



STRATEGIC REVIEW OF THE BANDED IRON FORMATION RANGES OF THE MIDWEST AND GOLDFIELDS

This review consists of:

- **Executive Summary and Actions Arising. Endorsed by Government.**
- **DEC report 'Banded Ironstone Formation Ranges of the Midwest and Goldfields - Interim Status Report - Biodiversity Values and Conservation Requirements'**
- **DoIR report 'Strategic Review of an Iron Ore Industry in the Yilgarn Region (With Focus on the Midwest)'**



Department of
Environment and Conservation

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Department of
Industry and Resources

STRATEGIC REVIEW OF THE BANDED IRON FORMATION RANGES OF THE MIDWEST AND GOLDFIELDS

EXECUTIVE SUMMARY & ACTIONS ARISING

World demand for iron ore is forecast to increase significantly in the next decade, prompting the Pilbara based BHP Billiton and Rio Tinto to announce, separately, plans to raise capacity to over 300 million tonnes per annum (Mtpa) each and FMG to 60 Mtpa. Chinese demand in particular has encouraged smaller companies to explore for new sources of iron ore, such as the Banded Iron Formation (BIF) ranges in the Midwest Region.

Since 2002 the Environmental Protection Authority (EPA) has completed formal assessments on three BIF mining proposals in the region and is currently assessing another three. There are, in addition, a further three at the feasibility stage of evaluation and some 25 prospects under exploration.

With the large number of mining proposals in the region, the EPA and government face an increasing and difficult challenge in addressing cumulative impacts and in balancing the economic, social and regional development benefits, against high conservation values.

The significant biodiversity values identified on the BIF ranges require measures to protect representative areas and species and ecosystems that are restricted to the ranges, consistent with State, national and international commitments on biodiversity conservation. However, the high biodiversity values and conservation requirements and the possible uniqueness of each of the ranges in the Midwest, if assessed individually, have the potential to preclude, or severely curtail as to render unviable, mining of millions of tonnes of iron ore. Alternatively, the broadscale mining of BIF ranges would have a significant detrimental effect on biodiversity values, particularly in respect of species and ecosystems restricted to those ranges.

Under the Environmental Protection Act 1986, the EPA is limited to assessing only the environmental aspects of proposals placed before it and, traditionally, such proposals are assessed on a project by project basis. Any assessment, strategic or otherwise, based on wider principles of sustainability or the “triple bottom line” of environmental, economic and social costs and benefits, is the role of government. Similarly,

environmental matters beyond the impact of the project are outside of the Part IV project environmental assessment process.

This Strategic Review of the biodiversity values and iron ore prospectivity in the Midwest and Goldfields (within the Yilgarn Craton) 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. The region covered in the review is shown in Figures 1 and 2.

Integrated Results

The BIF ranges are of very significant biodiversity value as a consequence of their unique geology, soils and relative isolation. The value of the ranges relate to the presence of endemic plant species, rare and restricted plant species and highly restricted and distinct plant communities and ecological communities. The ranges are also very distinct features in the regional landscape and in many cases possess outstanding landscape values. They also have fauna conservation values although these are less well documented than for flora.

Indigenous heritage values of BIF ranges are not addressed in this review.

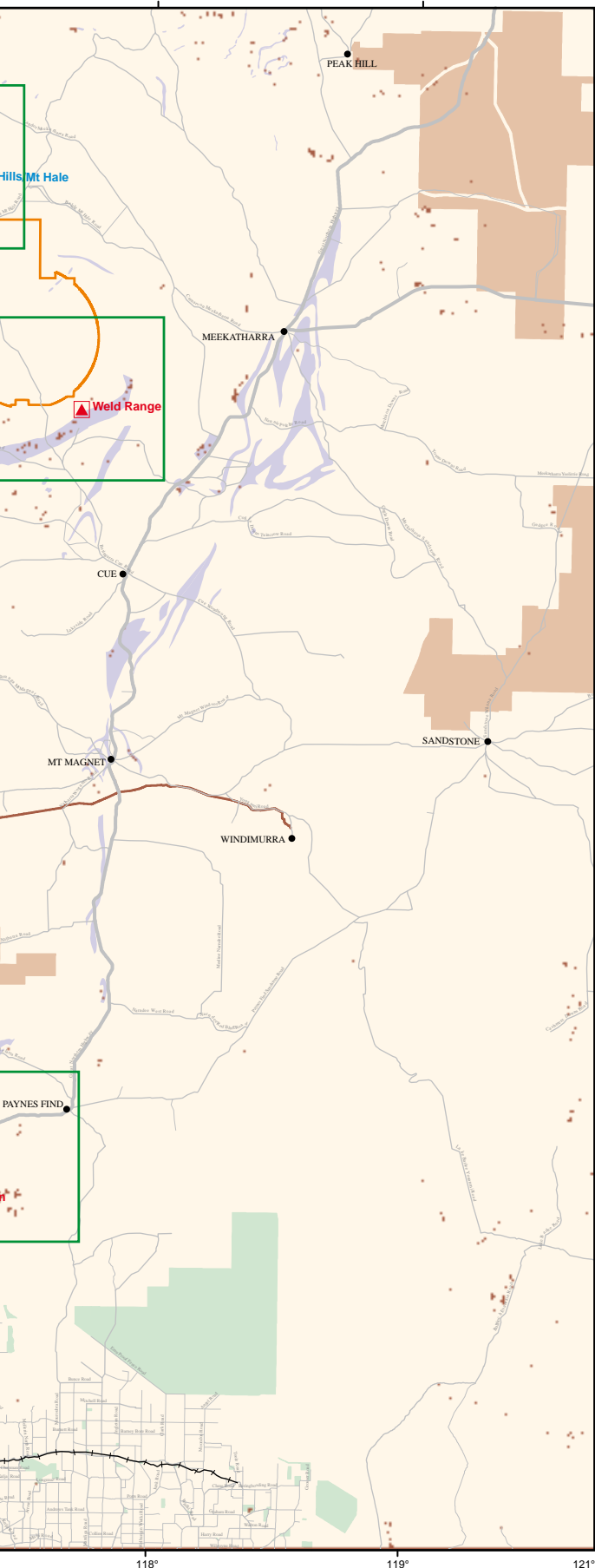
Implications for Economic, Social and Regional Development

Iron ore production in the region is at an early stage in its development, but is being shown to have very significant potential for the economic development and growth of the region and State overall. In addition to Portman’s Koolyanobbing operation in the central Yilgarn, five significant projects have thus far been identified in the Midwest region that could amount to a combined investment of around \$7 billion. A further three ‘starter’ projects have come into production in the last few years.

