording station is at Paynes Find (Station No. 007139). Key climatological indicators from this location are (BoM 2015):

- mean daily maximum temperature: 37.4 °C (January) – 18.5 °C (July);
- mean daily minimum temperature: 21.2 °C (February) – 5.4 °C (July);
- mean annual rainfall: 282.7 millimetres (mm); and
- mean number of days of rain ≥1 mm: 23.1 days.

5.2 Land systems

Three land systems occur within the development envelope: Tallering, Yowie and Cunyu (Payne et al. 1998; Table 2 and Figure 5).

Table 2: Land systems in the development envelope

Land System	Description
Tallering	Characterised by prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks. The soils of the hillslopes and ridges are shallow red earths and stony red earths with smaller areas of red clayey sands with ferruginous gravel found on the stony and gravely plains.
Yowie	Dominated by loamy plains and has soils of variable depth including red clayey sands, hardpan loams and red earths on hardpan. Smaller areas of variable depth exist, with red clayey sands and ferruginous gravel over hardpan and deep red earths and juvenile alluvial deposits occur on the gravely plains and narrow drainage tracts of the land system.
Cunyu	Calcrete platforms and intervening alluvial floors and minor areas of alluvial plains, including channels with Acacia shrublands and minor halophytic shrublands.

5.3 Geology and landform

The development envelope lies on the Yilgarn Craton of mainly crystalline Archaean rocks (Rockwater 2006). The portion of the Yilgarn Craton within the development envelope is mainly comprised of granitoid rocks containing enclaves of older metamorphosed and folded supracrustal sedimentary, mafic and volcanic rocks. The older rocks include banded iron formation (BIF) landforms, which generally form linear ridges protruding from comparatively flat areas underlain by granitoid rocks. However, the BIF landforms are generally of low elevation as a result of weathering over a very long period (Gibson et al. 2007). Two geology types occur in the development envelope as defined by the Geological Survey of Western Australia and Geoscience Australia (2008) (Figure 6):

- **Asy** - conglomerate, chert, small amounts felsic volcaniclastic rocks, sandstone, quartzite, siltstone, phyllite, schist, pelite, shale. Include former Hatfield Formation; and
- **Qrc** - colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite.

Indicative BIF occurs predominantly in the Asy geological type which is defined by the Geological Survey of Western Australia and Geoscience Australia (2008) as Aih (Hematite, Magnetite and Quartz) (Figure 6).

The Blue Hills range includes the landscape features of Mount Karara, Blue Hills and Mungada Ridge, and forms some of the highest relief in the local area. A portion of the development envelope is located on Mungada Ridge. Mungada Ridge is 685 ha in size, and at its highest point, lies at 510 metres Australian Height Datum (mAHD). The steepest slopes of Mungada Ridge are between 19 to 20 degrees.

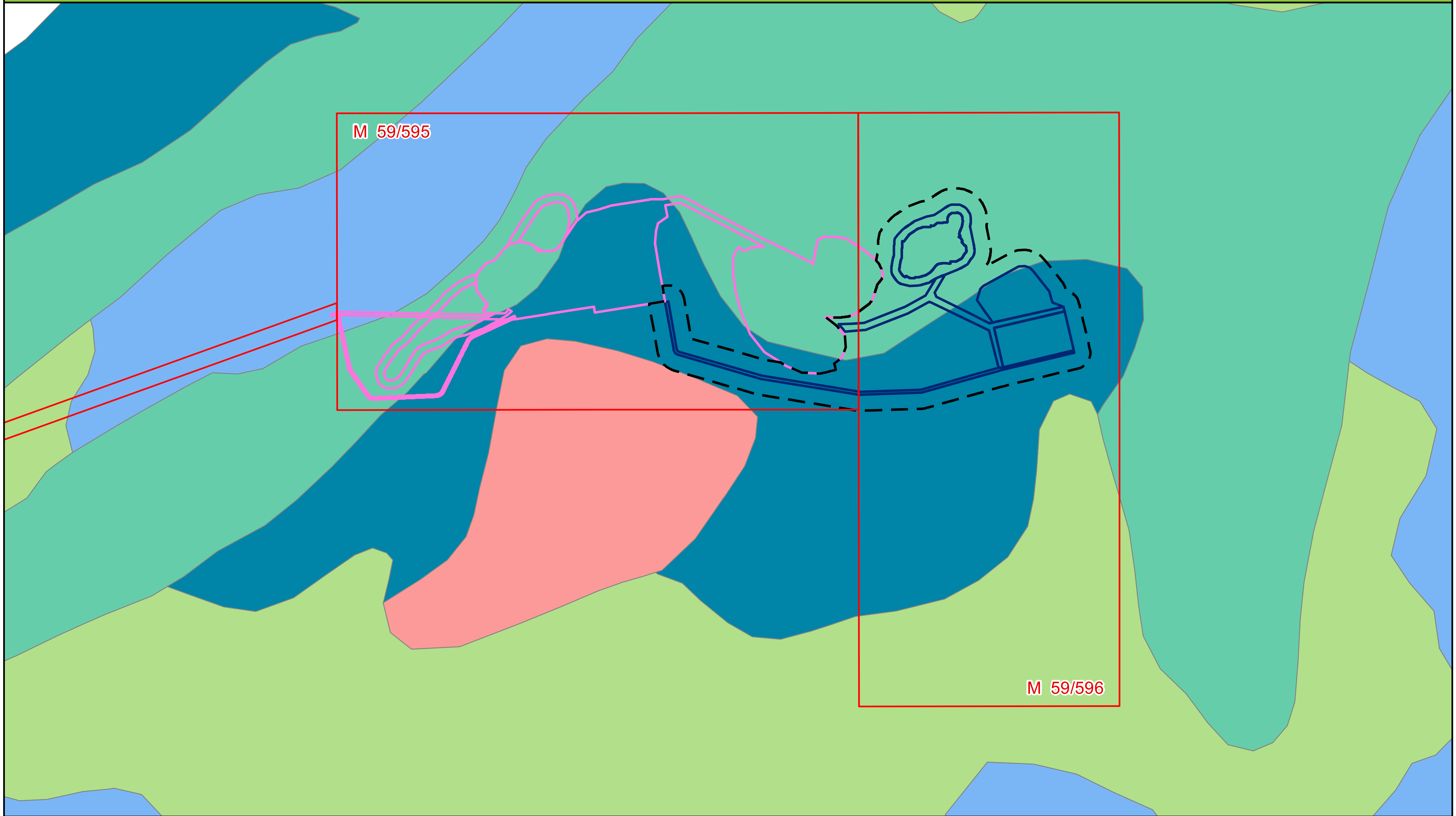
5.4 Surface hydrology and hydrogeology

There are no major rivers or creeks within or surrounding the development envelope. Surface water drainage occurs predominately through overland sheet flow. Drainage pathways (generated using a digital elevation model in ArcGIS) for the development envelope and surrounds are shown in Figure 7.

Surface water that drains from the Blue Hills Range generally discharges southwards to a low-lying drainage depression that represents the headwaters of a surface water drainage pathway. This is a 60 ha area approximately 700 m due south of the existing Mungada East pit and is considered a seasonal surface water-dependent wetland. This seasonal wetland is not groundwater dependent (refer to Section 20.1).

Large groundwater supplies are not uncommon on the Yilgarn Craton (Rockwater 2006). In most cases, rates of supply are quite low and salinities are in the range 2,000 to 5,000 mg/L total dissolved solids (TDS). Fresh groundwater is generally associated with hilly areas and groundwater salinity generally increases markedly towards the lower parts of the landscape and with depth in bores (Rockwater 2006). The mining associated with the Proposal will not extend below the water table and therefore the hydrogeology of the Proposal area has not been described in further detail in this PER document.

Figure 5: Land systems



Legend

SMC Tenure
Development Envelope
Approved DSO Project (Blue Hills) and West Expansion
Proposed Disturbance Footprint

Land Systems

Cunyu
Graves
Pindar
Tallering
Tealtoo
Yowie

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

www.ecoaus.com.au

Prepared by: SM Date: 6/05/2016

Figure 6: Geology

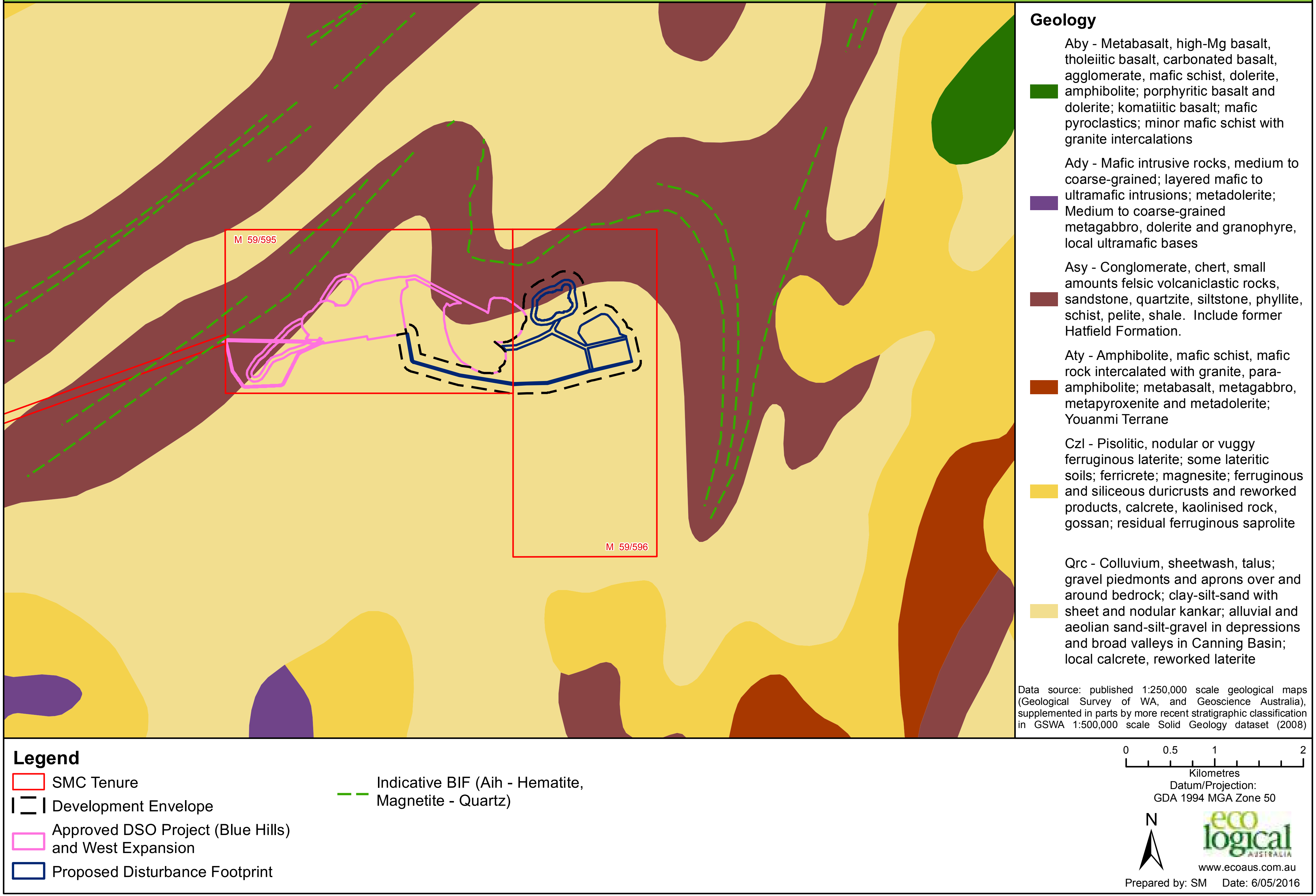
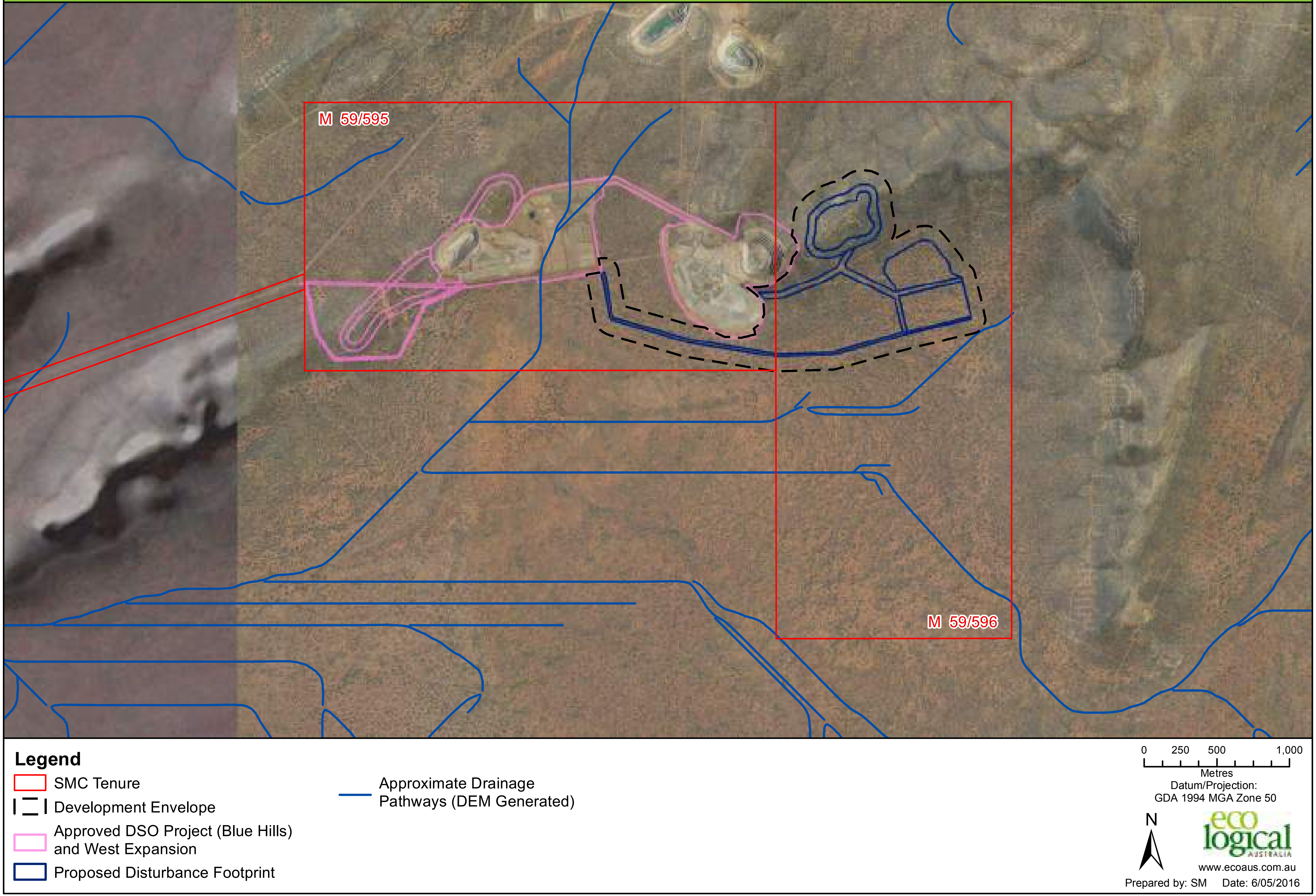


Figure 7: Surface hydrology



6 Biological environment

6.1 Biogeographic region

The Interim Biogeographic Regionalisation for Australia (IBRA) divides the Australian continent into 89 bioregions and then into 419 sub-regions according to the major geomorphic features in each bioregion (Department of the Environment 2013). The development envelope is located within the Yalgoo IBRA bioregion and the Tallering IBRA sub-region. The Yalgoo bioregion is characterised by low woodlands to open woodlands containing *Eucalyptus*, *Acacia* and *Callitris*. These are on red sandy plains of the Western Yilgarn Craton and southern Carnarvon Basin.

6.2 Vegetation and flora

Numerous flora and vegetation surveys have been conducted within and in the vicinity of the development envelope, commencing in 2003 (refer to Section 11).

6.2.1 Vegetation

Based on the most recent vegetation mapping for SMC's tenements at Blue Hills (Maia 2016), seven vegetation associations occur in the development envelope. In general, the vegetation is dominated by Low Woodland of *Eucalyptus loxophleba* subsp. *supralaevis* and/or *E. kochii* with smaller areas of Mixed and *Acacia* shrublands (Maia 2016). The majority of the vegetation in the development envelope is in Excellent condition (as defined by Keighery 1994), with some small areas of Good condition and some that have been previously cleared.

Based on a conservation significance rating system developed by Maia (2016), six of the seven vegetation associations mapped during the assessment are considered to be of high conservation significance at the local scale. Regional significance of vegetation is indicated by Floristic Community Types (FCTs) mapped by Woodman (2008a) across Mt Karara and Mungada Ridge.

No Threatened Ecological Communities (TECs) occur within or in the vicinity of the development envelope. One PEC occurs in the development envelope: the Priority 1 'Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation)'.

6.2.2 Flora

In the broader area comprising SMC's Blue Hills tenements (M59/595 and M59/596), 394 vascular flora taxa from 57 families and 174 genera have been recorded to date (Maia 2016). Of these, 362 taxa are native and 32 are introduced. The most common families recorded are Asteraceae (65 taxa), Fabaceae (53 taxa) and Myrtaceae (26 taxa).

One Threatened flora species and 10 Priority (P) flora species occur in the development envelope:

- *Acacia woodmaniorum* (Threatened);
- *Acacia karina* (P1);
- *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1);
- *Acacia subsessilis* (P3);
- *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3);
- *Drummondita fulva* (P3);
- *Gunniopsis divisa* (P3);
- *Micromyrtus acuta* (P3);
- *Micromyrtus trudgenii* (P3);

- *Persoonia pentasticha* (P3); and
- *Rhodanthe collina* (P3).

All but three of these species (*Calotis* sp. Perrinvale Station [R.J. Cranfield 7096], *Gunniopsis divisa*, *Persoonia pentasticha*) are considered to be regional endemics (restricted to an area within a 100 km radius) (Markey & Dillon 2008; Meissner & Coppen 2014 as cited in Maia 2016). The majority of the individuals of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) occur on Mungada Ridge; however, a comprehensive desktop analysis of all available biological survey information determined these species are not strictly endemic to the ridge (ecologia 2013).

The vegetation and flora of the development envelope is described in more detail in Section 14.

6.3 Terrestrial fauna

A number of terrestrial surveys have been conducted within and in the vicinity of the development envelope, commencing in 2004 (refer to Section 11).

6.3.1 Habitats

Terrestrial fauna habitat types were originally mapped across the majority of SMC's Blue Hills tenements (M59/595 & M59/596) by ecologia (2011a). This mapping was updated and extended to cover the whole of the tenements by ecoscape (2016a). Based on this most recent mapping, four terrestrial fauna habitats occur across the tenements including within the development envelope:

- rocky ridge with steep slopes;
- low slopes with dense acacia shrubs;
- Eucalypt woodland plain with acacia shrubs; and
- Acacia shrubland plain.

6.3.2 Terrestrial vertebrate fauna

A total of 28 native mammal species, 181 bird species, 80 reptile species and eight amphibian species have been recorded, or have the potential to occur, in the development envelope (ecoscape 2016a). A number of conservation significant vertebrate fauna have the potential to occur in the development envelope with three of these having been recorded:

- Malleefowl (Leipoa ocellata);
- Peregrine Falcon (*Falco peregrinus*); and
- Gilled Slender Blue-Tongue (*Cyclodomorphus branchialis*).

A total of six introduced mammal species have been recorded, or have the potential to occur, in the development envelope including; rats, house mice, rabbits, goats, foxes and cats (ecoscape 2016a).

6.3.3 Short range endemic (SRE) terrestrial invertebrate fauna

One confirmed SRE species has been recorded in the development envelope; the conservation listed *Idiosoma nigrum*. An additional two potential SRE species and one species of 'unknown' SRE status (due to lack of taxonomic information) have been also recorded in the development envelope:

- *Idiosoma nigrum*. (confirmed);
- *Beierolpium* 'sp. 8/2' (unknown);
- *Urodacus* sp. 'blue hills' (potential); and
- *Westralaoma aprica* (potential).

The terrestrial fauna of the development envelope is described in more detail in Section 15.

6.4 Subterranean fauna

A Level 1 subterranean fauna assessment has been conducted for the development envelope (Bennelongia 2015). Two other subterranean fauna surveys have been conducted near the development envelope for the existing Blue Hills mine (ecologia 2008d, 2008e).

There is no suitable habitat for stygofauna in the development envelope, based on evidence of unsuitable geological and hydrological conditions (Bennelongia 2015). There is suitable habitat for troglofauna in the development envelope and surrounds in the form of BIF. One potentially troglobitic species has been recorded from the proposed mine pit, belonging to the hemipteran family Meenoplidae. All five specimens recorded were nymphs (sub-adults) and as such could not be identified to species level with certainty because of a lack of sexual and other characters used for species identification (S. Halse, Bennelongia pers. comm. 2015).

The subterranean fauna of the development envelope is described in more detail in Section 16.

7 Social environment

7.1 Social environment

The Proposal is in the Shire of Perenjori, which is approximately 360 km north of Perth and covers approximately 8,313 km^2 (Figure 8). There are six towns in the Shire of Perenjori: Bowgada, Bunjil, Caron, Latham, Rothsay and Perenjori. As of 30 June 2013, 924 people lived in the shire; the median age of the residents was 38.6 years (ABS 2015). The mining (22.7%); agriculture, forestry and fishing (22.1%); and construction (21.4%) industries accounted for 65% of all jobs in the Shire (ABS 2011). A total of 5.9% of individuals within this shire identify as Aboriginal/Torres Strait Islander (ABS 2011). The towns closest to the development envelope are Perenjori and Morawa (in the Shire of Morawa), approximately 65 km south and 85 km west of the Proposal respectively.

Morawa (895 residents within the statistical local area; ABS 2011) is a regional hub for the area. The closest major town is Geraldton (19,132 residents within the statistical local area; ABS 2011), which is approximately 225 km north-west of the Proposal. Geraldton is a major port hub for distribution of raw materials for the regional mining industry.

7.2 Land use and tenure

The key land uses in the region are pastoral and mining. In addition, several nature reserves occur in the Shire of Perenjori including Weelhamby Lake, Bowgada, West Perenjori and Caron nature reserves. SMC's two main Blue Hills tenements are M59/595 and M59/596. Two additional SMC tenements at Blue Hills are L59/62 (east-west access road) and L59/137 (small tenement of 0.024 ha providing access to water pipeline from Karara).

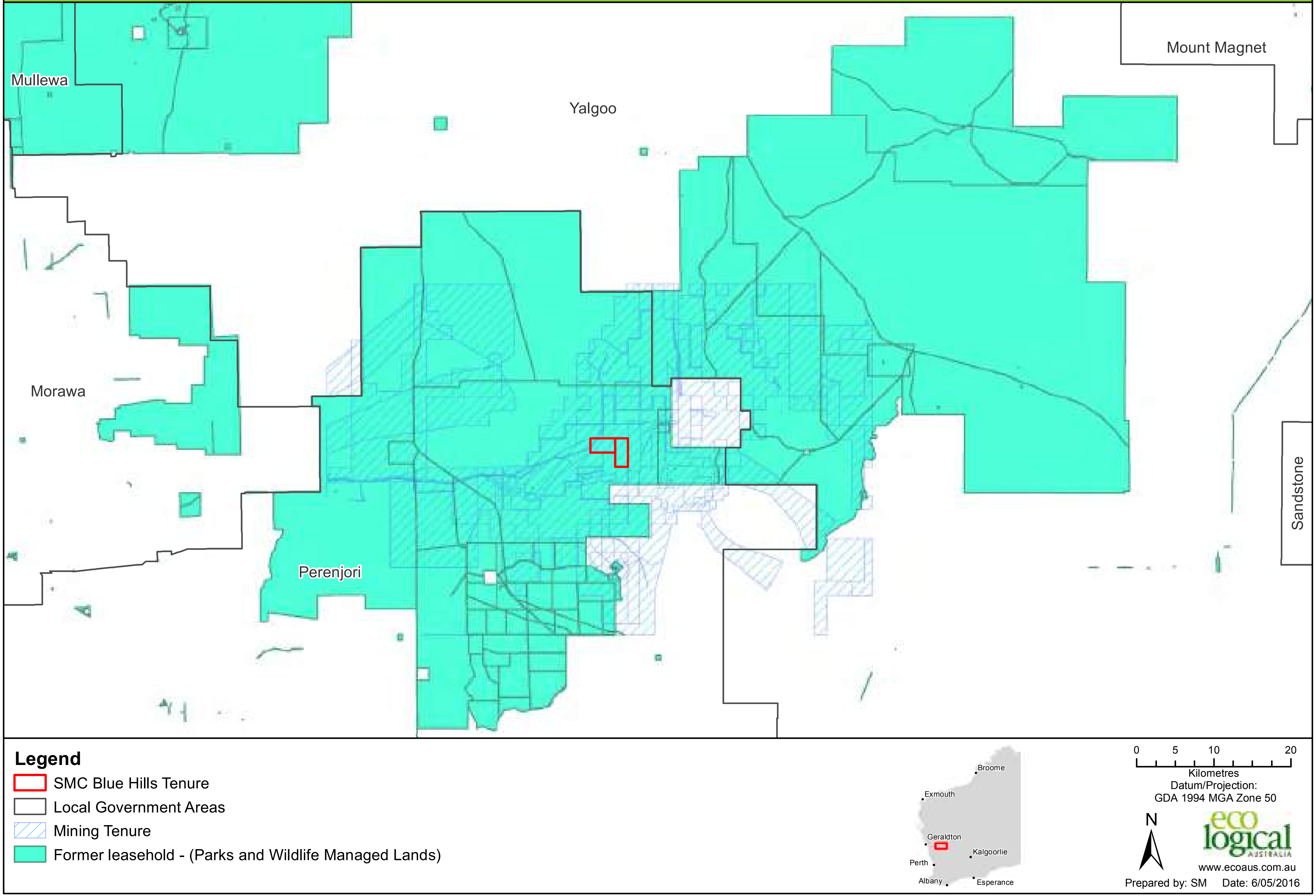
The area surrounding Blue Hills was formerly a pastoral lease, but is now Conservation and Land Management (CALM) Purchased Lease (CPL) 16 (Karara Station) and is under direct management by DPaW. Karara Station is 105,000 ha in size, and includes Windaning Hill and the Blue Hills Range. The entire area encompassing Karara Station, combined with other nearby CALM purchased stations (Lochada, Kadji and Warriedar) is proposed by DPaW to form one contiguous Conservation Park.

7.3 Heritage

The Blue Hills tenements have one registered Native Title Claimant Group: the *Widi* Mob. Several archaeological and ethnographic sites are known from Blue Hills. These were recorded/confirmed during the archaeological heritage and ethnographic surveys undertaken at the Blue Hills mine and vicinity in 2011 (Terra Rosa 2011a, 2011b). There are no 'Registered Aboriginal Sites' (Department of Aboriginal Affairs [DAA] 2015) within the development envelope. The DAA does list three registered Aboriginal 'Other Heritage Places' within the development envelope (DAA 2015): ID 24148 – Midwest Artefact Scatter 1, ID 24148 – Midwest Artefact Scatter 2 and ID 20859 – Blue Hills.

A search for European heritage places using the 'inHerit' search tool on the WA Heritage Council website returned no results for any sites of European heritage significance within or near the development envelope. The closest site of European heritage significance is the Rothsay townsite (place number 14133), located approximately 16 km south of the development envelope.

Figure 8: Land use and tenure



Part 4 Approach to environmental impact assessment

This Part describes the approach taken in considering the potential environmental impacts of the Proposal. This Part also includes details and outcomes of the stakeholder consultation process undertaken to date and includes information on the environmental studies conducted in support of the impact assessment.

8 Environmental assessment process

8.1 State environmental assessment process

The Proposal (in its original form which included the Mungada West expansion) was referred to the EPA under Section 38 of the EP Act in September 2013. The subsequent milestones in the environmental approvals process for the Proposal are summarised in Section 2.2.

The EPA issued an ESD (Appendix A) for the Proposal in July 2015. The ESD provides an outline of the preliminary key environmental factors, a description of the scope of the assessment of the Proposal and an indicative timeline for the assessment process.

The purpose of this PER document is to present an environmental review of the principal components of the Proposal, and a detailed impact assessment and description of proposed environmental management measures for relevant environmental aspects in accordance with the ESD. Relevant EPA Position and Guidance Statements have been used to determine the significance of the potential environmental impacts of the Proposal (Section 8.2).

The EPA will need to confirm the PER document as suitable for the six week public review period on the basis that it adequately addresses the expectations of the EPA set out in the ESD. Following the public review period, the EPA will provide to SMC copies (and a summary) of all the submissions received. SMC will respond to matters raised in the submissions to the satisfaction of the EPA.

The EPA will then assess the PER document, submissions received, SMC's response to submissions, and obtain advice from any other person it considers appropriate before submitting its assessment report to the Minister for Environment.

The EPA will then publish its report and recommendations. Any person may lodge an appeal to the Minister for Environment against the findings or recommendations of the EPA assessment report within 14 days of its publication. Subsequent to the determination of appeals (if any), the Minister then decides whether or not the Proposal should be implemented and if so, under what conditions.

The environmental assessment process for a PER is depicted in Figure 9.

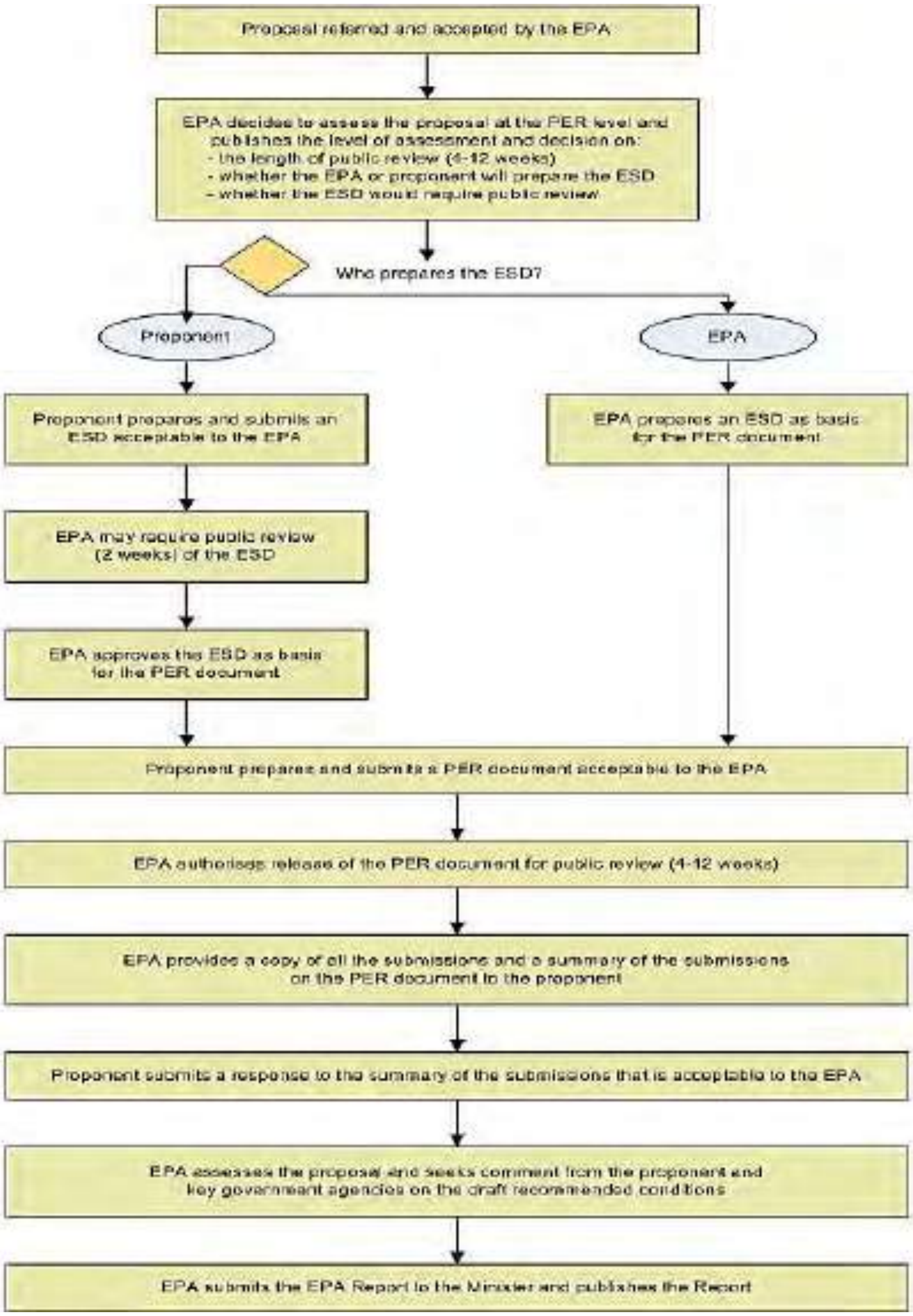


Figure 9: Public Environmental Review assessment process

8.2 Relevant State legislation, policy and guidance

The Proposal is subject to compliance with relevant state legislation and regulations. There are also key overarching state policies and strategies that are relevant to the Proposal. In addition, there are EPA Protection Bulletins, Position Statements, Environmental Assessment Guidelines and Guidance Statements that have been used to determine the significance of the potential environmental impacts of the Proposal. The relevant state legislation/regulations, policies, strategies and EPA guidance documents, are listed in Sections 8.2.1 to 8.2.5.

A table outlining how the relevant considerations in the relevant policies identified in the ESD have been given due consideration in the assessment is provided in Appendix B.

8.2.1 State legislation

- *Aboriginal Heritage Act 1972;*
- *Biosecurity and Agricultural Management Act 2007;*
- *Bush Fires Act 1954;*
- *Conservation and Land Management Act 1984;*
- *Contaminated Sites Act 2003;*
- *Country Areas Water Supply Act 1947;*
- *Dangerous Goods Safety Act 2004 and Regulations;*
- *Electricity Act 1945;*
- *Environmental Protection Act 1986 and Regulations;*
- *Health Act 1911 ;*
- *Heritage of Western Australia Act 1990;*
- *Land Administration Act 1997;*
- *Land Drainage Act 1925;*
- *Local Government Act 1995;*
- *Main Roads Act 1930;*
- *Mines Safety and Inspection Act 1994;*
- *Mining Act 1978;*
- *Native Title (State Provisions) Act 1999;*
- *Occupational Health and Safety Act 1984;*
- *Poisons Act 1964;*
- *Public Works Act 1902;*
- *Rights in Water and Irrigation Act 1914;*
- *Soil and Land Conservation Act 1945;*
- *Waste Avoidance and Resource Recovery Act 2007;*
- *Waterways Conservation Act 1976;* and
- *Wildlife Conservation Act 1950.*

8.2.2 State policies and strategies

- Hope for the future: The Western Australian State Sustainability Strategy (Government of Western Australia 2003);
- Statement of Planning Policy No. 2 - Environment and Natural Resources Policy (Western Australian Planning Commission [WAPC] 2003);
- Western Australia Greenhouse Strategy (Government of Western Australia 2004);
- WA Environmental Offsets Policy (Government of Western Australia 2011);
- Western Australia Water in Mining Guideline (Government of Western Australia 2013); and
- WA Environmental Offsets Guidelines (Government of Western Australia 2014a).

8.2.3 EPA Protection Bulletins and Position Statements

- Environmental Protection Bulletin (EPB) No. 1 – Environmental Offsets – Biodiversity (EPA 2014a);
- EPB No. 11 – Consultation on Conditions Recommended by the EPA (EPA 2012b);
- EPB No. 19 – EPA Involvement in Mine Closure (EPA 2013a);
- EPB No. 23 – Guidance on the EPA Landforms Factor (EPA 2015a);
- Position Statement No. 2 – Environmental Protection of Native Vegetation in WA (EPA 2000);
- Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002a);
- Position Statement No. 7: Principles of Environmental Protection (EPA 2004d); and
- Position Statement No 8: Environmental Protection in Natural Resource Management (EPA 2005).

8.2.4 EPA Environmental Assessment Guidelines and Guidance Statements

- EAG 1 – Defining the Key Characteristics of a Proposal (EPA 2012a);
- EAG 8 – Environmental Assessment Guideline for Environmental Principles, Factors and Objectives (EPA 2015b);
- EAG 9 – Application of a Significance Framework in the Environmental Impact Assessment Process (EPA 2015c);
- EAG 12 – Consideration of Subterranean Fauna in Environmental Impact Assessment in WA (EPA 2013b);
- EAG 17 – Preparation of Management Plans under Part IV of the Environmental Protection Act 1986 (EPA 2015d);
- Guidance Statement No. 6 – Rehabilitation of Terrestrial Ecosystems (EPA 2006);
- Guidance Statement No. 12 – Minimising Greenhouse Gas Emissions (EPA 2002b);
- Guidance Statement No. 20 – Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in WA (EPA 2009b);
- Guidance Statement No. 33 – Environmental Guidance for Planning and Development (EPA 2008);
- Guidance Statement No. 41 – Assessment of Aboriginal Heritage (EPA 2004a);
- Guidance Statement No. 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA (EPA 2004b);
- Guidance Statement No. 54a – Sampling Methods and Survey Considerations for Subterranean Fauna in WA (EPA 2007); and
- Guidance Statement No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in WA (EPA 2004c).

8.2.5 Other guidance documents

- Guidelines for Preparing Mine Closure Plans (DMP and EPA 2015);
- Recommended Interim Protocol for Flora Surveys of Banded Ironstone Formations of the Yilgarn Craton (Department of Environment and Conservation [DEC] 2006);
- The Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2012 (EPA 2012c);
- Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA and DPaW 2015);
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010);
- Visual Landscape Planning in Western Australia: a Manual for Evaluation, Assessment, Siting and Design ([WAPC 2007);

- Survey Guidelines for Australia's Threatened Reptiles (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2011);
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010);
- Strategic Framework for Mine Closure (ANZMEC and MCA 2000); and
- Mine Closure and Completion (Department of Industry, Tourism and Resources [DITR] 2006a) Mine Rehabilitation (DITR 2006b).

8.3 Commonwealth environmental assessment process

The Proposal has not been referred to the Commonwealth Department of the Environment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on the basis that the Proposal was considered unlikely to have a significant impact to any Matters of National Environmental Significance (MNES).

8.4 Principles of environmental protection

SMC acknowledges the environmental protection principles listed in Section 4a of the EP Act and presented in the EAG 8 (EPA 2015b). These environmental principles are:

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

Consideration has been given to these principles in the assessment of the potential environmental impacts of the Proposal. These principles are addressed in Section 21.3.

8.5 Principles of environmental impact assessment

The Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2012 (EPA 2012c) outline the principles of EIA for the proponent, as follows:

1. Consult with all stakeholders, including the EPA, decision-making authorities (DMAs), other relevant government agencies and the local community as early as possible in the planning of their proposal, during the environmental review and assessment of their proposal, and where necessary during the life of the project.

2. Ensure the public is provided with sufficient information relevant to the EIA of a proposal to be able to make informed comment, prior to the EPA completing the assessment report.

3. Use best practicable measures and genuine evaluation of options or alternatives in locating, planning and designing their proposal to mitigate detrimental environmental impacts and to facilitate positive environmental outcomes and a continuous improvement approach to environmental management.

4. Identify the environmental factors likely to be impacted and the aspects likely to cause impacts in the early stages of planning for their proposal. The onus is on the proponent through the EIA process to demonstrate that the unavoidable impacts will meet the EPA objectives for environmental factors and therefore their proposal is environmentally acceptable.

5. Consider the following, during project planning and discussions with the EPA, regarding the form, content and timing of their environmental review:

    a. The activities, investigations (and consequent authorisations) required to undertake the environmental review;

    b. The efficacy of the investigations to produce sound scientific baseline data about the receiving environment;

c. The documentation and reporting of investigations; and

d. The likely timeframes in which to complete the environmental review; and use best endeavours to meet assessment timelines.

6. Identify in their environmental review, subject to the EPA's guidance:

   a. Best practicable measures to avoid, where possible, and otherwise minimise, rectify, reduce, monitor and manage impacts on the environment; and

   b. Responsible corporate environmental policies, strategies and management practices, which demonstrate how the proposal can be implemented to meet the EPA's environmental objectives for environmental factors.

SMC has considered these principles of EIA throughout the PER process for the Proposal.

9 Stakeholder engagement

9.1 Key stakeholders

The following key stakeholders have been identified for the Proposal:

- government agencies:
  - Office of the Environmental Protection Authority (OEPA);
  - DAA;
  - DPaW;
  - Department of Environment Regulation (DER);
  - DMP;
  - DoW;
- non-government organisations:
  - Conservation Council of WA;
  - Wildflower Society of WA;
- community:
  - Traditional Owners (*Widi* Mob, *Binyardi* and West *Badimia*); and
  - Shire of Perenjori.

9.2 Stakeholder engagement process

Discussions regarding the Proposal have been held with a number of stakeholders (Table 3). The timing of the consultation program has enabled topics raised to be considered in the early design phase of the Proposal, during determination of management measures and as part of the preparation of the PER document.

DAA has not been available to discuss the Proposal with SMC. SMC will continue to endeavour to contact and consult with the DAA. However, an application under Section 18 of the *Aboriginal Heritage Act 1972* (WA) (Aboriginal Heritage Act) to disturb sites in the development envelope has been endorsed by the Traditional Owners and was approved on 12 February 2016.

9.3 Stakeholder comments and Proponent responses

The main topics/issues raised by stakeholders to date and SMC's responses are outlined in Table 3.

Table 3: Stakeholder consultation undertaken to date

Agency/group	Date	Topics/issues raised	Outcome and proponent response where necessary
Department of Water (DoW)	27 October 2015	Acid mine drainage needs to be assessed. Concerns regarding surface water runoff (including sediment) and control were also raised.	• SMC engaged MBS Consulting to specifically assess the risk of acid and metalliferous drainage (AMD) and propose appropriate management solutions if required. • SMC engaged SRK Mining to provide advice on surface water management and the management of AMD material in waste rock dumps. These issues are covered in the PER document (Section 18).
Department of Parks and Wildlife (DPaW)	1 July 2015	• The methodology for regional analysis of *Acacia woodmaniorum* by Karara Mining Limited was queried • SMC's proposed management if groundwater is present in the bottom of the proposed mine pit. • Stygofauna and troglofauna sampling may be required • Amenity issue was discussed. DPaW's concern is the impact to amenity when viewed close to the range. • Level 2 flora and vegetation surveys were ongoing, but the surveys may not align with the DPaW BIF survey guideline (ESD requirement 1 and 2). The BIF survey guideline is the required standard. • Woodman (2012) is an inappropriate basis for assessment in the PER document due to its applicability to environmental impact assessment having not been verified by DPaW. • Fauna surveys to be used for the PER were accepted as being focused on target conservation significant fauna species. • Only targeted *Idiosoma nigrum* surveys have been conducted in the proposed disturbance footprint, not an	• SMC has not been able to obtain the methodology that was used for regional analysis of *Acacia woodmaniorum* by Karara Mining Limited. • Groundwater will not be intercepted by the proposed mine pit and therefore stygofauna sampling is not considered to be required. Troglofauna sampling has been carried out and is addressed in the PER document in Section 16. • SMC considers that amenity close to the range is not an issue as the Karara Mining Limited mining operation to the south will preclude public access to the area for many decades. An amenity impact assessment has been carried out in accordance with WAPC Guidelines and is described in Section 17. • A Visual Landscape Evaluation and Visual Impact Assessment were conducted and are discussed in Section 17. • The Maia (2016) survey complied with the DEC (2006) Recommended Interim Protocol for Flora Surveys of Banded Ironstone Formations of the Yilgarn Craton. This is further described in Section 14.2.1 and in the Maia (2016) report included in Appendix C.

Agency/group	Date	Topics/issues raised	Outcome and proponent response where necessary
		SRE survey. Further consideration is required if SRE habitat exists. • Subterranean fauna surveys should be required as habitat is known to exist within the proposed disturbance footprint • Amenity should consider the long-term, not only during mining, and include consideration of proposed reserves (including the proposal for a class A nature reserve at Mungada Ridge) and potential areas of future visitation such as lookouts rather than only travel routes.	• Woodman (2008a) has been used in place of Woodman (2012) in this updated PER document (Section 14). • No response required. The terrestrial fauna surveys undertaken are discussed in Section 15. • Errors in the existing spatial data have now been corrected showing that six SRE sampling sites are located within the development envelope; four wet pitfall sites (located on the southern slope of Mungada Ridge) and two hand foraging sites. One of the wet pitfall sites is located in the proposed disturbance footprint. Detailed discussion is provided in Section 15. • Section 16.2.2 has been amended to describe the potential stygofauna habitat in the development envelope providing further justification that survey is not required. • The Visual Impact Assessment report in Appendix C, and Section 17 have been updated to consider amenity in the long-term in the context of proposed reserves and potential areas of future visitation including lookouts.
Department of Environment Regulation (DER)	5 November 2015	Dust control and correct approvals need to be obtained.	• SMC has a sound record of compliance relating to dust control and has addressed dust control in the PER document in Sections 13, 14, 15, 18 and 19. • SMC will ensure all necessary approvals are obtained before implementing the Proposal.
Traditional Owners (Widi Mob, Binyardi and West Badimia)	8 October 2015 (Widi Mob and West Badimia) and 13 October 2015 (Binyardi)	The Traditional Owners were consulted during and after surveys undertaken over the entire development envelope. The Traditional Owners had no objection to any of the sites within the Blue Hills area being disturbed as long as they were informed prior and provided an update about the project. The Traditional Owners requested that they are	SMC has committed to following the Traditional Owners' recommendations on the Section 18 application (Section 20.2).

Agency/group	Date	Topics/issues raised	Outcome and proponent response where necessary
		given the opportunity to salvage and relocate the archaeological material and monitor the ground disturbing activities around the sites.	
Department of Mines and Petroleum (DMP)	23 June 2015	• SMC needs to look at post-mining land use • The management of potentially acid forming waste needs to be assessed and addressed in accordance with DMP guidelines.	• SMC will undertake rehabilitation of the Proposal area in accordance with all approvals and commitments (Section 18). • SMC advised DMP of the ESD requirements and agreement on the methodology of AMD assessment was reached with DMP. The agreed methodology for AMD assessment has been followed and covered in the PER document (Section 18).

9.4 Ongoing consultation

SMC will continue to consult with relevant stakeholders during the environmental assessment process and through the implementation of the Proposal. In addition to the Traditional Owner groups represented and non-government organisations, SMC will consult with regulators including, but not limited to:

- DoW on the management of water resources and licensing requirements for the operations;
- DAA on the management of Aboriginal heritage sites and other matters related to Aboriginal Heritage Act requirements;
- DPaW regarding Threatened and Priority flora and fauna species and communities
- DER regarding licensing matters under Part V of the EP Act;
- DMP and other relevant stakeholders regarding closure objectives and indicative completion criteria for the Proposal; and
- OEPA regarding details of the Proposal, environmental offsets, and progress of its assessment of the Proposal.

10 Identification of preliminary key environmental factors

Scoping of relevant environmental factors was completed as part of the EPA process in preparing and finalising the ESD for the Proposal. The ESD was prepared with input from relevant DMAs and SMC.

The EPA identified seven preliminary key environmental factors relevant to the Proposal that require detailed consideration by SMC. These preliminary key environmental factors are:

- landforms;
- flora and vegetation;
- terrestrial fauna;
- subterranean fauna;
- amenity;
- offsets (integrating factor); and
- rehabilitation and decommissioning (integrating factor).

Table 2 of the ESD sets out for each preliminary key environmental factor:

- the EPA objective;
- the relevant aspects;
- the potential impacts and risks;
- the work required to be undertaken; and
- the relevant policy/guidance documents.

The EPA identified other environmental factors that it considered relevant to the Proposal: Hydrological processes and inland waters environmental quality, and Heritage. These other environmental factors also warrant attention as part of the environmental review of the Proposal to the extent that the PER document must demonstrate how these factors will be mitigated and the extent to which other statutory decision-making processes can regulate the potential effects to meet EPA objectives and principles of EIA.

A compliance table has been provided in Appendix B showing where the various ESD-listed work requirements for each preliminary key environmental factor (and other environmental factors) have been addressed or presented in the PER document.

11 Environmental studies

SMC has conducted a number of environmental studies as part of the EIA process for the DSO Project and for the Proposal. The studies provided the basis for assessing the significance of the potential environmental impacts for each preliminary key environmental factor identified in the ESD. Where applicable, the studies were undertaken using commonly accepted methodologies and in accordance with relevant EPA Guidance Statements. Key reports on these studies are listed in Table 4 and attached in Appendix C.

Table 4: Studies and investigations supporting the PER

Factor	Studies, investigations and/or reports
Flora and vegetation	• 2003, Level 2 survey, including 29 quadrats (1.16 ha) and 13 relevés in M59/595 and M59/596, (Bennett 2004) • 2005, Level 2 survey, including three quadrats (0.12 ha) in M59/595 and M59/596, Banded iron formation survey across central Tallering, including Mt Karara, Jasper Hills, Windaning Hill, Warriedar Hill, Pinyalling Hills, Walagnumming Hills and Minjar Hill (Markey and Dillon 2008) • 2006, Level 2 survey, including one quadrat (0.04 ha) and 17 relevés in M59/595 and M59/596, Mt Karara and Mungada Ridge (Woodman 2008a) • 2007, Targeted flora survey, SMC Blue Hills tenements M59/595, M59/596, E59/971, E59/1059 and E59/1175 (ecologia 2007a) • 2006 and 2007, Level 2 survey, including 27 quadrats (1.64 ha) in M59/595 and M59/596 (15 quadrats re-sampled in spring), SMC Blue Hills tenements M59/595 and M59/596 (ecologia 2008a) • 2008, Targeted flora survey, SMC Blue Hills tenement M59/596 (ecologia 2008b) • 2008 - 2011, Regional Level 2 survey, including four quadrats (0.16 ha) in M59/595 and M59/596, Karara to Minjar Block (Woodman 2012) • 2011, Targeted flora surveys, including transects traversing 390.62 ha in M59/595 and M59/596, Blue Hills SMC haul road to Mungada (Maia 2011a), SMC Blue Hills tenements M59/595 and M59/596 (Maia 2011b) and Blue Hills s45C infrastructure areas (Maia 2012) • 2013, Comprehensive desktop analysis of all available biological survey information for Mungada Ridge to determine the likely endemism of significant flora populations and ecological communities known to occur on Mungada Ridge (including the Proposal area), Desktop assessment for Mungada Ridge (ecologia 2013) • 2014, Targeted flora survey, including transects traversing 28.92 ha in M59/595 and M59/596, SMC Blue Hills tenements M59/595 and M59/596 (Maia 2014a) • 2014, Vegetation monitoring annual assessment, including 16 quadrats (0.64 ha) in M59/595 and M59/596, SMC Blue Hills tenements M59/595 and M59/596 (Maia 2014b) • 2015, Level 2 survey and targeted flora survey, including 39 quadrats (1.56 ha) and transects traversing 116.38 ha in M59/595 and M59/596, SMC Blue Hills tenements (Maia 2016).
Terrestrial fauna	• 2004, Single phase Level 2 (comprehensive) vertebrate assessment and opportunistic SRE invertebrate collection, Blue Hills Fauna Assessment (Bamford & Wilcox 2004)

Factor	Studies, investigations and/or reports
	• 2006, Two Phase Level 2 (comprehensive) vertebrate assessment and opportunistic SRE invertebrate collection, Fauna Values of Gindalbie Metals' Karara and Mungada Haematite/Magnetite Projects (Bancroft & Bamford 2006) • 2007, Level 2 SRE invertebrate fauna survey, Koolanooka/Blue Hills Short Range Endemic Biological Assessment (ecologia 2007b) • 2008, Literature review and risk assessment, Koolanooka/Blue Hills Short Range Endemic Literature Review and Risk Assessment (ecologia 2008c) • 2010, Level 2 SRE invertebrate fauna survey, ecologia Baseline SRE Blue Hills (2010) • 2011, Level 1 vertebrate fauna assessment, ecologia Blue Hills Level 1 Vertebrate Fauna Survey (ecologia 2011a) • 2011, Level 2 SRE invertebrate fauna survey, Blue Hills Additional Short Range Endemic Invertebrate Survey (ecologia 2011b) • 2012, Targeted survey for *Idiosoma nigrum* (ecologia 2012a) • 2015, Desktop assessment, gap analysis and additional targeted fauna survey (ecoscape 2016a).
Subterranean fauna	• 2008, Stygofauna assessment and sampling, Koolanooka - Blue Hills DSO Project. (ecologia 2008d) • 2008, Troglofauna assessment and sampling, Koolanooka/Blue Hills DSO Mining Project (ecologia 2008e) • 2015, Blue Hills Mungada East Expansion: Subterranean Fauna Level 1 Assessment (Bennelongia 2015).
Amenity	• 2015, Visual Landscape Evaluation and Visual Impact Assessment (ecoscape 2016b).
Rehabilitation and decommissioning	• 2012 – ongoing, Kings Park Botanic Gardens and Parks Authority are continuing a Restoration and Rehabilitation Project for SMC aimed at ensuring effective restoration of vegetation communities at SMC's mining projects at Koolanooka, Blue Hills and Weld Range • 2015, Soil And Waste Rock Desktop Review Blue Hills Iron Ore Mine (MBS 2015) • 2015, Mungada East Extension Waste rock dump Conceptual Design (SRK 2015).
Hydrological processes and inland waters environmental quality	• 2006, Groundwater exploration drilling at Koolanooka and Blue Hills (Rockwater 2006).
Heritage	• 2011, Archaeological Survey of the Blue Hills Project Area (Terra Rosa 2011a) • 2011, Ethnographic Survey of the Blue Hills Project Area (Terra Rosa 2011b).

12 Environmental management plans

12.1 Condition Environmental Management Plan

A Condition EMP has been developed for the Proposal and is contained in Appendix D. The Blue Hills Mungada East Expansion Condition EMP has been prepared in line with the EPA's Environmental Assessment Guideline for Preparation of Management Plans under Part IV of the EP Act (EAG 17) and associated templates. The key environmental factors that the Blue Hills Mungada East Expansion Condition EMP addresses are:

- flora and vegetation; and
- terrestrial fauna.

The Blue Hills Mungada East Expansion Condition EMP includes Proposal-specific management measures for conservation significant flora and fauna species, so the Malleefowl Management Plan and Conservation Significant Flora and Ecological Communities Management Plan prepared for the existing Blue Hills mine will not be applicable to the Proposal.

The Blue Hills Mungada East Expansion Condition EMP will be updated throughout the life of the Proposal where any substantial changes are proposed or additional information is known (e.g. additional weed control requirements, new conservation listed species occurrence). The plan sets out procedures to minimise and manage the environmental impacts of construction and operation activities and provides a framework for minimising the risk of impacts.

12.2 Closure Plan

A Mine Closure Plan has been prepared for the Proposal (SMC 2016, Appendix E). The Blue Hills Mungada East Expansion Mine Closure Plan has been prepared consistent with the Closure Guidelines (DMP and EPA 2015) and the requirements of the ESD. It provides a closure vision for the development envelope that is part of a broader integrated vision for tenements M59/595 and M59/596.

During the life of mine, the plan will be reviewed and updated as required to ensure information remains current, including additional provisions associated with the Proposal. In particular, any specific rehabilitation and closure requirements relevant to the restoration of habitat for conservation significant flora and fauna will be included in this plan.

12.3 Implementation Strategy

Prior to ground disturbing activities, SMC will prepare a staged implementation strategy setting out management and monitoring strategies and objectives for meeting the requirements of conditions within any Statement issued by the WA Minister for Environment allowing the Proposal to be implemented. The implementation strategy will assist SMC in demonstrating its compliance with all relevant conditions.

12.4 Aboriginal Heritage Management Plan

The Aboriginal Heritage Management Plan (AHMP) has been drafted to ensure SMC's staff and contractors understand the general requirements and management of heritage sites. The AHMP documents the management of all significant Aboriginal heritage sites within the development envelope. It is a working document that will allow for new information to be added where necessary and is contained in Appendix D.

Part 5 Assessment of environmental factors

This Part provides an assessment of the potential environmental impacts of the Proposal for each of the key preliminary environmental factors and other environmental factors identified in the Environmental Scoping Document. Proposed management measures and anticipated outcomes are also discussed in this Part.

13 Landforms

13.1 Key statutory requirements, environmental policy and guidance

13.1.1 EPA objective

The EPA has applied the following objective for Landforms:

"To maintain the variety, integrity, ecological functions and environmental values of landforms."

13.1.2 Regulatory framework

The following legislation is relevant to the Proposal with respect to the protection of landform values and the above EPA objective:

- EP Act.

13.1.3 Relevant guidelines and policy

The following guidelines are relevant to the Proposal with respect to the protection of landform values and the above EPA objective:

- EPB 23: Guidance on the EPA Landforms factor (EPA 2015a);
- EAG 8: Environmental Assessment Guideline for Environmental principles, factors and objectives (EPA 2015b);
- EPA Guidance Statement 33: Environmental Guidance for Planning and Development (EPA 2008); and
- Visual Landscape Planning in Western Australia (WAPC 2007).

13.2 Description of factor

The EPA recently released EPB 23: Guidance on the EPA Landforms factor (EPA 2015a). The bulletin states that landforms are considered a component of the landscape and their defining feature is their combination of geology (composition) and morphology (form). For the purpose of EIA, EPB 23 defines the following:

- **Landscape** – all the features of an area that can be seen in a single view, which distinguish one part of the Earth's surface from another part. Landscapes can be either natural (largely unaffected by human activity) or human (created or significantly modified by human activity); and
- **Landform** – a distinctive, recognisable physical feature of the Earth's surface having a characteristic shape produced by natural processes.

Natural landscapes consist of a variety of landforms, large or small, which can have numerous and varied environmental, social and cultural values. The EPA has defined key criteria to be applied as the basis for determining the significance of a landform in the context of an EIA. The landform does not have to meet all criteria, and may only meet one, to be considered significant. The EPA slightly modified the key criteria in the ESD to apply specifically to the Proposal. These Proposal-specific criteria are as follows:

- **Variety** – are the landforms considered a particularly good or important example of their type? How adequately are these types of landforms represented in the local and regional area? How do the landforms differ from other examples at these scales?;
- **Integrity** – are the landforms intact, being largely complete or whole and in good condition? To what extent have the landforms, and the environmental values they support, been impacted by previous activities or development? For example; have part of the landforms been removed?;
- **Ecological importance** – do the landforms have a role maintaining existing ecological and physical processes? For example; do the landforms provide a microclimate, source of water flow or shade? Include a discussion on complexity of the landforms. For example; do the landforms have important geological features like cliffs, caves, monoliths or outcropping?;
- **Scientific importance** – do the landforms provide evidence of past ecological processes or are they an important geomorphological or geological site? Are the landforms of recognised scientific interest as a reference site or an example of where important natural processes are operating?; and
- **Rarity** – are the landforms rare or relatively rare; being one of the few of its type at a local and regional level?

The landform associated with the Proposal is Mungada Ridge in the Blue Hills Range, which is one of a number of BIF ranges in the Yilgarn Craton. The Proposal is located on the western, lower-lying component of Mungada Ridge (Figure 10). In order to assess the potential impacts from the Proposal on Mungada Ridge, the EPA identified three contexts in the ESD in which to consider the affected landform:

1. the Mungada Ridge landform (Figure 10);
2. the local assessment unit (LAU) (Blue Hills Range) (Figure 11); and
3. the regional context, being the Mungada/Karara/Koolanooka region (Figure 12).

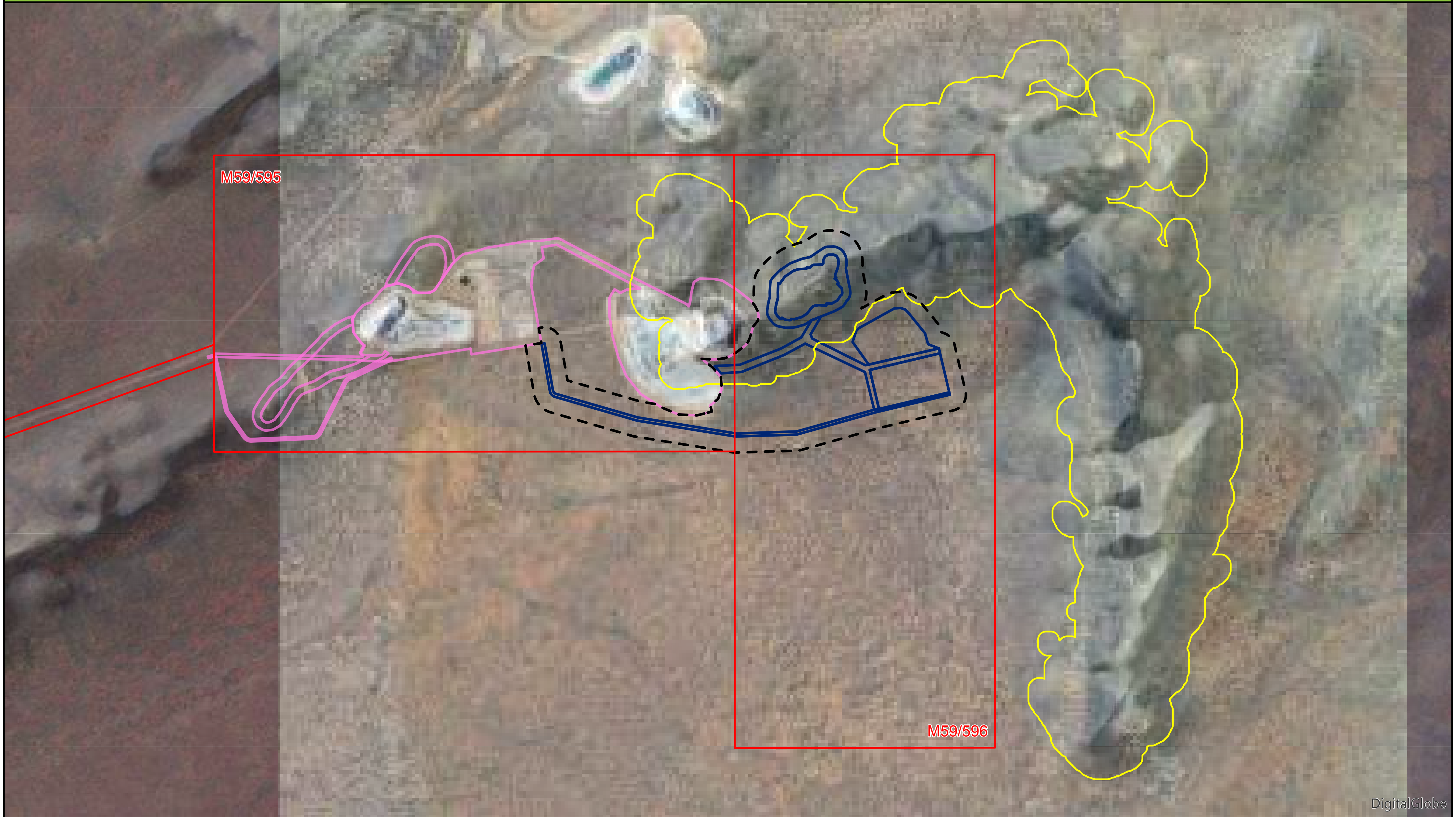
This section provides a description of the significance of the Mungada Ridge landform and the potential impacts to the landform as a result of the Proposal. The potential impacts have been evaluated against the key criteria and within each of the three contexts listed above.

An independent peer review of this section in a preliminary version of the PER document was completed by Karl-Heinz Wyrwoll, of the School of Earth and Environment at the University of Western Australia in accordance with the requirements of the ESD. The review is provided in Appendix F. The review generally found the information presented and used to assess potential impacts to landform to provide a sound basis upon which further geological information could provide additional context, if considered appropriate. SMC responded to Mr Wyrwoll's findings, and Mr Wyrwoll subsequently provided a close out report, providing comment on how SMC has considered the peer review comments. SMC's response document and Mr Wyrwoll's close out report are contained in Appendix F.

In terms of further geological information that could provide additional context to the assessment, Mr Wyrwoll, and also DMP (during agency review of the draft PER), suggested that further discussion of the interrelationships between landform elements, soil characteristics and microclimate in relation to their effects on ecological diversity would improve the assessment of the Landforms factor in the PER. SMC agrees that implementing this suggestion would benefit the assessment. However, a comparative analysis of this additional information would be required against other BIF landforms in the LAU and regional context to allow for rigorous conclusions to be made, and also to meet the requirements of the ESD. SMC has minimal information regarding these interrelationships for Mungada Ridge, which would require substantial further geological/ecological surveys and assessments to be conducted. More importantly, the information is limited or not available for BIF landforms locally and, in particular, in the Mungada/Karara/Koolanooka region. Such information would be required to allow SMC to investigate the interrelationships of BIF landform characteristics through a comparative analysis. In discussions with SMC regarding the Proposal, the OEPA recognised the difficulties for SMC and acknowledged that minimal information is available to allow SMC to undertake the analysis that would be required.

SMC has addressed the requirements of the ESD in regard to Landform as far as practicable with the information that is available for BIF landforms locally and regionally, particularly through a detailed comparative analysis of the external characteristics of BIF landforms (shape, slope, height, area etc.)

Figure 10: Mungada Ridge landform



Legend

- SMC Tenure
- Development Envelope
- Mungada Ridge Landform
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint

0 0.5 1
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

eco logical AUSTRALIA
www.ecoaus.com.au

Prepared by: SM Date: 6/05/2016

Figure 11: Local assessment unit

Legend

- Local Assessment Unit (LAU)
- SMC Tenure
- Development Envelope
- Mungada Ridge Landform
- Local BIF Landforms

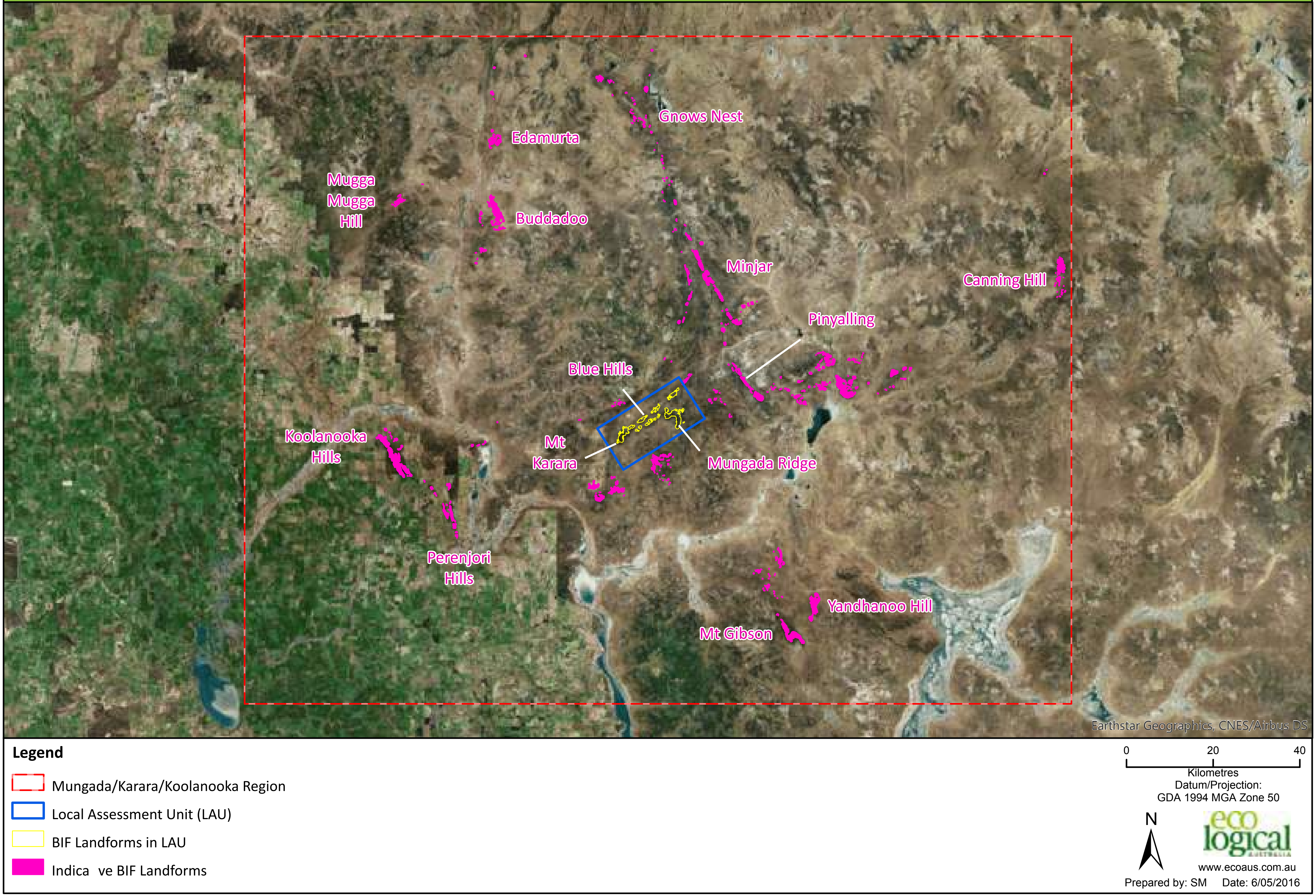
0 2.5 5
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

eco logical AUSTRALIA
www.ecoaus.com.au

Prepared by: SM Date: 6/05/2016

Figure 12: Mungada/Karara/Koolanooka region



13.2.1 Conservation significance of BIF ranges in the Yilgarn Craton

The Yilgarn Craton covers much of the southern half of Western Australia (Figure 13) and includes parts of 13 IBRA bioregions (Department of the Environment 2013). The Craton was formed 2,630-2,780 million years ago, which makes it one of the oldest and most stable parts of the Earth's surface (Myers 1993 as cited in Gibson et al. (2007).

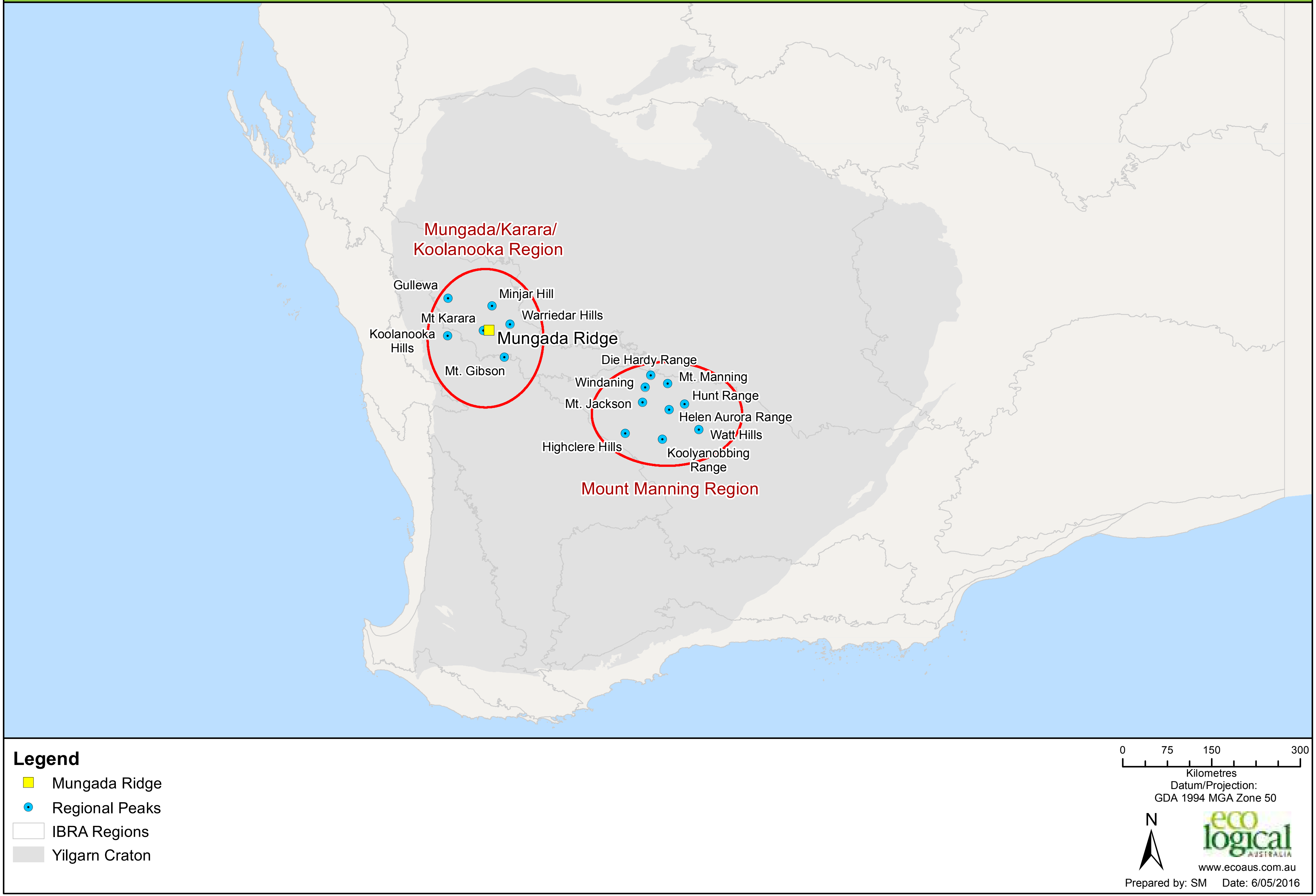
The Craton comprises granitic basement interspersed with both mafic, ultramafic (greenstone) and BIF landforms. The BIF landforms are generally of low elevation as a result of weathering over a very long period (Gibson et al. 2007). The BIF landforms of the Yilgarn Craton were deposited on the older rocks 2,700-3,100 million years ago and retain some of the oldest known fragments of terrestrial rocks on Earth (Myers 1993; Brox & Semeniuk 2007; Menneken et al. 2007 as cited in Gibson et al. 2007). There are two key areas in the Yilgarn Craton where BIF landforms occur: the south-west cluster known as the Mungada/Karara/Koolanooka region and the south-east cluster known as the Mount Manning region (Figure 13).

Due to their unique geology, soils and relative isolation, the BIF landforms of the Yilgarn Craton are considered to be of significant biodiversity value (DEC 2007). The BIF landforms in general are also important due to the presence of locally endemic plant species and communities (DEC 2007), which in some cases are restricted to individual landforms. Although the ecological and evolutionary processes that have developed these distinctive patterns of endemism are not well understood, there are various theories as to why these species tend to be locally endemic or restricted to certain BIF landforms (Garcia et al. 2009; Jacobi and Carmo 2009 as cited in Gibson et al. 2010).

One theory is that the BIF landforms, despite their limited topographic relief, may have provided refugia for many plant species during phases of localised extinction due to climate cycling, resulting in relictual, geographically restricted and fragmented or disjunct population remnants (Gibson et al. 2007). An alternative hypothesis is that the concentration of the restricted plant species on BIF landforms may be a result of distinct geochemistry of these landforms. This is suggested by the potential correlation between the richness of the plant species with soil chemistry; however, this question warrants further research (Gibson et al. 2012).

For the reasons outlined above, the BIF ranges in both the Mungada/Karara/Koolanooka and Mount Manning regions are identified as having high biodiversity conservation values in the Strategic Review of Banded Iron Formation Ranges of the Midwest and Goldfields (DEC and DoIR 2007).

Figure 13: BIF landform regions in the Yilgarn Craton



13.2.2 Proposed class 'A' nature reserve

The Strategic Review of Banded Iron Formation Ranges of the Midwest and Goldfields (DEC and DoIR 2007) was undertaken to provide an additional level of information to government to allow for a more strategic approach to resource utilisation and biodiversity conservation decision making in the Yilgarn Craton. The review states that, due to the highly restricted distribution of several flora species and plant communities within BIF ranges, it would be ideal to formally protect 100% of BIF ranges (in conservation reserves) that have ecological communities which are restricted to them. However, acknowledging that 100% protection of these values would be very difficult given the overlapping occurrence of mineral resources, the review suggests that a 'compromise' criterion of at least 60% formal protection be applied. Further, the review suggests protection of at least 60% of the habitat area supporting each highly restricted species and community is viewed as a minimum and may not be sufficient to ensure the long-term viability of these values in cases where key species and communities have a particularly limited distribution. The review also states "examples of the most outstanding BIF ranges should be protected in their entirety where development has not significantly progressed, e.g. Mt Karara/ Mungada Ridge (Blue Hills) and the Helena and Aurora Range (consistent with recommendations in EPA Bulletin 1256)."

The EPA's Annual Report for 2013-14 (EPA 2014b) indicates the EPA's recognition of the environmental values of the Mungada/Karara/Koolanooka region. In its assessments of the Karara Iron Ore, Mungada Iron Ore and Koolanooka-Blue Hills Direct Shipping Ore proposals (EPA Reports 1321, 1322 and 1328 respectively), the EPA stated that the cumulative impacts arising from the proposed development at the time could only be acceptable if a large, intact section of Mungada Ridge was protected as class 'A' nature reserve, and any mining tenements relinquished. In 2009, the then Minister for Environment also reaffirmed this position in determining the appeals on the Mungada and Karara Iron Ore projects (Appeals Convenor's Report 65-74/09) stating: "A critical component with regard to the acceptability of both the Mungada Iron Ore Project and Karara Iron Ore Project proposals will be in ensuring that an adequate and representative portion of the Karara/Blue Hills/Mungada Ridge system is reserved for conservation purposes and protected from development." This position was further reflected in the Minister for Environment's Appeal Determination (Appeal Number 107-254 of 2009) for the EPA's recommendation against mining Mungada East (on Mungada Ridge) as part of the DSO Project. The Appeal Determination stated "the environmental values of the Mungada Ridge will be protected through the Government's intention to include part of the Ridge in a conservation reserve."

From the Appeal Determinations, it is clear that it was not Government's intention to place a conservation reserve over Mungada Ridge in its entirety, but rather only part of the ridge. Notwithstanding this, SMC is of the view that, if the current Proposal is approved, an adequate and representative portion (88.4%) of Mungada Ridge will remain undisturbed and available for protection and conservation in reservation. In addition, the assessment of potential impacts to flora and vegetation presented in Section 14.3 of this PER document demonstrates that the long-term viability of the conservation significant flora species that occur primarily on Mungada Ridge will not be compromised as a result of the implementation of the Proposal.

13.2.3 Significance of Mungada Ridge

In order to characterise the significance of the Mungada Ridge landform in the LAU and the Mungada/Karara/Koolanooka region, several analyses have been undertaken, the results of which are discussed in the following sections. The analyses presented in this section are based on the mapped boundary of each landform as shown in Figure 11 and Figure 12. To assist in the interpretation of the characteristics of >300 landforms in the Mungada/Karara/Koolanooka region, each landform was assigned a name according to the general cluster or range within which it is located. For example, Mungada Ridge and the four smaller BIF landforms that occur in the immediate vicinity of Mungada Ridge were identified as the 'Mungada Ridge' group, consisting of five individual BIF landforms and named

Mungada Ridge 1 to 5. The largest landform of each group, in this case Mungada Ridge itself, is identified by No. 1, in this case 'Mungada Ridge 1'. An overview of the groups is provided in Figure 14. A list of the names assigned to each landform is included in the description of the methodology provided in Appendix G, which also includes the datasets used in the analyses.

Variety

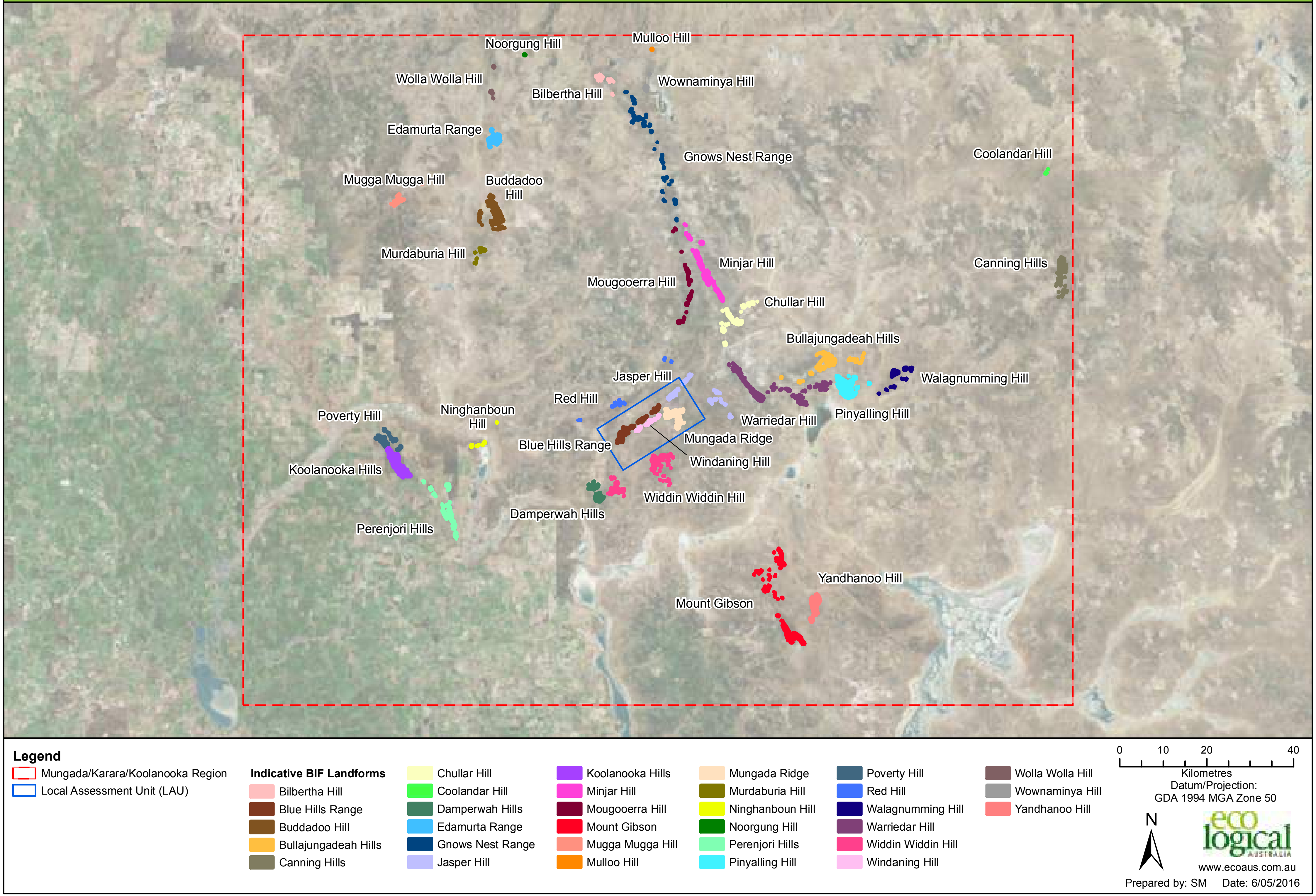
Size

Mungada Ridge is one of 31 BIF landforms in the LAU and one of 362 BIF landforms in the Mungada/Karara/Koolanooka region. Mungada Ridge is 685 ha in size and is the largest BIF landform in the LAU (Figure 11). Other landforms in the LAU range in size from 1.7 ha to 415 ha. In a regional context, Mungada Ridge is one of the six largest BIF landforms in the broader Mungada/Karara/Koolanooka region, all of which are greater than 600 ha in size. In addition to Mungada Ridge ('Mungada Ridge 1'), these large landforms are Koolanooka Hills 1, Pinyalling Hill 1, Mount Gibson 1, Buddadoo Hill 1, and Yandhanoo Hill 1 (Figure 15 and Figure 16). Mungada Ridge is the fifth-largest landform in the Mungada/Karara/Koolanooka region. Outside the LAU, other landforms in the Mungada/Karara/Koolanooka region range in size from 3 ha to 1,183 ha.

Elevation

At its highest point, Mungada Ridge lies at 510 mAHD. Mungada Ridge is the highest landform in the LAU; other landforms in the LAU range in maximum elevation from 350 mAHD to 450 mAHD (Figure 17). Mungada Ridge is the third-highest BIF landform in the Mungada/Karara/Koolanooka region (Figure 18 and Figure 19). Figure 18 shows that there are numerous other BIF landforms in the Mungada/Karara/Koolanooka region of a similar height to Mungada Ridge (i.e. in the order of 500 mAHD). Figure 20 shows the elevation of each landform in the Mungada/Karara/Koolanooka region. The elevations shown for landforms represent pre-development conditions as digital elevation data were not available for all developments in the LAU or the Mungada/Karara/Koolanooka region.

Figure 14: Regional BIF landforms grouped by area



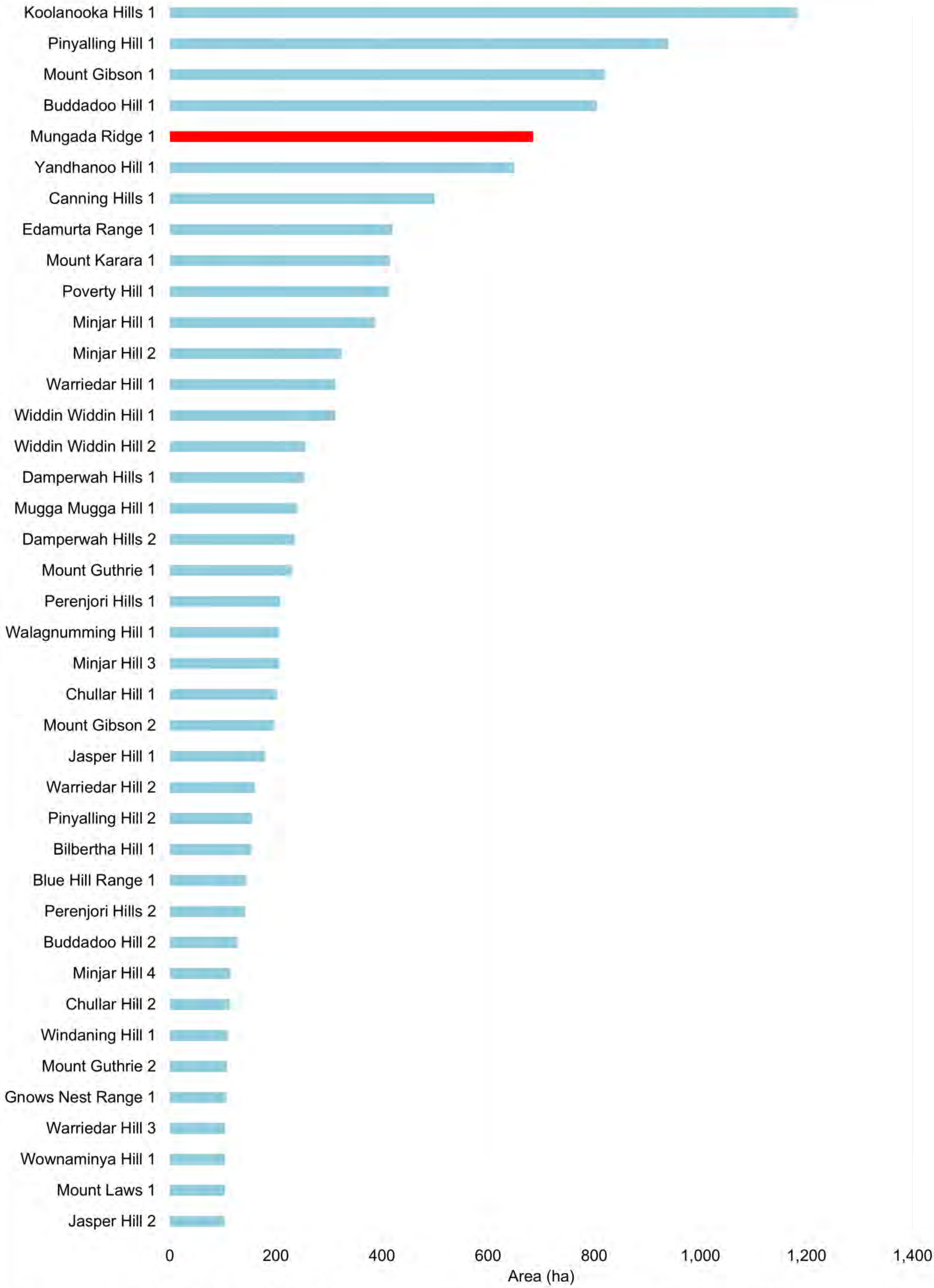


Figure 14: Size of BIF landforms in the Mungada/Karara/Koolanooka region (only BIF landforms >100 ha are included)

Figure 16: BIF landforms in the Mungada/Karara/Koolanooka region by area

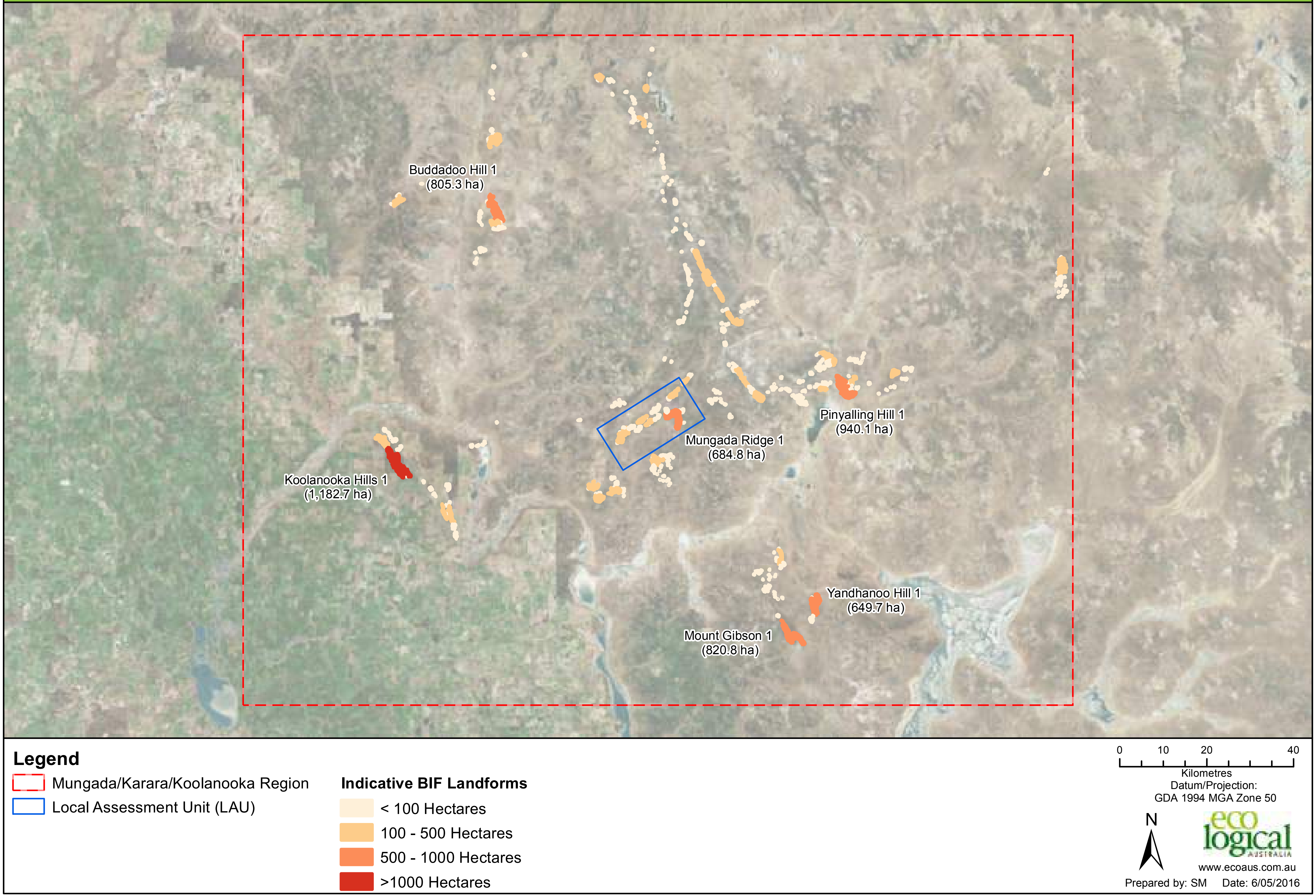
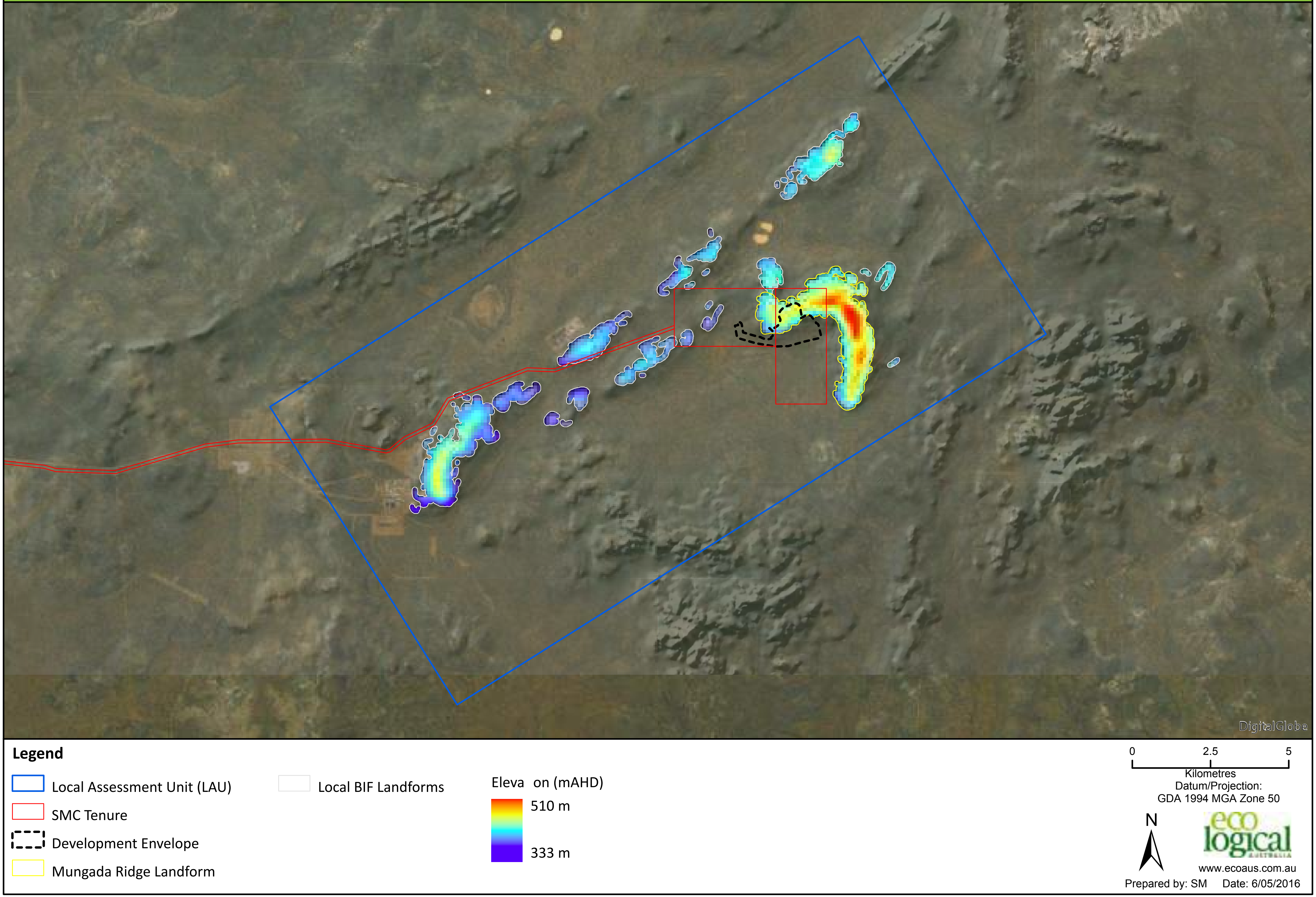


Figure 17: Elevation of BIF landforms in the local assessment unit



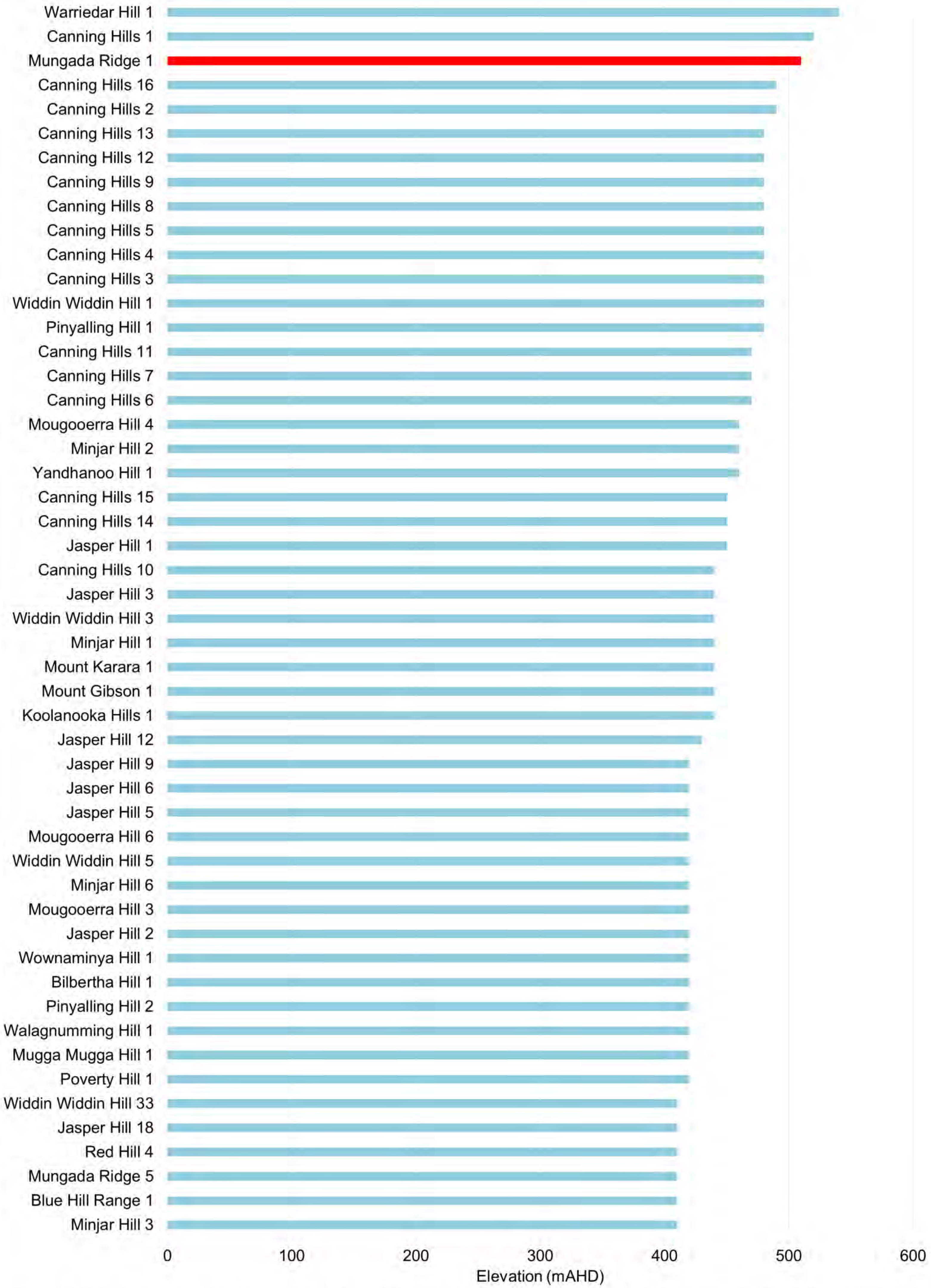
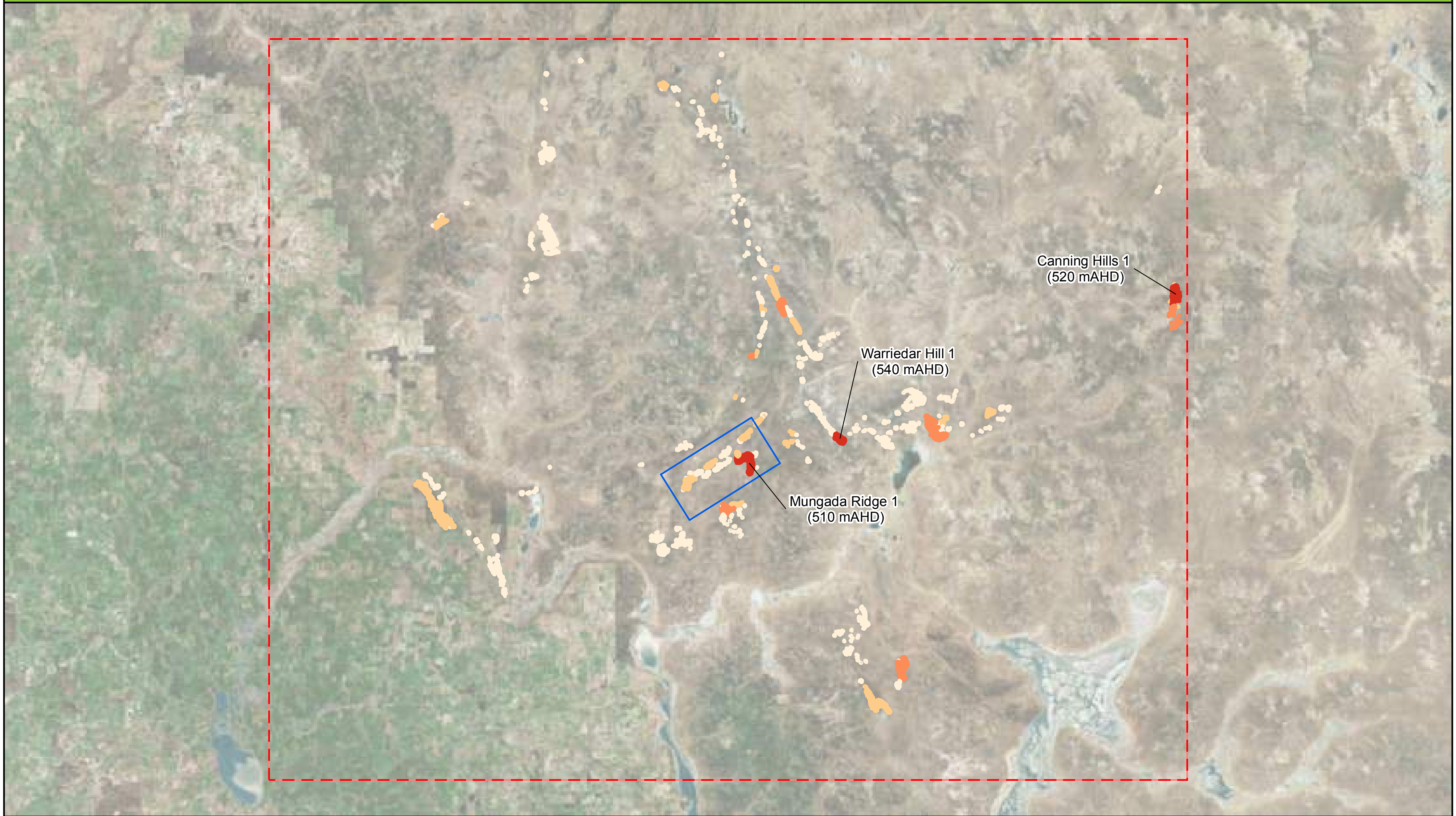


Figure 17: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (only BIF landforms >400 mAHD are included)

Figure 19: BIF landforms in the Mungada/Karara/Koolanooka region by maximum elevation



Legend

Mungada/Karara/Koolanooka Region

Local Assessment Unit (LAU)

Indicative BIF Landforms

- <400 mAHD
- 400 - 450 mAHD
- 450 - 500 mAHD
- >500 mAHD

0 10 20 40
Kilometres

Datum/Projection:
GDA 1994 MGA Zone 50

N

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Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 1)

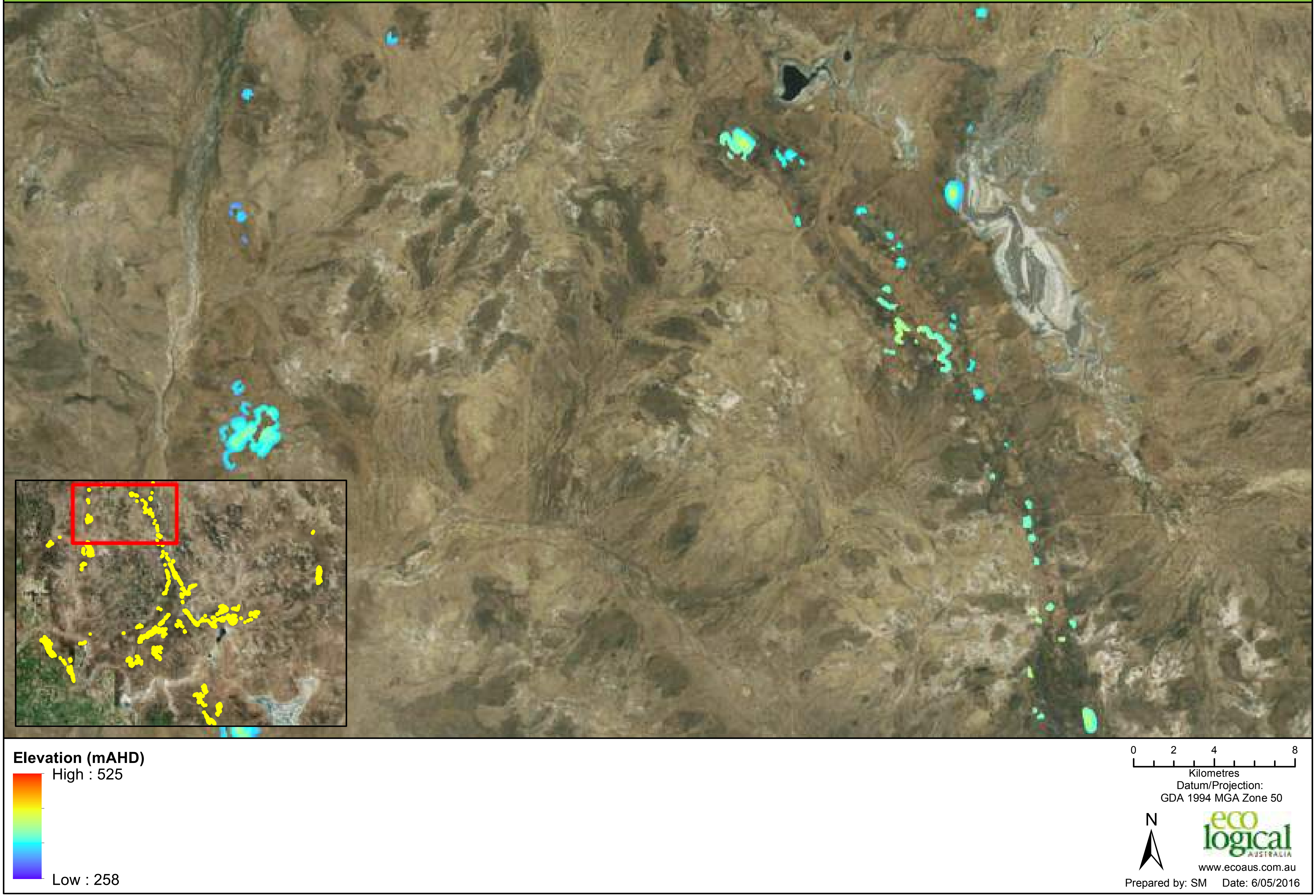


Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 2)

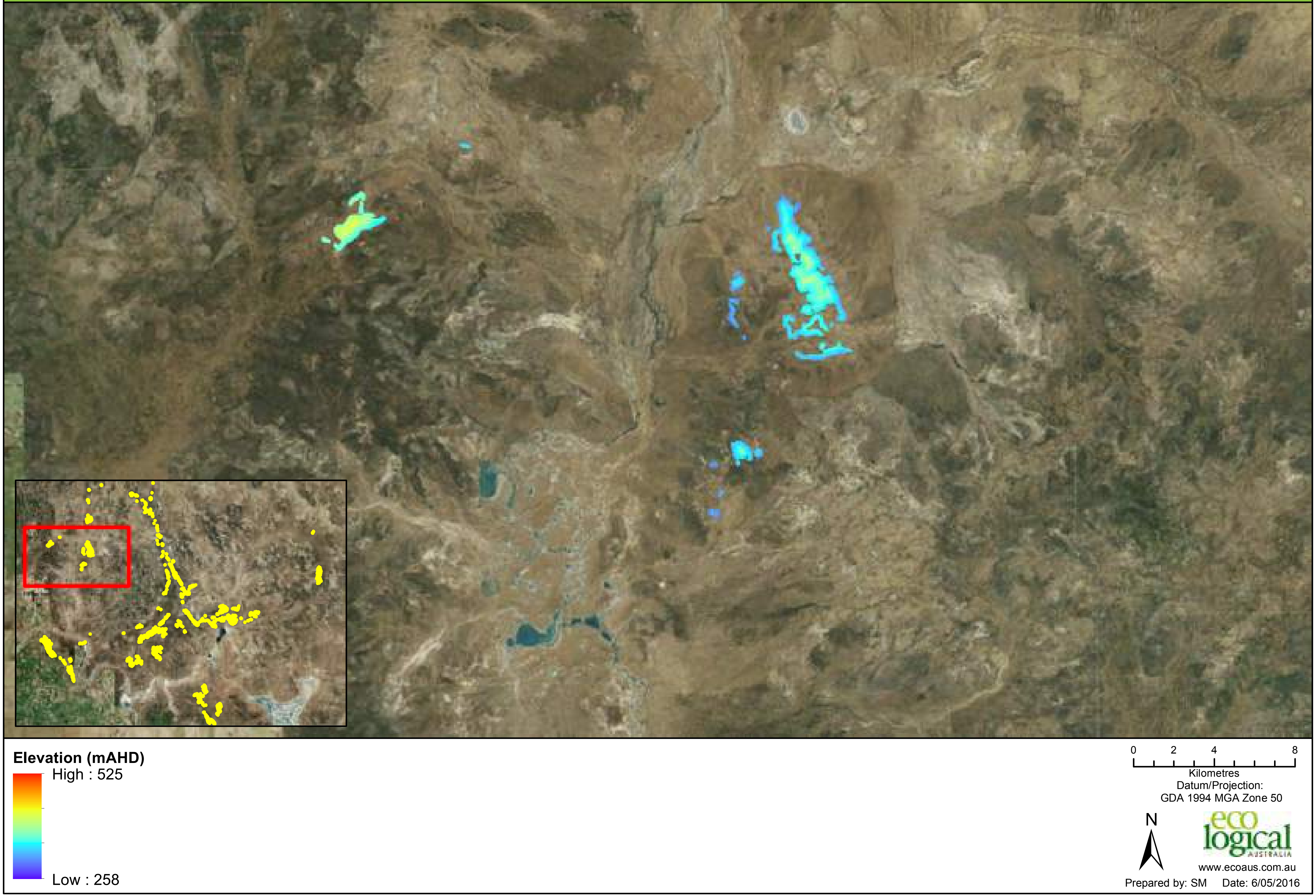


Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 3)

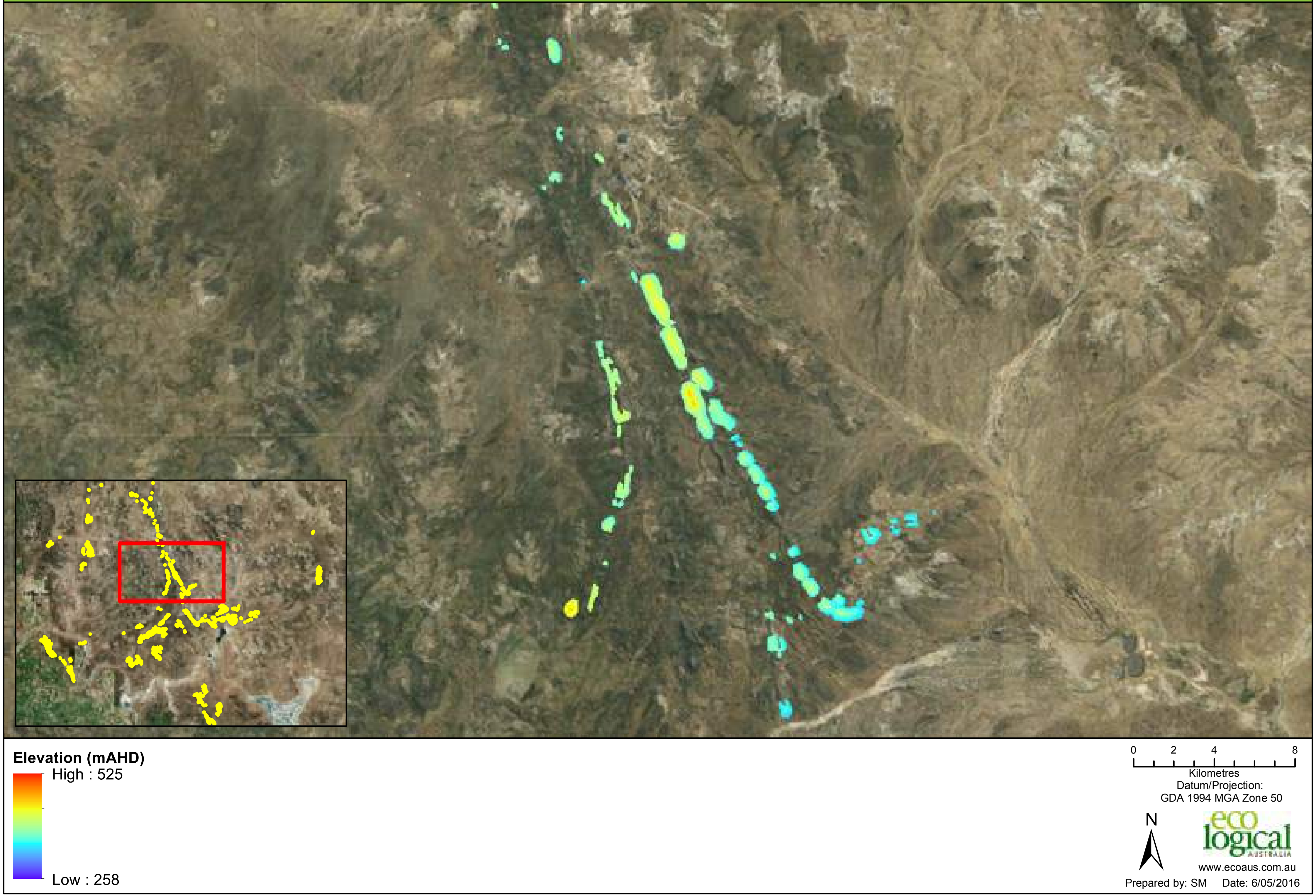


Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 4)

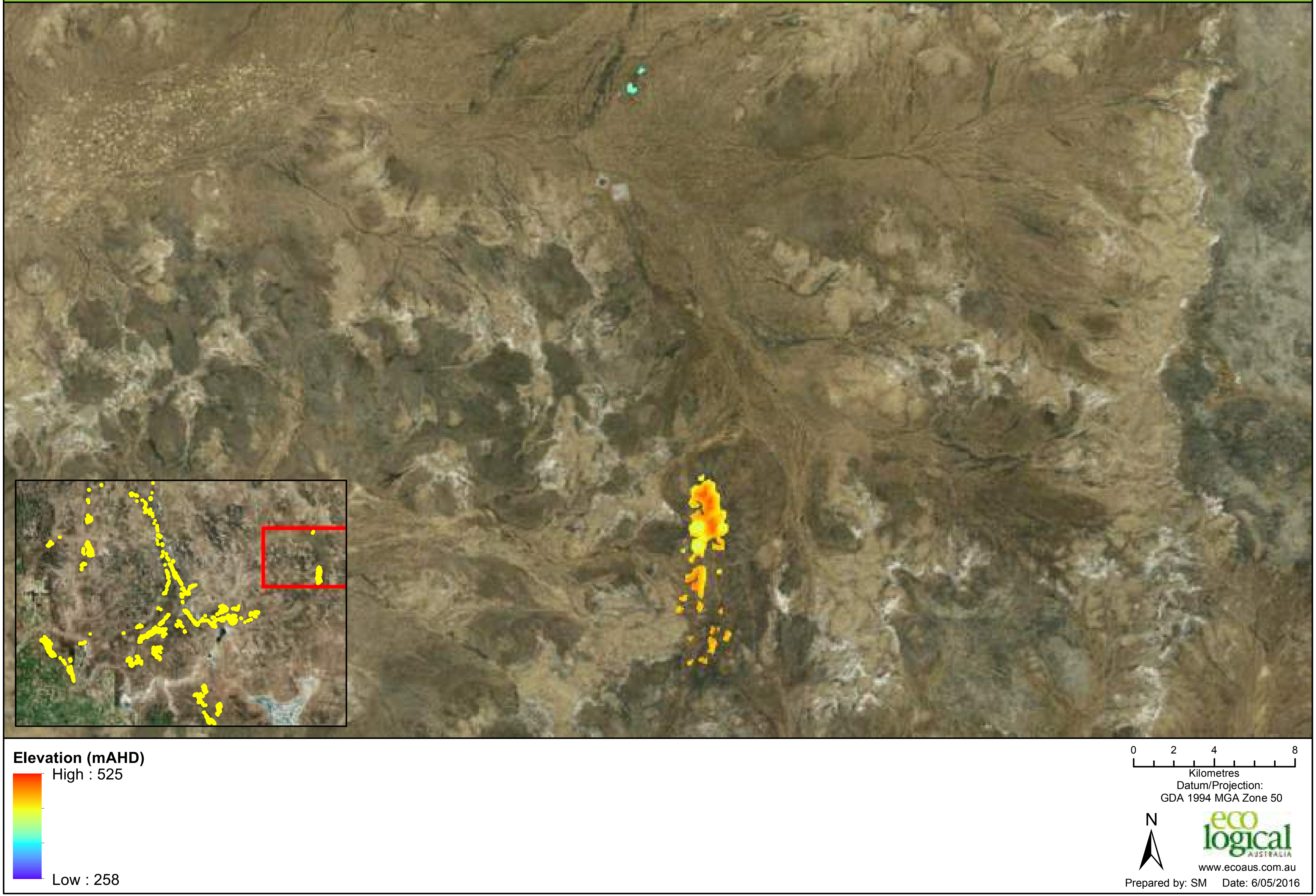


Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 5)

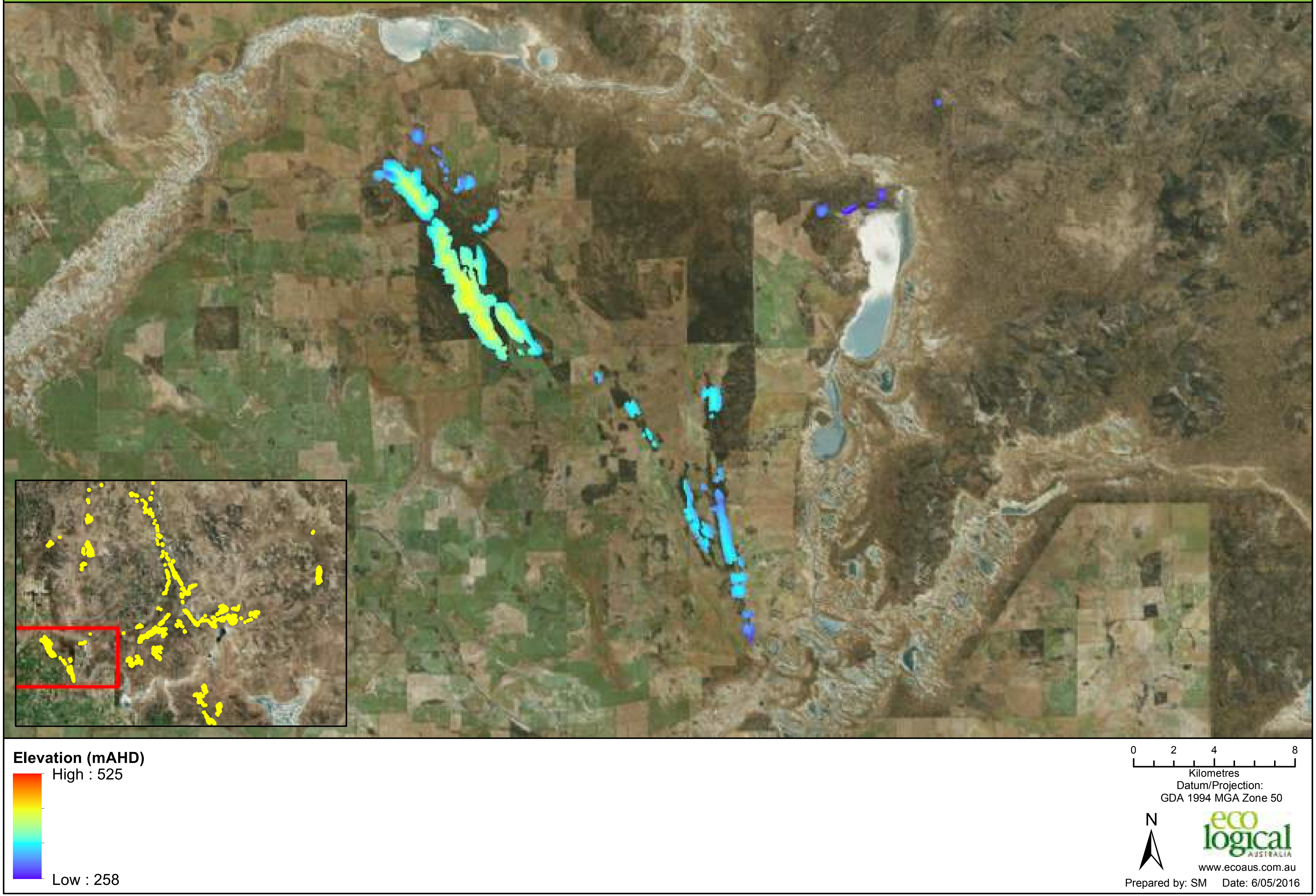


Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 6)

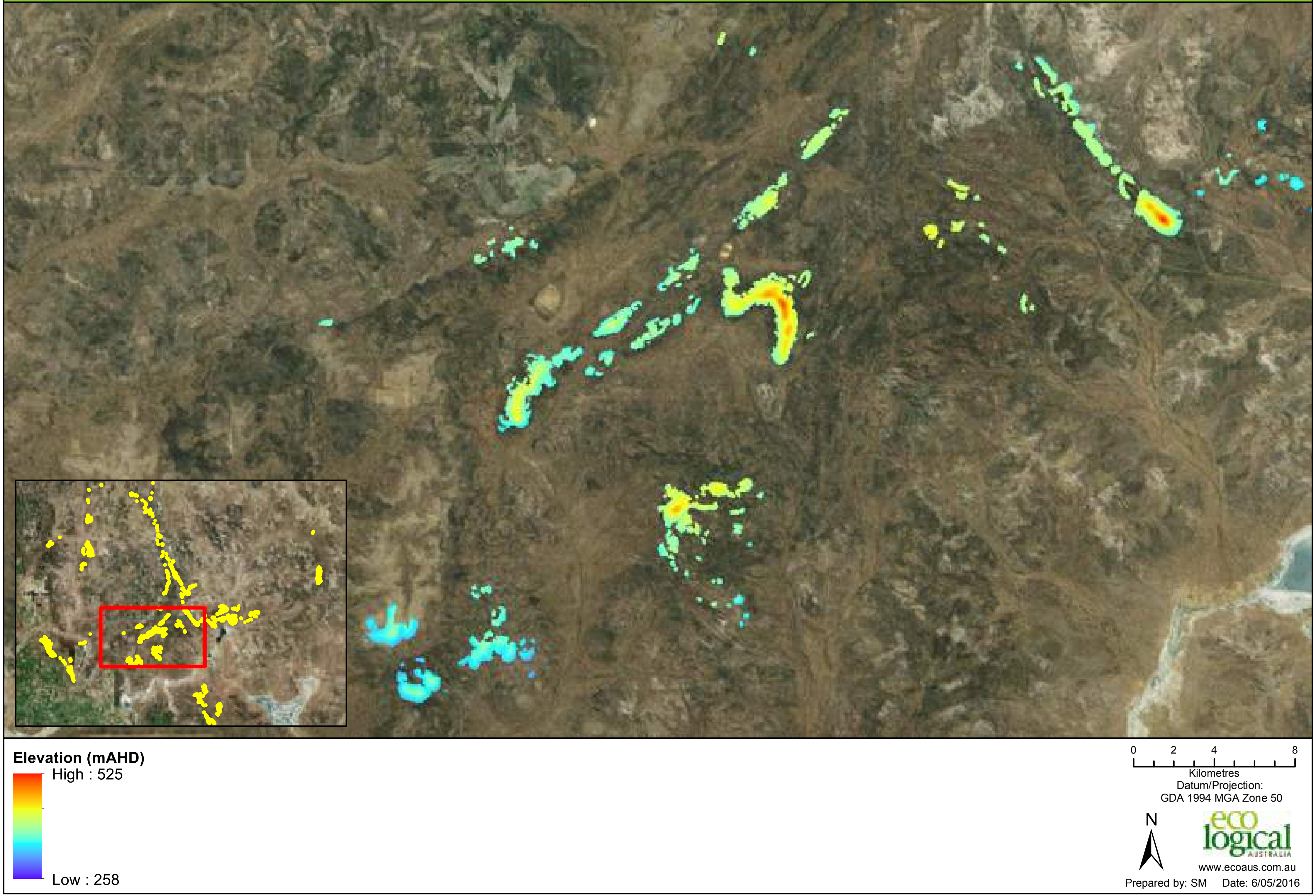


Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 7)

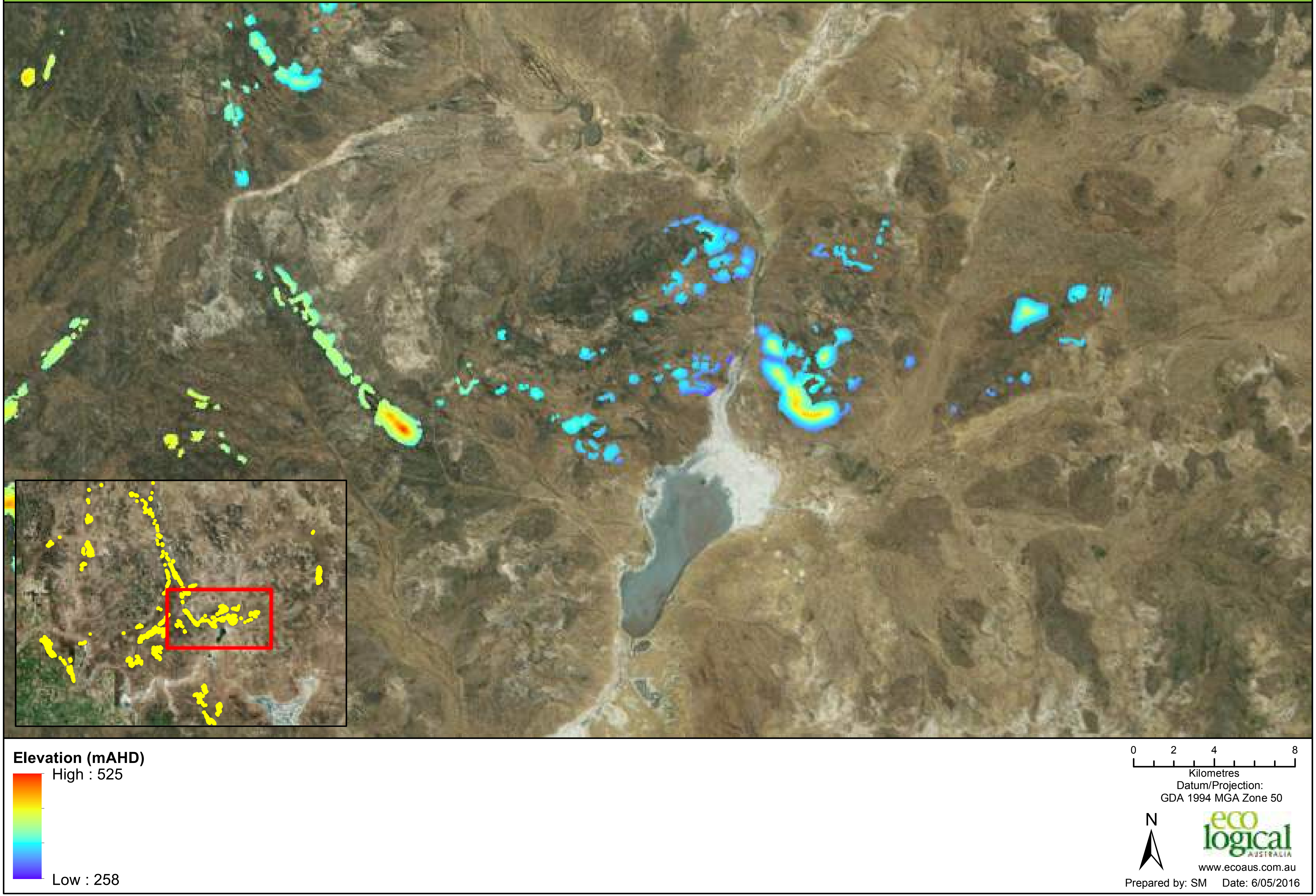
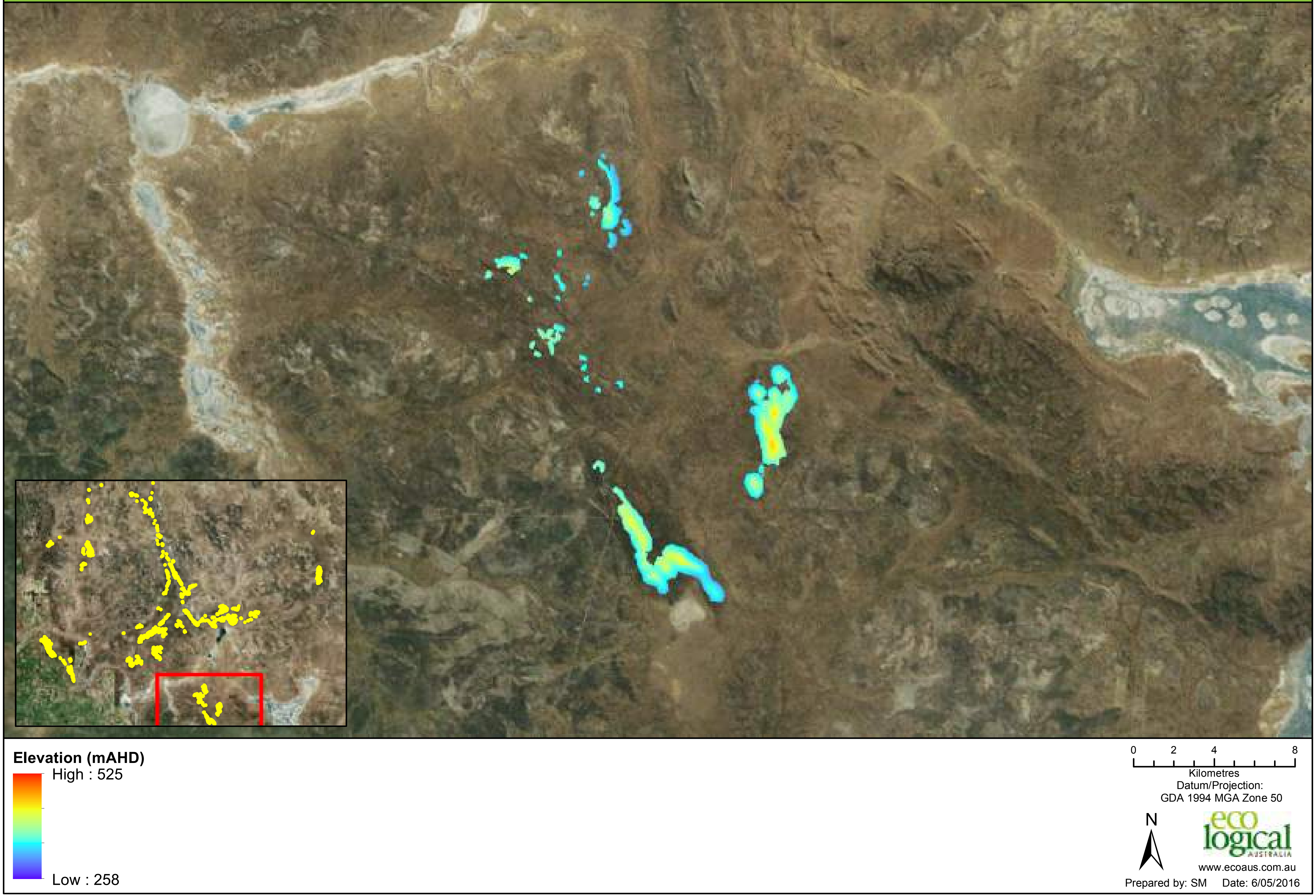


Figure 20: Elevation of BIF landforms in the Mungada/Karara/Koolanooka region (Map 8)



Slope

The steepest slopes on BIF landforms in the LAU occur on Mungada Ridge and are between 19 to 20 degrees. The steepest slopes on other BIF landforms in the LAU are between 14 to 15 degrees (Figure 21). However, the steepest slopes on Mungada Ridge only form a small portion of its overall area; approximately 3% of Mungada Ridge has a slope greater than 15 degrees. A total of 11 BIF landforms in the Mungada/Karara/Koolanooka region (including Mungada Ridge) have slopes of 15 degrees or greater (Figure 22). Two of these BIF landforms have steeper slopes than Mungada Ridge, of between 20 and 21 degrees: Pinyalling Hill 1 and Warriedar Hill 1. Mungada Ridge is therefore the third-steepest BIF landform in the Mungada/Karara/Koolanooka region in terms of maximum slope. The distribution of slopes on these 11 landforms as a percentage of their overall area is shown on Figure 23. These landforms are relatively comparable in terms of slope, in that the major portion of each landform has a slope of roughly 3-7 degrees. While still generally conforming to the same slope profile, somewhat distinct within this group of landforms are Widdin Hill 1 and Wownaminya Hill 1: Widdin Hill 1 has a higher percentage of its area within the 3-7 degree range (and a lower percentage at steeper slopes) and Wownaminya Hill 1 has a more even slope profile between 1-17 degrees. The slope of BIF landforms across the Mungada/Karara/Koolanooka region is shown in Figure 24.

Shape

Mungada Ridge has a distinctive crescent shape. An analysis of the shape of each individual BIF landform in the LAU and the Mungada/Karara/Koolanooka region was conducted using six broad categories of shapes/forms: oval, circular, square, linear, curvilinear, or other. In the LAU, the majority of larger landforms were classified as linear and the smaller landforms as oval. The majority of BIF landforms in the Mungada/Karara/Koolanooka region were classified as oval (Table 5).

Around 25% of BIF landforms in the Mungada/Karara/Koolanooka region were classified as ‘other’; these were further classified as either ‘odd shape’ or ‘crescent shape’ (Table 5). A total of 30 BIF landforms in the Mungada/Karara/Koolanooka region were classified as ‘crescent-shaped’. However, with the exception of Mungada Ridge, all of the ‘crescent-shaped’ landforms are <100 ha in size and the apparent ‘crescent shape’ appeared to be a function of sharp changes in elevation in a small area, rather than the landform being an actual crescent shape. This was attempted to be ‘ground truthed’ using aerial photography; however, the small size of these landforms meant that they were not able to be seen clearly on the aerial to confirm their shape. Regardless, given Mungada Ridge is much larger than each of these landforms (at least six times larger), Mungada Ridge is considered to be unique in the Mungada/Karara/Koolanooka region as an example of a ‘large’ crescent-shaped BIF landform.

In comparison to the five other BIF landforms in the Mungada/Karara/Koolanooka region that are >600 ha in size (Figure 15), Mungada Ridge is the only crescent-shaped landform; the other five landforms are either linear or curvilinear.

Although Mungada Ridge is distinctive in the LAU and the Mungada/Karara/Koolanooka region as the only crescent-shaped BIF landform >500 ha in size, its shape has not been confirmed to, and is not suspected to, provide any ecological function or benefit to biodiversity values occurring there, compared to any other shape of BIF landforms in the LAU or the Mungada/Karara/Koolanooka region. The shape of BIF landforms is likely to be a visual, aesthetic characteristic, rather than a functional one.

Table 5: Results of the regional BIF landform shape analysis

Shape	Example	Percentage of BIF landforms in Mungada/Karara/Koolanooka region
Circular		2%
Oval		62%
Square		2%
Linear		6%
Curvilinear		4%
Other – crescent shape		8%
Other – odd shape		17%

Figure 21: Slope in the local assessment unit

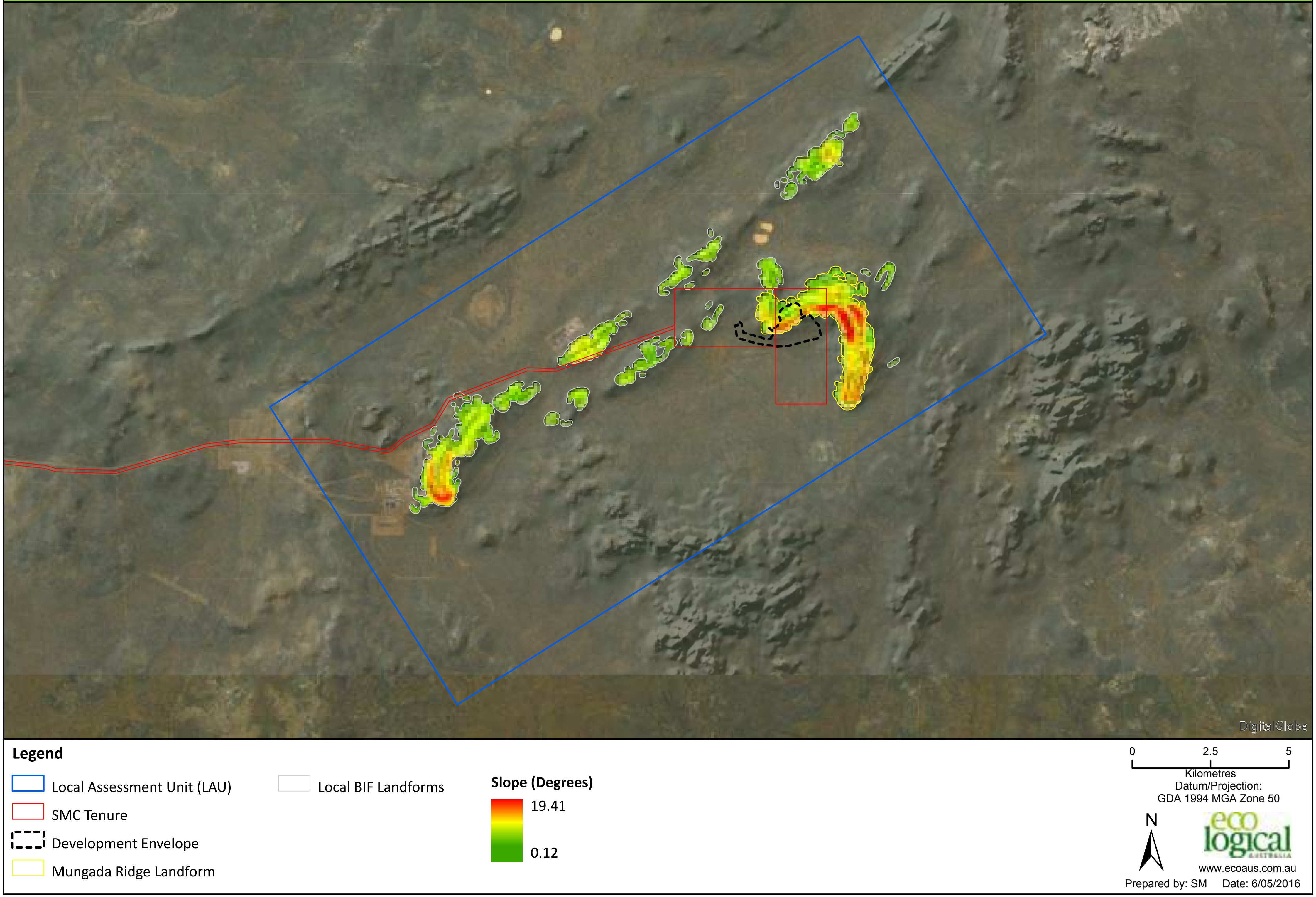
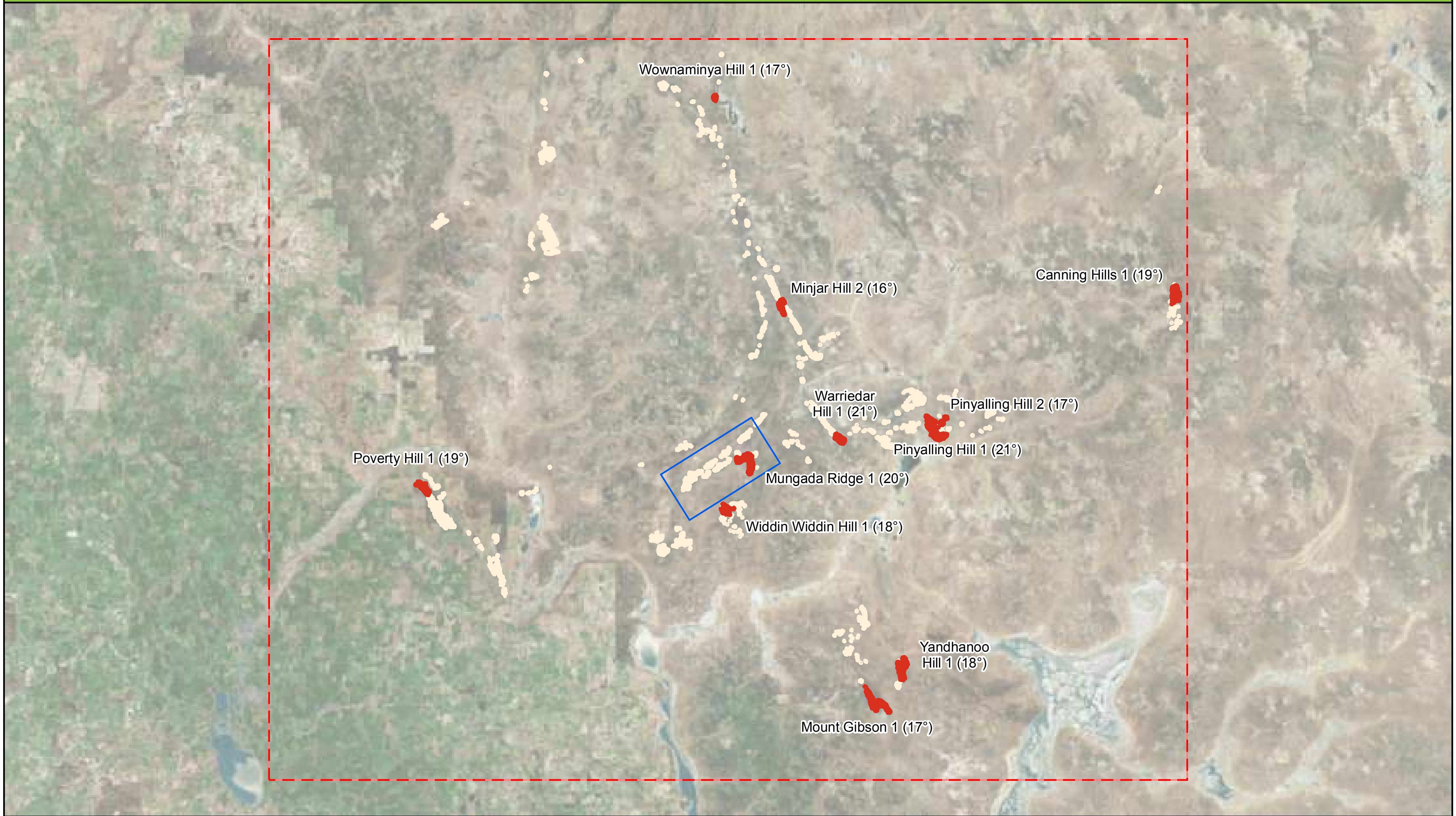


Figure 22: BIF landforms in the Mungada/Karara/Koolanooka region by slope



Legend

Mungada/Karara/Koolanooka Region

Local Assessment Unit (LAU)

Indicative BIF Landforms

<15°

>15°

0 10 20 40
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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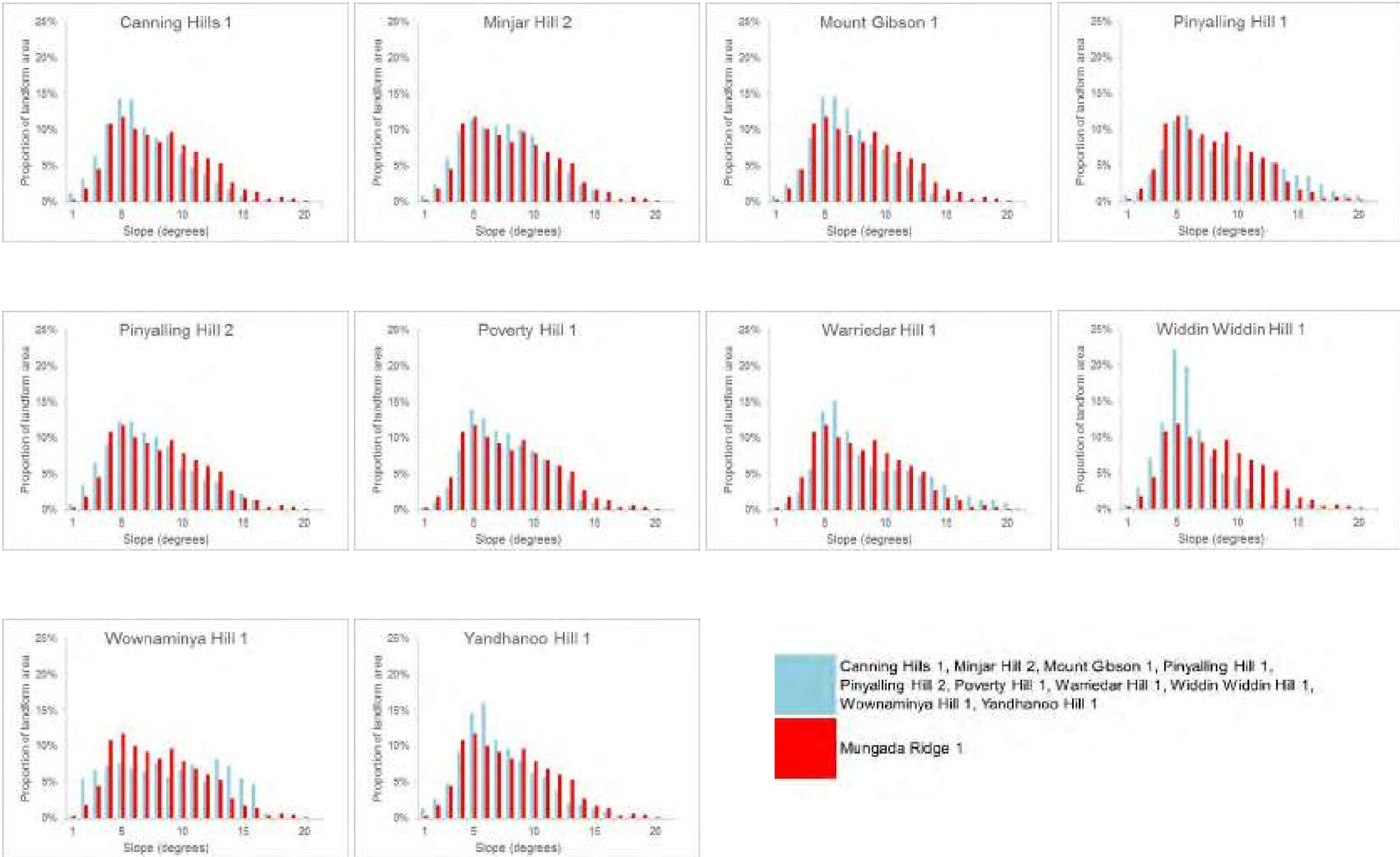


Figure 22: Slope distribution on regional BIF landforms (only landforms with slopes >15 degrees included)

Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 1)

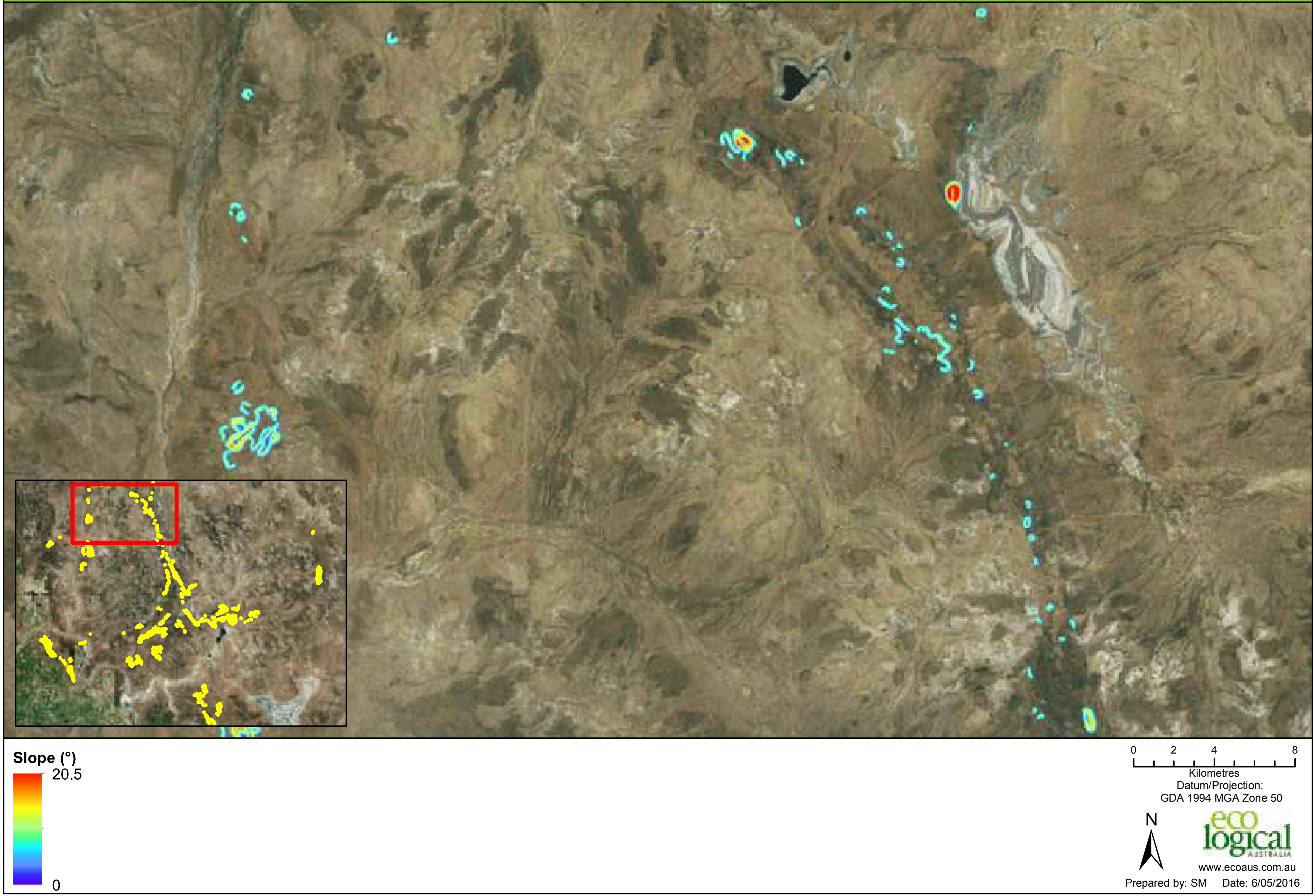
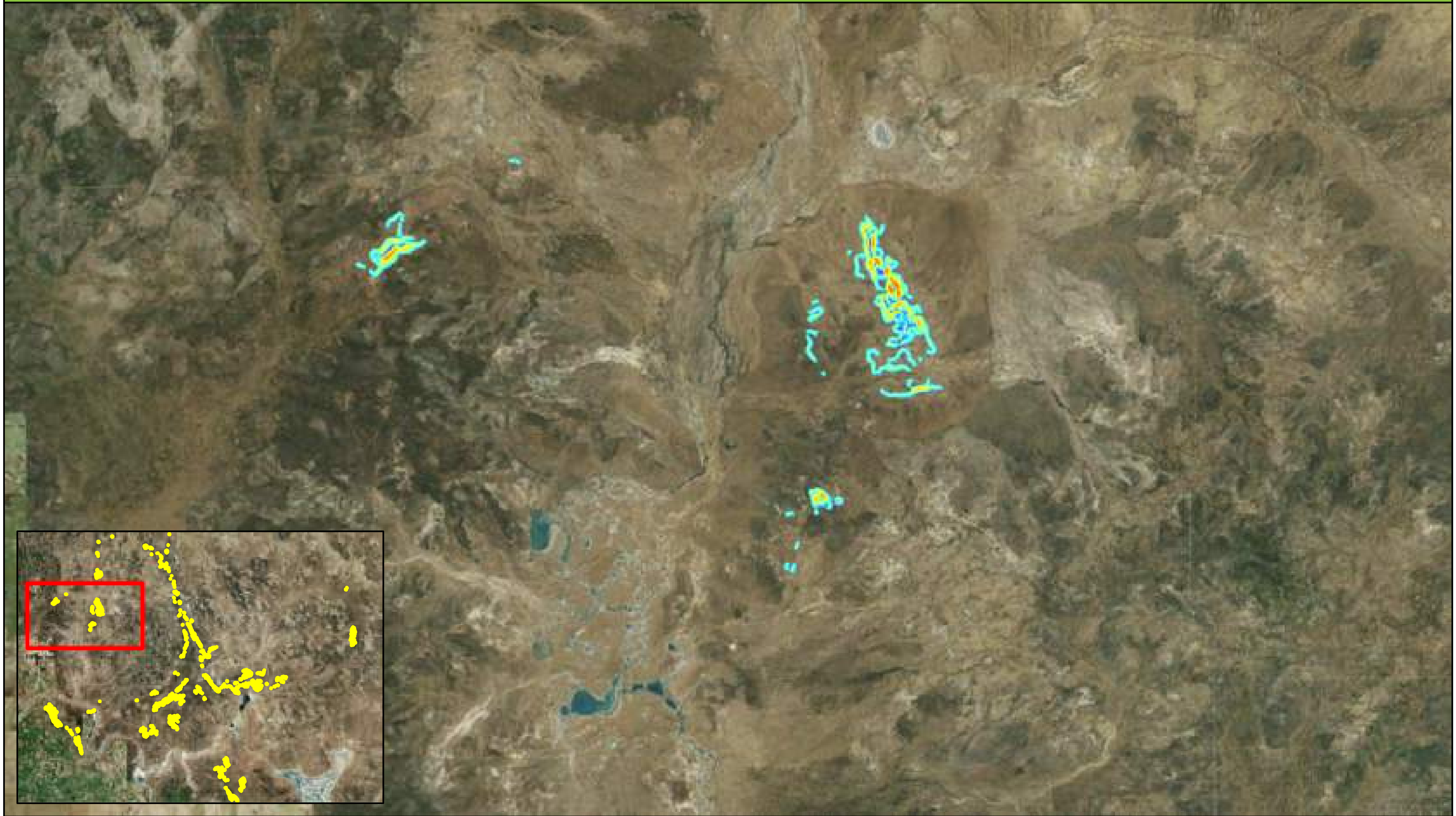


Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 2)



Slope (°)
20.5
0

0 2 4 8
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 3)

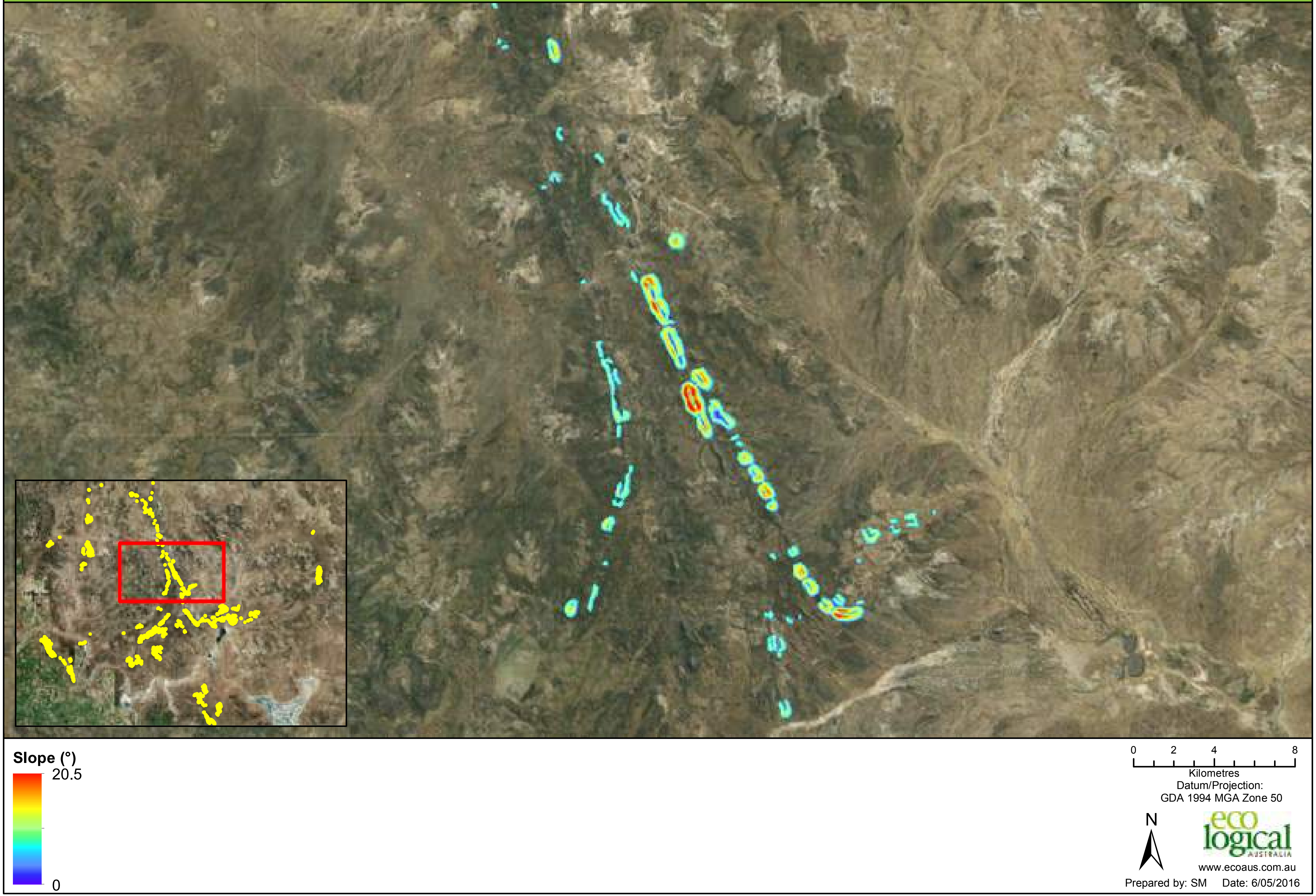


Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 4)

Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 5)

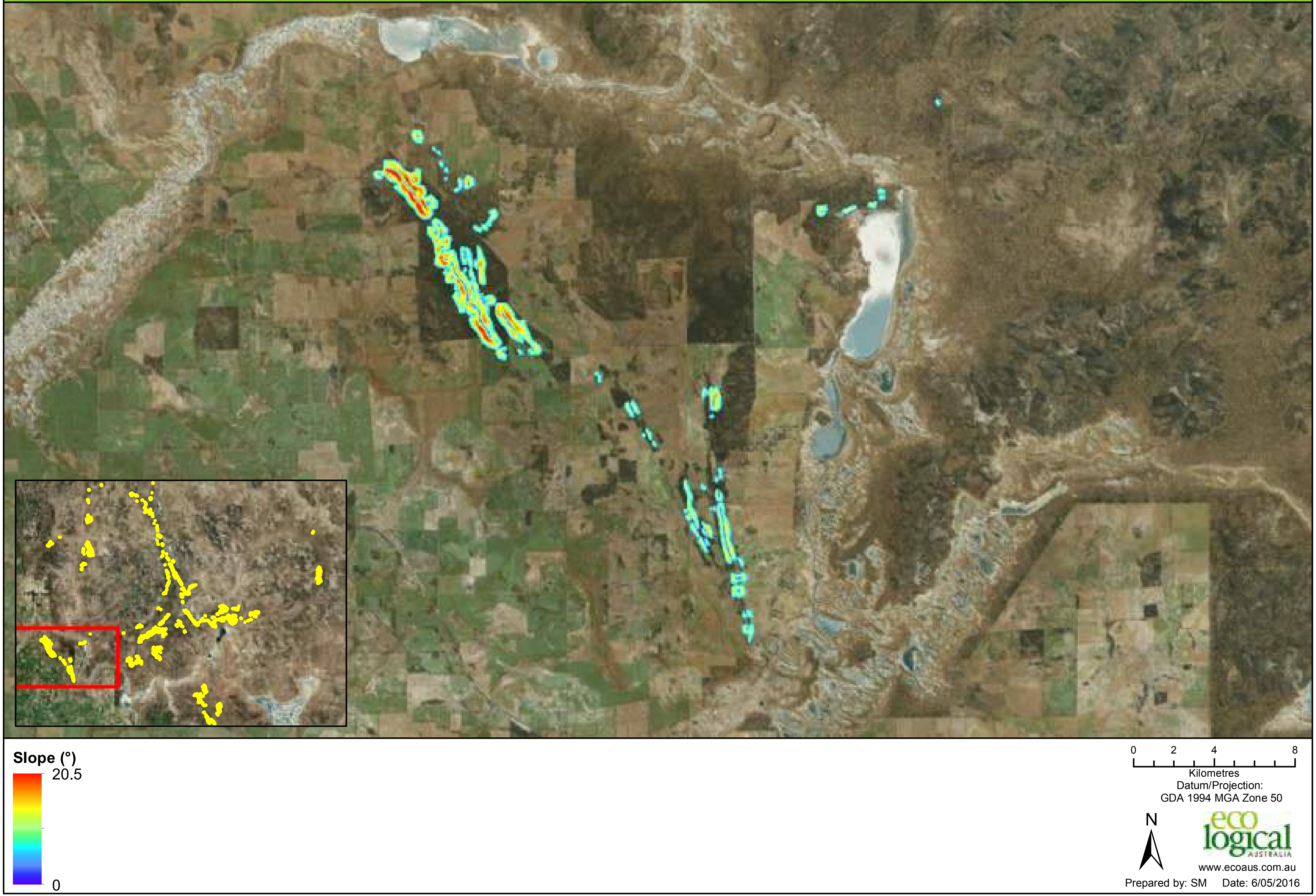


Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 6)

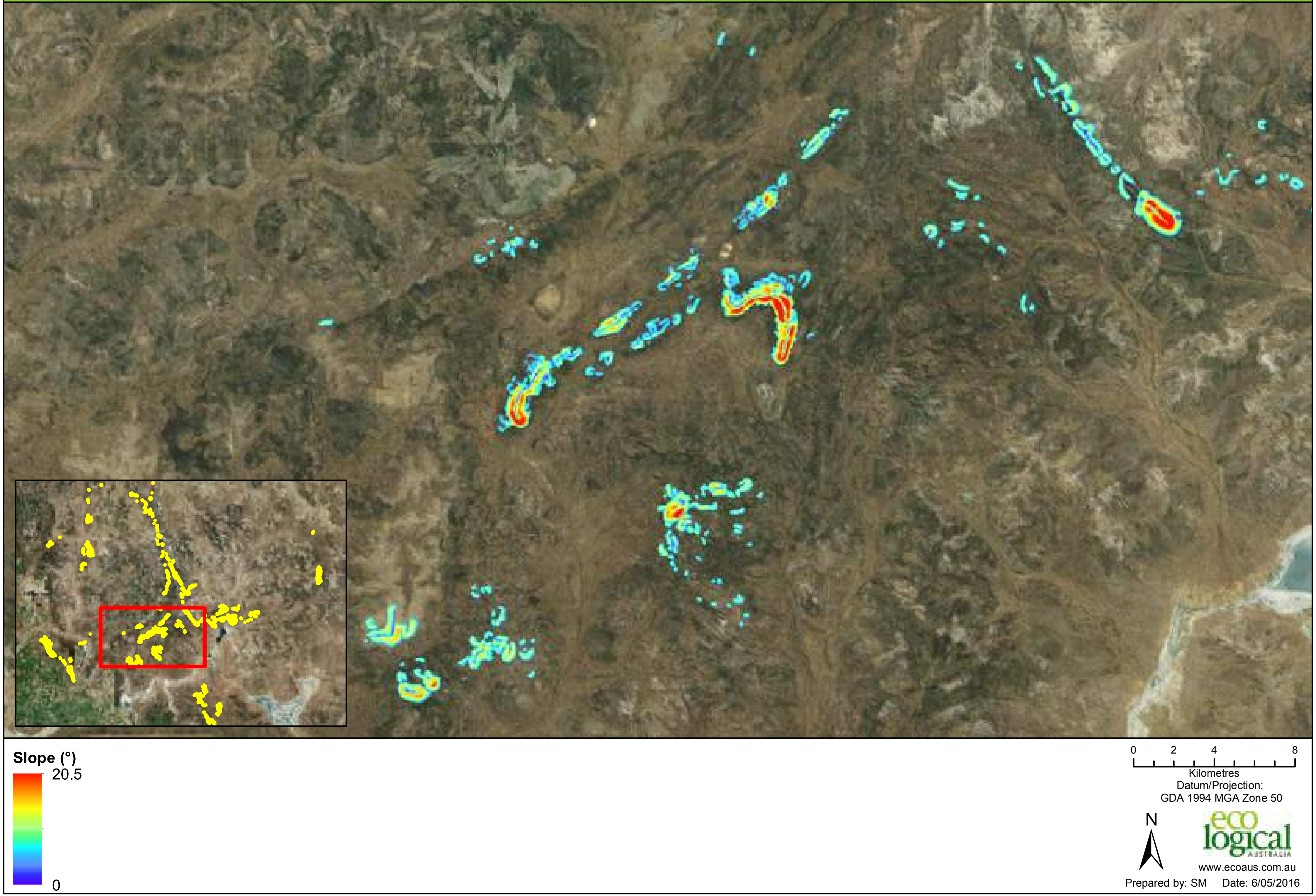
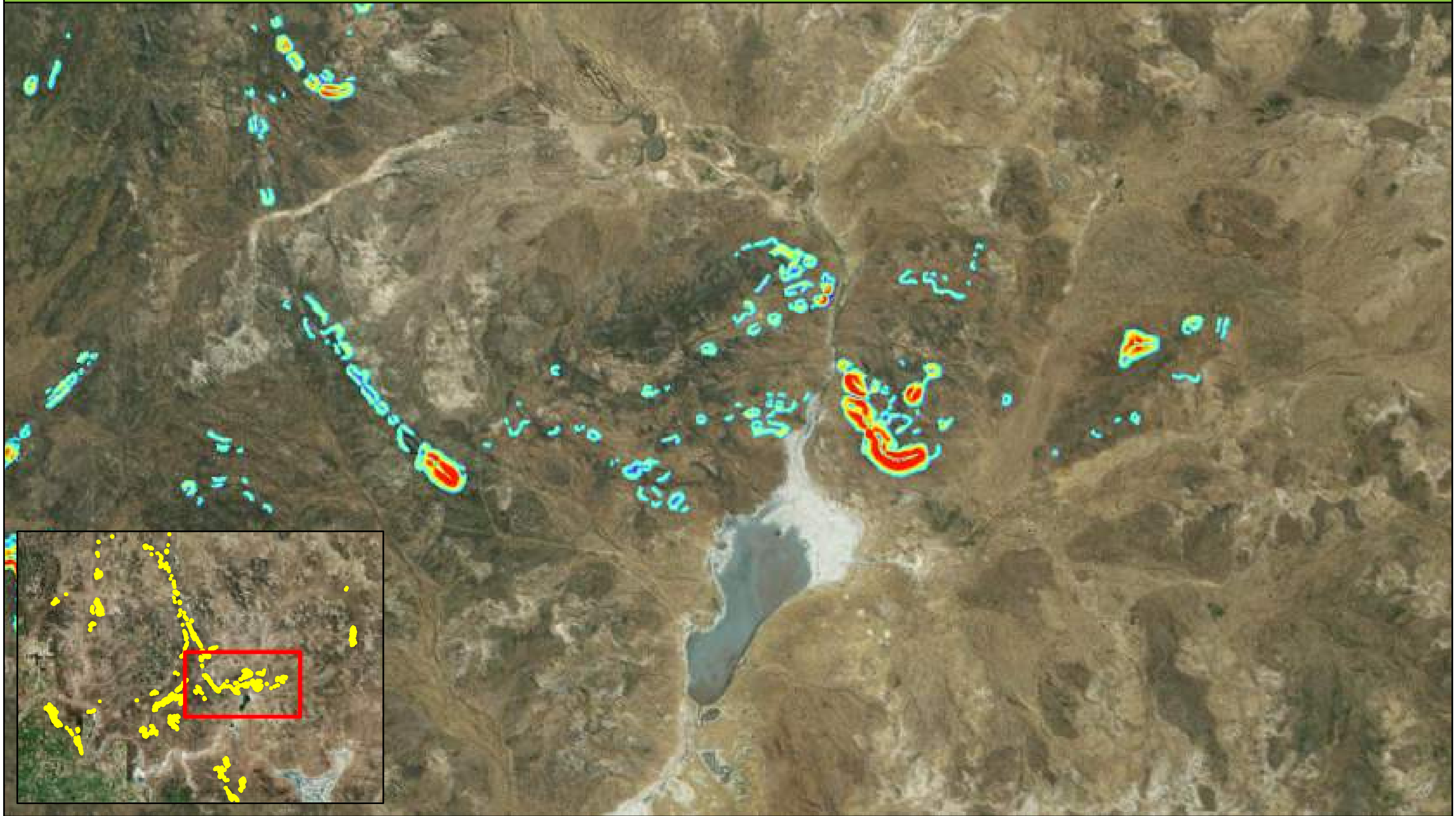


Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 7)



Slope (°)
20.5
0

0 2 4 8
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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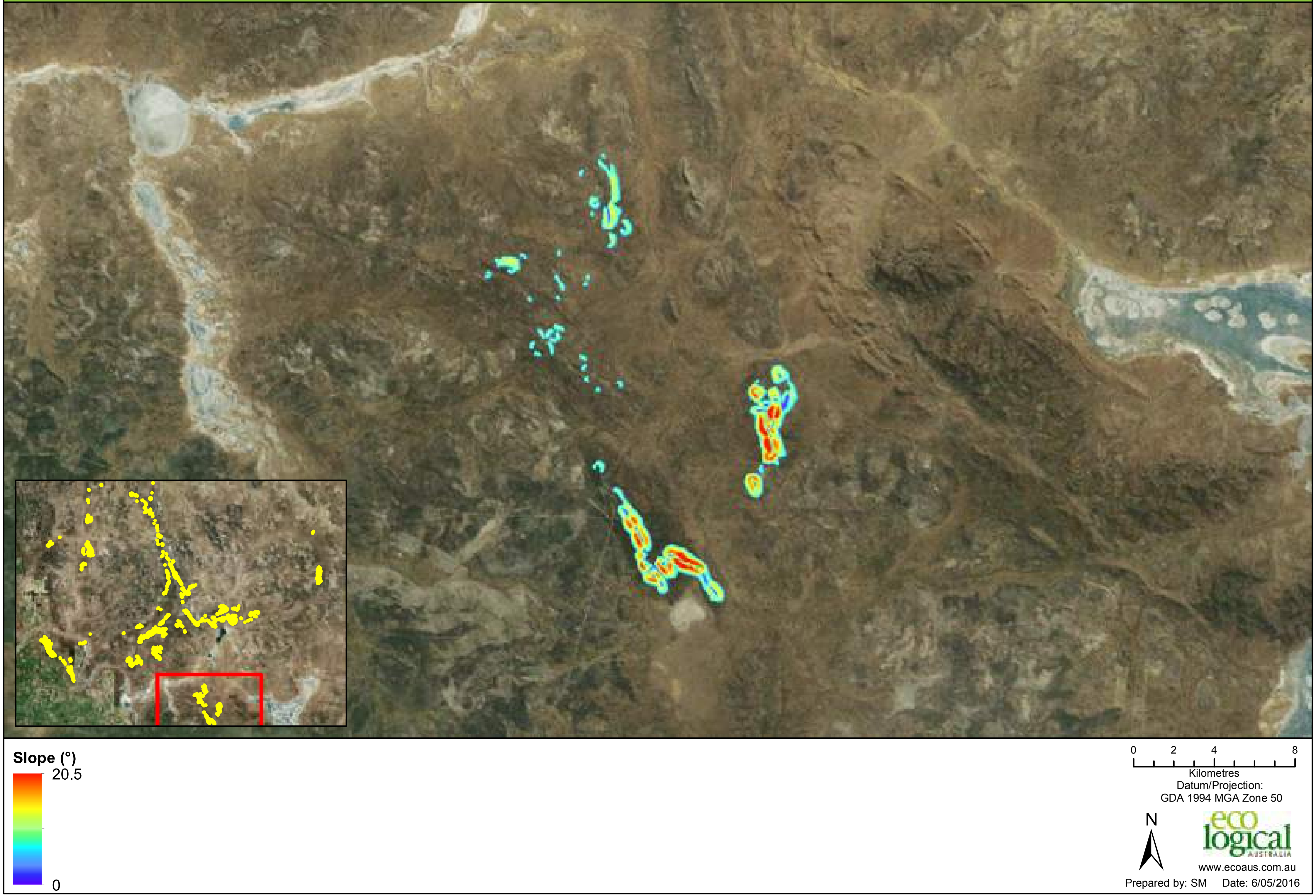
Figure 24: Slope in Mungada/Karara/Koolanooka region (Map 8)



Integrity

A total of six of the 31 BIF landforms in the LAU are completely intact, with zero disturbance. The remainder, including Mungada Ridge, have been disturbed by mining and/or exploration to varying degrees. Table 6 shows the level of existing disturbance to BIF landforms in the LAU, and includes a breakdown of how much disturbance is from exploration activities and how much is a result of mining or infrastructure development. Exploration activities are considered to have minimal, superficial impacts to the integrity of landforms in comparison to the construction of mine pits and associated infrastructure.

Table 6: Existing disturbance to BIF landforms in the LAU

Name	Area (ha)	Existing disturbance (ha)		Total (ha)	% of total area disturbed		Total (%)
		Mining and Infrastructure	Exploration		Mining and Infrastructure	Exploration	
Mount Karara 5	4.9	4.9	0	4.9	100.0	0	100.0
Mount Karara 4	7.3	6.9	0	6.9	94.2	0	94.2
Windaning Hill 3	24.9	22.6	0.1	22.7	91.0	0.4	91.4
Mount Karara 1	414.9	338.7	1.2	340.0	81.6	0.3	81.9
Windaning Hill 4	18.3	7.9	0.1	8.1	43.2	0.8	43.9
Mungada Ridge 5	65.6	28.5	0.1	28.6	43.4	0.2	43.6
Mount Karara 6	2.0	0.9	0	0.9	42.5	0	42.5
Mount Karara 7	1.7	0.7	0	0.7	41.5	0.8	42.3
Blue Hill Range 1	144.6	47.7	2.0	49.6	33.0	1.4	34.3
Mount Karara 3	9.1	1.5	0.1	1.6	16.6	0.6	17.2
Blue Hill Range 3	45.1	4.4	1.0	5.4	9.8	2.3	12.1
Mungada Ridge 1	684.8	33.5	23.9	57.5	4.9	3.5	8.4
Jasper Hill 19	3.5	0	0.2	0.2	0	4.8	4.8
Mungada Ridge 2	30.6	0	1.1	1.1	0	3.5	3.5
Blue Hill Range 4	6.0	0	0.2	0.2	0	3.2	3.2
Blue Hill Range 7	3.9	0	0.1	0.1	0	3.0	3.0
Windaning Hill 5	18.0	0	0.5	0.5	0	3.0	3.0
Mungada Ridge 4	5.8	0	0.1	0.1	0	2.6	2.6
Windaning Hill 6	6.6	0	0.1	0.1	0	1.1	1.1
Jasper Hill 8	20.3	0	0.2	0.2	0	0.9	0.9
Windaning Hill 2	37.6	0	0.3	0.3	0	0.9	0.9
Windaning Hill 1	110.5	0	0.6	0.6	0	0.5	0.5
Mount Karara 2	81.7	0	0.3	0.4	0	0.4	0.4
Jasper Hill 1	180.0	0	0.8	0.8	0	0.4	0.4
Blue Hill Range 2	54.0	0	0.1	0.1	0	0.2	0.2

Name	Area (ha)	Existing disturbance (ha)		Total (ha)	% of total area disturbed		Total (%)
		Mining and Infrastructure	Exploration		Mining and Infrastructure	Exploration	
Blue Hill Range 5	4.5	0	0	0	0	0	0
Blue Hill Range 6	4.0	0	0	0	0	0	0
Jasper Hill 20	3.0	0	0	0	0	0	0
Mungada Ridge 3	6.9	0	0	0	0	0	0
Windaning Hill 7	4.7	0	0	0	0	0	0
Windaning Hill 8	2.6	0	0	0	0	0	0
Total	**2,007.8**	**498.3**	**33.2**	**531.5**	**24.8**	**1.7**	**26.5**

A total of 57.5 ha or 8.4% of Mungada Ridge is already disturbed. The existing disturbance on Mungada Ridge consists of 33.5 ha of mining/infrastructure and 23.9 ha of exploration. The mining/infrastructure disturbance comprises the existing Mungada East pit and waste rock dump, which occur on the less-prominent, western-most area of Mungada Ridge (Figure 25). The majority of the disturbance from exploration occurs on the eastern portion of Mungada Ridge, within Karara Mining Limited's tenements.

The BIF landforms in the LAU (Figure 11) cover approximately 2,000 ha in total and are all located within mining tenure (Figure 26). Existing disturbance on BIF landforms in the LAU (Figure 27) comprises approximately 531.5 ha, or 26.5% of the total area of BIF landforms in the LAU. Within the 531.5 ha of existing disturbance, 498.3 ha is a result of mining or infrastructure development and 33.2 ha is a result of exploration activities. Three of the BIF landforms in the LAU have had >90% of their total area disturbed; Mount Karara 5 (100%), Mount Karara 4 (94.2%) and Windaning Hill 3 (91.4%). The largest mining operation is situated on Mount Karara (Mount Karara 1) in the south-west of the LAU and has disturbed 81.9% of the landform's total area to date (mining/infrastructure and exploration) (Figure 27; Table 6).

The tenure of the BIF landforms in the Mungada/Karara/Koolanooka region is shown in Figure 28. A total of 23 BIF landforms are located only in former pastoral leases (DPaW managed lands) and 149 are located only in mining tenure. A total of 182 are located in areas covered by both mining tenure and former pastoral leases (DPaW managed lands). A further eight BIF landforms are not within either mining tenure or former pastoral leases. Four are within Crown Reserve land, three within Freehold land and one in Crown Lease land.

Some of these regional BIF landforms are also already disturbed. However, an analysis similar to what was undertaken for landforms in the LAU (Table 6) is unable to be undertaken at a regional scale as the spatial data showing specific areas of disturbance on each landform are not publicly available. Figure 29 provides an indication of where mining or exploration activities are being conducted or have been conducted in the past, in the Mungada/Karara/Koolanooka region based on information from DMP's GeoVIEW database. Figure 29 shows the point locations of all operations in the region including abandoned (historic) mine sites, areas of historical exploration as well as mine sites that are operating, closed, or under care and maintenance (proposed and undeveloped sites were not included).

Of the 362 BIF landforms in the Mungada/Karara/Koolanooka region, six are associated with abandoned (historical) mine sites, 10 with areas of historical exploration and 30 with mine sites that are either operating, closed, or under care and maintenance. Of the five BIF landforms in the Mungada/Karara/Koolanooka region that are >600 ha in size, three are associated with existing mining disturbance: Mungada Ridge 1 (one mine site in care and maintenance – the existing Blue Hills mine), Mount Gibson 1 (one mine site, operating) and Yandhanoo Hill 1 (five mine sites, all closed).

Figure 25: Existing impact on Mungada Ridge

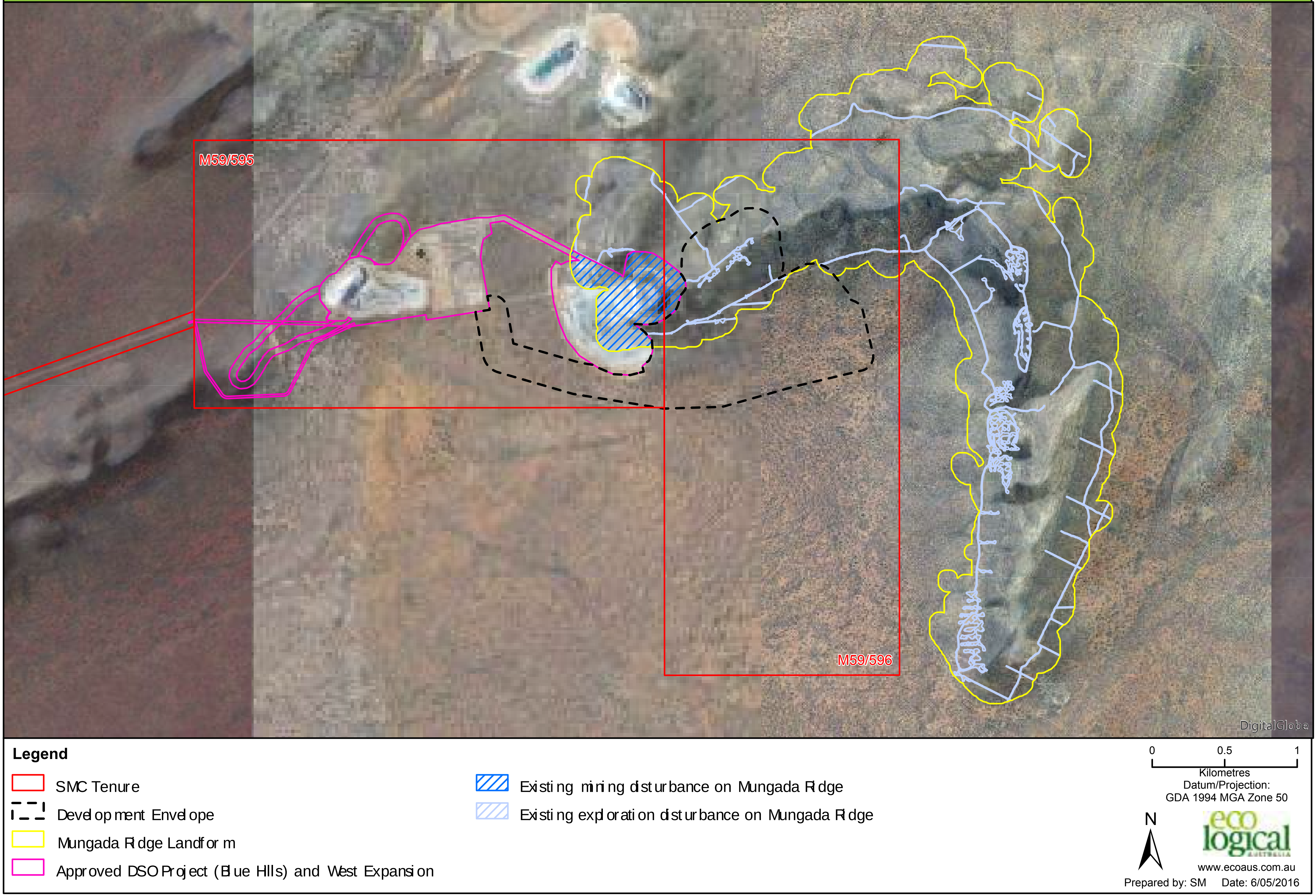


Figure 26: Current land tenure in the local assessment unit

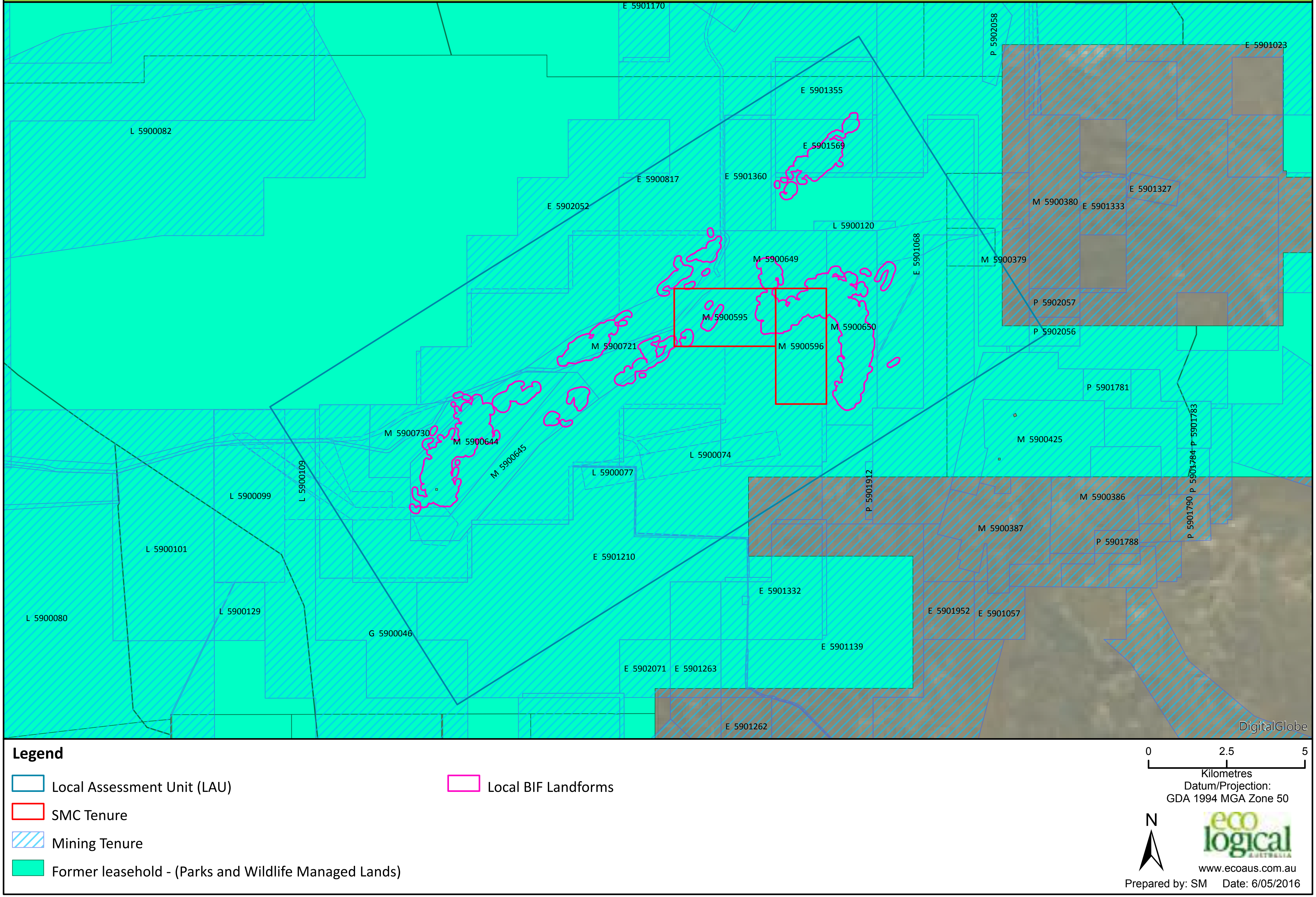


Figure 27: Existing impact in the local assessment unit

Legend

- Local Assessment Unit (LAU)
- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Mungada Ridge Landform
- Local BIF Landforms
- Exis ng mining disturbance in LAU
- Exis ng explora on disturbance in LAU

0 2.5 5
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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Figure 28: Tenure in the Mungada/Karara/Koolanooka region

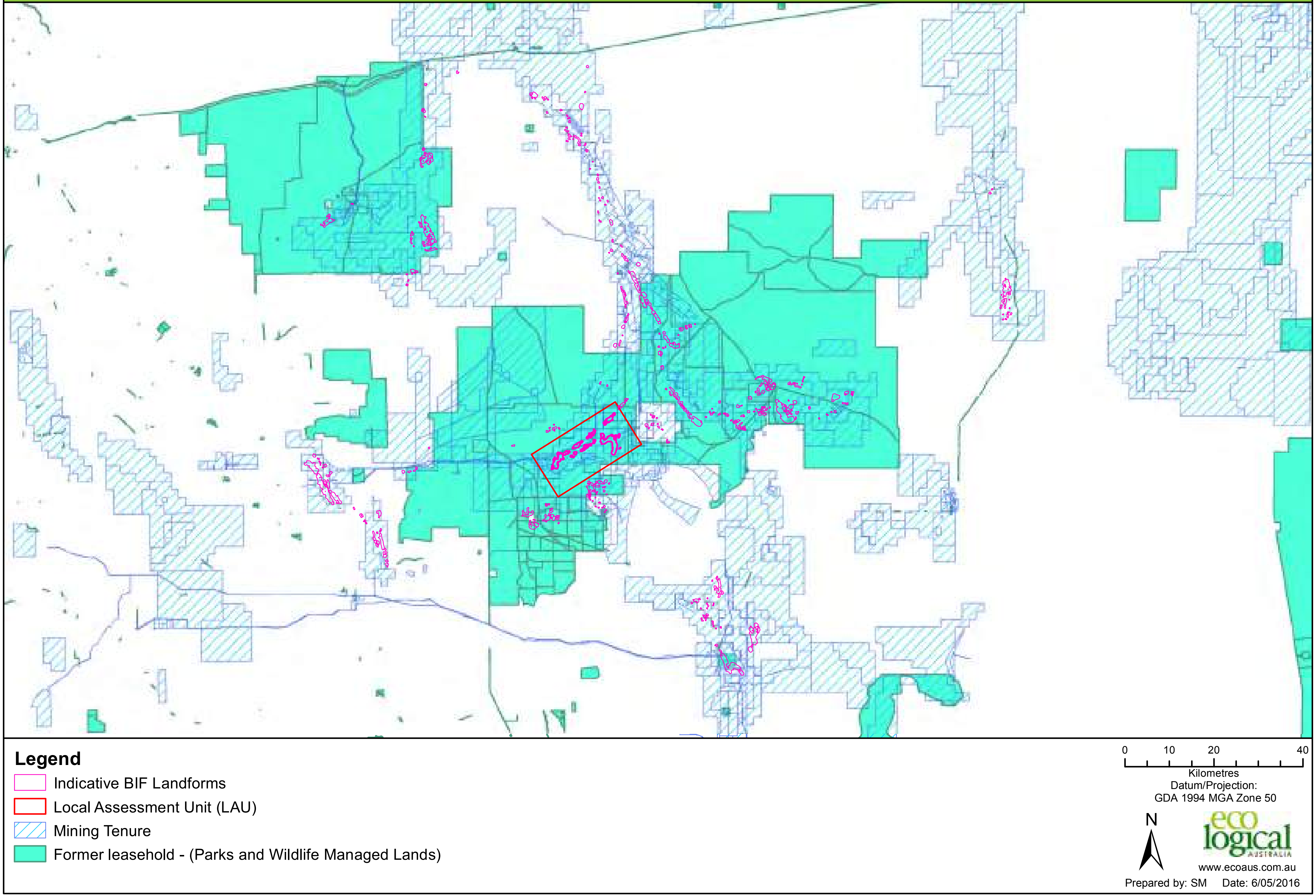
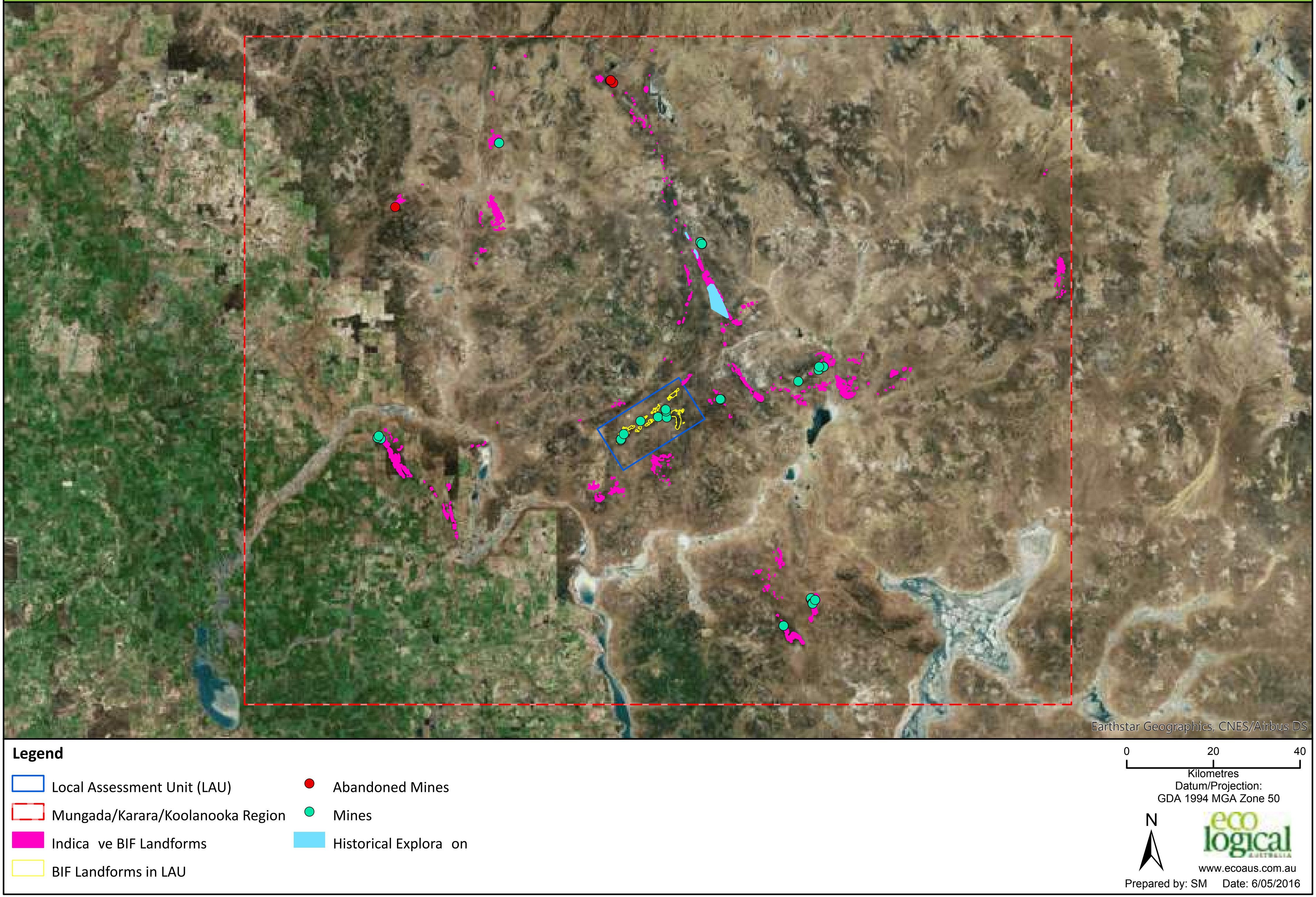


Figure 29: Existing impact in the Mungada/Karara/Koolanooka region



Ecological importance

The environmental values of Mungada Ridge are described in detail in Sections 14 and 15. A summary of the key values is provided in this section.