In-ground resource value thus far defined is between \$45 billion and \$75 billion dependent on price forecasts. If these major projects were developed to their planned first phase of capacity, they could result in export revenues of \$3.6 billion to \$5.3 billion per annum with direct revenues to the State Government in the order of \$225 million to \$330 million per annum in royalties alone, plus payroll tax and other indirect returns through taxation income.

Figure 1. Banded Iron Formation occurrence in relation to Iron Ore mining tenements and Conservation estate in the Midwest and Goldfields





Major Resources Existing Proposed

- Ports Existing: Proposed:
- Industrial areas Existing: Proposed:
- Iron ore project Existing: Proposed:
- Coalfields Existing:
- Gasfields Existing:

Conservation areas

- CALM conservation reserves
- CALM managed ex-pastoral leases
- Shark Bay World Heritage Area

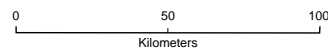
Radio Astronomy Park

- SKA radio telescope (Section 19)
- 70 km radio quiet zone

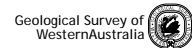
Localities and infrastructure

- Localities
- Railway
- Major road
- Minor road
- Unsealed road or track
- Gas pipeline
- Powerline
- Topographic ridges
- Iron formations

Scale 1: 1 300 000



UNIVERSAL TRANSVERSE MERCATOR PROJECTION
Map Grid of Australia Zone 50



**MID WEST REGION
POTENTIAL IRON ORE
INDUSTRY DEVELOPMENT**
(For discussion purposes only)

Iron ore trade already makes up 34% of cargo volume through Geraldton port. As a result of committed iron ore development plans, port capacity is being significantly expanded and there are plans for this to expand even further. However it is the triggering of the Oakajee port which is likely to have most impact for industrial development in the Midwest. The port development would provide the catalyst for the establishment of the Oakajee Industrial Estate. Not only is there the potential for iron ore based added value projects, but other heavy industrial projects.

Some “starter” or short lived stage 1 developments are proceeding, in many cases to provide the cash flow to fund a full scale, stage 2 development. It is the stage 2 projects which could bring the longer term benefits over a 20-30 year period. In addition to Mt Gibson, the other four major projects thus far identified in the Midwest region (Mt Karara Magnetite, Jack Hills Stage 2, Weld Range and Koolanooka Magnetite) as well as the Mungada Hematite are expected to be formally progressed through the environmental approvals process over the next 12 to 18 months. Triggering of the assessments of the major infrastructure development of the railway and Oakajee port should also be forthcoming in this period.

Major overseas companies are actively participating in and largely underwriting each of the significant developments and they are expressing frustration with time delays in accessing land, the slow speed of project development and the overall lack of certainty now emerging. A project-by-project assessment does not allow effective policies or strategies to be pursued. Given that major international owned enterprises are involved in the region’s iron ore projects, an adverse “unanticipated” outcome for the more significant projects could impact on WA’s – international business relationships. A number of major international companies could review their future investment in WA if the “rules of engagement” are not clarified upfront.

A clear statement of Government’s policy position in respect to access to the BIF ranges for development is required to give confidence, on the one hand, that the significant sums being expended in exploration and feasibility studies are worthwhile and the major financing arrangements currently being put in place

can be brought to fruition through major project developments, and on the other hand, that the significant conservation values of BIF ranges will be adequately protected.

Decisions on the most advanced projects at Mt Karara/Mungada need to be made in the overall context of policies for all of the BIF ranges as they will create precedents and impact on the level of confidence for companies in being able to develop a significant sustainable iron ore industry in the Midwest. It needs to be noted, based on information that is currently available, that there are differences between the various BIF ranges in terms of their biodiversity conservation and mineral prospectivity/resource values.

Implications for Conservation

There is a strong case for conserving the unique and irreplaceable biodiversity values of the BIF ranges in situ within intact ecosystems. It is clear that the current approach to mining the BIF ranges has the potential to result in loss of unique communities and reduction in the populations of restricted plant species to the point where they will be under significantly increased threat of extinction in the wild. There is no clear understanding of the level of loss that can be sustained on the identified range communities without compromising the sustainability of the local ecosystems and their component species. The ranges are also very distinct features in the regional landscape and in many cases possess outstanding landscape values. Examples of the BIF landscapes need to be retained, both partially and in their entirety, for protection of their unique landscape and geodiversity values and for their tourism potential.

Unless appropriate guidance is in place there is a very high probability that, over time, none of the most outstanding range systems and very few of the remainder will be preserved intact. At present, of the 28 BIF ranges discussed in the review, two are in conservation parks and three are in former pastoral leases purchased for conservation but not yet reserved. None are in national parks or Class A nature reserves which offer the highest level of conservation security and protection from mining (i.e. Parliamentary approval required)

Expansion of the conservation reserve system in relation to BIF ranges will be required where high biodiversity values are designated for protection as a consequence of the formal project assessment process, or following further consideration of the Environmental Protection Act 1986 Section 16 (e) advice on the Mt Manning area or through reservation of pastoral lands already purchased for conservation or as an outcome of Government's consideration of this review. In this regard, if consideration was given to reservation as class A nature reserve or national park of BIF ranges identified as having the most significant biodiversity conservation values (eg the Helena-Aurora Range and the Mt Karara/Mungada/Blue Hills system) would provide a strong indication of recognition of the ranges' values.

Reservation of some of these most outstanding ranges would have potential implications for some sections of the iron ore industry.

Conservation and Industry Development

On current floristic information, Jack Hills and Weld Range have fewer environmental obstacles and should be able to proceed to development with minimal constraint and support the development of Oakajee Port. Both these ranges are quite extensive, and portions of them should be conserved in line with biodiversity conservation principles when the values are more precisely defined.

The south-west cluster of ranges (ie Karara/Mungada/Blue Hills, Mt Gibson, Koolanooka) present significant environmental impact assessment challenges because of their biodiversity richness. The Karara/Mungada/Blue Hills range system represents the most outstanding of these ranges and is worthy of full protection, however, development planning and environmental assessment of Karara/Mungada/Blue Hills is well advanced. Creation of a reserve category such as national park or Class A nature reserve over the entirety of this area at this stage would be inappropriate (notwithstanding that existing tenements would be honoured).

It will be important that mining approvals in these areas are coupled with conservation outcomes for appropriate parts of these ranges, as an outcome

of the environmental process. In regard to the partly mined Koolanooka Range, the remainder of this range is also worthy of full protection and may face significant environmental impact assessment challenges. The Koolanooka Ranges have two very significant magnetite deposits within their boundary.

In the south-east cluster (Mt Manning area), the Helena-Aurora Range is of the highest biodiversity significance and is at the exploration stage. Given the less advanced development planning and high biodiversity value, reservation as national park or Class A nature reserve could be considered (as recommended in EPA Bulletin No. 1256 'Advice on Areas of the Highest Conservation Value in the Proposed Extensions to Mount Manning Nature Reserve' (May 2007)). The Bungalbin East area, is the focus of one exploration company's interest and any decision on this area in regard to Class A nature reserve should be deferred until further prospectivity information is available.