Ecological values

Two Threatened flora species, *Acacia woodmaniorum* and *Stylidium scintillans*, occur on Mungada Ridge. *Acacia woodmaniorum* occurs predominantly on Mungada Ridge and some *Stylidium scintillans* records occur on or adjacent to Mungada Ridge with the remainder occurring up to approximately 40 km from ridge. The Priority 1 flora species *Lepidosperma* sp. Blue Hills also has high representation on Mungada Ridge. An additional Priority 1 flora species, *Acacia karina*, occurs on Mungada Ridge, as well as eight Priority 3 flora species (Section 14).

The Priority 1 PEC 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' occurs on Mungada Ridge. This PEC occurs across 7,098 ha, extending approximately 20 km to the north and south, 7 km to the east and 16 km to the west of the development envelope. Approximately 9% of the total mapped area of the PEC occurs on Mungada Ridge.

A total of four conservation significant terrestrial vertebrate fauna species are known to occur on Mungada Ridge:

- *Lophochroa leadbeateri* (Major Mitchell's Cockatoo);
- *Falco peregrinus* (Peregrine Falcon);
- *Cyclodomorphus branchialis* (Gilled Slender Blue-tongue); and
- Leipoa ocellata (Malleefowl).

The following conservation significant invertebrate fauna species are known to occur on Mungada Ridge:

- *Idiosoma nigrum* (Shield-backed Trapdoor Spider) (Confirmed SRE) (recent unpublished research has confirmed that the records of *Idiosoma nigrum* at the Blue Hills mine and vicinity and other areas of the Midwest are a different species of *Idiosoma*. However, for the purpose of this assessment, the records of *Idiosoma* recorded in the development envelope will be treated as *Idiosoma nigrum* until gazetted otherwise. Refer to Section 15);
- '*Urodacus?*' 'sp.' (Potential SRE);
- Barychelidae sp. A (Unknown SRE);
- Barychelidae sp. B (Unknown SRE);
- *Beierolpium* 'sp. 8/2' (Unknown SRE);
- *Beierolpium* 'sp. 8/4' large (Unknown SRE);
- *Bothriembryon* sp. 'Northern Wheatbelt (Potential SRE);
- *Cormocephalus* sp. (Potential SRE);
- *Mecistocephalus* sp (Unknown SRE);
- *Sinumelon* cf. *vagente* (Potential SRE);
- *Urodacus* 'blue hills' (Potential SRE);
- *Urodacus* sp. 'koolanooka' (Potential SRE);
- *Westralaoma aprica* (Potential SRE); and
- *Westralaoma* cf. *expicta* (Potential SRE).

None of the conservation significant terrestrial fauna species recorded on Mungada Ridge are considered to be restricted to the ridge or reliant on the landform for their habitat, and all have been recorded in a variety of habitat types in the vicinity. Further discussion of these species and the nature of their occurrence on or near Mungada Ridge and is provided in Section 15.

Ecological maintenance

Mungada Ridge provides habitat preferred by two conservation significant flora species. Millar et al. (2014) consider *Acacia woodmaniorum* to be highly substrate-specific to the skeletal soils of the steep slopes, rock crevices and gullies of low-altitude BIF outcrops. The Priority 1 flora species *Lepidosperma* sp. Blue Hills also prefers hill slopes, breakaways and rocky outcrops of laterite, granite, banded ironstone and sandstone (FloraBase 2015). Although not strictly endemic to the ridge (ecologia 2013), the majority of the individuals of these two flora species occur on Mungada Ridge and therefore favour the habitat and substrate it provides, over surrounding areas.

It is not known exactly which characteristic of the habitat is favoured by these species, and further research would be required to determine this. However, in their study of patterns of plant diversity across 24 ironstone ranges in arid South Western Australia, Gibson et al. (2012) found some potential correlation between the richness of various plant species with soil chemistry (Section 13.2.1).

None of the fauna species recorded on Mungada Ridge are restricted to the landform or the habitat it provides (Section 15). Rocky Ridge habitats are often associated with SRE taxa, particularly where they have deep rocky crevices and shaded, south-facing slopes (ecoscape 2016a). Mungada Ridge contains Rocky Ridge habitat, as well as south-facing slopes; however, these characteristics are not unique to Mungada Ridge. Furthermore, records of conservation significant fauna species on Mungada Ridge, in particular confirmed and potential SREs and Malleefowl mounds, occur across varying habitat types and on slopes facing various directions so are not restricted to the ridge or specific areas of the ridge.

The indicative drainage pathways on and around Mungada Ridge were generated using a digital elevation model in ArcGIS (Appendix G) and are shown in Figure 30. No significant drainage lines appear to originate on Mungada Ridge (Figure 30), or on any of the other landforms in the LAU (Figure 31), and there are no major rivers or creeks flowing through or nearby the LAU (Figure 31 and Figure 32). Therefore none of the flora or fauna occurring on Mungada Ridge are considered likely to be reliant on readily available surface water sources.

The role of Mungada Ridge in ecological maintenance of the values that occur is only considered to be of particular importance to the conservation significant flora species that prefer habitat on Mungada Ridge.

Microclimate

An analysis of shade used as surrogate for identification of cooler microclimates was undertaken to identify any areas of Mungada Ridge that may provide a refuge for restricted species. Areas that are shaded for high percentages of the day are likely to have cooler microclimates than areas that are less shaded; these highly shaded areas occur mainly on slopes on the southern sides of ridges.

The shade provided by Mungada Ridge was modelled using GIS at three intervals during daylight hours: morning (9:30 AM), midday (12:00 PM) and afternoon (3:30 PM) (Figure 33). Areas which experience the most total shade across two or more intervals during the day (e.g. morning and midday, or morning and afternoon) were defined as ‘areas of prolonged shade’ and are shown in Figure 34. These areas of prolonged shade were considered to potentially support cooler microclimates that may provide a refuge for restricted species.

To ascertain whether these areas of prolonged shade may provide specific habitat for any of the conservation significant environmental values of Mungada Ridge (aligned with those potentially impacted by the Proposal), the relationship between the occurrence of these values and the areas of prolonged shade was investigated (Figure 35 to Figure 37). The environmental values included in the analysis and the occurrence of records or hectares of these values within areas of prolonged shade are outlined below:

- flora:
  - *Acacia woodmaniorum* (Threatened) (2,396 plants);
  - *Lepidosperma* sp. Blue Hills (Priority 1) (96 plants);
  - *Acacia karina* (Priority 1) (45 plants);
- vegetation:
  - vegetation associations/FCTs considered to be of high conservation significance as mapped by Woodman (2008a) and Maia (2016) (only those considered to have some form of alignment with the areas of prolonged shade were considered):
    - Woodman (2008a): FCT 13, 3.52 ha;
    - Maia (2016): vegetation association MSL (9), 4.81 ha;
- vertebrate fauna:
  - Malleefowl (EPBC Act Vulnerable, WC Act Vulnerable) (0 mounds);
  - Gilled Slender Blue-tongue (WC Act Vulnerable) (0 records);
- SREs (Confirmed, Potential and Unknown):
  - *Beierolpium* 'sp. 8/2' (Unknown SRE) (0 records);
  - *Westralaoma aprica* (Potential SRE) (0 records);
  - *Idiosoma nigrum* (EPBC Act Vulnerable, WC Act Vulnerable) (Confirmed SRE) (3 burrows); and
  - *Urodacus* sp. 'blue hills' (Potential SRE) (1 record).

No patterns were evident which would indicate any of the environmental values considered require areas of prolonged shade to persist, and none of the conservation significant flora, vegetation or fauna considered appear to be reliant on the areas of prolonged shade (Figure 35). The occurrence of the conservation significant flora species *Acacia karina* appears to have some alignment with the areas of prolonged shade. This indicates the species may prefer cooler areas to those that receive full sun. However, this species is not restricted to these areas and also occurs in locations other than Blue Hills, as it has been recorded in an area 75 km by 60 km within the Tallering IBRA sub-region.

<u>Landform complexity</u>

Mungada Ridge has some outcropping features and small cliffs that are typical of other BIF landforms in the Mungada/Karara/Koolanooka region. Two small caves are also present on the ridge which correspond to two Aboriginal 'Other Heritage Places' that are described further in Section 20.2.1. Figure 38 shows the known locations of some of the geological features which have been observed and their locations recorded during surveys of the area. These type of features are not considered to be rare, and there are likely to be various other examples of these features across Mungada Ridge. Plate 1 to Plate 5 show examples of geological features that have been opportunistically recorded. Mungada Ridge does not have any significant features such as monoliths or other highly distinct features of a similar nature.

Plate 1: Large outcropping / rock face approximately 5-10 m high (Maia 2016)

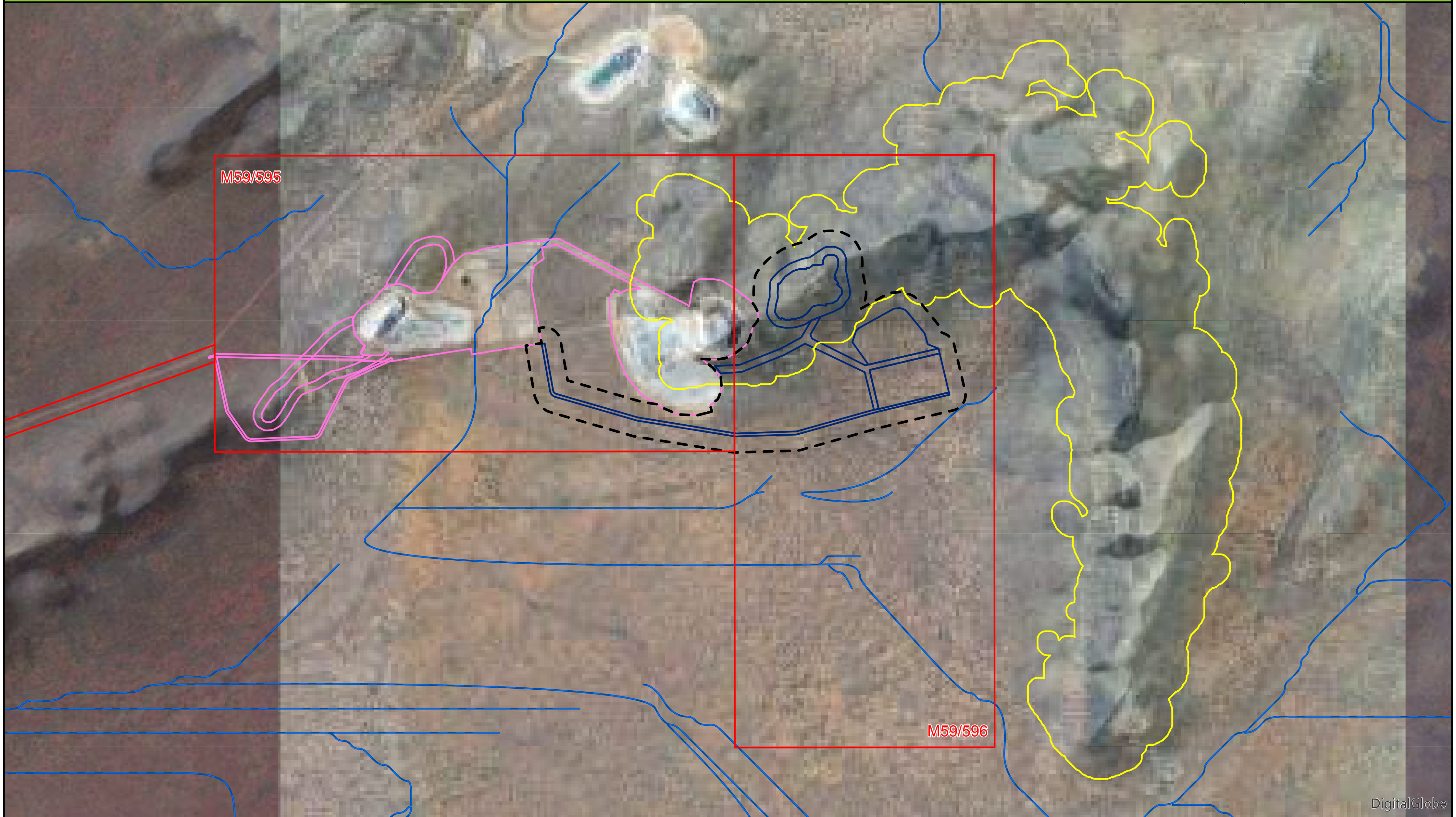
Plate 2: Large outcropping / rock face approximately 5 m high (Maia 2016)

Plate 3: Large outcropping / rock face approximately 5-10 m high (Maia 2016)

Plate 4: Outcropping (Maia 2016)

Plate 5: Outcropping (Maia 2016)

Figure 30: Hydrology of Mungada Ridge



Legend

- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Mungada Ridge Landform
- Proposed Disturbance Footprint
- Approximate Drainage Pathways (DEM Generated)

0 0.5 1
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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Figure 31: Hydrology of local assessment unit

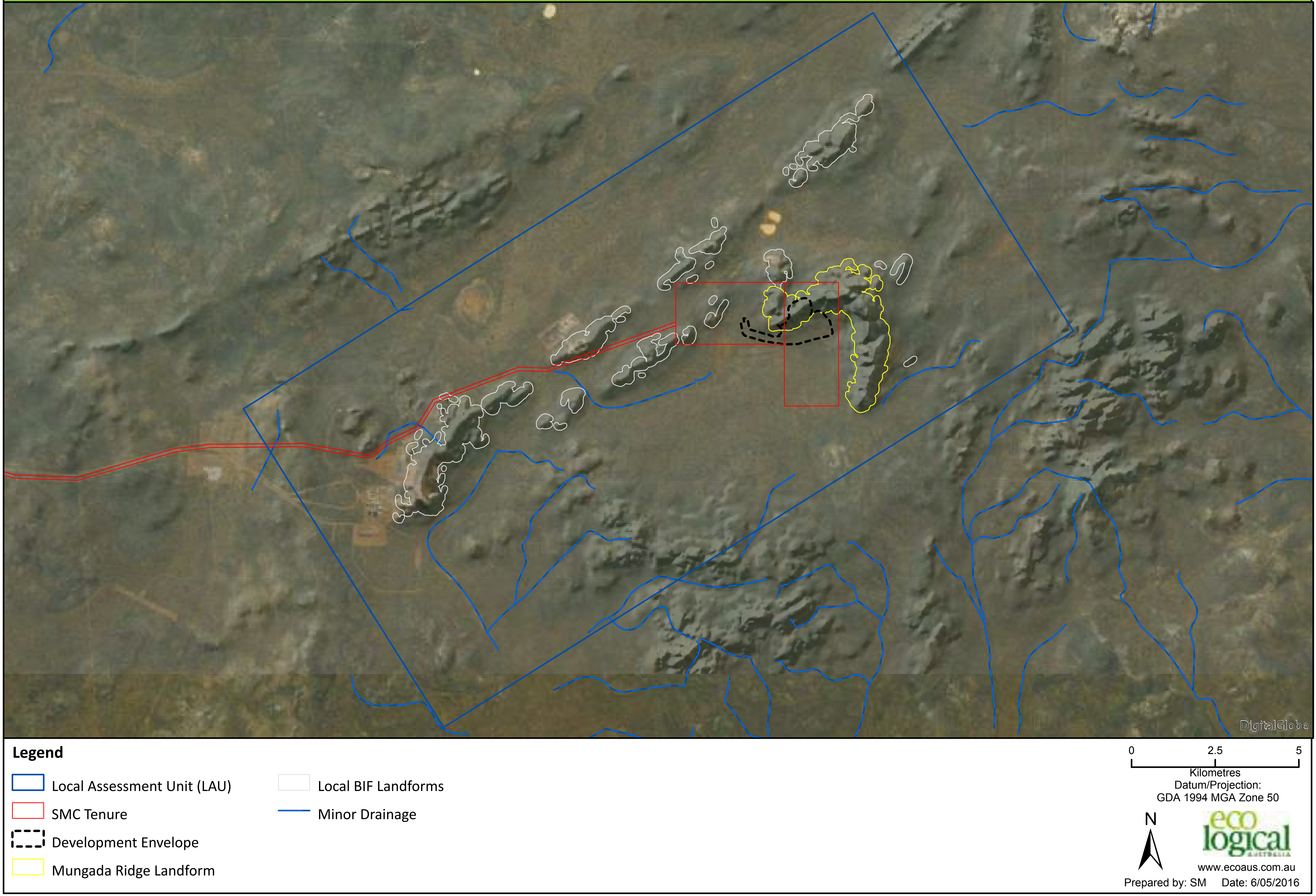


Figure 32: Hydrology of Mungada/Karara/Koolanooka region

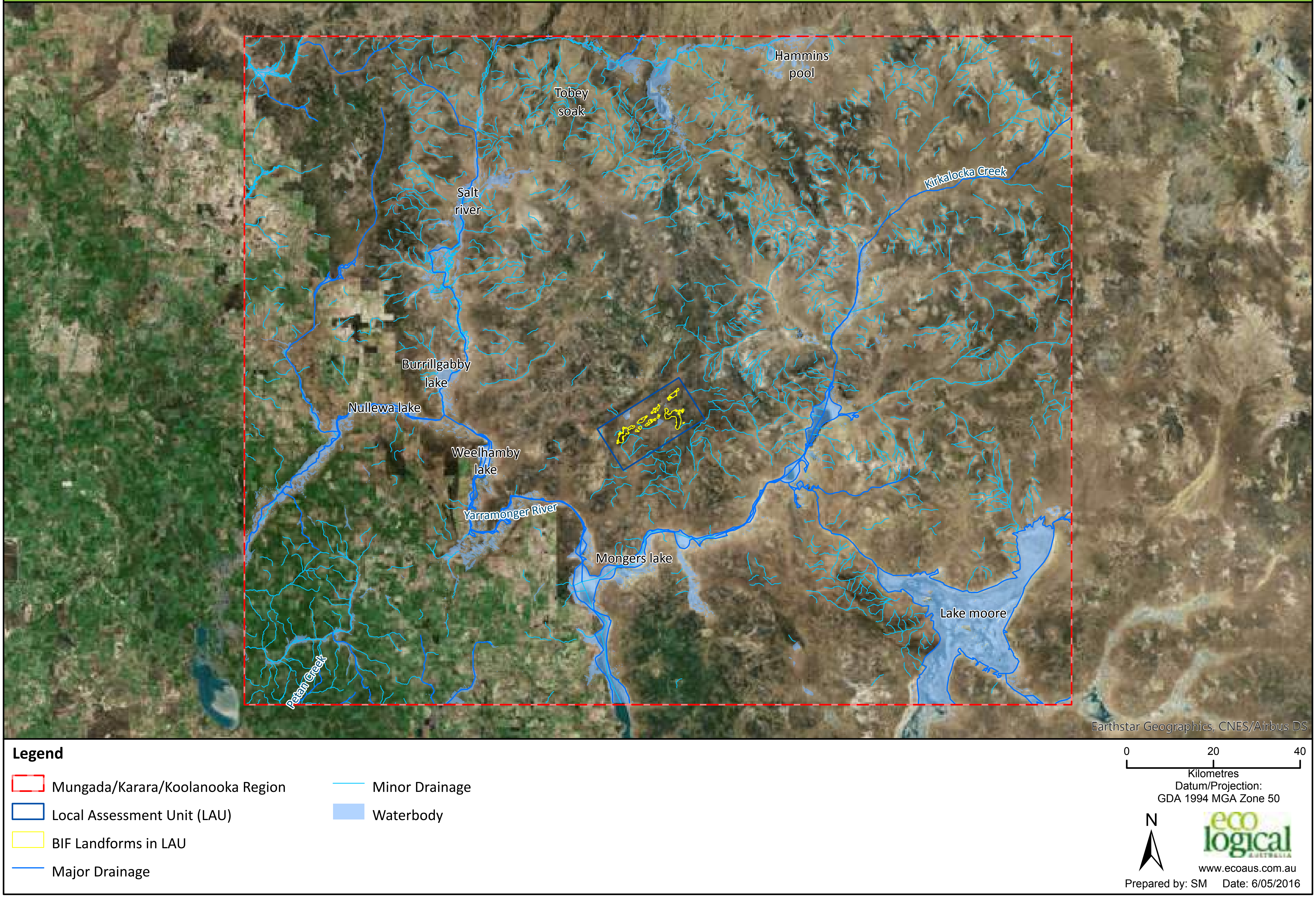
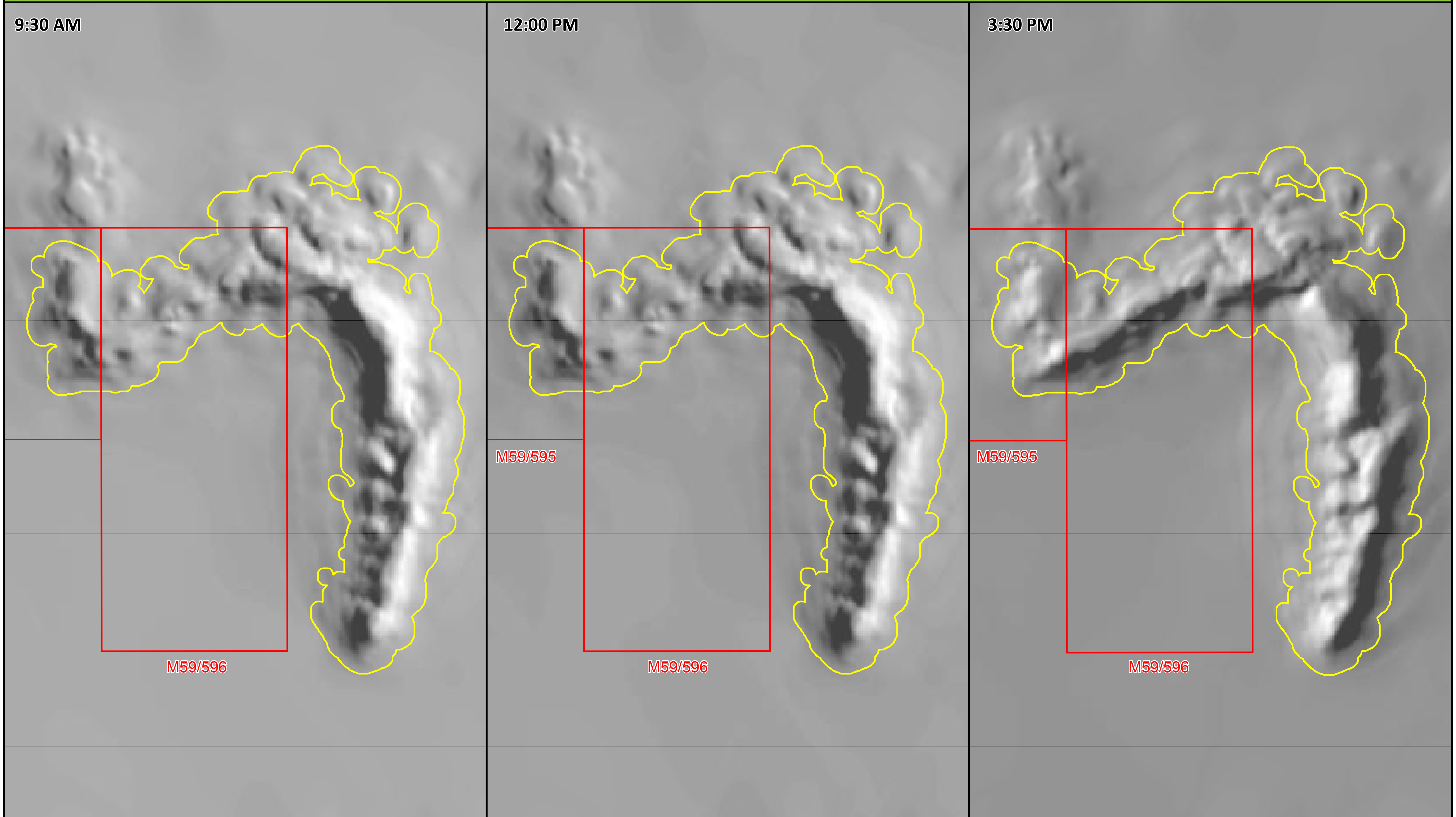


Figure 33: Shadow cast by Mungada Ridge



Legend

SMC Tenure

Mungada Ridge Landform

Shade

Unshaded

Highly Shaded

0 0.75 1.5
Kilometres

Datum/Projection:
GDA 1994 MGA Zone 50

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Figure 34: Prolonged Shade cast by Mungada Ridge

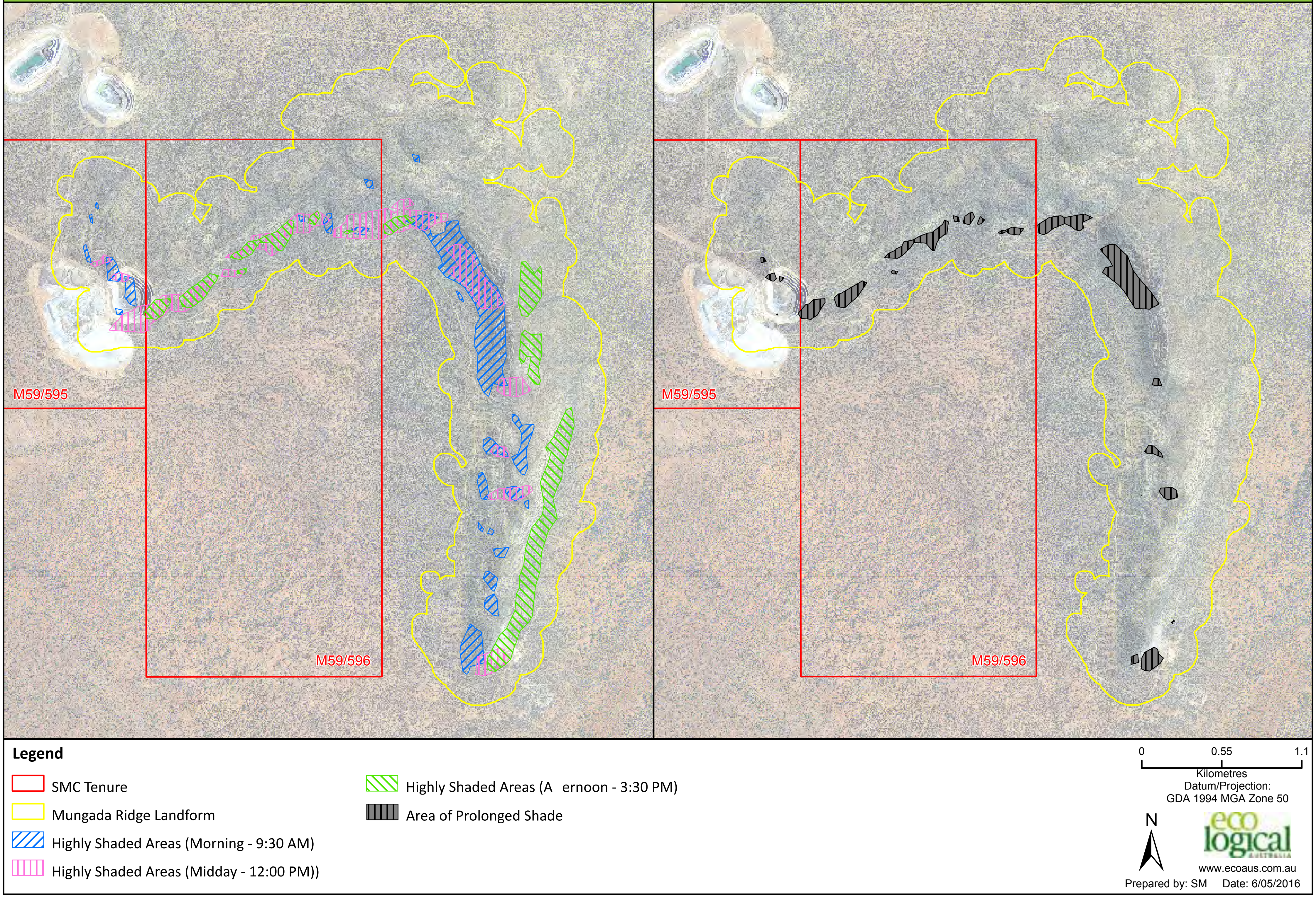
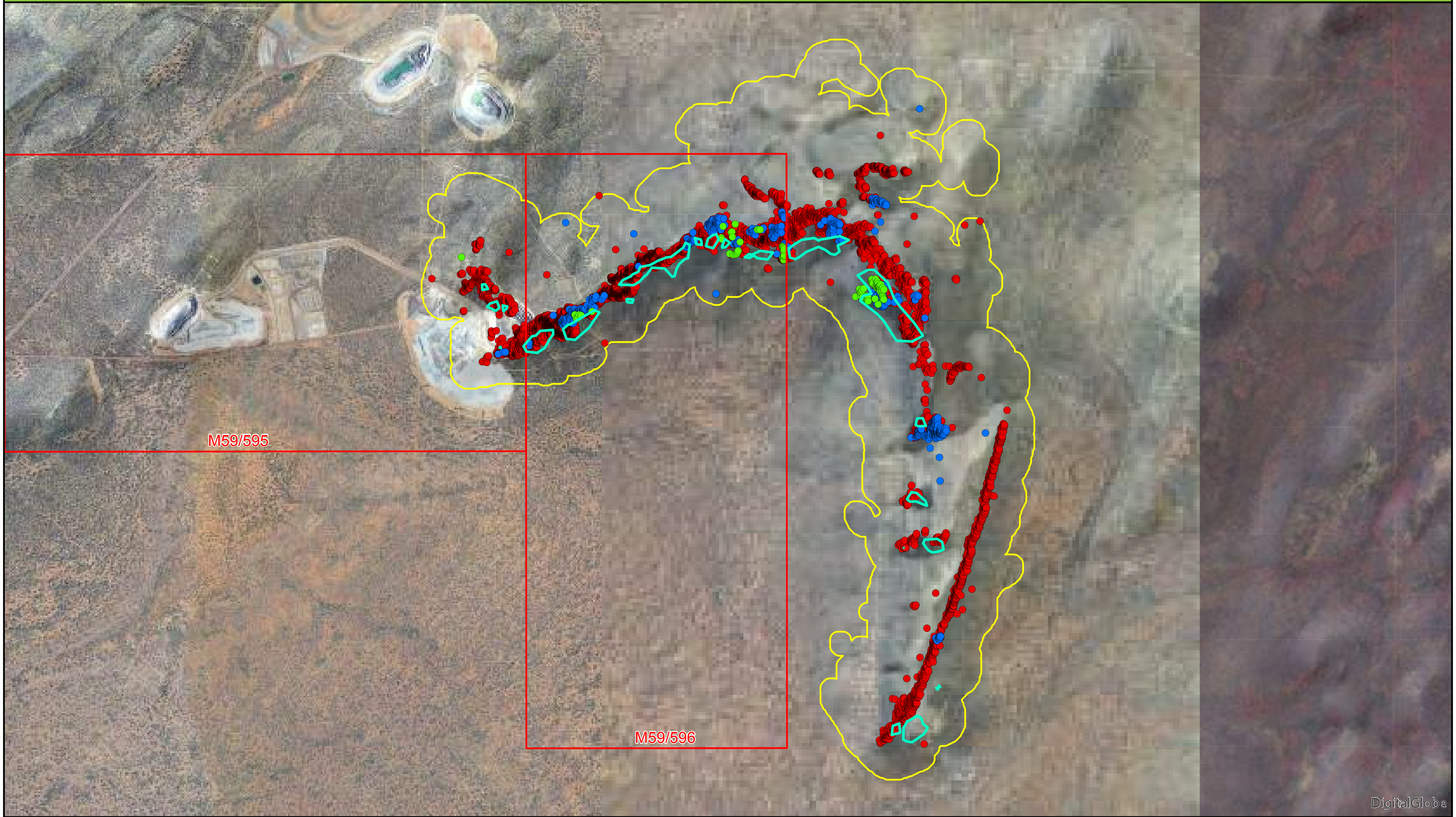


Figure 35: Prolonged shade and conservation significant flora on Mungada Ridge



Legend

- SMC Tenure
- Mungada Ridge Landform
- Prolonged Shaded Area

Conservation Signtificant Flora Record

- *Acacia karina*
- *Acacia woodmaniorum*
- *Lepidosperma* sp. Blue Hills (A. Markey and S. Dillon 3468)

0 0.5 1
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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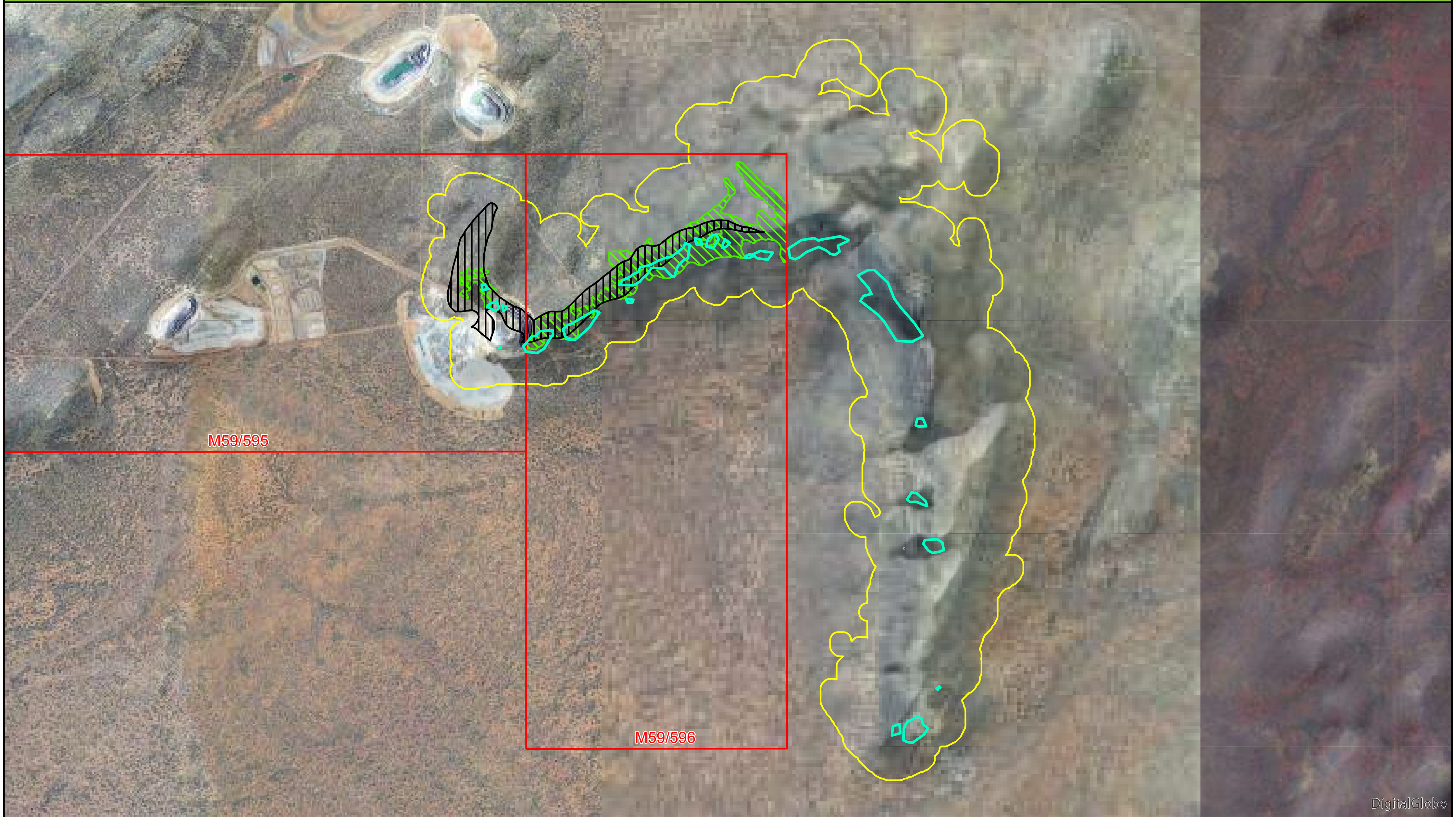
Figure 36: Prolonged shade and conservation significant vegetation on Mungada Ridge



Legend

- SMC Tenure
- Mungada Ridge Landform
- Prolonged Shaded Area

Vegetation Mapping Unit
Maia (2016)

MSL (9)

Woodman (2008a)

13

0 0.5 1
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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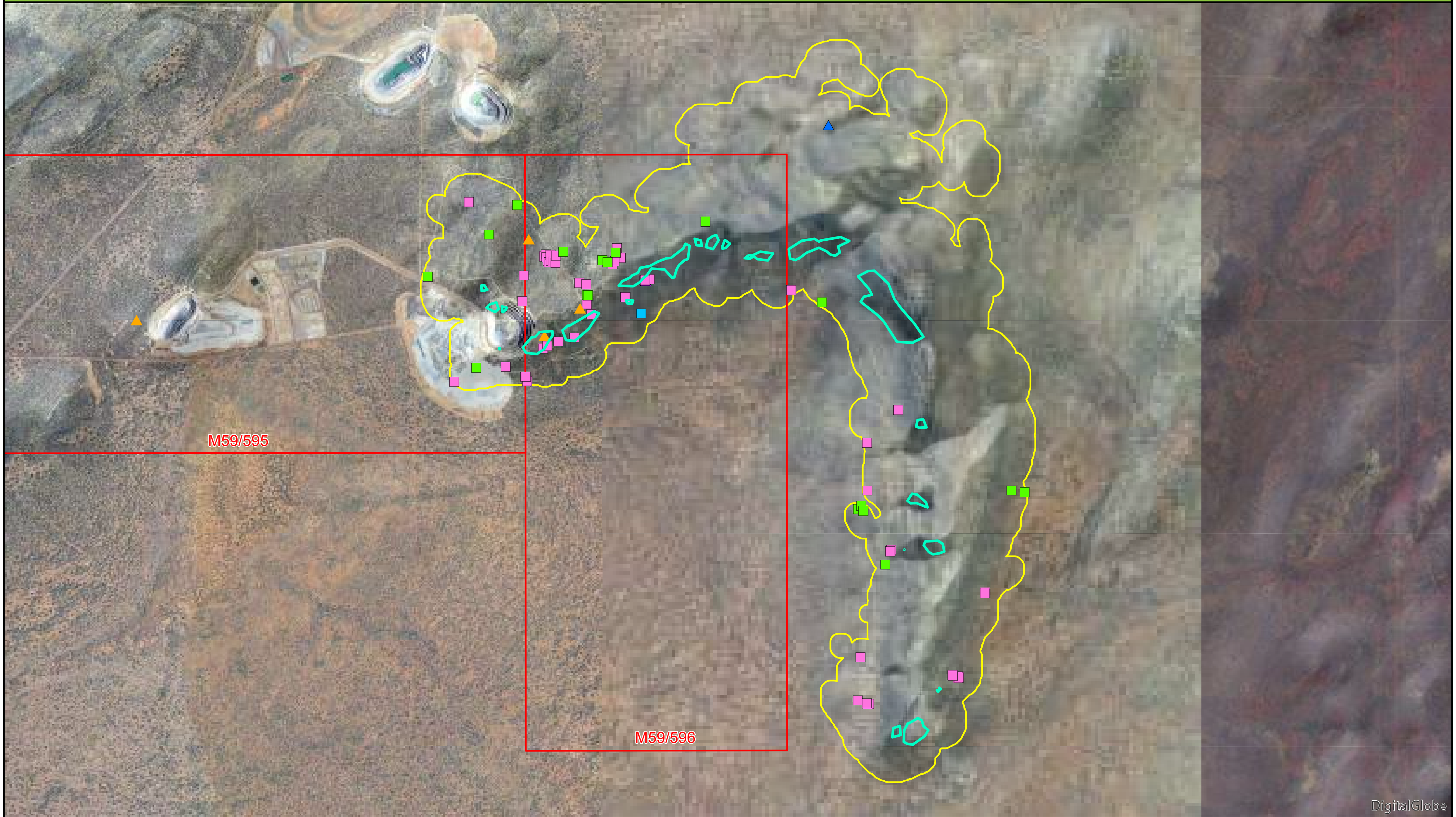
Figure 37: Prolonged shade and conservation significant terrestrial fauna on Mungada Ridge



Legend

- SMC Tenure
- Mungada Ridge Landform
- Prolonged Shaded Area

SREs

- *Beierolpium 'sp. 8/2'* (unknown status)
- *Westralaoma aprica.* (poten al SRE)
- *Urodacus* sp. Blue Hills (poten al SRE)
- *Idiosoma nigrum* (con rmed SRE)

Vertebrate Fauna

- Gilled Slender Blue-tongue (Schedule 1 Vulnerable)
- Mallefowl (EPBC Act Vulnerable, Schedule 1 Vulnerable)

0 0.5 1
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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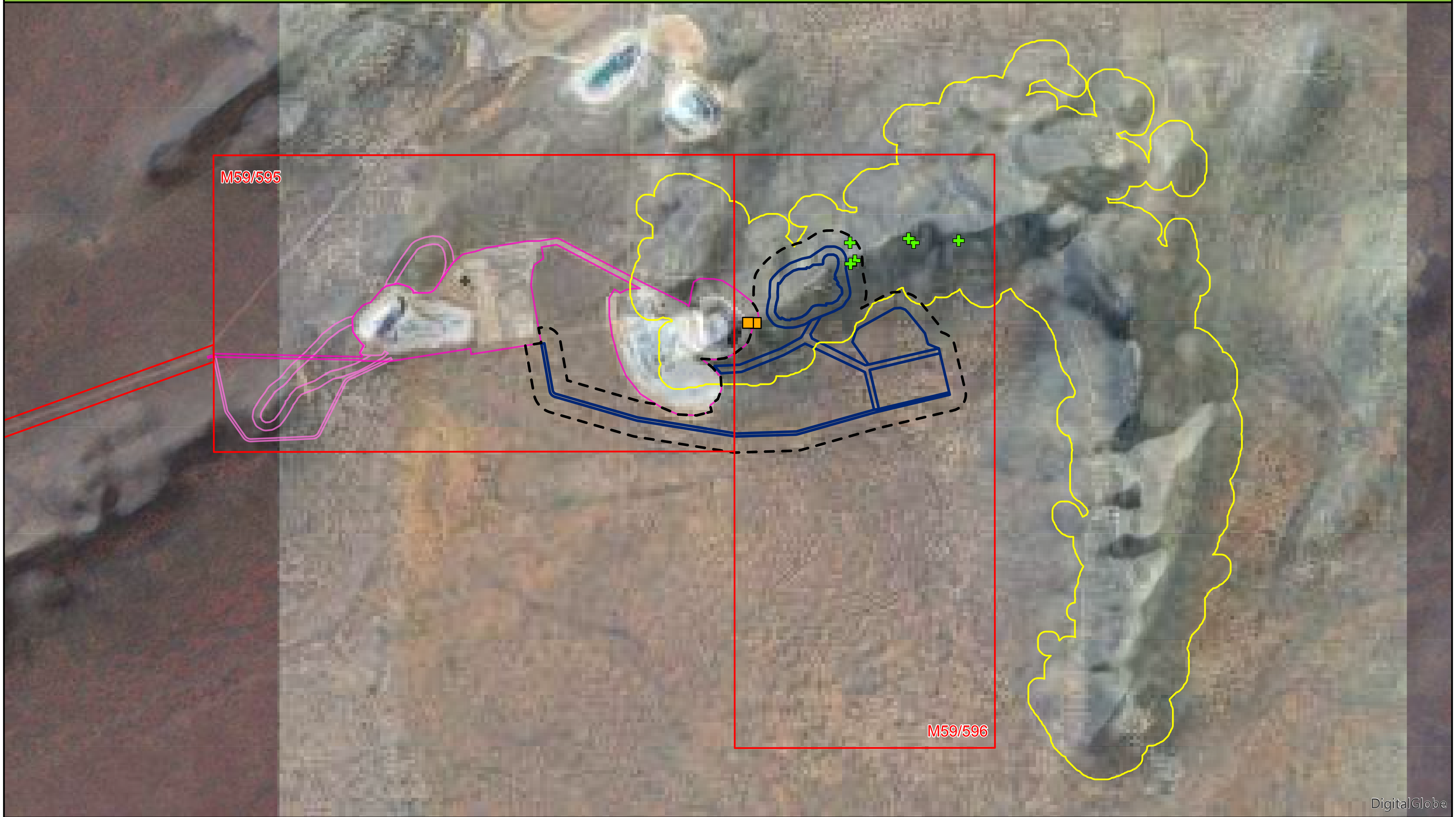
Figure 38: Geological features of Mungada Ridge



Legend

- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Mungada Ridge Landform
- Proposed disturbance footprint

Feature

- Cave
- Rock Outcrop

0 0.5 1
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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Scientific importance

Although many aspects of the origin of iron formations in general remain unresolved, it is widely accepted that changes in the style of their deposition are linked to the environmental and geochemical evolution of Earth (Bekker et al. 2010). The temporal distribution of BIF landforms provides a record of the complex interactions between a cooling Earth and changes including the Earth's mantle plume events (upwelling of abnormally hot rock within the Earth's mantle), continental growth and plate tectonics, evolution of the biosphere and an increased flux of iron to the hydrosphere, which in turn had a fundamental control on the oxygen content of the hydrosphere and redox state of the oceans (Isley and Abbott 1999; Holland 2005; Bekker et al. 2010 as cited in Evans et al. 2012). The BIF landforms in the Midwest of WA, including Mungada Ridge, are examples of these ironstone formations which developed as a result of a combination of the aforementioned processes and have been undisturbed by seas or glaciers for more than 250 million years.

The term geoheritage is used to refer to features of geology that occur at a global, national, state, regional, or local scale and that are intrinsically or culturally important, offer information or insights into the formation or evolution of the Earth, or into the history of science, or that can be used for research, teaching, or reference (Brocx and Semeniuk 2007). Geoheritage focuses on the diversity of minerals, rocks and fossils, and features that indicate the origin and/or alteration of minerals, rocks and fossils. It also includes landforms and other geomorphological features that illustrate the effects of present and past effects of climate and Earth forces (McBriar 1995 as cited in Brocx and Semeniuk 2007).

Geoheritage is protected in WA through the listing of Geoheritage Sites and Geoheritage Reserves. There are eight Geoheritage Reserves and more than 140 Geoheritage Sites in WA. The WA Register of Geoheritage Sites includes: 'Geological features of the Earth that are considered to be unique and of outstanding value within Western Australia and to have significant scientific and educational values' (Grey et al. 2010).

State Geoheritage Reserves are sites that are recognised nationally and internationally for their geoscientific importance and are created under Section 41 of the *Land Administration Act 1997* (WA). Geoheritage Reserves fall into two main categories: those related to evidence of early life (fossil sites), and those related to meteorite or asteroid impact structures. Six of WA's eight reserves are fossil sites located in the Pilbara region and contain the Earth's earliest visible traces of life at approximately 3.5 billion years old. The other two reserves (one in the Pilbara and one in the Midwest) are records of much younger asteroid or meteorite impacts.

None of the BIF landforms in the LAU or the Mungada/Karara/Koolanooka region are listed or proposed as Geoheritage Sites or Reserves, and none form part of any sites or reserves. It is unlikely that Mungada Ridge would fit the definition of a Geoheritage Reserve given it is not currently known to be a fossil site, nor is it related to meteorite or asteroid impact structures.

Rarity

Mungada Ridge is one of 31 BIF landforms in the LAU and one of 362 BIF landforms in the Mungada/Karara/Koolanooka region, and has some distinctive features including height, steepness and shape.

The LAU is approximately 25,000 ha in size and the BIF landforms occupy approximately 2,007 ha of this, equating to approximately 8%. Mungada Ridge is 685 ha in size, and represents 34% of the total area of BIF landforms in the LAU.

The Mungada/Karara/Koolanooka region (Figure 12) covers approximately 2.9 million ha and approximately 18,780 ha (0.6%) of this is occupied by BIF landforms. The BIF landforms in the LAU represent approximately 10%, and Mungada Ridge represents approximately 3.6%, of the total area of BIF landforms in the Mungada/Karara/Koolanooka region.

Summary

Located within the Mungada/Karara/Koolanooka region, Mungada Ridge is the largest, highest and steepest BIF landform in the LAU and is one of a small number of very large, high and steep BIF landforms in the Mungada/Karara/Koolanooka region (although it is not the largest, highest, nor steepest landform in the region). Mungada Ridge is unique in that it is the only one of the relatively few large, high and steep BIF landforms in the region that is distinctly crescent-shaped. While unusual, the distinct crescent shape of Mungada Ridge is not known, nor believed to influence the ecological or scientific importance of the landform. Like most of the BIF landforms in the LAU, Mungada Ridge is not completely intact; 8.4% of Mungada Ridge has been affected by existing disturbance. A number of conservation significant flora and fauna values occur on Mungada Ridge. Although none are strictly endemic to the ridge, two in particular, *Acacia woodmaniorum* (Threatened) and *Lepidosperma* sp. Blue Hills (Priority 1), are endemic to the local area and have the majority of their known records located on the ridge.

A summary of the characteristics and values of Mungada Ridge, in the context of the LAU and Mungada/Karara/Koolanooka region is provided below.

- Variety:
  - Mungada Ridge is the largest BIF landform in the LAU and fifth-largest in the Mungada/Karara/Koolanooka region;
  - Mungada Ridge is the highest BIF landform in the LAU and third-highest in the Mungada/Karara/Koolanooka region;
  - Mungada Ridge has the steepest slopes in the LAU, but these steep slopes (>15 degrees) form only 3% of its total area;
  - Mungada Ridge is the third-steepest of 11 BIF landforms in the Mungada/Karara/Koolanooka region that have some slopes >15 degrees, and all are relatively comparable in terms of slope, in that the major portion of each landform has a slope of roughly 3-7 degrees;
  - Mungada Ridge is the only crescent-shaped BIF landform in the LAU and the only crescent-shaped BIF landform >500 ha in size in the Mungada/Karara/Koolanooka region; 29 other potentially crescent-shaped BIF landforms occur in the Mungada/Karara/Koolanooka region, but all of these are <100 ha in size;
  - There is no evidence to suggest that the distinct crescent shape of Mungada Ridge would provide any function other than visual aesthetic value;
- Integrity:
  - 8.4% of Mungada Ridge is already disturbed;
  - 26.5% of the total area of BIF landforms in the LAU is already disturbed. Three of these BIF landforms have had >90% of their total area disturbed; Mount Karara 5 (100%), Mount Karara 4 (94.2%) and Windaning Hill 3 (91.4%);
  - The largest mining operation is situated on Mount Karara (Mount Karara 1) in the south-west of the LAU and has disturbed 81.9% of the landform's total area to date;
  - Of the 362 BIF landforms in the Mungada/Karara/Koolanooka region, 46 are associated with existing disturbance;
- Ecological importance:
  - Mungada Ridge supports a variety of environmental values including conservation significant flora and fauna species, and a PEC, all of which are not endemic to the ridge;

  - The rocky habitat of Mungada Ridge is preferred by two conservation significant flora species; *Acacia woodmaniorum* (Threatened) and *Lepidosperma* sp. Blue Hills (Priority 1);
  - Mungada Ridge contains Rocky Ridge habitat, as well as south-facing slopes; however, these characteristics are not unique to Mungada Ridge;
  - The records of potential or confirmed SREs and Malleefowl mounds, occur across varying habitat types and on slopes facing various directions so are not restricted to the ridge or specific areas of the ridge;
  - No significant rivers, creeks or drainage lines occur on or near Mungada Ridge;
  - None of the conservation significant flora, vegetation or fauna considered appear to be reliant on areas of prolonged shade provided by Mungada Ridge;
  - Mungada Ridge does not have any significant features such as monoliths or other highly distinct features of a similar nature;
- Scientific importance:
  - None of the BIF landforms in the Mungada/Karara/Koolanooka region are currently listed or proposed as Geoheritage Sites or Reserves;
- Rarity:
  - Mungada Ridge is one of 31 BIF landforms in the LAU and one of 362 BIF landforms in the Mungada/Karara/Koolanooka region;
  - 8% of the LAU and 0.6% of the Mungada/Karara/Koolanooka region is occupied by BIF landforms; and
  - Mungada Ridge represents approximately 34% and 3.6% of the total area of BIF landforms in the LAU and Mungada/Karara/Koolanooka region respectively.

13.3 Assessment of potential impact, mitigation and residual impact

The only landform in the LAU which the Proposal will affect is the western, lower-lying area of Mungada Ridge. Therefore, the following discussion and subsequent sections will relate to the potential impacts to this component of Mungada Ridge, and where relevant, the context of these impacts in the LAU and the Mungada/Karara/Koolanooka region.

Mining and excavation earthworks associated with the proposed pit, pit abandonment bund and haul roads on the landform are the only aspects of the Proposal which may potentially affect Mungada Ridge. The potential direct and indirect impacts which may result from these aspects during construction, operation and closure, not considering mitigation efforts, include:

- direct impacts:
  - structural alteration of the landform from excavation of the proposed mine pit (construction and operations);
- indirect impacts:
  - erosion (construction, operations and closure); and
  - instability (construction, operations and closure).

Mining excavation and earthworks will also potentially impact upon the environmental values of Mungada Ridge. These potential impacts are addressed in Sections 14 and 15.

13.3.1 Structural alteration of the landform

The areas of Mungada Ridge which will be altered permanently or temporarily are shown three-dimensionally in Figure 39 to Figure 42. The proposed Mungada East Extension pit and pit abandonment bund will alter the landform permanently; the proposed haul roads will alter the landform temporarily.

An assessment conducted for SMC has concluded that backfilling of the proposed mine pit is not a viable option for SMC. Therefore, the excavated pit will remain as a structural impact on the landform, and, together with the pit abandonment bund, will be the residual impact of the Proposal on Mungada Ridge. The portion of proposed haul roads located on Mungada Ridge will be rehabilitated upon closure of the Proposal and so will only alter the surface of the landform for the duration of construction and operations.

Figure 39: Areas of Mungada Ridge to be altered by Proposal (View 1)

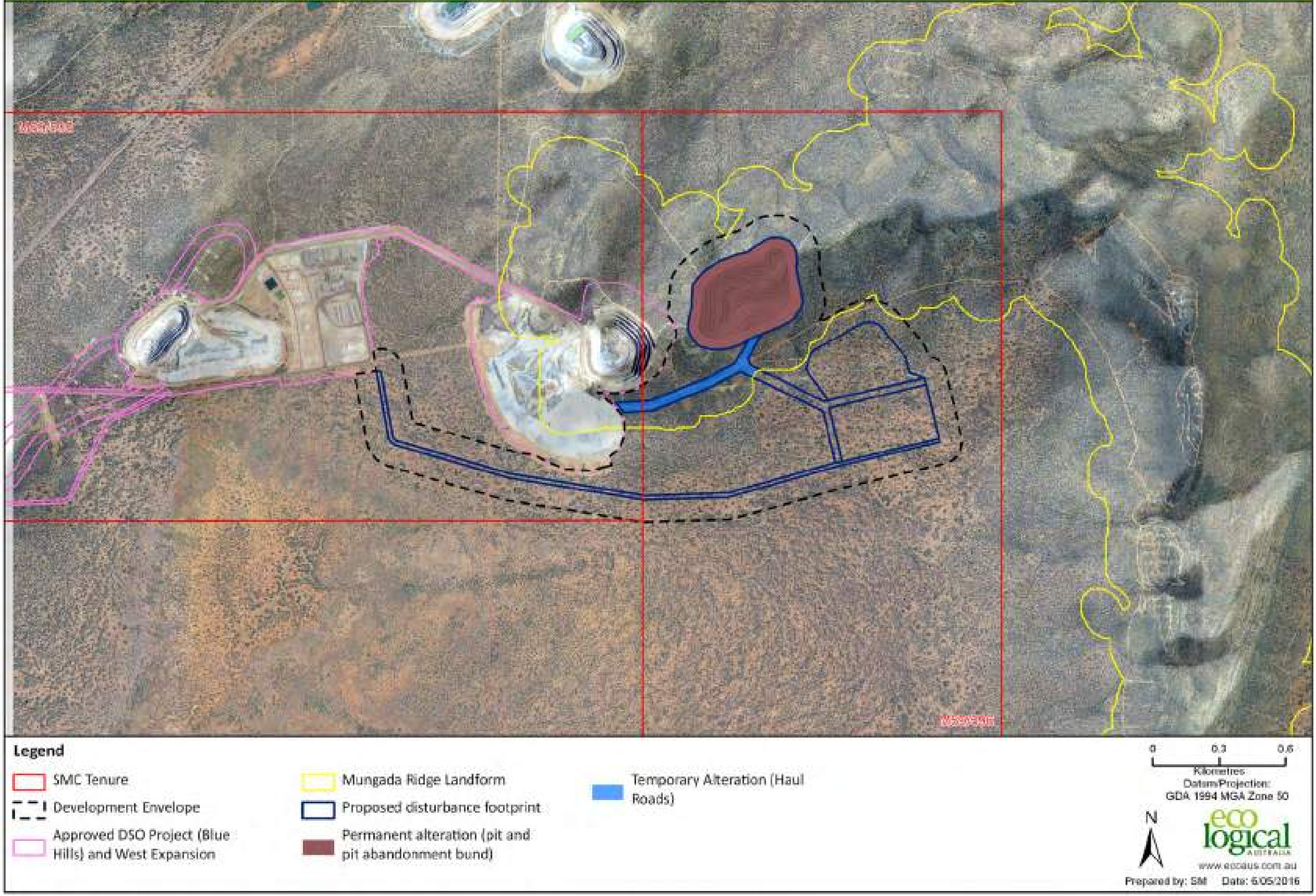


Figure 40: Areas of Mungada Ridge to be altered by Proposal (View 2)

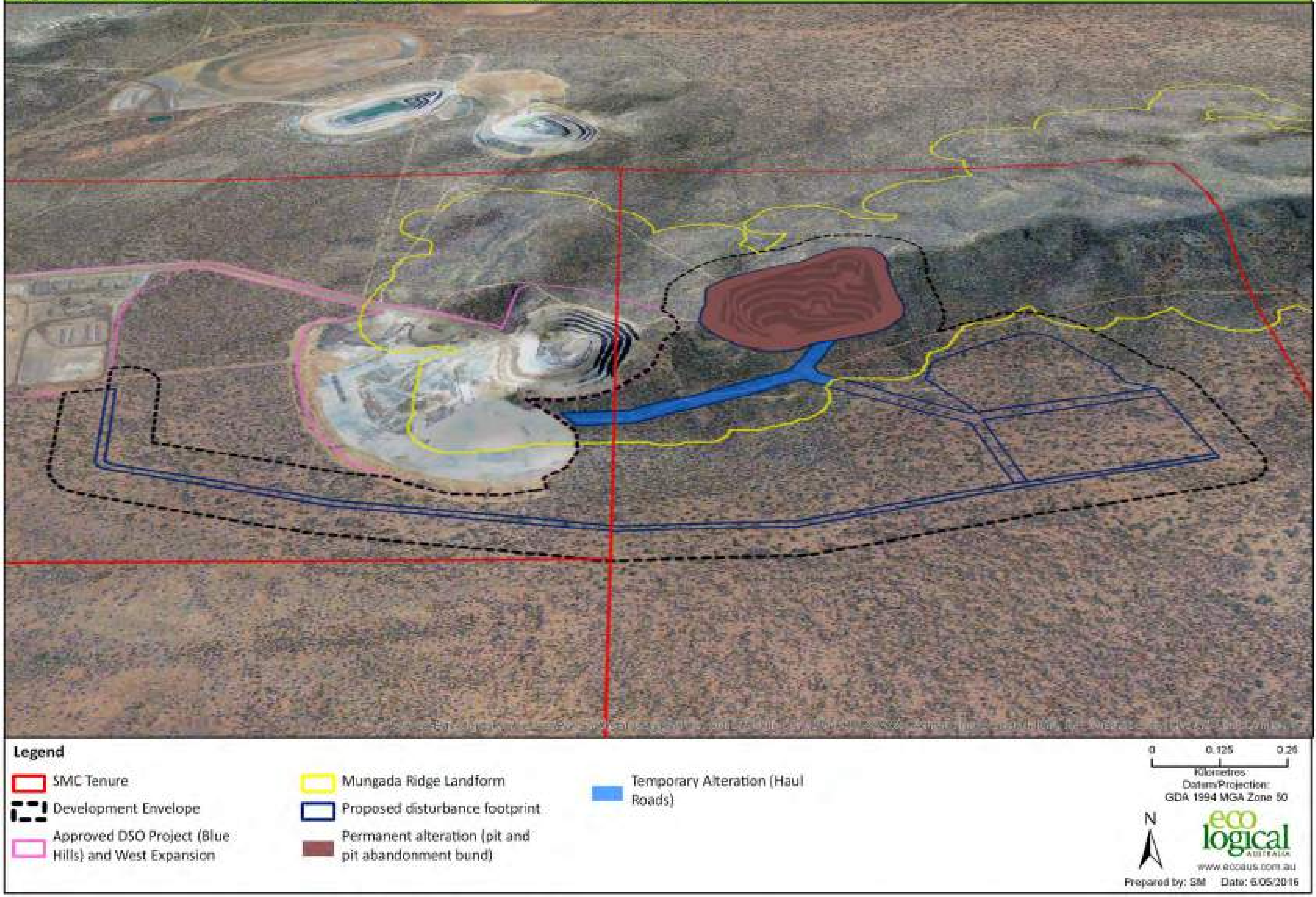


Figure 41: Areas of Mungada Ridge to be altered by Proposal (View 3)

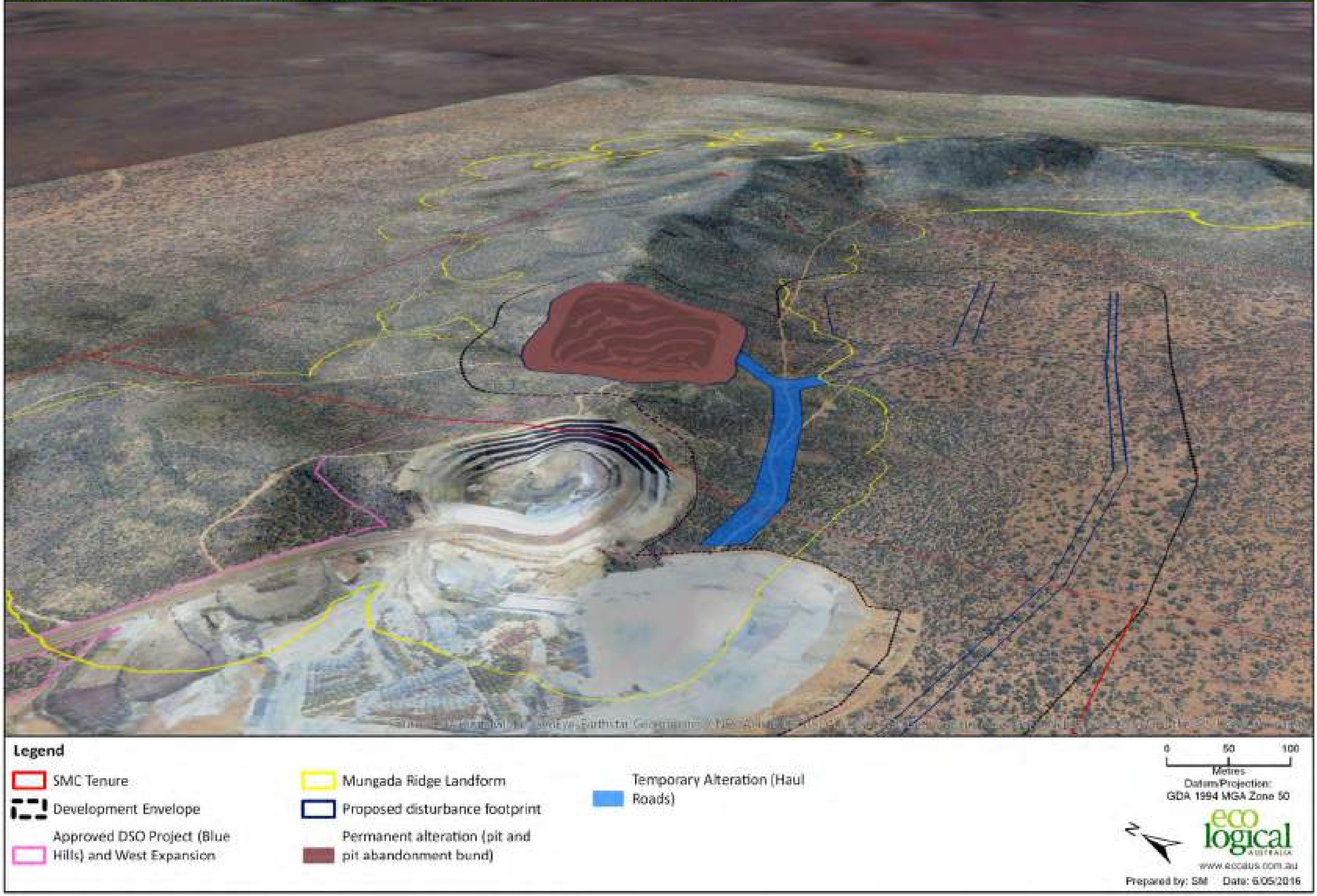
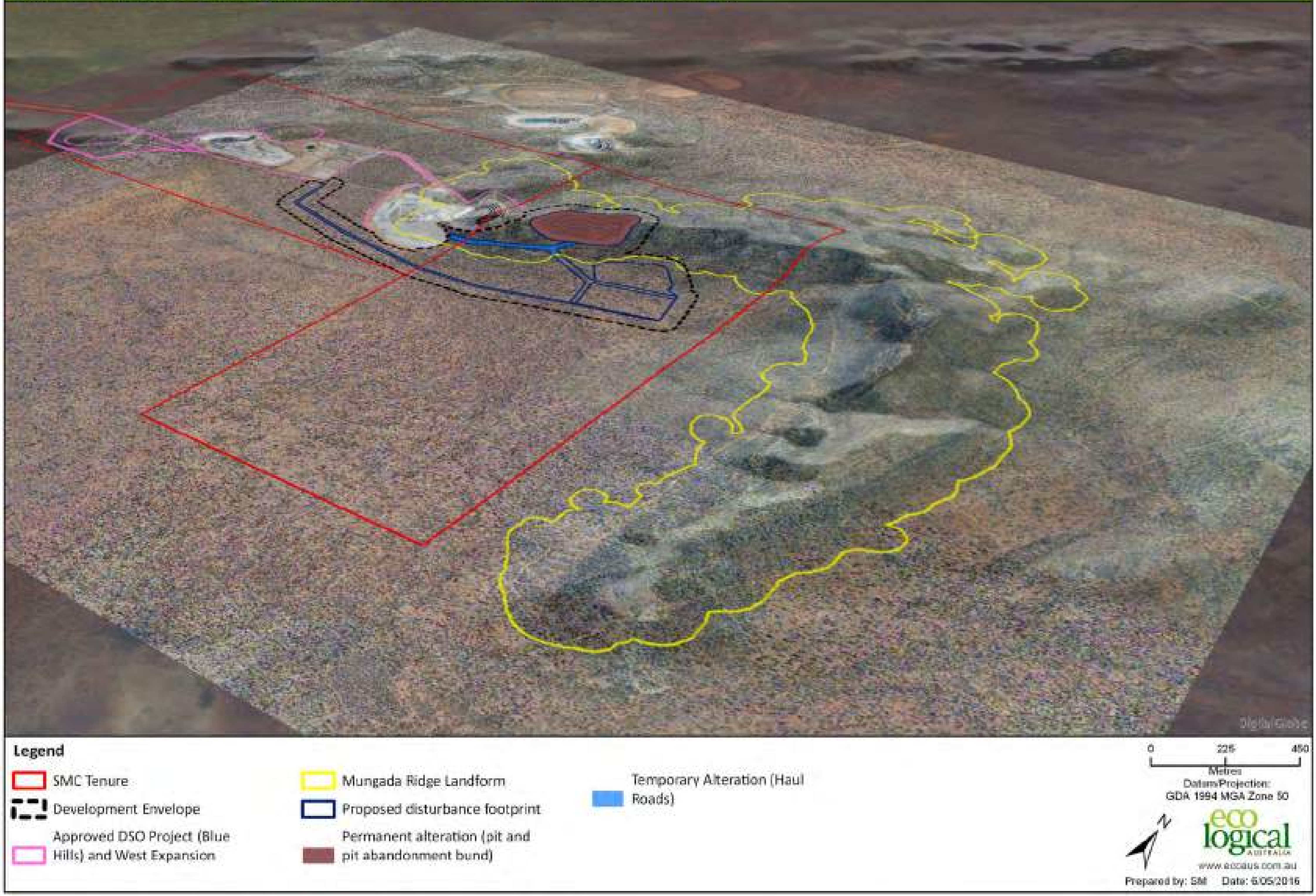


Figure 42: Areas of Mungada Ridge to be altered by Proposal (View 4)



13.3.2 Erosion

The construction of the proposed Mungada East Extension pit, pit abandonment bund and haul roads has the potential to result in erosion of the landform in the vicinity of these structures. This would primarily occur if surface water drainage patterns were significantly altered due to the placement of the pit and roads, redirecting natural surface water flows to concentrate in certain areas.

Surface water management will ensure that the surface water hydrological system is not altered as a result of the Proposal. Surface water diversion infrastructure will be constructed to minimise the risk of flooding, erosion and sedimentation within the development envelope to minimise resultant impacts to the landform, environmental values and mine infrastructure. The areas of development on Mungada Ridge will be monitored to ensure surface water management infrastructure is working effectively and any erosion occurring is minimal and not resulting in adverse effects to the landform. Surface water management with regard to the proposed waste rock dump is discussed further in SRK (2015) contained in Appendix C.

With the application of surface water management in the development envelope, it is unlikely significant erosion of the landform would result from the construction, operation and closure of the Proposal.

13.3.3 Instability

The construction of the proposed mine pit could result in instability of the landform within and around the edge of the pit. Depending on the nature of the geological characteristics, the process of pit excavation can expose geological planes of weakness in the rock which are susceptible to collapse if disturbed.

Geotechnical assessment and management will be conducted in accordance with DMP requirements to ensure the stability of the pit walls and reduce the risk of pit wall failure. A pit abandonment bund will be constructed around the proposed mine pit in line with DMP requirements.

13.3.4 Effects of potential impacts on landform characteristics

Variety

The potential impacts to Mungada Ridge from the Proposal are not expected to affect the variety of landforms in the LAU.

The Proposal will result in approximately 22 ha of disturbance to Mungada Ridge (approximately 3.2%), which will be in addition to the existing impacts of the DSO Project (refer to Section 13.3.5 for a discussion on cumulative impacts). The structural alteration of Mungada Ridge will involve excavation of the proposed mine pit and construction of haul roads, all of which will occur on the flatter part of the ridge on the western-most end of the landform. The highest elevation in the proposed disturbance footprint on the ridge is 442.7 mAHD and the steepest slope 12.4 degrees. The most prominent (highest and steepest) areas of the ridge are >500 mAHD and 15-20 degrees and will not be affected by the Proposal. The crescent shape of Mungada Ridge will also not be affected by the Proposal.

The vast majority of the Mungada Ridge landform and its more distinctive attributes (height, slope, shape and size) will remain in the landscape. Therefore, the Proposal will not significantly affect the variety of landforms present in the LAU or the Mungada/Karara/Koolanooka region.

Integrity

Mungada Ridge is not considered an intact landform as it has already been altered by Western Mining operations in the 1960's and subsequent expansions by SMC for the Mungada East pit and waste rock dump. The construction and operation of the Proposal will result in an additional impact to the integrity of the landform. The potential impact to the integrity of Mungada Ridge and other BIF landforms in the

LAU as a result of the Proposal is not considered to be significant (refer to the assessment of cumulative impacts to the ridge and LAU; Section 13.3.5). The proposed management of the potential for instability of the landform and for erosion during construction, operation and closure is described in Sections 13.3.2 and 21.

Ecological importance

Three of the rock outcrop features identified in the vicinity of the proposed mine pit may be affected as they are located in the development envelope, but outside the proposed disturbance footprint. However, these are not considered to be rare features requiring protection.

No significant drainage lines originate on Mungada Ridge, nor on any of the other landforms in the LAU. Therefore, minimal impact is expected to surface water drainage as a result of the Proposal. Any potential impacts to surface water drainage will be managed as described in Section 21.

The areas of prolonged shade, or potentially cooler microclimates, provided by Mungada Ridge are not considered to provide vital functions or habitat for conservation significant flora or fauna species or vegetation.

An assessment of the potential impacts to vegetation and flora and fauna species of conservation significance occurring on Mungada Ridge is provided in Sections 14.5 and 15.4.4.

Scientific importance and rarity

The potential impacts to Mungada Ridge will not affect the characteristics of scientific importance or rarity. Mungada Ridge and the other BIF landforms in the LAU and the Mungada/Karara/Koolanooka region are not considered to be of particular scientific importance, nor to be rare, or relatively rare (Section 13.2.3). In the event Mungada Ridge was deemed to be a Geoheritage Site, the Proposal would not affect its geoheritage value given that a significant proportion of the ridge would remain undisturbed (Section 13.3.5).

13.3.5 Cumulative impacts in LAU

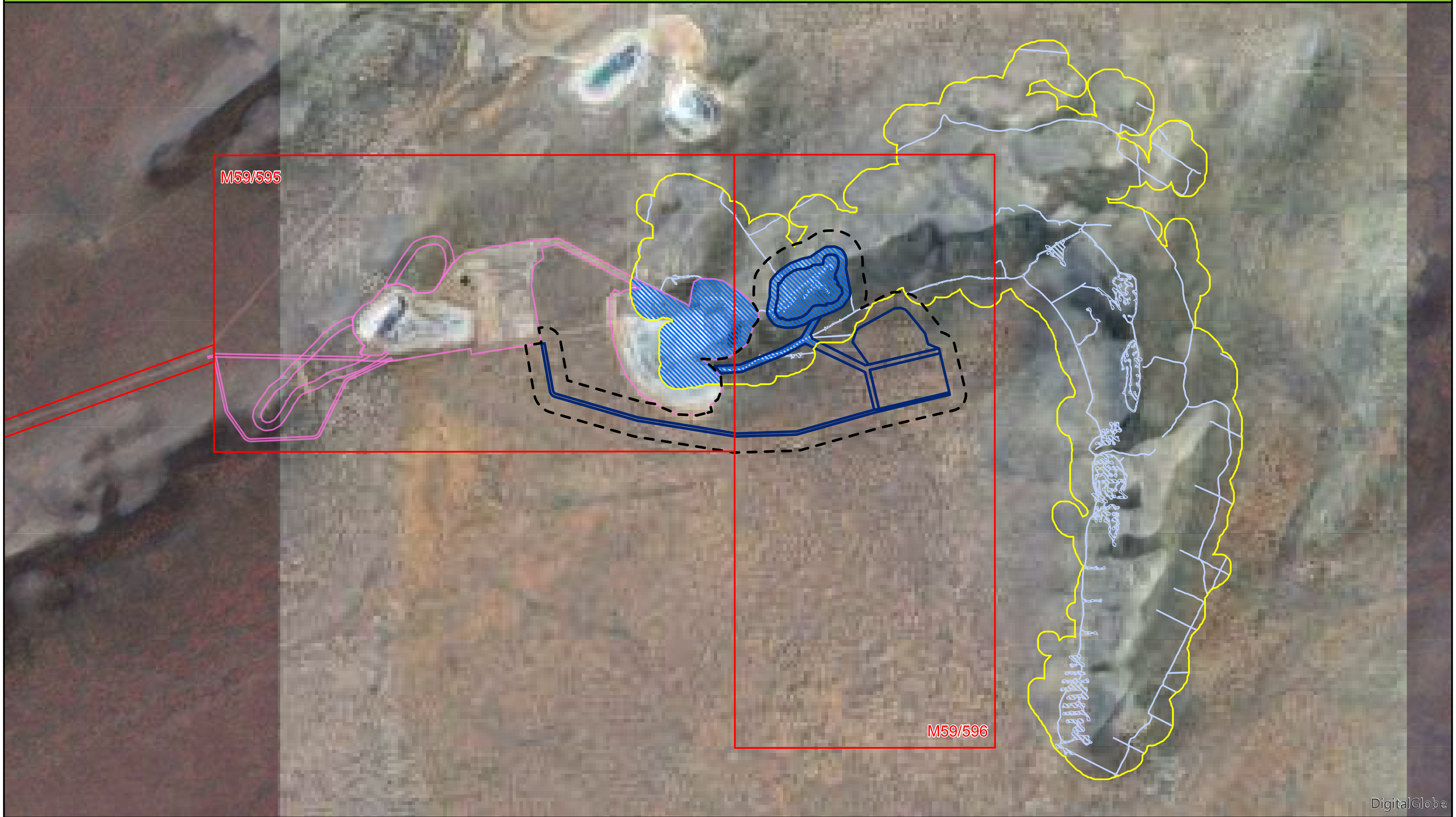
Approximately 57.5 ha of Mungada Ridge, which covers a total area of 685 ha, has already been affected by the DSO Project, from the existing Mungada East pit and part of the associated waste rock dump. The Proposal will affect an additional 22 ha of the ridge (Figure 43), which will increase the total disturbance on Mungada Ridge from 57.5 ha to 79.5 ha. This would increase disturbance from 8.4% to 11.6% of the ridge. The total disturbance to BIF landforms in the LAU will increase from 531.5 ha to 553.5 ha as a result of the Proposal. This would increase disturbance from 26.5% to 27.5% of the total area of BIF landforms in the LAU (Figure 44).

Currently, 91.6% of Mungada Ridge is undisturbed. After implementation of the Proposal, 88.4% of the ridge would remain undisturbed. SMC is of the view that, if the Proposal is approved, 88.4% is an adequate and representative portion of Mungada Ridge to remain undisturbed and available for protection and conservation in reservation. Furthermore, once the proportion of Mungada Ridge affected by exploration only (23.9 ha) is rehabilitated this would increase the undisturbed or restored area of Mungada Ridge to 91.8%.

The Proposal will result in a minimal increase in impact to Mungada Ridge of 3.2%, and an even smaller proportional increase in impact to BIF landforms in the LAU of 1%. The impact of the Proposal on Mungada Ridge is therefore considered to be minimal and not a significant residual impact.

DMP's online GeoVIEW database was interrogated to ascertain the location of any other reasonably foreseeable developments on landforms in the LAU. Reasonably foreseeable developments are defined in the Mineral Council of Australia's (MCA's) Cumulative Environmental Impact Assessment Industry Guide (MCA 2015) as including those projects where financial forecasts are positive and have been approved and commencement announced. No developments fitting this description occur on landforms within the LAU.

Figure 43: Cumulative impact to Mungada Ridge



Legend

SMC Tenure

Development Envelope

Approved DSO Project (Blue Hills) and West Expansion

Proposed Disturbance Footprint

Mungada Ridge Landform

Exis ng and proposed mining disturbance on Mungada Ridge

Exis ng explora on disturbance on Mungada Ridge

0 0.5 1
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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Figure 44: Cumulative impact to landforms in local assessment unit

Legend

- Local Assessment Unit (LAU)
- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Mungada Ridge Landform
- Local BIF Landforms
- Exis ng and proposed mining disturbance in LAU
- Exis ng explora on disturbance in LAU

0 2.5 5
Kilometres

Datum/Projection:
GDA 1994 MGA Zone 50

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Prepared by: SM Date: 6/05/2016

13.4 Key management actions

Potential impacts to the Mungada Ridge landform will be minimised through implementation of management measures for the Proposal in accordance with the Blue Hills Mungada East Expansion Condition EMP (Appendix D). Stability of the landform during construction and operation will be ensured via geotechnical design measures including pit wall angles and appropriate widths and gradients of haul ramps.

Measures relating to rehabilitation of disturbed areas will be implemented in accordance with the Blue Hills Mungada East Expansion Mine Closure Plan (Section 18 and Appendix E).

Key management measures to be implemented for the Proposal include:

- an investigation to determine storm/surface water management requirements will be completed as part of project design;
- drainage structures will be designed and constructed to ensure minimal alteration to existing surface drainage patterns;
- scour protection measures will be incorporated into the design of drainage structures where required; inspections of drainage structures will be carried out regularly and as soon as possible after periods of heavy rainfall;
- a pit abandonment bund will be constructed around the proposed mine pit in line with DMP's requirements; and
- all roads will be rehabilitated upon closure.

These management measures are considered to be standard practice, feasible and appropriate to manage the potential impacts of the Proposal on the Mungada Ridge landform. These measures are already being implemented at the DSO Project and EPA audit reports confirm SMC is in compliance with MS 811 as a result (See Section 21.4).

13.5 Predicted outcome

After application of mitigation and management, the residual impact to the Mungada Ridge landform will be the proposed mine pit and pit abandonment bund remaining as structural impacts on the landform, covering approximately 18.6 ha. The proposed haul roads and access road will alter the landform temporarily; these will be rehabilitated upon closure of the Proposal and will therefore alter the surface of the landform only for the duration of construction and operations.

The permanent impact associated with the proposed mine pit and pit abandonment bund will be restricted to the western, lower-lying area of Mungada Ridge. The highest elevation in the proposed disturbance footprint on the ridge is 442.7 mAHD and the steepest slope 12.4 degrees. The most prominent (highest and steepest) areas of the ridge are >500 mAHD and 15-20 degrees and will not be affected by the Proposal. The crescent shape of Mungada Ridge will also not be affected by the Proposal. The vast majority of the Mungada Ridge landform and its more distinctive attributes (height, slope, shape and size) will remain in the landscape. Therefore, the Proposal will not significantly affect the variety of landforms present in the LAU or the Mungada/Karara/Koolanooka region.

Mungada Ridge is not 100% intact as it has already been altered by the existing Mungada East pit and waste rock dump. Existing disturbance on Mungada Ridge comprises 57.5 ha, which represents 8.4% of the landform. The Proposal will affect an additional 22 ha of the ridge (3.4 ha of which is associated with roads and will be rehabilitated upon closure), which will increase the total disturbance on Mungada Ridge from 57.5 ha (8.4%) to 79.5 ha (11.6%).

The management measures proposed are considered to be standard practice and are therefore both feasible and achievable. These measures will minimise the potential indirect impacts to the landform. The Proposal is considered to be consistent with the EPA's objective for the landforms factor. After implementation of the Proposal, 88.4% of the ridge would remain undisturbed. Furthermore, once the proportion of Mungada Ridge affected by exploration (23.9 ha, the majority of which is on Karara Mining's tenements) is rehabilitated, the undisturbed or restored area of Mungada Ridge would increase to 91.8%.

14 Flora and vegetation

14.1 Key statutory requirements, environmental policy and guidance

14.1.1 EPA objective

The EPA has applied the following objective for the Proposal to its assessment of flora and vegetation:

"To maintain representation, diversity, viability and ecological function at the species, population and community level."

14.1.2 Regulatory framework

The following legislation is relevant to the Proposal with respect to the protection of flora and vegetation values and the above EPA objective:

- WC Act and associated Wildlife Conservation (Rare Flora) Notice 2015;
- Conservation and Land Management Act 1984 (WA); and
- EP Act and associated Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

14.1.3 Relevant guidelines and policy

The following guidelines are relevant to the Proposal with respect to the protection of flora and vegetation values and the above EPA objective:

- DEC Recommended Interim Protocol for Flora Surveys of Banded Ironstone Formations of the Yilgarn Craton (DEC 2006);
- EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000);
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002a);
- EPA Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b);
- EPA Position Statement No. 7: Principles of Environmental Protection (EPA 2004d); and
- EPA Position Statement No. 8: Environmental Protection in Natural Resource Management (EPA 2005).

The EPA and DPaW (2015) 'Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment' is also relevant to the protection of flora and vegetation values; however, it was released in December 2015, after completion of flora and vegetation surveys for the Proposal.

14.2 Description of factor

14.2.1 Flora and vegetation surveys

Numerous flora and vegetation surveys have been conducted in the Blue Hills locality, with the earliest surveys being conducted in 2003 (Table 7; Figure 45). The most recent was a Level 2 flora and vegetation survey conducted by Maia (2016) in June and September 2015. This survey was conducted to meet the requirements of the ESD and ensure Level 2 survey coverage across the entire development envelope and any surrounding areas considered to potentially be subject to indirect impacts. It was conducted to also provide or supplement relevant information on the local occurrence of flora.

The Maia (2016) report includes a full literature review of previous surveys relevant to the Proposal. The results of the literature review influenced the design of the Level 2 survey undertaken by Maia (2016). Relevant data from previous surveys have been incorporated into the Maia (2016) report.

Table 7: Flora and vegetation survey effort

Survey location	Timing	Methodology
SMC Blue Hills tenements M59/595 and M59/596 (Bennett 2004)	October 2003 (spring)	Level 2 survey, including 29 quadrats (1.16 ha) and 13 relevés in M59/595 and M59/596
Banded iron formation survey across central Tallering, including Mt Karara, Jasper Hills, Windaning Hill, Warriedar Hill, Pinyalling Hills, Walagnumming Hills and Minjar Hill (Markey and Dillon 2008)	September and October 2005 (spring)	Level 2 survey, including three quadrats (0.12 ha) in M59/595 and M59/596
Mt Karara and Mungada Ridge (Woodman 2008a)	June, July and August 2006 (winter)	Level 2 survey, including one quadrat (0.04 ha) and 17 relevés in M59/595 and M59/596
SMC Blue Hills tenements M59/595, M59/596, E59/971, E59/1059 and E59/1175 (ecologia 2007a)	February 2007 (summer)	Targeted flora survey
SMC Blue Hills tenements M59/595 and M59/596 (ecologia 2008a)	July, September and October 2006 and June and August 2007 (winter and spring)	Level 2 survey, including 27 quadrats (1.64 ha) in M59/595 and M59/596 (15 quadrats re-sampled in spring)
SMC Blue Hills tenement M59/596 (ecologia 2008b)	July 2008 (winter)	Targeted flora survey
Karara to Minjar Block (Woodman 2012)	September and October 2008 (spring), May 2009 (autumn), July 2009 (winter), September to November 2010 (spring) and December 2010 and January 2011 (summer)	Regional Level 2 survey, including four quadrats (0.16 ha) in M59/595 and M59/596
Blue Hills SMC haul road to Mungada (Maia 2011a), SMC Blue Hills tenements M59/595 and M59/596 (Maia 2011b) and Blue Hills s45C infrastructure areas (Maia 2012)	June, July and September 2011 (winter and spring)	Targeted flora surveys, including transects traversing 390.62 ha in M59/595 and M59/596
Desktop assessment for Mungada Ridge (ecologia 2013)	-	Comprehensive desktop analysis of all available biological survey information for Mungada Ridge to determine the likely endemism of significant flora populations and ecological communities known to occur on Mungada Ridge (including the Proposal area)

Survey location	Timing	Methodology
SMC Blue Hills tenements M59/595 and M59/596 (Maia 2014a)	June 2014 (winter)	Targeted flora survey, including transects traversing 28.92 ha in M59/595 and M59/596
SMC Blue Hills tenements M59/595 and M59/596 (Maia 2014b)	September 2014 (spring)	Vegetation monitoring annual assessment, including 16 quadrats (0.64 ha) in M59/595 and M59/596
SMC Blue Hills tenements (Maia 2016)	June and September 2015 (winter and spring)	Level 2 survey and targeted flora survey, including 39 quadrats (1.56 ha) and transects traversing 116.38 ha in M59/595 and M59/596

The Maia (2016) survey was designed with reference to EPA Guidance Statement No. 51 (EPA 2004b), EPA Position Statement No. 3 (EPA 2002a) and the DEC (now DPaW) Recommended Interim Protocol for Flora Surveys of Banded Ironstone Formations of the Yilgarn Craton (DEC 2006). There are no limitations of the flora and vegetation surveys conducted to date when examined collectively in regard to their suitability of use for the impact assessment. In summary:

- many experienced botanists have carried out surveys in tenements M59/595 and M59/596 since 2004;
- one hundred and eighteen quadrats have been assessed in tenements M59/595 and M59/596 at different times of year by Maia, other companies and DPaW. Transects have been located across a large portion of the tenements at different times of the year and, between the Level 2 surveys and earlier targeted flora surveys, approximately 36% of the tenements have been directly assessed. This level of coverage is excellent and considered to be comprehensive with regard to EPA Guidance Statement 51 (EPA 2004b);
- all areas were relatively easily accessible on foot via exiting tracks in tenements M59/595 and M59/596;
- several surveys have been carried out in tenements M59/595 and M59/596 in June and July 2011 (winter), September 2011 (spring), June 2014 and June 2015 (winter) and an annual vegetation monitoring program in September (spring) from 2012 to 2015 (Maia 2015a, 2015b). The Maia (2016) survey was conducted in June (early winter) with total rainfall three months prior to the survey being above average (107.4 mm compared with 84.2 mm). Past surveys have been conducted at different times of the year, including many in spring. The flora in tenements M59/595 and M59/596 has been sampled at different times of the year and at the same time in different years;
- no disturbances had occurred in the months before the June 2015 survey and there were none while the survey was being carried out. No recent signs of fire or flooding were noted in tenements M59/595 and M59/596 by Maia (2016);
- information on tenements M59/595 and M59/596 and surrounds is available from flora and vegetation surveys conducted by Maia (2011a, 2011b, 2012, 2014a, 2014b, 2015a, 2015b, 2016), Bennett (2004), ecologia (2007a, 2008a, 2008b), Woodman (2006, 2008a, 2008b, 2009, 2012) and the DPaW Central Tallering BIF ranges survey (Markey & Dillon, 2008) as well as the DPaW Warriedar Fold Belt Greenstone ranges survey (Meissner & Coppen, 2014). Pre-European vegetation mapping and land system mapping are also available for the area. Recent searches of the DPaW rare flora and ecological community databases and NatureMap have been carried out;

- the vegetation of the development envelope (and within 50 m of the development envelope) was mapped by Maia (2016) using aerial imagery captured in November 2014. In some areas, the boundary between different vegetation associations was not clear. Where this occurred, boundaries were determined from field notes when available and approximated when they were not. As survey coverage was comprehensive and other mapping of the vegetation of tenements M59/595 and M59/596 and surrounds was available, mapping reliability is also considered to be very high; and
- the Maia (2016) survey complied with the DEC (2006) Recommended Interim Protocol for Flora Surveys of Banded Ironstone Formations of the Yilgarn Craton, which requires collection of a standard set of information from quadrat-based (usually 20 m by 20 m) surveys carried out at an appropriate time of year (spring or following seasonal rains) and covering the major geographical, geomorphologic and floristic variation found in the SMC Blue Hills tenements, with extra collections of unusual plant records outside quadrats.

Unless stated otherwise, the description in this section of flora and vegetation is adapted from Maia's (2016) report, which consolidated relevant results from previous surveys.

A peer review of the vegetation and flora information in the draft Maia (2016) report was undertaken by Mr Greg Woodman of Woodman Environmental Consulting (Appendix F). Mr Woodman concluded that the flora and vegetation assessment prepared by Maia (2016) largely fulfils the requirements of Level 2 flora and vegetation assessments as defined in EPA Guidance Statement No. 51 (EPA 2004b). The sampling intensity was deemed exceptional and survey timing appropriate, resulting in a comprehensive census of the flora, especially in combination with the previous surveys in the area. SMC responded to Mr Woodman's findings, and Mr Woodman subsequently provided a close out report, providing comment on how SMC has considered the peer review comments. SMC's response document and Mr Woodman's close out report are also contained in Appendix F.

14.2.2 Vegetation

Vegetation communities present in the development envelope

The development envelope lies within the Austin Botanical District of the Eremaean Botanical Province as defined by Beard (1974). The development envelope intersects two of the vegetation units defined by Beard (1974) and digitised and updated by DAFWA (2012), both of which have the majority of their pre-European extent remaining (Table 8).

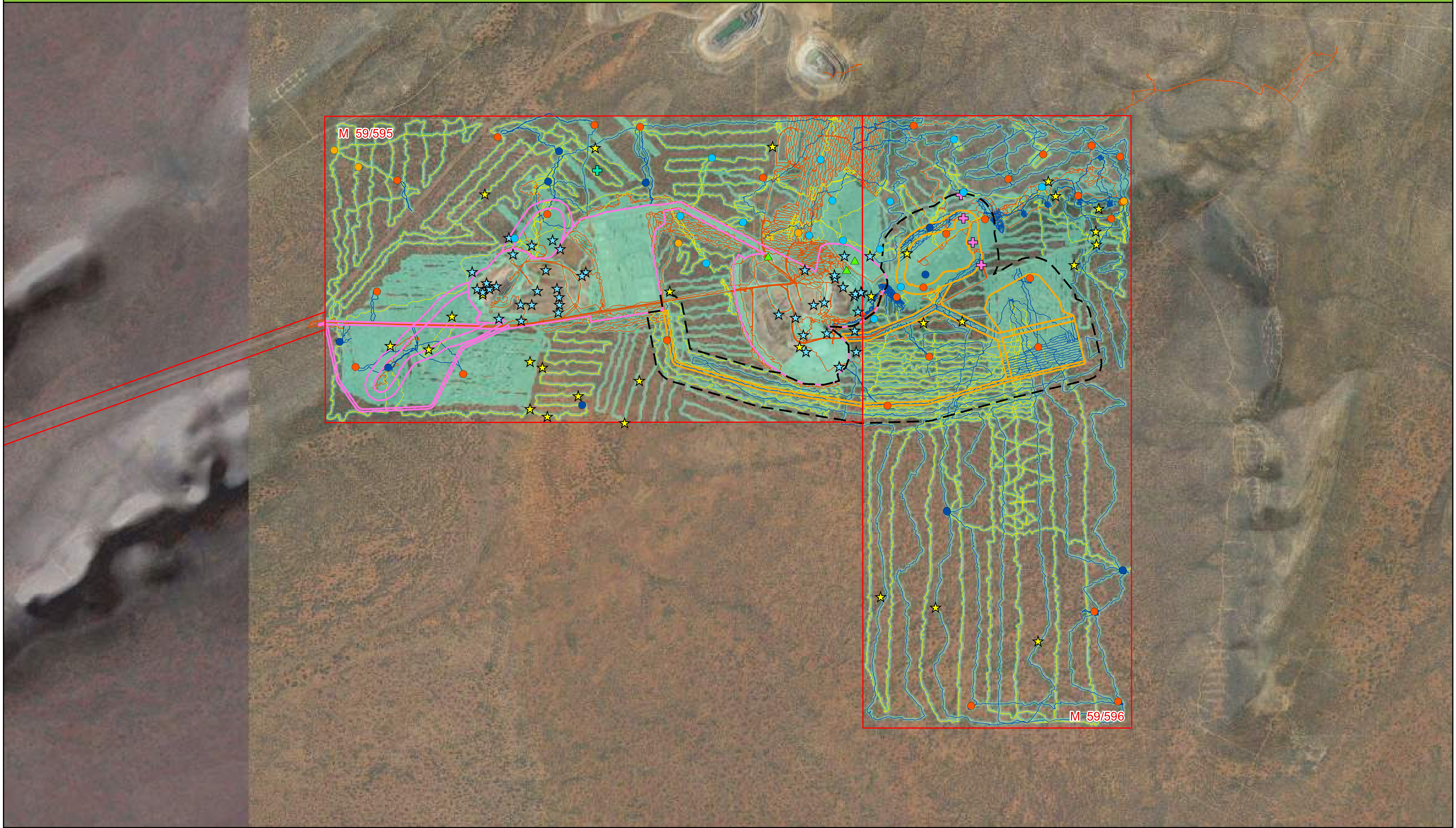
Table 8: Vegetation units defined by Beard (1974) occurring in the development envelope

Vegetation unit	Pre-European extent remaining*	Percent of pre-European extent in all DPaW managed lands (%)*
355: Shrublands; Bowgada and Jam Scrub with scattered York Gum and Red Mallee	95.3%	43.8%
358: Shrublands; Bowgada and *Acacia quadrimarginea* on stony ridges	99.8%	35.4%

* Source: Government of Western Australia (2014b).

Maia (2016) mapped seven vegetation units, referred to as associations, in the development envelope (Table 6; Figure 46). A full list and descriptions of the vegetation associations are provided in Maia (2016) contained in Appendix C. The vegetation associations were classified based on floristics. To do this, a local pattern analysis was conducted by Maia (2016) on floristic data collected by Bennett (2004), ecologia (2008a), Woodman (2008a, 2012), Markey and Dillon (2008) and Maia (2016). Data from 124 quadrats inside tenements M59/595 and M59/596 and 20 quadrats just outside these tenements were used in the pattern analysis.

Figure 45: Vegetation and flora survey locations



Legend

- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint

Quadrats

- Maia 2016 Combined L2 and Targeted Flora (Surveyed September 2015)
- Maia 2016 Combined L2 and Targeted Flora (Surveyed June and September 2015)
- Maia 2016 Combined L2 and Targeted Flora (Surveyed June 2015)
- Maia 2014b and 2016 Combined L2 and Targeted Flora / Monitoring (Surveyed September 2015)
- Bennett (2014) L2
- Ecologia (2008a) L2
- Markey and Dillon (2008) L2
- Woodman (2008a) L2
- Woodman (2012) Regional L2

Transects

- Maia 2016 Combined L2 and Targeted Flora (inc. partial *Acacia woodmaniorum* census) (Surveyed June 2015)
- Maia 2016 Combined L2 and Targeted Flora (inc. search for *Stylidium scintillans*) (Surveyed September 2015)
- Maia 2011 (September) Targeted Flora
- All Maia surveys (15m width)

0 195 390 780
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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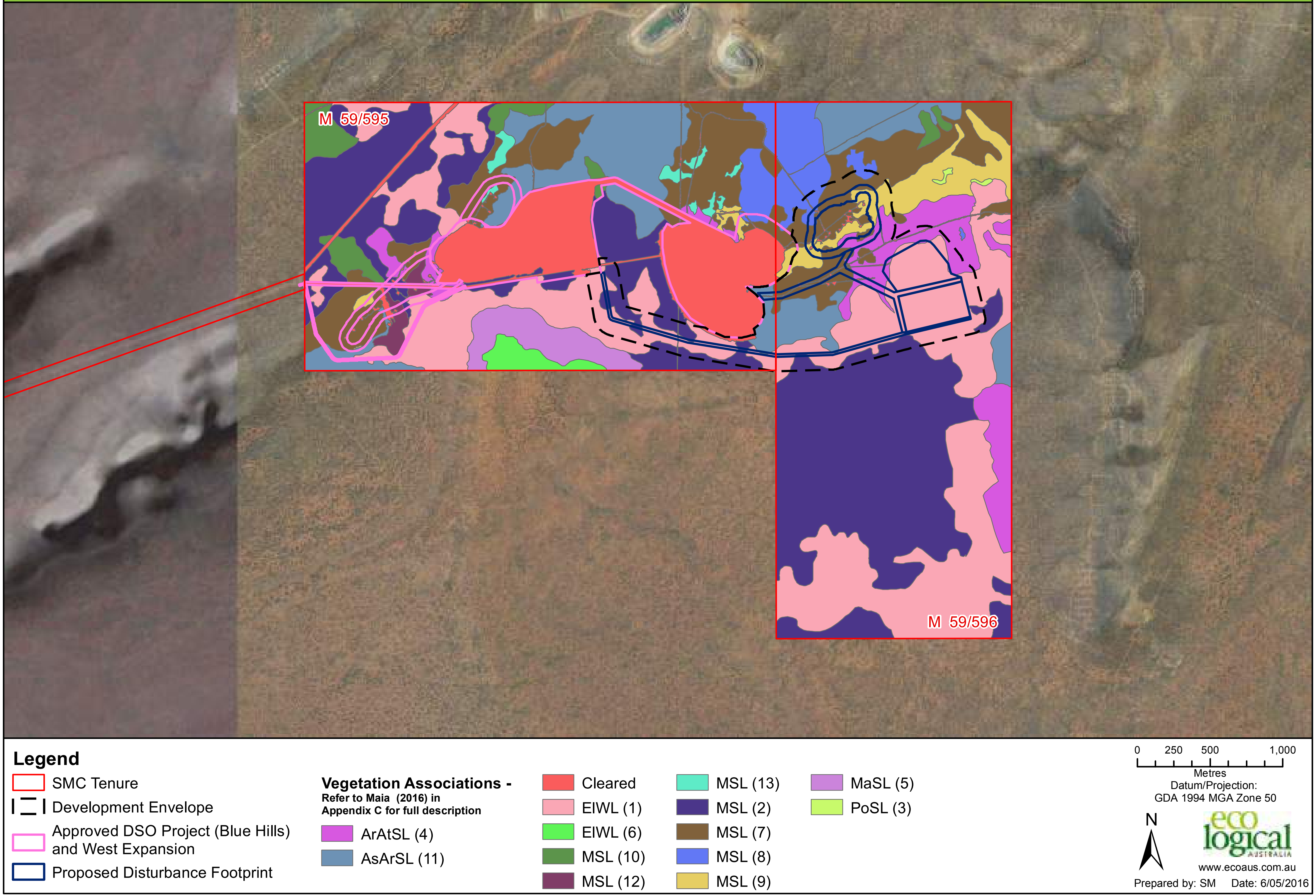
The results of the pattern analysis were used to define floristic communities while the growth form, height classes and cover characteristics of dominant species were used to describe the vegetation associations across tenements M59/595 and M59/596. The analysis divided the data into two broad groups at the 1.56 similarity scale and further divided the data into 12 groups at approximately the 0.85 similarity scale. Although the associations were in general not classified based on structure, one of the groups identified in the floristic pattern analysis was divided into two associations post analysis based on vegetation structure. Thirteen vegetation associations were subsequently mapped within tenements M59/595 and M59/596, seven of which occur in the development envelope (excluding already cleared areas) (Table 9).

Table 9: Vegetation associations in the development envelope

Vegetation association	Average condition	Extent in development envelope
*E*WL (1): *Eucalyptus* Woodland Low Woodland of *Eucalyptus loxophleba* subsp. *supralaevis* and/or *E. kochii* with a Sparse Tall Shrubland of *Acacia ramulosa* var. *ramulosa* and *A. tetragonophylla* and a Sparse Mid to Low Shrubland of *Senna artemisioides* subsp. *filifolia* and *Ptilotus obovatus* Occurred mainly on lower-lying areas of seasonal sheet flow-on hardpan gravelly plains	Excellent	74.2 ha
MSL (2): Mixed Shrubland Mixed Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *A. burkittii* and *Hakea recurva* subsp. *recurva* with mixed Isolated Low Shrubs (*Minuria cunninghamii*, *Ptilotus obovatus* and *Eremophila clarkei*) occasionally with Isolated Low Trees of *Eucalyptus* spp. (*Eucalyptus ewartiana*, *E. loxophleba* subsp. *supralaevis* and *E. kochii*) Occurred on hardpan gravelly plains and co-occurs with *E*WL (1)	Excellent	18.0 ha
*ArAt*SL (4): *Acacia* Shrubland Sparse to Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa* and/or *A. tetragonophylla* with Isolated Low Shrubs of *Ptilotus obovatus* and +/- Isolated Low Trees of *Eucalyptus loxophleba* subsp. *supralaevis* or *E. ewartiana* Occurred in a number of habitats, including stony undulating plains, hardpan plains, midslopes and footslopes of low relief ironstone hills	Good	17.7 ha
MSL (7): Mixed Shrubland Mixed Tall Shrubland mainly of *Acacia assimilis* subsp. *assimilis*, *Melaleuca nematophylla* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over a mixed Mid to Low Shrubland mainly of *Eremophila latrobei* subsp. *latrobei*, *Xanthosia kochii* and *Philotheca sericea* Occurred on upper to mid-slopes of BIF ridges and on low ironstone and BIF hills	Excellent	27.8 ha

Vegetation association	Average condition	Extent in development envelope
MSL (8): Mixed Shrubland Tall mixed Shrubland of *Acacia assimilis* subsp. *assimilis*, *A. sibina* and *Grevillea obliquistigma* subsp. *obliquistigma* with a Sparse Low Shrubland of *Aluta aspera* subsp. *hesperia* and *Philotheca sericea* and Isolated Low Trees of *Acacia aneura* Occurred on the mid and foot slopes on the northern side of the range along with association MSL (7), and occurred occasionally on BIF	Excellent	3.1 ha
MSL (9): Mixed Shrubland Tall mixed Shrubland of *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Calycopeplus paucifolius* and/or *Melaleuca nematophylla* with a Sparse mixed Mid Shrubland mainly of *Gastrolobium laytonii*, *Eremophila clarkei* and *Acacia woodmaniorum* (Threatened) with a Sparse Low Shrubland of *Xanthosia kochii* Occurred on the upper southern slopes and crests of BIF ridges and gully bases	Excellent	10.3 ha
*AsAr*SL (11): *Acacia* Shrubland Tall Shrubland of *Acacia sibina* and/or *A. ramulosa* var. *ramulosa* with a mixed Sparse Low Shrubland mainly of *Aluta aspera* subsp. *hesperia*, *Philotheca brucei* subsp. *brucei* and/or *Hibbertia arcuata*. Occurred on the lower slopes of low relief hills and hardpan plains in between, in areas of ironstone gravel and occasionally on BIF	Excellent	17.8 ha

Figure 46: Vegetation associations mapped by Maia (2016)



Vegetation condition

The condition of most of the vegetation in the development envelope (88%) has been mapped as Excellent by Maia (2016), with some areas in the eastern half of the development envelope (10%) mapped as Good. Vegetation condition was not mapped in areas that had been previously cleared in the western half of the development envelope (2%) (Figure 47). Vegetation condition was mapped using data collected by Maia (2011a, 2011b, 2012, 2014a, 2014b, 2016) and ecologia (2007a, 2008a, 2008b, 2013). Vegetation condition ratings were based on the scale developed by Trudgen (1988) and modified and adapted by Keighery (1994).

Threatened and Priority Ecological Communities

The development envelope does not intersect any TECs, but does intersect the Priority 1 PEC 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)'. This PEC occurs across 7,098 ha, extending approximately 20 km to the north and south, 7 km to the east and 16 km to the west of the development envelope (Figure 48).

All seven of the vegetation associations described for the development envelope (Table 9) occur within the boundary of the PEC, as follows:

- *ElWL* (1): *Eucalyptus* Woodland;
- MSL (2): Mixed Shrubland;
- *ArAtSL* (4): *Acacia* Shrubland;
- MSL (7): Mixed Shrubland;
- MSL (8): Mixed Shrubland;
- MSL (9): Mixed Shrubland; and
- *AsArSL* (11): *Acacia* Shrubland.

Floristic Community Types mapped across the Mungada Ridge Landform

Woodman (2008a) conducted a Level 2 flora and vegetation survey across Mt Karara and Mungada Ridge in June, July and August 2006 (winter) and mapped FCTs across the survey area. Twenty-three FCTs were mapped by Woodman (2008a), of which eight FCTs and two mosaics occur in the Mungada Ridge Landform: 1a/2 (mosaic), 3, 7c, 10a, 11, 11/9 (mosaic), 12, 13, 14 and 15 (Table 10; Figure 49).

The Mungada Ridge Landform was defined by the EPA for the purposes of assessment of potential impacts to landforms. The Woodman (2008a) FCTs have been used in this section, along with records of conservation significant flora, to assess the potential cumulative impacts to key flora and vegetation values of the Mungada Ridge landform (Section 14.5). Landform is addressed as a separate factor in detail in Section 13.

Within the Mungada Ridge landform, the seven Maia (2016) vegetation associations occurring in the development envelope overlap with the Woodman (2008a) FCTs 1a/2 (mosaic), 3, 7c, 10a, 11, 11/9 (mosaic), 12, 13, 14 and 15 (Table 10), as follows and as shown in Figure 50:

- *ElWL* (1): 3, 7c, 12, 15 and 1a/2 in mosaic;
- MSL (2): 3, 12 and 1a/2 in mosaic;
- *ArAtSL* (4): 3, 12, 13 and 1a/2 in mosaic;
- MSL (7): 3, 11, 12, 13, 14, 15 and 1a/2 and 11/9 in mosaic;
- MSL (8): 3, 11, 12, 13 and 14;
- MSL (9): 3, 10a, 12, 13, 14 and 11/9 in mosaic; and
- *AsArSL* (11): 3, 11, 12, 14, 15 and 1a/2 in mosaic.

Table 10: Floristic Community Types on the Mungada Ridge Landform (Woodman 2008a)

Woodman (2008a) FCT	Overlapping Maia (2016) vegetation associations							Extent in Mungada Ridge Landform
	E/WL (1)	MSL (2)	*ArAt*SL (4)	MSL (7)	MSL (8)	MSL (9)	*AsAr*SL (11)	
FCT 1a/2 (mosaic) 1a: Open Woodland of *Eucalyptus loxophleba* subsp. *supralaevis* with Open Shrubland dominated by *Acacia tetragonophylla* and *A. obtecta* over chenopod species including *Sclerolaena fusiformis*, *Sclerolaena diacantha* and *Rhagodia drummondii* on flats and drainage depressions 2: Open Woodland of *Eucalyptus loxophleba* subsp. *supralaevis* and/or *E. striaticalyx* over Shrubland of mixed species including *Acacia erinacea*, *Eremophila pantonii* and *Senna stowardii* over mixed species including *Sclerolaena fusiformis* and *Scaevola spinescens* on flats and rocky lower slopes with ironstone gravels	✓	✓	✓	✓	-	-	✓	0.3 ha
FCT 3 Open Woodland of *Eucalyptus kochii* subsp. *?plenissima* or Shrubland of *Acacia tetragonophylla*, *A. burkittii* and *A. assimilis* subsp. *assimilis* over mixed species including *Rhagodia drummondii*, *Scaevola spinescens*, *Philotheca brucei* subsp. *brucei* and *Eremophila clarkei* on flats to mid-slopes with ironstone gravels and rarely BIF	✓	✓	✓	✓	✓	✓	✓	31.6 ha
FCT 7c Open Woodland of *Eucalyptus loxophleba* subsp. *supralaevis* or *Eucalyptus striaticalyx* or Shrubland of *Melaleuca acutifolia* over chenopod species including *Sclerolaena diacantha*, *Maireana carnosa* and *M. thesioides* on drainage depressions and lower slopes	✓	-	-	-	-	-	-	2.2 ha

Woodman (2008a) FCT	Overlapping Maia (2016) vegetation associations							Extent in Mungada Ridge Landform
	*E*WL (1)	MSL (2)	*ArAt*SL (4)	MSL (7)	MSL (8)	MSL (9)	*AsAr*SL (11)	
FCT 10a Dense Shrubland of mixed *Acacia* species including *A. tetragonophylla* and *A. exocarpoides*, and *Allocasuarina acutivalvis* subsp. *prinsepiana* with occasional *Eucalyptus petraea* over mixed species including *Calycopeplus paucifolius*, *Dodonaea inaequifolia*, *Philotheca sericea* and occasional *Acacia woodmaniorum* on upper slopes to crests on BIF	-	-	-	-	-	✓	-	17.8 ha
FCT 11 Shrubland of *Acacia* species dominated by *A. umbraculiformis* over mixed species including *Aluta aspera* subsp. *hesperia*, *Mirbelia* sp. Bursarioides, *Philotheca sericea*, *Micromyrtus trudgenii* on lower slopes to upper slopes with ironstone gravels and occasional BIF	-	-	-	✓	✓	-	✓	67.2 ha
FCT 11/9 (mosaic) 11: Refer to FCT 11 above 9: Shrubland of mixed *Acacia* species, including *Acacia umbraculiformis*, *A. tetragonophylla* and *A. assimilis* subsp. *assimilis*, and occasional *Allocasuarina acutivalvis* subsp. *prinsepiana* over mixed species including *Eremophila clarkei*, *E. latrobei* subsp. *latrobei*, *Philotheca brucei* subsp. *brucei*, *P. sericea*, *Xanthosia kochii* and *Mirbelia* sp. Bursarioides on midslopes to crests with BIF or cherty soils	-	-	-	✓	-	✓	-	198.2 ha
FCT 12 Shrubland of *Acacia* species including *A. assimilis* subsp. *assimilis*, *Acacia ramulosa* var. *ramulosa*, *Acacia exocarpoides* and *Acacia sibina* over mixed species including *Hibbertia arcuata*, *Calycopeplus paucifolius* and *Grevillea obliquistigma* subsp. *obliquistigma* on flats to mid-upperslopes with ironstone gravels	✓	✓	✓	✓	✓	✓	✓	170.3 ha

Woodman (2008a) FCT	Overlapping Maia (2016) vegetation associations							Extent in Mungada Ridge Landform
	*E*WL (1)	MSL (2)	*ArAt*SL (4)	MSL (7)	MSL (8)	MSL (9)	*AsAr*SL (11)	
FCT 13 Dense Shrubland of *Allocasuarina acutivalvis* subsp. *prinsepiana* with *Melaleuca nematophylla* over *Grevillea paradoxa*, *Xanthosia kochii* and *Lepidosperma* sp. Blue Hills on mid-upper slopes on BIF	-	-	✓	✓	✓	✓	-	25.6 ha
FCT 14 Shrubland of *Acacia* species including *A. assimilis* subsp. *assimilis* and *Acacia ramulosa* var. *ramulosa* and *Allocasuarina acutivalvis* subsp. *prinsepiana* with emergent *Eucalyptus leptopoda* subsp. *elevata* over mixed species including *Aluta aspera* subsp. *hesperia*, *Prostanthera magnifica* and *Grevillea obliquistigma* subsp. *obliquistigma* on slopes and ridges	-	-	-	✓	✓	✓	✓	74.3 ha
FCT 15 Shrubland of mixed *Acacia* species including *A. burkittii*, *A. assimilis* subsp. *assimilis*, *A. latior* and *A. sibina* with *Melaleuca hamata* over *Eremophila* spp., *Malleostemon tuberculatus* and *Philotheca deserti* subsp. *deserti* on flats and lower slopes	✓	-	-	✓	-	-	✓	0.8 ha

Figure 47: Vegetation condition

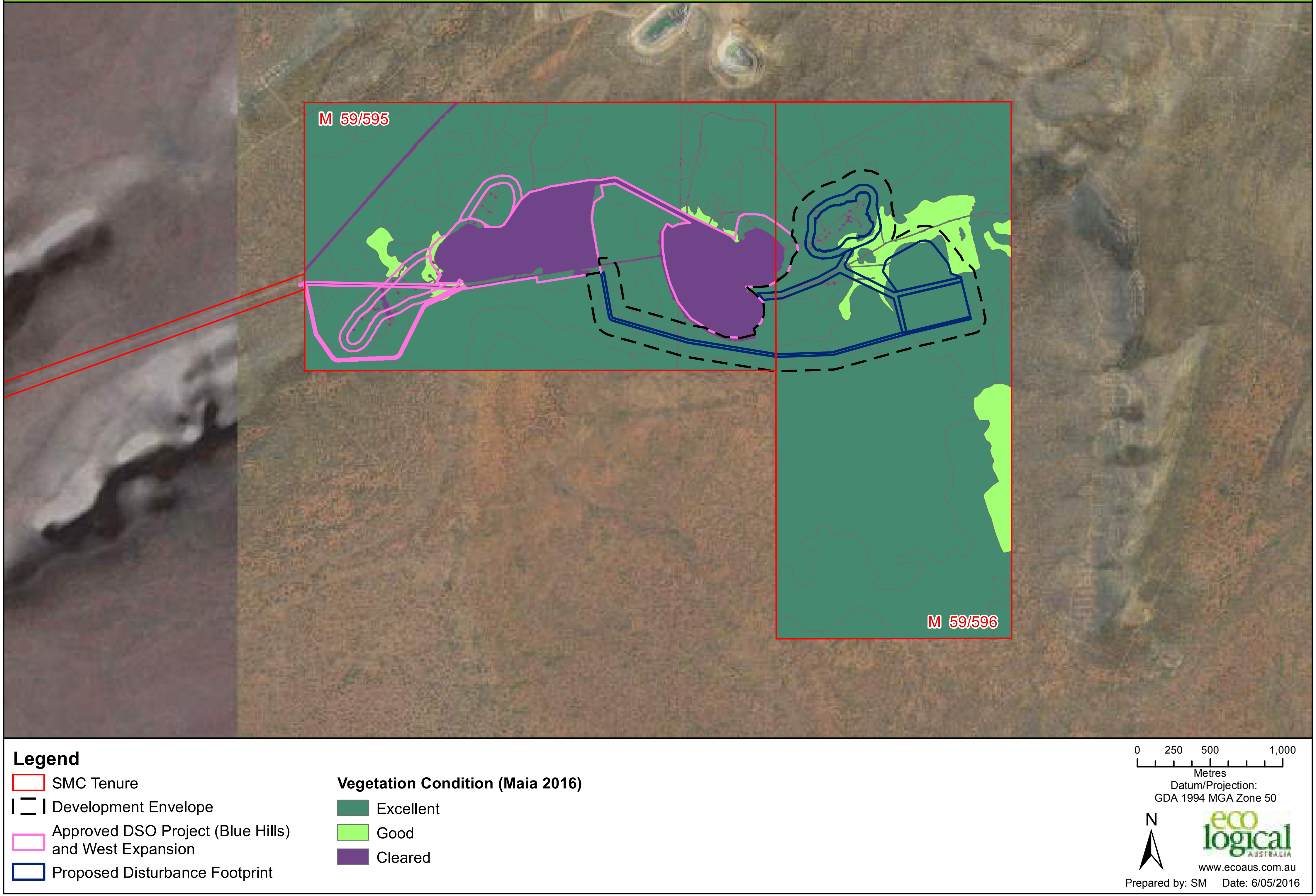


Figure 48: Blue Hills Priority Ecological Community

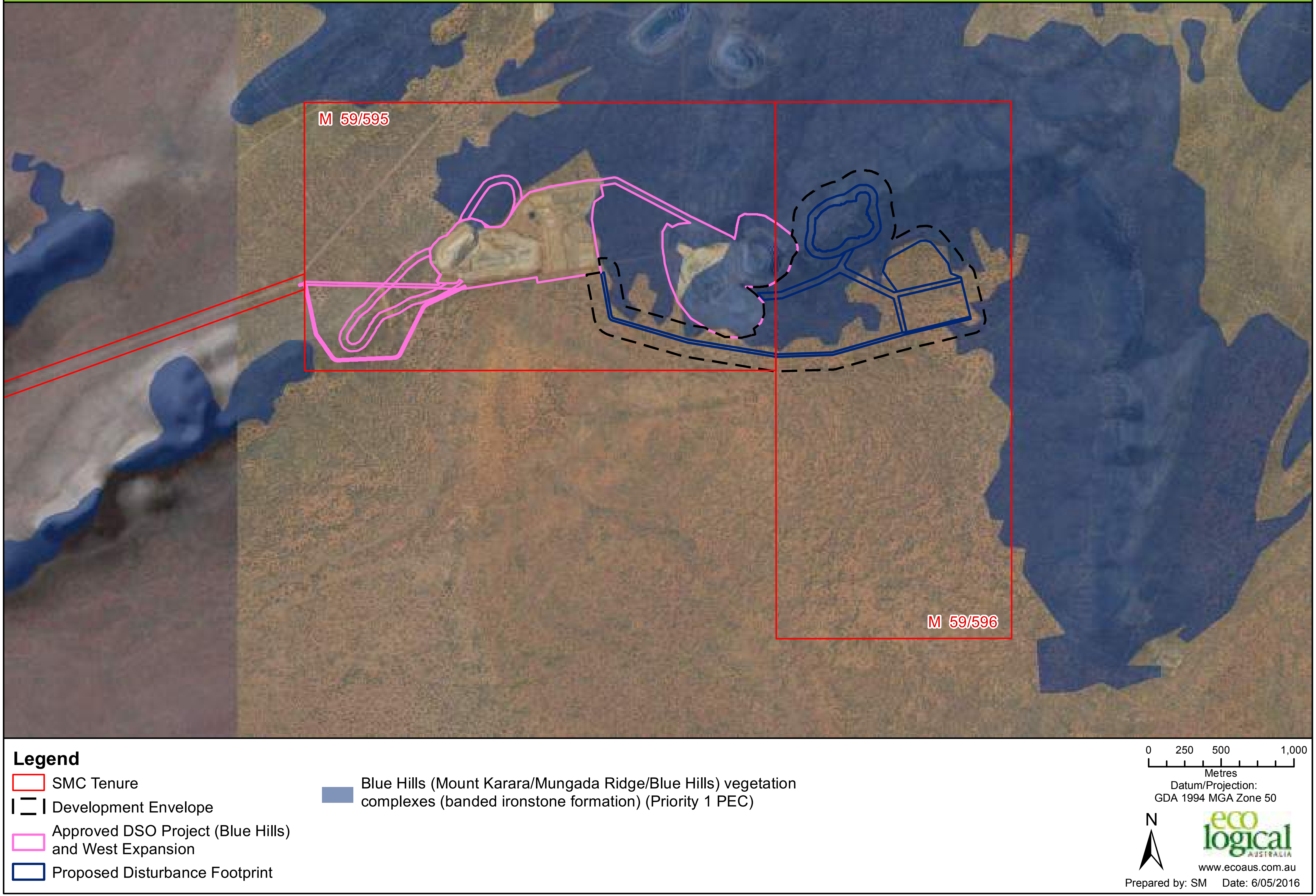


Figure 49: Local FCTs mapped by Woodman (2008a)

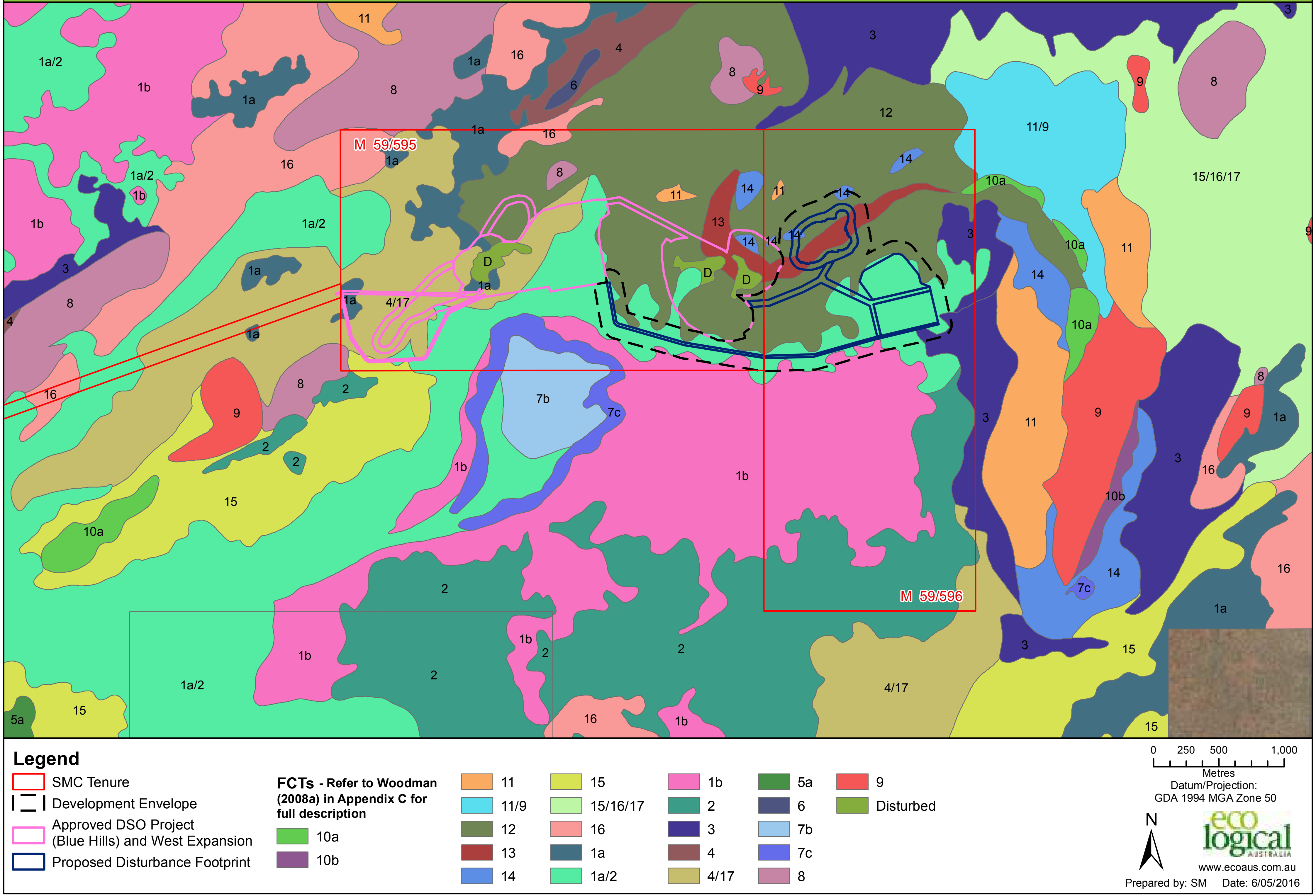
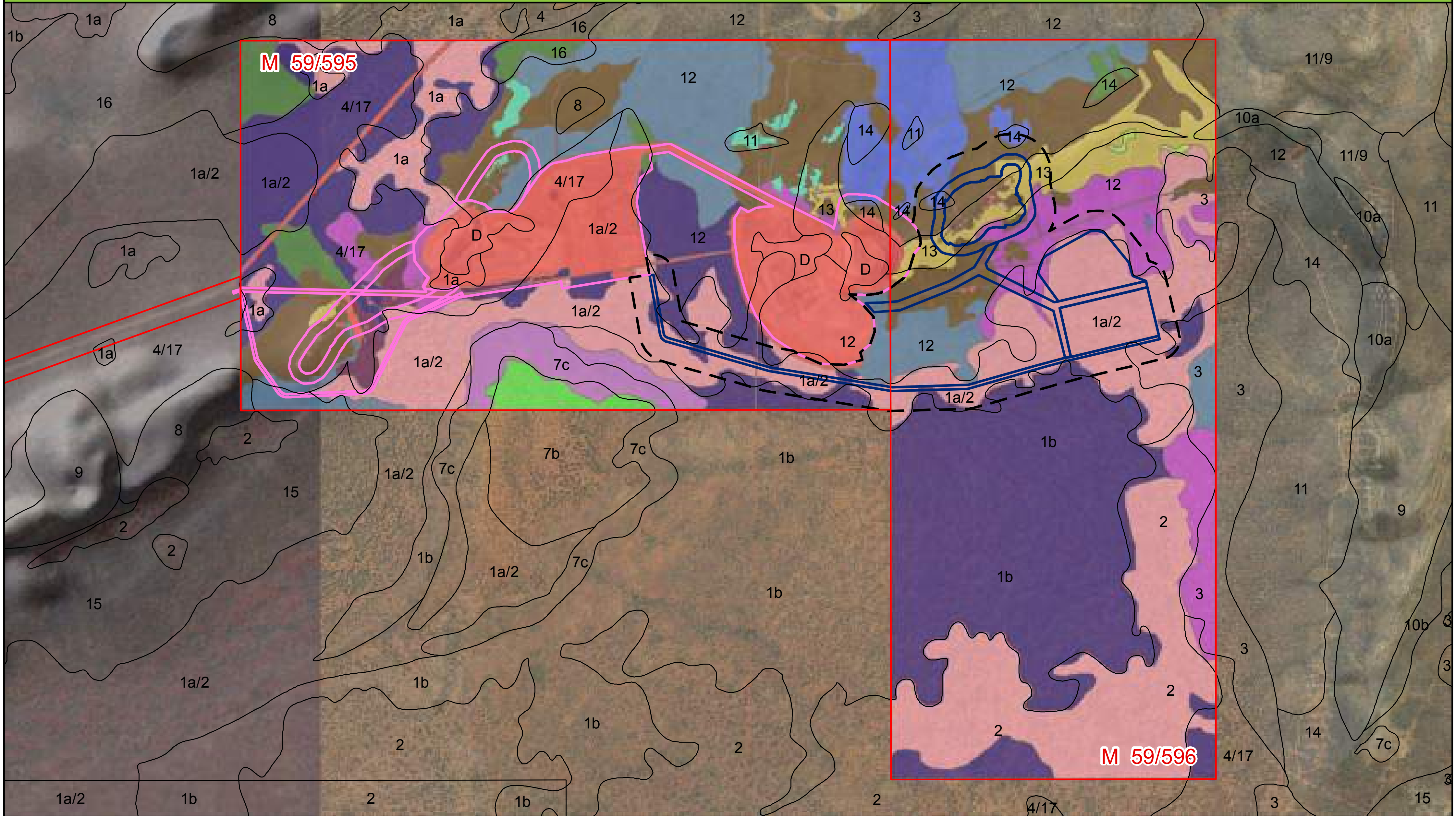


Figure 50: Overlap between Maia (2016) vegetation associations and Woodman (2008a) FCTs



Legend

- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint
- Woodman 2008a FCTs - Refer to Woodman (2008a) in Appendix C for full description

Maia (2016) Vegetation Associations

- ArAtSL (4)
- AsArSL (11)
- Cleared
- EIWL (1)
- EIWL (6)
- MSL (10)
- MSL (12)
- MSL (13)
- MSL (2)
- MSL (7)
- MSL (8)
- MSL (9)
- MaSL (5)
- PoSL (3)

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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14.2.3 Flora

Seventy-three vascular flora taxa, from 30 families and 50 genera, have been recorded in the development envelope. The most common families were Asteraceae (13 taxa), Fabaceae (11 taxa) and Myrtaceae (seven taxa). The most common genera were *Acacia* (10 taxa), *Rhodanthe* (four taxa), *Philotheca* (three taxa) and *Eremophila* (three taxa).

Threatened (Declared Rare) Flora

One Threatened flora species (flora considered likely to become extinct, rare or otherwise in need of special protection as declared by the Minister for Environment, pursuant to section 23F of the WC Act) has been recorded in the development envelope: *Acacia woodmaniorum* (Vulnerable) (Figure 51). This species is not listed as Threatened under the EPBC Act. No other threatened flora species listed under the WC Act or EPBC Act has been recorded in the development envelope; however, potential habitat for one other threatened flora species, *Stylidium scintillans* (Vulnerable; WC Act), does occur.

Acacia woodmaniorum is known from one population on Mungada Ridge and one on Jasper Hill, approximately 4 km north of the development envelope. The two populations together contain 26,990 individuals and occur in an approximately 5 km by 10 km area in the Tallering sub-region.

A partial census of *Acacia woodmaniorum* individuals within tenements M59/595 and M59/596 was conducted in June 2014 and June 2015 by Maia (2016). The census was conducted at locations where *Acacia woodmaniorum* had been previously recorded:

- within the proposed disturbance footprint;
- within the development envelope (outside the proposed disturbance footprint) to the east of the proposed mine pit;
- within 50 m and to the east of the proposed mine pit; and
- to the west of the proposed mine pit in and within 50 m of the development envelope.

The census recorded the coordinates, health, life stage and reproductive status of live plants and the coordinates of dead plants, along with the overall condition of each 15 m by 15 m cell within the census area in which live plants were recorded. Overall condition was rated as excellent, very good, average or poor based on live and dead plant density within the cell, average health of plants within the cell, percentage of reproductive material and percentage of juveniles and seedlings.

Outside the census area, the number of *Acacia woodmaniorum* individuals was determined from results of previous surveys. Where previous surveys recorded plant cover, frequency, or abundance, the number of *Acacia woodmaniorum* individuals was estimated by Maia (2016) based on knowledge of the species in the area and an assumed quadrat size of 20 m by 20 m (standard in the bioregion).

Based on census results and the number of individuals recorded and estimated from previous surveys outside the census area, 4,936 live individuals were estimated to occur in the development envelope. An additional 5,567 live individuals were estimated outside the development envelope within tenements M59/595 and M59/596. Approximately 92% of live individuals were adults, 8% were juveniles and less than 1% were seedlings. Approximately 72% of live individuals were fertile (had flower buds, flowers or pods) and 28% were vegetative.

Areas with the greatest density of live plants were within the development envelope, to the west of the proposed mine pit and within the proposed mine pit, and outside the development envelope towards the eastern boundary of tenement M59/596. The overall condition of live individuals was average in 72% of the 15 m by 15 m cells assessed, poor in 18% of cells and very good in 10% of cells. Areas of very good condition were more prevalent in the western part of the area assessed; areas of poor condition tended to occur along the ridge.

Stylidium scintillans has not been recorded in the development envelope. This follows targeted searches for the species conducted by Maia (2016) in June and September 2015 at locations within SMC's tenements M59/595 and M59/596 that were identified as potential habitat based on the following criteria:

- areas mapped by Woodman (2008a) as FCT 11 or FCT 11/9. There are 21 records of *Stylidium scintillans* lodged with the WA Herbarium and on Florabase. These are located to the north and east of the development envelope; six records are within 500 m of the northern boundary of SMC's tenements M59/595 and M59/596 and the remainder occur up to approximately 40 km from the tenement boundaries (Maia 2016). The six records closest to SMC's tenements M59/595 and M59/596 occur within the area mapped by Woodman (2008a); four records occur within FCT 9 and two records occur within a mosaic of FCT 9 and FCT 11 (FCT 11/9). Only a small area of FCT 11/9 occurs within the north-eastern corner of SMC's Blue Hills tenement M59/596; neither FCT 11/9, nor FCT 9 has any area mapped within the development envelope;
- naturally bare areas identified within SMC's tenements M59/595 and M59/596 from the most recent aerial photography available. The locations of the six records closest to the development envelope were inspected by Maia (2016) in September 2011. The *Stylidium scintillans* habitat at these locations was described by Maia (2016) as highly weathered areas of granitic rock. These three locations and the location of other Florabase records were inspected by Maia (2016) using aerial imagery; all but two locations appeared to be open and apparently weathered areas of rock; and
- areas where *Micromyrtus acuta* and/or *Borya sphaerocephala* have been recorded in relatively bare areas. Of the 21 Florabase records, 12 include a description of vegetation at the location; eight of the vegetation descriptions list *Micromyrtus acuta* and six list *Borya sphaerocephala*. *Micromyrtus acuta* and *Borya sphaerocephala* were therefore considered to commonly occur in areas where *Stylidium scintillans* has been recorded.

Based on these three criteria, 23 areas of potential habitat were identified and surveyed in June 2015. During the June 2015 survey, an additional three areas of potential habitat were identified where *Micromyrtus acuta* and/or *Borya sphaerocephala* and/or relatively bare areas were encountered. Therefore, 26 areas of potential *Stylidium scintillans* habitat were surveyed in June 2015. Each of these 26 areas was resurveyed in September 2015. As stated, no occurrences within the development envelope have been recorded.

Priority flora

Ten Priority flora species have been recorded in the development envelope (Figure 52 and Figure 53), as follows:

- *Acacia karina* (Priority 1). Two individuals recorded in the development envelope;
- *Acacia subsessilis* (Priority 3). Three individuals recorded in the development envelope;
- *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (Priority 3). Sixty-seven individuals recorded in the development envelope;
- *Drummondita fulva* (Priority 3). One thousand five hundred and ninety individuals recorded in the development envelope;
- *Gunniopsis divisa* (Priority 3). Two individuals recorded in the development envelope;
- *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1). Six hundred and ninety-eight individuals have been recorded in the development envelope;

- *Micromyrtus acuta* (Priority 3). Eight hundred and seventy-four individuals recorded in the development envelope;
- *Micromyrtus trudgenii* (Priority 3). Four thousand seven hundred and forty individuals recorded in the development envelope;
- *Persoonia pentasticha* (Priority 3). Seventy-three individuals recorded in the development envelope; and
- *Rhodanthe collina* (Priority 3). Three thousand and eighty-two individuals recorded in the development envelope. This species is endemic to the Tallering and Avon Wheatbelt P1 sub-regions based on known records.

Threatened (Declared Rare) Flora and Priority flora habitat assessment

Maia (2016) conducted a habitat assessment for *Acacia woodmaniorum* (Threatened – Vulnerable), *Stylidium scintillans* (Threatened – Vulnerable) and *Lepidosperma* sp. Blue Hills (Priority 1) to model the extent of each species' potential habitat in the local area around the development envelope. The habitat assessment considered the Beard (1974) vegetation associations (as digitised and updated by DAFWA 2012), land systems (DAFWA 2014), geological units (Stewart et al. 2008), and Woodman (2008a, 2012) FCTs within which each species has been recorded across its entire range.

Potential habitat for each species was then ranked and modelled within the Blue Hills Impact Assessment Area defined by Maia (2016) (Figure 54, Figure 55 and Figure 56). The Blue Hills Impact Assessment Area covers 73,579 ha and encompasses Karara Mining Limited's Karara, Blue Hills North, Terrapod and Hinge approved project footprints, as well as SMC's approved project footprints.

Habitat was ranked as either 0, 1, 2, 3 or 4, where 0 represents no potential or known habitat; 1, 2 and 3 represent areas progressively more likely to support these species or contain favourable habitat; and 4 represents areas most likely to contain favourable habitat. The habitat ranks were based on both the presence/absence of each species within the vegetation associations, land systems, geological units and FCTs, as well as the percentage of each species' records in each vegetation association, land system, geological unit and FCT. Full details of the habitat assessment methodology and scoring system used to develop the habitat ranks are provided in Maia (2016), which is included in Appendix C. The ranking system used by Maia (2016) provides an indication of the relative likelihood that areas contain favourable habitat for each species; however, the modelled extent of habitat should not be used as an accurate representation of each species' potential or actual distribution or extent of occurrence.

Other flora species of interest

In addition to Threatened and Priority flora, the EPA identified in the ESD that the definition of conservation significant flora includes endemic or restricted taxa, new taxa or affinities and taxa at the limits of their range.

The following taxa recorded in the development envelope were identified by Maia (2016) as regional endemics, all of which are listed Threatened or Priority species shown in Figure 51 to Figure 53:

- *Acacia woodmaniorum* (Threatened – Vulnerable), *Acacia karina* (Priority 1) and *Drummondita fulva* (Priority 3) (Tallering sub-region);
- *Acacia subsessilis* (Priority 3) (Tallering and Eastern Murchison sub-regions); and
- *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1), *Micromyrtus acuta* (Priority 3), *Micromyrtus trudgenii* (Priority 3), *Rhodanthe collina* (Priority 3) (Tallering and Avon Wheatbelt P1 sub-regions).

Potential impacts to these taxa are addressed in Section 14.3.2. No other flora taxa were identified by Maia (2016) as being regionally endemic.

Two species recorded in the development envelope were identified by Maia (2016) as having been recorded in areas where they have not been recorded previously (i.e. representing range extensions): *Acacia minyura* and *Goodenia corynocarpa* (Figure 57). Potential impacts to these species are addressed in Section 14.3.2.

One other potential range extension species, *Thryptomene mucronulata*, was recorded in the development envelope by Bennett (2004). It was recorded in one quadrat with a cover of 5%; however, it is considered likely to have been misidentified (C. Cox, Maia Environmental Consultancy, pers. comm. 2015). This species has not been recorded in the proposed disturbance footprint.

Endemism of significant flora species on Mungada Ridge

As described in Section 13.2.1, BIF landforms (such as Mungada Ridge) can provide habitat for locally endemic plant species and communities (DEC 2007), which in some cases can be restricted, or endemic, to individual landforms.

A comprehensive desktop analysis of all available biological survey information for Mungada Ridge was undertaken by ecologia (2013) to determine the likely endemism of significant flora populations and ecological communities known to occur on Mungada Ridge. The analysis found the majority of the individuals of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) occur on Mungada Ridge, but that these species are not strictly endemic to the ridge (ecologia 2013).

Introduced flora species

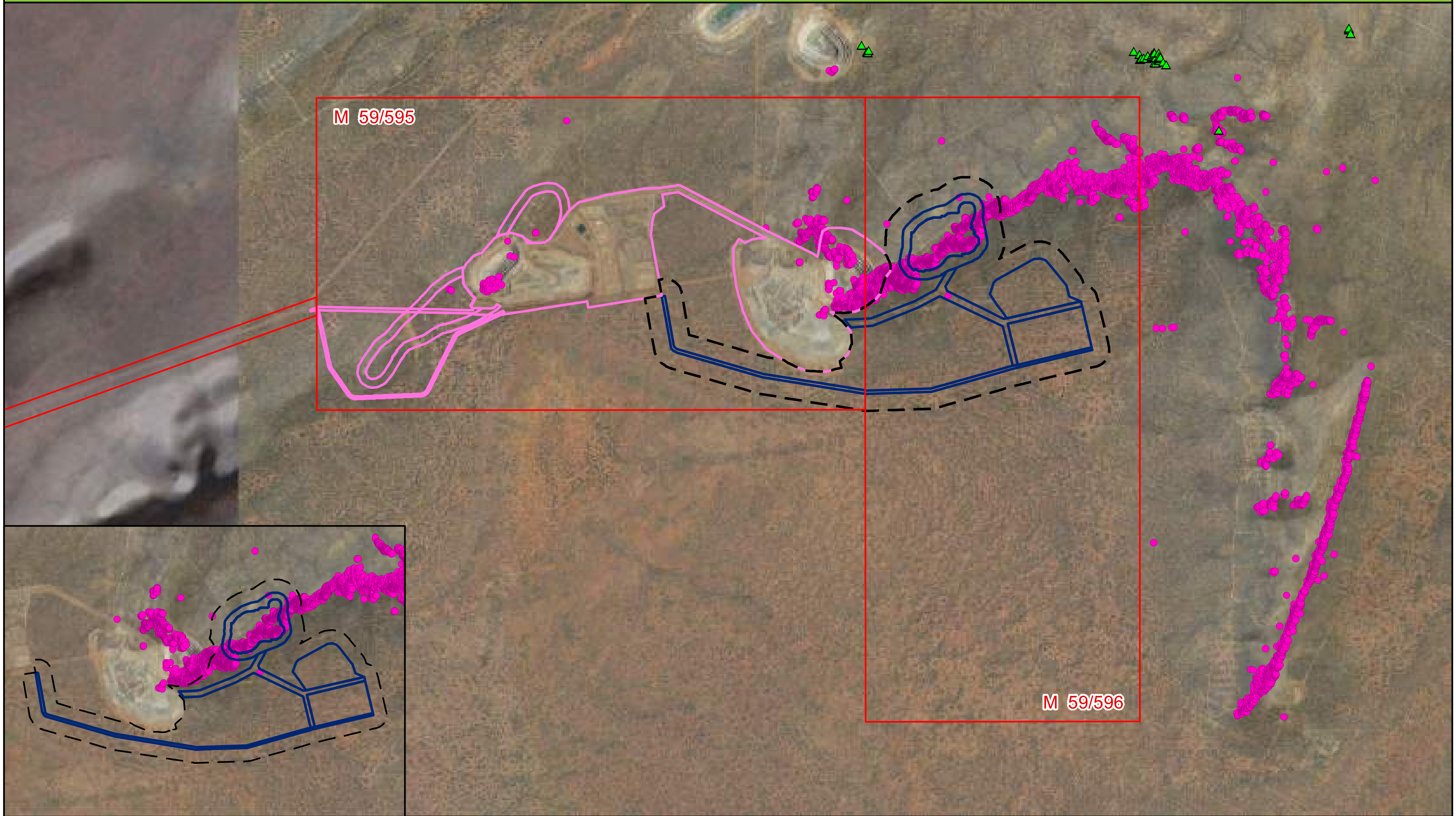
Three general environmental weed species have been recorded in the development envelope:

- *Cuscuta epithymum* (Lesser Dodder): This species is ranked as Negligible in the DPaW Midwest Region weed rankings;
- *Cuscuta planiflora* (Small-seeded Dodder): This species is ranked as Negligible in the DPaW Midwest Region weed rankings; and
- *Pentameris airoides* subsp. *airoides* (False Hairgrass): This species is ranked as Low in the DPaW Midwest Region weed rankings.

An additional general environmental weed species has been recorded within 50 m of the development envelope: *Arctotheca calendula*. This species is ranked as Low in the DPaW Midwest Region weed rankings.

None of the weed species recorded in, or within 50 m of, the development envelope are listed on a national weed list, or as declared plants.

Figure 51: Threatened flora species records



Legend

- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint

Threatened Flora Species

- *Acacia woodmaniorum*
- *Stylidium scintillans*

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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Figure 52: Priority 1 flora species records

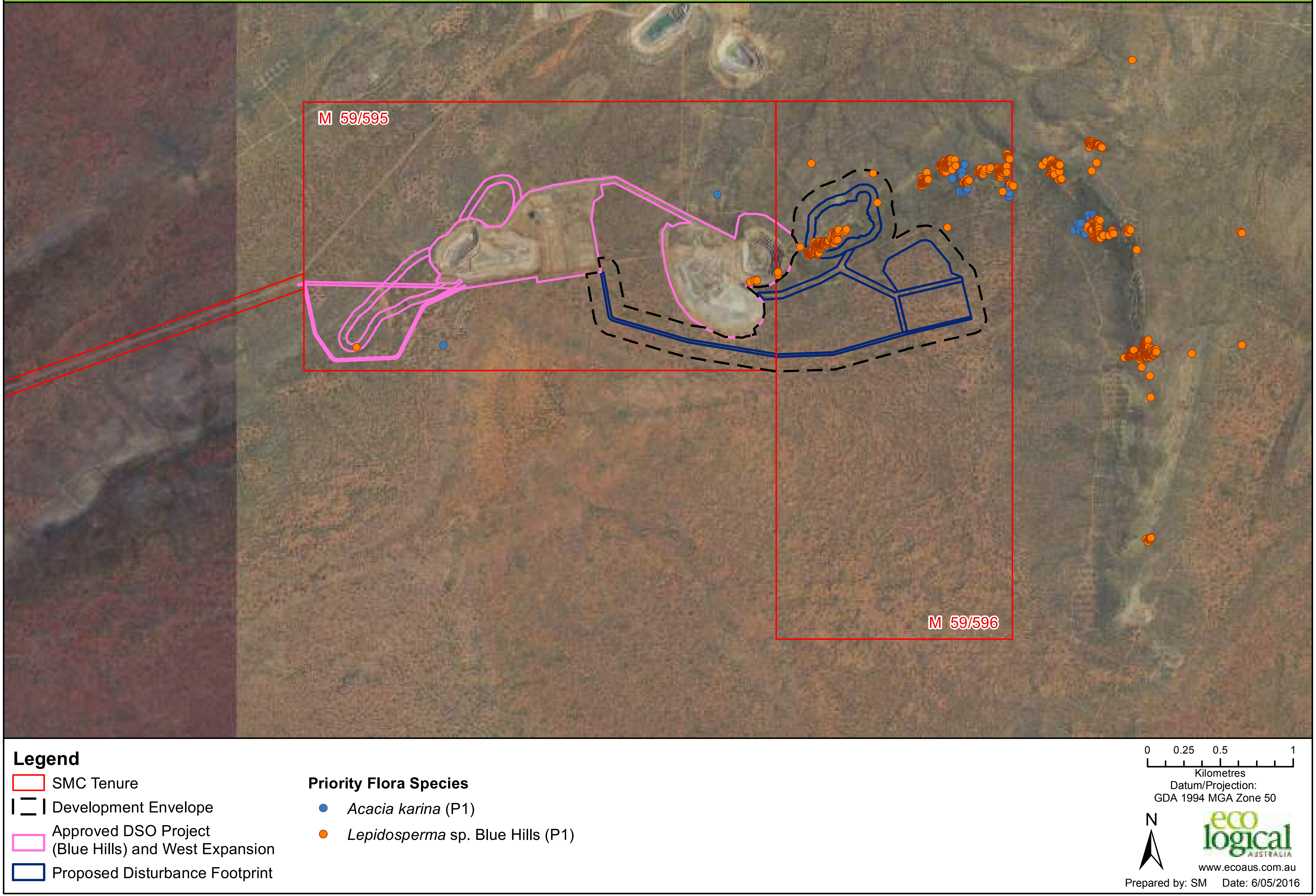


Figure 53: Priority 3 flora species records in vicinity of development envelope

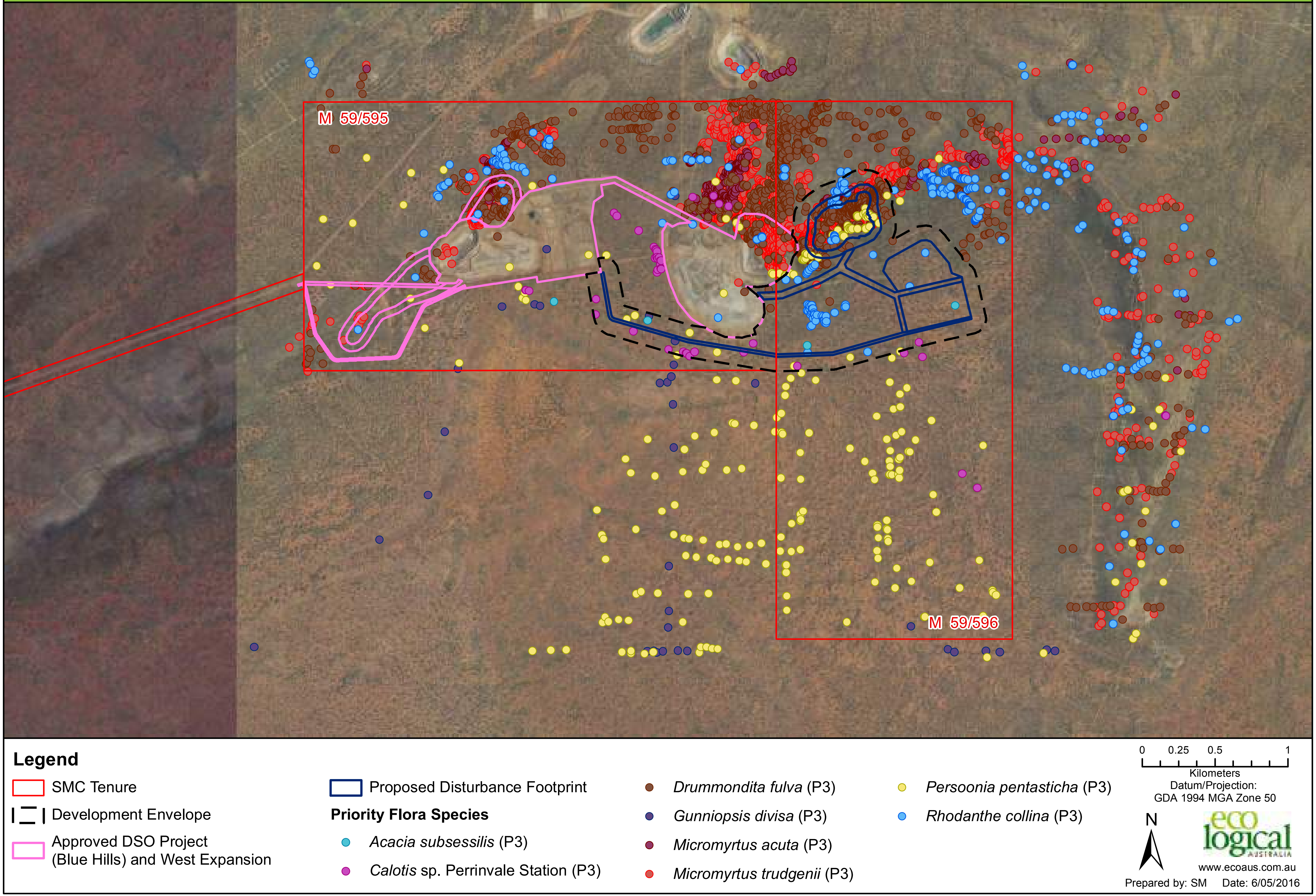
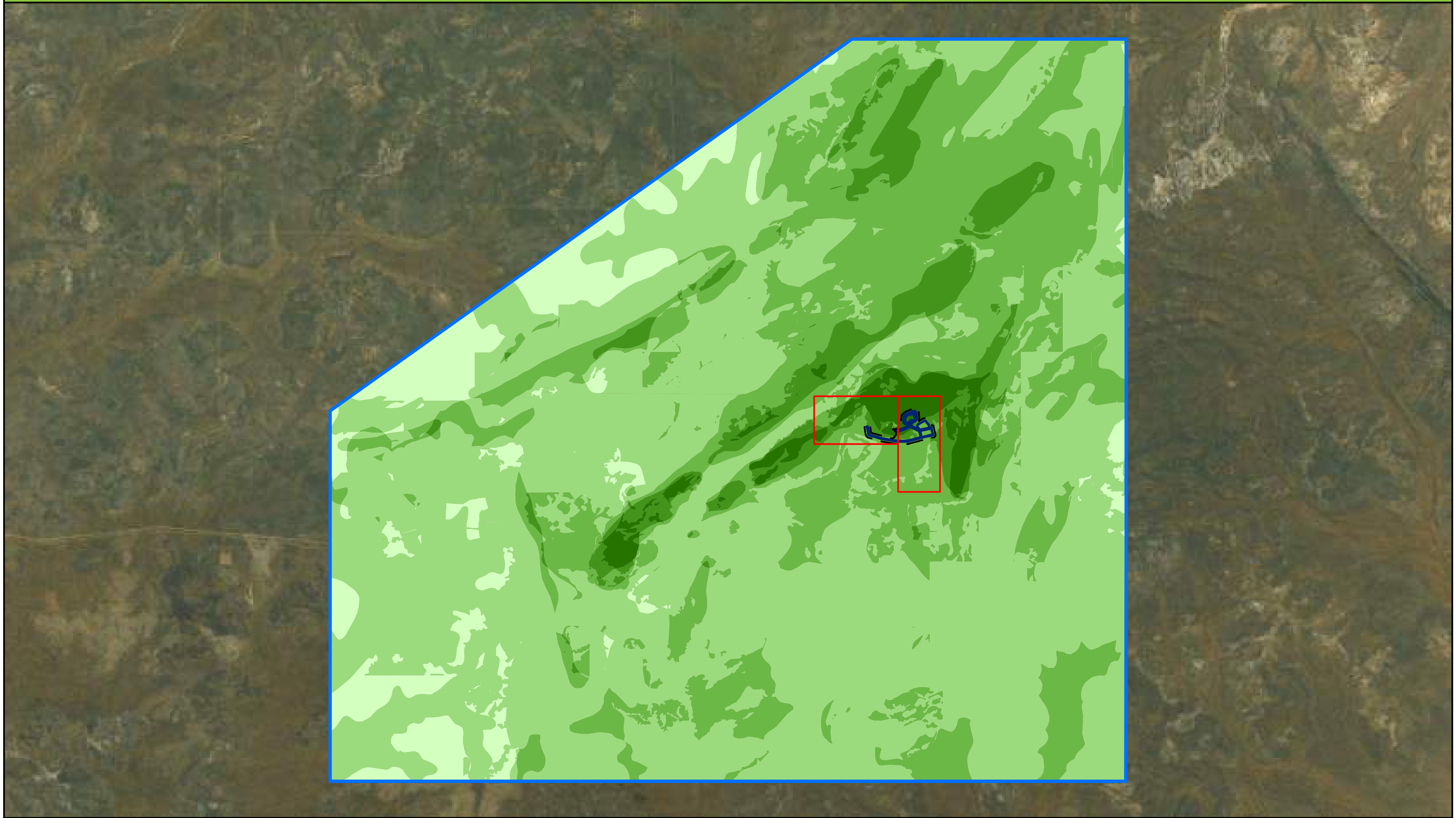


Figure 54: *Acacia woodmaniorum* potential habitat modelled by Maia (2016)



Legend

- SMC Tenure
- Development Envelope
- Proposed Disturbance Footprint
- Blue Hills Impact Assessment Area

***Acacia woodmaniorum* Habitat**

- 0, No Potential / Known Habitat Present
- 1
- 2
- 3
- 4, Most Potential / Known Habitat Present

0 2 4 8
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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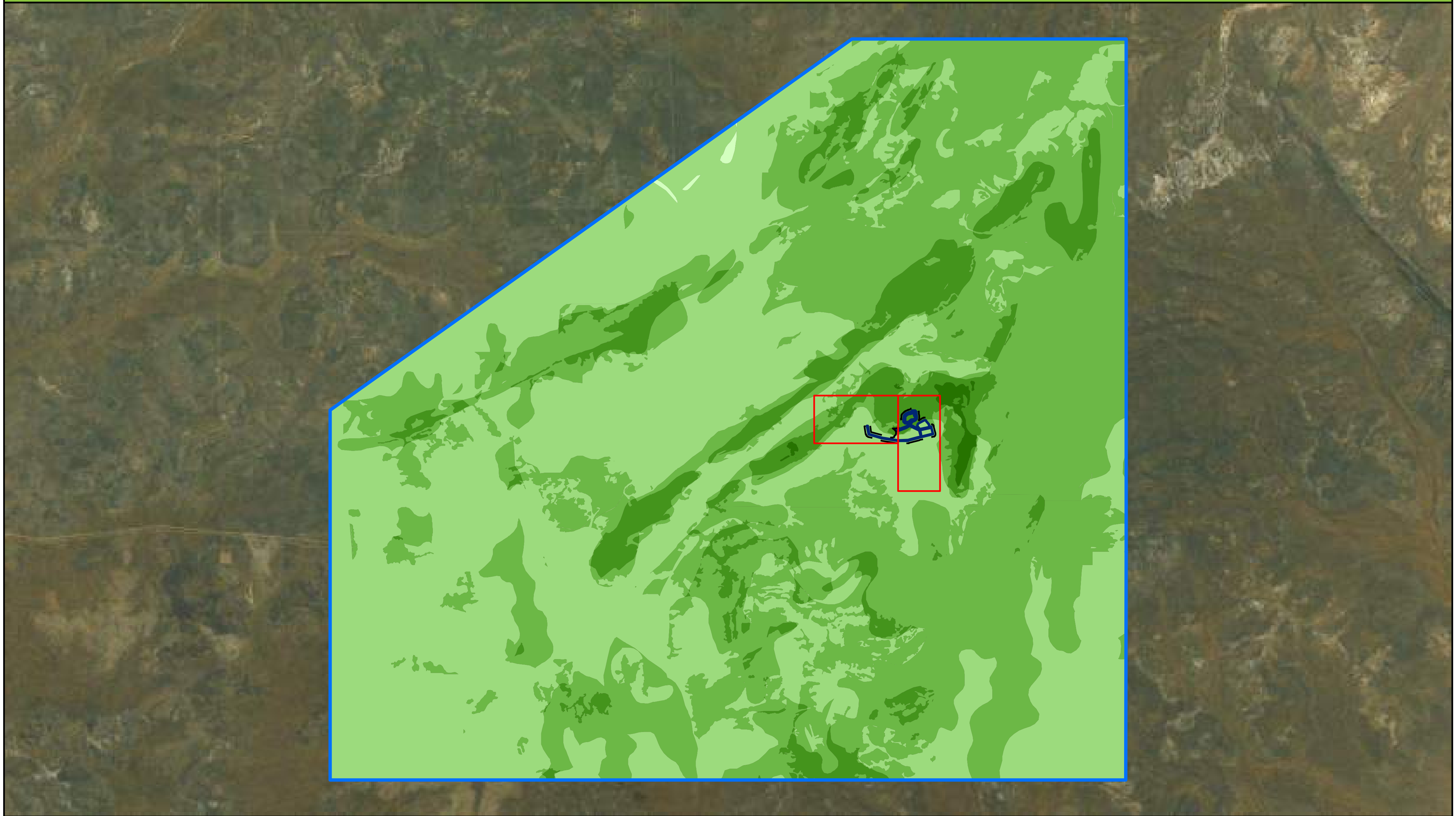
Figure 55: *Stylidium scintillans* potential habitat modelled by Maia (2016)



Legend

- SMC Tenure
- Development Envelope
- Proposed Disturbance Footprint
- Blue Hills Impact Assessment Area

***Stylidium scintillans* Habitat**

- 0, No Potential / Known Habitat Present
- 1
- 2
- 3
- 4, Most Potential / Known Habitat Present

0 2 4 8
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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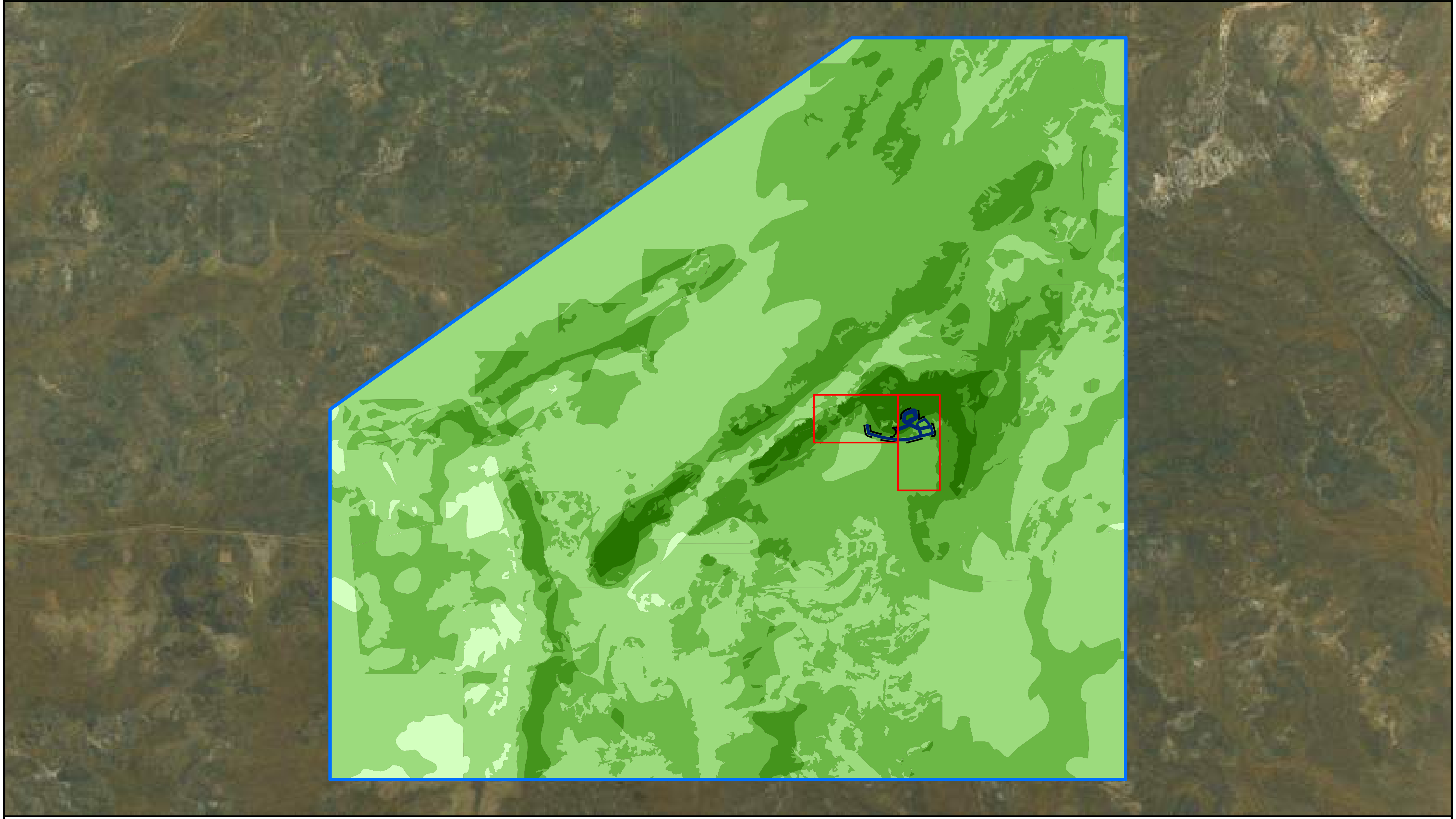
Figure 56: *Lepidosperma* sp. Blue Hills potential habitat modelled by Maia (2016)

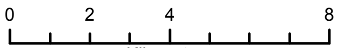


Legend

- SMC Tenure
- Development Envelope
- Proposed Disturbance Footprint
- Blue Hills Impact Assessment Area

***Lepidosperma* sp. Blue Hills Habitat**

- 0, No Potential / Known Habitat Present
- 1
- 2
- 3
- 4, Most Potential / Known Habitat Present



Datum/Projection:
GDA 1994 MGA Zone 50

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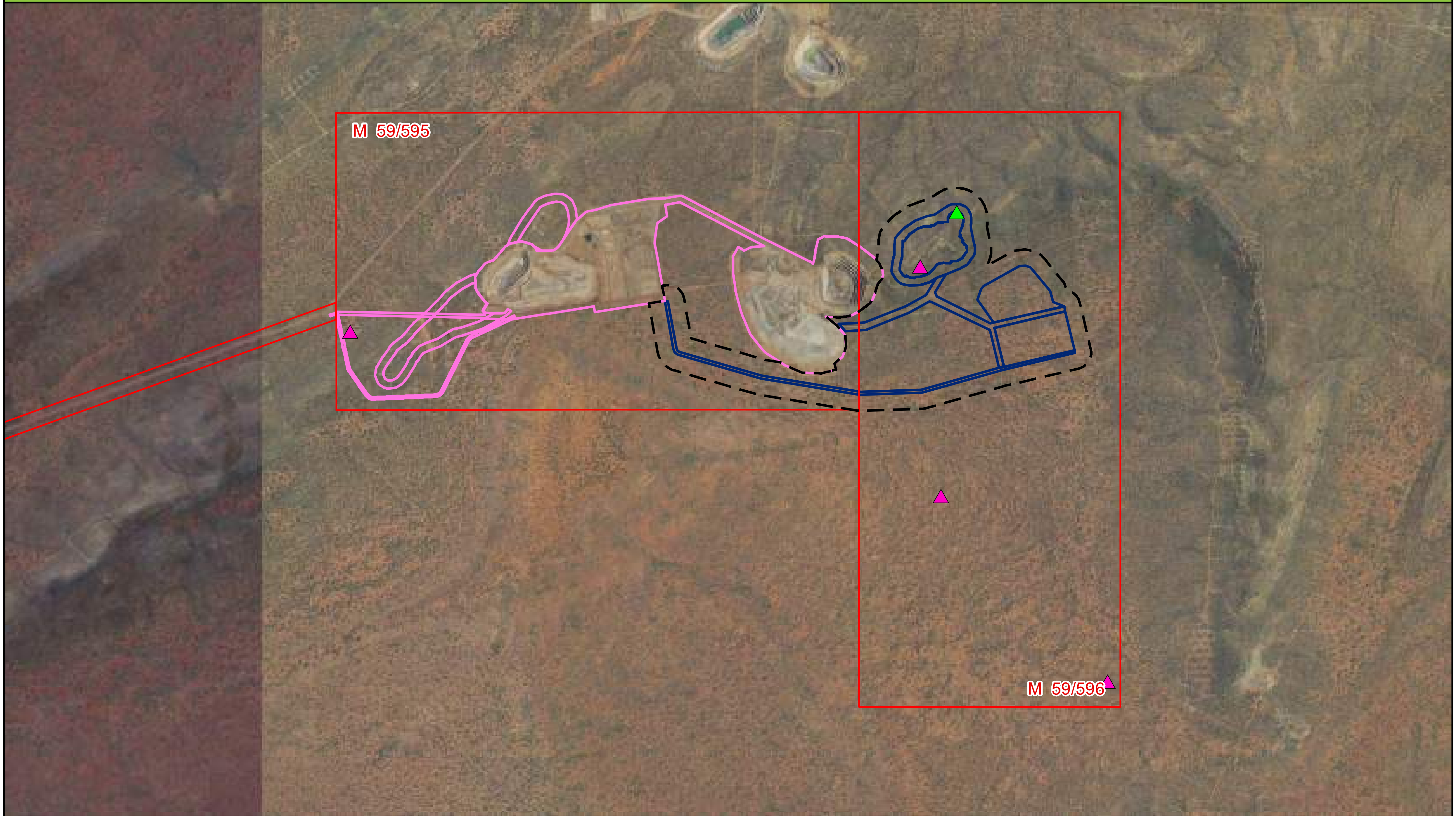
Figure 57: Range extension species records



14.3 Assessment of potential impact, mitigation and residual impact

Potential impacts associated with the Proposal in relation to flora and vegetation were identified by the EPA in the ESD as:

- clearing of native vegetation;
- indirect impacts to vegetation dependent on surface water due to alterations and disruptions to surface water flows;
- indirect impacts on flora and vegetation from dust;
- indirect impacts on flora and vegetation from fragmentation and change in microclimate;
- introduction and/or spread of introduced flora (weed) species into mining areas and adjacent native vegetation; and
- altered fire regimes.

Proposed clearing of native vegetation and associated impacts are addressed in Section 14.3.1 and Section 14.3.2. Indirect impacts and altered fire regimes are addressed in Section 14.3.3.

In a letter to SMC in February 2016, the OEPA requested an analysis of potential direct and indirect impacts and risks to long-term survival and population viability for *Acacia woodmaniorum* (Vulnerable; WC Act) and *Lepidosperma* sp. Blue Hills (Priority 1). The OEPA advised the analysis should consider:

- dust;
- changed microclimate;
- changed hydrology;
- changed ecosystem processes, including impacts to pollinators and reduced reproductive success;
- reduced genetic diversity;
- fragmentation;
- introduced weeds/disease;
- trampling by introduced fauna; and
- changes to seed dispersal.

This analysis has been addressed in Section 14.3.2, which describes potential direct impacts to these two flora species, and Section 14.3.3, which describes potential indirect impacts and risks to long-term survival and population viability.

14.3.1 Clearing of native vegetation

Potential impact to vegetation communities

Vegetation clearing is required for pit development and infrastructure construction. The development envelope covers 172.6 ha, within which the proposed disturbance footprint (i.e. the area in which vegetation is proposed to be cleared) is 53.6 ha. Efforts to avoid and minimise clearing impacts have been applied prior to finalisation of the proposed disturbance footprint (Section 14.5).

Within the proposed disturbance footprint, 48.3 ha (88%) of vegetation is in Excellent condition, 3.7 ha (10%) is in Good condition and 1.5 ha (2%) has already been cleared by approved exploration activities (Figure 47).

The Proposal will result in clearing of seven vegetation associations (Figure 46), six of which are of high local conservation significance and one of which is of moderate local conservation significance (levels of local conservation significance assessed by Maia (2016) using criteria described in footnote of Table 11). The Proposal will clear up to 59% of the extent within the development envelope of each Maia (2016) vegetation association and up to 18% of the extent within tenements M59/595 and M59/596. The associations most affected, in terms of the total area proposed to be cleared and as a percentage of the extent mapped in both the development envelope and tenements M59/595 and M59/596, are *ElWL* (1), MSL (7) and MSL (9) (Table 11).

In regards to local context, for each vegetation association proposed to be cleared, a minimum of 82% of the local mapped extent will be retained within tenements M59/595 and M59/596 outside the development envelope. These areas are proposed to be managed by SMC for the purposes of conservation (Section 19). An additional 5-24% of the mapped extent of each vegetation association occurs in the development envelope outside the proposed disturbance footprint.

As these associations have only been described and mapped at the local scale (i.e. within tenements M59/595 and M59/596), the implications of clearing at a regional scale have been evaluated in consideration of FCTs mapped by Woodman (2008a) across Mt Karara and Mungada Ridge. Regional representation in conservation tenure has been evaluated in consideration of the vegetation units defined by Beard (1974). Within the proposed disturbance footprint, the seven Maia (2016) vegetation associations occurring in the development envelope overlap with the Woodman (2008a) FCTs 3, 12, 13 and 14, and 1a/2 in mosaic (Table 12), as follows and as shown in Figure 50:

- *ElWL* (1): 3, 12 and 1a/2;
- MSL (2): 3, 12 and 1a/2;
- *ArAtSL* (4): 3, 12, 13 and 1a/2;
- MSL (7): 3, 12, 13, 14 and 1a/2;
- MSL (8): 3, 12, 13 and 14;
- MSL (9): 3, 12, 13 and 14; and
- *AsArSL* (11): 3, 12, 14 and 1a/2.

Potential impacts to these Woodman (2008a) FCTs are provided in Table 12. The potential impact to each FCT is less than 3% of the area mapped by Woodman (2008a) (Table 12). The FCTs that are most affected are FCT 1a/2 in terms of the area proposed to be cleared, and FCTs 12 and 13 in terms of the area proposed to be cleared as a percentage of the mapped extent.

Two vegetation units defined by Beard (1974) occur in the development envelope: vegetation units 355 and 358 (Table 8). Six of the eight Maia (2016) vegetation associations have been mapped in both vegetation unit 355 and 358; Maia (2016) vegetation associations MSL (8) and MSL (9) have been mapped only in Beard (1974) vegetation unit 358. Neither of the two Beard (1974) vegetation units have any of their current extent protected for conservation in IUCN I-IV areas in the Yalgoo region or Tallering sub-region. Approximately 45% and 31% respectively of the current extent of vegetation units 355 and 358 occurs in lands managed by DPaW in the Yalgoo region and Tallering sub-region.

Potential impact to the PEC

Approximately 21.4 ha (0.3%) of the 7,098 ha mapped area of the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC will be cleared for the Proposal (i.e. intersected by the proposed disturbance footprint). An additional 63.4 ha (0.9%) occurs inside the development envelope but it not within the proposed disturbance footprint. The remaining 312.9 ha (4.4% of the known extent of the PEC) within tenements M59/595 and M59/596 outside the development envelope is proposed to be retained and managed by SMC for the purposes of conservation (Section 19).

Table 11: Area of each vegetation association proposed to be cleared

Vegetation association	Local conservation significance[1]	Extent in proposed disturbance footprint[2]	Percentage of extent mapped in the development envelope	Percentage of extent mapped in tenements M59/595 and M59/596
*EI*WL (1)	High	28.7 ha	39%	10%
MSL (2)	Moderate	0.7 ha	4%	<1%
*ArAt*SL (4)	High	3.7 ha	21%	6%
MSL (7)	High	11.8 ha	42%	9%
MSL (8)	High	0.5 ha	16%	1%
MSL (9)	High	6.1 ha	59%	18%
*AsAr*SL (11)	High	0.5 ha	3%	<1%

[1] Local significance relates to tenements M59/595 and M59/596 and was rated by Maia (2016) for each vegetation association based on the cover of each association, the condition of the vegetation, the conservation significant flora and weed species recorded, whether the association occurs on BIF or outside the local area, and whether the association could be dependent on groundwater, or on sheetflow or runoff from the hills.

[2] The proposed disturbance footprint covers 53.5 ha. Total clearing shown in this table is 52 ha; the remaining 1.5 ha within the proposed disturbance footprint has already been cleared for exploration.

Table 12: Area of each Woodman (2008a) Floristic Community Type proposed to be cleared

Woodman (2008a) FCT	Overlapping Maia (2016) vegetation associations							Extent in proposed disturbance footprint	Percentage of extent mapped
	E/WL (1)	MSL (2)	*ArAt*SL (4)	MSL (7)	MSL (8)	MSL (9)	*AsAr*SL (11)		
3: Open Woodland of *Eucalyptus kochii* subsp. *?plenissima* or Shrubland of *Acacia tetragonophylla*, *A. burkittii* and *A. assimilis* subsp. *assimilis* over mixed species including *Rhagodia drummondii*, *Scaevola spinescens*, *Philotheca brucei* subsp. *brucei* and *Eremophila clarkei* on flats to mid-slopes with ironstone gravels and rarely BIF	✓	✓	✓	✓	✓	✓	✓	0.1 ha	<0.1%
12: Shrubland of *Acacia* species including *A. assimilis* subsp. *assimilis*, *Acacia ramulosa* var. *ramulosa*, *Acacia exocarpoides* and *Acacia sibina* over mixed species including *Hibbertia arcuata*, *Calycopeplus paucifolius* and *Grevillea obliquistigma* subsp. *obliquistigma* on flats to midupperslopes with ironstone gravels	✓	✓	✓	✓	✓	✓	✓	13.2 ha	2%
13: Dense Shrubland of *Allocasuarina acutivalvis* subsp. *prinsepiana* with *Melaleuca nematophylla* over *Grevillea paradoxa*, *Xanthosia kochii* and *Lepidosperma* sp. Blue Hills on mid-upper slopes on BIF	-	-	✓	✓	✓	✓	-	7.3 ha	3%
14: Shrubland of *Acacia* species including *A. assimilis* subsp. *assimilis* and *Acacia ramulosa* var. *ramulosa* and *Allocasuarina acutivalvis* subsp. *prinsepiana* with emergent *Eucalyptus leptopoda* subsp. *elevata* over mixed species including *Aluta aspera* subsp. *hesperia*, *Prostanthera magnifica* and *Grevillea obliquistigma* subsp. *obliquistigma* on slopes and ridges	-	-	-	✓	✓	✓	✓	0.6 ha	<1%

Woodman (2008a) FCT	Overlapping Maia (2016) vegetation associations							Extent in proposed disturbance footprint	Percentage of extent mapped
	*E*WL (1)	MSL (2)	*ArAt*SL (4)	MSL (7)	MSL (8)	MSL (9)	*AsAr*SL (11)		
Mosaic 1a/2: 1a: Open Woodland of *Eucalyptus loxophleba* subsp. *supralaevis* with Open Shrubland dominated by *Acacia tetragonophylla* and *A. obtecta* over chenopod species including *Sclerolaena fusiformis*, *Sclerolaena diacantha* and *Rhagodia drummondii* on flats and drainage depressions 2: Open Woodland of *Eucalyptus loxophleba* subsp. *supralaevis* and/or *E. striaticalyx* over Shrubland of mixed species including *Acacia erinacea*, *Eremophila pantonii* and *Senna stowardii* over mixed species including *Sclerolaena fusiformis* and *Scaevola spinescens* on flats and rocky lower slopes with ironstone gravels	✓	✓	✓	✓	-	-	✓	30.8 ha	<1%

14.3.2 Potential impact to conservation significant flora species

Potential impact to Threatened and Priority flora species

Clearing will result in the loss of individuals of one Threatened flora species and eight Priority flora species. Avoidance of all known records of conservation significant flora is not possible; however, the final layout of the Proposal will be designed to minimise the number of individuals required to be cleared.

The proposed clearing includes disturbance of an estimated 2,634 individuals of *Acacia woodmaniorum* (Threatened), two individuals of *Acacia karina* (Priority 1), 669 individuals of *Lepidosperma* sp. Blue Hills (Priority 1), as well as a combined total of 5,832 individuals across six Priority 3 flora species (Table 13). Two other Priority 3 flora species, *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) and *Gunniopsis divisa*, have been recorded in the development envelope; however, all records of these species are located outside the proposed disturbance footprint.

In all cases, individuals located within the proposed disturbance footprint belong to a single population (Table 14). The proposed clearing represents less than one third of each population, except for *Acacia karina* (50% of the population) and *Acacia subsessilis* (100% of the population); however, the higher percentage impacts to these two species are due to the low number of recorded individuals in the population (four individuals of *Acacia karina* and one individual of *Acacia subsessilis*; Table 13). The potential impact to these two species is only two individuals and one individual respectively (Table 13).

The proposed clearing represents up to 38% of the number of individuals of each taxon within tenements M59/595 and M59/596 and up to 25% of the number of individuals within the Tallering sub-region and WA (Table 13). There are several other populations in the Tallering sub-region and/or elsewhere in WA for each of these taxa, with the exception of *Acacia woodmaniorum* (Table 14). None of these species have any records protected for conservation in International Union for Conservation of Nature (IUCN) I-IV areas in the Tallering sub-region (Maia 2016).

In regards to *Acacia woodmaniorum*, the Proposal will affect one of the species' two known populations in WA. The Proposal includes disturbance of an estimated 2,634 individuals of *Acacia woodmaniorum* within a population of 23,844 known individuals. The other population of the species contains 3,146 known individuals and will not be affected by the Proposal. The Proposed disturbance of 2,634 individuals represents 11% of the affected population, 25% of the number of individuals in SMC's Blue Hills tenements, and 10% of the number of individuals in the Tallering sub-region and WA (Table 13). The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat for *Acacia woodmaniorum* (Habitat Rank 4; Table 15; refer to Section 14.2.3 for an explanation of the habitat ranks). This represents approximately 41% of the extent of Habitat Rank 4 modelled within the development envelope and 1.5% of the extent modelled within the Blue Hills Impact Assessment Area (Table 15). Together with existing disturbance to Habitat Rank 4 within the Blue Hills Impact Assessment Area (approximately 290 ha), the cumulative impact to Habitat Rank 4 is 311 ha, which represents 22% of the extent of Habitat Rank 4 modelled within the Blue Hills Impact Assessment Area.

In regards to *Lepidosperma* sp. Blue Hills, the Proposal will affect one of the species' 13 known populations in WA. The Proposal includes disturbance of an estimated 669 individuals of *Lepidosperma* sp. Blue Hills within a population of 5,449 known individuals. The other 12 populations of the species contain a total of 224 individuals and will not be affected by the Proposal. The Proposed disturbance of 669 individuals represents 12% of the affected population, 29% of the number of individuals in SMC's Blue Hills tenements, and 12% of the number of individuals in the Tallering sub-region and WA (Table 13). The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat for *Lepidosperma* sp. Blue Hills (Habitat Rank 4; Table 16; refer to Section 14.2.3 for an explanation of the habitat ranks). This represents approximately 41% of the extent of Habitat Rank 4 modelled within the development envelope and 1.3% of the extent modelled within the Blue Hills Impact Assessment Area (Table 16). Together with existing disturbance to Habitat Rank 4 within the Blue Hills Impact Assessment Area (approximately 407 ha), the cumulative impact to Habitat Rank 4 is 428 ha, which represents 27% of the extent of Habitat Rank 4 modelled within the Blue Hills Impact Assessment Area.

In regards to Stylidium scintillans, potential habitat for the species occurs in the development envelope, although the species has not been recorded. The proposed disturbance footprint intersects predominantly Habitat Ranks 3 and 1 for Stylidium scintillans, but not any of the most favourable habitat modelled for the species (Habitat Rank 4) (Table 17; refer to Section 14.2.3 for an explanation of the habitat ranks. The proposed clearing will result in the loss of approximately 21 ha of Habitat Rank 3 (Table 17), which represents approximately 37% of the extent of Habitat Rank 3 modelled within the development envelope and less than 0.5% of the extent modelled within the Blue Hills Impact Assessment Area (Table 17). With regard to the most favoured habitat (Habitat Rank 4), existing disturbance comprises 6.8 ha, which represents 3% of the extent of Habitat Rank 4 modelled within the Blue Hills Impact Assessment Area.

Potential impact to other flora species of interest

Clearing will result in the loss of one individual of *Acacia minyura* and 10 individuals of *Goodenia corynocarpa* (Table 13).

Acacia minyura was recorded by Woodman (2012) at one location in the proposed disturbance footprint. Based on aerial photography, the record appears to be of a single individual (C. Cox, Maia Environmental Consultancy, pers. comm. 2015). The species has not previously been recorded in the Tallering sub-region; the closest bioregion in which the species has been recorded is the Murchison bioregion, which is 70 km east of the development envelope. *Acacia minyura* has a widespread distribution in WA (Maia 2016).

Goodenia corynocarpa was recorded by Maia (2016) at one location in the proposed disturbance footprint. The number of individuals was not recorded, but was estimated to be 10 individuals based on quadrat cover data. The species has been recorded elsewhere in the Tallering sub-region and has a moderate distribution in WA (Maia 2016).

Table 13: Number of individuals of each conservation significant flora species proposed to be cleared

Taxon	Conservation significance[1]		No. of individuals				
	Regional	Local	Within proposed disturbance footprint	Within the development envelope	Within tenements M59/595 and M59/596	Within the Tallering sub-region	Within WA
Threatened species							
Acacia woodmaniorum	High	High	2,634 (11% of 23,844 individuals in population)	4,936	10,503	26,990	26,990
Priority 1 species							
Acacia karina	High	High	2 (50% of four individuals in population)	2	56	448	448
Lepidosperma sp. Blue Hills (A. Markey & S. Dillon 3468)	Moderate	High	669 (12% of 5,449 individuals in population)	698	2,285	5,555	5,673
Priority 3 species							
Acacia subsessilis	Moderate	High	1 (100% of one individual in population)	3	9	2,415	2,428
Drummondita fulva	High	Moderate	1,164 (23% of 4,990 individuals in population)	1,590	4,155	15,724	15,724
Micromyrtus acuta	Moderate	Moderate	867 (10% of 8,561 individuals in population)	874	2,753	13,628	13,759

Taxon	Conservation significance[1]		No. of individuals				
	Regional	Local	Within proposed disturbance footprint	Within the development envelope	Within tenements M59/595 and M59/596	Within the Tallering sub-region	Within WA
Micromyrtus trudgenii	Moderate	Moderate	3,754 (31% of 12,087 individuals in population)	4,740	9,902	15,417	15,430
Persoonia pentasticha	Moderate	Moderate	45 (13% of 354 individuals in population)	73	237	425	518
Rhodanthe collina	Moderate	Moderate	1 (<0.01% of 35,399 individuals in population)	3,082	10,142	36,073	36,222
Other flora of interest							
Acacia minyura	-	-	1 (100% of one individual in population)	1	1	Unknown[2]	Unknown[2]
Goodenia corynocarpa[3]	-	-	10 (100% of 10 individuals in population)	10	31	Unknown[4]	Unknown[4]

[1] Regional and local conservation significance relates to the Tallering sub-region and tenements M59/595 and M59/596 respectively. Conservation significance was rated by Maia (2016) for each species based on conservation status, distribution in the Tallering sub-region and surrounding bioregions, distribution and number of populations recorded in tenements M59/595 and M59/596 and in the Tallering sub-region, and occurrence in protected areas. [2] In addition to the single individual recorded in the proposed disturbance footprint, there are six other populations in the Tallering sub-region and 72 additional populations in WA; however, the total number of individuals in these populations is unknown. [3] The number of *Goodenia corynocarpa* individuals was estimated from quadrat cover data (the number of individuals within each quadrat was not recorded). [4] In addition to the 31 individuals in tenements M59/595 and M59/596, there are three other populations in the Tallering sub-region and 36 additional populations in WA; however, the total number of individuals in these populations is unknown.