Based on current levels of knowledge **Table 1** outlines the intersection between biodiversity and prospectivity values. Further biodiversity information will be gathered as a consequence of proponent surveys and DEC funded surveys and accordingly information may come forward that will have further implications for projects and for the outcomes of EPA assessments. Similarly, exploration is an ongoing process which may result in other ranges being identified as having high prospectivity and a clearer definition within ranges of areas of resource significance.



Table 1

Intersection between biodiversity and prospectivity values

Lowest * Highest ***

Note: These ratings are purely relative and the lowest rating does not imply that biodiversity or prospectivity values in any individual range are of no significance.

Range System	Stage	Biodiversity	Prospectivity
Jack Hills	Stage 1 mining. Part conservation	*	***
Weld Range	Exploration. Part conservation	*	***
Koolanooka	Partly mined. Scope for conservation	***	***
Mt Karara	Advanced mine planning	***	***
Mungada/Blue Hills	Advanced mine planning	***	***
Mt Gibson	Extension Hill approved	***	***
Helena & Aurora (including Bungalbin East)	Early exploration	***	**
Diemals / Die Hardy Range	Early exploration	**	?
Mt Manning	Exploration	**	?
Mt Jackson Range	Partly mined	***	***
Koolyanobbing Range	Extensive mining. Most conservation potential lost	***	***
Windarling Range	Partly mined. Significant impacts	***	***
Mayfield	Exploration	*	?
Minjar/Gnows Nest	Exploration	*	?
Mt Dimer	Exploration	*	?
Tallering Peak	Partly mined	*	**
Warriedar/Pinyalling	Exploration	*	*
Booylgoo Range	Exploration	?	*
Bulga Downs	?	?	?
Cashmere Downs	Exploration	?	?
Gullewa/Wolla Wolla	?	?	?
Lake Giles	?	?	?
Lake Austin	?	?	?
New Forest (inc Twin Peaks)	Exploration	?	?
Perrinvale/Walling Range	Exploration	?	?
Robinson Range	Exploration	?	?
Wiluna West	Exploration/preFS	?	***
Yalgoo	Exploration/preFS	?	**

?- Further investigation/exploration required. Limited information to date

MAJOR FINDINGS

There are significant biodiversity and mineral resource values in the banded ironstone ranges of the Midwest and Goldfields but that for many individual ranges, the mineral prospectivity is little or only partly defined and the knowledge of conservation values is not complete in both a detailed and regional context.

Under present known conditions, the current mining operations largely underpinning the economic and employment base of the Midwest, appear to have a limited foreseeable life.

The establishment of a significant iron ore industry in the Midwest would deliver substantial economic and social benefits to the Midwest Region and the State.

Without an appropriate framework for decision making, State commitments to biodiversity conservation will become increasingly difficult to meet in regard to banded iron ranges and the environmental approval process for developers will become increasingly problematic.

The development of substantial iron ore mines in the Jack Hills and Weld Range would be needed for the establishment of the Oakajee Port and associated infrastructure and this should be achievable in the light of current knowledge of biodiversity values (these ranges are quite extensive and that an adequate level of conservation of values can also be achieved taking into account the key principles. The Mt Karara, Mungada/Blue Hills and Koolanooka projects are likely to sustain the economic viability of Oakajee.

The BIF ranges located within the 'south west' cluster (i.e. Mt Karara/Blue Hills/Mungada, Mt Gibson and Koolanooka) have very high biodiversity conservation values, as well as advanced highly prospective project development proposals and strategic interests in regional development terms. Proposals relating to the Mt Karara, Mungada and Blue Hills range system are currently in the *Environmental Protection Act 1986* assessment process and Government will need to consider the economic and social benefits in the final decision-making process. The Mt Gibson Ranges have been the subject of a recent Ministerial decision with respect to development and conservation.

The BIF ranges located within the 'south east' cluster (Mt Manning Area) (i.e. Helena-Aurora, Mt Manning, Mt Jackson, Mt Windarling, Diemals/Die Hardy Ranges and Koolyanobbing Range) are still insufficiently explored to adequately assess prospectivity but have been the subject of EPA Bulletin No. 1256 'Advice on Areas of the Highest Conservation Value in the Proposed Extensions to Mount Manning Nature Reserve' (May 2007) which identifies very high conservation values.

ACTIONS ARISING

As a result of this Strategic Review, Government will provide the confidence for mining, investment, community and conservation interests by demonstrating its support for the establishment of an environmentally acceptable long term iron ore industry base in the region by endorsing a framework that:

- commits to sustainable economic, social and environmental outcomes in respect to development proposals and conservation needs in the banded iron ranges;
- provides for reservation as Class A conservation reserves (i.e. national parks, nature reserves or conservation parks) over appropriate areas of banded iron ranges;
- provides clear indications that the Government is pre-disposed to the development of key strategic iron ore resources needed to underwrite and sustain the proposed Oakajee Port and related infrastructure;
- provides guidance to the EPA and decision-making authorities for the remaining ranges, including the objective of achieving appropriate conservation outcomes in high conservation value Midwest Ranges currently undergoing assessment.
- provides adequate opportunity for further evaluation of prospectivity and conservation values to allow for informed decisions on land use.

Consistent with this framework the Government:

- (i) commits to the creation of Class A nature reserves or national parks over the Helena-Aurora Range, Die Hardy Range and Mt Manning Range (as generally recommended in Bulletin No 1256), with an indicated pre-disposition against development of these ranges,

- (ii) indicates its predisposition towards development over areas of
 - Jack Hills
 - Weld Range
 - Tallering Peak
 - Yalgoo
 - Wiluna West

where substantial iron ore resources are identified and are required to sustain a long term mining industry while also providing for an adequate level of conservation of their biodiversity values.

- (iii) indicates a predisposition that in the interests of sustainable economic development in the highly biodiverse Karara/Mungada Blue Hills area, to allow the development of the identified magnetite resource in the south west section of the range but the Government is not predisposed to the extraction of the hematite deposits of the area.

- (iv) further considers both the economic and biodiversity values present in the Koolanooka Hills when projects in this area come forward for assessment

- (v) indicates its intention to place the
 - Booylgoo
 - Bulga Downs
 - Cashmere Downs
 - Perrinvale
 - Walling
 - Warriedar/Pinyalling
 - Wolla Wolla
 - Lake Austin
 - Bungalbin East

ranges into an appropriate reserve status (e.g. conservation park or nature reserve not of Class A) that will facilitate ongoing assessment of both biodiversity and prospectivity with a view to reviewing that status in 3 years in light of increased knowledge at the appropriate time.

- (vi) agrees that an updated strategic review of available information on biodiversity and mineral resource values in three years will make more specific recommendations for conservation reserves across the remaining

BIF ranges in the Midwest and Goldfields regions. with development proposal in these areas put forward in the interim to be considered on a case by case basis as required and with reference to the key principles.

Further, the Government will draw to the EPA's attention the Government's predisposition, as set out above, that exploitation of appropriate iron ore resources should be carried out sustainably by ensuring that critical thresholds for conservation of biodiversity are recognised in the consideration of development proposals and that best practise environmental management and mitigation programmes are committed to by developers.

The following conservation principles and guidance should be taken into account in environmental assessments and the provision of advice to Government:

Key Principles

- (i) No development activity to proceed in the Yilgarn Craton BIFs that would result in the IUCN Threat Category of any given plant or animal taxon increasing ie. initially not being listed as threatened under any category to being listed (the three IUCN categories for threatened species being Vulnerable, Endangered and Critically Endangered), or increasing from Vulnerable to Endangered, or from Endangered to Critically Endangered.
- (ii) No development activity to proceed in the Yilgarn Craton BIFs that would result in the IUCN Threat Category of any ecological community increasing from not being listed as threatened under any category to being listed, or where already listed (or qualifying for listing) as a TEC, having its actual or recommended Threat Category increased (i.e. from Vulnerable to Endangered or from Endangered to Critically Endangered).
- (iii) 15% - 30% of the total number of ranges should be reserved in their entirety, protecting complete examples of the landform and ecosystem. Examples of the most outstanding BIF ranges should be protected in their entirety where development has not significantly progressed, e.g. the Helena-Aurora Range (consistent with recommendations in EPA Bulletin 1256). The initial objective should be

to conserve 15% of ranges in their entirety. The DEC has completed 2 years of a 3 year flora survey program, and, when completed, a review should be undertaken to further define the list of ranges requiring reservation in their entirety, with the objective of achieving at least the 30% target.

Guidance

- (iv) Conservation reserves should include at least 60% of largely contiguous ecosystem/habitat for each of the key banded ironstone species and ecological communities which are restricted to the BIF ranges.
- (v) Subject to key conservation principles i and ii, identified above, an objective of detailed mine-site planning and assessment should be to maximize the protected area of any floristic community identified by detailed flora survey to be restricted to the BIF, or dependent on the BIF for its conservation. This would indicate that no development should occur in those floristic communities that are likely to be significant for the maintenance of long term viability of threatened species and threatened ecological communities
- (vi) Landscape, geodiversity, Aboriginal Heritage values and potential for nature based tourism should be taken into account in developing a reserve system. State, National and International assessment methodologies and criteria should be used for identifying areas of significant landscape, geodiversity, Aboriginal Heritage values and tourism potential for protection.

To support this work the Government will fund, in collaboration with industry, the completion of a major programme to fully define the overall regional conservation values and notes that industry is and will continue research into the mitigation of impacts and rehabilitation.

NOTE: Nothing in these undertakings derogates from the operation of the *Environmental Protection Act 1986* and consideration of proposals by the EPA.



Tetratheca harperi with the J3 pit on Mt Jackson in the background (Photo – Colin Yates)

BANDED IRONSTONE FORMATION RANGES OF THE MIDWEST AND GOLDFIELDS

Interim Status Report

Biodiversity Values and Conservation Requirement

September 2007



Department of
Environment and Conservation

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Executive Summary

Background

This document presents strategic level advice for Government for consideration of biodiversity conservation actions for the banded ironstone formation (BIF) ranges of the Yilgarn Craton with a specific focus on the Midwest and the Goldfields (primarily Mt Manning) regions.

The objectives of this review are:

- to the extent that available data allows, compile and deliver a strategic level understanding of the biodiversity values within the banded ironstone ranges;
- to explain the terms ecological and floristic communities and their application;
- to develop a framework and criteria for conservation and reservation decision-making;
- to commence comparative analysis of the relative biodiversity values of the individual ranges; and
- where there is adequate information, provide strategic recommendations identifying options for proposed conservation reserves in the Midwest and Goldfields, based on assessment of banded ironstone areas that warrant protection via reservation in order to meet recognised conservation reserve system criteria for comprehensiveness, adequacy and representativeness.

Summary of Findings

Whilst further investigations will be required to completely define all of the biodiversity conservation values of the banded ironstone ranges within the Yilgarn Craton, the existing level of information is adequate to make informed judgments with respect to conservation requirements at the strategic level and in some cases at the specific level, in order to ensure adequate conservation of species, communities and ecosystems.

Although forming a very small proportion of each bioregion, the BIF ranges are of very significant biodiversity value. This is a consequence of their unique geology, soils and relative isolation. The ranges are important due to the presence of endemic plant species, rare and restricted plant species and highly restricted and distinct plant communities. Based on survey information to date, every range is distinctly different from the other sampled ranges from an ecological perspective. The ranges are also

very distinct features in the regional landscape and in many cases possess outstanding landscape values. Examples of the BIF landscapes need to be retained, both partially and in their entirety, for protection of their unique landscape and geodiversity values and for their tourism potential.

Of the BIF ranges of the Yilgarn Craton referred to in this report, only two are within established conservation reserves, and even those are within categories where policy and legislation allow exploration and mining subject to recommendations (not concurrence) of the Minister for the Environment (notwithstanding any requirements for assessment under the Environmental Protection Act 1986). Accordingly, no BIF ranges are adequately protected to fully protect rare flora vegetation and fauna against development. Secure reserves such as A class nature reserve or national park would be required. One high conservation value BIF range system lies within a former pastoral lease (Karara) that the Western Australian Government has previously purchased for conservation purposes, along with other pastoral leases purchased in the Midwest and Goldfields.

The concept of environmental offsets as part of a package aiming for a 'no net loss' or a 'net environmental gain' outcome is being broadly applied to development projects in Western Australia through the environmental approvals process under the Environmental Protection Act 1986. In the case of the banded ironstone ranges many of the biodiversity values of the ranges are unique to a specific range and are therefore irreplaceable. For example at Mt Gibson, two species of threatened flora, *Darwinia masonii* and the newly discovered *Lepidosperma* sp. Mt Gibson are only known to occur on the upper slopes, crests and ridges of Mt Gibson range. The State has a responsibility to conserve the native fauna and flora of the State. This involves ensuring that species are properly conserved in situ and that no species are made extinct.

The unique and irreplaceable biodiversity values of the BIFs need to be conserved in situ within intact ecosystems. It is clear that mining of surveyed BIFs would result in irreplaceable loss of unique communities and would be likely to put species at risk. There is no clear understanding of the level of loss that can be inflicted on the identified range

communities without permanently compromising the sustainability of local ecosystems and their component species. Environmental offsets that result in no net loss or a net environmental gain are not feasible in this type of scenario.