Table 14: Number of populations of each conservation significant flora species

Taxon	Conservation significance[1]		No. of populations				
	Regional	Local	Within proposed disturbance footprint	Within the development envelope	Within tenements M59/595 and M59/596	Within the Tallering sub-region	Within WA
Threatened species							
Acacia woodmaniorum	High	High	1	1	1	2	2
Priority 1 species							
Acacia karina	High	High	1	2	3	41	41
Lepidosperma sp. Blue Hills (A. Markey & S. Dillon 3468)	Moderate	High	1	1	1	8	13
Priority 3 species							
Acacia subsessilis	Moderate	High	1	3	3	31	35
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)	Moderate	Moderate	0	1	1	13	19
Drummondita fulva	High	Moderate	1	1	1	37	37
Gunniopsis divisa	Moderate	High	0	1	1	10	20
Micromyrtus acuta	Moderate	Moderate	1	1	2	25	27
Micromyrtus trudgenii	Moderate	Moderate	1	1	1	48	51
Persoonia pentasticha	Moderate	Moderate	1	1	1	36	60
Rhodanthe collina	Moderate	Moderate	1	1	1	34	37
Other flora of interest							
Acacia minyura	-	-	1	1	1	7	79

Taxon	Conservation significance[1]		No. of populations				
	Regional	Local	Within proposed disturbance footprint	Within the development envelope	Within tenements M59/595 and M59/596	Within the Tallering sub-region	Within WA
Goodenia corynocarpa	-	-	1	1	4	7	43

[1] Regional and local conservation significance relates to the Tallering sub-region and tenements M59/595 and M59/596 respectively. Conservation significance was rated by Maia (2016) for each species based on conservation status, distribution in the Tallering sub-region and surrounding bioregions, distribution and number of populations recorded in tenements M59/595 and M59/596 and in the Tallering sub-region, and occurrence in protected areas.

Table 15: Potential impact to *Acacia woodmaniorum* potential habitat modelled by Maia (2016)

Habitat rank	Habitat rank description	Area modelled (ha)		
		Within proposed disturbance footprint	Within development envelope	Within Blue Hills Impact Assessment Area
4	Most potential/known habitat	21.0	51.8	1,391.6
3	↓ Progressively less potential/known habitat	0.6	36.8	3,940.5
2		30.4	80.4	19,886.9
1		0	0	43,042.3
0	No known/potential habitat	0	0	5,318.2

Table 16: Potential impact to *Lepidosperma* sp. Blue Hills potential habitat modelled by Maia (2016)

Habitat rank	Habitat rank description	Area modelled (ha)		
		Within proposed disturbance footprint	Within development envelope	Within Blue Hills Impact Assessment Area
4	Most potential/known habitat	21.0	51.8	1,584.9
3	↓ Progressively less potential/known habitat	0.6	36.8	6,669.8
2		30.4	80.4	30,166.4
1		0	0	33,536.0
0	No known/potential habitat	0	0	1,622.4

Table 17: Potential impact to *Stylidium scintillans* potential habitat modelled by Maia (2016)

Habitat rank	Habitat rank description	Area modelled (ha)		
		Within proposed disturbance footprint	Within development envelope	Within Blue Hills Impact Assessment Area
4	Most potential/known habitat	0	0	221.8
3	↓ Progressively less potential/known habitat	21.1	56.3	6,094.7
2		0.4	6.7	32,437.9
1		30.6	105.9	34,759.7
0	No known/potential habitat	0	0	65.3

14.3.3 Indirect impacts

Overview

For the purpose of this assessment, areas outside of the predicted disturbance footprint but within the development envelope, as well as an area extending 50 m from the boundary of the development envelope, are considered to have the potential to be subject to indirect impacts (Figure 58). Such indirect impacts include alterations and disruptions to surface water flows, dust, introduction and/or spread of weeds, and altered fire regimes. The actual extent of indirect impacts that occur may be less than the estimates provided in this document; but are considered appropriate to enable an adequate assessment of the likely maximum area subject to potential indirect impacts from the Proposal.

The results of the most recent vegetation monitoring report for the Blue Hills mine (Maia 2015a) provide an indication of the relative likelihood of significant indirect impacts occurring to flora and vegetation as a result of the Proposal. The report concludes there appears to have been no negative effects of mining from the DSO Project on the vegetation closest to the mine and infrastructure (i.e. impact treatment) relative to the vegetation further away from the mines and infrastructure (i.e. control treatment). Specifically, the monitoring assessment concluded the following key findings:

- When calculated as a percentage of all plants recorded in 2012 (908), the decrease in plant numbers between 2012 and 2015 was 1.9% greater at the impact sites (-6.4%) than at the control sites (-4.5%). As most of this change was in one vegetation association (AasAsSL-3) and in the plants less than 1 m in height, it could be a reflection of natural change in the flora of this vegetation association rather than of the effects of mining on plant numbers (Maia 2015a).
- The differences in the health rating, proportional canopy volume and diameter at breast height between control and impact groups were not statistically significant and neither was there a significant correlation between dust and plant health;
- Vegetation condition has been consistently rated as Excellent at both impact and control sites since 2012;
- There has been no increase in feral animals;
- There has been an increase in weed numbers but mostly in control sites;
- There has been no occurrence of fire; and
- The level of dust cover on foliage has remained low.

Table 18 provides an estimate of the area of vegetation associations and the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC, along with the number of individuals of conservation significant flora that are within the area considered to potentially be affected by indirect impacts from the Proposal.

The area of vegetation associations *ElWL* (1), MSL (2), *ArAtSL* (4), MSL (7), MSL (8), MSL (9) and *AsArSL* (11) within the area considered to be potentially subject to indirect impacts (referred herein as the indirect impact assessment area) ranges from approximately 9% to 31% of the extent mapped within tenements M59/595 and M59/596 (Table 18). It is important to note that the indirect impact assessment area does not represent an area in which all flora and vegetation located are certain to experience negative effects from indirect impacts. Rather, it is an area in which, if indirect impacts were to occur, they would likely be contained within the defined area in relatively close proximity and within a zone of influence of the mine.

Approximately 78.1 ha of the Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' PEC may be affected by indirect impacts associated with the Proposal. This area represents 20% of the extent of the PEC within tenements M59/595 and M59/596, but only approximately 1% of the total extent of the PEC (Table 18).

Approximately 3,700 *Acacia woodmaniorum* individuals occur in the indirect impact assessment area (in addition to the 2,634 individuals intersected by the proposed disturbance footprint), which represents 35% of the known records of the species within tenements M59/595 and M59/596 and 14% of the total known records of the species (Table 18). The species has been recorded in disturbed areas at the Blue Hills mine (Plate 6 and Plate 7), suggesting it may be likely to persist in and/or recolonise disturbed areas in the development envelope if any such areas were to occur as a result of indirect impacts.

There are no records of *Acacia karina* and 37 records of *Lepidosperma* sp. Blue Hills (both Priority 1) located in the indirect impact assessment area. For *Lepidosperma* sp. Blue Hills, this represents approximately 2% of the known records of the species within tenements M59/595 and M59/596 and less than 1% of the known records in the Tallering sub-region and WA (Table 18).

Records of six Priority 3 flora species are located in the indirect impact assessment area. These represent up to 36% of the number of records within tenements M59/595 and M59/596 and up to 10% of the number of records in the Tallering sub-region and WA (Table 18).

Figure 58: Areas of direct impact and areas considered to have potential for indirect impacts

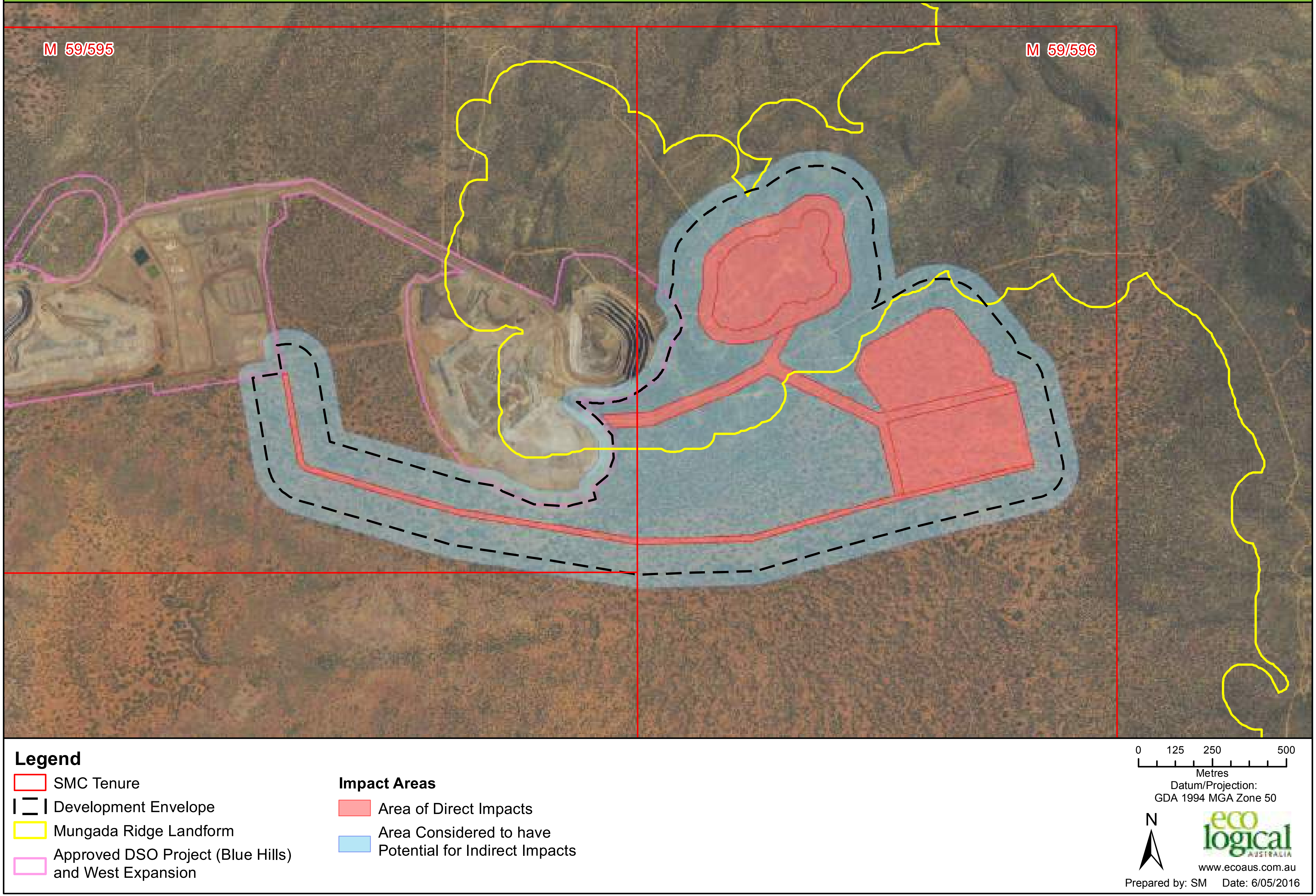


Plate 6: Juvenile *Acacia woodmaniorum* growing on top of the Mungada East ROM Pad and Haul Road exclusion bund; photo taken June 2015 by Maia Environmental Consultancy

Plate 7: Location inside the Mungada East pit exclusion bund boundary where approximately 60 juvenile *Acacia woodmaniorum* individuals were growing; photo taken June 2015 by Maia Environmental Consultancy

Alterations and disruptions to surface water flows

Alterations and disruptions to surface water flows can result in increased surface runoff to some areas and decreased runoff to others. In general, low-lying areas in the landscape would be most likely to be subject to altered surface runoff; erosion along flow paths may also occur and may result in sediment deposition in these low-lying areas. Both increased and decreased runoff could affect vegetation and flora.

Vegetation associations *EIWL* (1) and MSL (2) were assessed by Maia (2016) as possibly dependent on sheetflow in some areas. The areas of *EI*WL (1) and MSL (2) that will remain in tenements M59/595 and M59/596 following implementation of the Proposal are downslope of, i.e. in lower-lying areas than, the development envelope, and therefore have potential to be affected by alterations and disruptions to surface water flows up gradient. This consists of 54.5 ha (19%) and 29.5 ha (9%) of *EI*WL (1) and MSL (2) (Table 18). Potential impacts will be minimised through the design and construction of drainage structures to ensure minimal alteration to existing surface drainage patterns and application of scour protection measures where required.

The majority of records of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills are at higher elevations, typically along Mungada Ridge, compared to the proposed disturbance footprint (Figure 51; Figure 52). *Acacia woodmaniorum* typically occurs relatively high in the landscape (higher than 400 m), often in rock crevices on steep and exposed slopes (Maslin and Buscumb 2007). *Lepidosperma* sp. Blue Hills occurs on hill slopes, breakaways and rocky outcrops (Maia 2016). Given the majority of records of both species were recorded at locations at higher elevations than adjacent areas proposed for development, they would not be subject to either increased or decreased surface runoff.

Dust

Dust generation from the Proposal will be minimised by engineering controls, vehicle speed restrictions on cleared tracks and use of dust suppression measures, such as water trucks, sprinklers and deluge sprays. Dust deposition on vegetation will be mitigated by periodic high rainfall events, which would remove built-up materials on foliage. Native vegetation in the area is expected to be reasonably tolerant to dust deposition and at minimal risk of physiological impact. The combination of high wind speeds in summer months and high temperatures results in elevated evaporation rates and extremely high ambient dust levels. There are no empirical data available that suggest dust from iron ore mining activities would negatively affect flora species in the Midwest.

In addition, recent vegetation monitoring of the Blue Hills mine (Maia 2015a) showed minimal deposition of dust. The monitoring found the overall mean dust cover rating increased between baseline and 2015 but decreased between 2014 and 2015. However, the highest dust cover rating recorded in 2015 was 1 (on a scale of 0 (no dust) to 5 (thickly coated with dust)).

Introduction and/or spread of weeds and disease

The introduction and/or spread of weeds and disease will be minimised by ensuring equipment is cleaned to remove soil, vegetation, rock and debris prior to arrival to site, any equipment or vehicle considered to have been working in a weed risk area is cleaned down before remobilisation, and any new weed populations that arise in the development envelope as a result of the Proposal are removed.

The Maia (2015a) monitoring of the existing DSO Project showed minimal impacts have occurred from weeds following commencement of mining operations. One fewer weed species but many more weed individuals were recorded in 2015 than in 2012, however this was most evident in control sites rather than impact sites, indicating the increase in individuals was not related to the mine. Vegetation condition at the monitoring sites was Excellent in 2012 and has not changed.

Altered fire regimes

The potential for altered fire regimes will be minimised through implementation of fire prevention measures, including implementation of a total fire ban, establishment of 5 m firebreaks around all Proposal infrastructure and ensuring personnel are trained in the use of fire extinguishing equipment and fire prevention measures in work areas.

It is estimated that the last fire to have affected the vegetation of the area occurred more than 10 years ago (Maia 2015a).

Fragmentation

The scale of vegetation clearing proposed is not expected to cause significant fragmentation of vegetation communities or flora species or habitat. There will be some fragmentation of vegetation communities and flora habitat to an extent; however, the distances involved are not considered sufficient to affect seed dispersal, pollination (e.g. by insects, birds or wind), reproductive success or genetic diversity.

An assessment of the potential impacts of fragmentation was conducted for *Acacia woodmaniorum* in consideration of the proposed disturbance footprint expected to result in removal of 2,634 known individuals and the separation of a group of individuals on tenement M59/595 from the main group on Mungada Ridge (Figure 54). Following the removal of individuals within the proposed disturbance footprint, the distance between the majority of the M59/595 group and the main Mungada Ridge group would be approximately 1-1.2 km, with one record as close as approximately 700 m (Figure 54). This is not far enough to prevent dispersal of pollen between the two groups. Millar et al. (2013) recorded pollen dispersal in *Acacia woodmaniorum* over 1,870 m and suggested that maximum pollinator dispersal distances exceed this distance for the species.

The presumed pollen dispersal mechanism in *Acacia woodmaniorum* is wind-mediated and directional dispersal of small insect pollinators; this type of mechanism has been documented to occur over tens of kilometres (Millar et al. 2014). Given this, dispersal and pollination would be expected to be maintained over the 1-1.2 km that will separate the majority of the M59/595 group and the main Mungada Ridge group. Maintenance of dispersal and pollination between the two groups of *Acacia woodmaniorum* individuals would in turn be expected to ensure reproductive success and maintenance of genetic diversity.

Millar et al. (2013, 2014) suggest that high levels of long-distance gene flow and a predominantly out-crossed mating system in *Acacia woodmaniorum* act together to maintain large effective population sizes for small disjunct populations of the species. The species is, as a woody perennial, presumed to live for several decades, which would typically provide more temporal opportunity for out-crossed and long-distance pollination events than in herbaceous or annual species (Millar et al. 2014). In contrast to general population genetic predictions for rare endemic species with small, patchily distributed populations and short ranges, which tend to show limited genetic connectivity, findings for *Acacia woodmaniorum* suggest the species can maintain genetic connectivity through extensive pollen dispersal (Millar et al. 2014). Millar et al. (2014) suggest that, as long as the population system currently evident for *Acacia woodmaniorum*, being a series of large and small disjunct populations over a narrow geographic range, remains intact, the species is likely to persist, even as small populations, over significant historical time frames.

An assessment of the potential impacts of fragmentation was also conducted for *Lepidosperma* sp. Blue Hills. Clearing within the proposed disturbance footprint is expected to result in removal of 669 known individuals. This will result in the separation of a small group of records from the main population, whereby, following the removal of the 669 individuals, 26 individuals will remain to the west of the proposed disturbance footprint and the balance of the population (4,754 individuals; 87%) will remain to the east of the proposed disturbance footprint. The distance separating the closest of the group of 26 individuals from the remainder of the population will be approximately 577 m (Figure 56). There is no publically-available published information on pollen dispersal in *Lepidosperma* sp. Blue Hills; however, within the Mungada Ridge population, a number of individuals are isolated by distances of 620-964 m (Figure 56). These distances are greater than the separation distance of 577 m that will be introduced by the Proposal. Under the assumption that genetic connectivity can be maintained across the Mungada Ridge population, including the isolated records, it would follow that pollen dispersal in *Lepidosperma* sp. Blue Hills can occur over at least 964 m. Therefore, genetic connectivity would be expected to be maintained across the 577 m that would separate the group of 26 individuals from the main population.

Change in microclimate

An assessment of the potential impacts of change in microclimate is included in Section 13.2.3 as part of the landform assessment. In the assessment, shade was used as a surrogate for microclimate given the absence of microclimatic information specific to Mungada Ridge and the broader region. The assessment considered whether areas subject to prolonged shade provide specific habitat for key environmental values of Mungada Ridge, including *Acacia woodmaniorum* (Vulnerable; WC Act), *Acacia karina* (Priority 1), *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1) and vegetation associations considered to have some form of alignment with areas of prolonged shade. The assessment determined these flora species and vegetation associations were not reliant on habitats within the areas of prolonged shade. *Acacia karina* appeared to have some alignment with areas of prolonged shade, which may indicate the species prefers shaded areas; however, it also occurs outside the areas of prolonged shade and in locations in the region other than Blue Hills.

Impact of introduced fauna

Of the introduced mammal species recorded or that have the potential to occur in the development envelope, only goats pose a potential trampling risk to *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. All sightings of goats will be reported and trapping and removal of goats will occur if numbers have been determined to have increased and/or to have had an adverse effect on native flora.

During monitoring for the existing DSO Project, no goats have been sighted at Blue Hills since July 2013. No other introduced fauna species were observed during the latest monitoring survey (Maia 2015a).

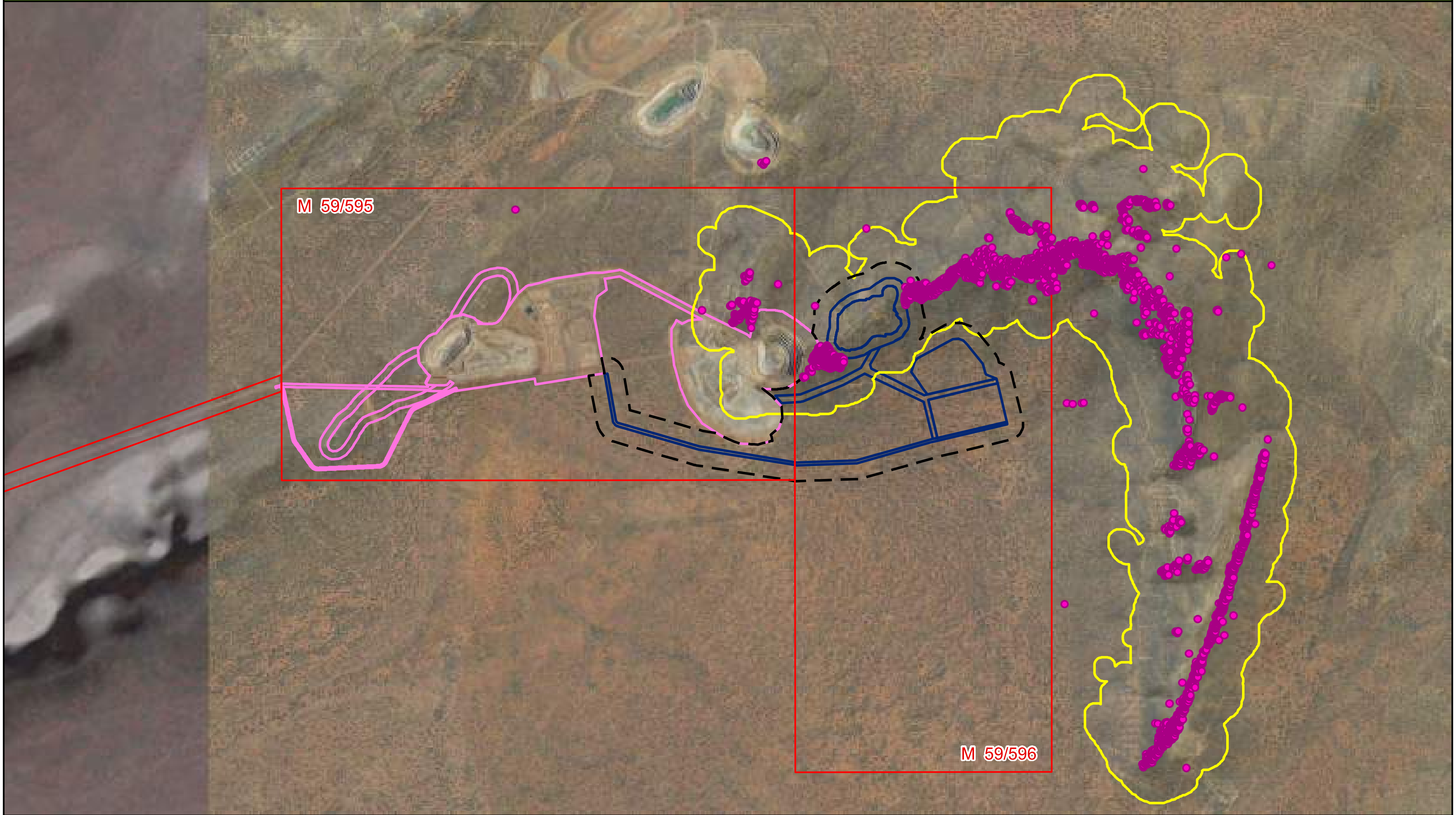
Table 18: Potential indirect impacts to flora and vegetation

Environmental value	Extent / no. individuals in the indirect impact assessment area[1]	Percentage of mapped extent/individuals in tenements M59/595 and M59/596	Percentage of mapped extent/individuals in Tallering sub-region	Percentage of mapped extent/individuals in WA
Vegetation associations (Maia 2016)				
*E*WL (1)	54.5 ha	19%	-	-
MSL (2)	29.5 ha	9%	-	-
*ArAt*SL (4)	17.9 ha	31%	-	-
MSL (7)	18.3 ha	14%	-	-
MSL (8)	5.6 ha	14%	-	-
MSL (9)	5.2 ha	15%	-	-
*AsAr*SL (11)	17.3 ha	16%	-	-
PECs				
Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation) (Priority 1)	78.1 ha	20%	1%	1%
Threatened species				
Acacia woodmaniorum (Vulnerable; WC Act)	3,697	35%	14%	14%
Priority 1 species				
Acacia karina	0	0%	0%	0%
Lepidosperma sp. Blue Hills (A. Markey & S. Dillon 3468)	37	2%	<1%	<1%
Priority 3 species				
Acacia subsessilis	2	22%	<0.1%	<0.1%
Drummondita fulva	467	11%	3%	3%

Environmental value	Extent / no. individuals in the indirect impact assessment area[1]	Percentage of mapped extent/individuals in tenements M59/595 and M59/596	Percentage of mapped extent/individuals in Tallering sub-region	Percentage of mapped extent/individuals in WA
Micromyrtus acuta	7	<1%	<0.1%	<0.1%
Micromyrtus trudgenii	1,142	12%	7%	7%
Persoonia pentasticha	44	19%	10%	8%
Rhodanthe collina	3,661	36%	10%	10%

[1] The indirect impact assessment area (Figure 58) encompasses the development envelope excluding the area of direct disturbance (i.e. the proposed disturbance footprint) and an additional area extending 50 m from the boundary of the development envelope. It represents a zone in which there is considered potential for environmental values to be subject to indirect impacts.

Figure 59: Predicted post-impact records of *Acacia woodmaniorum*



Legend

- SMC Tenure
- Development Envelope
- Mungada Ridge Landform
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint
- *Acacia woodmaniorum* (post development)

0 250 500 1,000
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

N

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Prepared by: SM Date: 6/05/2016

14.4 Cumulative impacts

Potential cumulative impacts to flora and vegetation values were assessed in consideration of development projects operating or approved within an area encompassing the entire Blue Hills Range referred to as the Blue Hills Impact Assessment Area (Figure 60). This Assessment Area covers 73,579 ha and includes Karara Mining Limited's Karara, Blue Hills North, Terrapod and Hinge approved project footprints, as well as SMC's approved project footprints. The Blue Hills Impact Assessment Area captures the entirety of the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC.

Potential cumulative impacts within the Blue Hills Impact Assessment Area were assessed for the following vegetation and flora values:

- the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC (Figure 61);
- Woodman (2008a) FCTs (Figure 62);
- *Acacia woodmaniorum* (Vulnerable; WC Act) (Figure 63);
- *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1) (Figure 64);
- *Acacia karina* (Priority 1) (Figure 65); and
- *Acacia subsessilis, Drummondita fulva, Micromyrtus acuta, Micromyrtus trudgenii, Persoonia pentasticha and Rhodanthe collina* (Priority 3) (Figure 66).

Vegetation associations *El*WL (1), MSL (2), *ArAt*SL (4), MSL (7), MSL (8), MSL (9) and *AsAr*SL (11) mapped by Maia (2016) were excluded from the cumulative impact assessment because they occur only within undisturbed areas in tenements M59/595 and M59/596.

The assessment of potential cumulative impacts considered original (pre-impact) numbers of each conservation significant flora species and extent of the PEC and FCTs. This differed from the impact assessment in Section 14.3, which considered the potential impact of the Proposal in the context of current/extant (i.e. post existing impact) numbers and extents. Further, the assessment of potential cumulative impacts has considered only the direct impacts associated with vegetation clearing within the Blue Hills Impact Assessment Area, as the extent of indirect impacts for other development projects is not able to be quantified. Minimal indirect impacts have resulted from implementation of the existing DSO Project, as described in Section 14.3.3 and Maia (2015a), and the Proposal is consequently not expected to significantly contribute to regional cumulative indirect impacts.

Direct impacts associated with vegetation clearing were determined from disturbance footprints available as GIS shape files for Karara Mining Limited's and SMC's approved projects, as well as other clearing digitised by Maia (2016) using Bing Map aerial imagery (from November 2013) and imagery provided by SMC (from November 2014).

The potential cumulative impact to the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC following implementation of the Proposal is approximately 942 ha, which represents approximately 13% of the total mapped extent of the PEC. Existing disturbance, primarily on Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd) tenure, accounts for the majority of the impact (Table 19).

The potential cumulative impact to FCTs mapped by Woodman (2008a) following the implementation of the Proposal is as follows (Table 20):

- approximately 122 ha of disturbance to FCT 3, which represents approximately 13% of the total mapped extent of the FCT;
- approximately 114 ha of disturbance to FCT 12 (18% of the total mapped extent);
- approximately 158 ha of disturbance to FCT 13 (61% of the total mapped extent);
- approximately 220 ha of disturbance to FCT 14 (68% of the total mapped extent); and
- approximately 703 ha of disturbance to FCT 1a/2 (20% of the total mapped extent).

Existing disturbance accounts for the majority of impacts. For FCT 12, the main contribution to existing impacts is from disturbance on Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd) and SMC tenure. For FCTs 3, 13, 14 and 1a/2, disturbance on Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd) tenure accounts for the majority of the impact (Table 20).

The potential cumulative impact to *Acacia woodmaniorum* is 6,601 plants, which represents approximately 21% of the mapped number of records of this species in the Tallering sub-region and in WA. Existing disturbance on SMC tenure (3,755 plants; 12% of the sub-regional and state populations) and disturbance from the Proposal (2,634 plants; 9% of the sub-regional and state populations) account for the majority of the impact (Table 21).

The potential cumulative impact to *Acacia karina* is 69 plants, which represents approximately 13% of the mapped number of records of this species in the Tallering sub-region and in WA. Existing disturbance on Minjar Gold Pty Ltd tenure (51 plants; 10% of the sub-regional and state population) accounts for the majority of the impact (Table 21).

The potential cumulative impact to *Lepidosperma* sp. Blue Hills is 701 plants, which represents approximately 13% of the mapped number of records of this species in the Tallering sub-region and 12% of records in WA. Disturbance from the Proposal (669 plants; 12% of the sub-regional and state population) accounts for the majority of the impact (Table 21).

The potential cumulative impact to Priority 3 flora species is as follows (Table 22):

- clearing of one individual of *Acacia subsessilis* (<0.1% of the sub-regional and state populations). The loss of this individual is due to the Proposal;
- clearing of 4,606 individuals of *Drummondita fulva* (24% of the sub-regional and state populations). Clearing on Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd) tenure and from the Proposal accounts for the majority of the impact;
- clearing of 2,005 individuals of *Micromyrtus acuta* (14% and 13% respectively of the sub-regional and state populations). Existing and proposed clearing on SMC tenure accounts for the majority of the impact;
- clearing of 9,209 individuals of *Micromyrtus trudgenii* (44% of the sub-regional and state populations). Existing and proposed clearing on SMC tenure accounts for the majority of the impact;
- clearing of 96 individuals of *Persoonia pentasticha* (21% and 17% respectively of the sub-regional and state populations). Existing and proposed clearing on SMC tenure accounts for the majority of the impact; and
- clearing of 3,446 individuals of Rhodanthe collina (9% of the sub-regional and state populations). Clearing on Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd) tenure accounts for the majority of the impact.

Figure 60: Blue Hills Impact Assessment Area and cumulative disturbance footprint

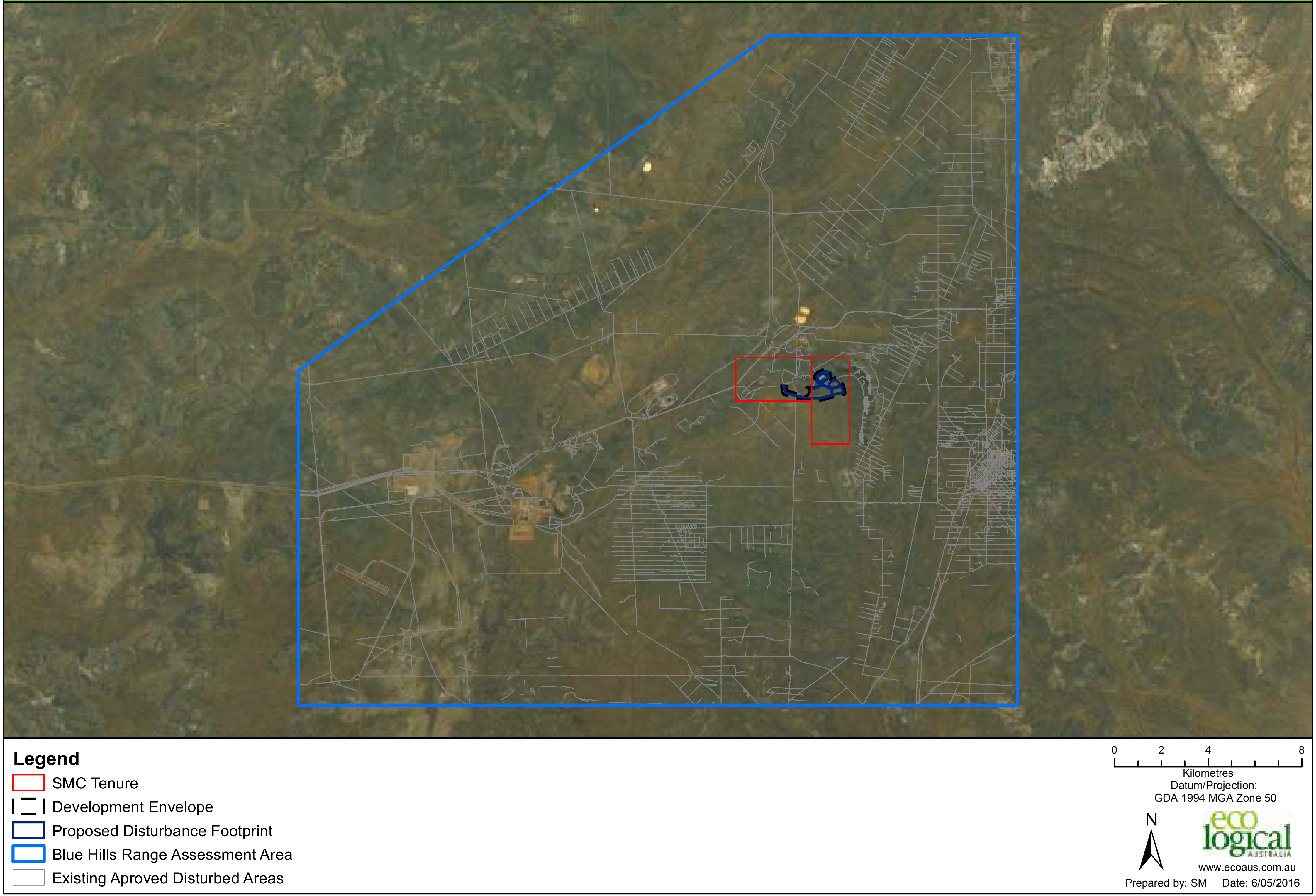

Figure 61: Cumulative disturbance footprint compared to mapped extent of the PEC

Legend

- SMC Tenure
- Development Envelope
- Proposed Disturbance Footprint
- Blue Hills Impact Assessment Area
- Existing Aproved Disturbed Areas
- Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (Priority 1 PEC)

0 2 4 8
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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Figure 62: Cumulative disturbance footprint compared to mapped extent of the Woodman (2008a) FCTs

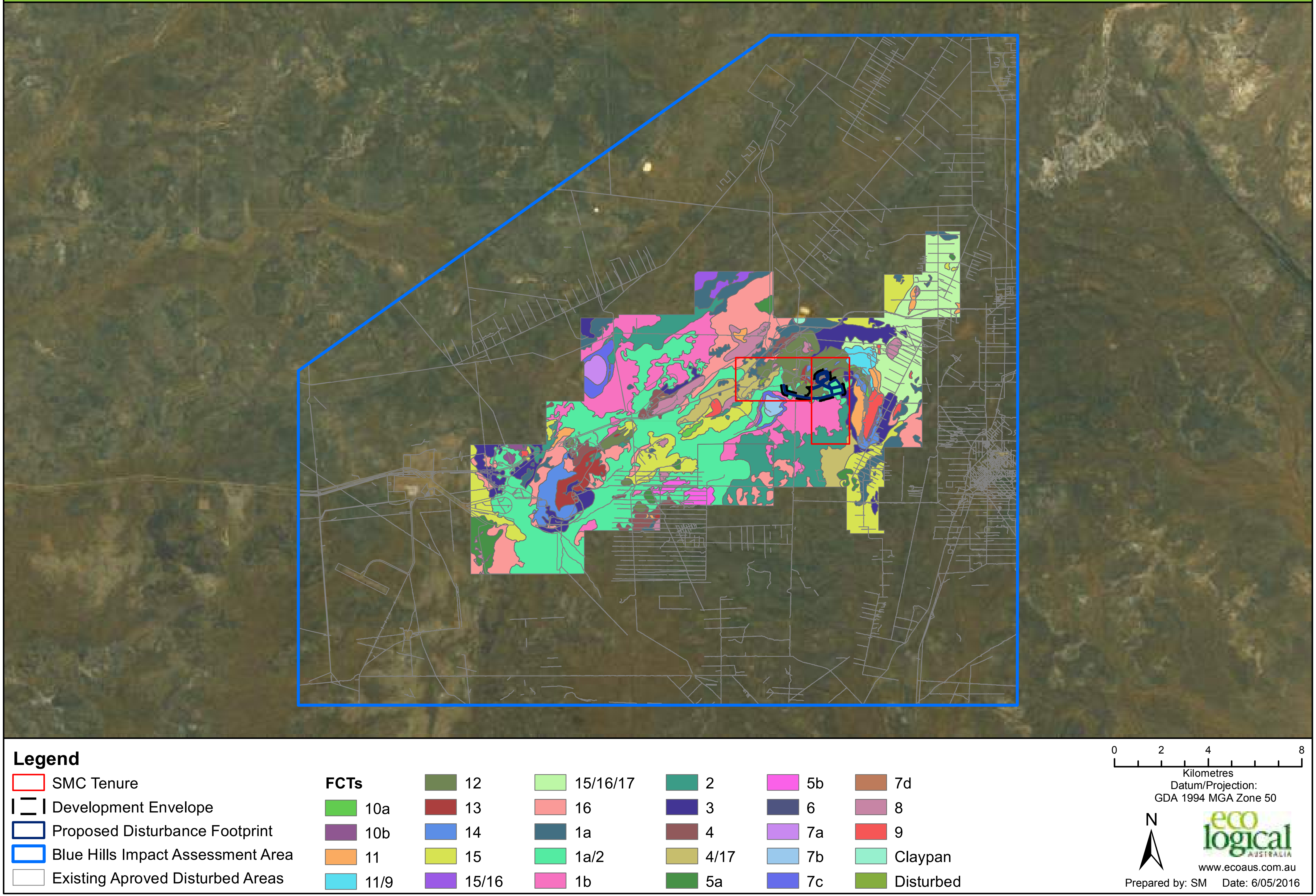


Figure 63: Cumulative disturbance footprint compared to records of *Acacia woodmaniorum*

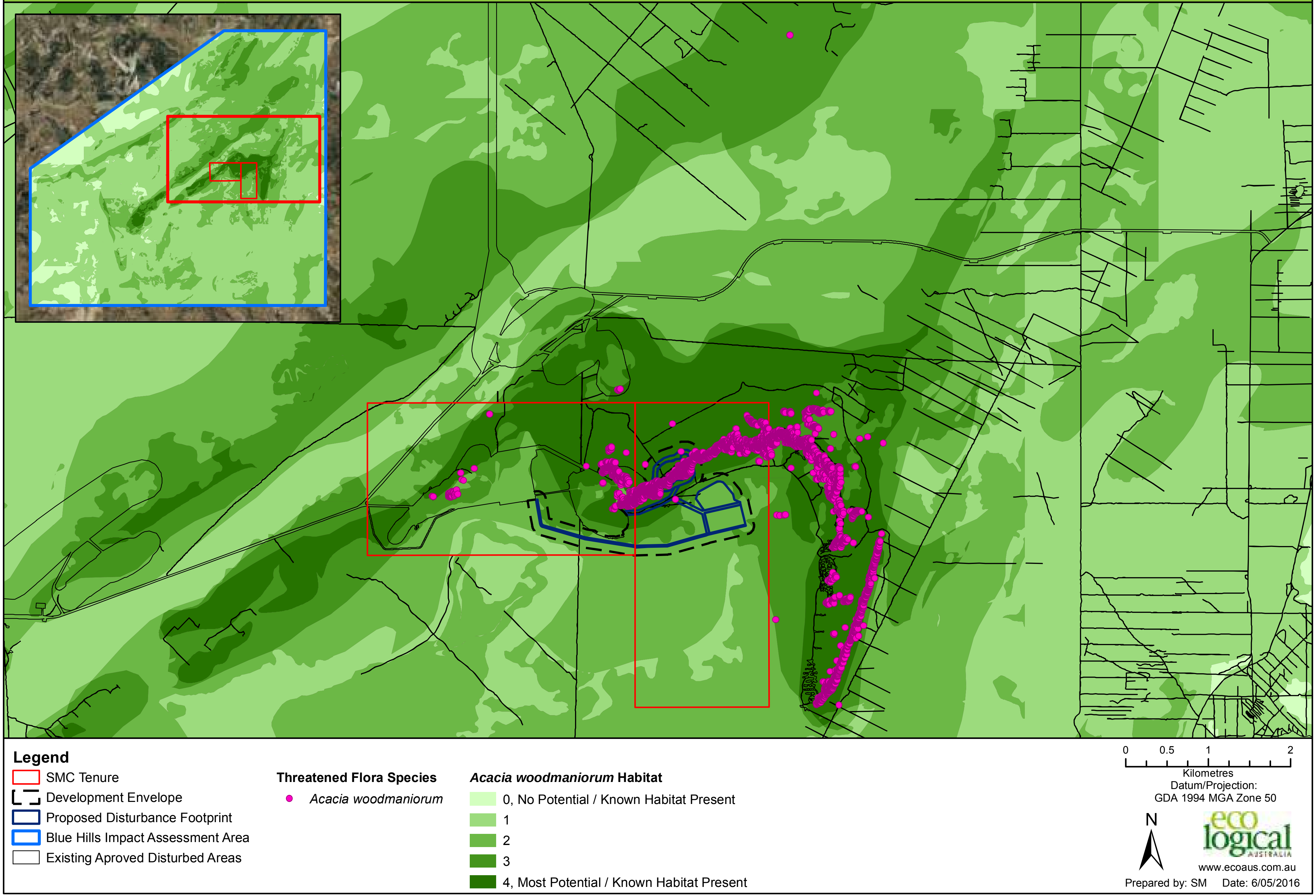


Figure 64: Cumulative disturbance footprint compared to records of *Lepidosperma* sp. Blue Hills (Priority 1)

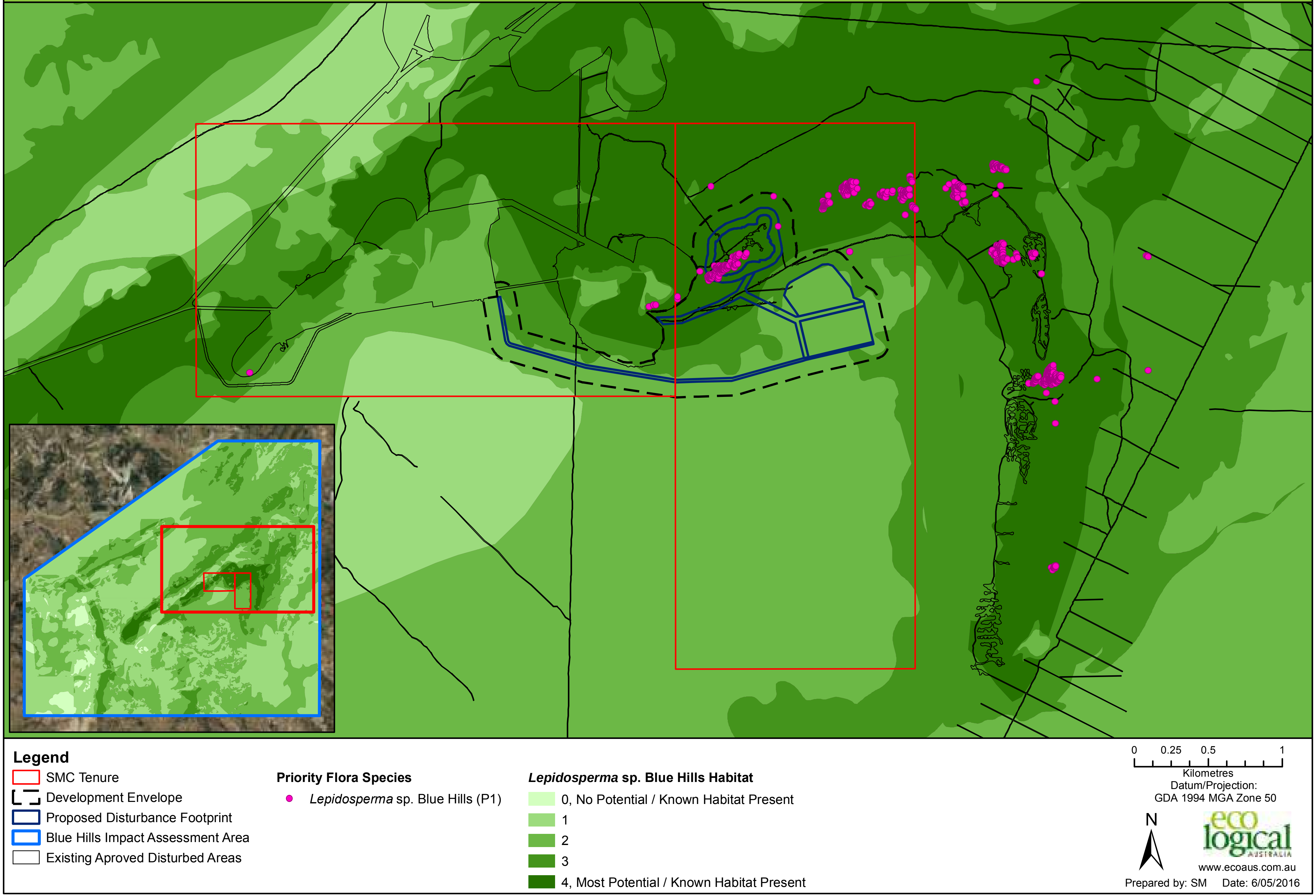


Figure 65: Cumulative disturbance footprint compared to records of *Acacia karina* (Priority 1)

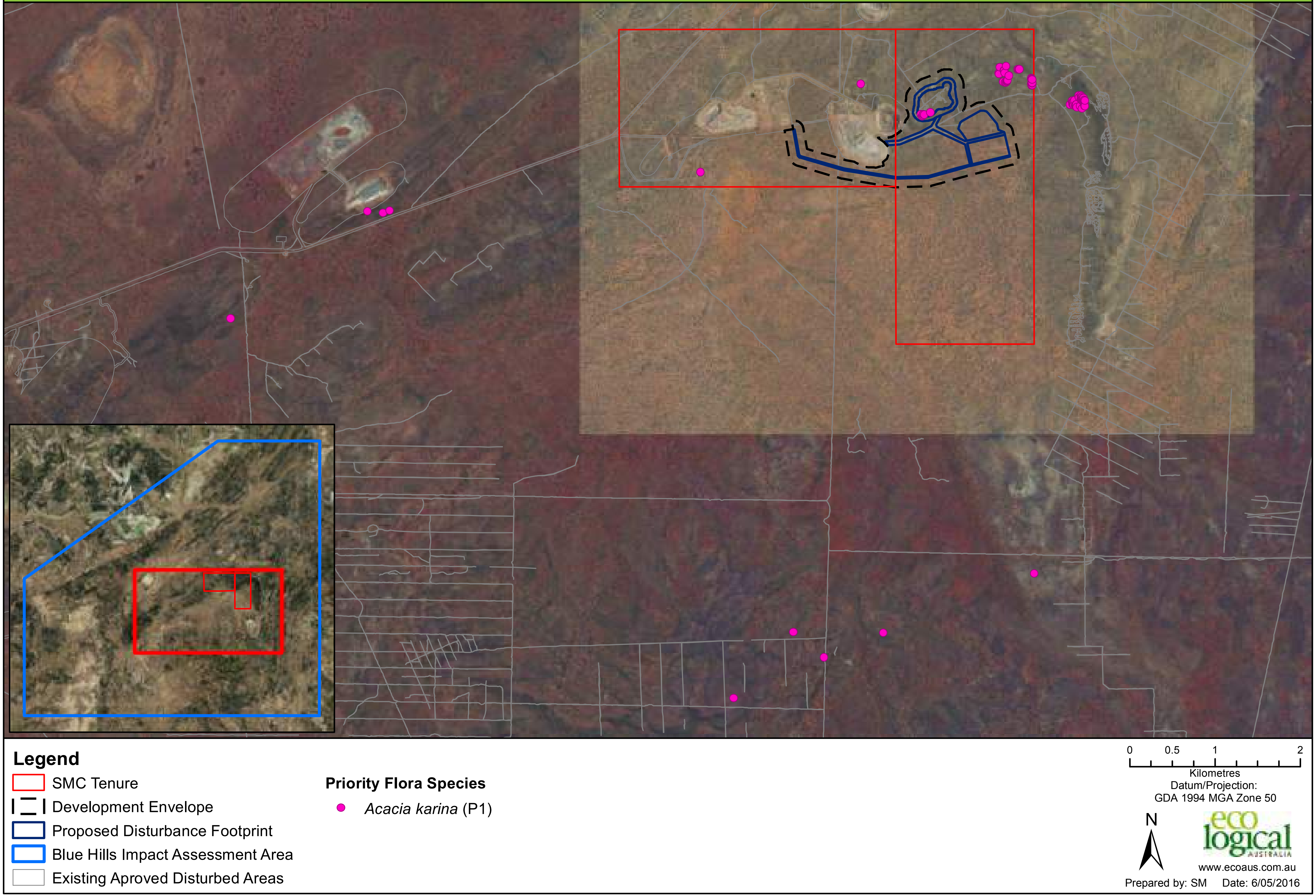


Figure 66: Cumulative disturbance footprint compared to records of Priority 3 flora species (to be affected by Proposal)

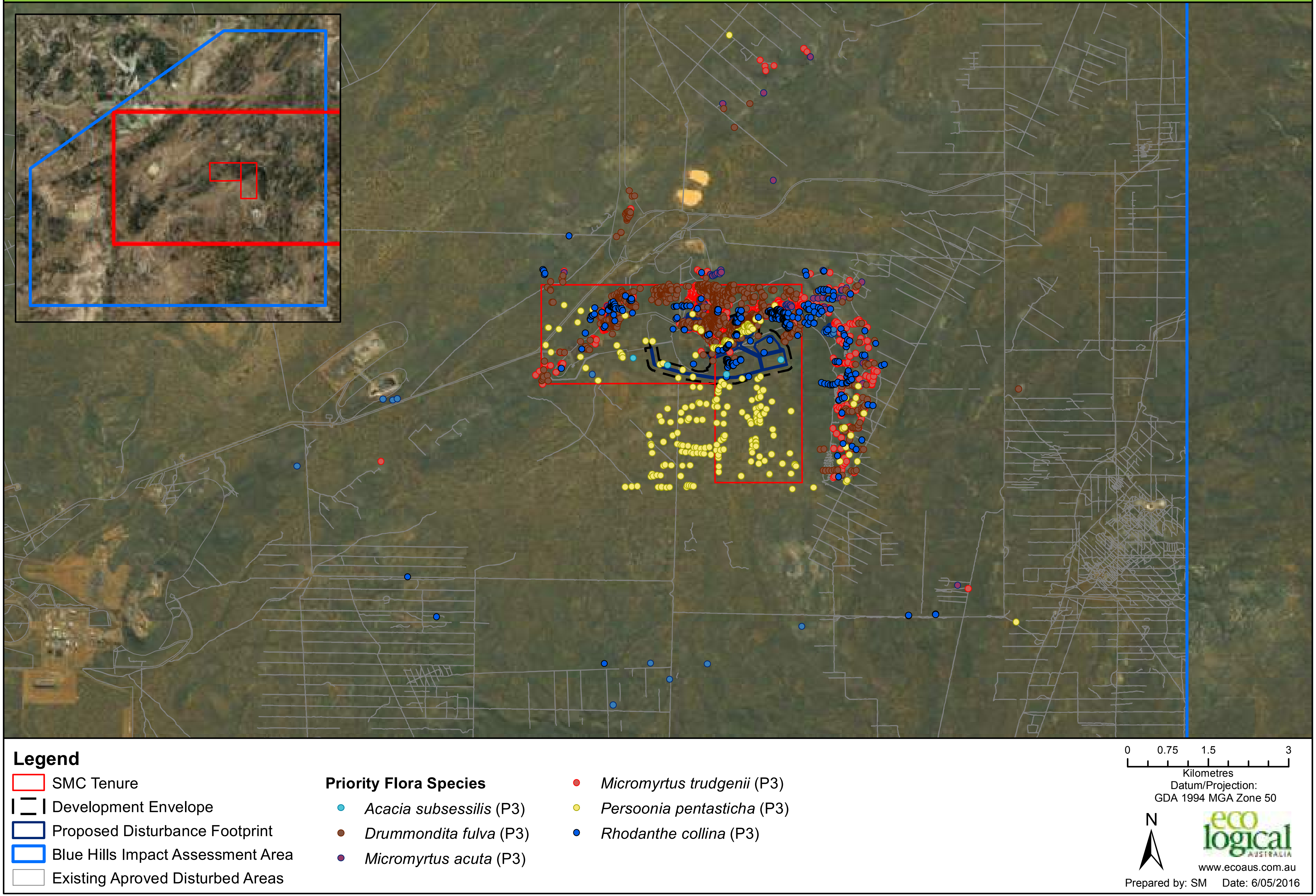


Table 19: Summary of potential cumulative impacts to the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC

Project/tenement holder	Impact (ha)
Existing impacts	
Auricorp (Rothsay) Pty Ltd	0
Falcon Minerals Limited	0
FMG Resources Pty Ltd	5.2
Fraka Investments Pty Ltd	2.25
Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd)	830.9
Minjar Gold Pty Ltd	3.6
Mount Gibson Mining Limited	0.5
Raptor Resources Limited	0.5
Sinosteel Midwest Corporation Limited	82.6
Zetec Resources Pty Ltd	0
Non-tenement holder	13.9
Proposal impact	21.4 (+ 78 indirect)
Cumulative impact *	**941.5** **(+78 indirect)**
Total mapped extent (pre-impact)	**7,098**

* The total cumulative impact is less than the sum of all individual impacts due to overlap between some tenements in the Blue Hills Impact Assessment Area. Clearing in overlapping areas could not be attributed to a particular tenement holder and therefore was attributed to both. In contrast, the total cumulative impact was based on disturbance footprints for Karara Mining Limited's and SMC's approved projects and other clearing digitised by Maia (2016); this did not include double-counting of clearing in overlapping areas and is therefore less than the sum of all individual impacts.

Table 20: Summary of potential cumulative impacts to Woodman (2008a) FCTs

Project/tenement holder	Impact (ha)				
	FCT 3	FCT 12	FCT 13	FCT 14	FCT 1a/2
Existing impacts					
Auricorp (Rothsay) Pty Ltd	0	0	0	0	0
Falcon Minerals Limited	0	0	0	0	0
FMG Resources Pty Ltd	0	0	0	0	0
Fraka Investments Pty Ltd	0	0	0	0	0
Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd)	121.8	50	140.4	218	641.7
Minjar Gold Pty Ltd	0	0	0	0	0
Mount Gibson Mining Limited	0	0	0	0	0
Raptor Resources Limited	0.04	0	0	0	0
Sinosteel Midwest Corporation Limited	7.7	52.6	9.9	1.8	54.1
Zetec Resources Pty Ltd	0	0	0	0	0
Non-tenement holder	0	0	0	0	0
Proposal impact	0.07 (+ 4 indirect)	13.2 (+ 67.6 indirect)	7.3 (+ 4.5 indirect)	0.6 (+ 1.9 indirect)	30.8 (+ 55.8 indirect)
Cumulative impact *	**122 (+ 4 indirect)**	**113.6 (+ 67.6 indirect)**	**157.6 (+4.5 indirect)**	**220 (+ 1.9 indirect)**	**703.2 (+ 55.8 indirect)**
Total mapped extent (pre-impact)	**933.3**	**643.3**	**258.1**	**324.1**	**3,488.4**

* The total cumulative impact is less than the sum of all individual impacts due to overlap between some tenements in the Blue Hills Impact Assessment Area. Clearing in overlapping areas could not be attributed to a particular tenement holder and therefore was attributed to both. In contrast, the total cumulative impact was based on disturbance footprints for Karara Mining Limited's and SMC's approved projects and other clearing digitised by Maia (2016); this did not include double-counting of clearing in overlapping areas and is therefore less than the sum of all individual impacts.

Table 21: Potential cumulative impacts to *Acacia woodmaniorum* (Threatened), *Acacia karina* (Priority 1) and *Lepidosperma* sp. Blue Hills (Priority 1)

Project/tenement holder	Impact (no. of individuals)		
	Acacia woodmaniorum	*Acacia karina*	*Lepidosperma* sp. Blue Hills
Existing impacts			
Auricorp (Rothsay) Pty Ltd	0	0	0
Falcon Minerals Limited	0	0	0
FMG Resources Pty Ltd	0	0	0
Fraka Investments Pty Ltd	0	0	0
Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd)	212	15	19
Minjar Gold Pty Ltd	0	51	0
Mount Gibson Mining Limited	0	0	0
Raptor Resources Limited	0	0	0
Sinosteel Midwest Corporation Limited	3,755	0	13
Zetec Resources Pty Ltd	0	1	0
Non-tenement holder	0	0	0
Proposal impact	2,634 (+ 3,697 indirect)	2	669 (+ 37 indirect)
Cumulative impact *	**6,601 (+ 3,697 indirect)**	**69**	**701 (+ 37 indirect)**
Total mapped no. of plants in the Tallering sub-region (pre-impact)	**30,957**	**515**	**5,587**
Total mapped no. of plants in WA (pre-impact)	**30,957**	**515**	**5,705**

* The total cumulative impact is less than the sum of all individual impacts due to overlap between some tenements in the Blue Hills Impact Assessment Area. Clearing in overlapping areas could not be attributed to a particular tenement holder and therefore was attributed to both. In contrast, the total cumulative impact was based on disturbance footprints for Karara Mining Limited's and SMC's approved projects and other clearing digitised by Maia (2016); this did not include double-counting of clearing in overlapping areas and is therefore less than the sum of all individual impacts.

Table 22: Summary of potential cumulative impacts to Priority 3 flora species

Project/tenement holder	Impact (no. of individuals)					
	Acacia subsessilis	*Drummondita fulva*	*Micromyrtus acuta*	*Micromyrtus trudgenii*	*Persoonia pentasticha*	*Rhodanthe collina*
Existing impacts						
Auricorp (Rothsay) Pty Ltd	0	0	0	0	0	0
Falcon Minerals Limited	0	0	0	0	0	0
FMG Resources Pty Ltd	0	0	0	0	0	0
Fraka Investments Pty Ltd	0	0	0	0	0	0
Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd)	0	1,574	101	319	10	3,335
Minjar Gold Pty Ltd	0	0	0	0	6	0
Mount Gibson Mining Limited	0	0	0	0	0	0
Raptor Resources Limited	0	0	0	0	0	0
Sinosteel Midwest Corporation Limited	0	656	906	4,166	27	109
Zetec Resources Pty Ltd	0	0	0	0	0	0
Non-tenement holder	0	0	0	0	0	0
Proposal impact	1 (+ 2 indirect)	1,164 (+ 467 indirect)	867 (+ 7 indirect)	3,754 (+ 1,142 indirect)	45 (+ 44 indirect)	1 (+ 3,661 indirect)
Cumulative impact *	**1 (+ 2 indirect)**	**4,606 (+ 467 indirect)**	**2,005 (+ 7 indirect)**	**9,209 (+ 1,142 indirect)**	**96 (+ 44 indirect)**	**3,446 (+ 3,661 indirect)**
Total mapped no. of plants in the Tallering sub-region (pre-impact)	**2,415**	**19,166**	**14,636**	**20,782**	**468**	**39,518**

Project/tenement holder	Impact (no. of individuals)					
	Acacia subsessilis	*Drummondita fulva*	*Micromyrtus acuta*	*Micromyrtus trudgenii*	*Persoonia pentasticha*	*Rhodanthe collina*
Total mapped no. of plants in WA (pre-impact)	**2,428**	**19,166**	**14,897**	**20,885**	**569**	**39,667**

* The total cumulative impact is less than the sum of all individual impacts due to overlap between some tenements in the Blue Hills Impact Assessment Area. Clearing in overlapping areas could not be attributed to a particular tenement holder and therefore was attributed to both. In contrast, the total cumulative impact was based on disturbance footprints for Karara Mining Limited's and SMC's approved projects and other clearing digitised by Maia (2016); this did not include double-counting of clearing in overlapping areas and is therefore less than the sum of all individual impacts.

14.5 Potential cumulative impacts to key flora and vegetation values of the Mungada Ridge landform

Potential cumulative impacts to flora and vegetation values were assessed within the Mungada Ridge Landform area (as defined by the EPA for the purposes of assessment of potential impacts to landforms (Figure 10). The following flora and vegetation values were included in the assessment:

- the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC;
- FCTs defined by Woodman (2008a);
- *Acacia woodmaniorum* (Vulnerable; WC Act); and
- *Acacia karina* and *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1).

The predicted cumulative impact to these flora and vegetation values as a result of existing, approved and proposed disturbance (following Proposal implementation) is as follows:

- approximately 76.4 ha (12%) of the 658.9 ha of the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC. The remaining 582.5 ha occurs across SMC and Karara mining tenure (Table 23);
- up to 49% of each of the FCTs mapped by Woodman (2008a). The greatest potential direct impact is to FCT 13 (Dense Shrubland of *Allocasuarina acutivalvis* subsp. *prinsepiana* with *Melaleuca nematophylla* over *Grevillea paradoxa, Xanthosia kochii*). The remaining extent of each FCT occurs across SMC and Karara mining tenure (Table 23);
- over 6,300 individuals of *Acacia woodmaniorum* (Threatened – Vulnerable), representing approximately 23% of the number of individuals on Mungada Ridge. The remaining 21,358 individuals occurs across SMC and Karara mining tenure (Table 23); and
- four and 689 individuals respectively of the Priority 1 flora species *Acacia karina* and *Lepidosperma* sp. Blue Hills, representing 3% and 13% respectively of the number of individuals on Mungada Ridge. The remaining individuals occur across SMC and Karara mining tenure (Table 23).

Table 23: Potential cumulative impacts to key flora and vegetation values of the Mungada Ridge landform

Environmental value	Original (pre-impact) extent / no. of individuals on Mungada Ridge Landform	Existing impact on Mungada Ridge Landform	Proposal impact on Mungada Ridge Landform[1]	Cumulative impact on Mungada Ridge Landform
PECs				
Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation) (Priority 1)	658.9 ha	55.6 ha	20.8 ha	76.4 ha (12%)
FCTs (Woodman 2008a)				
FCT 1a/2 (mosaic)	0.3 ha	0 ha	0 ha	0 ha (0%)
FCT 3	33.0 ha	1.3 ha	0 ha	1.3 ha (4%)
FCT 7c	2.2 ha	0 ha	0 ha	0 ha (0%)
FCT 10a	20.1 ha	2.3 ha	0 ha	2.3 ha (11%)
FCT 11	71.4 ha	4.2 ha	0 ha	4.2 ha (6%)
FCT 11/9 (mosaic)	202.5 ha	4.3 ha	0 ha	4.3 ha (2%)
FCT 12	190.9 ha	20.7 ha	12.8 ha	33.5 ha (18%)
FCT 13	35.4 ha	9.9 ha	7.3 ha	17.2 ha (49%)
FCT 14	80.7 ha	6.4 ha	0.6 ha	7.0 ha (9%)
FCT 15	0.8 ha	0.01 ha	0 ha	0.01 ha (1%)
Threatened species				
Acacia woodmaniorum (Vulnerable; WC Act)	27,702	3,710	2,634	6,344 (23%)
Priority 1 species				
Acacia karina	130	2	2	4 (3%)

Environmental value	Original (pre-impact) extent / no. of individuals on Mungada Ridge Landform	Existing impact on Mungada Ridge Landform	Proposal impact on Mungada Ridge Landform[1]	Cumulative impact on Mungada Ridge Landform
Lepidosperma sp. Blue Hills (A. Markey & S. Dillon 3468)	5,454	20	669	689 (13%)

[1] The 'Proposal impact on Mungada Ridge Landform' represents the extent or number of individuals intersected by both the proposed disturbance footprint and the Mungada Ridge Landform. It excludes Proposal impacts outside the Mungada Ridge Landform and may therefore be less than the total impact of the Proposal.

14.6 Key management actions

SML has undertaken measures to avoid and, where avoidance was not practicable, minimise impacts to flora and vegetation. The proposed disturbance footprint has been reduced to the smallest area practicable while maintaining operability and safety requirements. Original mine plans for the Proposal involved a larger proportion of the footprint on Mungada Ridge. In particular, the proposed waste rock dump, which was previously proposed to be located immediately east of the proposed mine pit, was relocated to the south away from the ridge, and backfill of the existing Mungada East pit was proposed. This has reduced potential impacts to a number of environmental values, particularly *Acacia woodmaniorum*.

Flora and vegetation values in the development envelope will be protected through implementation of measures in accordance with the e Blue Hills Mungada East Expansion Condition EMP which includes the following key management measures for the Proposal:

- prior to commencement of ground disturbing activities, areas to be disturbed will be surveyed and demarcated by pegs in the field with reference to design/site plans.
- a Ground Disturbance Form will be completed and authorised by the Mine Manager or delegate, prior to the commencement of any ground disturbing activities
- locations of significant flora and significant vegetation units will be demarcated on site plans. These areas will be managed according to relevant permits;
- training in land clearing procedures will be included in the site environmental induction and land disturbance requirements will be included in contracts with all earthmoving and land clearing contactors;
- disturbed areas will be rehabilitated as soon as practicable to facilitate fauna habitat restoration;
- potential impacts resulting from alterations and disruptions to surface water flows will be minimised through the design and construction of drainage structures to ensure minimal alteration to existing surface drainage patterns and incorporation of erosion protection measures where required.
- dust generation from the Proposal will be minimised by engineering controls, vehicle speed restrictions on cleared tracks and the use of dust suppression measures, such as water trucks, sprinklers and deluge sprays;
- the introduction and/or spread of weeds will be minimised by ensuring equipment is cleaned to remove soil, vegetation, rock and debris prior to arrival to site; any equipment or vehicle considered to have been working in a weed risk area is cleaned down before remobilisation; and any new weed populations that arise in the development envelope area as a result of the Proposal are controlled;
- the potential for altered fire regimes will be minimised through implementation of fire prevention measures, including implementation of a total fire ban, establishment of 5 m firebreaks around all Proposal infrastructure and ensuring personnel are trained in the use of fire extinguishing equipment and fire prevention measures in work areas.; and
- areas within tenements M59/595 and M59/596 outside the development envelope will be retained and managed by SMC for the purposes of conservation (Section 19).

These management measures are considered to be standard practice, feasible and appropriate to manage the potential impacts of the Proposal on flora and vegetation. These measures are already being implemented at the existing DSO Project and EPA audit reports confirm SMC is in compliance with MS 811 as a result (See Section 21.4). Monitoring of the DSO Project also confirms minimal impacts have occurred to flora and vegetation as a result of indirect impacts, indicating management at the DSO Project has been effective to date (Section 14.3.3).

SMC has implemented a rehabilitation and research project at its existing operations at the Koolanooka mine and the Blue Hills mine (Mungada East and West) to meet the restoration requirements of its operations. The research trials are a collaboration between SMC and the Kings Park Botanic Gardens and Parks Authority (BGPA). Key findings of the trials to date are discussed in Section 18.3.3.

14.7 Predicted outcome

After considering the application of avoidance, minimisation, mitigation (including rehabilitation and restoration) and offset measures, the following residual impacts on vegetation and flora, are predicted:

- clearing of approximately 52 ha of vegetation in Good to Excellent condition across six vegetation associations of high local conservation significance and one vegetation association of moderate local conservation significance;
- clearing of approximately 21.4 ha within the boundary of the ‘Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)’ Priority 1 PEC, representing 0.3% of the mapped area of the PEC;
- removal of 2,634 individuals of *Acacia woodmaniorum* (Threatened – Vulnerable), representing 25% of the number of individuals within tenements M59/595 and M59/596 and 10% of the number of individuals within the Tallering sub-region and WA. The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat modelled for *Acacia woodmaniorum*, which represents approximately 41% of the extent modelled in the development envelope and 1.5% of the extent modelled within the Blue Hills Impact Assessment Area;
- removal of two individuals of *Acacia karina* (Priority 1), representing 4% of the number of individuals within tenements M59/595 and M59/596 and less than 1% of the number of individuals within the Tallering sub-region;
- removal of 669 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1), representing 29% of the number of individuals within tenements M59/595 and M59/596 and 12% of the number of individuals within the Tallering sub-region and WA. The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat for *Lepidosperma* sp. Blue Hills, which represents approximately 41% of the extent modelled within the development envelope and 1.3% of the extent modelled within the Blue Hills Impact Assessment Area; and
- removal of 5,832 individuals of eight Priority 3 species, representing up to 24% of each species’ sub-regional population.

SMC considers residual impacts can be restricted to those described and offsets can be applied such that the EPA objective for flora and vegetation is met (refer to Section 19).

15 Terrestrial fauna

15.1 Key statutory requirements, environmental policy and guidance

15.1.1 EPA objective

The EPA has applied the following objective for terrestrial fauna:

"To maintain representation, diversity, viability and ecological function at the species, population and assemblage level."

15.1.2 Regulatory framework

The following legislation is relevant to the Proposal with respect to the protection of terrestrial fauna values and the above EPA objective:

- WC Act;
- *Conservation and Land Management Act 1984* (WA);
- EP Act; and
- EPBC Act.

15.1.3 Relevant guidelines and policy

The following guidelines are relevant to the Proposal with respect to the protection of terrestrial fauna values and the above EPA objective:

- EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002a);
- EPA Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in WA (EPA 2009b);
- EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in WA (EPA 2004c);
- Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010);
- Species bank *Idiosoma nigrum* (DEWHA 2009);
- Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011); and
- Survey guidelines for Australia's threatened birds (DEWHA 2010).

15.2 Description of terrestrial vertebrate fauna

15.2.1 Terrestrial fauna surveys

Numerous terrestrial vertebrate and invertebrate fauna surveys and assessments have been undertaken in the vicinity of the development envelope. A desktop assessment of these surveys with evaluation of relevancy and consistency with EPA Guidelines was undertaken as part of the most recent fauna work (ecoscape 2016a; Appendix C). Table 24 summarises the nine reports that have covered part or all of the development envelope (Appendix C).

Table 24: Fauna survey effort

Report name (author)	Timing	Methodology
Blue Hills Fauna Assessment (Bamford & Wilcox 2004)	February 2004	Single phase Level 2 (comprehensive) vertebrate assessment and opportunistic SRE invertebrate collection
Fauna Values of Gindalbie Metals' Karara and Mungada Haematite/Magnetite Projects (Bancroft & Bamford 2006)	April, August and October 2006 (autumn, winter and spring)	Two Phase Level 2 (comprehensive) vertebrate assessment and opportunistic SRE invertebrate collection
Koolanooka/Blue Hills Short Range Endemic Biological Assessment Level 2 SRE invertebrate fauna survey (ecologia 2007b)	January, February, June and July 2007 (summer and winter)	Level 2 SRE invertebrate fauna survey
Koolanooka/Blue Hills Short Range Endemic Literature Review and Risk Assessment (ecologia 2008c)	N/A	Desktop literature review and risk assessment.
Blue Hills Short Range Endemic Invertebrate Survey (ecologia 2010)	2010 (report does not list survey month)	Level 2 SRE invertebrate fauna survey
Blue Hills Project Level 1 Vertebrate Fauna Survey (ecologia 2011a)	July 2011 (winter)	Level 1 vertebrate fauna assessment
Blue Hills Additional Short Range Endemic Invertebrate Survey (ecologia 2011b)	August 2011 (winter)	Level 2 SRE invertebrate fauna survey
Blue Hills *Idiosoma nigrum* Targeted Survey (ecologia 2012a)	October 2012 (spring)	Targeted survey for *Idiosoma nigrum*
Blue Hills Mungada East Terrestrial Fauna Assessment (ecoscape 2016a).	August 2015 (winter)	Terrestrial vertebrate fauna and SRE invertebrate fauna desktop assessment. Targeted surveys for *Idiosoma nigrum, Cyclodomorphus branchialis* and *Egernia stokesii badia.*

Overall, the surveys meet current industry guidance (DEWHA 2009; DSEWPaC 2011; DEWHA 2010; EPA 2004c; EPA 2009b; EPA & DEC 2010), with the exception of the initial Level 2 terrestrial fauna assessments (Bamford & Wilcox 2004; Bancroft & Bamford 2006), which only included five nights of trapping and the use of 5 m fences on pitfall traps. Current guidelines (EPA & DEC 2010) indicate that a minimum of seven nights is required for vertebrate fauna trapping, and pitfall fences should be a minimum of 7 m, although 10 m is recommended. Subsequent surveys met these guidelines and provided a sufficient level of knowledge on fauna occurrence in the development envelope and region.

The recent Blue Hills Mungada East Terrestrial Fauna Assessment (ecoscape 2016a) collated all previous survey information and supplemented this with a targeted survey for a number of conservation significant species. The assessment provided a comprehensive list of fauna species likely to occur in the development envelope and addressed the requirements of the ESD. Additionally, this assessment included an update to previous fauna habitat mapping for SMC's Blue Hills tenements based on current land system mapping, soils, geology and recent vegetation mapping undertaken by Maia (2016).

The survey work conducted to date for the Proposal incorporates targeted Level 1 and 2 surveys within and outside the development envelope, allowing for the identification of potential impacts to conservation significant vertebrate and invertebrate fauna species listed under the WC Act and EPBC Act, as well as SRE invertebrates. This work included mapping of confirmed locations or indications of conservation significant fauna recorded as part of surveys.

The culmination of the aforementioned local information is considered sufficient to undertake an environmental impact assessment for terrestrial fauna. The descriptions provided in the following sections regarding habitat and fauna of the development envelope are adapted from ecoscape (2016a), unless otherwise stated. The full versions of the survey reports are included in Appendix C. The locations of fauna sampling sites for each survey are indicated in Figure 67.

15.2.2 Terrestrial fauna habitats

Fauna habitats occurring across the majority of SMC's Blue Hills tenements were originally mapped by ecologia (2011a). Ecoscape (2016a) updated this habitat mapping for SMC's Blue Hills tenements based on current land system mapping, soils, geology and recently mapped vegetation associations (Maia 2016). The revised habitat mapping defines five terrestrial fauna habitats occurring across SMC's Blue Hills tenements, four of which occur in the development envelope. These are described in Table 25 and shown in Figure 68.

The habitats of the development envelope are considered typical of the surrounding region (ecologia 2011a); none are restricted to the development envelope. Photographs of some of the different habitat types are provided in Plate 8 to Plate 10.

Table 25: Terrestrial fauna habitats in the development envelope (ecologia 2011a; ecoscape 2016a)

Habitat type	Description	Area in the proposed disturbance footprint (ha)
Rocky ridge with steep slopes	Associated with the Tallering land system, this habitat was identified based on mainly landform features. This habitat type is characterised by an elevated rocky ridge top with steep rocky hill slopes consisting of a continuous surface layer of banded ironstone with numerous solid outcrops interspersed with loose rocky stones and pebbles. The vegetation is dominated by a dense shrub layer of small leaf Myrtaceae species, with sparse trees consisting of *Melaleuca* spp., *Acacia* spp. and *Eucalyptus* spp.	6.7
Low slopes with dense *Acacia* shrubs	Although associated with the rocky ridges and steep slopes habitat type and the Tallering land system, this habitat type is considered separate due to the low sloping landform and a dense shrub layer. The soil substrate in this habitat type typically ranges from continuous stony surface layers of lose pebbles to red loamy soils with few rocks. The substrate has a distinct gradient from rocky areas on the higher slopes to an almost exclusively loamy soil near the surrounding plains. Vegetation associated with this habitat type is dominated by dense *Acacia* spp. shrubs, typically growing to a maximum height of approximately 1.7 m, with larger *Acacia* spp. trees scattered throughout.	16.4
Eucalypt woodland plain with *Acacia* shrubs	Associated with the Yowie, Pindar and Tealtoo land systems, this habitat type is characterised by a flat plain landscape with stands of mature *Eucalyptus* spp. trees and a scattered understorey of *Acacia* spp. shrubs and trees. The eucalypts provide an important feature to this habitat type and the surrounding landscape. Typically, a small group of trees occurs in close proximity to each other, resulting in abundant leaf and wood litter at the base of these trees. The leaf and wood litter provides important microhabitats for a number of species, particularly reptiles, while the many tree hollows provide important nesting areas for many bird species. The substrate typically consists of reddish clay loam, with few surface rocks.	28.7
Acacia shrubland plain	Associated with the Yowie and Tealtoo land systems, this habitat type is characterised by flat to gently undulating loamy/sandy plains with fine ironstone gravel mantles supporting dense *Acacia* shrublands. Vegetation associated with this habitat type is dominated by dense, mixed tall shrubland of *Acacia ramulosa*, *A. burkittii* and *Hakea recurva* occasionally with isolated low *Eucalyptus salubris* trees.	0.1

Plate 8: Rocky ridges and steep slopes habitat type (ecoscape 2016a).

Plate 9: Low slopes with dense *Acacia* shrubs habitat type (ecoscape 2016a).

Plate 10: Eucalypt woodland plain with *Acacia* shrubs habitat type (ecoscape 2016a).

Figure 67: Terrestrial fauna survey locations

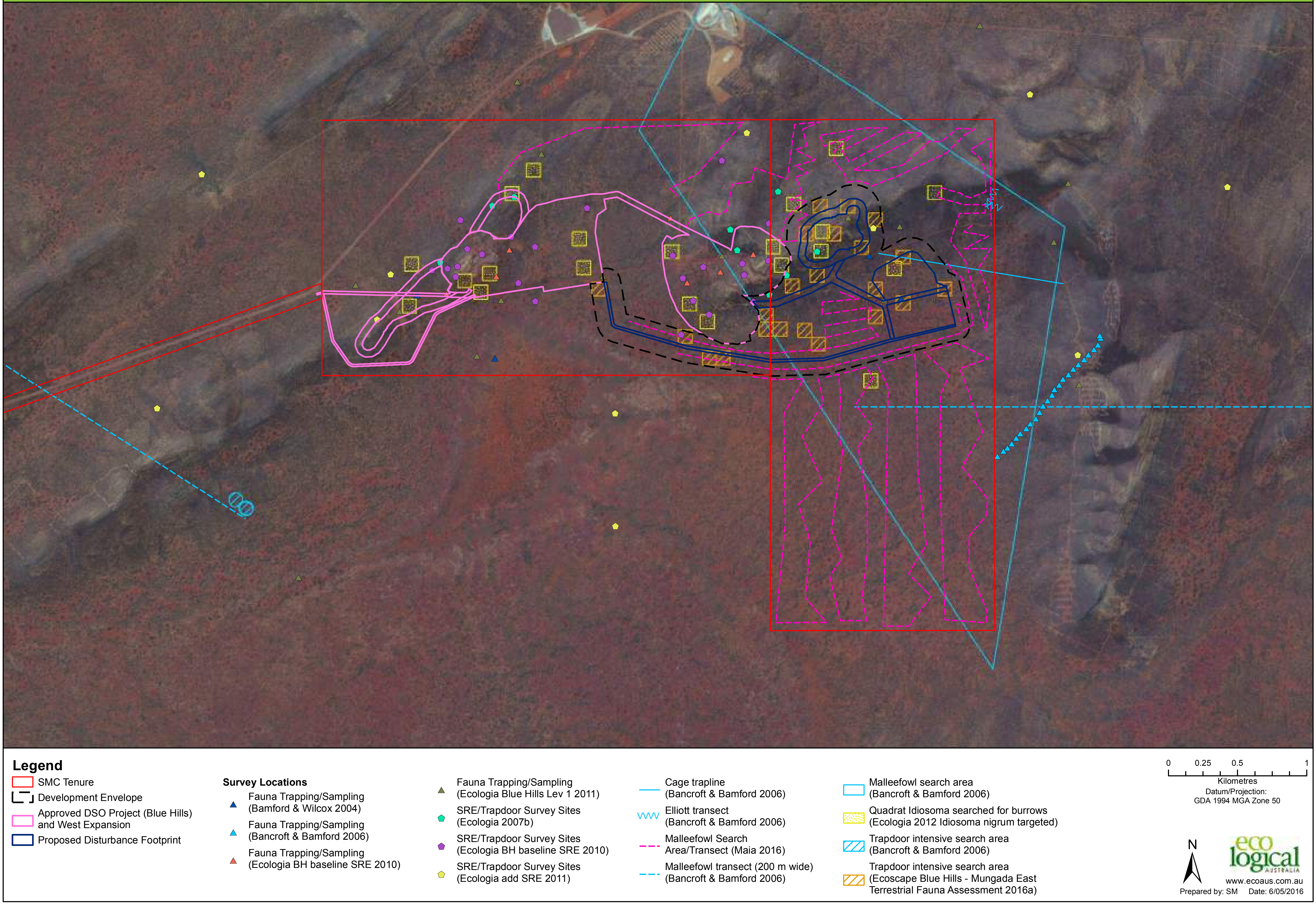
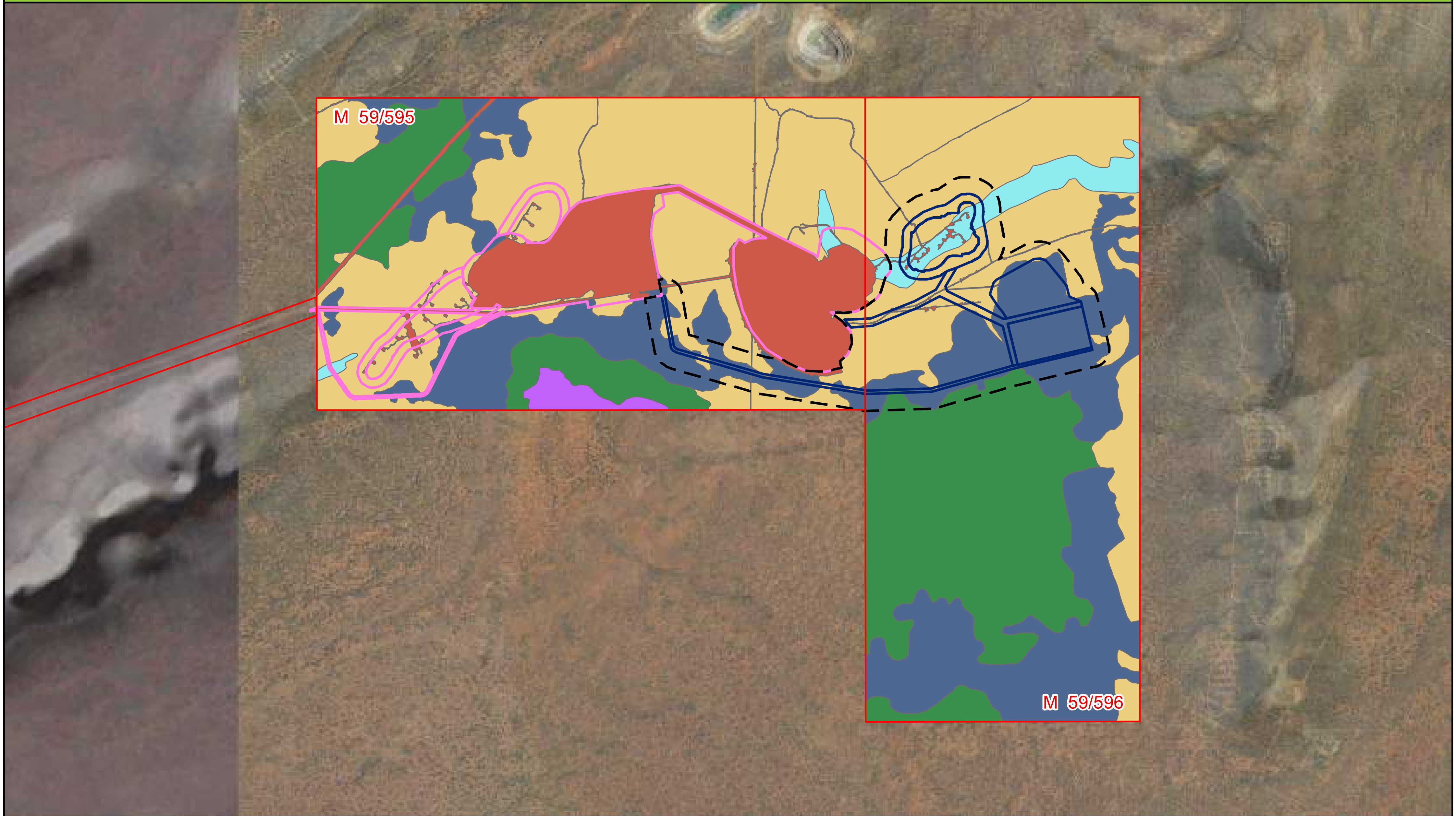


Figure 68: Fauna habitats



Legend

SMC Tenure
Development Envelope
Approved DSO Project (Blue Hills) and West Expansion
Proposed Disturbance Footprint

Fauna habitat (ecoscape 2016a)

Acacia shrubland plain
Alluvial plain
Cleared
Eucalypt woodland plain with acacia shrubs
Low slopes with dense acacia shrubs
Rocky ridge with steep slopes

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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15.2.3 Occurrence of terrestrial vertebrate fauna

A total of 28 native mammal species, 181 bird species, 80 reptile species and eight amphibian species have been recorded, or have the potential to occur in the development envelope (ecoscape 2016a). A total of six introduced mammal species have been recorded, or have the potential to occur in the development envelope: Black Rat (**Rattus rattus*), House Mouse (**Mus musculus*), European Rabbit (**Oryctolagus cuniculus*), Goat (**Capra hircus*), Red Fox (**Vulpes vulpes*) and Feral Cat (*Felis catus) (ecoscape 2016a).

15.2.4 Conservation significant vertebrate fauna

A total of three conservation significant vertebrate fauna species have been recorded in the development envelope, including one listed under both the EPBC Act and WC Act, and two listed under only the WC Act (Table 26). These are the Malleefowl (*Leipoa ocellata*), Peregrine Falcon (*Falco peregrinus*) and Gilled Slender Blue-tongue (*Cyclodomorphus branchialis*). The locations of the recordings of these conservation significant fauna are shown in relation to the development envelope in Figure 69.

Table 26: Conservation significant vertebrate fauna species recorded within the development envelope

Species	Common name	Conservation Status*			Number of records in the development envelope	Number of records in the proposed disturbance footprint
		EPBC Act	WC Act	DPaW		
Leipoa ocellata	Malleefowl	VU	CR	VU	5	5
Falco peregrinus	Peregrine Falcon	-	OS	-	2	0
Cyclodomorphus branchialis	Gilled Slender Blue-tongue	-	VU	VU	1	0

*VU = Vulnerable, CR = Critically Endangered, OS = Other Specially Protected Fauna.

A further four conservation significant vertebrate fauna species have been identified as having a high or medium likelihood of occurring in vicinity of the development envelope (Table 27). An additional two species identified in database searches have a low likelihood of occurring and there are six species identified in database searches for which there is no suitable habitat in or near the development envelope (Table 27).

Table 27: Likelihood of occurrence of other conservation significant vertebrate fauna species (ecoscape 2016a)

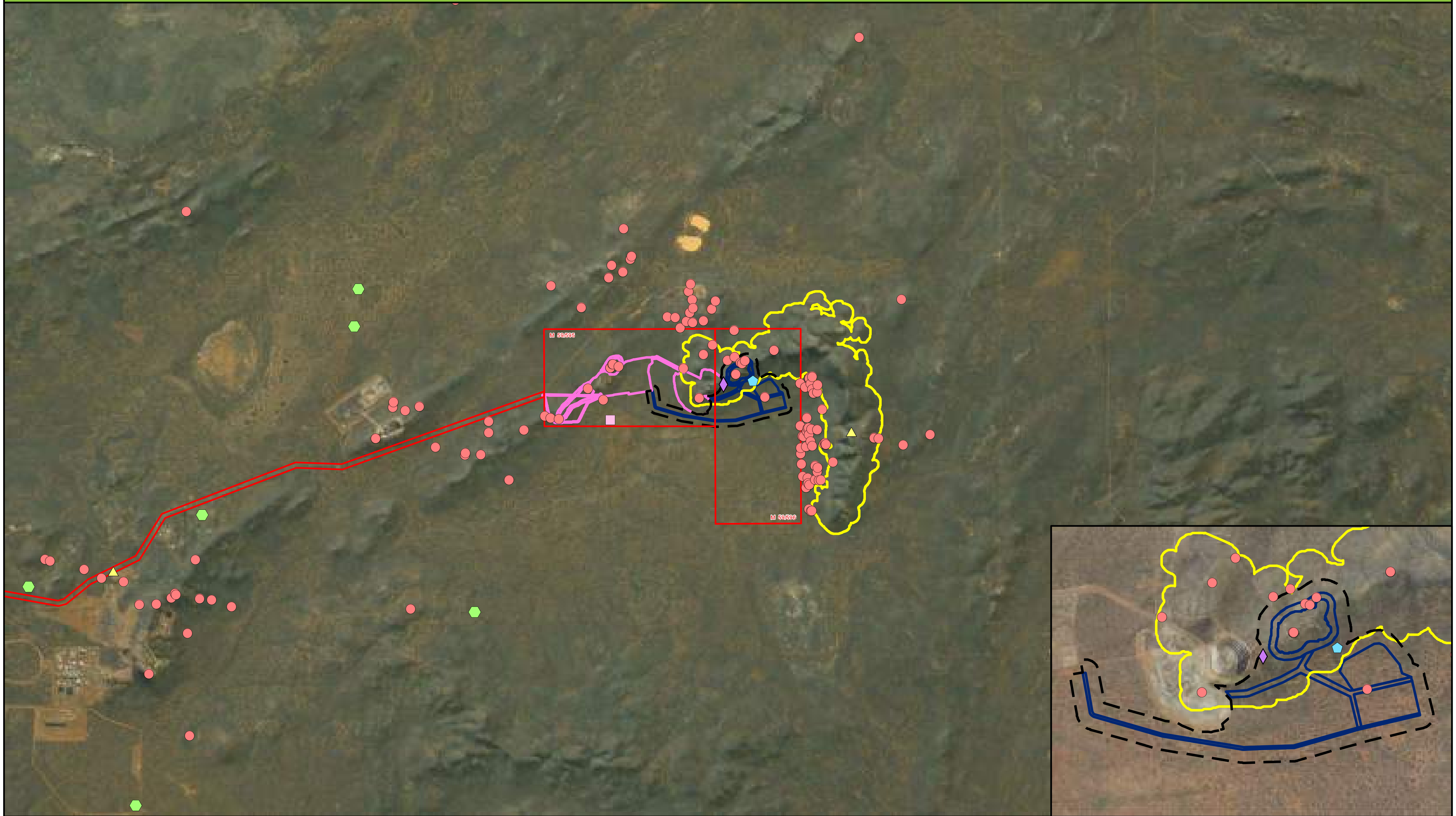
Species	Common name	Conservation Status*			Likelihood of occurrence in development envelope**
		EPBC Act	WC Act	DPaW	
Merops ornatus	Rainbow Bee-eater	M	IA	-	High
Egernia stokesii badia	Western Spiny-tailed Skink	EN	VU	VU	Medium
Apus pacificus	Fork-tailed Swift	M	-	-	Medium
Macropus irma	Western Brush Wallaby	-	-	P4	Medium

Species	Common name	Conservation Status*			Likelihood of occurrence in development envelope**
		EPBC Act	WC Act	DPaW	
Sminthopsis longicaudata	Long-tailed Dunnart	-	-	P4	Low
Nyctophilus major tor	Greater Long-eared Bat	-	-	P4	Low
Pezoporus occidentalis	Night Parrot	EN	CR	CR	No suitable habitat
Rostratula australis	Australian Painted Snipe	EN	-	-	No suitable habitat
Tringa nebularia	Common Greenshank	M	IA	-	No suitable habitat
Ardea modesta (as *Ardea alba)*	Eastern Great Egret	M	IA	-	No suitable habitat
Ardea ibis	Cattle Egret	M	IA	-	No suitable habitat
Oxyura australis	Blue-billed Duck	-	-	P4	No suitable habitat

*VU = Vulnerable, M = Migratory, EN = Endangered, CR = Critically Endangered, IA = Migratory birds protected under an international agreement, P = Priority.

**As defined in ecoscape (2016a): High = species recorded in close proximity to the development envelope within 20 years, and suitable habitat occurs within the development envelope; Medium = species historically recorded in close proximity to the development envelope (more than 20 years ago) and suitable habitat may exist within the development envelope; Low = species not recorded in the proximity of the development envelope or rarely recorded within 50 km of the development envelope and suitable habitat unlikely to occur within the development envelope.

Figure 69: Records of conservation significant vertebrate fauna



Legend

- SMC Tenure
- Development Envelope
- Mungada Ridge Landform
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint

Fauna Habitat

- Gilled slender blue-tongue
- Major Mitchell's Cockatoo
- Malleefowl mound
- Peregrine Falcon
- Rainbow Bee-eater
- Western Spiny-tailed Skink

0 1 2 4
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 50

N

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15.3 Description of SRE invertebrate fauna

EPA guidance defines SREs as terrestrial and freshwater invertebrates that have naturally small distributions of less than 10,000 km^2 (EPA 2009b). Within this distribution, the actual areas occupied may be small, discontinuous, or fragmented, and SREs are typically at greater risk of population extinctions than more widely-distributed taxa (EPA 2009b).