Notwithstanding this, if the Government approves a proposal that results in significant risk to the biodiversity values of any BIF range, then proponents and the Government need to provide for the enhanced protection (conservation reserve status) and management (resources) to help mitigate the risk to the long-term sustainability of any remaining part of that BIF range.

As a general principle BIF ranges and their component floristic communities should be preserved in their entirety given their biodiversity conservation significance and their vulnerability to the cumulative impacts of multiple major iron ore resource proposals and other threatening processes.

If the Government wishes to balance expectations between biodiversity requirements and the economic benefits of resource development, then strategically planned 'compromise' reserve criteria and proposals will need to be considered. Completion of the Strategic Review (and this Interim Status Report) is a critical aspect of progressing a coordinated Government approach to the establishment of a system of conservation reserves that attempts to balance both interests.

Reserve proposals which aim for the protection of representative areas of BIF ranges and habitat of each of the plant species and communities, whilst allowing for the development of strategically important iron ore resources, need to be defined. However, given the general congruence between discrete plant communities and iron ore deposits in the BIF ranges, any compromise reserve proposal that provides for mining is highly likely to result in some plant communities being completely lost or severely degraded as well as some significant species being exposed to elevated threat of extinction. It therefore needs to be recognised that under this scenario the community will be accepting a situation where adequate protection of all plant communities will not be achievable, plant communities will be degraded or lost and species placed at increased risk.

Recommendations

In the absence of full protection of BIF ranges and if mining is to be contemplated, the following regional conservation targets should be considered. These criteria are in line with international and national standards and are suggested as a minimum:

1. No development activity to proceed in the Yilgarn Craton BIFs that would result in the IUCN threat category of any given plant or animal taxa increasing, ie. initially not being listed as threatened under any category to being listed (the three IUCN categories for threatened species being Vulnerable, Endangered and Critically Endangered), or increasing from Vulnerable to Endangered, or from Endangered to Critically Endangered.
2. No development activity to proceed in the Yilgarn Craton BIFs that would result in the IUCN Threat Category of any ecological community increasing from not being listed as threatened under any category to being listed, or where already listed (or qualifying for listing) as a threatened ecological community, having its actual or recommended Threat Category increased (ie. from Vulnerable to Endangered, or from Endangered to Critically Endangered).
3. A minimum of 15% and up to 60% of the total number of ranges should be reserved in their entirety, protecting complete examples of the landform and ecosystem. 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 initial objective should be to conserve 15% of ranges in their entirety. At the end of the three year DEC flora survey program, a further review should be undertaken to further define the list of ranges requiring reservation in their entirety, with the objective of achieving the 60% target.
4. Conservation reserves to include at least 60% of largely contiguous ecosystem/habitat

for each of the key banded ironstone species and ecological communities which are restricted to the BIF ranges.

5. Subject to recommendations 1 and 2 above, the aim of detailed mine-site planning and assessment should be to maximise the protected area of any floristic community restricted to the BIF, or dependent on the BIF for its conservation. This would require that no development should occur in those floristic communities that are likely to be significant for the maintenance of long-term viability of threatened species and threatened ecological communities.
6. Landscape, geodiversity, indigenous heritage values and potential for nature based tourism should be taken into account in developing a reserve system. State, national and international methodologies and criteria should be used for identifying areas of significant landscape, geodiversity, indigenous heritage and tourism potential for protection.

Given the biodiversity conservation significance of banded ironstone ranges and their vulnerability to the cumulative impacts of multiple major iron ore resource proposals, a broad target reservation level of at least 60% (recommendation 4) of the total area of restricted banded ironstone formation range ecosystems is deemed appropriate. The precedent of 60% protection of vulnerable ecosystems was established by the 'Janis Report', The Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia (Commonwealth of Australia 1997).

This report also states that rare and endangered ecosystems are to be protected 'as much as is practicable'. This acknowledges that the ideal scenario for threatened species and communities is full protection in their entirety. Intact ranges are important for the long-term survival of these ecosystems and their component species including endemic and rare species, especially in periods of climate change. Species and communities restricted to small areas of essential habitat such as BIF ranges, and which are dependent on such ranges as part of their life cycle, are particularly vulnerable to threats.

There is no certainty that protecting parts of ranges, even the 60% suggested in this paper, will be adequate to prevent extinctions in the long term. This is especially the case when the most substantial landforms are lost and / or a range is fragmented. Reservation of largely contiguous unfragmented habitat is considered essential.

Due to the highly restricted distribution of several flora species and plant communities within the BIF ranges recommendation 4 above would ideally be to formally protect 100% of these occurrences. However a 'compromise' criterion of at least 60% has been suggested, that acknowledges that 100% protection of these values would be very difficult given the overlapping occurrence of mineral resources. Protecting 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 limited distribution.

Recommendation 3 above requiring that up to 60% of the ranges be protected from any disturbance in their entirety is to ensure examples of the complete landform are protected and conserved. Reserves also need to be of sufficient size and condition to ensure long-term sustainability and of appropriate tenure to secure ranges from further mining. An initial level of 15% of all ranges should be fully protected with an objective of achieving the 60% target following the final (third) year of the DEC floristic surveys.

All of the recommendations have been made according to the BIF biodiversity values as outlined in this report, the current level of protection afforded to them, and the guiding objectives and targets provided in relevant documentation such as the Convention on Biological Diversity, the National Strategy for the Conservation of Australia's Biological Diversity, Australian Guidelines for Establishing the National Reserve System, National Criteria for a Comprehensive, Adequate and Representative Forest Reserve System and the draft Biodiversity Conservation Strategy for Western Australia.

The following table outlines the status of mining and the potential to achieve full protection for the most outstanding ranges (based on current information). In this regard it should be noted that only four of the highest value ranges have the potential to be conserved intact, although there is scope to conserve a large proportion of the Koolanooka Hills.

PRIORITY AREAS FOR CONSERVATION

Highest biodiversity and landscape value sites – intact and protectable

Location	Region	Development Status	Potential to Conserve Intact Range
Diemals/Die Hardy Range	Goldfields	Early exploration.	Intact and protectable; good potential and priority to fully conserve.
Helena and Aurora Range (incl. Bungalbin Hill)	Goldfields	Early exploration.	Intact and protectable; high priority for conservation.
Mt Karara/Mungada Ridge (Blue Hills)	Midwest	Advanced mine planning and EIA commenced; significant investment and high expectations to mine.	Intact and protectable; high priority for conservation.
Mt Manning	Goldfields	No activity.	Intact and protectable.