15.3.1 SRE invertebrate fauna surveys

There have been numerous SRE surveys for the Proposal consistent with EPA Guidance Statement 20 (EPA 2009b). All of the terrestrial fauna surveys listed in Table 24, with the exception of ecologia (2011a), included a component involving some a degree of SRE sampling; however ecologia (2012a) and ecoscape (2016a) were targeted at the conservation listed *Idiosoma nigrum* only. SRE sampling locations are shown in Figure 67.

Three specific level 2 SRE invertebrate surveys have been previously conducted for the existing operations at the Blue Hills mine (ecologia 2007b, 2010 and 2011b). These assessments are considered relevant due to the continuation of the habitat types between the previous survey site locations and the development envelope, and the close proximity of the study sites to the development envelope (25 wet pitfall sites and 22 foraging sites are located within 3 km of the development envelope). Six SRE sampling sites are located within the development envelope (ecoscape 2016a); four wet pitfall sites (located on the southern slope of Mungada Ridge) and two hand foraging sites (Figure 67). One of the wet pitfall sites (ecologia 2007b) is located in the proposed disturbance footprint. The Level 2 SRE invertebrate surveys (ecologia 2010, ecologia 2011b) were designed to comply with Guidance Statement 20 (EPA 2009b). The ecologia (2007b) assessment preceded EPA (2009b), however the methods were developed in consultation with senior WAM staff and other local experts, and can be considered comparable to modern survey methods (ecoscape 2016a).

No additional SRE surveys were conducted within the development envelope for the Proposal as it was determined that sufficient survey effort had been completed for the existing operations at the Blue Hills mine to provide appropriate data for the Proposal (ecoscape 2016a).

15.3.2 SRE invertebrate fauna habitat

The terrestrial fauna habitat types identified during terrestrial fauna assessments are typically too broad to be attributed with specific SRE taxa. SREs generally persist in microhabitats characterised by permanent moisture and shade, which can occur within various terrestrial fauna habitat types (ecoscape 2016a). This is confirmed by the spread of records across each habitat type (ecoscape 2016a). They are often associated with rocky ridge habitats supporting deep rocky crevices and shaded, south-facing slopes, and woodland habitats, which can provide suitable microhabitats in the form of accumulated leaf litter underneath shrubs and trees. Prospective habitat for SRE species is present across the majority of, and outside, the development envelope, but is not aligned specifically to any one mapped habitat type.

15.3.3 Occurrence of SRE invertebrate fauna

One confirmed SRE species has been recorded in the development envelope; the conservation listed *Idiosoma nigrum*. An additional two potential SRE species and one species of ‘unknown’ SRE status have been also recorded in the development envelope (Table 28 and Figure 70); *Beierolpium* 'sp. 8/2', *Urodacus* sp. ‘blue hills’ and *Westralaoma aprica*. Taxonomy and nomenclature for SRE invertebrate taxa is notoriously difficult, as many taxa are historically understudied and in many cases, lack formal descriptions. An extensive, reliable taxonomic evaluation of these species has begun only recently and thus the availability of literature relevant to SREs is relatively scarce (ecoscape 2016a). Additional taxonomic clarification of the potential and unknown SRE taxa recorded from Blue Hills and their SRE status was not available for the purposes of this EIA due to data deficiencies and limits to the WAM’s available resources. The WAM was consulted during the development of the Ecoscape (2016a) report, with the information reflected within this PER.

Table 28: Potential and unknown SRE species recorded in the development envelope

Order	Family	Species	Habitat	SRE Status
Arachnida				
Aranae	Idiopidae	*Idiosoma nigrum*	*Acacia ramulosa* var. *ramulosa* or *Acacia caesanura*	Confirmed
Pseudoscorpionida	Olpiidae	*Beierolpium* 'sp. 8/2'	Mulga woodland or *Acacia/Eucalytpus* mixed woodland	Unknown
Scorpiones	Urodacidae	*Urodacus* sp. 'blue hills'	Tall mixed *Acacia*/*Melaleuca*/ *Allocasuarina* shrubland on rocky ridges	Potential
Gastropoda				
Stylommatophora	Punctidae	*Westralaoma aprica*	Mulga woodland	Potential

A further eight potential SRE taxa and six taxa with no information available to determine SRE status (unknown) have been identified from the area surrounding the development envelope (Table 29 and Figure 70).

Table 29: Potential and unknown SRE species recorded near the development envelope

Order	Family	Species	SRE Status
Arachnida			
Aranae	Barychelidae	Barychelidae sp. A	Unknown
		Barychelidae sp. B	Unknown
	Nemesiidae	*Aname* 'sp. juv'	Potential
Scorpiones	Urodacidae	*Urodacus* sp. 'koolanooka'	Potential
Pseudoscorpionida	Chthoniidae	*Tyrannochthonius* sp. nov. Blue Hills	Potential
	Olpiidae	*Austrohorus* sp.	Unknown
		Beierolpium 'sp. 8/4' large	Unknown
		Beierolpium 'sp. 8/3'	Unknown
Malacostraca			
Isopoda	Platyarthridae	*Trichorhina* sp.	Potential

Order	Family	Species	SRE Status
Chilopoda			
Scolopendromorpha	Scolopendridae	*Cormocephalus* sp.	Potential
Geophilomorpha	Mecistocephalidae	*Mecistocephalus* sp.	Unknown
Grastropoda			
Stylommatophora	Placostylidae	*Bothriembryon* sp. 'Northern Wheatbelt	Potential
	Punctidae	*Westralaoma cf. expicta*	Potential
	Camaenidae	*Sinumelon cf. vagente*	Potential

The Shield-backed Trapdoor Spider (*Idiosoma nigrum*) has been found both within and outside the development envelope. This species is listed under both the EPBC Act and WC Act as Threatened: Vulnerable. The WAM recently provided advice (WAM 2016) that the *Idiosoma* records from the Blue Hills Range (*Idiosoma nigrum* and *Idiosoma* 'MYG018') were not considered to be *Idiosoma nigrum* (based on molecular and morphological data). This has been reflected in ecoscape (2016a). The WAM is currently working on the taxonomy and systematics of idiopids; information from this research is anticipated to be available in the next year and will provide a better understanding of the *Idiosoma nigrum*'s distribution and the diversity and distribution of idiopids in WA. However, at the time of publishing this PER, the records of *Idiosoma* 'MYG018' are still treated as *Idiosoma nigrum* on NatureMap, and DPaW are yet to formally gazette *Idiosoma* 'MYG018' as a new species. Until the new taxonomic arrangement is recognised by DPaW, all records from the Blue Hills area previously identified as *Idiosoma nigrum* or *Idiosoma* 'MYG018' will be referred to as the listed threatened species *Idiosoma nigrum* and a known SRE, and treated as thus throughout this PER.

There is suitable habitat for this species across the vast majority of the development envelope (excluding cleared areas). Within and near the development envelope, *Idiosoma nigrum* burrows have been recorded in a variety of microhabitats on plains or hillslopes, but not in gullies or on hilltops. Almost all burrows have been recorded in the leaf litter of either *Acacia ramulosa* var. *ramulosa* or *A. caesaneura* shrubs indicating the species likely has a preference for the microhabitat provided by these flora species (shade, protection and moisture). Although *A. caesaneura* is restricted to hilly areas, *A. ramulosa* var. *ramulosa* occurs with relative homogeneity throughout most of the Blue Hills tenements and the surrounding area (ecoscape 2016a).

All vegetation within the proposed disturbance footprint is considered to be of high (17.2 ha; 33% of the footprint area) or medium value (34.8 ha; 67% of the footprint) to *Idiosoma nigrum* (ecoscape 2016a). This habitat is mapped in Figure 71 and described in Table 30.

Table 30: Suitable *Idiosoma nigrum* habitat.

Vegetation Type	Habitat Suitability	Extent in proposed disturbance footprint (ha)	Extent in the development envelope (ha)
Acacia assimilis tall shrubland	High Value	12.3	30.9

Vegetation Type	Habitat Suitability	Extent in proposed disturbance footprint (ha)	Extent in the development envelope (ha)
Acacia ramulosa tall shrubland	High Value	4.9	53.5
Eucalyptus woodland	Medium Value	28.7	74.2
Mixed *Allocasuarina* and *Melaleuca* tall shrubland	Medium Value	6.1	9.8
Mid to tall mixed shrubland	Unsuitable	0.0	0.5
Cleared	Unsuitable	1.5	3.7

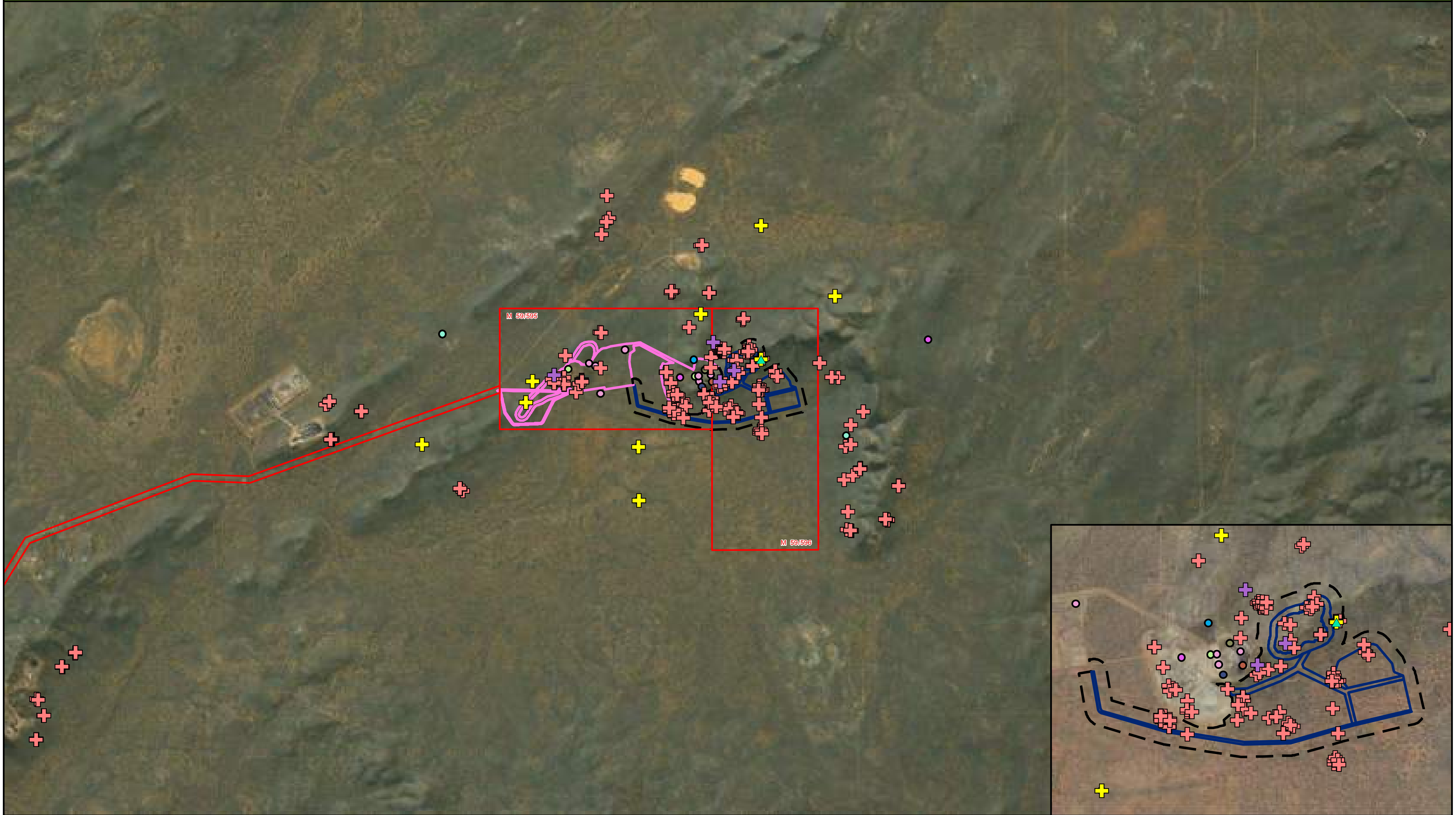
A total of 84 burrows of *Idiosoma nigrum* have been recorded in the development envelope, with 26 found within the proposed disturbance footprint (includes one burrow located 3 cm outside of this boundary). A further 45 burrows have been recorded within SMC's Blue Hills tenements and an additional 132 more broadly across the Blue Hills range (within the Blue Hills Impact Assessment Area). When compared to other population density estimates in the surrounding region (145-273 burrows per hectare), the populations of *Idiosoma nigrum* within the development envelope are quite low (3.02 burrows per hectare; ecoscape 2016a).

One specimen of *Beierolpium* 'sp. 8/2' has been recorded in the development envelope and a further eight specimens recorded outside. While members of the genus *Beierolpium* are considered to be widespread, due to a lack of taxonomic knowledge, the SRE status of these taxa cannot be determined. A complete systematic revision of the Western Australian members of Beierolpium is necessary to establish the identity of these taxa; as such, the SRE status of *Beierolpium* 'sp. 8/2' is considered to be unknown (ecologia 2011b).

The single specimen of *Westralaoma aprica* recorded in the development envelope is the only record in the Blue Hills area (ecologia 2011b). However, another reliable record of *W. aprica* is known from the locality of Nangeenan, which is near Merredin (290 km south of the development envelope). Ecologia (2011b) determined that the distribution of the species therefore excluded it from classifying as an SRE; however currently this species is still considered a potential SRE by WAM (ecoscape 2016a) based on the criteria A (Data Deficient) and E (Research & Expertise).

Urodacus sp. 'blue hills' has been recorded from four locations in the vicinity of the Proposal, two of which occur in the development envelope. These two specimens were identified in the WAM database search and have locations that relate to survey sites sampled during the ecologia (2007b) survey, however no information of these records was included in the ecologia (2007b) report (ecoscape 2016a).

Figure 70: Records of confirmed, potential and unknown SRE fauna species



Legend

- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint

Potential SRE Fauna Species

- *Aname* 'sp.juv'
- *Austrohorus* sp..
- *Barychelidae* sp. A
- *Barychelidae* sp. B
- *Beierolpium* 'sp. 8/2'
- *Beierolpium* 'sp. 8/3'
- *Beierolpium* 'sp. 8/4' large
- *Bothriembryon* sp. 'Northern Wheatbelt
- *Cormocephalus* sp.
- *Idiosoma nigrum*
- *Mecistocephalus* sp
- *Sinumelon* cf. vagente
- *Trichorhina* sp.
- *Tyrannochthonius* sp.nov. Blue Hills
- *Urodacus* sp. Blue Hills
- Urodacus sp. Koolanooka
- 'Urodacus?' 'sp.'
- *Westralaoma aprica*
- *Westralaoma* cf. expicta

0 0.5 1 2
Kilometers
Datum/Projection:
GDA 1994 MGA Zone 50

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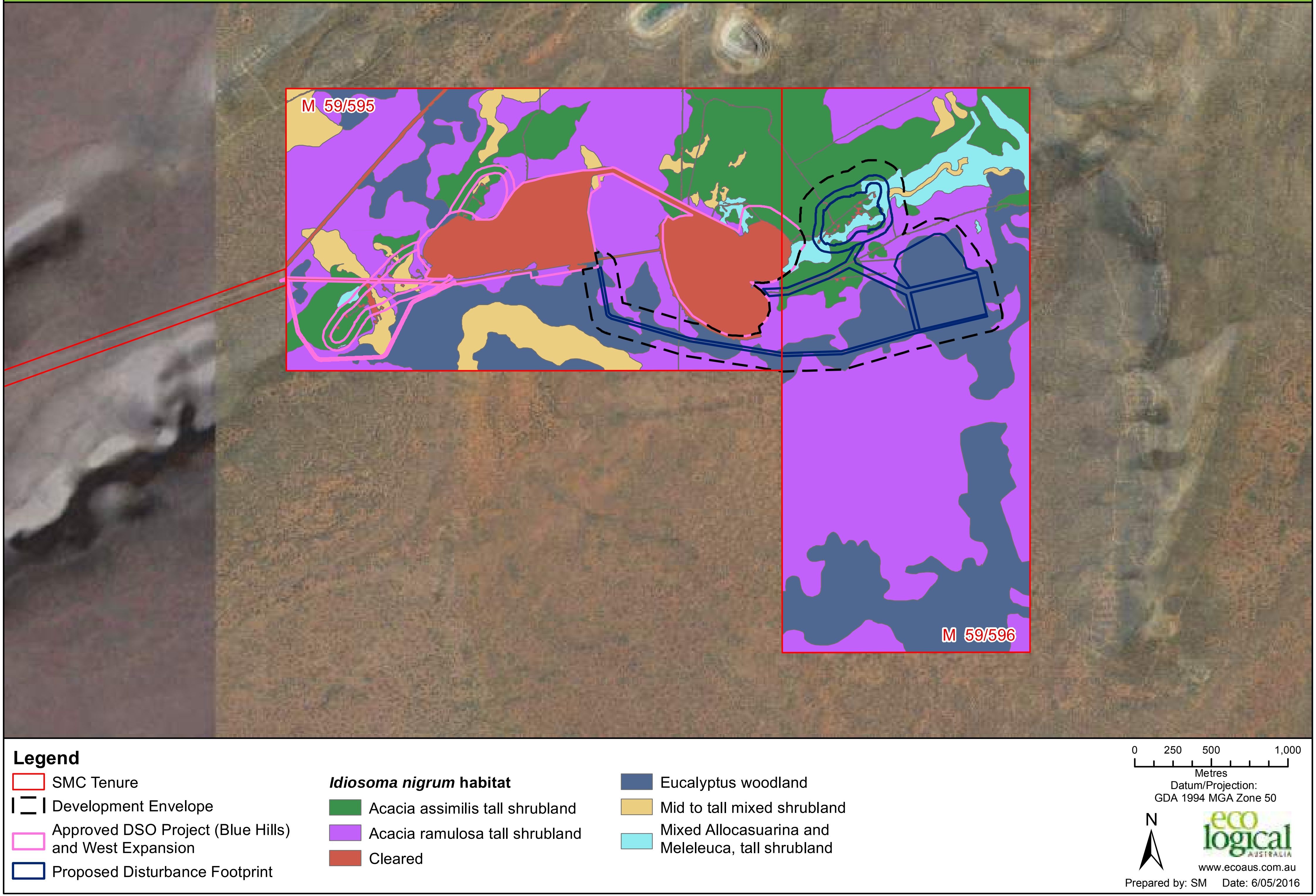
Figure 71: *Idiosoma nigrum* habitat



15.4 Assessment of potential impact, mitigation and residual impact

The EPA has listed the following potential impacts for the Proposal in relation to terrestrial fauna:

- loss or fragmentation of habitat;
- death or displacement of fauna species; and
- indirect impacts that may occur through change in quality/condition of fauna habitat, attraction of fauna to storage areas of water and food wastes, changes to feral animal populations, increased risk of collision with vehicles, introduction and spread of weeds, dust, noise and vibration, lighting and loss of habitat from altered fire regimes.

These are addressed in the following sub-sections with the exception of noise, vibration and lighting, which are considered highly unlikely to affect the fauna species known to occur, or that could potentially occur, in the development envelope.

15.4.1 Loss or fragmentation of habitat

Direct impacts to habitat will occur as a result of clearing of vegetation for mining and construction of associated elements of the Proposal. The amount of each habitat type to be cleared is shown in Table 31. Habitat clearing will be restricted to the development envelope and will be the minimum necessary for safe construction and operation of the Proposal. Clearing areas will be demarcated on the ground to ensure clearing is limited to only what is necessary and approved. Upon closure, all disturbed areas, with the exception of the pit void, will be rehabilitated to contain self-sustaining fauna habitats that reflect the pre-disturbed state of the area; the pit void will remain open post-closure (refer to Section 18).

Some localised fragmentation of habitat will occur as a result of clearing of vegetation for the Proposal. The effect of this fragmentation will decrease over time as rehabilitation and return of vegetation progresses. The extent of the *Acacia* shrubland plain habitat in the proposed disturbance footprint is minimal (0.1 ha), and will not result in the fragmentation of this habitat outside this area. The low slopes with dense *Acacia* shrubs habitat will not be fragmented; while 16.4 ha of this habitat will be removed, outside the proposed disturbance footprint broad and contiguous areas will remain intact. During construction and operation phases of the proposal, the Eucalypt woodland plain with *Acacia* shrubs will be fragmented by the clearing of 28.7 ha of vegetation for the waste rock dump, infrastructure and roads. However, large areas of this habitat will remain both east and west of the proposed disturbance footprint, which will be reconnected by post-mining rehabilitation activities.

Table 31: Impact to fauna habitats

Habitat type	Extent in proposed disturbance footprint (ha)*	Percentage of extent mapped in the development envelope	Percentage of extent mapped in tenements M59/595 and M59/596
Rocky ridge with steep slopes	6.7	67%	22%
Low slopes with dense *Acacia* shrubs	16.4	20%	3%
Eucalypt woodland plain with *Acacia* shrubs	28.7	39%	10%
Acacia shrubland plain	0.1	2.5%	<1%

* The proposed disturbance footprint covers 53.5 ha. Total clearing shown in this table is 52 ha; the remaining 1.5 ha within the proposed disturbance footprint has already been cleared for exploration.

The rocky ridge with steep slopes habitat will also be fragmented. The proposed pit will separate a large eastern portion of this habitat from a small portion of this habitat to the west of the proposed pit. Post-closure, the pit will not be rehabilitated, thus the fragmentation of this habitat will remain. None of the species recorded in the development envelope are restricted to this habitat type; thus the fragmentation of this habitat to not expected to cause significant impacts to fauna taxa (ecoscape 2016a). The preferred habitat for the Gilled Slender Blue-tongue has been previously suggested to be rocky habitats (including BIF; Bancroft & Bamford 2006; DEC 2007), but records have been found in Mulga woodland and shrubland, distant from any rocky outcrop (ecoscape 2016a). The observation of this species within the development envelope was recorded in low slopes with dense *Acacia* shrubs habitat.

15.4.2 Potential direct and indirect impacts to vertebrate fauna of conservation significance

It is unlikely the potential indirect impacts identified by the EPA for the Proposal would significantly impact conservation significant terrestrial fauna species in the vicinity of the proposed disturbance footprint. Potential indirect threats or impacts include:

- change in quality/condition of fauna habitat;
- attraction of fauna to storage areas of water and food wastes;
- changes to feral animal populations;
- increased risk of collision with vehicles;
- introduction and spread of weeds;
- deposition of dust;
- noise emissions;
- anthropogenic lighting; and
- loss of habitat from altered fire regimes.

The impacts are expected to be minimal as they will be mitigated in accordance with measures outlined in Section 15.5, and further expanded upon in the Blue Hills Mungada East Expansion Condition EMP (Appendix D).

Malleefowl (Recorded)

All five of the inactive Malleefowl mounds recorded in the proposed disturbance footprint will be removed as a result of the Proposal. One mound is located over the proposed Mungada East Extension pit, one within the proposed haul road alignment and three within the pit abandonment bund area.

Despite extensive survey effort within and in the vicinity of the development envelope, no individuals or active Malleefowl mounds have been recorded in the development envelope. However, this species is known to reuse inactive mounds, years after they were last utilised, rather than constructing new mounds (NHT 2007). Active mounds have been recorded in the past decade near the development envelope (recorded by Bancroft & Bamford 2006 and ecologia 2011b and other records shown on Naturemap (DPaW 2015 as cited in ecoscape 2016a)), with an active mound recently found 400 m to the north-east of the development envelope (C. Cox, Maia pers. comm., 2015). Although the substrate is generally not very sandy (as preferred by the species), suitable Malleefowl habitat exists in the shrubland plains in the southern portion of the development envelope, where fire does not appear to have occurred for over ten years and leaf litter is dense in places. The entire proposed disturbance footprint to be cleared is considered potential Malleefowl habitat.

Malleefowl have been commonly recorded across the Midwest region indicating that suitable habitat occurs extensively outside the development envelope and viable breeding populations occur across the region (ecoscape 2016a). Although Malleefowl habitat will be cleared as part of the Proposal, only a relatively small proportion of the available habitat in the vicinity and regionally will be affected. Risks to Malleefowl will be reduced by the management measures outlined in Section 15.5 and are discussed in the detail in the Blue Hills Mungada East Expansion Condition EMP (Appendix D); these include monitoring and adaptive management strategies such as reduced speed limits if the species is observed in the development envelope.

Impacts to the Malleefowl from the Proposal are not expected to be significant due to the limited evidence to date of frequent and current use of the development envelope by Malleefowl and the extent of occurrence of Malleefowl in the surrounding region.

Peregrine Falcon (Recorded)

Two individuals of the Peregrine Falcon were recorded in the development envelope by ecoscape (2016a). The birds were observed in the development envelope circling above a small clifftop on a hill before flying away (location shown in Figure 69). The only other known record nearby is of a potentially breeding female and nest observed on the eastern side of Mungada Ridge, estimated to be approximately 2 km from the development envelope (actual location not recorded; Bancroft & Bamford 2006).

Peregrine Falcons are known to prefer rocky ledges and cliffs as nesting locations, so the pair recently observed in the development envelope could potentially be using one of the small cliffs in the area for this purpose. However, the small, gently inclined cliffs in the development envelope and nearby are not ideal nest sites as they are not well-protected and may better be described as rocky outcrops (ecoscape 2016a). There is also a lack of large trees or stick nests built by other raptors in the development envelope, which can also be used as nest sites for the Peregrine Falcon.

Although the species has been recorded, it is unlikely the species is nesting in the development envelope due to a lack of records and appropriate habitat. The species may be using the area as part of its larger foraging range, which can extend over 100 km^2. Various fauna species which are common prey for the Peregrine Falcon were regularly observed during the most recent survey (Galah, Common Bronzewing and Crested Pigeon; ecoscape 2016a).

The Proposal is not expected to significantly impact the Peregrine Falcon as no nest sites have been recorded in the development envelope and it is likely that the species only utilising the area opportunistically as part of its wider foraging range.

Gilled Slender Blue-tongue (Recorded)

The Gilled Slender Blue-tongue was recorded at two locations during the Bamford & Wilcox (2004) survey; one individual was recorded within the development envelope (outside the proposed disturbance footprint) and the second recorded 9 km to the south. A third individual was recorded in 2006 at a location named as ‘Karara Ridge’ (Bancroft & Bamford 2006); however, specific location details for this record are unknown. The individual is considered likely to have been recorded on Mount Karara, approximately 10 km south-west of the development envelope. The species was also recorded in 2003 approximately 23 km south of the development envelope, and one historical record exists from 1965 approximately 44 km north-east of the development envelope (DPaW 2015 as cited in ecoscape 2016a). The known distribution of this species extends from Geraldton to Mt Magnet.

An extensive amount of time was spent actively searching for the Gilled Slender Blue-tongue within the development envelope during the ecoscape (2016a) survey, and no individuals were found. The ecology of this species is relatively unknown; however, it is cryptic in nature and thought to generally occur in dense low vegetation (ecoscape 2016a). It has also been recorded from rocky habitats including BIF ranges (ecoscape 2016a); with this habitat previously suggested to be its preferred habitat type (Bancroft & Bamford 2006; DEC 2007), but records have been found in Mulga woodland and shrubland, distant from any rocky outcrop (ecoscape 2016a). During targeted searches of the development envelope for this species in the ecoscape (2016a) survey, other reptile species known to occupy similar niches to Gilled Slender Blue-tongue were recorded. This, together with the historical record of the species in the development envelope, demonstrates that suitable habitat for the species is present. The entire proposed disturbance footprint to be cleared is considered to contain areas of potential Gilled Slender Blue-tongue habitat.

Individuals of this species could also be potentially harmed or killed by vehicles or feral animals during the construction and operation of the Proposal; however, the risk of vehicle strike and predation will be managed through implementation of management measures outlined in Section 15.5 and detailed in the Blue Hills Mungada East Expansion Condition EMP (Appendix D).

However, the scarcity of records of this species in the development envelope and vicinity, despite significant search effort in the area, indicates that the populations of Gilled Slender Blue-tongue are likely to be sparsely distributed throughout the landscape at low densities (ecoscape 2016a). The Proposal is unlikely to significantly impact the Gilled Slender Blue-tongue given its broad known distribution and lack of records in the development envelope.

Rainbow Bee-eater (High likelihood of occurrence)

This species is widespread and common in the Midwest region and more broadly, and has been recorded from nearby the development envelope. Suitable conditions for breeding may exist along banks of drainage lines near the development envelope; however, the lack of exposed sand and/or sandbanks suggests it is unlikely the species uses the area for nesting (ecoscape 2016a). This species forages in a wide range of habitats; thus the entire proposed disturbance footprint is considered to contain habitat for this species. However, given the lack of foraging habitat specificity of this species and the widespread nature of its records, it is unlikely the Proposal will significantly impact the Rainbow Bee-eater.

Western Spiny-tailed Skink (Medium likelihood of occurrence)

The Western Spiny-tailed Skink has not been recorded from the development envelope, despite extensive targeted searches during several surveys, but is known from 26 records in the vicinity of the development envelope extending approximately 30 km north, west and south. The closest record to the development envelope is 5 km to the south-west. More broadly, the species' distribution extends south from Mullewa, with an isolated area of distribution around Shark Bay including Dirk Hartog Island and Peron Peninsula (ecoscape 2016a).

The Western Spiny-tailed Skink occupies tree hollows and log piles mostly in/of York Gum (*Eucalyptus loxophleba*) woodland, but also occurs associated with Gimlet (*E. salubris*) and Salmon Gum (*E. salmonophloia*) (DSEWPaC 2012; How et al. 2003 as cited in ecoscape 2016a). Its distribution does not seem to be determined by particular species of trees, but rather by the structural properties of available crevices (e.g. tin, woodpiles and abandoned buildings).

Despite extensive areas of *Eucalyptus loxophleba* subsp. *supralaevis* on the lower plains to the west and south of the development envelope, this habitat may not be currently suitable for the Western Spiny-tailed Skink. This is because most of the logs observed during the ecoscape (2016a) survey did not appear gnarled or thick enough to create the numerous, narrow and deep crevices that are preferred by the Western Spiny-tailed Skink. A total of 28.7 ha of Eucalypt woodland plain with *Acacia* shrubs habitat will be cleared as a result of the Proposal. If the Western Spiny-tailed Skink exists within the development envelope or vicinity, it would be expected to occur in low densities as the available habitat is not optimal. Therefore, significant impacts to this species from the Proposal are unlikely.

Fork-tailed Swift (Medium likelihood of occurrence)

The Fork-tailed Swift has not been observed from the development envelope but there are two historic records within 90 km from 2000 and 2008 (ecoscape 2016a). Due to this species' aerial nature and association with storm fronts, its occurrence in the Blue Hills area is expected to be limited to fly-overs on occasion and therefore the species will not be significantly impacted by the Proposal.

Western Brush Wallaby (Medium likelihood of occurrence)

The development envelope is close to the northern limit of distribution for this species, which has been recorded from the Karara operations approximately 10 km to the south-west and from 36 km north-west of the development envelope (ecoscape 2016a). There is a lack of optimal habitat for this species in the development envelope and vicinity (open forest or woodland and particularly open, seasonally wet flats with low grasses and scrubby thickets); however, small pockets of suitable habitat may occur in the surrounding region. The lack of records and habitat indicate it is unlikely the Western Brush Wallaby will be significantly impacted by the Proposal.

15.4.3 Potential direct and indirect impacts to SREs

The clearing of vegetation to facilitate construction of the Mungada East Extension pit (proposed) and associated infrastructure will result in the loss of SRE invertebrate individuals and associated habitat within the proposed disturbance footprint.

While the terrestrial fauna habitats are considered to be defined at a scale broader than at which the microhabitats that SREs utilise occur, it can be assumed that the microhabitats associated within each of the four broad habitat types (Table 25) extend outside the Proposal impact area within these broad habitat types (Figure 68). There is no indication that there are microhabitats limited to the disturbance footprint and that do not occur further afield in association with the broader habitat types. Potential habitat for SRE species is considered continuous and extensive beyond the development envelope, with the habitat proposed to be removed representing only a small proportion of the potential habitat available to SRE taxa across the region.

All recorded or potentially occurring SRE species have been recorded outside the development envelope, and increased survey effort is likely to record additional occurrences. The local population mortality within the proposed disturbance footprint during clearing and the loss of potential habitat in the proposed disturbance footprint is unlikely to significantly impact potential SRE species recorded or potentially occurring in the development envelope.

The habitat preferences of the conservation listed SRE species *Idiosoma nigrum* have been studied more intensively than other SREs, with targeted surveys undertaken to determine the distribution and abundance of this species in proximity to the development envelope (ecologia 2012a, ecoscape 2016a). A total of 26 of the 84 burrows of *Idiosoma nigrum* recorded in the development envelope are located within the proposed disturbance footprint and will be cleared, resulting in local population mortality. The remaining 58 burrows are unlikely to be disturbed and SMC will avoid impact to these burrows where possible. The Proposal will mostly affect hilly areas for which the local *Idiosoma nigrum* population does not appear to have a preference. The species is closely associated with the presence of certain *Acacia* shrubs, one of which in particular, *Acacia ramulosa* var. *ramulosa*, occurs extensively beyond the development envelope. Approximately one third of the proposed disturbance footprint is mapped as high value *Idiosoma nigrum* habitat and the remainder mapped as medium *Idiosoma nigrum* habitat, all of which will be cleared as a result of the Proposal (Figure 71). The extent of available high and medium habitat beyond the proposed disturbance footprint and the distribution of this species outside this area, coupled with the low population density locally (3 burrows per hectare), suggests it is unlikely the removal of *Idiosoma nigrum* individuals, burrows and potential habitat as a result of the Proposal will significantly affect the species.

15.4.4 Potential cumulative impacts to key terrestrial fauna values of Mungada Ridge

Potential cumulative impacts to terrestrial fauna values within the Mungada Ridge landform area as defined by the EPA for the purposes of assessment of potential impacts to landforms (Figure 72) were assessed. The following terrestrial fauna values were included in this cumulative impact assessment:

- Tallering and Yowie land systems;
- Malleefowl mounds; and
- *Idiosoma nigrum* burrows.

The potential impact to terrestrial values of the Mungada Ridge landform ranges from no impact up to approximately 28.6% of the extent or number of records on Mungada Ridge as a result of existing, approved and proposed disturbance (Table 32). The greatest potential impacts are to *Idiosoma nigrum* burrows (28.6%) and currently inactive Malleefowl mounds (26.3%; Table 32).

Table 32: Potential cumulative impacts to key terrestrial fauna values of the Mungada Ridge landform

Environmental value	Original (pre-impact) extent / no. of mounds/burrows on Mungada Ridge	Existing impact on Mungada Ridge	Proposal impact on Mungada Ridge*	Cumulative impact on Mungada Ridge
Land systems*				
Tallering (associated with habitat types: Rocky ridge with steep slopes and Low slopes with dense Acacia shrubs)	656 ha	56 ha	22 ha	11.9%
Yowie (associated with habitat types: Eucalypt woodland plain with Acacia shrubs and Acacia shrubland plain)	0.4 ha	0 ha	0 ha	0.0%
Conservation significant species/potential SREs				
Malleefowl mounds	19	1	4	26.3%
Idiosoma nigrum burrows	84	2	22**	28.6%

* The ‘Proposal impact on Mungada Ridge’ represents the extent or number of individuals intersected by both the proposed disturbance footprint (Figure 3) and the Mungada Ridge landform area (Figure 10). It excludes Proposal impacts outside the Mungada Ridge landform area and may therefore be less than the total impact of the Proposal. ** Includes one burrow located 3 cm outside of the proposed disturbance footprint.

15.4.5 Potential cumulative impacts to key terrestrial fauna values of the Blue Hills Impact Assessment Area

Potential cumulative impacts to terrestrial fauna were assessed within the broader Blue Hills Impact Assessment Area; (Figure 72), which covers 73,579 ha. Cumulative impacts within the Blue Hills Impact

Assessment Area were assessed based on the proposed clearing together with approved and existing disturbance associated with the following mining operations:

- Auricorp (Rothsay) Pty Ltd;
- Falcon Minerals Limited;
- FMG Resources Pty Ltd;
- Fraka Investments Pty Ltd;
- Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd);
- Minjar Gold Pty Ltd;
- Mount Gibson Mining Limited;
- Raptor Resources Limited;
- Sinosteel Midwest Corporation Limited; and
- Zetec Resources Pty Ltd.

A small amount of additional existing disturbance considered was due to non-tenement holders (pastoralists of the Shire of Perenjori). Fauna habitat mapping was not available for the entire Blue Hills Impact Assessment Area at the time of undertaking this environmental impact assessment. Land systems have been used as a surrogate as the fauna habitats mapped by ecoscape (2016a) within the development envelope have been aligned with the Tallering and Yowie land systems (Table 25).

Potential cumulative impacts have been assessed within the Blue Hills Impact Assessment Area for the following:

- Tallering and Yowie land systems;
- Malleefowl mounds; and
- *Idiosoma nigrum* burrows.

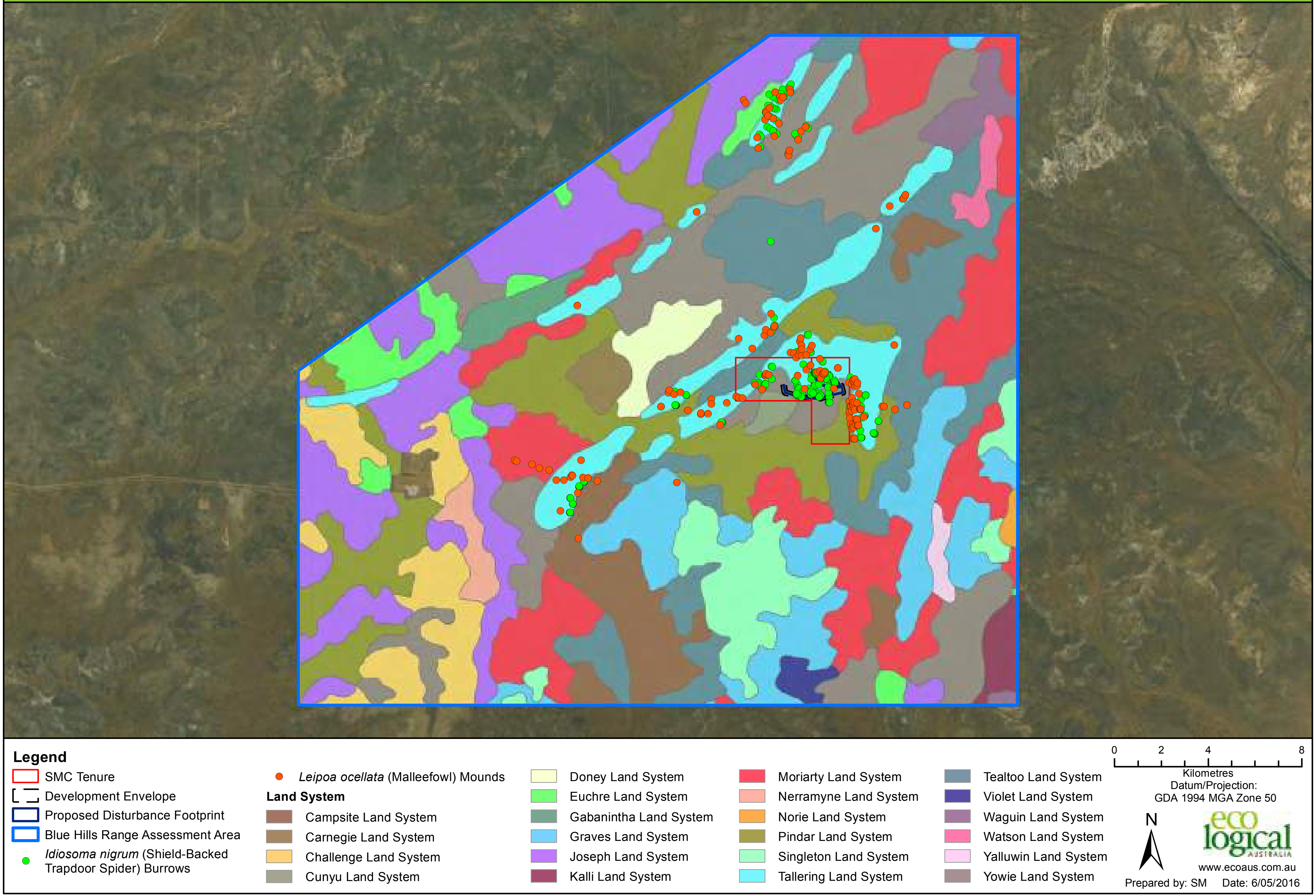
The potential cumulative direct impact of existing disturbance and Proposal disturbance ranges from approximately 22.3% to 28.8% of the extent or number of records in the Blue Hills Impact Assessment Area for the terrestrial fauna values assessed (Table 33). The greatest potential impacts are to the burrows of the confirmed SRE species *Idiosoma nigrum* (Table 33), with 28.8% of all known burrows to be have been impacted in the Blue Hills Impact Assessment Area following implementation of the Proposal and all other approved disturbance. The values provided in Table 33 are based on extent/records contained within existing project boundaries for other mining operations and may not reflect the actual extent or records that have been cleared.

Table 33: Potential cumulative impacts to terrestrial fauna values in the Blue Hills Impact Assessment Area

Project/tenement holder	Area of land systems (ha)		Conservation listed species	
	Tallering[1]	Yowie[2]	No. of Malleefowl mounds	No. of *Idiosoma nigrum* burrows
Existing impacts				
Auricorp (Rothsay) Pty Ltd	0.0	0.0	0	0
Falcon Minerals Limited	0.0	0.0	0	0
FMG Resources Pty Ltd	8.5	2.0	1	1
Fraka Investments Pty Ltd	2.4	0.0	0	0
Karara Mining Limited (including Gindalbie Metals Ltd and DSO Ventures Pty Ltd)	680.1	673.8	31	45
Minjar Gold Pty Ltd	1.3	16.9	0	0
Mount Gibson Mining Limited	0.4	4.5	0	0
Raptor Resources Limited	0.2	3.4	0	0
Sinosteel Midwest Corporation Limited	104.9	56.1	8	24
Zetec Resources Pty Ltd	0.0	0.0	0	0
Non-tenement holder	8.0	20.3	0	0
Total existing impacts	793.6	772.6	39	69
Proposal impact	21.4 (+ 8.7 indirect)	30.7 (+ 21.0 indirect)	5 (+ 2 indirect)	26 (+ 65 indirect)
Cumulative impact *	**815.0 (22.3%) (+8.7 indirect)**	**803.3 (28.3%) (+21.0 indirect)**	**44 (22.8%) (+2 indirect)**	**95 (28.8%) (+65 indirect)**
Pre-impact amount	**3,654**	**2,840**	**193**	**330**

[1]Associated with habitat types: Rocky ridge with steep slopes and Low slopes with dense *Acacia* shrubs. [2]Associated with habitat types: Eucalypt woodland plain with *Acacia* shrubs and *Acacia* shrubland plain. * The total cumulative impact may be less than the sum of all individual impacts due to overlap of projects.

Figure 72: Land Systems, Malleefowl Mounds and *Idiosoma nigrum* Burrows in the Blue Hills Impact Assessment Area



15.5 Key management actions

SMC have undertaken measures to avoid and where not practicable, minimise, impacts to fauna and fauna habitat. The proposed disturbance footprint has been reduced to the smallest area practicable while still maintaining operability and safety requirements. Original mine plans for the Proposal involved a larger proportion of the footprint on Mungada Ridge. In particular, the proposed waste rock dump was relocated from east of the proposed Mungada East Extension pit to south of the Mungada Ridge landform. This has reduced potential impacts to environmental values, including the rocky ridge with steep slopes fauna habitat.

Fauna values in the development envelope will be protected through implementation of measures in accordance with the Blue Hills Mungada East Expansion Condition EMP (Appendix D). Key mitigation and management measures to address potential direct and indirect impacts, include:

- injured vertebrate fauna will be given to a trained wildlife carer, or if not possible, euthanized humanely in accordance with DPaW standard operating procedures;
- containment and regular removal of food waste will be undertaken. Access to artificial water sources will be prevented;
- feeding animals will be prohibited and trapping and eradication programs will be implemented to remove feral animals as appropriate;
- speed limits will be enforced on roads in the development envelope to reduce dust;
- at locations of known active Malleefowl mounds and known Gilled Slender Blue-tongue locations, vehicle speed limits will be reduced further;
-
- as part of their on-site induction, all site personnel will be made aware of fauna species that occur in the locality (native and introduced);
- all known Malleefowl mounds and *Idiosoma nigrum* burrows, excluding those approved to be cleared, will be demarcated by survey pegs in the field with reference to design/site plans as a disturbance avoidance zone;
- all new observations of conservation significant fauna species (including new Malleefowl mounds and new *Idiosoma nigrum* burrows) will be reported to the site Environmental Superintendent;
- all fauna injuries or deaths will be reported to the site Environmental Superintendent. A Conservation Significant Fauna Mortality Register will be maintained by the Environmental Superintendent;
- dust generation from the Proposal will be minimised by engineering controls, vehicle speed restrictions on cleared tracks and use of dust suppression measures, such as water trucks, sprinklers and deluge sprays;
- noise generating equipment will be turned off when not in use or required;
- the introduction and/or spread of weeds will be minimised by ensuring equipment is cleaned to remove soil, vegetation, rock and debris prior to arrival to site; any equipment or vehicle considered to have been working in a weed risk area is cleaned down before remobilisation; and any new weed populations that arise in the development envelope area as a result of the Proposal are removed;
- external lighting will be restricted to the minimum required for a safe working environment;
- fire risk will be assessed and a fire prevention and management strategy developed. An emergency team will be located on-site to respond to fires; and
- disturbed areas will be rehabilitated as soon as practicable to facilitate fauna habitat restoration.

These management measures are considered to be standard practice, feasible and appropriate to manage the potential impacts of the Proposal on the terrestrial fauna. These measures are already being implemented at the existing DSO Project and EPA audit reports confirm SMC is in compliance with MS 811 as a result (See Section 21.4). Monitoring of the DSO Project also confirms minimal impacts have occurred as a result of indirect impacts, indicating management at the DSO Project has been effective to date (Section 14.3.3). Annual monitoring will be conducted of known Malleefowl mounds in the development envelope by suitability trained/experienced personnel. Information collected will include:

- location of mound;
- status (active, inactive);
- size;
- vegetation type;
- if Malleefowl were directly observed; and
- photograph of mound.

If new Malleefowl mounds are opportunistically recorded (or if inactive mounds become active), appropriate habitat will be resurveyed to determine the current Malleefowl distribution in the development envelope. Contingency actions will be implemented if a Malleefowl is found deceased due to anthropogenic reasons, such as vehicle strike or feral predation including investigation and retraining/education of personnel (see Blue Hills Mungada East Expansion Condition EMP in Appendix D).

15.6 Predicted outcome

After considering the application of avoidance, minimisation and mitigation measures, the following residual impacts on terrestrial fauna are predicted:

- direct loss of some individual fauna, particularly during vegetation clearing, including five inactive Malleefowl mounds and 25 *Idiosoma nigrum* burrows;
- clearing of approximately 52 ha of fauna habitat; and
- fragmentation of fauna habitat caused by the Mungada East Extension pit (proposed) and associated infrastructure.

The habitat types present in the development envelope are considered to be well represented in the local and regional area. It is considered likely that fauna will continue to forage in the remaining habitats within and adjacent to the development envelope. Rehabilitation of vegetation will be undertaken, with consideration given to restoring fauna habitat values where practicable.

SMC considers that it can restrict residual impacts to those described and manage the Proposal such that the EPA objective for terrestrial fauna can be met without further mitigation in the form of specific offsets being required for terrestrial fauna.

16 Subterranean fauna

16.1 Key statutory requirements, environmental policy and guidance

16.1.1 EPA objective

The EPA has applied the following objective to its assessment of the Proposal and potential impacts on subterranean fauna:

"To maintain representation, diversity, viability and ecological function at the species, population and assemblage level."

16.1.2 Regulatory framework

The following legislation is relevant to the Proposal with respect to the protection of subterranean fauna values and the above EPA objective:

- WC Act;
- EP Act; and
- EPBC Act.

16.1.3 Relevant guidelines and policy

The following guidelines are relevant to the Proposal with respect to the protection of subterranean fauna and the above EPA objective:

- EAG 12: Environmental Assessment Guideline for Consideration of subterranean fauna in Environmental Impact Assessment in Western Australia (EPA 2013b); and
- EPA Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in WA (EPA 2007).

16.2 Description of factor

Subterranean fauna are for the most part invertebrates subsisting under the ground consisting of two types of animals: troglofauna and stygofauna. Stygofauna are aquatic invertebrates that live in groundwater. Troglofauna breathe air and exist usually at depths greater than 3-4 m, with a distribution that extends down to the water table. Both troglofauna and stygofauna portray characteristics adapted for subterranean existence including pale colour, lack of eyes and elongated body appendages (Bennelongia 2015).

16.2.1 Subterranean fauna surveys

A Level 1 subterranean fauna assessment was conducted for the development envelope by Bennelongia (2015). The Level 1 assessment examined the subterranean fauna habitat in and around the development envelope, reviewed results of previous surveys in the area, and assessed the risk to subterranean fauna associated with the Proposal. The Bennelongia (2015) assessment also included a Level 1 reconnaissance field survey for troglofauna in the development envelope. Troglofauna samples were collected between 25 August and 14 October 2015 from 14 drill holes within the proposed mine pit area, with each hole scraped twice and trapped once. The survey was conducted in accordance with the general principles laid out for subterranean fauna sampling in EAG 12 and Guidance Statement No. 54a (EPA 2007, 2013b). The Bennelongia (2015) report is provided in Appendix C.

Two other subterranean fauna surveys have been conducted near the development envelope for the existing Blue Hills mine (ecologia 2008d, 2008e). Twelve stygofauna samples were taken from the

Koolanooka mine (approximately 67 km east), three were taken from Karara (10-20 km south-west) and one from Mungamia well (approximately 2 km north-west). The analysis conducted on these samples found that there is a very low stygofauna diversity in the area and that the species present are likely to be stygophilic (rather than stygobitic) species, which live part of their lives above ground and part below ground (ecologia 2008a, 2008b). The ecologia (2008a, 2008b) reports are provided in Appendix C.

Bennelongia (2015) conducted a Level 1 reconnaissance field survey for troglofauna in the development envelope between 25 August and 14 October 2015. Troglofauna samples were collected from 14 drill holes within the proposed mine pit, with each hole scraped twice and trapped once. The survey was conducted according to the general principles laid out for subterranean fauna sampling in EAG 12 and Guidance Statement 54a (EPA 2007, 2013b). Further description of the methodology used in the survey is provided in Bennelongia (2015), which is contained in Appendix C.

16.2.2 Stygofauna habitat

Extensive palaeochannel sand aquifers suitable for stygofauna occur in the Lake Monger and Moore palaeodrainage systems near the development envelope; however, these do not intersect the development envelope. The calcrete bodies and alluvial aquifers in the palaeovalleys of the Yilgarn Craton have been identified as areas rich in stygofauna species, with many of the species being restricted to single calcretes or particular habitats within a single calcrete (Guzik et al. 2008; Karanovic and Cooper 2011; Karanovic et al. 2014 as cited in Bennelongia 2015). Surveys in geologies other than alluvium and calcrete, including BIF (which occurs in the development envelope) have recorded low levels of stygofauna richness (Bennelongia 2009b).

Previous hydrogeological investigations in the development envelope (Rockwater 2006) identified large proportions of clay, unfractured orthoquatzite and chert in aquifiers in the vicinity of the Blue Hill mine, leading to low permeability and low porosity of the underlying sediments. Further, minimal fracturing of the metasedimentary rocks on the southern side of the Blue Hills range has also been observed, with all strata generally having a very low permeability. Large supplies of fresh groundwater are not readily available within the development envelope. Overall, these geological and hydrogeological data suggest lack of habitat and low likelihood of recording stygofauna at the Blue Hills mine or in the vicinity (ecologia 2008d, 2008e). Any stygal community that may occur would likely contain widespread stygophilic species, rather than stygobitic species. It is considered that there is no suitable habitat for stygofauna in the development envelope (Bennelongia 2015). On this basis and in accordance with EAG 12 (EPA 2013b), reconnaissance stygofauna sampling in the development envelope was determined to be not required (Figure 73) and was not undertaken.

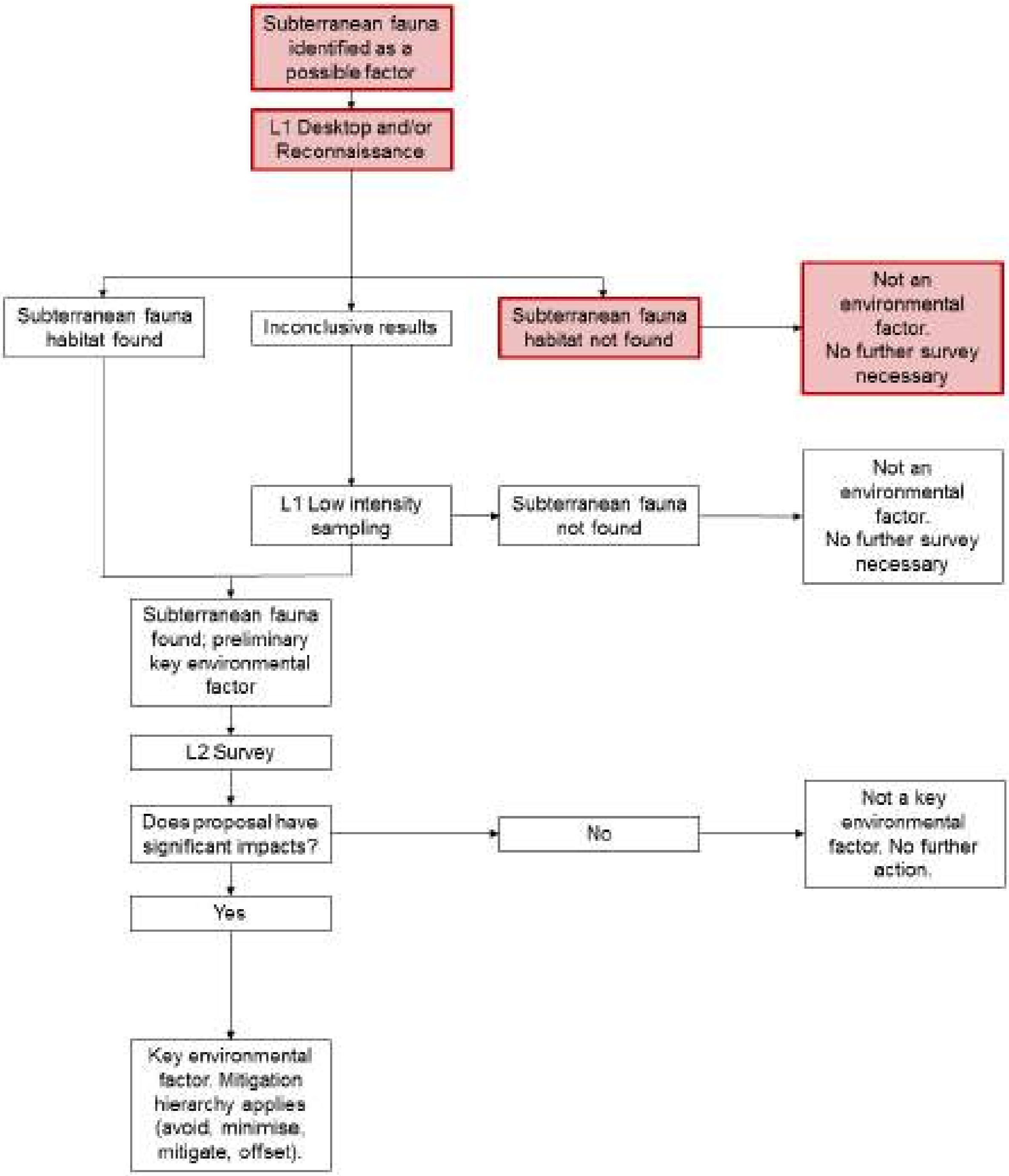


Figure 73: Diagram showing the process for undertaking subterranean fauna survey for EIA (EPA 2013b)

16.2.3 Stygofauna occurrence

A single stygofauna record has been previously collected from Mungamia Well, approximately 20 km south of the development envelope (ecologia 2008d). The stygofauna species was tentatively identified as the cosmopolitan species *Microcyclops varicans*, which was also recorded from one bore at the Koolanooka mine approximately 60 km west of the development envelope. No additional stygofauna surveys have been undertaken in the vicinity of Blue Hills and were not specifically undertaken for the Proposal due to the lack of suitable habitat in the Development Envelope (Section 16.2.2).

16.2.4 Troglofauna habitat

In the Yilgarn Craton, troglofauna appear to be more common in karstic calcrete than in other habitats (Guzik et al. 2010; Humphreys 2008 as cited in Bennelongia 2015), although they also occur widely, at low abundance, in BIF and some other weathered or fractured rocks (e.g. Bennelongia 2009a, 2009b; 2011, GHD 2010 as cited in Bennelongia 2015). Regionally, there is evidence that troglofauna species occur in BIF habitats of the western Yilgarn Craton when suitable microhabitats are present (e.g. vugs, fractures and cavities). However, existing surveys (sometimes based on very low sampling effort) suggest that troglofauna communities in the area are depauperate and that the constituent species probably occur at a very low abundance.

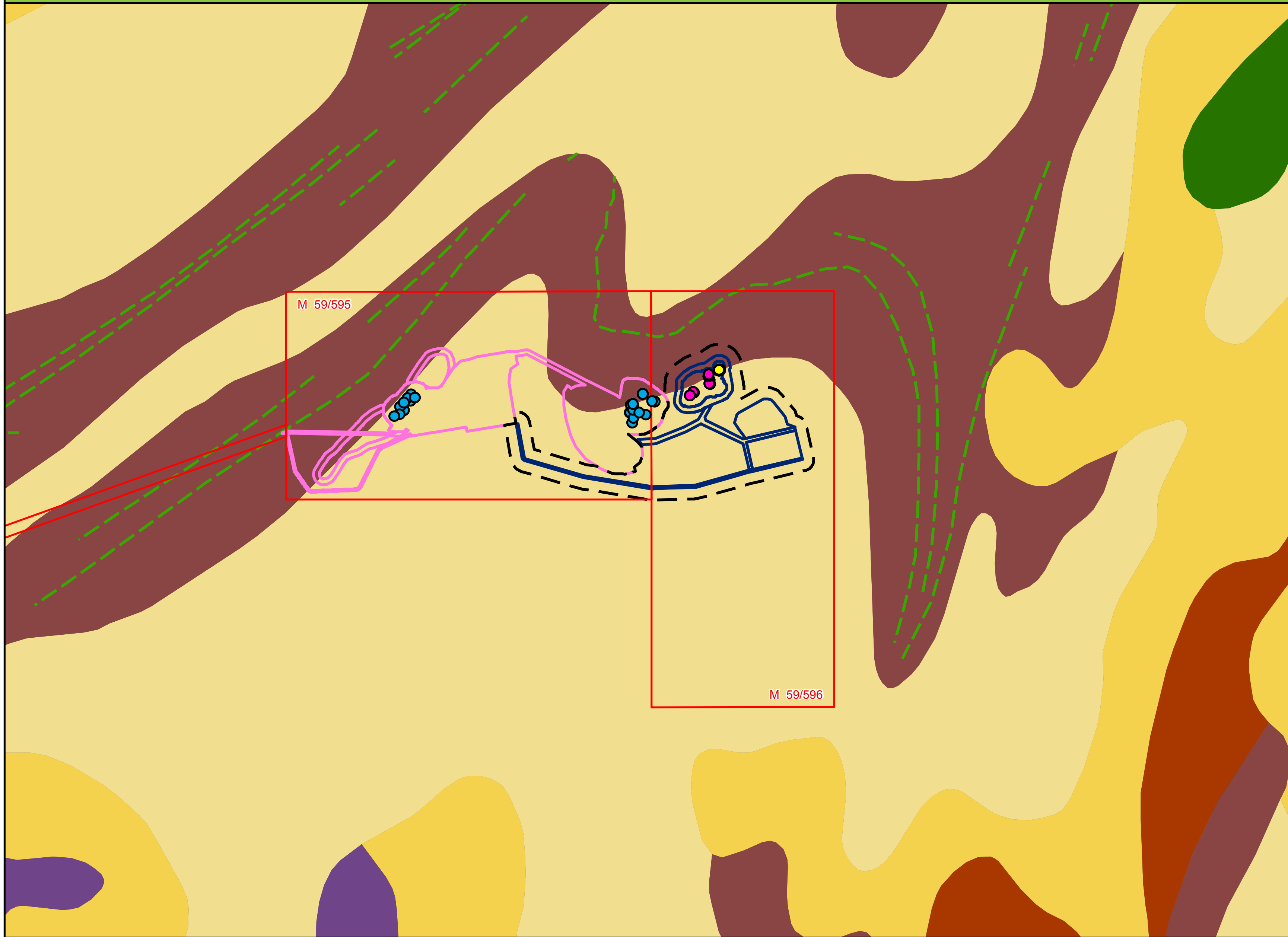
Prospective habitat for troglofauna is present within the development envelope in the form of BIF. The host BIF unit in which the proposed mine pit is located extends for approximately 10 km in a south-west to north-east direction along a fault line and represents a large expanse of prospective habitat around the proposed mine pit (Figure 74). The hematite ore in the proposed mine pit is not a unique geological formation in a regional context, but rather nests within a stretch of continuous BIF that contains few, if any, potential spatial barriers to dispersal. As such, contiguous prospective habitat for troglofauna is available to the north, east and west of the proposed mine pit.

Bennelongia (2015) assessed more than 40 photos of recently collected diamond drill cores from the proposed mine pit for evidence that the BIF habitat of the area is suitable for troglofauna. The photos showed numerous large vugs and cavities in several, but not all, diamond drill cores. This indicates there is suitable troglofauna habitat in the form of vugs, cavities and open holes in some, but not all, parts of the proposed mine pit. This habitat extends from relatively shallow depths (<8 m) through to deeper strata.

16.2.5 Troglofauna occurrence

One troglofauna species was collected (as five juvenile specimens) from two drill holes in the proposed mine pit during the 2015 survey (Figure 74). All specimens were nymphs (sub-adults) belonging to the hemipteran family Meenoplidae. Nymphs lack the sexual and other characteristics used for species identification and cannot be identified to species level with certainty (Bennelongia pers. comm. 2015). However, all specimens were morphologically similar and were considered likely to be troglophiles (with surface occurrence in one life stage, although mostly subterranean) rather than troglobites (with all life stages being subterranean) (Bennelongia 2015). No other troglofauna species have been recorded from Blue Hills.

Figure 74: Troglofauna habitat, sampling and records



Geology

- Aby - Metabasalt, high-Mg basalt, tholeiitic basalt, carbonated basalt, agglomerate, mafic schist, dolerite, amphibolite; porphyritic basalt and dolerite; komatiitic basalt; mafic pyroclastics; minor mafic schist with granite intercalations
- Ady - Mafic intrusive rocks, medium to coarse-grained; layered mafic to ultramafic intrusions; metadolerite; Medium to coarse-grained metagabbro, dolerite and granophyre, local ultramafic bases
- Asy - Conglomerate, chert, small amounts felsic volcaniclastic rocks, sandstone, quartzite, siltstone, phyllite, schist, pelite, shale. Include former Hatfield Formation.
- Aty - Amphibolite, mafic schist, mafic rock intercalated with granite, para-amphibolite; metabasalt, metagabbro, metapyroxenite and metadolerite; Youanmi Terrane
- Czl - Pisolitic, nodular or vuggy ferruginous laterite; some lateritic soils; ferricrete; magnesite; ferruginous and siliceous duricrusts and reworked products, calcrete, kaolinised rock, gossan; residual ferruginous saprolite
- Qrc - Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite

Data source: published 1:250,000 scale geological maps (Geological Survey of WA, and Geoscience Australia), supplemented in parts by more recent stratigraphic classification in GSWA 1:500,000 scale Solid Geology dataset (2008)

Legend

- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint

Subterranean Fauna Sampling and Records

- Bennelongia (2015) Sample Sites
- Meenoplidae Recorded
- Historical Sample Sites

- Indicative BIF (Aih - Hematite, Magnetite - Quartz)

0 0.5 1 2
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

www.ecoaus.com.au

Prepared by: SM Date: 6/05/2016

16.3 Assessment of potential impact, mitigation and residual impact

The EPA has listed the following potential impacts for the Proposal in relation to subterranean fauna:

- mortality and loss of habitat from excavation; and
- impacts to habitat from ground disturbance, stockpiling and surface contamination.

16.3.1 Stygofauna

There is no suitable stygofauna habitat in the development envelope and the Proposal will not intersect groundwater. The Proposal is therefore not expected to affect stygofauna and has negligible potential to contribute to local or regional cumulative impacts to stygofauna.

16.3.2 Troglofauna

The excavation of ore from the proposed mine pit will result in the direct removal of potential troglofauna habitat. The only troglofauna recorded from 14 drill holes sampled within the proposed mine pit area were five specimens of nymphs belonging to the hemipteran family Meenoplidae considered likely to be troglophilic, rather than troglobitic.

The potential troglofauna habitat in the development envelope extends for approximately 10 km in a south-west to north-east direction along a fault line and represents a large expanse of continuous prospective habitat around the proposed mine pit with few, if any, potential spatial barriers to dispersal. The proposed mine pit comprises <1% of this potential habitat, and in this context the loss of potential habitat from excavation of the proposed mine pit is considered to be negligible (Bennelongia 2015). It is expected that the distribution of the few troglofauna recorded in the development envelope will be more widespread based on the availability of habitat. It is therefore considered unlikely that troglofauna will be significantly impacted as a result of the Proposal. Consequently, the Proposal is not likely to contribute to local or regional cumulative impacts to troglofauna.

16.4 Key management actions

Extraction of potential troglofauna habitat will be restricted to the area of the proposed mine pit, limiting the geographic extent of potential impacts. Environmental management procedures to maintain surface water quality in the development envelope will provide mitigation of potential indirect impacts. Such measures will include the management of waste rock, erosion, sedimentation and contamination from sources such as spills from mine vehicles. The risk of pollutants being transported into subterranean habitats is likely to be low and restricted to localised areas. Storage areas for fuel will be located on the plains below the proposed mine pit; these areas do not support suitable habitat for subterranean fauna.

16.5 Predicted outcome

Subterranean fauna are unlikely to be significantly impacted by the Proposal. Extraction of troglofauna habitat will occur; however, continuous habitat is present beyond the proposed mine pit area and the extent of impact will be limited to less than 1% of a large expanse of continuous prospective habitat that extends for approximately 10 km in a south-west to north-east direction. SMC considers that there are no significant residual impacts to subterranean fauna that require an offset. After management and mitigation measures have been applied, it is expected that the Proposal will result in the following outcomes for subterranean fauna:

- direct mortality of individuals and reduction in available troglofauna habitat as a result of pit excavation. The continuous nature of BIF geology in which troglofauna have predominately been recorded indicates that geology is not a limiting factor in the distribution of the taxa currently known from the proposed mine pit within the development envelope.

17 Amenity

17.1 Key statutory requirements, environmental policy and guidance

17.1.1 EPA objective

The EPA has applied the following objective for amenity:

"To ensure that impacts to amenity are reduced as low as reasonably practicable."

17.1.2 Regulatory framework

The principal framework relevant to the assessment of impacts of the Proposal on amenity is the 'Visual Landscape Planning in Western Australia: a manual for evaluation, assessment, siting and design' (WAPC 2007). The manual outlines an approach to visual landscape planning that is appropriate for the planning framework of Western Australia. Completing a visual impact assessment for the Proposal in accordance with the manual is a requirement of the ESD.

17.1.3 Relevant guidelines and policy

The following guidelines are relevant to the Proposal with respect to the protection of amenity values and the above EPA objective:

- Visual Landscape Planning in Western Australia: a manual for evaluation, assessment, siting and design (WAPC 2007);
- Statement of Planning Policy No. 2 (Environment and Natural Resources; WAPC 2003); and
- EPA Guidance Statement No. 33 (EPA 2008).

17.2 Description of factor

Ecoscape (2016b; Appendix C) completed a Visual Landscape Evaluation (VLE) for the Proposal to provide baseline information on landscape values of the proposed disturbance footprint and surrounding areas (within 50 km). Results of the VLE are summarised in this section and have informed a Visual Impact Assessment (VIA), which identifies potential impacts of the Proposal on landscape and amenity values (Section 17.3.2). The information presented in this section has been sourced from the report containing the VLE and VIA (ecoscape 2015b) unless otherwise specified.

An independent peer review of the ecoscape (2016b) study was completed by Urbis (2015; Appendix F) in accordance with the requirements of the ESD. The peer review found that the ecoscape (2016b) assessment was prepared in accordance with the methodology outlined by the Western Australian Planning Commission Guidelines (WAPC 2007) and confirmed that the conclusions were appropriate and that the report accurately responded to the requirements of the Amenity factor as identified in the ESD. SMC responded to Urbis' findings, and Urbis subsequently provided a close out report, providing comment on how SMC has considered the peer review comments. SMC's response document and Urbis' close out report are also contained in Appendix F.

17.2.1 Landscape character

Landscape character is derived from a combination of biophysical and social characteristics such as landform, vegetation, waterform and land use. Broad Landscape Character Types (LCTs) have been identified by CALM (1994) for WA. Within the vicinity of the proposed disturbance footprint, the Meekatharra Plateau LCT is dominant, with its characteristics summarised in Table 34.

Table 34: Characteristics of the Meekatharra Plateau LCT

Landform	Vegetation	Waterform
Ancient, eroded landscape typified by gently undulating plains with rounded outcrops and conspicuous low, rugged ranges and hills. Small erosional scarps or breakaways and flat-topped mesas. Level to gently undulating burnt red sand plains interrupted by scattered, wind-formed dunes.	Diverse mix of vegetation dominated by *Acacia* scrub and York Gum-Salmon Gum woodland, the Mulga tree is a very characteristic species of this landscape. Warm terracotta to deep orange/red soils contrast with olive mulga and light green spinifex.	Shallow drainage lines and ephemeral water forms. Periods of extended dry weather are common, resulting in vast salt lakes. Following rainfall, these lakes appear almost as inland seas, linking along shallow watercourses. Tributary creeks and headwaters of major rivers, which in dry periods appear as flat beds of water sculptured sand and isolated pools.

The general character of the broad landscape encompassing the Proposal is of a natural landscape that is a densely vegetated scrub plain interspersed with woodland vegetation. Major landscape features include rolling hills and peaks and expansive salt lake systems. A number of iron ore mines operate in the area, including the Blue Hills mine, which is located adjacent to the development envelope. Large-scale infrastructure, such as transmission towers, has been installed within the landscape, but does not dominate the overall character. Broad acre agriculture occurs to the south-west of the proposed disturbance footprint (approximately 35 km away).

17.2.2 Landscape characteristics

The proposed disturbance footprint is located within the Karara Hills, Plains and Lakes soil landscape zone with elevation ranging between 370 and 440 m above sea level. Elevation in landscapes surrounding the proposed disturbance footprint is more variable, ranging from 250 to 680 m above sea level. Sandy plains with mulga shrubs and expansive salt lakes that are often dry dominate the landscape.

Vegetation is a dominant visual characteristic of the landscape surrounding the proposed disturbance footprint, due to its extensive distribution, which affects the view experience. *Acacia* species dominate, including low mulga (*Acacia aneura*) and *Acacia* shrublands on the hills such as *Acacia aneura*, *A. quadrimarginea, A. ramulosa* and *A. grasbyi*. Banded ironstone formations are covered in scrub including *A. ramulosa, Allocasuarina* spp., *Melaleuca* cf. *uncinata*, *A. quadrimarginea* and *Acacia acuminata* and scattered eucalypts. Valley systems contain *Acacia* scrub and scattered trees (Markey and Dillon 2008).

Land use surrounding the proposed disturbance footprint has a history of grazing, with some pastoral leases being progressively destocked with the intention of future gazettal as conservation estate (Markey and Dillon 2008). Large areas of remnant vegetation therefore dominate the landscape. There is also a history of extensive mining for gold and iron ore in the landscape surrounding the proposed disturbance footprint.

17.2.3 Landscape Character Units

While an LCT has common characteristics at a regional scale, there will be variations within an LCT that can be defined at a local scale. A Landscape Character Unit (LCU) is a geographic area within an LCT sharing common characteristics such as landform, vegetation, waterform and cultural land use patterns relevant to human interaction and experience. Ecoscape (2016b) identified four LCUs surrounding the proposed disturbance footprint from fieldwork and desktop analysis. The LCUs display particular aesthetic characteristics which relate to form, line, colour, texture, scale, vegetation, waterform and land use, as follows:

- Hills;
- Scrub Plain;
- Salt Lakes; and
- Agricultural.

The Hills LCU (Plate 11) is a natural landscape characterised by an expansive horizon which appears as a dark silhouette with straight to subtle curved lines of horizontal form when viewed from a distance. The horizon line transitions to a rolling form as opposed to a horizontal form and the colours consist of red to orange underneath dark green vegetation that is dotted on the hill slopes, contributing to a textured appearance.

Plate 11: Hills LCU viewed from close proximity

The Scrub Plain LCU (Plate 12) is the general character of the landscape surrounding the proposed disturbance footprint covering the greatest area. It also affects the view experience from most of the travel routes in the region. This LCU is a natural and expansive landscape covered in scrub vegetation that is generally dense. Occasionally, the canopy is open where woodland is present. Infrastructure is evident occasionally, including for example the transmission line that is visible along Mungada Road that is also visible from high lookout points where it runs to the Karara Mine.

Plate 12: Scrub Plain LCU viewed from a distance with elevation and the Hills LCU visible on the horizon line

The Salt Lakes LCU (Plate 13) occurs as an arc surrounding the proposed disturbance footprint, and its natural character makes it a feature landscape amongst the Scrub Plain LCU. When viewed from a distance and at high elevations, the Salt Lakes LCU is characterised by straight lines, horizontal form, a light blue colour and smooth texture which contrasts with the surrounding landscape, which is dark and textured. From a closer view, there is a greater variety of colours such as pale creams, light orange and light blues of the bare areas and dark green patches of vegetation.

Plate 13: Salt Lakes LCU viewed from close proximity

The Agriculture LCU (Plate 14) is located to the south-west of the proposed disturbance footprint. It is a rural landscape that has been cleared for cropping and grazing. This LCU is characterised by straight lines and horizontal forms of flat relief, with straight and vertical fences. The colours vary depending on the season from light creams, greens and yellow with an orange undertone of the soil. Exposed stony soils can create a textured appearance at close views. When viewed from a distance, the open paddocks have a smooth texture.

Plate 14: Agriculture LCU viewed from close proximity

17.2.4Landscape values

Visual quality is described in CALM (1994) as "the relative visual character of a landscape, expressed as an overall visual impression or value held by society after perceiving an area of land / water." CALM (1994) identified that visual quality increases with greater:

- naturalness value, such as landscapes that have minimal modification and where natural features are prominent;
- presence of water features;
- topographic relief and ruggedness;
- vegetation and landscape diversity, including rural landscapes showing topographic variety and transition zones between agricultural and natural land; and
- historic features and land use patterns that strengthen the local rural character.

More recently the WAPC (2007) identified key character indicators that can be used as a basis for classifying the landscape into two preference categories; 'most' preferred and 'least' preferred landscapes. These preference categories were established for natural, rural and built landscapes. 'Most' preferred characteristics are defined as landscape features that are highly valued by the community and contribute to the visual character. 'Least' preferred are features not valued by the community and detract from the visual character.

Within the landscape surrounding the proposed disturbance footprint, there are a variety of preferred characteristics that occur, such as:

- topographic variety (Hills LCU);
- expansive landforms (Hills LCU and Salt Lakes LCU); and
- presence of water bodies (Salt Lakes LCU).

These values are associated with the Hills LCU and Salt Lakes LCU, which are feature landscapes amongst the extensive Scrub Plain LCU. They provide visual variation in line, form, colour and texture. The Hills LCU consists of rolling form amongst a horizontal landscape and the Salt Lakes LCU has a lighter colour and smoother texture amongst the dark green textured Scrub Plain. There are also landscape values at a smaller scale, such as vegetation diversity and rock outcrops.

17.2.5View experience

The way a landscape is perceived will differ amongst observers but general valued characteristics can be categorised from the extensive desktop research undertaken by CALM (1994) and WAPC (2007). Understanding view experience is an integral part of developing strategies to manage visual landscape character.

The main factors contributing to view experience within landscape surrounding the proposed disturbance footprint are position in the landscape and the presence of vegetation. The view experience in the region is generally enclosed by landscape features, such as hills and roadside vegetation that consists of dense scrub and occasionally, woodland vegetation. When the road traverses higher elevations, there are views to the distant horizon. Where the road approaches a hill, the vegetation creates a focal view experience.

17.2.6 Recreation

The Proposal is situated in the Karara complex. The area attracts a variety of recreation users to undertake activities such as 4WD exploration, camping, walking, prospecting and nature study.

There are also future plans to promote particular areas as a tourism-conservation-recreation destination. For example, a conservation park is proposed in the Mungada Ridge area to be managed by DPaW, which may include a recreation site (picnic area) and a walk trail. Similarly, the Karara complex is identified for development into a conservation/recreation destination in both the Midwest Tourism Development Strategy 2014 and the Midwest Development Commission's Regional Blueprint 2015. The Karara complex has also been identified as part of Tourism Western Australia's Caravan and Camping Action Plan (Tourism Western Australia 2013) and Parks Wildlife's Parks for People Program (DPaW 2014) with funds allocated for recreation development. This includes further promotion of existing travel routes, such as the Rothsay Heritage Trail[1], defined bush camping areas in appropriate sites, defined camping at homesteads and other forms of recreation.

17.3 Assessment of potential impact, mitigation and residual impact

17.3.1 Visual assessment framework approach

A VLE was undertaken to assess the proposed disturbance footprint in context of the surrounding landscape and to set objectives for managing the visual landscape character (ecoscape 2016b). Potential impacts of the Proposal on the landscape were then described in a VIA, utilising the results of a desktop assessment, site assessment, photo montage analysis (comprising three-dimensional modelling), viewshed analysis and visual impact analysis. Methodology for the assessment followed WAPC (2007) (as summarised in Figure 75).

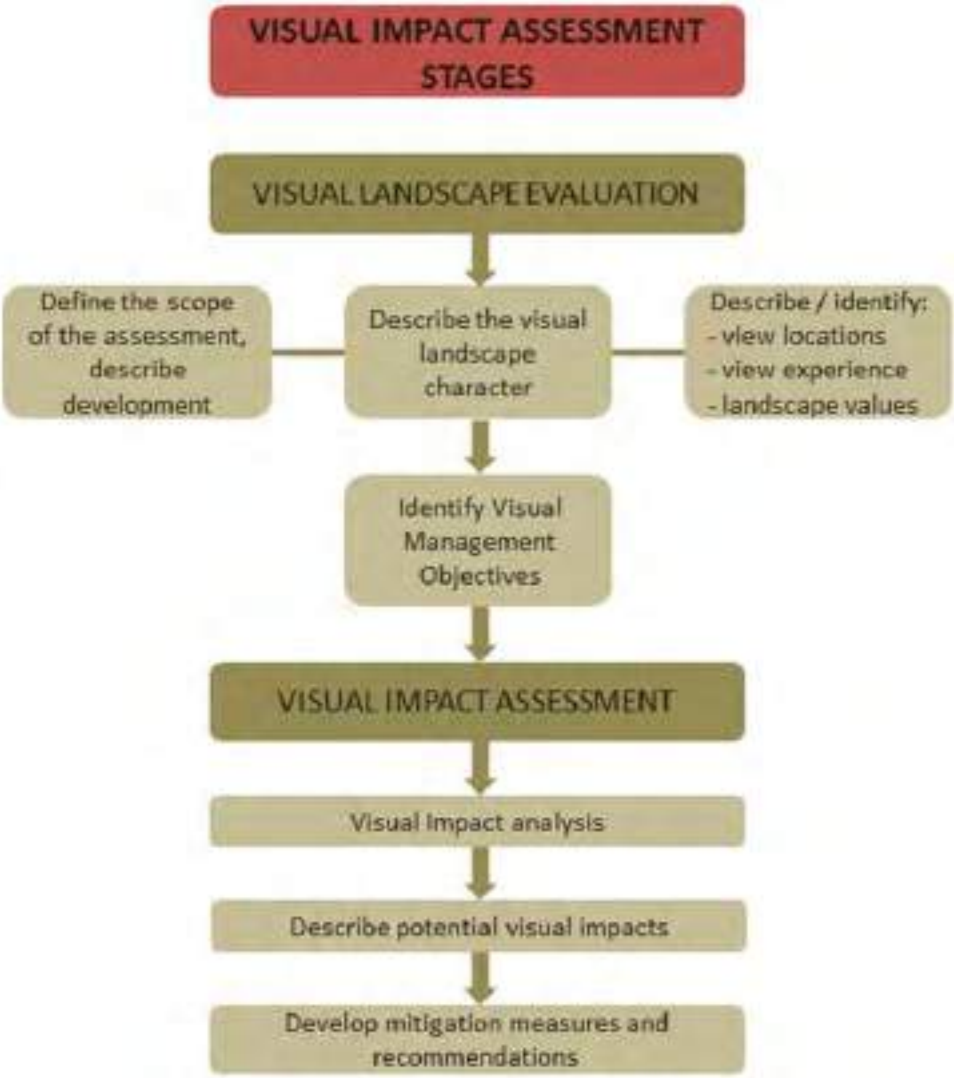


Figure 75: Visual Assessment Framework (ecoscape 2016b)

[1] Perenjori Rothsay Road and Warriedar Copper Mine Road are promoted by the Shire of Perenjori and Yalgoo as the Rothsay Heritage Trail, which is a 180 km route tracing the early history of the area and the links to gold mining and agriculture.

Visual management objectives (VMOs) for managing landscape character were developed through the evaluation and mapping of LCUs, landscape values, key views and viewsheds, in accordance with WAPC (2007). The aim of VMOs is to provide criteria that enable the assessment of visual impacts.

'Protection and maintenance' was assessed to be the appropriate VMO for the Hills LCU and Salt Lakes LCU. Protection and maintenance is the maximum retention of existing visual character, which is likely to apply to highly valued visual landscapes. Future development in these areas is to be planned and designed in a manner that has minimal visual impact on landscape character (WAPC 2007).

'Best practice siting and design' was assessed to be the appropriate VMO for the Scrub Plains LCU and Agriculture LCU. Best practice siting and design is the baseline objective that should apply to the landscape surrounding the proposed disturbance footprint and includes applying sensitive design guidelines that do not detract from the visual landscape (WAPC 2007).

17.3.2 Visual Impact Assessment

To determine the level of visual impact of the Proposal on the landscape, visual impact criteria developed as a conceptual framework for analysing landscapes, and include the visual elements that are used to describe landscape character: line, form, colour, texture and visibility.

Ecoscape (2016b) adapted these criteria into an assessment table to categorise visual impacts into three levels. These visibility categories relate to how much the proposed change contrasts with the surrounding landscape and were defined as:

- not evident: development is hidden, screened or not visible, from specified viewing locations;
- moderate visibility: development is evident, but is not a dominant feature and blends with the existing landscape; and
- high visibility: development is a dominant feature in the landscape, drawing attention to itself.

Visibility was also assessed in the context of the public sensitivity level and the VMO identified for the landscape, to identify an overall 'impact level' rating which can also be described as the significance of visual impact.

The overall impact levels were:

- Level 1: Visual impact is likely to be at variance with the VMO;
- Level 2: Visual impact may be at variance with the VMO;
- Level 3: Visual impact is unlikely to be at variance with the VMO; and
- None: There is no visual impact.

The impact of the Proposal was assessed according to these levels by applying the criteria (evaluating visibility categories) from a variety of view locations within 50 km of the proposed disturbance footprint. View locations were selected in consultation with representatives of DPaW as required by the ESD.

From most view locations, there will be no visual impact to the view experience as a result of the Proposal (Table 35). From most of the view locations, the proposed disturbance footprint is not visible due to the extensive Scrub Plain LCU, which screens views. Additionally, landforms screen the proposed disturbance footprint from view locations along Warriedar Copper Mine Road and Yalgoo Ninghan Road. From Lochada Road (a minor road), the proposed disturbance footprint may be visible at a distance of 50 km. While the viewshed and three-dimensional modelling predicted that the proposed disturbance footprint should be visible from this location, the existing Mungada East pit and proposed disturbance footprint were not visible to the naked eye during the site inspection. If the proposed disturbance footprint was visible from this location, the impact would be Level 2 (and may be at variance with the VMO of protection and maintenance) based on the landscape values within the view.

The Proposal was assessed to have a Level 2 impact when the landscape was viewed from a distance of 24 km at John Forrest Lookout. Although the results of the VIA indicate the Proposal would have a Level 2 impact to the view from the John Forrest Lookout, and Lochada Road if the proposed disturbance footprint was visible from this location, it is considered unlikely that the impact at either location would actually be at variance with the VMO. This conclusion is mainly based on the distance of these sites from the proposed disturbance footprint and the minimal proportion that the proposed disturbance footprint would occupy within the field of view.

The Karara mine is visible from John Forest Lookout and only just visible from Lochada Road. However, although the colour and texture of the proposed disturbance footprint would draw the eye to the mine, as it would contrast with the surrounding dark green textured landscape, the mine would also share some similar visual elements to the surrounding landscape such as line and form, which would assist in it ‘blending’ into the landscape and could be seen particularly if the observer is stationary, such as at John Forrest Lookout.

DPaW is proposing to develop a walk trail around the eastern portion of Mungada Ridge. From the conceptual walk trail, the Proposal would be partially visible as demonstrated by the viewshed analysis provided in ecoscape (2016b). It is likely that the proposed eastern extension pit will have a greater visibility from the trail if there is no vegetation screening present (ecoscape 2016b). Other mining development in the vicinity is also expected to be visible from the walk trail.

The visual impact to landscape character is limited to the Hills LCU. The objective for this LCU is the protection and maintenance of the rugged landform. From a broad scale (within 50 km), this VMO will be met as the overall character of the Hills LCU will retain its prominence.

Table 35: Overall visual impact level within 50 km of the proposed disturbance footprint

View Location	Visibility	VMO	Sensitivity Level	Visual Impact Level
Mungada Road	Not visible	Best practice siting and design	3	**None**
Lochada Road	Inconclusive	Protection and maintenance	3	**Level 2 if visible**
Perenjori Rothsay Road	Not visible	Best practice siting and design	3	**None**
Rothsay Road	Not visible	Protection and maintenance	3	**None**
Karara Road	Not visible	Best practice siting and design	3	**None**
John Forrest Lookout	Moderately visible	Protection and maintenance	3	**Level 2**
Damperwah Hills	Potentially visible	Protection and maintenance	3	**Level 2**

View Location	Visibility	VMO	Sensitivity Level	Visual Impact Level
Warriedar Copper Mine Road	Not visible	Best practice siting and design	3	**None**
Yalgoo Ninghan Road	Not visible	Protection and maintenance	3	**None**
Great Northern Highway	Not visible	Best practice siting and design	1	**None**
Mungada Ridge (conceptual trail)	Potentially visible	Protection and maintenance	3	**Level 2**

17.3.3 Summary of findings

The assessment concluded that for most of the landscape within 50 km of the proposed disturbance footprint, the Proposal will not have a visual impact on the surrounding landscape due to the following:

- vegetation screening along travel routes;
- landform screening along travel routes that occur to the east of the development envelope; and
- distance of the proposed disturbance footprint to key view locations. The closest location is along Warriedar Copper Mine Road, which is approximately 6-7 km to the south-east. From this location, Mungada Ridge screens the view to the proposed disturbance footprint.

From John Forrest Lookout and possibly Lochada Road, the visual impact was assessed as Level 2 due to the landscape values that are evident from these views however, it is considered that the proposed disturbance footprint is not likely to be actually at variance with the VMOs identified, due to:

- distance – the proposed disturbance footprint occupies a minimal proportion of the field of view when viewed from John Forrest lookout and possibly from Lochada Road;
- shared visual characteristics - the line and form of the proposed mine pit are similar to the surrounding landscape; and
- low public sensitivity – both view locations were assessed to have a low public sensitivity level (Level 3 – local significance).

Cumulatively, the Proposal is not likely to have a significant impact on visual amenity, as even though the Karara mine is also visible from John Forest Lookout and just visible from Lochada Road, the factors described above also apply for existing infrastructure. The Proposal is not expected to significantly contribute to local or regional cumulative impacts to visual amenity. The VMO for the Hills LCU and Salt Lakes LCU is likely to be achieved as the prominence of these landscape features and the view experience would be retained if the Proposal was to proceed. From all other view locations within 50 km of the proposed disturbance footprint, the VMOs of best practice siting and design (for the Agriculture LCU and Scrub Plain LCU) would be achieved as the development is not visible from these locations.

With regard to the Conceptual Mungada Ridge walk trail, it is unlikely that the Proposal, including the existing Blue Hills mine, will generally be noticeable after rehabilitation (ecoscape 2016b). Some of the pit wall of the proposed pit may be visible where it extends above the proposed 2 m high bund that will surround the pit once rehabilitated (ecoscape 2016b). The waste rock dump, haul roads and infrastructure area will be rehabilitated with local endemic species and should blend with the surrounding landscape (ecoscape 2016b).

17.4 Key management actions

It has been identified that the proposed disturbance footprint is unlikely to be at variance with the VMOs for the surrounding landscape. Therefore visual impact mitigation to manage landscape character and view experience are not likely to be required.

In regards to the DPaW conceptual Mungada Ridge walk trail, there are a number of strategies that can be considered when designing the trail to minimise the potential visual impact of the development area, such as:

- Design the walking direction to be clockwise so that visitors are walking away from the mine when traversing the ridgeline;
- Locate lookouts for visitors to enjoy key views that are focussed away from the development area; and
- Locate the trail outside of the viewshed of the visible portions of the development area.

Alternatively, the recreation masterplan for the area may incorporate the mine into the visitor experience providing lookouts and interpretation facilities for the mine. Mine legacy planning is another option that converts the land use of the mine into recreation opportunities which may increase visitor numbers to the area.

17.5 Predicted outcome

Photo montages prepared by ecoscape (2016b) for Lochada Road (Plate 15) and John Forrest Lookout (Plate 16) depict the likely visibility of the proposed disturbance footprint from these sensitive locations. The Proposal will have minimal impacts on amenity and landscape values due to screening provided by roadside vegetation and the distance at which sensitive view locations are located from the proposed disturbance footprint.

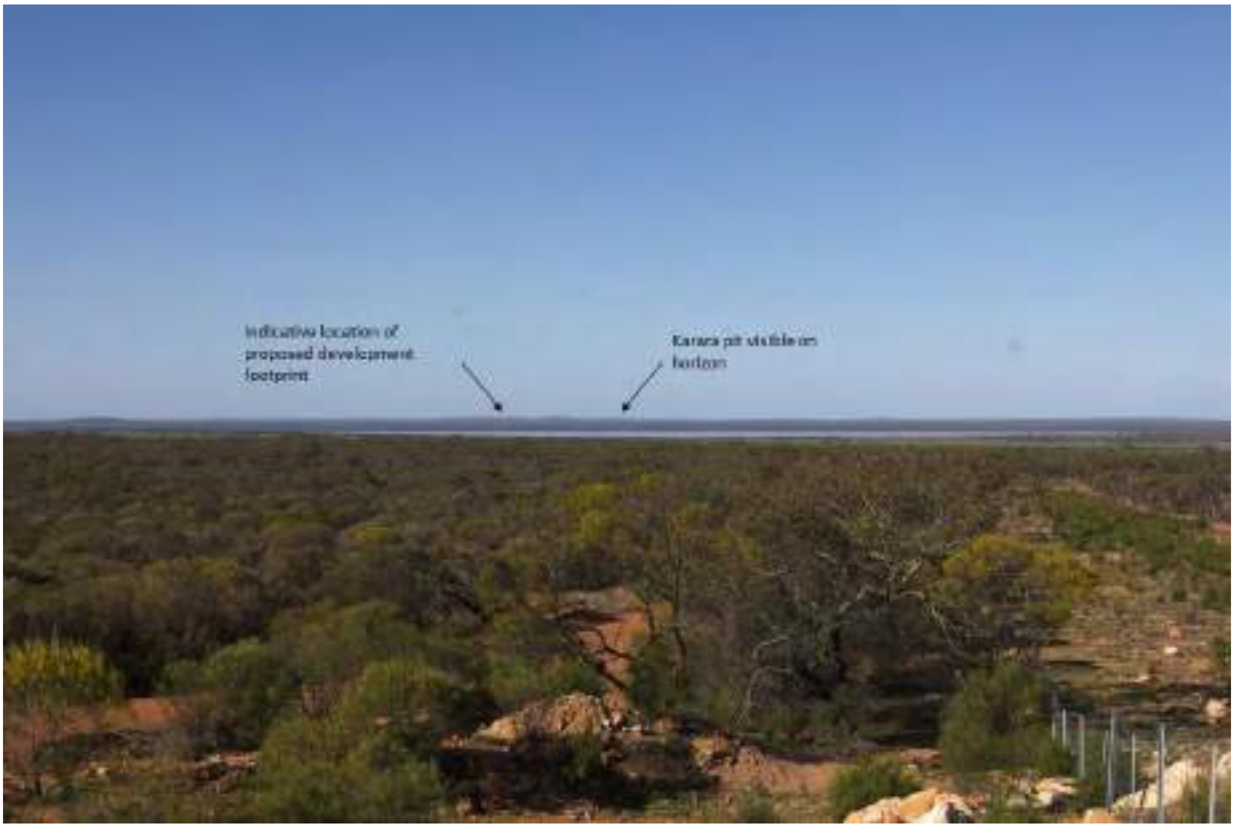


Plate 15: Photo montage of the proposed disturbance footprint (marked in red on the horizon) from Lochada Road

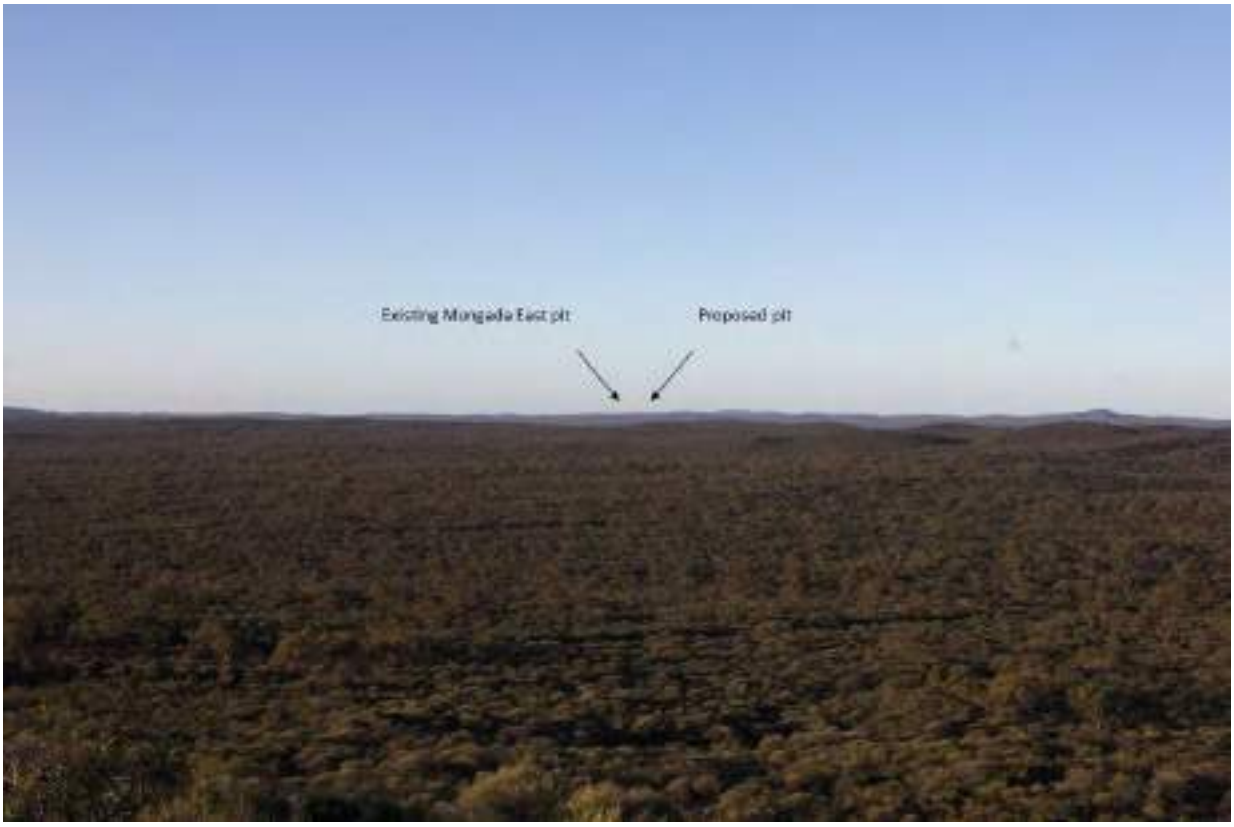


Plate 16: Photo montage of the proposed disturbance footprint (marked in red on the horizon) from John Forrest Lookout

18 Rehabilitation and decommissioning

18.1 Key statutory requirements, environmental policy and guidance

18.1.1 EPA objective

The EPA has applied the following objective for rehabilitation and decommissioning:

"To ensure that premises are decommissioned and rehabilitated in an ecologically sustainable manner."