Highest biodiversity and landscape value sites – being mined or approval process advanced

Location	Region	Development Status	Potential to Conserve Intact Range
Jackson Range	Goldfields	Partly mined – advanced mine planning and EIA commenced over part.	Being mined; existing and potential loss of conservation values; part conservation only.
Koolanooka Hills (incl. Perenjori Hills)	Midwest	Partly mined – advanced mine planning and EIA commenced over part.	Being mined; scope to conserve substantial part.
Koolyanobbing Range	Goldfields	Extensively mined, mining ongoing.	Being mined; potential lost; conservation of small portion only.
Mt Gibson	Midwest	Mining approved.	Potential significantly diminished; existing and potential loss of conservation values; conservation of restricted portion only.
Windarling Range	Goldfields	Partly mined - significant impacts; pressure to expand.	Being mined; significant loss of conservation values from mining already. Ministerial conditions relate to the release of a further 15% of original (27% of remaining) rare flora; final extent of impact dependent on the proponent being able to meet specified conditions relating to threatened flora.

Lower biodiversity value sites* - although still providing refugial habitats with localised species and vegetation communities

	Region	Stage of Mine Development & Comments
Finnerty Range	Goldfields	Surveyed by DEC, no known BIF endemics, areas of BIF small.
Jack Hills (incl. Mt Hale, Gould, Taylor)	Midwest	Being mined; significant potential loss through cumulative impacts; part conservation only.
Mayfield	Goldfields	Surveyed in part by Portman and in part by DEC, no known BIF endemics, areas of BIF small.
Minjar/Gnows	Midwest	Early exploration; covered in Central Talling report; Nest regional sampling suggests communities more widespread than in the Mt Karara and Mungada Ridge area.
Mt Dimer	Goldfields	Surveyed in part by DEC; no known BIF endemics, areas of BIF small.
Talling Peak	Midwest	Being mined; existing loss; significant mining has already taken place.
Warriedar/ Pinyalling	Midwest	Early exploration; covered in Central Talling report; regional sampling suggests communities more widespread than in the Mt Karara and Mungada Ridge area.
Weld Range	Midwest	Currently being explored; communities in DEC survey area not restricted to specific areas within range; part conservation only.

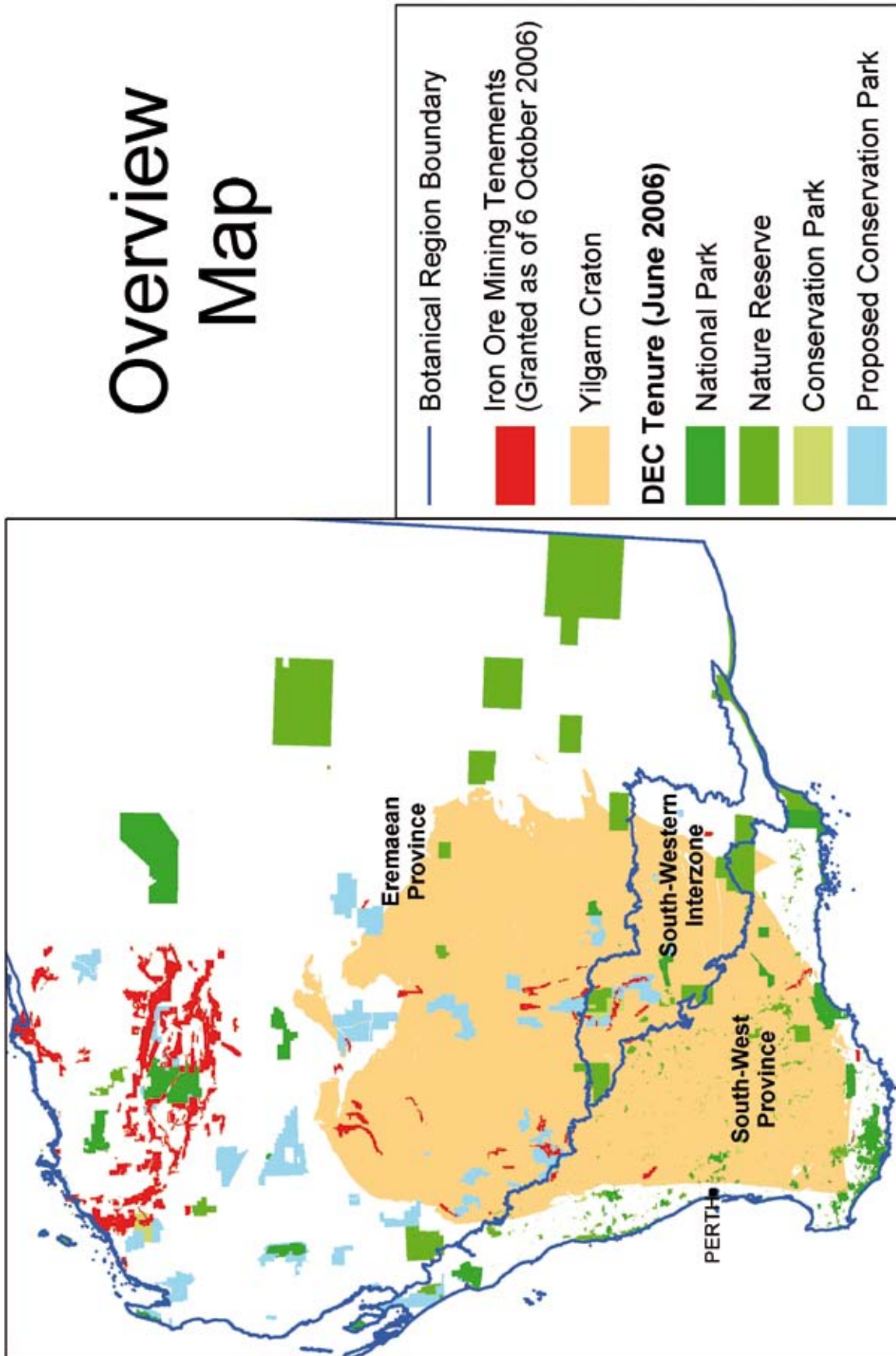
*These areas may be candidates for reservation (in entirety or part A class or as conservation park) subject to further investigations.