18.1.2 Regulatory framework

The following legislation is relevant to the Proposal with respect to rehabilitation and decommissioning and the above EPA objective:

- EP Act;
- Contaminated Sites Act 2003 (WA);
- Mining Act 1978 (WA);
- Mines Safety and Inspection Act 1994 (WA); and
- Rights in Water and Irrigation Act 1914 (WA).

18.1.3 Relevant guidelines and policy

The DMP and EPA (2015) have issued the Guidelines for Preparing Mine Closure Plans – May 2015 (Closure Guidelines), which establish standards for closure plans being submitted to Government. The *Mining Act 1978* (WA) has been amended to specifically require closure plans that comply with the Closure Guidelines to be submitted with mining proposals, and reviewed on a three-yearly basis.

The following guidelines are relevant to the Proposal with respect to rehabilitation and decommissioning and the above EPA objective:

- Guidelines for Preparing Mine Closure Plans – May 2015 (DMP and EPA 2015);
- EPA Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (EPA 2006);
- Strategic Framework for Mine Closure (ANZMEC and MCA 2000);
- Mine Closure and Completion (DITR 2006a); and
- Mine Rehabilitation (DITR 2006b).

18.2 Description of factor

The Proposal will result in the clearing of up to 53.5 ha of native vegetation on and adjacent to the Mungada Ridge within a 172.5 ha development envelope. This disturbance comprises:

- up to 18.6 ha for the proposed mine pit and pit abandonment bund area;
- up to 11 ha for the proposed waste rock dump;
- up to 11.3 ha for the proposed supporting infrastructure (processing); and
- up to 12.6 ha for the proposed haul roads and access road.

These areas will be rehabilitated at the completion of the proposed mining operations. The following sections provide an overview of the Blue Hills Mungada East Expansion Mine Closure Plan, including stakeholder consultation, closure objectives and indicative completion criteria.

18.2.1 Existing closure and rehabilitation requirements

Rehabilitation for the Proposal will be undertaken in accordance with existing closure and rehabilitation requirements for the DSO Project and tenements M59/595 and M59/596, as far as practicable.

Key existing closure and rehabilitation requirements for the DSO Project that will be applied to the Proposal are:

- the provision of a detailed rehabilitation planning strategy to ensure the proposed waste rock dump is constructed to optimise rehabilitation outcomes, taking into consideration soil chemistry, landforms, hydrology and appropriate plant species for the area;
- progressive rehabilitation of all areas disturbed by mining activity, except the proposed mine pit, including:
    - The re-establishment of flora and vegetation as far as practicable;
    - Weed coverage no more than that in undisturbed nearby areas or less than 10%, whichever is the lesser;
- progressive monitoring of the performance of rehabilitation in liaison with DPaW and DMP, with annual reporting; and
- post-closure management and monitoring of the mine pit void to ensure no significant environmental effects through attraction of native fauna (which may be harmed by contact with the water), attraction of fauna or stock (which may harm surrounding vegetation), or attraction of predators (which may prey on native fauna).

Closure-related tenement conditions for M59/595 and M59/596 are included in the Legal Obligations Register of the Blue Hills Mungada East Expansion Mine Closure Plan (Appendix E).

18.3 Assessment of potential impact, mitigation and residual impact

The implementation of the Proposal will result in the loss of vegetation and habitat, soil disturbance, and changes to the natural landforms. The following sections provide a description of the existing and proposed mitigation measures to effectively rehabilitate the Proposal.

18.3.1 Mine Closure Plan

A Mine Closure Plan has been prepared for the Proposal (Appendix E). The Blue Hills Mungada East Expansion Mine Closure Plan has been prepared consistent with the Closure Guidelines (DMP and EPA 2015) and the requirements of the ESD. It provides a closure plan for the Proposal that is part of a broader integrated vision for tenements M59/595 and M59/596.

Stakeholder engagement

Discussions regarding the Proposal have been held with a number of stakeholders (Table 3). The Blue Hills Mungada East Expansion Mine Closure Plan has taken into consideration concerns raised during consultation for the Proposal, including in relation to AMD, surface water runoff, amenity and post-mining landforms.

Closure objectives

The closure and rehabilitation objectives for the Proposal are to ensure that land disturbed by the proposed mining activities remains undisturbed from secondary impacts in the future, that all disturbed areas are rehabilitated to as close as possible to the natural surroundings, and that rehabilitated areas are:

- safe to humans and wildlife;

- non-polluting;
- geotechnically and erosionally stable;
- self-sustaining with minimal maintenance required post-closure;
- ecologically similar to the pre-mining environment, incorporating local native plant taxa and fauna habitat;
- visually compatible with the surrounding natural landscape;
- suitable for agreed post-mining land uses; and
- compliant with the requirements of SMC's statutory approvals.

Development of completion criteria

Indicative closure completion criteria have been developed for the Proposal (Table 36). These will be refined following further rehabilitation trials to be conducted during operation and based on findings of rehabilitation monitoring.

Table 36: Completion criteria for the Proposal

Closure objectives	Completion criteria	Measurement tools
• Impacted areas are returned to self-sustaining vegetation communities and fauna habitats that reflect the pre-disturbed state.	• Within five years post closure, flora and vegetation has been re-established to at least 70% composition of the original known diversity. • The creation of habitat features similar to those present in the development envelope prior to mining will be created, wherever practical. • Habitat creation initiatives include, but are not limited to the following: - Creation of rock piles to provide potential habitat opportunities for reptiles and mammals; - Creation of landscape features, which may include small hollows and cracks suitable for reptiles and mammals; and - Return of vegetation debris, logs and rocks to areas which have been disturbed to provide microhabitats for recolonising fauna. - Vegetation includes locally endemic species of known importance to fauna. • Signs of fauna recolonisation are apparent. • Vertebrate pests (rabbit, foxes, goats and feral cats) have been controlled where necessary.	• Rehabilitation conducted as per BGPA research program. • Deep ripping has been conducted in rehabilitation areas. • Flora species have been identified for use in rehabilitation and seed collection, and reflect principles of vegetation succession. • Comparison of vegetation density and diversity with agreed criteria. • Flora monitoring surveys to determine health of rehabilitated vegetation. • Fauna surveys to determine the presence or absence of fauna indicator species. • Completion of fauna habitat assessment using site inspection and evaluation of vegetation monitoring results. • Vertebrate fauna surveys have been conducted in representative rehabilitated areas in order to demonstrate that local bird, mammal and reptile species are recolonising in typical rehabilitated sites. • Vertebrate pest species have been controlled as required.

Closure objectives	Completion criteria	Measurement tools
• Weed species cover does not increase, relative to the pre-mining condition.	• Within five years post closure, weed coverage represents no more than in undisturbed bushland or less than 10%, whichever is the greater.	• Annual weed surveys and vegetation health assessments.
• Water quality will be maintained so as to ensure that pre-mining beneficial uses of surface water and groundwater are unaffected by changes in water quality.	• Groundwater concentrations do not exceed Groundwater Investigation Levels as stated in the National Environmental Protection Measure (Guideline on Investigation Levels for Soil and Groundwater, Schedule B1, Australian Government, 2013); or • If initial site baseline groundwater surveys indicate higher levels than the National Environmental Protection Measure investigation levels, post-mining water quality will not exceed pre-mining contaminant concentrations by more than two standard deviations.	• Monitoring of groundwater quality on an annual basis. • Monitoring program demonstrates that pollutant levels at potentially contaminated sites are within National Environmental Protection Measure investigation levels or comparable to pre-mining concentrations.
• Soil quality will be maintained so as to ensure that pre-mining beneficial uses of soil are unaffected by changes in soil chemical or physical condition. • Chemical and physical condition of surface soils does not impede plant growth.	• Soil bulk density and infiltration capacity in the upper 0.5 m of the rehabilitated surface are comparable to the pre-mining condition.	• Pre-closure contamination survey of infrastructure area where fuels and chemicals are stored, including the explosives magazine. • Testing of soil parameters relevant to plant growth in the upper 0.5 m of rehabilitated landforms. • Annual vegetation monitoring.
• Topsoil remains viable and has the capacity to support a safe, stable and functioning ecosystem that meets the requirements of the post-mining land use.	• Topsoil will be stored for use during rehabilitation.	• Adequate topsoil / alternate subsoil material has been provisioned and stored in advance of mine closure.
• Prepare for Care and Maintenance	• All waste is removed and disposed of appropriately. • Safety/abandonment bunds are in place. • Pit and waste dump slopes are geotechnically stable and safe. • Erosion from landforms is similar (frequency of rills, rate of sediment	• Selected infrastructure has been removed prior to Care and Maintenance and rehabilitation has commenced to simulate the pre-disturbance state as closely as possible. • Safety and abandonment structures are in place and waste

Closure objectives	Completion criteria	Measurement tools
	yield) to naturally occurring slopes in the development envelope.	dumps have been shaped to design criteria. • Annual audits of pit and bund integrity. • Comparison of erosion response of landforms with agreed reference sites.
• At final closure, to remove all infrastructure and waste to enable the site to be rehabilitated to the agreed post-closure land use.	• At final closure, selected project infrastructure has been decommissioned and taken off site. • All waste has been removed and disposed of appropriately.	• Selected infrastructure has been removed and rehabilitation has commenced to simulate the pre-disturbance state as closely as possible. • Site inspection / audit before final demobilisation.
• Final landforms have been developed such that they will remain structurally stable, and safe to humans and fauna without ongoing maintenance. • Waste dump landforms to conform to the agreed post-closure land use.	• Safety/abandonment bunds are in place. • Pit and waste dump slopes are geotechnically stable and safe. • Erosion from landforms is similar (frequency of rills, rate of sediment yield) to naturally occurring slopes in the development envelope.	• Safety and abandonment structures are in place and final landforms have been shaped to design criteria. • Annual audits of bund integrity. • Results of pre-closure geotechnical review. • Comparison of erosion response of built landforms with agreed reference sites.
• Ensure that aesthetic values of the landscape are considered, and measures are adopted to reduce the visual impacts on the landscape. • Maintain and protect any significant landscape, indigenous heritage and geo-heritage values.	• The waste dump blends in with the surroundings and reduces the visual impact of mine.	• The waste dump is surveyed to ensure it is within specified parameters.

18.3.2Waste

Geochemical characterisation of waste

MBS environmental undertook a Soil and Waste desktop assessment for the Proposal (MBS 2015). The geochemical composition of waste rock for the Proposal was characterised by MBS (2015) using laboratory data from SMC's exploration and resource definition activities. Samples used had been taken at 1 m intervals from exploration holes drilled within the proposed mine pit. A total of 2,267 samples of ore grade materials (iron contents >50%) and 1,373 samples of waste rock materials (iron contents <50%) were included in the assessment.

Sulphur concentrations (and the risk of acid formation) within ore grade and waste rock samples were generally assessed to be low to very low. Only 0.4% of the total ore grade samples and 2.7% of waste rock samples contained sulphur concentrations greater than 0.3% (MBS 2015).

The acid neutralising capacity of the material has been assessed to be low (MBS 2015). The only significant rock type containing elevated concentrations of sulphur were carbonaceous 'black shales', which are expected to contribute a minor proportion of total mine waste. These materials are easily identified by texture and colour and are expected to be encountered deep in the proposed mine pit (at depths of at least 65 m). These black shales are the only waste type requiring segregation from other mine waste for preventing formation of AMD (MBS 2015).

A summary of the acid formation potential classification of mineral waste that will be generated from the Proposal is provided in Table 37.

Table 37: Acid formation potential classification for mineral waste that will be generated from the Proposal (MBS 2015)

Waste class*	Ore grade samples		Waste rock samples	
	Number	Percentage	Number	Percentage
Barren	1,692	74.6	886	64.5
Non-acid forming (NAF)	566	25.0	450	32.8
Uncertain (Probably NAF)	9	0.4	18	1.3
Potentially acid forming (PAF) – low capacity	0	0.0	1	0.1
PAF – high capacity	0	0.0	18	1.3

* Barren = sulphur (S) concentration <0.3% and Acid Neutralising Capacity (ANC) <5 kg H2S04/t; NAF = S concentration <0.3%, ANC >5 kg H2S04/t and negative Net Acid Producing Potential (NAPP); Uncertain (Probably NAF) = S concentration >0.3%, NAPP 0-5 kg H2S04/t; PAF (low capacity) = S concentration >0.3%, NAPP 5-10 kg H2S04/t; PAF (high capacity) = S concentration >0.3%, NAPP >10 kg H2S04/t.

Indications of the degree of salinity and sodicity in ore grade and waste rock materials were provided by examination of the measured sodium concentrations in the samples analysed. Ore grade materials contained very little sodium, with 99% of samples analysed containing 0.10% or less as sodium oxide (Na_2O). The proportion of waste rock samples with 0.10% or less Na_2O was lower (87.2%), but the majority of samples were still classified as either non-saline or of low sodicity based on these data. The risk of waste rock forming saline drainage or containing dispersive sodic clays was rated as very low (MBS 2015).

Ore grade materials and, to a lesser degree, ferruginous waste rock samples, were enriched in manganese compared with average crustal abundance (Bowen 1979; Table 38). As the chemical properties of manganese are similar to iron, enrichment is not uncommon. Concentrations of copper, nickel, lead and zinc were generally very low in ore grade and waste rock samples, with most samples containing lower concentrations than the corresponding average crustal abundance values (Bowen 1979; Table 38). The risk of production of AMD containing these metals from stockpiles of ore or waste rock landforms is considered very low (MBS 2015).

Table 38: Heavy metal concentrations in ore grade and waste rock samples (MBS 2015)

Statistic	Concentration (mg/kg)				
	Manganese	Copper	Nickel	Lead	Zinc
Ore grade samples					
Minimum	<100	<10	<10	<10	<10
Maximum	46,000	380	330	300	130
Mean	2,700	30	20	<10	<10
Median	1,000	30	20	<10	<10
Waste rock samples					
Minimum	<100	<10	<10	<10	<10
Maximum	49,800	790	860	1,860	160
Mean	1,110	60	40	20	<10
Median	300	30	20	10	<10
Average crustal abundance					
	950	55	75	12.5	70

There are no available data for other potential environmentally significant metals and metalloids such as arsenic, cadmium, mercury, molybdenum and selenium. However, enrichment of metals such as cadmium, mercury and molybdenum is generally not associated with iron mineralisation. Although metalloids including arsenic and selenium are known to have a strong affinity for iron oxide minerals and may therefore be present in concentrations above the corresponding average crustal abundances, they are unlikely to be soluble under circum-neutral drainage conditions because of very strong surface adsorption reactions (MBS 2015).

Physical characterisation of waste and landform design

The total waste that will be produced from the Proposal is approximately 13.5 Mt, the total volume of which is 5.68 million cubic metres (Mm^3). Approximately 4.17 Mm^3 (74%) will be backfilled to the existing Mungada East pit, which would exhaust the available space in this pit void. A further 1.2 Mm^3 (22%) will be disposed of to the existing Mungada East waste rock dump, which currently has 1.2 Mm^3 of available storage capacity as it has not been developed to the full approved capacity. This would leave a balance of 310,000 cubic metres (m^3) (4%), which will be disposed of to the proposed new waste rock dump to be constructed to the south-east of the proposed mine pit.

The proposed waste rock dump (Plate 17) will have a maximum elevation below the highest point on the natural ridge line of Mungada Ridge. Drainage systems will be constructed to minimise the risk of contamination of natural water courses and groundwater. Suitable surface water drainage will be incorporated to limit seepage into the waste rock dump and reduce erosion of the slopes. A stability assessment of the proposed waste rock dump conducted by SRK (2015) determined the slopes of the proposed waste rock dump would meet recommended slope stability and safety criteria

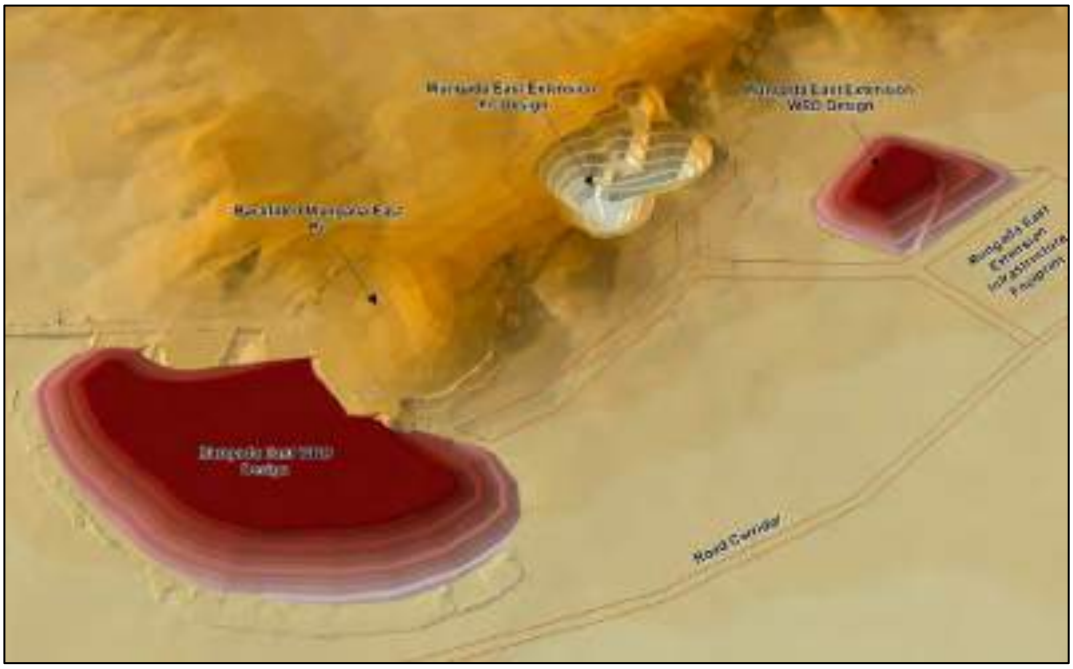


Plate 17: Conceptual layout of the Proposal showing proposed backfilling of the existing Mungada East pit

Water management of the site will be implemented to keep clean water clean and direct the contact water to appropriate containment systems. The strategy adopted to manage any potential for AMD is to:

- define the location of PAF material;
- quantify the amount of PAF material;
- avoid disturbance of PAF material where possible; and
- store PAF material in designated PAF cells constructed within the waste rock dump to minimise exposure to air and water.

Suitability of soil for rehabilitation

Based on similarities of soil types and vegetation within the development envelope and nearby areas, topsoil harvested from disturbed areas within the development envelope is expected to provide adequate quantities of nitrogen when used for rehabilitation of waste landforms, provided it is stockpiled in accordance with the DMP and EPA (2015) Closure Guidelines.

As phosphorus and sulphur concentrations in topsoil from the development envelope are expected to be comparable with those from nearby areas (MBS 2015), there is no requirement for supplementary phosphorus and sulphur from fertiliser to promote effective rehabilitation of waste landforms. Concentrations of copper, iron, manganese and zinc were within typical ranges of WA soil types and not likely to adversely affect nutrition of plants on rehabilitated landforms (MBS 2015).

Gravelly soil excavated from slopes and ridges of BIF landforms are expected to be ideal for rehabilitation of batters of mine waste landforms. However, the skeletal nature and shallow depth of these soils may limit the volume of harvested soil. Additional soil resources are expected to be provided by harvesting from areas at lower elevations, such as waste rock dump footprints and other operational areas.

Topsoil and vegetation will be stripped and stockpiled in dedicated areas for later use in rehabilitation. Topsoil stockpiling will occur in small volumes given soil profiles naturally contain only a thin topsoil horizon.

As far as possible, topsoil will be placed directly onto areas ready for revegetation to minimise the need for topsoil stockpiling. Where stockpiling is unavoidable, designated stockpiles will be placed within existing approved stockpile areas for the DSO Project.

18.3.3 Rehabilitation and research trials undertaken to date

With regard to SMC's existing DSO Project, the biodiversity criteria for rehabilitation of both the Koolanooka mine and the Blue Hills mine are to achieve the following within five years after cessation of productive mining:

- re-establishment of flora and vegetation with not less than 70% composition (not including weed species) of the known original species diversity; and
- weed coverage of no more than that in undisturbed bushland in the area or <10%, whichever is the lesser.

SMC is currently undertaking research and rehabilitation trials to ensure that these biodiversity criteria will be able to be achieved. The trials will provide valuable information to improve rehabilitation outcomes for the Proposal and are a collaboration with BGPA; the most recent annual report is contained in Appendix C. In addition to achievement of the biodiversity criteria, the trials aim to ensure disturbed areas can be rehabilitated with vegetation representative of original communities, including sub-communities of disturbed TECs and PECs. This will include trials to restore vegetation representative of the 'Plant assemblages of the Koolanooka System' TEC and the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC.

Field trials of rehabilitation techniques have so far shown the effectiveness of topsoil for seed germination and cross ripping in improving soil physical properties (water infiltration). Key findings to date of progressive rehabilitation at the Blue Hills and Koolanooka mines and the research trials are provided in Table 39.

Table 39: Key findings to date of progressive rehabilitation and research trials for SMC

Aspect	Key findings
Plant communities target	• Vegetation surveys have informed the target species selection and the identification of reference sites for monitoring
Informing seed collection	• Shallow broadcasting of smaller seeds requires surface sowing, whereas larger seeds, e.g. *Senna* and *Acacia*, have improved emergence and vigour when buried at 1-3 cm • Seed storage for PEC species indicates that most species are capable of long-term storage that involves drying (15 °C, 15% relative humidity) followed by storage at -18 °C, though longer-term testing is underway.
Substrate trials	• Topsoil can be blended with substratum crushed rock to cover a larger area, as the addition of rock to topsoil ('topsoil + rock') had no negative impact on seedling emergence • Cross ripping improves soil properties, including alleviation of machine-based soil compaction, and increases water infiltration relative to areas that were not ripped • Seedling emergence from broadcast seed is significantly lower in 'fines' substrate (a residue material from the mining process) than topsoil and 'topsoil + rock' substrates

Aspect	Key findings
	• Seedling survival is influenced by growth medium, with substantial differences between rock and fines • Soil crusting issues indicate that soil should be spread dry and seeded as soon as possible to ensure that seed integrates into the soil.
Climate	• Restoration success may be hampered by low rainfall years, and therefore irrigation should be considered where feasible, and trials are underway.
Progress towards achievement of 70% species replacement for the 'Plant assemblages of the Koolanooka System' TEC	• In 2014, 62 species from the TEC offset area target community germinated from soil, seed or cuttings (the 70% reinstatement requires 59 species) • In 2015, 46 species from the TEC offset area target community germinated from collected, stored and dormancy-alleviated seed, with an additional eight species established from cutting or seed propagated tubestock (total 54 species of the target 59 species) • 'Restoration nodes' have been established as intense plantings to create establishment islands within the restoration context as a means of focusing the limited and valuable propagation materials • Use of 'smart seed' technology including seed priming and seed pelleting represents the first time in Australia and represents a key approach for ensuring limited seed from the TEC and PEC areas is used in an most ecologically responsible way • Plant community analysis is underway in restored sites compared to reference communities to provide regulatory confidence that restored communities in the TEC at the Koolanooka mine resemble composition of TEC reference sites. Assessments underway • Grazing controls such as fencing show benefits to rehabilitation, particularly from feral goats.

Overall, the research programs are well resourced and focused on key issues that will ultimately provide a benchmark for resolving restoration capability for the PEC. A summary report detailing quantitative results of the research program to date (as per the requirements of the ESD) was prepared by Kingsley Dixon, and was peer reviewed by Mr Greg Woodman of Woodman Environmental Consulting. Both reports are contained in Appendix F. SMC responded to Mr Woodman's findings, and Mr Woodman subsequently provided a close out report, providing comment on how SMC has considered the peer review comments. SMC's response document and Mr Woodman's close out report are also contained in Appendix F.

The status and outcomes of rehabilitation currently being undertaken at other BIF environments in the Yilgarn Craton are provided in Table 40.

Table 40: The status and outcomes of rehabilitation currently being undertaken at other BIF environments in the Yilgarn Craton

Mine location	Commencement date	Finished date/ ongoing	Rehabilitation activities	Completion criteria	Status/outcome
Mt Gibson Mining Ltd – Tallering Peak					
Approximately 220 km north-west of the Mt Gibson Ranges.	The mine started operation in 2004. Operations concluded and rehabilitation began in 2014.	Rehabilitation works are understood to have been completed in 2015.	The following activities have been undertaken in areas of rehabilitation (Mount Gibson Iron 2014, 2015): • Landforms were reshaped to resemble the surrounding landscape • Topsoil was applied to a depth of 5-20 m • Deep ripping along contours was undertaken • Rehabilitation areas were hand-seeded with a variety of local provenance species.	The aim of the rehabilitation is to create a safe, stable, non-polluting and self-sustaining landform consistent with the surrounding landscape (Mount Gibson Iron 2014). The four completion criteria for rehabilitation areas are (Mount Gibson Iron 2015): • Vegetation composition on rehabilitated areas is representative of the pastoral land use, ecosystems and vegetation community requirements • Mean Landscape Function Analysis stability rating of ≥50% • Infiltration rating of 20% • Nutrient rating of >15% and compares favourably with natural analogue site trends. The site will have regular monitoring for several years post-closure until agreed completion criteria targets have been achieved.	Currently half of the waste rock landforms at Tallering Peak have reached an advanced stage of rehabilitation. The northern face of the landform has met all completion criteria and performance indicators. The remaining 50% of waste rock landforms have undergone initial rehabilitation. This includes landform stabilisation, earthworks, growth media spreading and on-contour ripping complete (Mount Gibson Iron 2015).
Cliffs Natural Resource Operations – Mt Jackson Range					
Approximately 110 km north-north-east of Southern Cross near Mount Manning, on a	The mine commenced in 2004.	The mine expansion is expected to operate until 2021 after which	The Mt Jackson Range deposit was divided into discrete areas that included landforms or features with similar rehabilitation needs.	The rehabilitation aim of the site is to re-establish a self-sustaining ecosystem compatible with surrounding undisturbed areas. Reference sites were established around Mt Jackson, consisting of undisturbed landforms.	The outcomes of the most recent survey (Cliffs Asia Pacific Iron Ore Pty Ltd 2014) are as follows: Vegetation cover:

Mine location	Commencement date	Finished date/ ongoing	Rehabilitation activities	Completion criteria	Status/outcome
section of BIF Range (EPA 2010). The mine expansion is composed of two pits, one waste rock landform and ore stockpiles.		rehabilitation will commence.		Relevant completion criteria are: Finishing earthworks: • Surface cover of 0.2 m of soil covered by rock/gravel and vegetation debris to mitigate against erosion Revegetation: • 20-70% foliage cover, species richness and plant density based on three reference sites • Less than the average of the three reference sites for weed coverage • Managed grazing of introduced species to reduce impact on rehabilitation Sustainability: • 20-70% foliage cover, species richness and plant density maintained for five consecutive years post-mining • Rehabilitated landforms provide habitat and food for a variety of fauna species • Water management structures are in place. Emissions and discharges do not result in off-site impacts to soil, water or vegetation • Rehabilitated landforms do not require ongoing management of stability, erosion, drainage and soil or water contamination. The site will have constant monitoring of the rehabilitation areas and weed control will be undertaken annually for an estimated period of	• For dominant species, the average total foliage cover per plot was comparable to each of the three previous monitoring events Vegetation condition: • All plots were in excellent or very good condition, with the majority in excellent condition • No decline in vegetation condition between 2013 and 2014 surveys Condition of conservation listed flora: • There was an overall improvement in the health of *Bossiaea sp.* Jackson Range from 2013 to 2014 • *Spartothamnella canescens* individuals within 100 m of

Mine location	Commencement date	Finished date/ ongoing	Rehabilitation activities	Completion criteria	Status/outcome
				10 years. The following assessments are planned: Landform stability: • Assessment of erosion, sedimentation and physical condition of water management structures in rehabilitated areas Soil cover: • Annual assessment of soil cover of rehabilitated landforms against design criteria Vegetation: • Annual assessment of foliage cover, species richness and plant density of perennial native vegetation at rehabilitated landforms and references sites • Annual assessment of weed cover • Annual assessment of grazing impacts on rehabilitated areas Sustainability: • Observation of native vertebrate and invertebrate fauna occurring in rehabilitated areas • Assessment of contaminated soils, emissions and discharges (including groundwater quality and vegetation downstream).	operations remained healthy during 2013 • Overall health of *Stenanthemum newbeyi* increased at all three locations • The health of *Calytrix* sp. individuals decreased in operations areas and increased in control areas Weeds: • No weeds were recorded in plots during the 2014 survey, or previous years Soil moisture: • Monitoring in 2014 showed a decrease in average soil moisture at all plot locations, likely due to a lack of rainfall.

Mine location	Commencement date	Finished date/ ongoing	Rehabilitation activities	Completion criteria	Status/outcome
Polaris Metals Pty Ltd – Carina Iron Ore Project					
Approximately 60 km north-west of Koolyanobbing.	Operations began in 2011.	Operation of the Carina Iron Ore Project is proposed for 5-10 years after which rehabilitation will commence.	The rehabilitation plan outlines the process for waste rock landforms. In cleared areas topsoil (100 mm where available) is to be removed and stockpiled. Earthworks will be conducted to reshape the waste rock and construct major water management features. The topsoil will be replenished to a depth of approximately 100 mm. Revegetation is scheduled for May and June to benefit from seasonal rains and will consist of: • Ripping waste landforms on contours • Application of local native seed mix at rates of 5-10 kg/ha • Application of phosphorus and trace elements fertiliser at a rate of 100 kg/ha • Optional supplementary planting of seedlings.	The overall objective is to establish safe and stable final landforms, with self-sustaining vegetation, similar to the surrounding landscape. The criteria for the successful rehabilitation of the mine is as follows (Polaris Metals Pty Ltd 2011b): Safety, stability, and sustainability: • The overall health and safety of humans, stability of soils and landforms, long-term sustainability for agreed land uses Soils: • Soil profiles and structures must ensure landform stability Off-site impacts: • Significant adverse off-site impacts must be avoided Pollution: • Pollution due to chemical spillage, excavation of substrates, or changes to hydrology (e.g. acid drainage) must be avoided or managed Hydrology: • If there are major changes to hydrology as a result of mining operations, criteria must be established to measure flows and availability of surface and groundwater to receiving environments Resilient and self-sustaining vegetation:	It is understood that rehabilitation recently commenced at a 5 ha site.

Mine location	Commencement date	Finished date/ ongoing	Rehabilitation activities	Completion criteria	Status/outcome
			Acacia, Allocasuarina, Atriplex, Eucalyptus and *Maireana* species will be used due to ease of collection of large quantities and relative ease of successful establishment in mine site rehabilitation (Polaris Metals Pty Ltd 2011a). Rehabilitation will be conducted throughout the life of the mine.	• Species diversity: Specified targets are based on site data or analogue plots. Setting appropriate targets requires knowledge of the proportion of plant species that are likely to recruit or can be propagated from seed in the short term • Abundance and cover: Sustainable rehabilitation requires vegetation cover to be sufficient to stabilise landforms and exclude weeds. In most cases, completion criteria are based on relative cover of native plants in permanent plots or transects. Permanent photographic monitoring points will be established • Weed management: Effective weed management requires demonstration that: (a) the relative cover of minor weeds is low, and (b) major weeds capable of becoming dominant at the expense of native plants are absent Pest species: • Control of introduced animal species that can have a major impact on native plants and animals. Animal grazing also requires effective management in rehabilitated areas. Monitoring and assessment of rehabilitation will be based on Ecosystem Function Analysis methodology. This comprises three modules: vegetation composition and dynamics, habitat	

Mine location	Commencement date	Finished date/ ongoing	Rehabilitation activities	Completion criteria	Status/outcome
				complexity and Landscape Function Analysis. Initial targets are: • Species diversity: Rehabilitated landforms should trend towards a target of 30% of the reference site after three years • Abundance and cover: Rehabilitated landforms should trend towards a target of 30% plot cover after three years • Weed management: Monitoring and photographic records showing weed species on-site are limited to <5% cover.	

18.3.4 Next stages of research

A field trial is underway to achieve a target species diversity of 70% of original diversity at the offset site associated with the Koolanooka mine. The field trial involves the use of topsoil, seeding and tubestock. Future stages of the collaborative research project will focus on accurate development of seeding rates for a wide range of species to reduce seed wastage and analysis of potential efficiency measures such as the use of seed versus tubestock, the use of seed technologies (e.g. seed pelleting – the addition of inert materials to seeds to improve plantability), and irrigation (including investigation of the effects on emergence of single irrigation events versus several pulses of irrigation). Plant survival will also be assessed to inform planting density for infill planting in subsequent years.

An upcoming field trial at the Blue Hills mine will determine which species are lost from the seed bank in the topsoil stockpiles after one year of storage to recommend species for seed collection and quantify the benefits of short stockpiling times (in terms of species recruitment and requirements for seed collection).

Laboratory trials at Kings Park will determine propagation methods for species with insufficient seed for broadcasting and which will need to be replaced via tubestock. Glasshouse and laboratory trials will determine the threshold rainfall required for seedling emergence, and hence indicate the likelihood of seedling emergence each year, for unirrigated sites.

18.3.5 Best practice mining rehabilitation

SMC considers that it is at the forefront of research to address the lack of knowledge and experience in BIF restoration of semi-arid floristic communities, including re-instatement of Threatened and Priority Ecological Communities. Detailed research, trials and monitoring to achieve successful outcomes have been conducted by SMC and are ongoing. SMC and BGPA are leading research techniques and technologies developed by BGPA to underpin rehabilitation success at three of SMC's sites (Koolanooka, Blue Hills and Weld Range). Knowledge derived from this research will provide a solid foundation to develop effective rehabilitation strategies for the Proposal.

The research should be of regional significance to land managers and conservation agencies with an interest in the conservation and rehabilitation in the Midwest. The project will contribute to long-term conservation benefits and ultimately enable significant biodiversity conservation and rehabilitation in the post-mined landscape of the SMC's operations with flow-on benefits in terms of:

- ecosystem function and stability;
- meeting best practice standards in biodiversity following mining; and
- contributing information towards developing a scientifically robust means for establishing completion criteria for rehabilitation programs.

18.3.6 Post-mining land uses

SMC will conduct rehabilitation and restoration such that the post-mining land use reflects the environmental values of the surrounding landscape.

18.4 Key management actions

Rehabilitation and closure for the Proposal will be structured around a number of 'closure domains', each of which will be characterised by landforms or infrastructure that have similar rehabilitation, decommissioning and closure requirements/objectives. The closure domains for the Proposal will be as follows:

- proposed mine pit (including pit abandonment bund area);
- proposed waste rock dump;

- infrastructure (processing); and
- roads (haul roads and access road).

For each domain, a set of consolidated closure implementation strategies has been assigned (Section 18.4.1). Prior to commencement of rehabilitation, SMC will prepare a rehabilitation planning strategy to ensure the characteristics of the proposed waste rock dump optimise rehabilitation outcomes.

18.4.1 Key rehabilitation strategies

SMC has adopted the following key rehabilitation strategies for the Proposal:

- progressive rehabilitation of disturbed areas and the proposed waste rock dump;
- control of disturbance through on-ground delineation and a well-defined permitting system;
- establishment of vegetation communities consistent with pre-mining communities in similar landscape units in and around the development envelope;
- salvage topsoil and segregate soil bearing seed bank from different landscape units; and
- implement stringent weed hygiene practices throughout construction, operations, decommissioning and rehabilitation.

All disturbed areas will be rehabilitated upon closure with the exception of the mine pit void, which will remain open. Infrastructure will be removed and the site will be left clean and tidy. The rehabilitation process will involve contouring for blending into the natural topography, then ripping, spreading topsoil and seeding to promote natural regeneration of native vegetation communities.

18.4.2 Rehabilitation

Rehabilitation measures proposed to be implemented to minimise impacts to environmental values as a result of the Proposal include the following:

- ripping on contours will be undertaken to reduce compaction and erosion and improve water infiltration;
- stable landforms will be re-established with erosion control measures for long-term stability;
- where available, topsoil will be utilised to provide a foundation into which native vegetation will be planted and/or seeded;
- vegetation debris, logs and leaf litter (previously stockpiled) from clearing of areas will be spread over rehabilitated areas to provide fauna habitat;
- direct seeding and/or planting will be undertaken to encourage vegetation growth to stabilise surfaces and aid the integration of landforms into the surrounding landscape and ecosystems;
- seeding and/or planting will be undertaken prior to the wet season (as soon as possible after earthworks) using seed and plants native to the Blue Hills area;
- local provenance seeds will be collected from the proposed disturbance footprint prior to disturbance and stored separately for use in rehabilitation;
- where necessary, fertiliser will be applied to offset the loss of nutrients and soil microbiota associated with loss of topsoil;
- weed outbreaks as a result of the Proposal will be assessed and controlled in a manner agreed with stakeholders and responsible authorities;
- rehabilitation measures and methods utilised will comply with agreed and approved rehabilitation management guidelines; and
- rehabilitation and closure procedures will fulfil commitments made to stakeholders and regulators regarding closure outcomes.

18.4.3 Final landform design concepts

Proposed mine pit

Closure works at the mine pit void will involve the construction of a pit abandonment bund around the pit consistent with DMP requirements. SMC will agree with the DMP on the final design of the pit abandonment bund.

Proposed waste rock dump

Rehabilitation will involve the reshaping and revegetation of the proposed waste rock dump. In relation to construction of the waste rock dump landform, waste material will be dumped in nominal 10 m high benches with 10 m berms prior to commencement of the next bench. When lower benches have reached capacity, they will be shaped by dozer to a final batter angle of 15-18 degrees. Slopes will be cross-ripped along contours at a depth of 0.5-1 m. There is currently no significant erosion or other evidence of instability in the existing waste rock dump landforms at the Blue Hills mine, which are more than 30 years old and typically have slopes of 14-19 degrees.

The final elevation of the waste rock dump will be lower than the elevation of Mungada Ridge. The waste rock dump will be similar in scale and form to the natural hills in the Blue Hills area. A crest bund will be established to prevent runoff down the slope of the waste rock dump. If required, toe drains and sediment capture sumps will be constructed at the base of the waste rock dump to capture local drainage. Topsoil will be spread at a nominal depth of 100 mm over the final waste rock landform. Local provenance seed will be applied on the slopes and crest of the waste rock dump. If necessary, fencing will be installed to prevent access to the revegetated areas by livestock or other grazing animals. Rehabilitated areas will be sign posted as “no-entry” to avoid impacts from vehicles.

As part of SMC’s commitment to progressive rehabilitation, a detailed rehabilitation planning strategy has been completed to ensure that the characteristics of the proposed waste rock dump optimise rehabilitation outcomes. This planning strategy has been completed in accordance with EPA Guidance Statement No. 6 (EPA 2006) and outlines SMC’s consideration of soil chemistry and physical properties, landform, hydrology and plant species specific to the development envelope.

Roads

If haul roads are not to be used in post-closure land uses, they will be rehabilitated with topsoil where available, and ripped and seeded. The roads will be rehabilitated by means of winged tine, followed by seeding with a local provenance seed mix. Windrows may be constructed along selected roads to limit surface erosion and restrict unwanted vehicle access.

18.4.4 Monitoring

The implementation of a monitoring program is crucial to measure the success of completion criteria and validate agreed criteria for relinquishment of the site. Monitoring will address the following areas:

- biological (flora and fauna);
- surface and groundwater;
- remediation of contaminated sites and AMD issues;
- public safety;
- landform stability; and
- revegetation status.

Monitoring will identify the need for further remedial work at an early stage. Monitoring will be conducted annually and will continue for at least five years post-closure to demonstrate the acceptable health of vegetation communities in and around rehabilitated areas and the successful return of rehabilitated areas to agreed completion criteria. Monitoring will continue until agreed completion criteria are met.

Rehabilitation will be conducted progressively where possible, and as such, final closure works are not anticipated to exceed 12 months from closure.

During closure works, an environmental representative from SMC will be present to ensure safety and monitor rehabilitation. The representative will attend rehabilitation sites regularly to assess rehabilitation success. Table 41 summarises the timing of closure monitoring programs for the Proposal.

Table 41: Timing of closure monitoring

Aspect	Monitoring	Criteria	Timing
Public safety	• Engineering assessment of stability of final landforms • Pit abandonment bund and adequate signage in place.	• Agreed Closure Plan criteria • Safety Bund Walls around Abandoned Open Pit Mines (Department of Industry and Resources 1997).	On closure.
Waste rock dumps	• Engineering assessment of stability and erosion of final landforms.	• Agreed Closure Plan design criteria.	On closure and 12 months following closure.
Contamination	• Contaminated sites assessment.	• *Contaminated Sites Act 2003* (WA) • NEPM.	On closure and 12 months after remediation if required.
AMD	• Assessment of waste rock landform for acidity.	-	On closure and 12 months following closure.
Water	• Groundwater and surface water assessment.	• Groundwater – total dissolved solids and standing water level component analyses meet requirements • Surface water – total suspended solids, pH and electrical conductivity component analyses meet requirements • Drainage – agreed Closure Plan criteria.	On closure, and annually thereafter until completion criteria are met.
Rehabilitation earthworks	• Confirmation that earthworks have been completed at all sites in accordance with specifications.	• Agreed Closure Plan design criteria.	12 months after closure.
Vegetation	• Visual assessment of rehabilitated/revegetated areas, including assessment of weed	• Agreed Closure Plan criteria.	Annually for five years post-closure.

Aspect	Monitoring	Criteria	Timing
	species, vegetation establishment and cover, and erosion.		
Maintenance	• Implement maintenance procedures if required.	• Agreed Closure Plan maintenance strategies.	12 months after closure and annually as required until completion criteria are satisfied.

18.4.5Maintenance

Based on monitoring assessments, periodic maintenance may be required to ensure rehabilitation success. Where closure criteria have not been met, remedial action may be required. Table 42 identifies maintenance actions that may be implemented in the event of unsuccessful rehabilitation. Regular maintenance and identification of rehabilitation problems at an early stage will contribute to successful environmental outcomes and mine closure.

Table 42: Possible maintenance actions

Aspect	Possible maintenance actions
Landform stability	• Contour ripping or scalloping in affected areas • Rock armouring • Construction of permanent drainage structures.
Contamination and AMD	• Bioremediation • Transportation for treatment and/or disposal of contaminated soils • Implementation of AMD control measures.
Vegetation	• Reseeding of rehabilitation areas • Planting of tubestock • Removal/spraying of weeds.
Topsoil viability	• Additional ripping/aeration • Reduce stockpile time (and therefore increase seedbank viability) by progressively rehabilitating areas.
Introduced fauna	• Implement appropriate control measures.

18.5 Predicted outcome

Implementation of the Proposal is expected to produce the following long-term outcomes:

- the development envelope will be non-polluting and safe to humans and wildlife;
- areas disturbed for waste landforms will be geotechnically and erosionally stable, visually compatible with the surrounding natural landscape, and ecologically similar to the pre-mining environment;

- areas disturbed for mining and infrastructure will be rehabilitated to a condition compatible with the post-mining land use following decommissioning; and
- land disturbed by the proposed mining activities will remain undisturbed from secondary impact in the future.

19 Offsets

19.1 Key statutory requirements, environmental policy and guidance

19.1.1 EPA objective

The EPA has applied the following objective for offsets, which is an 'integrating factor':

"To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets."

19.1.2 Relevant guidelines and policy

The following policy and related guidelines are relevant to the Proposal with respect to the provision of offsets and the above EPA objective:

- WA Environmental Offsets Policy (Government of WA 2011);
- WA Environmental Offsets Guidelines (Government of WA 2014a); and
- EPB No. 1 – Environmental Offsets (EPA 2014).

19.2 Description of factor

Environmental offsets are actions that provide environmental benefits which counterbalance the significant residual environmental impacts or risks of a project or activity. Unlike mitigation actions that occur on-site as part of a project and reduce the direct impact of that project, offsets are undertaken outside of the project area and counterbalance significant residual impacts (Government of WA 2014a).

Environmental offsets will only be applied where the residual impacts of a project are determined to be significant, after avoidance, minimisation and rehabilitation have been pursued (Government of WA 2014a).

Management controls to ensure key environmental factors are addressed include measures and/or actions prescribed within various environmental management plans. These plans provide a clear framework for the avoidance, minimisation, and mitigation of impacts arising from the Proposal. SMC recognises that some significant residual impacts are likely to result, even after the application of these management measures.

SMC negotiated offsets as part of the approvals process for the original DSO Project and has followed through on all of these commitments. These commitments included:

- financial contribution of $100,000 to DPaW for conservation management within the Karara Block of former pastoral stations, specifically to assist:
  - maintenance of existing feral goat trap yards;
  - purchase and establishment of new trapping yards;
  - management of feral goat removal and weed control programs; and
- relinquishment of approximately 4,500 ha of exploration tenement for the purposes of conservation management by DPaW.

In addition to the offsets discussed above for the DSO project, SMC has developed a comprehensive rehabilitation planning strategy for Blue Hills including a $1.6M (with in-kind support >$2M) restoration research program with BGPA (discussed in Section 18). The BGPA research program was enacted by SMC to ensure best practice rehabilitation is undertaken on its operations. SMC has targeted its environmental research investment into the BGPA restoration research program, which is providing data and findings that may be able to be used to inform land/mine rehabilitation efforts across the mining industry. This research program has also improved knowledge on key environmental values and functions of Mungada Ridge and the broader Blue Hills area, in particular those values identified as requiring or potentially requiring offsets. SMC proposes to continue the BGPA rehabilitation research project as part of its commitment to rehabilitation management for the DSO project.

There are generally three types of environmental offsets– land acquisition, on-ground management and research. The type of offset depends on the:

- impact predicted (e.g. temporary or permanent, broad scale clearing or effect on an individual species);
- options for offsets in the vicinity of the Proposal (such as the availability of land for purchase and protection); and
- state of knowledge of the environmental value being impacted.

The relinquishment of approximately 4,500 ha of exploration tenement for the purposes of conservation management by DPaW as a commitment of the original DSO Project was a significant measure. SMC now considers there are no further land acquisition or relinquishment opportunities in the region for provision as offsets. It is the view of SMC that this should be taken into account or at least considered for context in evaluating the adequacy of offsets for the current Proposal. This is consistent with Environmental Protection Bulletin 1 (EPA 2014a), which notes that where a proponent is seeking expansion of an existing proposal, consideration will be given to any offsets that were a requirement of the existing proposal.

Regardless, there is little in the way of suitable land in the region that SMC would have the capability of acquiring and protecting. SMC has proposed offsets which are described in the following sections, however is committed to working with the EPA, in consultation with DPaW to determine the final appropriate environmental offsets for the Proposal.

19.3 Assessment of potential impact, mitigation and residual impact

SMC has applied the required steps in the mitigation hierarchy – avoid, minimise, and rehabilitate prior to the consideration of offsets – as per Government of WA (2014a) to reduce the potential impacts of the Proposal on the environment.

The following is a summary of key measures applied to avoid, minimise and mitigate impacts. Further detail in regards to the benefits of key measures for each factor is provided in each related section in this PER document. Table 43 also presents these measures as they apply to each of the various environmental values with potential to be impacted by the Proposal.

19.3.1 Avoidance and minimisation

The proposed mine plan represents the outcome of a process of avoidance and minimisation of environmental impacts. An original mine plan was developed that provided the optimum layout for best economic return and also most straight forward engineering requirements. This was subject to a preliminary environmental review and subsequently major modifications were made to reduce impacts. Of particular note, this involved reducing the extent of the proposed mining disturbance footprint on the Mungada Ridge, which is recognised as supporting higher conservation values than surrounding areas.

The modifications to the mine plan included:

- relocation of the proposed waste rock dump further away from the proposed mine pit, outside the PEC and off the Mungada Ridge;
- realignment of the proposed haul roads to reduce disturbance on Mungada Ridge; and
- backfilling of the existing Mungada East pit.

This process of minimising direct impact to Mungada Ridge has resulted in a reduction of impacts to a number of key values, including (but not limited to):

- Mungada Ridge landform;
- *Acacia woodmaniorum*;
- *Lepidosperma* sp. Blue Hills;
- Priority 1 Ecological Community: Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation); and
- Rocky ridge with steep slopes terrestrial fauna habitat type.

Further measures to avoid or minimise potential direct impacts to key values include (but are not limited to):

- prior to commencement of works, areas to be disturbed will be demarcated by survey pegs in the field with reference to design/site plans. This will constitute a hold point requiring written approval from the Mine Manager, or delegate, on the Ground Disturbance Form;
- locations of significant flora, significant vegetation units, and quarantine boundaries will be demarcated on site plans. These areas will be managed according to relevant permits and management plans; and
- training in land clearing procedures will be included in the environmental induction and land disturbance requirements will be included in contracts with all earthmoving and land clearing contactors.

19.3.2 Mitigation (including rehabilitation)

Mitigation measures will be applied for the Proposal in accordance with the relevant management plans. These have been detailed in Sections 13.4, 14.6, 15.5, 16.4 and 17.4 as they relate to landforms, flora and vegetation, terrestrial fauna, subterranean fauna and amenity respectively. These have also been summarised in Table 43.

Key mitigation measures relating to environmental issues that can be exacerbated by mining operations, such as weeds and dust, include (but are not limited to):

- design and construction of drainage structures to ensure minimal alteration to existing surface drainage patterns and incorporation of scour protection measures where required;
- engineering controls, and use of dust suppression measures, such as water trucks, sprinklers and deluge sprays to minimise dust generation;
- weed hygiene and controls including ensuring equipment is cleaned to remove soil, vegetation, rock and debris prior to arrival to site; any equipment or vehicle considered to have been working in a weed risk area is cleaned down before remobilisation; and any new weed populations that arise in the development envelope area as a result of the Proposal are removed; and
- progressive rehabilitation aimed at restoring the maximum environmental value that is reasonably practicable given a modified landform, consistent with Government of WA (2014a).

Detail on proposed rehabilitation is included in Chapter 19. Research that SMC has been undertaking in conjunction with BGPA will inform successful rehabilitation outcomes. As described in Chapter 19, this program has already delivered valuable information relating to germination, seeding and substrate management as well as more broadly provide information on environmental values and function in the Blue Hills area.

19.3.3 Guidance for determination of significant residual impacts

Offsets are, or may be, required for significant residual impacts remaining after application of avoidance, minimisation and mitigation measures to ensure the EPA objective for the relevant factor can be achieved. In general, significant residual impacts include those that affect declared rare flora and threatened species that are protected by legislation, areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context (Government of WA 2014a). The WA Environmental Offsets Guidelines indicates that impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions.

The WA Environmental Offsets Guidelines (Government of WA 2014a) includes a residual impact significance model that outlines how significance will be determined and when an offset is likely to be required, or may be required, in relation to EPA biodiversity factors. The model identifies four levels of significance for residual impacts:

- unacceptable impacts – those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset.
- significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level.
- potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement; and
- impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset.

The Environmental Offsets Template (as per Government of Western Australia 2014) has been used to assist in defining the residual impacts of the Proposal which require offsets. The first part of the template presents the potential environmental impacts due to the implementation of the Proposal, the mitigation and management measures proposed and an assessment of the significant residual impact (and therefore the necessity of offsets) and is summarised for each preliminary factor in Table 43. The second part of the template defines the offsets proposed for the significant residual impacts and is provided later in this section.

19.3.4 Significant residual impacts

Following the implementation of the mitigation hierarchy, impacts to terrestrial and subterranean fauna (both direct and indirect) are not considered to be significant. Avoidance, minimisation and rehabilitation activities that contribute to this outcome are summarised in Table 43. Further detail is included in Chapters 15 and 16. As such, no offsets are considered necessary for these factors. Non-biodiversity impacts (in this case landforms) are not addressed under the WA Environmental Offsets Guidelines. Nevertheless, these have also been included in Table 43 to demonstrate the avoidance and mitigation measures relevant to the factors. The residual impacts to these factors are not considered to be significant.

In the case of native flora and vegetation, the following residual impacts have been evaluated against the impact significance impact model from the WA Environmental Offsets Guidelines for rationale for application of offsets (Table 43):

- clearing of 21.4 ha of Priority 1 PEC 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)';
- clearing of 32.3 ha of other vegetation communities;
- loss of 2,634 individuals of *Acacia woodmaniorum*;
- loss of 669 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468);
- loss of two individuals of *Acacia karina*; and
- potential for indirect impacts to occur within a 148.3 ha area (defined as the indirect impact assessment area) that includes 78.1 ha of the PEC, 3,697 *Acacia woodmaniorum* plants and 37 *Lepidosperma* sp. Blue Hills plants.

After applying the significance model, the following residual impacts are considered significant impacts requiring an offset or potentially significant impacts, which may require an offset.

- 'Significant residual impacts that will require an offset':
    - removal of 2,634 individuals of *Acacia woodmaniorum* representing 25% of the number of individuals within tenements M59/595 and M59/596 and 10% of the number of individuals within the Tallering sub-region;
- Significant residual impacts that may require an offset':
    - clearing of 669 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1), representing 29% of the number of individuals within tenements M59/595 and M59/596 and 12% of the number of individuals within the Tallering sub-region.

The second part of the Environmental Offsets Template (as per Government of Western Australia 2014) was used to assist in selecting appropriate offsets for the significant residual impacts and is provided in Table 44.

Consideration of indirect impacts

Potential indirect impacts to flora and vegetation as a result of the Proposal are not considered to be significant residual impacts. As described in Section 14.3.3, indirect impacts to flora and vegetation are considered unlikely, or if any negative effects do occur these will be minimal as has been shown by the monitoring conducted to date by Maia (2015a) at the Blue Hills mine. Regardless, the OEPA has requested potential indirect impacts to *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills be included as significant residual impacts.

It is unlikely that individuals of these two species located in the indirect impact assessment area would be impacted indirectly by the Proposal in such a way that it would be considered significant. However, to respond to the OEPA's request, SMC considers the monitoring undertaken to date at the Blue Hills mine to be an indicator of how many individuals of those located in the indirect impact assessment area may be actually affected by indirect impacts.

The Maia study found the decrease in plant numbers between 2012 and 2015 was 1.9% greater at the impact sites (-6.4%) than at the control sites (-4.5%) (see Section 14.3.3). It was concluded that these decreases could be a reflection of natural change in the flora rather than of the effects of mining on plant numbers. These results indicate that even if indirect impacts from mining do result in loss of some individual plants, it is unlikely that all plants located in the indirect impact assessment area would be affected. Nevertheless, for the specific purpose of determining suitable offsets for the Proposal if potential indirect impacts must be considered, the difference between the decrease in plant numbers at the control and impact sites at the Blue Hills mine (1.9%) will be used as an indicator of how many plants may actually be affected in this area from the potential indirect impacts of the Proposal. Therefore, in consideration of potential offsets, of the 3,697 *Acacia woodmaniorum* plants located in the indirect impact assessment area, only 69 of these will be considered as having the potential to be affected and of the 37 *Lepidosperma* sp. Blue Hills plants, <1 plants have the potential to be affected.

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Table 43: WA Environmental Offsets template Part 1- Identification of residual impacts and requirement for offsets

Existing environment/ impact	Mitigation			Residual impact	Offset requirement
	Avoid and minimise	Rehabilitation type	Likely rehabilitation success		
Landforms					
Mungada Ridge	Major modifications to the original mine plan were made to reduce impacts including: • Placement of the new waste rock dump further away from the Mungada East Extension pit (proposed) and off the Mungada Ridge • Backfilling of the Mungada East pit (current) Key management measures as identified in Section 13.4 include: • Minimal alteration to existing surface drainage patterns. • Regular inspections of drainage structures and evidence of erosion • Geotechnical design measures for stability of the landform during construction and operation	See native vegetation and flora. Haul roads will be rehabilitated. Due to the very high cost, it is not feasible to commit to backfilling the Mungada East Extension pit.	See native vegetation and flora	New Mungada East Extension pit and pit abandonment bund covering approximately 18.6 Ha. Localised to the lower western component of the ridge. This residual impact is not considered to be significant.	N/A
Native vegetation and flora					
397.7 Ha of Priority 1 PEC 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' occur within tenements M59/595 and M59/596, of which approximately 21.4 Ha are in the proposed disturbance area and proposed to be cleared.	Major modifications to the original mine plan were made to reduce impacts including: • Placement of the new waste rock dump further away from the Mungada East Extension pit (proposed) and off the Mungada Ridge • Backfilling of the Mungada East pit (current) Each of these modifications has reduced the impact to the PEC. As a result only 0.3% of the mapped extent of the PEC will be affected by clearing. Management measures will include: • Formal processes for commencement of ground disturbance • Demarcation of significant flora and vegetation on site plans • Training in land clearing procedures	Areas will be progressively rehabilitated with local native vegetation. The Blue Hills Closure Plan will be implemented to ensure that closure of the Project will be undertaken and completed in an ecologically sustainable manner, consistent with agreed outcomes and post-mining land uses.	<u>Can the environmental values be rehabilitated/Evidence?</u> To date over 60 species from the target community of SMC's research and rehabilitation project with BGPA have germinated from soil, seed or cuttings, demonstrating positive evidence towards successful rehabilitation at Koolanooka/Blue Hills. <u>Operator experience in undertaking rehabilitation?</u> SMC has implemented research trials at its existing operations at the Blue Hills and Koolanooka mines as part of the BGPA research and rehabilitation project. The aims and current findings from these trials are described further in Section 18.3.3.	<u>Extent</u> Clearing of approximately 21.4 Ha of PEC. <u>Quality</u> 19.1 ha with an average condition of 'Excellent'. 2.3 ha with an average condition of 'Good'. <u>Conservation Significance</u> Priority 1 ecological community is considered to be representative of vegetation with high regional biodiversity values associated with the Mungada Ridge. <u>Land Tenure</u> The area to be cleared is within mining tenure M59/595 and M59/596. <u>Time Scale</u> N/A <u>Conclusion</u> After avoidance and mitigation, including post-mining rehabilitation, are considered and given the area of clearing represents only 0.3% of the total mapped extent as the PEC, the residual impact is not considered to be significant.	None required
32.3 Ha of vegetation outside the PEC boundary is within the proposed disturbance area and proposed to be cleared.	For each vegetation association proposed to be cleared, a minimum of 82% of the local mapped extent will be retained within tenements M59/595 and M59/596 outside the development envelope. The potential impact to each FCT is less than 3% of the area mapped by Woodman (2008a). Management measures will include: • Formal processes for commencement of ground disturbance. • Demarcation of significant flora and vegetation on site plans.		<u>What is the type of vegetation being rehabilitated?</u> Various vegetation types are currently required to be rehabilitated by Condition 13-3 of MS 811. At the Blue Hills mine specifically a target of 59 flora species are to be restored with a mean species richness of 15 at Mungada East and 17 at Mungada West (per 20m x 20m quadrat). It is	<u>Extent</u> Clearing of approximately 32.3 Ha of vegetation outside the PEC boundary. <u>Quality</u> 19.1 ha with an average condition of excellent 2.3 ha with an average condition of good The remaining 1.5 Ha has already been cleared by approved exploration activities <u>Conservation Significance</u>	None required

Existing environment/ impact	Mitigation			Residual impact	Offset requirement
	Avoid and minimise	Rehabilitation type	Likely rehabilitation success		
	• Training in land clearing procedures.		expected that this condition will be extended to also apply to the expansion area. Time lag? Progressive rehabilitation will be undertaken. Condition 13-3 currently requires targets for rehabilitation to be reached within five years following the cessation of productive mining at the Blue Hills mine. The start and finish dates for the Proposal are not yet confirmed, however the duration of the Proposal will be three years, with rehabilitation to commence immediately after completion. Credibility of the rehabilitation proposed (evidence of demonstrated success) See response to first question above 'can the environmental values be rehabilitated/Evidence?' as well as Section 18.3.3.	No Land Tenure The area to be cleared is within mining tenure M59/595 and M59/596. Time Scale N/A Conclusion According to the significance framework, after mitigation, including post-mining rehabilitation is considered, the residual impact is unlikely to be significant.	
10,503 individuals of *Acacia woodmaniorum* occur within tenements M59/595 and M59/596, of which 2,634 occur within the proposed disturbance area and are proposed to be cleared. Also, potential indirect impact to 69 individuals of *Acacia woodmaniorum*.	Major modifications to the original mine plan were made to reduce impacts including: • Placement of the new waste rock dump further away from the Mungada East Extension pit (proposed) and off the Mungada Ridge • Backfilling of the Mungada East pit (current). Each of these modifications has reduced the impact to *Acacia woodmaniorum*.			Extent Clearing of 2,634 individuals of *Acacia woodmaniorum* within the proposed disturbance area and potential indirect impact to 69 individuals. Quality N/A Conservation Significance *Acacia woodmaniorum* is listed as Threatened – Vulnerable under the WC Act and the number of individuals to be cleared represents 25% of the number of individuals within tenements M59/595 and M59/596 and 11% of the number of individuals in the population. Land Tenure The individuals to be cleared are within mining tenure M59/595 and M59/596. Time Scale N/A Conclusion According to the agreed significance framework, the residual impact is considered to be significant because *Acacia woodmaniorum* is protected under legislation and the cumulative impact to this species may be considered to be already at a critical level.	Yes. See Table 44 for proposed offset.
2,285 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) occur within tenements M59/595 and M59/596, of which 669 occur within the proposed disturbance area and are proposed to be cleared.	Major modifications to the original mine plan were made to reduce impacts including: • Placement of the new waste rock dump further away from the Mungada East Extension pit (proposed) and off the Mungada Ridge • Backfilling of the Mungada East pit (current).			Extent Clearing of 669 individuals of *Lepidosperma sp. Blue Hills* (A. Markey & S. Dillon 3468) within the proposed disturbance area Quality N/A Conservation Significance *Lepidosperma sp. Blue Hills* is a Priority 1 species on DPaW's Priority Flora list, reflecting the fact that it is a known only from a small number of locations and requires further survey. The number of individuals to be cleared represents 29% of the number of individuals within tenements M59/595 and M59/596 and 12% of the number of individuals in the population. Land Tenure The individuals to be cleared are within mining tenure M59/595 and M59/596. Time Scale N/A Conclusion	Yes. See Table Table 44 for proposed offset.

Existing environment/ impact	Mitigation			Residual impact	Offset requirement
	Avoid and minimise	Rehabilitation type	Likely rehabilitation success		
				According to the agreed significance framework, there may be a significant residual impact to *Lepidosperma* sp. Blue Hills but this is uncertain due to the *conservation status* of the species (on the Priority flora list).	
56 individuals of *Acacia karina* occur within tenements M59/595 and M59/596, of which two occur within the proposed disturbance area and are proposed to be cleared.	Major modifications to the original mine plan were made to reduce impacts including: • Placement of the new waste rock dump further away from the Mungada East Extension pit (proposed) and off the Mungada Ridge • Backfilling of the Mungada East pit (current).			Extent Clearing of two individuals of *Acacia karina* within the proposed disturbance area Quality N/A Conservation Significance *Acacia karina* is a Priority 1 species on DPaW's Priority Flora list, reflecting the fact that it is a known only from a small number of locations and requires further survey. The number of individuals to be cleared represents 4% of the number of individuals within tenements M59/595 and M59/596 and 50% of the number of individuals in the population. Land Tenure The individuals to be cleared are within mining tenure M59/595 and M59/596. Time Scale N/A Conclusion The residual impact is not considered to be significant.	None required
A total of 148.3 Ha of native vegetation associations occur in areas identified to have the potential for indirect impacts to occur (within the indirect impact assessment area). This includes: • Approximately 78.1 Ha is Priority 1 PEC 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' • 3,697 *Acacia woodmaniorum* plants • 37 *Lepidosperma* sp. Blue Hills plants	Avoidance of unintentional impacts within the indirect impact assessment area will be supported by requirements for Ground Disturbance Permits and on-ground demarcation. Mitigation measures to address potential indirect impacts are described in Section 14.3.3including: • Design and construction of drainage structures to ensure minimal alteration to existing surface drainage patterns and incorporation of scour protection measures where required to minimise impacts to sheetflow-dependent vegetation associations. • Dust generation from the Proposal will be minimised by engineering controls, vehicle speed restrictions on cleared tracks and use of dust suppression measures, such as water trucks, sprinklers and deluge sprays. • The introduction and/or spread of weeds and disease will be minimised by ensuring equipment is cleaned to remove soil, vegetation, rock and debris prior to arrival to site; any equipment or vehicle considered to have been working in a weed risk area is cleaned down before remobilisation; and any new weed populations that arise in the development envelope as a result of the Proposal are removed. • The potential for altered fire regimes will be minimised through implementation of fire prevention measures, including implementation of a total fire ban, establishment of 5 m firebreaks around all Proposal infrastructure and ensuring personnel are trained in the use of fire extinguishing equipment and fire prevention measures in work areas.	None likely to be required, though this will be undertaken as for the proposed disturbance area in the event that vegetation within the indirect impact assessment area is impacted.	N/A	After mitigation and management measures are implemented, in particular specific controls to protect occurrences of conservation significant species outside of the disturbance footprint, residual indirect impacts are not likely to be significant.	None required

Existing environment/ impact	Mitigation			Residual impact	Offset requirement
	Avoid and minimise	Rehabilitation type	Likely rehabilitation success		
Terrestrial and subterranean fauna					
The entire proposed disturbance footprint is mapped as fauna habitat and is proposed to be cleared.	Major modifications to the original mine plan were made to reduce impacts including: • Placement of the new waste rock dump further away from the Mungada East Extension pit (proposed) and off the Mungada Ridge • Backfilling of the Mungada East pit (current). As described in Section 15.5, fauna specific management measures include: • Designated "no-entry" sites communicated to project personnel. • Procedures for reporting of feral fauna and Malleefowl nests. • Restrictions on vehicle speed limits. • Drill holes capped as soon as possible.	Areas will be progressively rehabilitated with local native vegetation. The Blue Hills Closure Plan will be implemented to ensure that closure of the Proposal will be undertaken and completed in an ecologically sustainable manner, consistent with agreed outcomes and post-mining land uses. Rehabilitation will contain a wide variety of fauna habitats. Disturbed areas will be rehabilitated as soon as practicable to facilitate fauna habitat restoration.	See response under Native Flora and Vegetation regarding planned rehabilitation.	Clearing of up to 52 Ha of fauna habitat. The residual impact is not considered to be significant.	None required
Possible death or displacement of individuals of any of the fauna species that have potential to occur in the development envelope.				Direct loss of some individual fauna. The residual impact is not considered to be significant.	
Possible indirect impacts to any of the fauna species that have potential to occur in the development envelope.				The residual impact is not considered to be significant.	

Table 44: WA Environmental Offsets template Part 2- Proposed offset

Residual impact	Offset calculation				
	Type	Risk	Likely offset success	Time lag	Offset quantification
Clearing of 2,634 individuals of *Acacia woodmaniorum* within the proposed disturbance area and potential indirect impact to 69 individuals in the indirect impact assessment area (see Table 43).	• Re-establishment of individuals of *Acacia woodmaniorum* • On ground management aimed at the protection of habitat of *Acacia woodmaniorum* within the M59/595 and M59/596 tenements, outside the development envelope, contributing to the long-term viability of *Acacia woodmaniorum* through management of threatening processes. This is planned to be implemented through development of a Biodiversity Conservation Management Program.	Survival rates of planted individuals (lack of knowledge around re-establishment of this species).	<u>Can the values be defined and measured?</u> Yes. Key objectives and targets or performance indicators will be established for both the re-establishment of individuals and the Biodiversity Conservation Management Program. <u>Operator experience/Evidence?</u> • The rehabilitation and restoration research and implementation being undertaken with BGPA for the Blue Hills Mine. • Measures proposed for the Biodiversity Conservation Management are similar to management already being undertaken by SMC at the Blue Hills and Koolanooka mines, on a broader scale and for a separate area. <u>What is the type of vegetation being revegetated?</u> N/A <u>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?</u> Yes. Karara's work on re-establishing Acacia woodmaniorum on adjacent tenements.	• Successful establishment of *Acacia woodmaniorum* individuals is estimated to be achieved over five years (to be confirmed, see Section 19.4) • The benefits of the Biodiversity Conservation Management Program would involve some time lag. The anticipated general improvement and maintenance of the condition of vegetation in tenements M59/595 and M59/596 would be achieved over time as would the general reduction in threats to and risk of loss of individuals of conservation significant flora.	• Re-establishment of individuals of *Acacia woodmaniorum* (for quantity see results of the EPBC Offsets calculator in Section 19.4) • Management of approximately 133 ha of habitat for this species within tenements M59/595 and M59/596.
Clearing of 669 individuals of *Lepidosperma* sp. Blue Hills within the proposed disturbance area (see Table 43).	• Re-establishment of individuals of *Lepidosperma* sp. Blue Hills • On ground management aimed at the protection of *Lepidosperma* sp. Blue Hills habitat within the M59/595 and M59/596 tenements, outside the development envelope, contributing to the long-term viability of *Lepidosperma* sp. Blue Hills through management of threatening processes. This is planned to be implemented through development of a Biodiversity Conservation Management Program.	Survival rates of planted individuals (lack of knowledge around re-establishment of this species).	<u>Can the values be defined and measured?</u> Yes. Key objectives and targets or performance indicators will be established for both the re-establishment of individuals and the Biodiversity Conservation Management Program. <u>Operator experience/Evidence?</u> • The rehabilitation and restoration research and implementation being undertaken with BGPA for the Blue Hills Mine. • Measures proposed for the Biodiversity Conservation Management are similar to management already being undertaken by SMC at the Blue Hills and Koolanooka mines, on a broader scale and for a separate area. <u>What is the type of vegetation being revegetated?</u> N/A <u>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?</u> Not specifically for *Lepidosperma* sp. Blue Hills. However, results of re-establishment of other species at the Blue Hills mine as part of the BGPA work would be drawn upon to inform the early trials for this species.	• Successful establishment of *Lepidosperma* sp. Blue Hills individuals is estimated to be achieved over five years (to be confirmed, see Section 19.4). • The benefits of the Biodiversity Conservation Management Program would involve some time lag. The anticipated general improvement and maintenance of the condition of vegetation in tenements M59/595 and M59/596 would be achieved over time as would the general reduction in threats to and risk of loss of individuals of conservation significant flora.	• Re-establishment of individuals of *Lepidosperma* sp. Blue Hills (for quantity see results of the EPBC Offsets calculator in Section 19.4). • Management of approximately 133 ha of habitat for this species within tenements M59/595 and M59/596.

19.4 Description of proposed offsets

SMC proposes the following offsets for the Proposal:

- re-establishment of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills individuals and their monitoring within SMC's Blue Hills tenements ($300,000 in total, over a period of mining and then post-mining for a total duration of five years). As part of this offset, research and trials to inform best-practice rehabilitation specific to these species will be undertaken through a five year Participants Agreement for the Australian Research Council (ARC) Training Centre for Mining Restoration specific to rehabilitation of the Blue Hills mine and the Proposal (SMC will contribute an additional $200,000 towards this program as well as $525,701 in-kind support); and
- on-ground management of portions of the Mungada Ridge outside of existing operations and the proposed development envelope and within SMC's Blue Hills tenements to maintain habitat for both *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills (This is included in the $300,000 total, over a period of mining and then post-mining for a total duration of five years).

The Commonwealth offsets calculator has been applied as per the EPBC Act Environmental Offsets Policy (DoE 2012a), to assist in quantifying an adequate level of offsets for the Proposal. A summary of the key inputs and results of the calculation for *Acacia woodmaniorum* is provided in Table 45 and for *Lepidosperma* sp. Blue Hills in Table 46. The full calculators used for each species are provided in Appendix H. Several values are generated automatically by the calculator, these are indicated by green highlighted rows in Table 45 and Table 46 and a brief description provided of what these values mean. Further descriptions of the calculator functions and generated values are provided in (DoE 2012b).

Table 45: Offset calculator inputs and results for *Acacia woodmaniorum*

Attribute	Input	Justification
Protected matter attribute: Number of individuals		
Total quantum of impact	2,703	Total number of individuals of *Acacia woodmaniorum* predicted to be impacted by the Proposal directly (2,634), plus 69 individuals with potential to be indirectly impacted.
Units	Count	Calculator recognises this automatically.
Proposed offset	Planting individuals	This is considered to be the most appropriate offset to achieve as close as possible a ‘like for like’ offset.
Time horizon (years)	5	This is an estimate only. Information regarding the ecology of *Acacia woodmaniorum* is lacking and it is not known what age this species reaches reproductive maturity. The 5 year estimate is based on the approximate juvenile period of other Acacia species recorded post-fire in WA (Shedley 2007).
Start value	7,800	This is the total number of *Acacia woodmaniorum* individuals in SMC’s Blue Hills tenements (10,503) less the individuals that will be affected by the Proposal (i.e. what will remain after the Proposal is implemented).
Future value without offset	7,800	There would be no benefit without the proposed offset occurring

Attribute	Input	Justification
Future value with offset	11,213	The total number of *Acacia woodmaniorum* individuals would increase to this number following successful implementation of the offset.
Raw gain	3,413	The total number of individuals required to be planted in order to reach 100% offset.
Confidence in result (%)	80	Karara has undertaken specific trials re-establishing *Acacia woodmaniorum* on adjacent tenements and have informed SMC that an 80% success rate of planted individuals has been achieved in certain trials, however these are still in progress.
Adjusted gain	2,730.4	The difference between the total future value with offset and total future value without offset.
Net present value	2703.26	The net present value of the proposed offset, taking into account the annual probability of extinction (0.2% for Vulnerable species), the time horizon and the adjusted gain.
% of residual impact offset	100.01	The degree to which the proposed offset compensates for the total quantum of impact.
Summary of results		
Quantum of impact		2,703
Net present value of offset		2,703.36
% of impact offset		100.01
Direct offset adequate?		Yes
Direct offset ($)		$300,000
Other compensatory measures ($)		N/A
Total ($)		$300,000

Table 46: Offset calculator inputs and results for *Lepidosperma* sp. Blue Hills

Attribute	Input	Justification
Protected matter attribute: Number of individuals		
Total quantum of impact	669	Total number of individuals of Lepidosperma sp. Blue Hills predicted to be impacted by the Proposal.
Units	Count	Calculator recognises this automatically.
Proposed offset	Planting individuals	This is considered to be the most appropriate offset to achieve as close as possible a ‘like for like’ offset.
Time horizon (years)	5	This is an estimate only. Information regarding the ecology of *Lepidosperma* sp. Blue Hills is lacking and it is not known what age this species reaches reproductive maturity. The 5 year estimate is based on

Attribute	Input	Justification
		the juvenile period of a similar species which occurs in the Mount Gibson ranges nearby; *Lepidosperma gibsonii* (Threatened: Vulnerable). Seedlings of this species which germinate after fire flowered after 4–5 years (Miller and Barrett 2010 as cited in Wallace 2016).
Start value	1,616	This is the total number of *Lepidosperma* sp. Blue Hills individuals in SMC's Blue Hills tenements (2,285) less the individuals that will be affected by the Proposal (i.e. what will remain after the Proposal is implemented)
Future value without offset	1,616	There would be no benefit without the proposed offset occurring
Future value with offset	2,453	The total number of *Lepidosperma* sp. Blue Hills individuals would increase to this number following successful implementation of the offset.
Raw gain	837	The total number of individuals required to be planted in order to reach 100% offset.
Confidence in result (%)	80	SMC has not undertaken any specific trials to date on *Lepidosperma* sp. Blue Hills and therefore cannot be entirely confident of the survival rates of planted individuals. However, SMC are confident the experience from the BGPA research at the Blue Hills mine and learnings from the ARC proposed research program (see Section 0) will support the re-establishment program to achieve the highest survival rates possible.
Adjusted gain	669.60	The difference between the total future value with offset and total future value without offset.
Net present value	669.60	The net present value of the proposed offset, taking into account the annual probability of extinction (0.2% for Vulnerable species), the time horizon and the adjusted gain.
% of residual impact offset	100.09	The degree to which the proposed offset compensates for the total quantum of impact.
Summary of results		
Quantum of impact		669
Net present value of offset		669.60
% of impact offset		100.09
Direct offset adequate?		Yes
Direct offset ($)		$300,000
Other compensatory measures ($)		N/A
Total ($)		$300,000

19.4.1 Re-establishment of individuals

Description

In order to offset losses of individuals of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills, it is proposed that a program be established which ultimately seeks to increase the populations of these flora and prospects of long-term survival of these species. The ARC research program will inform the re-establishment of the two key species at Blue Hills. A significant part of the research program will consist of targeted research toward rehabilitation of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills.

Components of both the ARC research program and the on-ground re-establishment program for the two species will include seed collection, trials to improve germination and establishment techniques, identification of potential habitat sites and translocation of seedlings. Seed collection would be undertaken prior to clearing, as well as from retained populations annually. A portion (10%) of this seed could be provided to the Threatened Flora Seed Centre for storage, contributing to the long-term security of the species. Other aspects of the ARC research program which will directly assist the re-establishment of the two key species as an offset will include:

- The production of a restoration practitioner's manual for SMC environmental staff to assist with the implementation of scientific findings for on-ground restoration. The restoration manual will address:
  - plant substrate (e.g. topsoil, subsoil and rock), composition and management;
  - surface hydrology and landform re-creation considerations;
  - seed collection, storage, timing, quality and enabling management;
  - optimal plant seeding and planting techniques;
  - management of rehabilitated areas;
  - recommendations for the restoration of threatened and Priority species including *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills, in both disturbed areas and surrounding undisturbed areas in SMC leases for the purpose of increasing overall numbers of these species; and
  - options (with cost benefit analyses) for restoring species that are difficult to propagate;
- a model that predicts the 'survivability' of all species;
- recommendations for methods and procedures to apply before, during and following mining and exploration activities to:
  - meet best practice standards with respect to biodiversity;
  - re-establish 'keystone' flora species for vegetation communities disturbed by SMC operations; and
  - propagate and/or successfully re-establish threatened and Priority species affected by SMC operations, including *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. These methods and procedures will include those able to be applied to undisturbed areas for the purpose of increasing numbers of these species in SMC leases; and
- recommendations on how to achieve the best possible ecosystem function and stability to maximise potential for ongoing survival of re-established flora.

In the case of *Acacia woodmaniorum*, work is being undertaken by Karara mining adjacent to SMC's Blue Hills tenements, in conjunction with DPaW, to re-establish individuals of this species. Any program of translocation of *Acacia woodmaniorum* for the Proposal would consider work already being undertaken by Karara. Although not yet publicly available, in discussions between SMC and Karara the early results from Karara's work have shown up to 80% success rates with certain approaches (R. Houlihan , Karra MiningLtd pers. comm. 2016).

Furthermore, Acacia woodmaniorum has been recorded in disturbed areas at the Blue Hills mine (Section 14.3.3), suggesting it may be likely to persist in and/or recolonise disturbed areas naturally. No targeted research appears to have been undertaken in relation to the re-establishment of *Lepidosperma* sp. Blue Hills. However, it is anticipated that the outcomes of the ARC research program will indicate potential survival rates for the species to inform the implementation of the re-establishment offset. Cultivation and establishment would also be informed by research currently being undertaken as part of the post-mining rehabilitation program for the Blue Hills mine, where relevant.

Using the Commonwealth offsets calculator (with a certainty level of 80%), replacement of approximately 3,413 *Acacia woodmaniorum* and 837 *Lepidosperma*. sp. Blue Hills individuals would be required to completely offset the losses of individuals of these species as a result of implementation of the Proposal. These numbers are indicative and the final numbers required to be planted may be lower. Furthermore, SMC intends to re-establish individuals of these species as part of the rehabilitation of the development envelope and greater Blue Hills mine and will set specific targets related to this leading up to closure.

SMC is committed to ensuring the highest level of confidence in the success of re-establishment prior to implementation of the offset through increasing the knowledge around re-establishment of these species. This will be possible through the outcomes of the ARC program and potentially through information sharing with Karara.

Replanting would occur in areas identified as potentially suitable habitat which may include but would not necessarily be limited to post-mining landforms, other land within tenements M59/595 and M59/596, and within the Blue Hills PEC.

19.4.2 On-ground management

SMC proposes that its additional offset for the proposal consist of on-ground management of portions of the Mungada Ridge outside of existing operations and the proposed development envelope and within tenements M59/595 and M59/596 (herein referred to as the proposed management area) (Figure 76), which provides habitat for both *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. Approximately 5,563 individuals of *Acacia woodmaniorum* and 1,587 individuals of *Lepidosperma* sp. Blue Hills occur within the proposed management area. On-ground management would directly benefit both of these species by reducing threatening processes and thereby avert the future loss of key environmental values.

SMC proposes to undertake this through preparation and implementation of a Biodiversity Conservation Management Program. Once prepared, SMC will fund and manage this Program. The Program will focus on managing threatening processes other than mining, outside the development envelope. The Program is not to manage impacts of the Proposal, which is already specifically covered by the key management measures described in this PER document, Blue Hills Mungada East Expansion Condition EMP and Closure Plan. The program's design is to manage all potential threats to the two flora species and their habitat.

The objectives of the Program are to:

- manage threatening processes to the Mungada Ridge and its biodiversity values within the proposed management area;
- contribute to the long-term viability of *Acacia woodmaniorum* through protection of its habitat; and
- contribute to the long-term viability of *Lepidosperma* sp. Blue Hills through protection of its habitat.

Threatening processes, apart from mining-related activities, which could affect *Acacia woodmaniorum*, and *Lepidosperma* sp. Blue Hills, including competition from weeds; changes to fire regimes; and grazing or trampling by feral animals. Management actions are proposed to reduce the risk of loss from these threats.

The following targets are proposed:

- decrease the abundance and distribution of high priority weeds on the Mungada Ridge within the proposed management area;
- prevent and minimise the risk of bushfire; and
- reduce grazing and trampling pressure on the two species from feral animals.

One weed of National Environmental Significance, *Echium plantagineum* (Paterson's Curse), and two Declared Pests in WA, *Galium aparine* (Cleavers) and *Galium spurium* (False Cleavers), have been recorded around the existing Blue Hills mine, but not within the area proposed to be managed. However if these species are found to occur in the proposed management area during the duration of the Proposal, actions will be undertaken to treat the plants for removal. This will involve appropriate herbicide application where necessary or other forms of weed removal to be determined in consultation with DPaW.

Twenty-eight other environmental weed species have been recorded in, or within 5 km of SMC's Blue Hills tenements, 17 of which have been recorded within the proposed management area:

- *Cleretum papulosum* subsp. *papulosum*;
- *Cuscuta epithymum*;
- *Cuscuta planiflora;*
- *Ehrharta longiflora;*
- *Erodium botrys;*
- *Erodium cicutarium;*
- *Hypochaeris radicata;*
- *Lamarckia aurea;*
- *Mesembryanthemum nodiflorum;*
- *Mesembryanthemum* sp.;
- *Pentameris airoides* subsp. *airoides;*
- *Rostraria pumila;*
- *Sisymbrium irio;*
- *Sonchus oleraceus;*
- *Spergula pentandra;*
- *Stellaria media;* and
- *Urospermum picroides.*

DPaW has assigned ten of these species a low (L) weed species ranking, which indicates they are to be eradicated, controlled or contained. The remainder are assigned to be either negligible (N) requiring no action to be taken, or they require further assessment before they can be ranked. Those species ranked as low (L) will be prioritised for treatment and removal. This will involve appropriate herbicide application where necessary or other forms of weed removal to be determined in consultation with DPaW.

Weed management will contribute to a reduced fire risk to environmental values. In the case that the Ridge is affected by fire, the proposed management area will subsequently become a priority for increased weed monitoring and management. Post-fire weed germination and establishment monitoring will be conducted to inform weed control activities.

Control of any feral animal populations will be undertaken in response to regular monitoring. Trapping and removal of feral pests such as goats will occur if numbers are increasing and/or are deemed to be having a detrimental impact on the flora species or their habitat. It is unlikely that rabbits will be of concern given that they generally do not inhabit rocky areas such as Mungada Ridge. While there is currently no evidence that goats are affecting the vegetation of the Range, is possible that in the future goat numbers could increase to the point that they require management.

Actions to be undertaken are similar to those already required as conditions of approval for SMC's existing mines, except that they will be undertaken in a non-mining affected area.

Part of the proposed management area is located adjacent to the boundary of the proposed development envelope. The proposed management area is not considered to be at risk from indirect impacts because vegetation monitoring for the existing Blue Hills mine has shown minimal indirect impacts (a decline of 1.9% over 3 years), as described in Section 14.3.3 of the PER and Maia (2015a). However, this interface will be monitored to check for any potential effects from indirect impacts such as dust.

19.4.3 Monitoring and reporting

For the re-established individuals a specific monitoring program would be developed to support the program of re-establishing individuals of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. This would involve a range of monitoring approaches which would include annual health monitoring utilising, annual survey of flowering and/or seed producing individuals and photographic monitoring of re-establishment sites. Reporting on monitoring findings would be by SMC to the EPA and DPaW.

19.4.4 Timing and responsibilities

The re-establishment program and on-ground management will commence within the first year of Proposal implementation and continue for five years post-mining. The ARC research program will be implemented over the next five years, commencing this year. Specific timing and milestones for the application of the offsets will be finalised in consultation with EPA and DPaW. SMC intends to implement and manage the proposed offsets internally, in consultation with EPA and DPaW to allow agreement on all aspects of the programs to ensure adequacy to meet condition requirements as well as transparency and setting of reporting requirements. The ARC research program component will be managed through Curtin University and BGPA.

19.4.5 Completion criteria

The offsets proposed are in the early stages of development and SMC is committed to refining the offsets package in consultation with OEPA and DPaW to achieve the best possible benefits for *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. Therefore, specific completion criteria have not yet been finalised, however will be focussed on establishing the number of individuals required to ensure the 100% offset target is met (dependent on final % confidence in success) and ensuring these individuals reach an established state of reproductive maturity.

The Biodiversity Management Program will also have set completion criteria which will be directly related to the monitoring of the targets around feral animals, weeds and fire.

A monitoring, evaluation, reporting and improvement program that tracks the performance of the Biodiversity Management Program against its key objectives/targets to ensure the conservation of the key species. Annual vegetation condition assessments will be undertaken using quadrats. This aligns with existing requirements to undertake a vegetation monitoring program, which could be expanded if required to incorporate this monitoring. This, along with the monitoring of weeds and feral animal pressure will help to inform the implementation of management actions using an adaptive approach.

19.4.6 Risk management

The key risk of the re-establishment of individuals of the two key flora species will be around the survival rate of planted individuals. The lack of knowledge around re-establishment of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills presents challenges however this risk would be minimised through the knowledge that will be gained prior to commencement of the offset through information sharing with Karara and the ARC research program. SMC will also plan for environmental risk associated with survival rates of planted individuals, through implementation of irrigation systems to support the re-establishment program which are also being used as part of the BGPA rehabilitation research project.

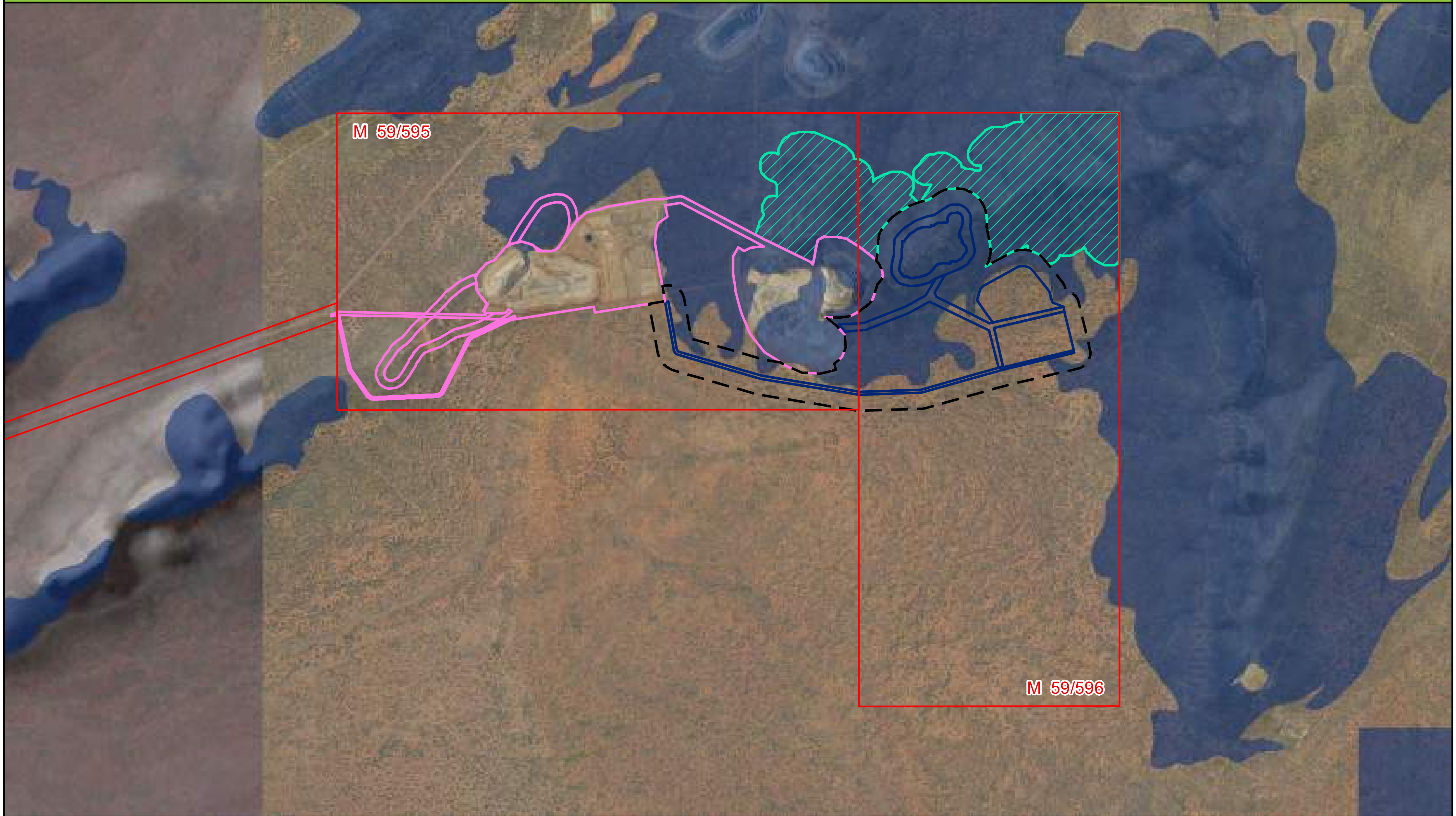
The Biodiversity Management Program is not considered to present any risk as the type of management actions to be carried out are a targeted extension of management already being successfully undertaken at the Blue Hills mine as well as what will be undertaken for the Proposal.

19.5 Predicted outcome

SMC considers the EPAs objective for this integrating factor will be achieved through the implementation of the proposed offset to counterbalance the significant residual impacts identified for the Proposal, in this case being the impact to *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills plants. The proposed offset is designed to increase the number of individuals of these species and to reduce the risk of loss of existing individuals of these species outside the proposed disturbance footprint.

SMC will work with the EPA, in consultation with DPaW, in finalising the proposed environmental offsets based on mitigating as far as practicable significant residual impacts likely after consideration of efforts to avoid, minimise and mitigate impacts.

Figure 76: Proposed offset management area



Legend

- Proposed Management Area
- SMC Tenure
- Development Envelope
- Approved DSO Project (Blue Hills) and West Expansion
- Proposed Disturbance Footprint
- Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes(banded ironstone formation) (Priority 1 PEC)

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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Prepared by: SM Date: 6/05/2016

20 Other factors

In the ESD, the EPA identified Hydrological processes and inland waters environmental quality and Heritage as other factors or matters relevant to the Proposal, but not of significance to warrant further assessment by the EPA. As such, these factors do not require further work or detailed discussion and evaluation in this PER document, but rather must be included in this PER document in a summarised, format, which is provided below.

20.1 Hydrological processes and inland waters environmental quality

20.1.1 Assessment of potential impact, mitigation and residual impact

The Proposal is located within the 7,700 km^2 Yarra Monger catchment (Yarra sub-catchment) of the Yarra Basin. There are no major rivers or creeks within or surrounding the development envelope. Surface water drainage occurs predominately through overland sheet flow. Groundwater for the existing DSO Project is sourced from two bores located to the south and west of the development envelope. Ninety-four exploration holes were drilled and logged within the proposed mine pit area from June to October 2007 (

Figure 77).

The proposed mine pit will extend to a maximum depth of 112 m below ground level and the exploration holes extended to a maximum depth of 132 m below ground level. When the holes were drilled, they were logged by a Geologist at various depths, including a recording of whether the samples were dry, moist or wet. No wet samples were recorded. Four of the holes returned some moist samples, indicating the presence of minor moisture at short intervals. SMC considers it important to note that a recording of moist, does not necessarily indicate that groundwater has been detected as it is likely to be a result of additional water injected into the hole by the driller to assist the drilling process. SMC has concluded the lack of wet samples recorded inside the pit shell to be a clear indication that groundwater will not been intercepted in the proposed pit.

Given the proposed mine pit is not anticipated to intersect groundwater, elevated evaporation rates and infiltration of incident rainfall will occur, it is not expected that a pit lake will form.