Sites requiring further investigation*

Booylgoo Range	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Bulga Downs	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Cashmere Downs	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Gullewa / Wolla Wolla	Midwest	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Lake Austin	Midwest	No information
Lake Giles	Goldfields	Early exploration; DEC survey in 2007.
Mt Dugel/Mt Nairn	Midwest	No information; DEC survey in 2007.
New Forest (incl. Twin Peaks)	Midwest	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Perrinvale/ Walling Range (incl. Lake Barlee, Brooking Hills and Mt Mason/ Mt Hope)	Goldfields	Early exploration. DEC survey in 2007.
Robinson Range	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Wiluna West	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Yalgoo	Midwest	No information

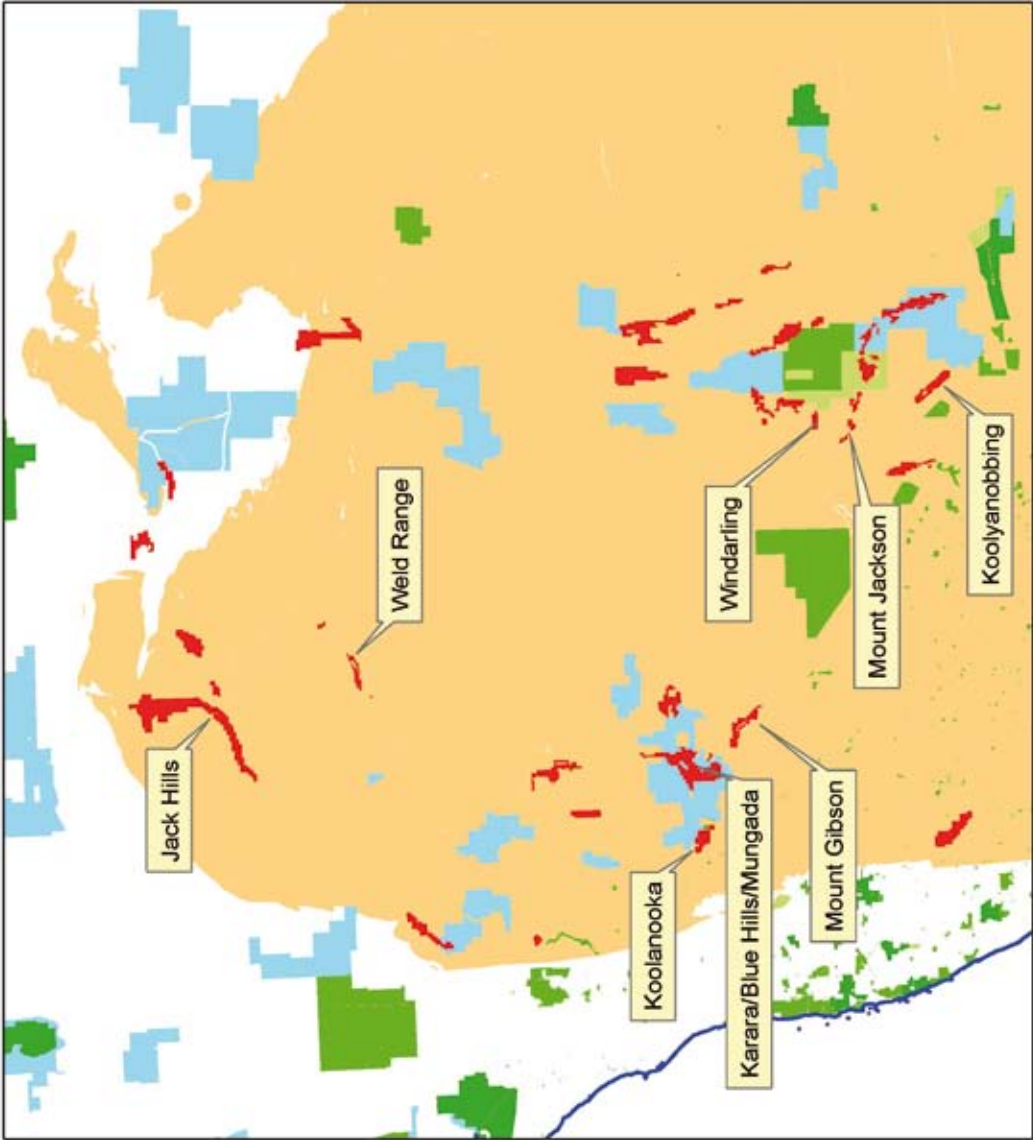
* These areas may be candidates for reservation (in entirety or part A class or as conservation park) subject to further investigations.