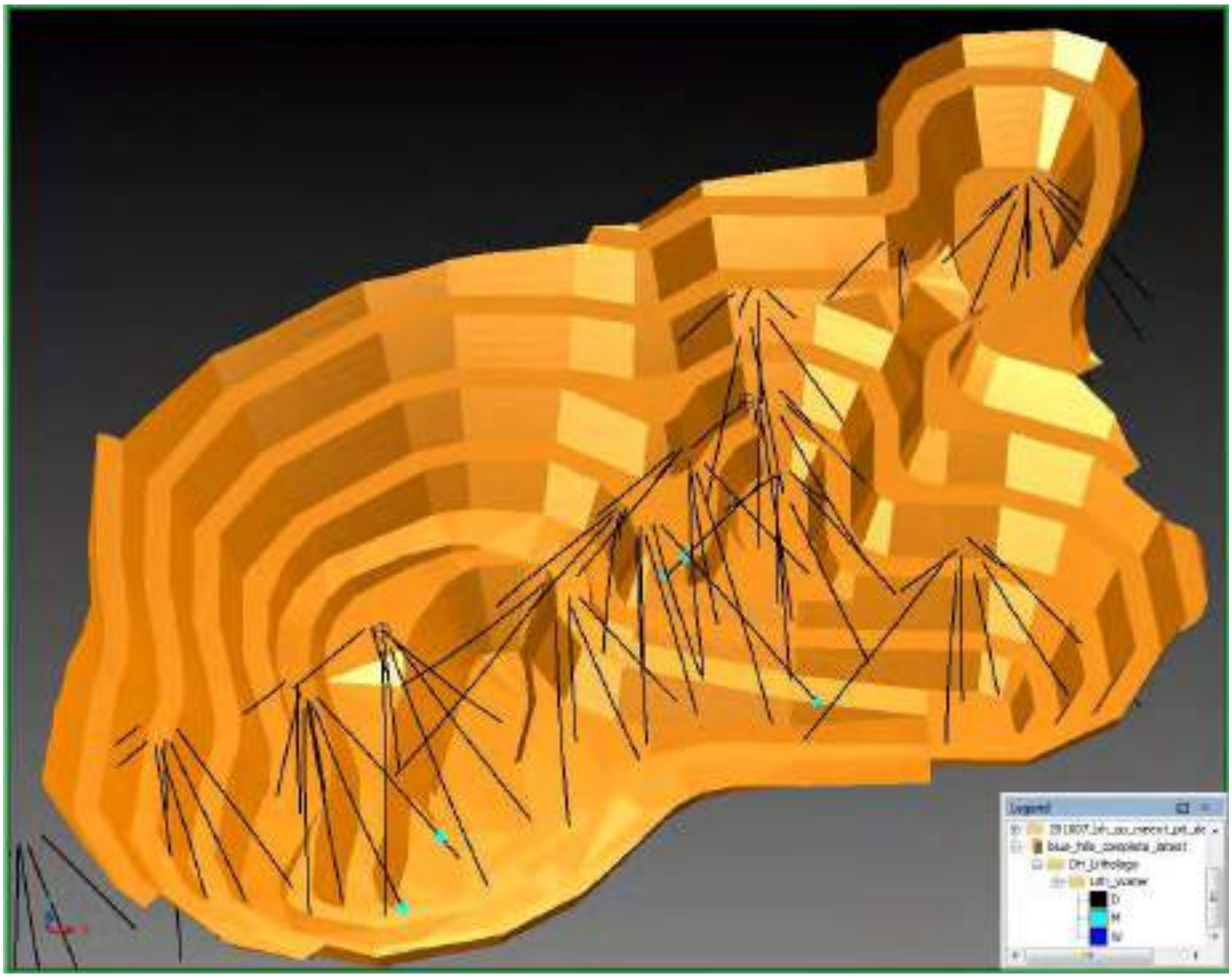

Figure 77: 3D representation of exploration holes drilled in the proposed pit

The surface water that drains from the Blue Hills range discharges southwards to a low-lying wetland basin that represents the headwaters of a surface water drainage pathway. This 60 ha area is approximately 700 m south of the existing Mungada East pit. This area was originally thought to be a gilgai formation (a specific surface feature with clay soils generally associated with groundwater dependent vegetation; EPA 2012d); however, studies commissioned by Karara Mining Limited and verified by the DEC (now DPaW) confirmed the drainage depression is not groundwater dependent and therefore not a gilgai formation (EPA 2012d). The drainage depression is now considered a seasonal surface water-dependent wetland, and therefore any potential changes to the groundwater table as a result of the Proposal are unlikely to impact the vegetation in this area.

Potential impacts to surface water and groundwater due to the implementation of the Proposal are as follows:

- reduced surface water quality;
- AMD;
- reduced surface water runoff and/or increased erosion and sedimentation as a result of altered surface water flows due to mine infrastructure (a disruption of natural drainage patterns);
- reduced groundwater levels due to reduced recharge; and
- indirect impacts to vegetation dependent on surface water flows.

No impacts to groundwater quantity or quality are expected as dewatering is not required for the Proposal. All groundwater abstraction for the Proposal will be in accordance with the existing licence conditions for the DSO Project.

Key management actions relating to surface water and groundwater include the appropriate installation and use of structures such as vehicle wash down bays, waste hydrocarbon remediation facilities and oil water separators, to minimise the risk of spills and contamination to surface water and groundwater.

Surface water drainage will be managed to ensure that the surface water hydrological system is not altered as a result of the Proposal. Surface water diversion infrastructure will be installed to minimise the risk of flooding, erosion and sedimentation in the development envelope and to minimise resultant impacts to mine infrastructure. Mine infrastructure and surface water diversion structures will be sited to minimise disruption of natural drainage patterns. In particular, surface water management for the proposed waste rock dump has been indicatively designed as part of the waste landform design study (SRK 2015; Appendix C).

The key elements of the surface water management approach include:

- clean water diversion channels;
- contact water collection channels;
- sediment ponds to receive water from the contact water collection channels;
- contact water ditch east and south of the waste rock dump;
- sump to receive water from the contact water ditch and this water would be pumped into the sediment ponds; and
- spillways to discharge contact water from the sediment ponds into the clean water channels and later into the environment.

20.1.2 Key management actions

Key actions to ensure effective management of groundwater and surface water are as follows:

- wherever possible, options to reduce water requirements and utilise alternative sources of water will be reviewed;
- drainage structures will be designed and constructed to ensure minimal alteration to existing surface drainage patterns;
- disturbance areas will be designed for minimal impact on surface drainage as far as practicable.
- contaminated water from work areas will be kept separate from clean storm water;
- groundwater contamination will be prevented by appropriate secondary containment and management of waste and hazardous materials, and management of surface water quality;
- appropriate installation and use of structures such as vehicle wash down bays, waste hydrocarbon remediation facilities and oil water separators; and
- personnel will receive relevant spill response training and spill response equipment will be readily accessible in each work area to enable quick response to spills. Spills will be controlled at the source, contained and cleaned up as soon as they occur. Contaminated material will be removed and bioremediated (if biodegradable) or disposed of at a licensed facility.

20.1.3 Predicted outcome

After mitigation and management measures have been applied, the potential impacts to hydrogeological regimes and the environmental quality of groundwater and surface water as a result of the Proposal are not considered to be significant. Any potential impacts can be managed by the measures proposed and under other statutory processes, such as the *Rights in Water and Irrigation Act 1914* (WA).

20.2 Heritage

20.2.1 Assessment of potential impact, mitigation and residual impact

The Blue Hills tenements have one registered Native Title Claimant Group: the *Widi* Mob. The *Binyardi* People and West *Badimia* have a registered heritage interest in the land (SMC 2013); however, their claims over the tenements have been dismissed by the Native Title Tribunal.

Several archaeological and ethnographic sites are known from the Blue Hills Range. These were recorded/confirmed during the archaeological heritage and ethnographic surveys undertaken for the DSO Project in 2011 (Terra Rosa 2011a, 2011b). There are no 'Registered Aboriginal Sites' (DAA 2015) within the development envelope; however, the DAA lists three registered Aboriginal 'Other Heritage Places' within the development envelope (DAA 2015); ID 24148 - Midwest Artefact Scatter 1, ID 24149 - Midwest Artefact Scatter 2 and 20859 - Blue Hills. Two additional 'Other Heritage Places' are located just outside the development envelope, near the existing Mungada East pit; 20857 - Blue Hills Larger Cave and ID 20858 – Blue Hills Smaller Cave.

Other Heritage Places are sites assessed by the Aboriginal Cultural Materials Committee (ACMC) as not satisfying the criteria for recognition as Aboriginal heritage sites under Section 5 the Aboriginal Heritage Act, or sites that are yet to be assessed by the ACMC. The status of these sites as per the most recent archaeological and ethnographic surveys (Terra Rosa 2011a, 2011b) is provided in Table 47.

Table 47: Aboriginal Other Heritage Places located within the development envelope

DAA Site	Site description	Location coordinates	Status of site
20859: Blue Hills	Mythological	488111E 6775709N	DAA site 20859 is 'stored data' and is not considered a site under Section 5 (a) of the Aboriginal Heritage Act. During the most recent survey (Terra Rosa 2011b), no further detailed ethnographic information was provided by the Traditional Owners that would warrant re-consideration of this feature as an Aboriginal heritage site under the Aboriginal Heritage Act.
24148: Midwest Artefact Scatter 1	Artefact Scatter	489342E 6776515N	DAA site 24148 has been determined to not be a site under the Aboriginal Heritage Act, as no artefactual material was recorded within this area (Terra Rosa 2011a). However, assessment of the site by the ACMC remains outstanding.
24149: Midwest Artefact Scatter 2 (BH11-12)	Artefact Scatter	489299E 6776516N	DAA site 24149 constitutes an Aboriginal site under Section 5 (a) of the Aboriginal Heritage Act, and should be considered under Section 39 (2a) and (2c) of the Aboriginal Heritage Act (Terra Rosa 2011a). However, assessment of the site by the ACMC remains outstanding.

The major risks to Aboriginal heritage are related to the disturbance of archaeological or ethnographic sites and impacts on the heritage values of sites and places. Aboriginal heritage sites could potentially be disturbed by proposed activities such as vegetation clearing and excavation.

During the consultation with the three Traditional Owner groups (*Widi* Mob, *Binyardi* People and West *Badimia*) the following requests were made (Terra Rosa 2011a, 2011b):

- every effort should be made to avoid site disturbance, including consideration of alternative locations for the works; and
- all project personnel should be aware of their obligations under the Aboriginal Heritage Act.

These and other recommendations have been adopted in the AHMP (SMC 2013, Appendix D). The AHMP has been prepared to ensure SMC's staff and contractors understand the general requirements and management of heritage sites. In particular, the AHMP contains measures in accordance with Section 17 of the Aboriginal Heritage Act to prevent the excavation, destruction, damage, concealment, or alteration of any Aboriginal site, and the possession, custody or control of any object on or under an Aboriginal site, unless authorised to do so under Section 16 or Section 18 of the Aboriginal Heritage Act.

Disruption of the sites in Table 47 to facilitate construction and operation of the Proposal is unavoidable. An application to disturb the sites listed in Table 47 was approved on 12 February 2016 under Section 18 of the Aboriginal Heritage Act. The two cave sites located just outside the development envelope are also included in the Section 18 application.

A search for European heritage places using the 'inHerit' search tool on the WA Heritage Council website returned no results for any sites of European heritage significance within or near the development envelope. The closest site of European heritage significance is the Rothsay townsite (place number 14133), located approximately 16 km south of the development envelope.

20.2.2 Key management actions

Management strategies to address potential impacts to heritage are included in the AHMP (SMC 2013, Appendix D), which has been developed to ensure SMC:

- implements the Proposal in a manner that complies with statutory obligations related to the Aboriginal Heritage Act;
- complies with any approvals issued under Section 18 of the Aboriginal Heritage Act;
- complies with an accepted and peer-approved framework for managing Aboriginal heritage;
- provides a procedural framework for the management of existing and potential unidentified Aboriginal sites and materials during construction;
- mitigates any disturbance to Aboriginal sites in a planned and appropriate manner; and
- informs relevant Aboriginal groups of ground disturbance and relevant development issues in a timely and effective manner.

Part 6 Proposed environmental management program and environmental commitments

This Part describes the proposed management framework for the Proposal to ensure that the management measures identified in Part 5 are implemented to prevent and mitigate potential environmental impacts. This Part also proposes conditions of approval for consideration by the EPA to ensure the environmental acceptability of the Proposal.

21 Environmental management framework

21.1 Overview

SMC has an overarching Environmental Policy which promotes the company's objective to develop resources while also protecting and preserving the environment. SMC accepts responsibility for the impacts their operations have on the environment, and is committed to eliminate, mitigate, reduce, manage or offset these impacts. All activities will meet statutory requirements as a minimum standard and be planned and performed so that adverse effects on the environment are either avoided or appropriately managed.

To achieve the objective of the policy, SMC will:

- establish a set of policies, objectives and commitments for all activities;
- identify and comply with all legal responsibilities;
- develop and apply responsible environmental management where laws and regulations are inadequate or do not exist;
- assess potential environmental impacts before conducting new activities;
- institute a management system that identifies environmental responsibilities for all employees and contractors;
- design and implement a system of work procedures and training programs to encourage respect for the environment and the prevention of pollution and enable employees and contractors to identify and fulfil their environmental responsibilities;
- implement monitoring and auditing systems to ensure environmental commitments and objectives are being achieved; and
- develop and foster a culture that encourages continuous improvement in environmental performance.

SMC will manage environmental impacts through:

- compliance with environmental approval conditions;
- implementation of the management measures outlined in this PER document and the Blue Hills Mungada East Expansion Condition EMP;
- implementation of the Blue Hills Mungada East Expansion Mine Closure Plan;
- regular review of the performance of the above mentioned plans;
- measurement of energy use and greenhouse gas emissions, and continually seeking opportunities to reduce emissions;

- regular updates to plans for ground disturbance and closure;
- progressive rehabilitation of disturbed land and measurement of rehabilitation success;
- training staff and contractors in environmental requirements and considerations of their work;
- seeking stakeholder views and ensuring that they are respected and considered; and
- regular liaison with key stakeholders.

21.2 Summary of likely environmental control instruments

SMC has identified the regulatory controls that will ensure environmental values are protected during implementation of the Proposal. The key controls are:

- environmental conditions in any Statement issued by the WA Minister for Environment allowing the Proposal to be implemented;
- conditions relating to the rate and volume of groundwater extraction in accordance with the existing Licence to take Water #GWL159255(1) issued by the DoW;
- conditions of any Works Approval or Licence issued by the DER; and
- conditions of any Program of Works or Mining Proposal approvals issued by the DMP.

Other relevant measures and/or actions are contained in the management plans outlined in Section 0.

21.3 Principles of environmental protection

The principles of environmental protection (EPA 2004a) were taken into account when developing impact mitigation and management measures for the Proposal (Table 48).

21.4 Existing management of the DSO Project

During each annual audit of the existing DSO Project by the EPA and DMP since its commencement in 2013, SMC was found to be operating in compliance with all conditions of MS 811. During the DER inspection in 2014, two minor non-compliances were recorded relating to liquids being present in the bunding of diesel tanks and chemical storage containers at the wash-down bay, resulting in the capacity of the bunding to be reduced (see DER 2014 audit report in Appendix I). However, SMC has an otherwise sound record of successful environmental management at Blue Hills and Koolanooka which would continue as such for the Proposal.

Table 48: Principles of environmental protection

Principle	Relevant (Yes/No)	If Yes, consideration	Section addressed in this document
1. The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk – weighted consequences of various options.	Yes	SMC used a risk assessment approach in the development of the Proposal to identify at an early stage the potential key environmental values and impacts. This included undertaking site investigations of the biological and physical environments to identify existing values and significance as part of a detailed environmental assessment of the Proposal. The current mine plan is the result of a planning process aimed at avoiding and minimising environmental impacts to environmental values. Major modifications were made to reduce potential environmental impacts early on. In particular, the extent of the mining footprint located on Mungada Ridge, which supports higher conservation values than areas off the ridge, was significantly reduced. This was achieved by relocating the proposed waste rock dump off the ridge. The key values identified in the early stages of development of the Proposal align now with environmental factors potentially at risk from the Proposal under the revised mine plan. These factors and the potential environmental impact on these factors are addressed in this PER document. Scoping of relevant environmental factors was undertaken through the ESD process for the Proposal. The EPA prepared and issued the ESD in consultation with relevant decision-making authorities and SMC, which involved scoping of potentially relevant environmental factors. The EPA, in its development of the ESD, consulted with SMC on the details of the Proposal and its environmental setting, the environmental surveys and investigations required, and expected outcomes.	Section 10

Principle	Relevant (Yes/No)	If Yes, consideration	Section addressed in this document
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	The Proposal incorporates progressive rehabilitation of disturbed areas through the Blue Hills Mungada East Expansion Mine Closure Plan. The aim of closure and rehabilitation is to ensure that post-mining land uses are enabled to ensure that relevant areas of the Proposal retain enduring value for future generations.	Section 18
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	Environmental studies have been conducted in the development envelope and broader SMC Blue Hills tenements to identify environmental values and the potential impacts of the Proposal. The scope of the studies was defined through preliminary risk assessment, stakeholder consultation and scoping of the Proposal as part of the ESD process. Results from these studies have been used to assess the significance of potential impacts to preliminary key environmental factors for the Proposal. In defining these potential impacts, associated avoidance, mitigation and management measures have been identified to be implemented for the Proposal to avoid, reduce and/or minimise the impacts. A number of biodiversity management measures are included in the Blue Hills Mungada East Expansion Condition EMP, and the Blue Hills Mungada East Expansion Mine Closure Plan to prevent and mitigate potential impacts to local and regional biological diversity and ecological integrity.	Sections 11, 13, 14, 15, 16
4. Principles relating to improved valuation, pricing and incentive mechanisms (a) Environmental factors should be included in the valuation of assets and services.	Yes	SMC recognises the importance of improved valuation, pricing and incentive mechanisms and has developed an environmental management program for the Proposal. Implementation of this program will involve the use of significant human and financial resources and SM is committed to this.	Appendix D (EMP)

Principle	Relevant (Yes/No)	If Yes, consideration	Section addressed in this document
(b) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. (c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. (d) Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.		Environmental, economic and social considerations were accounted for during SMC's pre-feasibility study of the Proposal. The full life cycle costs of the Proposal, including costs associated with decommissioning and closure will be re-estimated at appropriate stages throughout the life of the Proposal. SMC recognises the polluter pays principle, and management measures to minimise these impacts have been developed. Pollution will largely be addressed through a combination of minimisation and on-site treatment, resulting in minimal movement of pollutants off site. Environmental goals will be pursued in the most cost-effective manner, using a combination of internal resources and where appropriate, external expertise.	
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Yes	The Proposal includes measures to minimise the generation of waste and reuse and recycle waste materials, wherever possible.	Appendix D (EMP)

22 Proposed environmental conditions

The environmental footprint and other key characteristics of the Proposal, as described in Section 4, have been developed for consideration by the EPA and are anticipated to form the basis of any statement issued by the State Minister for Environment, pursuant to the approval of the Proposal. The Proposal will be implemented such that the resultant environmental effects will be as assessed in this PER document.

SMC has proposed environmental conditions for consideration by the State Minister for Environment (Table 49). These conditions are outcome-based in that they prescribe the environmental outcomes to be achieved rather than how to achieve the outcomes; this approach aligns with the EAG 4 (EPA 2009c). These outcome-based conditions are also suitable for internal and external auditing. SMC considers these conditions to be technically feasible, clear and relevant to the key environmental factors associated with the Proposal and to meet the EPA objectives for environmental protection.

The proposed environmental conditions (Table 49) have been developed to avoid duplication with other regulatory controls that can be applied under other existing legislation. A condition relating to the management of a specific environmental factor has not been proposed if environmental impact can, or is, adequately addressed by other environmental control instruments, including the Blue Hills Mungada East Expansion Condition EMP and/or the Blue Hills Mungada East Expansion Closure Plan (Appendix D and Appendix E).

SMC recognises that an offsets condition may be required if the EPA determines that the residual impacts of the Proposal are significant. SMC will discuss offset requirements with the EPA once a conclusion has been reached on the significance of the residual impacts.

Table 49: Proposed environmental conditions

Condition No.	Proposed condition
1 Proposal Implementation	
1-1	When implementing the Proposal, the proponent shall not exceed the authorised extent of the Proposal, unless amendments to the Proposal and the authorised extent of the Proposal have been approved under the *Environmental Protection Act 1986*.
2 Contact Details	
2-1	The proponent shall notify the Chief Executive Officer (CEO)* of any change of its name, physical address or postal address for the serving of notices or other correspondence within 28 days of such change. Where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State.
3 Time Limit for Proposal Implementation	
3-1	The proponent shall not commence implementation of the Proposal after the expiration of five (5) years from the date of this Statement, and any commencement, within this five (5) year period, must be substantial
3-2	Any commencement of implementation of the Proposal, within five (5) years from the date of this Statement, must be demonstrated as substantial by providing the

Condition No.	Proposed condition
	CEO with written evidence, on or before the expiration of five (5) years from the date of this Statement.
4 Compliance Reporting	
4-1	The proponent shall prepare, submit and maintain a Compliance Assessment Plan to the CEO at least six (6) months prior to the Compliance Assessment Report required by condition 4-6.
4-2	The Compliance Assessment Plan shall indicate: 1) the frequency of compliance reporting; 2) the approach and timing of compliance assessments; 3) the retention of compliance assessments; 4) the method of reporting of potential non-compliances and corrective actions taken; 5) the table of contents of Compliance Assessment Reports; and 6) public availability of Compliance Assessment Reports.
4-3	After receiving notice in writing from the CEO that the Compliance Assessment Plan satisfies the requirements of condition 4-2 the proponent shall assess compliance with conditions in accordance with the Compliance Assessment Plan required by condition 4-1.
4-4	The proponent shall retain reports of all compliance assessments described in the Compliance Assessment Plan required by condition 4-1 and shall make those reports available when requested by the CEO.
4-5	The proponent shall advise the CEO of any potential non-compliance within seven (7) days of that non-compliance being known..
4-6	The proponent shall submit to the CEO the first compliance assessment report fifteen (15) months from the date of issue of this Statement addressing the twelve (12) month period from the date of issue of this Statement and then annually from the date of submission of the first Compliance Assessment Report, or as agreed in writing by the CEO. The Compliance Assessment Report shall: 1) be endorsed by the proponent's CEO or a person delegated to sign on the CEO's behalf; 2) include a statement as to whether the proponent has complied with the conditions; 3) identify all potential non-compliances and describe corrective and preventative actions taken; 4) be made publicly available in accordance with the approved Compliance Assessment Plan; 5) indicate any proposed changes to the Compliance Assessment Plan required by condition 4-1.
5 Public Availability of Data	
5-1	Subject to condition 5-2, within a reasonable time period approved by the CEO of the issue of this Statement and for the remainder of the life of the Proposal, the

Condition No.	Proposed condition
	proponent shall make publicly available, in a manner approved by the CEO, all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products (e.g. maps)) relevant to the assessment of this Proposal and implementation of this Statement.
5-2	If any data referred to in condition 5-1 contains particulars of: (1) a secret formula or process; or (2) confidential commercially sensitive information; the proponent may submit a request for approval from the CEO to not make this data publicly available. In making such a request the proponent shall provide the CEO with an explanation and reasons why the data should not be made publicly available.
6 Flora and Vegetation	
6-1	The proponent shall ensure that the disturbance to *Acacia woodmaniorum*, *Lepidosperma* sp. Blue Hills and the PEC does not exceed that specified in Schedule 1 and is contained to within the development envelope defined in Figure 1 of Schedule 1.
6-2	Prior to ground disturbing activities, the proponent shall prepare and submit a Condition Environmental Management Plan in accordance with EAG 17 to the CEO.
6-3	The plan shall detail specific management actions to be undertaken for Threatened and Priority Flora and Priority Ecological Communities as follows: (1) demonstrate that all infrastructure is sited and constructed to avoid *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills and the PEC where practicable and minimise the impact to other conservation significant flora or vegetation as identified and spatially defined in the PER; (2) identify potential direct and indirect impacts to *Acacia woodmaniorum*, *Lepidosperma* sp. Blue Hills, the PEC and any other conservation significant flora or vegetation; (3) specify management actions that will be implemented to ensure that indirect impacts to conservation significant flora species and the PEC are minimised; (4) develop an appropriate monitoring methodology and detail the proposed frequency and timing of monitoring; (5) specify appropriate early response indicators to ensure condition 6-1 is being met; (6) specify additional management actions to be implemented in the event that the early response indicators specified by condition 6-6(5) are recorded; (7) provide a protocol or procedure for the monitoring and review of the Condition Environmental Management Plan to ensure that the plan is meeting the objective specified in condition 6-1; and

Condition No.	Proposed condition
	(8) provide a reporting schedule to demonstrate to the CEO that the Condition Environmental Management Plan is meeting the objective specified in condition 6-1.
6-4	In the event that the monitoring specified in the Condition Environmental Management Plan indicates that the early response indicators have been recorded, the proponent shall: (1) immediately implement additional management actions and continue implementation of those actions until the environmental objectives are met, or until the CEO has confirmed by notice in writing that it has been demonstrated that the outcome in condition 6-1 is being and will continue to be met and implementation of the additional management actions is no longer required; (2) investigate to determine the likely cause of the early response indicators being recorded and to identify any additional management actions required to prevent the early response indicators being recorded in the future; and (3) provide a report to the CEO within 30 days of an event, referred to in condition 6-4, occurring. The report shall include: (a) details of additional management actions implemented; and (b) the findings of the investigation required by condition 6-4(2).
6-5	The proponent may review and revise the Condition Environmental Management Plan.
6-6	The proponent shall review and revise the Condition Environmental Management Plan, as and when directed by the CEO.
6-7	The proponent shall implement the latest revision the Condition Environmental Management Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 6-1 to 6-7.
7 Terrestrial Fauna	
7-1	The proponent shall prepare and implement procedures to avoid fauna deaths in areas as a result of implementation of the Proposal.
7-2	The proponent shall submit the procedures required by condition 7-3 to the CEO prior to commencement.
7-3	The proponent shall record the death of any fauna listed as specially protected under the *Wildlife Conservation Act 1950* (WA) or listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* or listed as Priority Fauna by the Department of Parks and Wildlife including the location of death and species of fauna.
7-4	The proponent shall review and revise the procedures required by condition 7-3 as required by the CEO.

Condition No.	Proposed condition
8 Rehabilitation and Decommissioning	
8-1	The proponent shall ensure that the Proposal is decommissioned and rehabilitated in an ecologically sustainable manner, through the implementation of the Mine Closure Plan required by condition 8-2.
8-2	The proponent shall prepare a Mine Closure Plan in accordance with the Guidelines for Preparing Mine Closure Plans, May 2015, and any updates, to the requirements of the CEO on advice of the Department of Mines and Petroleum. The proponent shall revise the Mine Closure Plan until notified that it is satisfactory in writing by the CEO.
8-3	The proponent may review and revise the Mine Closure Plan.
8-4	The proponent shall review and revise the Mine Closure Plan required by condition 8-2 at intervals not exceeding three years starting from the date of notification from the CEO under condition 8-2, or as otherwise specified in writing by the CEO. The revised Mine Closure Plan shall be submitted to the CEO.
8-5	The proponent shall implement the latest revision of the Mine Closure Plan required by condition 8-2, which the CEO has confirmed by notice in writing satisfies the requirements of condition 8-2.

* The CEO of the Department of the Public Service of the State responsible for the administration of section 48 of the EP Act, or their delegate.

23 Conclusions

This PER document provides:

- a description of the key components of the Proposal;
- a summary of the important physical, biological and social factors of the existing environment;
- a description of stakeholder consultation;
- an evaluation of potential impacts of the Proposal to environmental factors, including cumulative impacts; and
- strategies and measures to ensure environmental factors and values are protected and managed appropriately.

This PER document has been prepared in accordance with the ESD developed by the EPA (Appendix A). This PER document and all supporting biological survey reports have been prepared in accordance with the guidelines presented in the EPA checklist for documents submitted for Environmental Impact Assessment on marine and terrestrial biodiversity (Appendix J).

23.1 Environmental impacts and mitigation

The preliminary key environmental factors identified by the EPA in the ESD for the Proposal were:

- landforms;
- flora and vegetation;
- terrestrial fauna;
- subterranean fauna;
- amenity;
- offsets (integrating factor); and
- rehabilitation and decommissioning (integrating factor).

Other environmental factors identified by the EPA in the ESD to be relevant to the Proposal were:

- hydrological processes and inland waters environmental quality; and
- heritage.

23.1.1 Landforms

After application of mitigation and management, the residual impact to the Mungada Ridge landform will be the proposed mine pit and pit abandonment bund remaining as structural impacts on the landform, covering approximately 18.6 ha. The proposed haul roads and access road will alter the landform temporarily; these will be rehabilitated upon closure of the Proposal and will therefore alter the surface of the landform only for the duration of construction and operations. The permanent impact associated with the proposed mine pit and pit abandonment bund will be restricted to the western, lower-lying area of Mungada Ridge. Neither the most prominent (highest and steepest) areas, nor the crescent shape of Mungada Ridge will be affected by the Proposal. The vast majority of the Mungada Ridge landform and its more distinctive attributes (height, slope, shape and size) will remain in the landscape. Therefore, the Proposal will not significantly affect the variety of landforms present in the LAU or the Mungada/Karara/Koolanooka region.

The Proposal is considered to be consistent with the EPA's objective for the landforms factor. After implementation of the Proposal, 88.4% of the ridge would remain undisturbed. Furthermore, once the proportion of Mungada Ridge affected by exploration (23.9 ha) is rehabilitated the undisturbed or restored area of Mungada Ridge would increase to 91.8%.

23.1.2 Flora and Vegetation

After considering the application of avoidance, minimisation and mitigation (including rehabilitation and restoration) measures, the following key residual impacts on vegetation and flora are predicted:

- clearing of approximately 52 ha of vegetation in Good to Excellent condition across six vegetation associations of high local conservation significance and one vegetation association of moderate local conservation significance;
- clearing of approximately 21.4 ha within the boundary of the 'Blue Hills (Mount Karara/ Mungada/ Blue Hills) vegetation complexes (banded ironstone formation)' Priority 1 PEC, representing 0.3% of the mapped area of the PEC;
- removal of 2,634 individuals of *Acacia woodmaniorum* (Threatened – Vulnerable), representing 25% of the number of individuals within tenements M59/595 and M59/596 and 10% of the number of individuals within the Tallering sub-region and WA. The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat modelled for *Acacia woodmaniorum*, which represents approximately 41% of the extent modelled in the development envelope and 1.5% of the extent modelled within the Blue Hills Impact Assessment Area;
- removal of two individuals of *Acacia karina* (Priority 1), representing 4% of the number of individuals within tenements M59/595 and M59/596 and less than 1% of the number of individuals within the Tallering sub-region;
- removal of 669 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1), representing 29% of the number of individuals within tenements M59/595 and M59/596 and 12% of the number of individuals within the Tallering sub-region and WA. The proposed clearing will result in the loss of approximately 21 ha of the most favourable habitat for *Lepidosperma* sp. Blue Hills, which represents approximately 41% of the extent modelled within the development envelope and 1.3% of the extent modelled within the Blue Hills Impact Assessment Area; and
- removal of 5,832 individuals of eight Priority 3 species, representing up to 24% of each species' sub-regional population.

SMC considers residual impacts can be restricted to those described and offsets can be applied such that the EPA objective for flora and vegetation is met.

23.1.3 Terrestrial Fauna

After considering the application of avoidance, minimisation and mitigation measures, the following residual impacts on terrestrial fauna are predicted:

- direct loss of some individual fauna, particularly during vegetation clearing, including five inactive Malleefowl mounds and 25 *Idiosoma nigrum* burrows;
- clearing of approximately 52 ha of fauna habitat; and
- fragmentation of fauna habitat caused by the Mungada East Extension pit (proposed) and associated infrastructure.

SMC considers that it can restrict residual impacts to those described and manage the Proposal such that the EPA objective can be met without further mitigation in the form of specific offsets being required for terrestrial fauna.

23.1.4 Subterranean Fauna

After management and mitigation measures have been applied, it is expected that the Proposal will result in the following outcome for subterranean fauna:

- direct mortality of individuals and reduction in available troglofauna habitat as a result of pit excavation. The continuous nature of BIF geology in which troglofauna have predominately been recorded indicates that geology is not a limiting factor in the distribution of the taxa currently known from the proposed mine pit within the development envelope.

SMC considers that it can restrict residual impacts to those described and manage the Proposal such that the EPA objective can be met without further mitigation in the form of specific offsets being required for subterranean fauna.

23.1.5 Amenity

The Proposal will have minimal impacts on amenity and landscape values due to screening provided by roadside vegetation and the distance at which sensitive view locations are located from the proposed disturbance footprint.

23.1.6 Rehabilitation and decommissioning

- whole development envelope is non-polluting and safe to humans and wildlife;
- areas disturbed for waste landforms are geotechnically and erosionally stable, visually compatible with the surrounding natural landscape, and ecologically similar to the pre-mining environment;
- areas disturbed for mining and infrastructure are rehabilitated to a condition compatible with the post-mining land use following decommissioning; and
- land disturbed by the proposed mining activities remains undisturbed from secondary impact in the future.

23.1.7 Offsets

The following residual impacts are considered significant impacts requiring an offset, or potentially significant impacts which may require an offset:

- ‘Significant residual impacts that will require an offset’:
  - removal of 2,634 individuals of *Acacia woodmaniorum* representing 25% of the number of individuals within tenements M59/595 and M59/596 and 10% of the number of individuals within the Tallering sub-region and WA;
- ‘Significant residual impacts that may require an offset’:
  - clearing of 669 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (Priority 1), representing 29% of the number of individuals within tenements M59/595 and M59/596 and 12% of the number of individuals within the Tallering sub-region and WA.

In light of these residual impacts, offsets are proposed for both *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. SMC proposes that its main offset consists of a re-establishment program to be undertaken which ultimately seeks to increase the populations of these flora and prospects of long-term survival of these species. Components of this program would include seed collection, trials to improve germination and establishment techniques, identification of potential habitat sites and translocation of seedlings. The replacement of approximately 3,413 *Acacia woodmaniorum* and 837 *Lepidosperma*. sp. Blue Hills would be undertaken to completely offset the losses of these species as a result of implementation of the Proposal.

SMC proposes that its additional offset consists of on-ground management of portions of Mungada Ridge outside existing operations and the proposed development envelope and within tenements M59/595 and M59/596 (the Management Area), which provide habitat for approximately 5,563 individuals of *Acacia woodmaniorum* and 1,587 individuals of *Lepidosperma* sp. Blue Hills. On-ground management is considered likely to be of benefit to both species by reducing threatening processes and thereby averting the future loss of key environmental values.

SMC will work with the EPA, in consultation with DPaW, in finalising the proposed environmental offsets, counterbalancing as far as practicable significant residual impacts likely after consideration of efforts to avoid, minimise and mitigate impacts.

23.1.8 Hydrological Processes and Inland Waters Environmental Quality

After mitigation and management measures have been applied, the potential impacts to hydrogeological regimes and the environmental quality of groundwater and surface water as a result of the Proposal are not considered to be significant. Any potential impacts can be managed by proposed measures and as regulated under other statutory processes, such as the *Rights in Water and Irrigation Act 1914* (WA).

23.1.9 Heritage

The Proposal will require salvage and removal of the two artefact scatter ‘Other Heritage Places’; ID 24148 - Midwest Artefact Scatter 1, ID 24149 - Midwest Artefact Scatter 2 and will partially affect 20859 - Blue Hills. An application to disturb these Other Heritage Places was approved on 12 February 2016 under Section 18 of the Aboriginal Heritage Act. Disturbance will be in accordance with the provisions of the Aboriginal Heritage Act and will have the consent of the Traditional Owners. SMC will maintain ongoing consultation with Aboriginal stakeholders over the life of the Proposal. There are no sites of European heritage significance within or near the development envelope.

23.2 Environmental management framework

The Proposal will be subject to SMC’s Environmental Policy. Management controls to be implemented as part of the Proposal to ensure preliminary key environmental factors are managed as described in the PER document include measures and/or actions contained within the following key documents:

- Blue Hills Mungada East Expansion Condition EMP;
- Blue Hills Mungada East Expansion Mine Closure Plan; and
- Blue Hills AHMP.

SMC has a sound record of successful environmental management at Blue Hills and Koolanooka. This should provide regulator confidence that the development of the Proposal will be undertaken by an experienced proponent with demonstrated success in environmental management.

23.3 Environmental acceptability of the Proposal

The approach taken in this PER document has been based on a risk assessment approach to characterise the environmental factors, determine potential impacts and develop mitigation measures.

SMC has consulted with key stakeholders to scope the potential impacts of the Proposal and to determine the significance of environmental issues and the acceptability of proposed mitigation. This process, together with the environmental impact assessment of all identified environmental factors provided in this PER document for the Proposal, provides a high level of certainty that all significant environmental issues have been identified, investigated and mitigated as far as practicable.

SMC has demonstrated, and continues to demonstrate, its compliance with the conditions of MS 811 with regard to the effective management of environmental values for the DSO Project. The experience gained from the successful management of impacts to environmental values at the DSO Project to date is anticipated to lead to a greater level of confidence in achieving specified environmental outcomes for the Proposal.

On the basis of the findings of this PER document, the Proposal is considered to be environmentally acceptable if implemented in accordance with the proposed management and mitigation measures, including proposed environmental conditions.

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Appendix A Environmental Scoping Document

Contained on attached CD.

Appendix B ESD Compliance Checklist and EPA Policy consideration table

ESD compliance checklist

Environmental factor	Work required	Section addressed in this document
Flora and vegetation	1. Undertake a Level 2 flora and vegetation survey for the entire development envelope and any additional areas where vegetation may be indirectly impacted as a result of the proposal, or where local population information is required for conservation significant species and vegetation units. Surveys are to be undertaken in accordance with EPA Guidance Statement 51 and the Department of Environment and Conservation (now the Department of Parks and Wildlife) *Recommended interim protocol for flora surveys of banded ironstone formations of the Yilgarn Craton*. A peer review of the vegetation and flora information by a suitably qualified professional will also be required. The peer reviewer should be selected in accordance with the criteria outlined in EPA Guidance Statement 51. Should the proponent intend to rely on results from previous surveys a literature review and justification will be required to ensure those surveys are relevant, representative of the development envelope, provide suitably current information on populations and locations of flora of conservation significance, and were carried out using methods consistent with EPA Guidance.	Section 14.2.1and Appendix C and Figure 45
	2. Identify and map threatened flora (Declared Rare Flora, DRF), Priority flora and other conservation significant flora species and vegetation units (including those vegetation units associated with the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (BIF) PEC and their areas to be cleared or indirectly impacted as defined in EPA Guidance Statement 51. Provide details of the methodology used in the identification and mapping of vegetation units. The vegetation units should be classified based on floristics, rather than structural vegetation features utilising the methodology of the recommended interim protocol above. Describe and map the condition of the vegetation. The definition of conservation significant species or vegetation incorporates the assigned status from State and/or Commonwealth lists and/or the EPA's definition of significant species and vegetation in EPA Guidance	Sections 14.2.2 and 14.2.3 and Figure 46 to Figure 57

Environmental factor	Work required	Section addressed in this document
	Statement 51. Significant species and vegetation are defined in EPA Guidance Statement 51 as species and vegetation that may be significant for a range of reasons other than listing under State or Commonwealth legislation as threatened, Priority and specially protected (e.g. endemic or restricted taxa, new taxa or affinities, taxa at the limits of their range, etc).	
	3. Provide a detailed description and figure(s) of the proposed clearing and impacts associated with the proposal.	Sections 14.3.1 and 14.3.3 and Table 11 to Table 18
	4. Predict the residual impacts from the proposal on flora and vegetation, both direct and indirect, after considering and applying avoidance and minimisation measures. Impact predictions are to include, but not be limited to: a) The extent of impacts on conservation significant flora species (noting those flora species that have ranges either centred on BIF (specialist) or restricted to a single BIF range (endemic), including the number of plants in the affected populations, the percentage of plants in the affected populations, the number of plants and populations to be impacted in a 'worst case scenario', and the number of plants and populations known to occur outside the disturbance footprint at both a local and regional scale. b) The extent of impacts on the different vegetation units including those vegetation units associated with the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (BIF) PEC. Analysis should include local and regional distribution of vegetation units. c) Provision of information on the representation of conservation significant flora and vegetation units on the remaining, unmined, areas of the Mungada Ridge. Provide information on the tenure of those occurrences, such as managed for conservation or within an exploration licence, mining lease or other mining tenure. d) Discussion of the cumulative impacts of past, current and approved mining activities on the Mungada Ridge and surrounding area on the conservation significant flora and vegetation units utilising quantitative data from relevant local and regional surveys. e) Provision of information on the representation of impacted conservation significant flora species and vegetation communities in secure conservation tenure. f) Provision of information on the implications of the proposal on the genetic diversity and structuring of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills, including consideration of the implications of the	Sections 14.3.1, 14.3.2, 14.3.3, 14.4, 14.5 and Table 11 to Table 23

Environmental factor	Work required	Section addressed in this document
	proposal on population dynamics and functionality (connectivity etc). g) Analysis and collation of the information from all the relevant flora reports to address impacts (direct and indirect) and risk of mining-related activities to the long-term survival and population viability of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. Indirect impacts include dust, changed microclimate, changed hydrology, changed ecosystem processes, including impacts to pollinators and reduced reproductive success, reduced genetic diversity, fragmentation, introduced weeds/disease, trampling by introduced fauna and changes to seed dispersal.	
	5. Demonstrate how the EPA's objective for this factor can be met.	Sections 14.6 and 14.7
	6. Identify management and mitigation measures for the proposal to ensure residual impacts are not greater than predicted. The PER is to include: a) A description of the management and mitigation measures for flora and vegetation; and b) A conservation significant species and communities management plan including environmental outcomes/objectives; other key regulatory requirements; management actions; monitoring (including methodology, frequency, location and rationale); trigger criteria; contingency actions; review, reporting and consultation.	Section 14.6 and Appendix D.
	7. Provide quantitative information (peer reviewed or an independent report) from a suitably qualified professional on the outcomes of the proponent's threatened flora (Declared Rare Flora, DRF) and Priority flora (including *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills) management, rehabilitation and restoration associated with the existing operations. Information should include, but not be limited to: a) The outcomes of research projects; b) The implementation of plans; c) The current status of any attempts to establish or improve populations of the species in the wild; and d) Implications of findings for other potential BIF specialist flora species.	Appendix F, Section 18
	8. Complete the EPA Checklist for documents submitted for Environmental Impact Assessment on terrestrial biodiversity.	Appendix J

Environmental factor	Work required	Section addressed in this document
Landforms	9. For the purpose of characterising the significance of landforms and assessing the potential impacts of the proposal on landforms, including from cumulative impacts, the EPA has identified the affected landform (Figure 3), the local assessment unit (Figure 4) and the regional context (Figure 5).	Section 13.2 and Figure 10 to Figure 12
	10. Characterise the significance of the affected landform in a local and regional context and the local assessment unit in a regional context, having regard to the following (include relevant maps, figures and aerial photography): a) Variety - are the landforms considered a particularly good or important example of their type? How adequately are these types of landforms represented in the local and regional area? How do the landforms differ from other examples at these scales? b) Integrity - are the landforms intact, being largely complete or whole and in good condition? To what extent have the landforms, and the environmental values they support, been impacted by previous activities or development? For example; have part of the landforms been removed? c) Ecological importance - do the landforms have a role maintaining existing ecological and physical processes? For example; do the landforms provide a microclimate, source of water flow or shade? Include a discussion on complexity of the landforms. For example; do the landforms have important geological features like cliffs, caves, monoliths or outcropping? d) Scientific importance - do the landforms provide evidence of past ecological processes or are they an important geomorphological or geological site? Are the landforms of recognised scientific interest as a reference site or an example of where important natural processes are operating? and e) Rarity - are the landforms rare or relatively rare; being one of the few of its type at a local and regional level?	Section 13.2, Figure 13 to Figure 38, Appendix G
	11. Identify the environmental values of the affected landform and note which of these environmental values will be addressed through other preliminary key environmental factors identified in this ESD. Identify and discuss any environmental values which are entirely dependent on the landform.	Section 13.2.3
	12. Identify the current land tenure of each of the landforms within the local assessment unit and the level of protection the land tenure affords, from any loss of the landforms integrity.	Section 13.2.3 and Figure 26 and Figure 28

Environmental factor	Work required	Section addressed in this document
	13. Identify and describe the aspects of the proposal which may potentially affect the landforms within the local assessment unit, including both direct and indirect impacts and for construction, operation and closure.	Section 13.3
	14. Based on the findings above identify, map (3 dimensionally) and describe the areas: a) That will be altered, both temporarily (define timescales) and permanently; and b) That will remain as a structural impact on the landforms.	Section 13.3.1 and Figure 39 to Figure 42
	15. Predict the impacts from the proposal, both direct and indirect, on the landforms within the local assessment unit after considering and applying avoidance and minimisation measures. Impact predictions are to include, but not be limited to: a) The likely extent, severity and duration of direct and indirect impacts on the landforms; and b) The direct and indirect impacts to variety, integrity, ecological functions and environmental values of the landforms.	Section 13.3 and Figure 39 to Figure 42
	16. Evaluate the cumulative impacts on the landforms (both individually and collectively) within the local assessment unit from the proposal and other currently approved exploration and developments. Provide information on any other reasonably foreseeable developments in the local assessment unit. Include relevant maps, figures and aerial photography.	Section 13.3.5 and Figure 43 and Figure 44
	17. Demonstrate how the EPA's objective for this factor can be met.	Section 13.4 and 13.5
	18. Identify management and mitigation measures for the proposal to demonstrate and ensure residual impacts are not greater than predicted (e.g. measures to stabilise the affected landforms during mining activities). This is to include a monitoring and management program to avoid and minimise indirect impacts and identify feasible contingencies.	Section 13.4
	19. Describe measures and actions to minimise permanent impacts to the structure of the affected landform(s) within the local assessment unit. Provide evidence to demonstrate that the proposed measures and actions are feasible and achievable.	Section 13.4
	20. A peer review of the landforms section of the PER, including any technical studies, by a suitably qualified professional is also required.	Appendix F

Environmental factor	Work required	Section addressed in this document
Subterranean fauna	21. In accordance with EPA Environmental Assessment Guideline 12 and Guidance Statement 54a: a) Conduct a desktop study, incorporating existing regional subterranean fauna surveys and databases to confirm whether subterranean fauna are present or likely to be present. b) If the area is prospective for subterranean fauna, undertake a Level 2 survey, this should include sampling inside and outside the impact areas. Consider cumulative impacts. If the proponent intends to rely on results from previous surveys, justify how those surveys are relevant, representative of the development envelope, and were carried out using methods consistent with EPA Guidance.	Section 16.2 and Appendix C
	22. Provide figure(s) showing the local extent of subterranean fauna habitat in relation to the proposal and species distributions. Provide a detailed description of impacts associated with the proposal.	Figure 74 and Section 16.3
	23. Predict the residual impacts from the proposal on subterranean fauna, including direct, indirect and cumulative, after considering and applying avoidance and minimisation measures.	Section 16.3
	24. Demonstrate how the EPA's objective for this factor can be met.	Section 16.4 and 16.5
	25. Identify management measures and monitoring for the proposal to ensure residual impacts are not greater than predicted.	Section 16.4
Terrestrial fauna	26. In accordance with EPA Guidance Statement 56 and the EPA/DEC Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment: a) Carry out a desktop assessment of previous surveys, justification should be provided to demonstrate that they are relevant and consistent with the EPA Guidance; b) Conduct a Level 1 fauna survey including local and regional mapping of habitats (including rare or unusual habitat types) inside and outside of the development envelope. Where existing local information is inadequate or incomplete, comprehensive Level 2 fauna surveys may be required; c) Prepare a comprehensive listing of fauna species likely to occur in habitats to be directly or indirectly impacted; and d) Provide figure(s) showing the likely extent of loss of the habitat types and the extent of areas where vegetation is expected to recover, from both direct and indirect impacts. e) Conduct targeted Level 2 surveys within the development envelope and immediate surrounds, to identify	Section 15.2.1, Appendix C, Figure 67 and Figure 68 and Table 25 to Table 27

Environmental factor	Work required	Section addressed in this document
	potential impacts to conservation significant vertebrate and invertebrate fauna species listed under the WC Act and the EPBC Act. Include mapping of the locations of any conservation significant fauna in relation to the proposal.	
	27. In accordance with EPA Guidance Statement 20, assess the likelihood of the habitats to support short range endemic invertebrate species. If the area is prospective for these species, undertake short range endemic invertebrate fauna sampling as per Guidance Statement 20. Include mapping of any short range endemic invertebrate fauna in relation to the proposal. Consider cumulative impacts.	Section 15.3, Section 15.4.3 to 15.4.5, Figure 67 and Figure 70, Appendix C, Table 32 and Table 33
	28. If the proponent intends to rely on results from previous surveys, justify how those surveys are relevant, representative of the development envelope, and were carried out using methods consistent with EPA Guidance.	Section 15.2.1 and 15.3.1, Appendix C
	29. Provide a detailed description and figures(s) of the proposal impacts on terrestrial fauna, including an analysis of the likely loss of fauna habitat, including percentages of habitat types to be impacted.	Section 15.4, Figure 68 and Table 31
	30. Predict the residual impacts from the proposal on terrestrial fauna, including short range endemic fauna, both direct and indirect and cumulative, after considering and applying avoidance and minimisation measures.	Section 15.6
	31. Demonstrate how the EPA's objective for this factor can be met.	Section 15.5 and 15.6
	32. Identify management measures and monitoring and feasible contingencies for the proposal to ensure residual impacts are not great than predicted.	Section 15.5
Amenity	33. Characterise the environment by providing a description of the visual landscape character and provide maps of the visual landscape units that may potentially be visually affected. This should include, but not limited to: landforms; vegetation; any waterways and can be undertaken by way of three dimensional modelling and/or photographs.	Section 17.2 and Appendix C
	34. Characterise the current, and any other reasonably foreseeable, land uses and amenity values of the Mungada Ridge.	Sections 17.2.2, 17.2.4, 17.2.5 and 17.2.6
	35. Design and undertake a visual impact assessment (VIA) for before, during and after the proposed mining activities, to assess the impacts of the proposal on visual amenity in accordance with the Western Australian Planning Commission (2007) *Visual Landscape Planning in Western Australia: a manual for revaluation,*	Section 17.3 and Appendix C

Environmental factor	Work required	Section addressed in this document
	assessment, siting and design, and in consultation with DPaW.	
	36. The VIA should identify and describe the aspects for the proposal which may potentially affect the visual landscape units both temporarily and permanently, using agreed (by EPA, in consultation with DPaW) reference and vantage points of surrounding areas including travel routes and use areas, viewer position and perceptions.	Section 17.3.2 and Section 17.3.3, Appendix C
	37. A peer review of the VIA information a by a suitably qualified individual with appropriate experience and expertise is also required.	Appendix C
	38. Predict the residual impacts from the proposal on the landscape after considering and applying avoidance and minimisation measures. Impact predictions are to include, but not be limited to: a) The likely extent, severity and duration of the impacts to the visual landscape; and b) Simulations of the predicted residual impacts from the proposal, changes to the landscape from the agreed reference and vantage points. Include the cumulative impacts on visual amenity from the proposal and other currently approved developments.	Section 17.3.3, Section 17.5, Plate 15 and Plate 16, Appendix C
	39. Demonstrate how the EPA's objective for this factor can be met.	Section 17.4 and 17.5
	40. Identify management and mitigation measures for the proposal to ensure residual impacts are not greater than predicted.	Section 17.4
Offsets (integrating factor)	41. Describe the residual impacts for the proposal and analyse these impacts to identify and detail any that are significant.	Section 19.2, 19.3 and Table 43
	42. If the proposal is likely to have any significant residual environmental impacts, identify environmental offsets, consistent with the requirements in the: a) WA Environmental Offsets Guidelines which includes the use of the WA Environmental Offsets Template; and b) EPA Environmental Protection Bulletin No. 1: Environmental Offsets.	Section 19.4
	43. Provide an assessment on the physical and chemical characteristics of soil to be disturbed by the proposal, with particular focus on the ability to use such soil materials in post-mining rehabilitation works.	Section 18.3.2 and Appendix C

Environmental factor	Work required	Section addressed in this document
Rehabilitation and decommissioning (integrating factor)	44. In consultation with the DMP, provide a detailed study on the waste characteristics (volume, chemical and physical properties) of waste rock material generated as part of the proposal. The proposed waste landform design should be based on the outcomes of the waste characterisation study to ensure the final design will achieve desired long-term stability and visual amenity as identified in completion criteria and ensure that the final landform design is non-polluting (i.e. any AMD materials are appropriately encapsulated within the waste rock dump or buffered by other waste).	Section 18.3.2, Plate 17 and Appendix C
	45. Undertake a literature review and provide evidence of successful best practice mining rehabilitation procedures, include a review of learnings from the rehabilitation currently being undertaken at other BIF environments in the Yilgarn Craton, including provision of outcomes to date. Include a review of the Closure and Rehabilitation Plan for the current operations at the DSO Project.	Section 18.3.5
	46. Prepare a Rehabilitation and Mine Closure Plan consistent with the DMP and EPA (2015) *Guidelines for Preparing Mine Closure Plans*. The Plan should include but not be limited to: a) Completion criteria and closure objectives addressing, native vegetation and habitat for conservation significant flora and fauna and base the conclusions on the availability of suitable substrates and landform design; and b) Establish and measure vegetation and fauna reference sites to inform completion criteria.	Section 18.3.1, Appendix E and Table 36
	47. Demonstrate that the proposal has been designed to avoid and minimise impacts including the placement of any access roads and infrastructure within vegetated areas has had regard to utilising existing areas of disturbance.	Section 4.2.1
	48. Describe the techniques of rehabilitation proposed, including but not limited to: a) Topsoil management; b) Retention or reuse of vegetative material; c) Return of species and communities consistent with the pre-existing composition of the affected area where this is likely to be feasible and the standards that will apply; and d) Identify a timeframe for establishment of the intended species and vegetation units.	Section 18.3.2, Section 18.4 Table 36 and Table 39 and Appendix E

Environmental factor	Work required	Section addressed in this document
	49. Identify completion criteria, including criteria for reconstructed soils and soil profiles (identification and profile reconstruction, landform stability, drainage/erosion control and species and communities.	Section 18.3.1, Table 36 and Appendix E
	50. Provide information on whether backfilling of the mine pit would be undertaken.	Section 18.3.6
	51. Demonstrate how the EPA's objective for this factor can be met.	Section 18.4 and 18.5
Other factor – Hydrological processes and inland waters environmental quality	Concisely describe and discuss Hydrological processes and inland waters environmental quality, including but not limited to: • Existing studies to confirm that the Gilgai formation is not groundwater dependent; • Evidence to support the assumption that all groundwater abstraction will be in accordance with existing licence conditions; • Information to demonstrate that the potential impacts to hydrogeological regimes and the environmental quality of groundwater and surface water are not significant and can be regulated under other statutory processes; and • Outcomes of consultation with DPaW and the Department of Water in relation to the above points.	Section 20.1
Other factor – Heritage	Concisely describe and discuss Heritage, including but not limited to: • Archaeological and ethnographic surveys undertaken; • Information to ensure that historical and cultural associations and natural heritage are not adversely affected; and • Outcomes of consultation with the Department of Aboriginal Affairs and the relevant Traditional Owner groups in relation to the above points.	Section 20.2

EPA Policy consideration table

Policy/Guidance	Relevant considerations	Consideration in the assessment
Flora and vegetation		
Recommended Interim Protocol for Flora surveys of Banded Ironstone Formations of the Yilgarn Craton	• Collection of a standard set of information from quadrat-based (usually 20 m by 20 m) surveys carried out at an appropriate time of year (spring or following seasonal rains) and covering the major geographical, geomorphologic and floristic variation found in the study area, with extra collections of unusual plant records outside quadrats.	The Maia (2016) survey complied with the DEC (2006) Recommended Interim Protocol for Flora Surveys of Banded Ironstone Formations of the Yilgarn Craton, as follows: • A total of 39 20 m by 20 m quadrats were surveyed. • Survey timing was 19-30 June and 14-22 September 2015. Rainfall conditions prior to the surveys and/or the presence of annuals were considered sufficient, and many other flora surveys have been conducted in the Project Area at different times of the year prior to the Maia (2016) survey. • Quadrats locations covered the major geographical, geomorphologic and floristic variation found in the SMC Blue Hills tenements. They were selected using aerial photographs, tenement boundaries and land system, pre-European and previous vegetation survey mapping. Quadrats locations were also chosen for areas that were considered to be data deficient. • Conservation significant species known to occur in the area and surrounds and novel species were targeted during transects. Compliance with DEC (2006) is addressed in Section 14.2.1 of the PER document and in the Maia (2016) report (included in Appendix C of the PER document). There are no limitations of the flora and vegetation surveys conducted to date when examined collectively in regard to their suitability of use for the impact assessment.
PS 3 – Terrestrial Biological Surveys as an Element of	Outlines the requirements of biodiversity protection and terrestrial biological surveys for EIA in Western Australia. In particular: • Demonstrate that all reasonable measures have been undertaken to avoid impacts on biodiversity. Where some impact cannot be	• The Proposal will not result in unacceptable loss to flora biodiversity. The impact assessment, avoidance and mitigation measures for terrestrial flora biodiversity are described in Sections 14.3 to 14.6 of the PER document. Predicted outcomes are described in Section 14.7 of the PER document.

Policy/Guidance	Relevant considerations	Consideration in the assessment
Biodiversity Protection	avoided, demonstrate that the impact will not result in unacceptable loss; • Information gathered for EIA must meet State, National, and International Agreements, Legislation and Policy in regard to biodiversity conservation; • The EPA will use the IBRA as the largest unit for EIA decision-making in relation to the conservation of biodiversity; • Ensure terrestrial biological surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered and the relevant EPA objectives for protection of the environment; and • Terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the particular region, to aid the overall biodiversity understanding and assessment by facilitating transfer into State biological databases.	• Field surveys for flora and vegetation have been carried out in accordance with the relevant policies, and state and Commonwealth legislation. Species listed under international agreements have also been considered. • The Project Area is located in the Yalgoo IBRA bioregion and the Tallering IBRA sub-region. • Numerous flora and vegetation surveys have been conducted in the Blue Hills locality. The most recent was a Level 2 flora and vegetation survey conducted by Maia (2016) in 2015. The Maia (2016) report includes a full literature review of previous surveys relevant to the Proposal. The relevant data from previous surveys was been incorporated into the Maia (2016) report (Appendix C of the PER document), and included in the PER. • Biological survey reports have been attached to the PER document will be made publicly available during the public review of the PER document.
GS 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA	• Determination of the level of flora and vegetation survey consistent with that expected in Table 3 of GS 51 • Description of the survey area and methodologies, including reference to timing, duration, survey effort, any survey limitations, and the nomenclature used (WA Herbarium) • Maps and text describing the survey area/plot sites, location of significant species, vegetation mapping, vegetation condition assessment and predicted extent of impact on the vegetation • A comprehensive list of flora species identified and assessment of threatened, priority or other significant flora / ecological communities (TECs, PECs) known or reasonably expected to occur in the area (as defined in GS 51)	• Compliance with GS 51 is addressed in Section 14.2.1 of the PER document and in the Maia (2016; included in Appendix C of the PER document) report in Table 3.8. Maia (2016) includes a full literature review of previous surveys relevant to the Proposal, including their limitations. When examined collectively in regard to their suitability of use for the impact assessment, it is considered that there are no major limitations of the flora and vegetation surveys. The only limitation identified during the Maia (2016) survey was this survey failed to confirm the presence of *Acacia subsessilis* (Priority 3) as these plants were not flowering or fruiting during the Maia surveys 2015 so could not be adequately identified.

Policy/Guidance	Relevant considerations	Consideration in the assessment
	• Evaluation of the impact of the proposal on the species/ communities, including reference to the extent of regional clearing of the vegetation complex/type and ecological linkage • Provision of all quadrat data used in reporting as electronic data in raw form, in addition to hardcopy reports.	
EPA Checklist for documents submitted for Environmental Impact Assessment on marine and terrestrial biodiversity	• This checklist covers details about the general quality of the PER and attached documents, and whether the PER assesses potential impacts in the context of GS 51.	• Part 3 – terrestrial biodiversity issues of the EPA Checklist, detailing flora and vegetation biodiversity, is provided in Appendix J of the PER document.
Landforms		
EAG 8 - Environmental Assessment Guideline for Environmental principles, factors and objectives	• The EPA's objective for the Landforms factor is to "maintain the variety, integrity, ecological functions and environmental values of landforms.	• The Proposal is considered to be consistent with the EPA's objective for the landforms factor. Although the proposed mine pit and pit abandonment bund will remain as structural impacts to the Mungada Ridge landform (18.6 ha), the impacts will be localised to the lower-lying western component of the ridge. Together with existing disturbance on Mungada Ridge, the extent of cumulative impact to the landform (79.5 ha; 11.6%) would not be significant as the vast majority of the ridge will remain undisturbed and the aspects of variety, integrity, ecological importance, scientific importance and rarity of Mungada Ridge would not be affected significantly. This is discussed in detail in Section 13 of the PER.
EPB 23 – Guidance on the EPA Landforms factor	• Description of the geology, soils and morphology of the landform • Identification of the current land tenure and the level of protection it affords from the landform's potential loss of integrity	• The environmental values and impact assessment of the Mungada Ridge Landform is detailed in Section 13.2 and 13.3 and Appendix G of the PER, and aligns with EPB 23.

Policy/Guidance	Relevant considerations	Consideration in the assessment
	• Description of whether the landform is robust and less sensitive to damage or degradation from human activities, or whether it is easily disturbed or degraded • Identification of whether the landform is rare at a local, regional and national level, or well represented • Comparison and contrast of the character and condition of the landform with others of the same type at the local, regional and national scale • Determination of the spatial extent of the landform and local assessment unit likely to be impacted • Assessment of the current integrity of the landform and the local assessment unit; the degree to which the landform and local assessment unit have been disturbed, and the degree to which previous disturbance has fragmented the landform and local assessment unit • Identification of the ecological functions supported by the landform and assessment of how the proposal will affect the role of the landform in maintaining these ecological functions, e.g. surface water or groundwater flows, wind movement, precipitation, temperature, landscape connectivity, soil composition/chemistry, etc. • Identification of any significant scientific or evolutionary values associated with the landform, e.g. past ecological or biological processes, unusual or important geomorphological, soil or geological sites, and determination of the extent to which these values will be impacted by the proposal • Estimation of the cumulative impacts on the landform and local assessment unit from reasonably foreseeable future development	

Policy/Guidance	Relevant considerations	Consideration in the assessment
	• Completion of other investigations as identified during the scoping stage.	
Subterranean fauna		
EAG 12 - Consideration of subterranean fauna in environmental impact assessment in Western Australia	• The level of subterranean fauna survey is consistent with that expected in Table 2 of EAG 12. • Survey design is consistent with requirements of EAG 12. • Vouchering and lodgement has been undertaken as per EAG 12. • The results of surveys are clearly presented and the report includes sections outlining the methodology, results and analysis. • The report considers all the information obtained from the results from the surveys, to quantify the likely degree of direct and indirect impacts to subterranean fauna.	• A Level 1 subterranean fauna assessment was conducted for the development envelope by Bennelongia (2015; attached in Appendix C). The survey was conducted in accordance with the general principles laid out for subterranean fauna sampling in EAG 12. Two other subterranean fauna surveys have been conducted near the development envelope for the existing Blue Hills mine (ecologia 2008d, 2008e).
GS 54a – Sampling Methods and Survey Considerations for Subterranean Fauna in WA	• Early initial desktop review • Inclusion of a subterranean fauna survey report • Maps and text identifying and describing the survey sites/area, and the geology/ habitat supporting subterranean fauna, and extent of predicted impacts on the habitat (noting that the survey area should extend beyond the predicted impact zone) • Description of survey methodologies, including reference to timing, duration and survey effort used to sample each of the fauna groups sampled, species identification, and any survey limitations • A comprehensive list and assessment of subterranean fauna recorded or reasonably expected to occur in the area, including any Specially Protected and other significant fauna and their known occurrence/habitats locally and their wider status if known, and an evaluation of the risk of the proposal to long-term survival of the species and community.	• Subterranean fauna surveys for the Proposal were conducted in accordance with GS 54a.

Policy/Guidance	Relevant considerations	Consideration in the assessment
EPA Checklist for documents submitted for Environmental Impact Assessment on marine and terrestrial biodiversity	• This checklist covers details about the general quality of the PER and attached documents, and whether the PER assesses potential impacts in the context of GS 54a.	• Part 3 – Terrestrial biodiversity issues of the EPA Checklist, detailing subterranean fauna diversity, is provided in Appendix J of the PER document.
Terrestrial fauna		
PS 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection	Outlines the requirements of biodiversity protection and terrestrial biological surveys for EIA in Western Australia. In particular: • Demonstrate that all reasonable measures have been undertaken to avoid impacts on biodiversity. Where some impact cannot be avoided, demonstrate that the impact will not result in unacceptable loss; • Information gathered for EIA must meet State, National, and International Agreements, Legislation and Policy in regard to biodiversity conservation; • The EPA will use the IBRA as the largest unit for EIA decision-making in relation to the conservation of biodiversity; • Ensure terrestrial biological surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered and the relevant EPA objectives for protection of the environment; and • Terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the particular region, to aid the overall biodiversity understanding and	• The Proposal will not result in unacceptable loss to fauna biodiversity. The impact assessment, avoidance and mitigation measures for terrestrial fauna biodiversity are described in Sections 15.4 and 15.5 of the PER document. Predicted outcomes are described in Section 15.6 of the PER document. • Field surveys for terrestrial fauna have been carried out in accordance with the relevant policies, and state and Commonwealth legislation. Species listed under international agreements have also been considered. • The Project Area is located in the Yalgoo IBRA bioregion and the Tallering IBRA sub-region. • Numerous terrestrial fauna surveys have been conducted in the Blue Hills locality. A desktop assessment of these surveys with evaluation of relevancy and consistency with EPA Guidelines was undertaken as part of the most recent fauna assessment (ecoscape 2016a). Table 24 summarises the nine reports that have covered part or all of the development envelope; the relevant data from these surveys have been incorporated into the ecoscape (2016a) report (Appendix C of the PER document), and included in the PER. These surveys provide sufficient information to address both biodiversity conservation and ecological

Policy/Guidance	Relevant considerations	Consideration in the assessment
	assessment by facilitating transfer into State biological databases.	function values of the Proposal Area and the EPA objectives for terrestrial fauna. • Biological survey reports attached to the PER document will be made publicly available during the public review of the PER document.
GS 20 – Sampling of Short range endemic Invertebrate Fauna for Environmental Impact Assessment in WA	• Early initial desktop review and advice received from WA museum on specific target groups for survey • Maps and text describing the survey area, potential SRE habitats and regional context and extent of predicted impact on the habitat • Description of survey methodologies, including reference to timing, duration and survey effort used to sample each of the SRE groups sampled, and any survey limitations • A survey report with assessment of SRE fauna found or reasonably expected to occur in the area, including any Specially Protected and other significant fauna, their known occurrence/habitats locally and their wider status if known, and an evaluation of the risk of the proposal to long-term survival of the species and community.	• SRE invertebrate fauna surveys for the Proposal were conducted in accordance with GS 20.
GS 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in WA	• Level of fauna survey consistent with that expected in Table 3 (Appendix 2) of GS 56 • Description of survey methodologies in the context of EPA and DEC (2010), including reference to timing, duration and survey effort used to sample each of the fauna groups sampled, any survey limitations and the nomenclature used (WA Museum checklist except for birds which should follow Christidis and Boles 2008) • Maps and text describing the survey area, sampling locations and fauna habitats	• Terrestrial fauna surveys for the Proposal were conducted in accordance with GS 56. • A desktop assessment of these surveys with evaluation of relevancy and consistency with EPA Guidelines was undertaken as part of the most recent fauna work (ecoscape 2016a; Appendix C). Overall, the surveys meet GS 56 and EPA and DEC (2010), with the exception of the initial Level 2 terrestrial fauna assessments (Bamford & Wilcox 2004; Bancroft & Bamford 2006). Subsequent surveys met these guidelines and provided a sufficient level of knowledge on fauna occurrence in the development envelope and region. Survey limitations were included in these surveys in accordance with GS 56.

Policy/Guidance	Relevant considerations	Consideration in the assessment
	• A comprehensive list and assessment of fauna known or reasonably expected to occur in the area, including Specially Protected and other significant fauna (as defined in GS 56), and an evaluation of the impact of the proposal on the species and key habitat/s.	
EPA Checklist for documents submitted for Environmental Impact Assessment on marine and terrestrial biodiversity	• This checklist covers details about the general quality of the PER and attached documents, and whether the PER assesses potential impacts in the context of GS 20 and 56, and EPA and DEC (2010).	• Part 3 – Terrestrial biodiversity issues of the EPA Checklist, detailing terrestrial fauna (vertebrate and SRE invertebrate) diversity, is provided in Appendix J of the PER document.
Technical Guide on Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment	• Protocols prior to survey, including obtaining land access and formal approvals required to conduct the survey • Appropriate level of survey, being either Level 1 survey, consisting of a desktop study and basic ground truthing through a reconnaissance survey, or Level 2 survey, which may range from a targeted survey of selected species to a comprehensive survey • Appropriate sampling techniques for baseline terrestrial vertebrate fauna surveys • Appropriate survey design to meet environmental impact assessment requirements, including in relation to site selection, sampling effort, timing, duration, seasonal or repeat surveys, and trapping design for terrestrial mammals and herpetofauna • Appropriate data analysis and reporting.	• A desktop assessment of these surveys with evaluation of relevancy and consistency with EPA and DEC (2010) was undertaken as part of the most recent fauna work (ecoscape 2016a; Appendix C). Overall, the surveys meet EPA & DEC (2010), with the exception of the initial Level 2 terrestrial fauna assessments (Bamford & Wilcox 2004; Bancroft & Bamford 2006). The current guidelines indicate that a minimum of seven nights is required for vertebrate fauna trapping, and pitfall fences should be a minimum of 7 m (10 m recommended). Subsequent surveys met these guidelines and provided a sufficient level of knowledge on fauna occurrence in the development envelope and region.

Policy/Guidance	Relevant considerations	Consideration in the assessment
Amenity		
Visual Landscape Planning in Western Australia: a manual for evaluation, assessment, siting and design.	• Completion of a visual landscape evaluation that (1) defines the scope of the evaluation and sets the context, (2) describes the visual landscape character, (3) evaluates the way the visual landscape character is viewed, experienced and valued, (4) develops strategies for managing visual landscape character, and (5) develops implementation strategies through the planning system. • Completion of a visual impact assessment that (1) determines visual management objectives, (2) describes proposed development, (3) describes the potential visual impacts, (4) develops visual management measures, and (5) prepares final recommendations and options for monitoring.	• Ecoscape (2016b; Appendix C) completed a Visual Landscape Evaluation (VLE) for the Proposal to provide baseline information on landscape values of the proposed disturbance footprint and surrounding areas. Results of the VLE are summarised in Section 17 of the PER and have informed a Visual Impact Assessment (VIA), which identifies potential impacts of the Proposal on landscape and amenity values (Section 17.3.2). • An independent peer review of the ecoscape (2016b) study was completed by Urbis (Appendix F) in accordance with the requirements of the ESD. The peer review found that the ecoscape (2016b) assessment was prepared in accordance with the methodology outlined by the WAPC Guidelines (WAPC 2007) and confirmed that the conclusions were appropriate.
Offsets		
WA Environmental Offsets Policy and Guidelines	There are six principles for the use of environmental offsets: • Environmental offsets will only be considered after avoidance and mitigation options have been pursued. • Environmental offsets are not appropriate for all projects. • Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted. • Environmental offsets will be based on sound environmental information and knowledge. • Environmental offsets will be applied within a framework of adaptive management. • Environmental offsets will be focused on longer-term strategic outcomes.	• The proposed offset is detailed in Section 19.4 of the PER. • The mitigation hierarchy has been applied to the Proposal's potential environmental impacts. Avoidance, minimisation and rehabilitation measures are summarised in Table 43, the Environmental Offset Template. • The residual environmental impact to the environmental factor Vegetation and Flora (specifically to the Rare Flora species *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills), is considered to meet the requirements for environmental offsets. The impact on these species falls under the category of 'impact to or removal of butters of other areas necessary to maintain ecological processes and function for species declared as rare flora under WC Act or listed as threatened under EPBC Act' in Figure 3 of the Guidelines. While *Lepidosperma* sp. Blue Hills is not listed under the

Policy/Guidance	Relevant considerations	Consideration in the assessment
		either of these Acts, it is a recognised as a Priority 1 species by DPaW and could be listed in the future. • The offset is considered relevant and proportionate to the significance of the *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills. It is 'like-for-like' – the proposed offset actions will benefit the remaining *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills individuals in the Management Area species by reducing the impact of threatening processes. • Offsets for the Proposal are proposed to consist of re-establishment of *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills individuals and their monitoring within SMC's Blue Hills tenements (including research to be undertaken through the ARC program), as well as on-ground management of portions of the Mungada Ridge outside of existing operations and the proposed development envelope and within SMC's Blue Hills tenements to maintain habitat for the two species.
WA Environmental Offsets Template (230914)	• The WA Environmental Offsets Template (attached in Appendix 1 of WA Environmental Offsets Guidelines) should be completed and attached to Environmental Review Documents where offsets are a key environmental factor.	• The WA Environmental Offsets Template has been included as Table 43 and Table 44 in Section 19.3 of the PER document.
EPB No 1. – Environmental Offsets-Biodiversity	• As part of an Environmental Review document, proponents must include a section discussing how it has applied the mitigation hierarchy to its proposal. Offsets should be addressed in a separate section of the document, after the assessment of environmental factors. • The minimum requirements for all proposals (whether the proponent believes offsets are required or not) are: (1) description of all potential impacts and identification of actions that will be applied to avoid, minimise or rehabilitate the impacts, (2)	• The mitigation hierarchy has been applied to the Proposal's potential environmental impacts. Avoidance, minimisation and rehabilitation measures are summarised in Table 43. • Offsets are addressed in detail in Section 19 of the PER, including potential environmental impacts, mitigation measures, significant residual impacts and a proposed offset. • The residual environmental impacts to the key factor Vegetation and Flora (specifically to the Rare Flora species *Acacia woodmaniorum* and *Lepidosperma* sp. Blue Hills), are considered to meet the requirements for

Policy/Guidance	Relevant considerations	Consideration in the assessment
	description of all residual impacts, and (3) analysis of impacts to identify and detail which of these residual impacts are significant • Provision of details about proposed offsets, which should include proposed offset projects, objectives and completion criteria, plans and policies, timelines and milestones, governance arrangements, financial arrangements, risk management, monitoring, and reporting.	environmental offsets. Details about the proposed offset are listed in Section 19.4 of the PER.
Rehabilitation and decommissioning		
Guidelines for Preparing Mine Closure Plans	• Key principles and approaches should be considered when preparing a Mine Closure Plan as defined in Section 3.1 of the Guidelines for Preparing Mine Closure Plans • Proponents must demonstrate in the Mine Closure Plan how they have identified and are managing relevant closure issues • The Mine Closure Plan must be structured in accordance with the format and contain the necessary information as defined in Section 4 of the Guidelines for Preparing Mine Closure Plans.	• A Mine Closure Plan (Appendix E) has been prepared consistent with the Closure Guidelines (DMP and EPA 2015).
GS 6 – Rehabilitation of Terrestrial Ecosystems	• Information should be provided to enable the EPA to assess the environmental significance of ecosystems, the capacity of the proponent to effectively rehabilitate equivalent environments, and the magnitude and significance of factors constraining favourable outcomes • The overall objective of rehabilitation should be stated • Specific targets/completion criteria (defined by measured outcomes or milestones) for monitoring and reporting of rehabilitation should be provided.	• Information on the environmental significance of the ecosystems of the Proposal Area are included in the PER in Sections 13 to 16. • Proposed rehabilitation and decommissioning activities are stated in Section 18 of the PER. • The closure and rehabilitation objectives for the Proposal are to ensure that land disturbed by the proposed mining activities remains undisturbed from secondary impacts in the future, that all disturbed areas are rehabilitated to as close as possible to the natural surroundings, and that rehabilitated areas are: o safe to humans and wildlife o non-polluting o geotechnically and erosionally stable

Policy/Guidance	Relevant considerations	Consideration in the assessment
		o self-sustaining with minimal maintenance required post-closure o ecologically similar to the pre-mining environment, incorporating local native plant taxa and fauna habitat o visually compatible with the surrounding natural landscape o suitable for agreed post-mining land uses o compliant with the requirements of SMC's statutory approvals. • Indicative closure completion criteria have been developed for the Proposal and are listed in Table 36 of the PER. • A Mine Closure Plan has been prepared to encompass the Proposal (Appendix E). The Mine Closure Plan has been prepared consistent with the Closure Guidelines (DMP and EPA 2015) and the requirements of the ESD.

Appendix C Supporting studies

Contained on attached CD:

Flora and vegetation

- Bennett (2004)
- Ecologia (2007a)
- Ecologia (2008a)
- Ecologia (2008b)
- Ecologia (2013)
- Maia (2011a)
- Maia (2011b)
- Maia (2012)
- Maia (2014a)
- Maia (2014b)
- Maia (2015a)
- Maia (2015b)
- Maia (2016)
- Markey and Dillon (2008)
- Woodman (2008)
- Woodman (2012)

Terrestrial fauna

- Bamford and Wilcox (2004)
- Bancroft and Bamford (2006)
- Ecologia (2007b)
- Ecologia (2008c)
- Ecologia (2010)
- Ecologia (2011a)
- Ecologia (2011b)
- Ecologia (2012a
- Ecoscape (2016a)

Subterranean fauna

- Ecologia (2008d)
- Ecologia (2008e)
- Bennelongia (2015)

Amenity

- Ecoscape (2016b)

Rehabilitation and decommissioning

- Relevant BGPA research project documents
- MBS (2015)

- SRK (2015)

Hydrological processes

- Rockwater (2006)

Heritage

- Terra Rosa (2011a)
- Terra Rosa (2011b)

Appendix D Management Plans

Contained on attached CD:

Flora and Vegetation and Terrestrial Fauna Condition Environmental Management Plan

Aboriginal Heritage Management Plan

Appendix E Closure Plan

Contained on attached CD.

Appendix F Peer review reports and SMC response

Contained on attached CD.

- **Peer Review terms of reference** – an outline of the scope and limitations of the peer reviews, provided to the peer reviewers prior to commencement.
- **SMC Response to peer review comments** – SMC response to each of the comments provided by peer reviewers

Flora and vegetation

- Peer review of Level 2 Flora and Vegetation Assessment Report (Maia 2016) – undertaken by Greg Woodman, Woodman Environmental Consulting

Rehabilitation and decommissioning

- **SMC Rehabilitation and Restoration Project Summary Report** – prepared by Kingsley Dixon (Kings Park Botanic Gardens and Parks Authority)
- Peer review of SMC Rehabilitation and Restoration Project Summary Report – undertaken by Greg Woodman, Woodman Environmental Consulting
- **Peer review close out report** – prepared by Greg Woodman, Woodman Environmental Consulting, addressing SMC consideration of initial peer review comments on both the SMC Rehabilitation and Restoration Project Summary Report and the Level 2 Flora and Vegetation Assessment Report (Maia 2016)

Landforms

- **Peer review of Landform Chapter of PER document** – undertaken by Karl-Heinz Wyrwoll, School of Earth and Environment, UWA
- **Peer review close out report** – prepared by Karl-Heinz Wyrwoll, addressing SMC consideration of initial peer review comments

Amenity

- Peer review of Visual Impact Assessment Report (ecoscape 2016b) – undertaken by Urbis
- **Peer review close out report** – prepared by Urbis, addressing SMC consideration of initial peer review comments

Appendix G GIS Methodology for Landform Factor

Development of BIF landform boundaries

The OEPA provided a shape file representing the Mungada Ridge and associated landforms within the LAU. As this shape file was restricted to the LAU, similar BIF landforms in the surrounding regional area were derived by Eco Logical Australia through the use of regional contour line data (5 m intervals) obtained on 3 April 2015 from Landgate. A digital elevation model (DEM) was derived from the contour data as a raster elevation surface using ArcMap 10.2. A slope surface was then derived from the DEM and all raster cells with a slope ≥5 degrees were extracted, converted to a vector polygon format, and used to define potential BIF landforms consistent with the OEPA's methodology for BIF landforms in the LAU.

The resulting regional BIF landform shape file was simplified by zooming to the extent of the shape file, converting to a geo-referenced raster, and then converting back into a vector shape file. This approach was equivalent to buffering areas by 50 to 100m, smoothing the geometry and quickly merging smaller, more intricate groups of polygons into larger areas that better represented formations adequate for regional visualisation.

This buffering was required because a slope raster was used as a base for the analytical process. When initially identifying areas where the slope was greater than five degrees, a discrete (or a directly definable) boundary was created. On the ground, the areas of greater than five degree slope actually form more of a continuous (or flowing/transitioning) boundary where values progressively change over distance as opposed to definitive cut-off line.

The process of simplifying/buffering was therefore carried out for three main purposes:

- As the real world boundary is continuous, the buffering process expands of the discrete boundary to encompass transitioning variations in slope across the terrain;
- As the analysis was based on defining discrete boundaries (greater than five degrees), polygons can be fragmented by holes or gaps. The smoothing and buffering removes these holes/gaps to create a more defined/single landform area; and
- As the analysis used a raster as a base, the boundaries created follow a jagged pattern of the pixel geometry. The smoothing/buffering process removes jagged features and creates a more realistic and smoother boundary line.

The potential BIF landforms defined by Eco Logical Australia were refined by comparison to known geology units from geo-rectified Geological Survey of Western Australia geological 1:250,000 scale map sheets and field magnetic data hosted on the GeoVIEW online search tool by the DMP. Map sheets used included Kirkalocka, Ninghan, Perenjori and Yalgoo. Potential BIF landforms were manually intersected with appropriate geology units (Table G1) and retained in all cases where the potential BIF landforms intersected any geological type aligned with iron formations. All others that did not intersect these geological types at all, were removed. Areas retained were further refined by removal of the polygons of potential BIF landforms that occurred in lower magnetic intensity areas.

Table G1: Geological Survey of Western Australia Mapping Units used to refine potential BIF landforms

Mapping unit symbol	Mapping unit description
Ac	Banded grey and white chert
Ah	Hematite, magnetite-quartz rock
Ai	Banded iron formation – includes banded chert
Aia	Magnetite (hematite) – amphibole-quartz; amphibole may be pale magnesian type or grunerite
Aic	Chert
Aig	Magnetite-amphibole-garnet-orthopyroxene
Aih	Hematite, magnetite-quartz
Aij	Jaspilite – red and black banded iron formation
Ail	Goethite-quartz
Aj	Jaspilite-banded quartz-jasper rock
Al	Goethite-quartz rock
Am	Hematite, magnetite-quartz-amphibole rock

Naming of BIF landforms

To assist in the interpretation of characteristics of >300 landforms in the region, each individual polygon has been assigned a name according to the general cluster or range within which it is located. For example, four smaller BIF landforms occur in the immediate vicinity of Mungada Ridge. Together with Mungada Ridge, this group is identified as the ‘Mungada Ridge’ cluster, consisting of five individual polygons representing five BIF landforms named Mungada Ridge 1 to 5. The largest polygon, Mungada Ridge is identified by ‘Mungada Ridge 1’. A list of the names assigned to each polygon is presented in the excel spreadsheet contained in Appendix folder G.

Terrain analysis

Terrain analysis was undertaken by associating various ecological datasets with a three-dimensional DEM with a cell size of 50 x 50 m. The DEM was generated in ArcMap 10.2 as a Triangular Irregular Network (TIN) file representing the raw, pre-development surface morphology of the development envelope and surrounding landscape (using the regional contour line data at 5 m intervals obtained on 3 April 2015 from Landgate), which was then modified by incorporation of contour line data (1 m intervals) for existing and proposed infrastructure provided by SMC. A high resolution aerial image of the area was ‘draped’ over the TIN file and visualised in three dimensions using ArcGlobe 10.2.

Slope

Slope represents the rate of change of elevation between each cell of the DEM and each adjacent cell. A slope raster was generated using the Slope tool in ArcMap 10.2 and the DEM developed for the terrain analysis, with a resulting output cell size of 50 x 50 m. Slope was output in the measurement unit 'degree rise', which represents slope in degrees. This unit is zero for a flat surface and increases up to 90 degrees for a vertical surface.

Shade

Shaded relief was generated using the DEM derived for the terrain analysis and the Hillshade tool in ArcMap 10.2. This tool creates a shaded relief surface representing shaded areas within the terrain and considers illumination source angle and shadows. Separate morning (9:30 AM), midday (12:00 PM) and afternoon (3:30 PM) shaded relief surfaces were derived using bearing values of 66°, 1° and 294° degrees respectively.

'Highly shaded' areas were created from each shaded relief surface by selecting values ≤130 degrees as these consistently represented highly shaded areas. This range of values was extracted into new reclassified rasters and then converted into polygon data. These polygons were then selected and intersected in the following manner:

- morning to lunch intersection;
- lunch to afternoon intersection; and
- morning to afternoon intersection.

These intersections were merged to form the separate polygon layer 'areas of prolonged shade'.

Hydrology

Impacts to drainage were assessed both before and after proposed development. This was achieved using the 'Arc Hydro Tools 10.2' tool package provided by ESRI. The final output from this process was a dataset of drainage pathways before and after proposed development. The process was as follows:

- The 'Topo to Raster' tool was utilised to create a 'Surface' DEM from the before and after proposed development contour lines generated. This DEM was required to generate drainage flow direction and accumulation datasets used to derive drainage data;
- Each DEM was inspected and corrected for 'sinks'. Sinks are defined as any raster cell surrounded entirely by higher elevation cells. Failure to remove sinks causes an inaccurate model output as simulated water collects in these sinks and prevents accurate flow accumulation modelling. Sinks were pre-screened and evaluated using the Arc Hydro tools Sink Pre-screening, Sink Evaluation, Depression Elevation, and Sink Selection. Sinks, once highlighted, were fed into the Fill Sinks tool and filled;
- Flow direction was generated using the 'Flow Direction' tool and each DEM as input. Flow direction is a key component of deriving hydrological characteristics of a surface. Every raster cell (representing elevation) in the input DEM was inspected in relation to each surrounding raster cell, ultimately creating a raster of flow direction values from each cell to its steepest downslope neighbour cell;
- Flow accumulation was generated using the 'Flow Accumulation' tool with each flow direction raster used as input. This tool calculates accumulated flow as the accumulated weight of all surrounding cells flowing into each downslope cell. Cells with a high flow accumulation value represent areas of concentrated flow and were used in the model to identify drainage pathways;

- Flow direction and accumulation rasters were used as inputs into the Stream Definition tool with the default number of cells used as a third input (1% of the overall area being defined). This tool was used to identify significant drainage networks from within the flow accumulation raster (i.e. to remove minor and insignificant drainage line offshoots from major drainage); and
- Finally, drainage line data were developed using the stream definition and flow direction rasters using the 'Drainage Line Processing' tool. This resulted in a polyline vector representing significant drainage lines for the development envelope and surrounds.

Appendix H EPBC Act Offsets calculator results

Contained on attached CD.

Appendix I MS 811 Compliance

Contained on attached CD.

Appendix J EPA checklist for documents submitted for Environmental Impact Assessment on marine and terrestrial biodiversity

Checklist Item	Completed	Section addressed in this document
PART 1 – GENERAL QUALITY OF DOCUMENTS		
Ensure that the following standard elements are present in all documentation (including appendices):		
A clear and concise title that outlines basic information about the proposal and purpose of the document.	✓	Cover page
Date and document revision number.	✓	Cover page, Page ii
Information identifying the document's author and publishing entity.	✓	Cover page, Page ii
All issues identified in a scoping guideline or scoping document have been addressed and covered in the report.	✓	Appendix B
Complete and correct tables of contents, maps, tables and figures.	✓	Table of Contents; Figure 1 to Figure 76, Table 1 to Table 49
Suitably-sized scale maps placing the proposal into both a regional and local context.	✓	Figure 1 to Figure 76
Figures, plates, maps, technical drawings or similar including scale bar, legend, informative caption, labels identifying important or relevant locations/features referred to in the document text.	✓	Figure 1 to Figure 76
All survey site locations and derived data products (e.g. benthic habitat maps, vegetation maps) have been provided in map and appropriate GIS-based electronic database forms.	✓	GIS-based electronic data contained on CD inside back cover
All survey data from terrestrial biological surveys have been provided in electronic database form (Access/Excel).	✓	Contained on CD inside back cover
Proposed infrastructure is shown on scale maps and associated spatial data, and are provided in an appropriate GIS-based electronic database form.	✓	Figure 1 to Figure 76.; GIS-based electronic data contained on CD inside back cover

Checklist Item	Completed	Section addressed in this document
A list of references that have been cross-checked to ensure that all references in the Reference list are cited in the text (and vice versa).	✓	References, page 280
All information based on 'expert' opinion/judgement are explicitly attributed, by name and qualification, to a person/s or organisation.	✓	Entire document
Where relevant, appendices are attached to the main EIA document that describe the details of technical work undertaken to underpin the content of the main document, and explicitly attributed by name to the author/s and (if applicable) their organisation.	✓	Appendix C, contained on CD inside back cover
Description(s) of the proposal are internally consistent throughout all documentation and are couched to allow potential environmental impacts to be placed in local and regional contexts, including cumulative impacts of existing and approved developments.	✓	Section 4, and entire document
Descriptions of the local and regional environmental features most likely to be directly or indirectly affected by the proposal.	✓	Sections 13, 17 and 20
PART 3 – TERRESTRIAL BIODIVERSITY ISSUES		
For proposals likely to impact on native flora and vegetation/plant communities, the EIA document describes how potential impacts have been addressed in the context of EPA Guidance Statement No. 51, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment (June 2004), including:		
Determining the level of flora and vegetation survey consistent with that expected in Table 3 of Guidance Statement No. 51 (Appendix 2);	✓	Appendix C; Maia (2016)
Describing the survey area and methodologies, including reference to timing, duration, survey effort, any survey limitations, and the nomenclature used (WA Herbarium);	✓	Appendix C; Maia (2016)
Maps and text describing the survey area/plot sites, location of significant species, vegetation mapping, vegetation condition assessment and predicted extent of impact on the vegetation;	✓	Figure 45 to Figure 66; Section 14.2 to 14.5
A comprehensive list of flora species identified and assessment of threatened, priority or other significant flora / Ecological Communities (TECs, PECs) known or reasonably expected to occur in the area (as defined in Guidance Statement 51);	✓	Section 14.2.2 and 14.2.3; further detail provided in Appendix C, Maia (2016)
Evaluating the impact of the proposal on the species/communities, including reference to the extent of regional clearing of the vegetation complex/type and ecological linkage; and	✓	Section 14.3 to 14.5

Checklist Item	Completed	Section addressed in this document
All quadrat data used in reporting provided as electronic database in raw form, in addition to hardcopy reports.	✓	Contained on CD inside back cover
For proposals likely to impact on vertebrate fauna or fauna habitat, the EIA document describes how potential impacts have been addressed in the context of EPA Guidance Statement No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment (June 2004) and Technical Guide Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA and Department of Environment and Conservation 2010), including		
Determining the level of fauna survey consistent with that expected in Table 3 (Appendix 2) of Guidance Statement No. 56.	✓	Appendix C; ecoscape (2016a)
Describing the survey methodologies in the context of EPA and DEC (2010), including reference to timing, duration and survey effort used to sample each of the fauna groups sampled, any survey limitations and the nomenclature used (WA Museum checklist except for birds which should follow Christidis and Boles 2008).	✓	Appendix C; ecoscape (2016a)
Maps and text describing the survey area, sampling locations and fauna habitats.	✓	Figure 67 to Figure 69, Section 15.2; further detail available in Appendix C, ecoscape (2016a)
A comprehensive list and assessment of fauna known or reasonably expected to occur in the area, including Specially Protected and other significant fauna (as defined in Guidance Statement No. 56), and an evaluation of the impact of the proposal on the species and key habitat/s.	✓	Section 15.2.3, 15.2.4, and 15.4; further detail available in Appendix C, ecoscape (2016a)
For proposals with the potential to impact on short range endemic (SRE) invertebrate fauna or SRE habitat, the EIA document describes how potential impacts have been addressed in the context of EPA Guidance Statement No. 20, Sampling of Short Range Invertebrate Fauna for Environmental Impact Assessment in Western Australia (May 2009), including:		
Early initial assessment for restricted habitat types that have potential to support SRE fauna, including advice from the WA Museum and the DEC/OEPA.	✓	Appendix C; ecoscape (2016a)
Maps and text describing the survey area, potential SRE habitats and regional context and extent of predicted impact on the habitat.	✓	Figure 67 and Figure 68, Section 15.3 and 15.4.3; further detail available in Appendix C, ecoscape (2016a)
Describing the survey methodologies, including reference to timing, duration and survey effort used to sample each of the SRE groups sampled, and any survey limitations.	✓	Appendix C; ecoscape (2016a)

Checklist Item	Completed	Section addressed in this document
A survey report with assessment of SRE fauna found or reasonably expected to occur in the area, including any Specially Protected and other significant fauna, their known occurrence/habitats locally and their wider status if known, and an evaluation of the risk of the proposal to long-term survival of the species and community.	✓	Appendix C; ecoscape (2016a)
For proposals with the potential to impact on subterranean (stygofauna and troglofauna) fauna, the EIA document describes how potential impacts have been addressed in the context of EPA Guidance Statement No. 54 Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (2003) and 54a, Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (Draft 2007), including:		
Early initial desktop review to determine if the site has potentially suitable geology /substrate habitat that could support subterranean fauna, including advice from the WA Museum and the DEC/OEPA and a pilot study, if appropriate.	✓	Appendix C; Bennelongia (2015)
A subterranean fauna survey report, if the site has a very high or high likelihood of supporting subterranean fauna, or a pilot study indicated that the site supports a significant subterranean fauna.	✓	Appendix C; Bennelongia (2015)
Maps and text identifying and describing the survey sites/area, and the geology/ habitat supporting subterranean fauna, and extent of predicted impacts on the habitat (Note the survey area should extend beyond the predicted impact zone).	✓	Figure 74, Section 16.2 and 16.3; further detail available Appendix C ; Bennelongia (2015)
Describing the survey methodologies (see Guidance Statement No. 54a), including reference to timing, duration and survey effort used to sample each of the fauna groups sampled, species identification, and any survey limitations.	✓	Appendix C; Bennelongia (2015)
A comprehensive list and assessment of subterranean fauna recorded or reasonably expected to occur in the area, including any Specially Protected and other significant fauna and their known occurrence/habitats locally and their wider status if known, and an evaluation of the risk of the proposal to long-term survival of the species and community.	✓	Section 16.2 and 16.3, further detail available Appendix C; Bennelongia (2015)