Overview Map

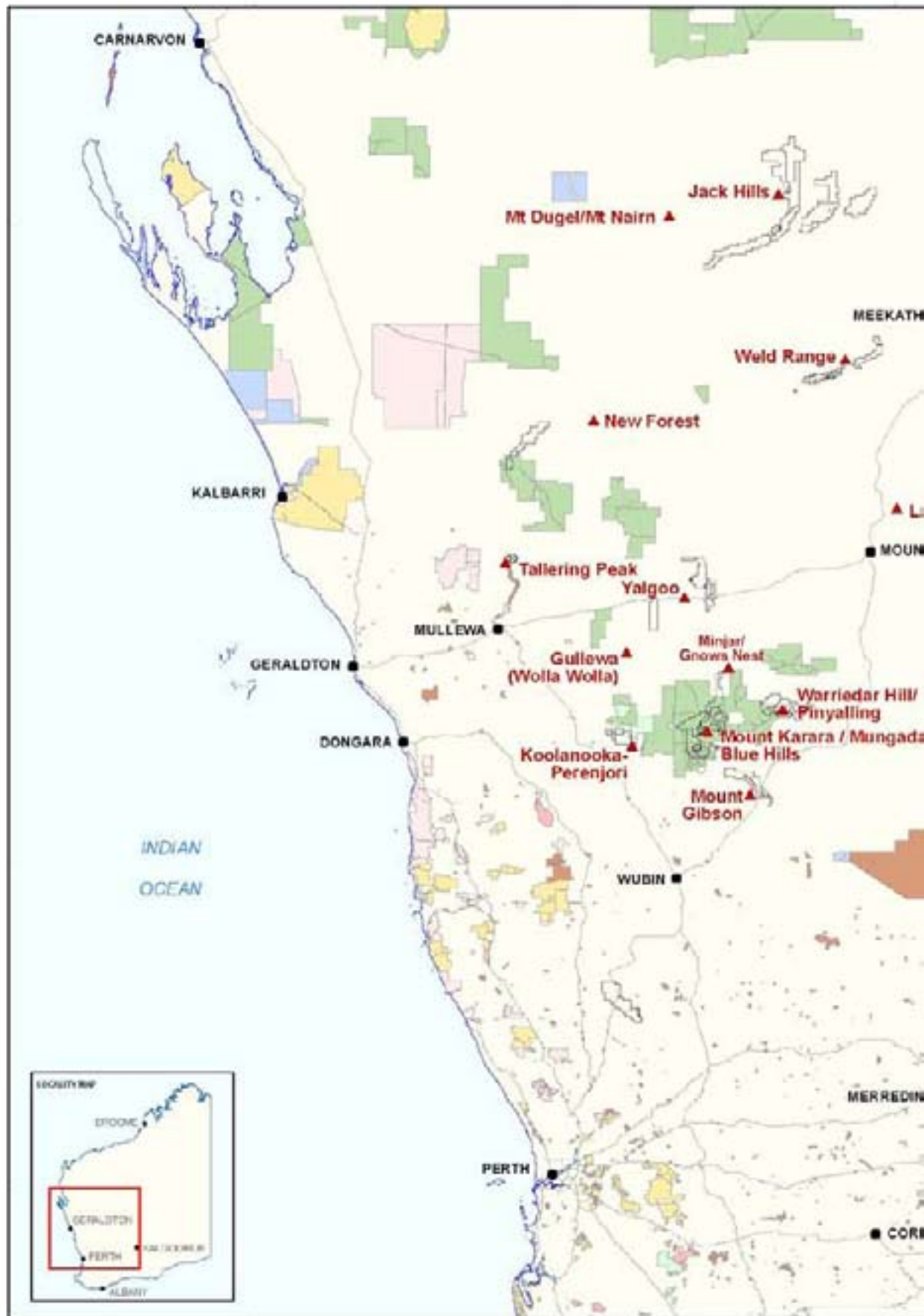


The banded ironstone formation ranges in the North Yilgarn Craton.

North Yilgarn Craton



Banded ironstone formation occurrence in relation to iron ore mining tenements and conservation estate in the Midwest and Goldfields.



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See also: Map Amendment 00000000-02, posted 1 September 2007.



TOPOGRAPHIC FEATURES

- Locality
- ▲ Centroid of project area
- Principal road

CONSERVATION ESTATE

- National Park
- Nature reserve - A class
- Nature reserve - other class



Produced by the GIS Section
under the direction of Keiran McNamara
Director General, Department of
Environment and Conservation.

Data Dictionary		
Dataset	Coordinate	Date
Location	UTM	2006
Project area	CRS	2007
Conservation Estate	CRS	2007
Location	CRS	

BANDED IRONSTONE FORMATIONS LOCATED IN NATURE RESERVES AND NATIONAL PARKS

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Abbreviations/Acronyms

ANZECC	Australian and New Zealand Environment and Conservation Council
BIF	Banded Ironstone Formation
BCI	Biodiversity Conservation Initiative
CAR	Comprehensive, Adequate and Representative
CALM	(Former) Department of Conservation and Land Management
DEC	Department of Environment and Conservation (formerly DoE and CALM)
DoE	(Former) Department of Environment
DoIR	Department of Industry and Resources
DRF	Declared Rare Flora
EPBC	Environment Protection and Biodiversity Conservation (Act) (Commonwealth)
EPA	Environmental Protection Authority
ESD	Ecologically Sustainable Development
FCT	Floristic Community Type
IBRA	Interim Biogeographic Regionalisation for Australia
Interzone	Intermediate Rainfall Zone between the wheatbelt and Eremaean zone
ICMM	International Council on Mining and Metals
IUCN	International Union for the Conservation of Nature and Natural Resources (now the World Conservation Union)
NHT	Natural Heritage Trust
NRS	National Reserve System
PEC	Priority Ecological Community
PER	Public Environmental Review
POW	Proposal of Works
SRE	Short-range Endemic
Taxa	Taxonomic entity - species, subspecies, etc.
TEC	Threatened Ecological Community
TSSC	Threatened Species Scientific Committee
WATECSC	WA Threatened Ecological Communities Scientific Committee



1. Introduction

1.1 Background

The banded ironstone formation (BIF) ranges of the Yilgarn Craton in the Midwest and Goldfields regions of Western Australia are isolated ancient ranges set in a predominately flat landscape. They form a relatively small proportion of the total land area of the region and act as unique habitat for flora and fauna due to different geology, soils and landforms to the majority of land in the region. These areas, while having some similarities to the Pilbara from a geological perspective, are significantly different from the Pilbara in terms of the composition of native flora, fauna and ecosystems.

The flora and fauna on the Midwest and Goldfields BIF ranges are believed to have evolved in isolation, and floristic surveys undertaken to date support this view, with a high concentration of rare and geographically restricted plant species and communities being found. A significant number of new plant species have also been identified during recent survey work.

Each BIF range tends to be biologically distinct, generally supporting different plant communities and often endemic species. In many cases a number of plant species and communities (assemblages of plant species) are endemic (restricted) to individual ranges. The ranges also support short-range endemic fauna (primarily invertebrate fauna with a highly restricted distribution).

Early biological surveys of the eastern Goldfields followed by botanical surveys of some of these areas by staff of the then Department of Conservation and Land Management (CALM) and by development proponents during the late 1980s and 1990s indicated the potential of very high conservation significance of these ranges. The specific conservation significance of the biodiversity values on many individual ranges is still in the process of being quantified.

The Department of Environment and Conservation (DEC) is conducting a three-year strategic regional flora and vegetation survey of key BIF ranges. The results of the first year of the survey (2005) are available as draft scientific papers, preliminary key findings from the second year of the survey (2006) are now available, and survey work for the third and final year

of the survey commences in October 2007, with data analysis and reporting expected to be completed by July 2008.

The three year DEC regional flora survey, in combination with detailed site surveys undertaken by iron ore proponents, continues to provide better information on the distribution of plant and animal species and communities, and their significance.

BIF ranges in the Midwest and Goldfields are very poorly represented in the formal conservation reserve system. Significant pressure on individual BIF ranges is likely, due to the congruence of ore bodies with restricted habitats, habitats being restricted in distribution, and multiple tenement holders at each range.

The Environmental Protection Authority (EPA) is currently assessing proposals for mining of banded ironstone ranges in the Midwest and Goldfields regions on a case by case basis, and has completed formal environmental assessment on Koolyanobbing Expansion (Portman Iron Ore Ltd 2002), Jack Hills Stage 1 proposals (Murchison Metals Ltd 2005), and Mt Gibson (Mount Gibson Mining Pty Ltd). Formal EPA assessments are currently underway on Karara Hematite (Gindalbie Metals Ltd), Karara Magnetite (Gindalbie Metals Ltd), and Koolanooka / Blue Hills DSO project (Midwest Corporation Ltd). The EPA's role is to provide recommendations to the Minister for the Environment on each of the potential environmental impacts. The decision on whether a proposal may be implemented is made by the Minister for the Environment, following a process to consider any appeals.

Under the Environmental Protection Act 1986, the EPA assesses only the environmental aspects of proposals. Any assessment, strategic or otherwise based on wider principles of sustainability or the "triple bottom line" of environmental, economic and social costs and benefits, is the role of Government. With the large number of mining proposals in the region, the EPA and Government will face an increasing and difficult challenge in addressing cumulative environmental impacts.

The Strategic Review of biodiversity and mineral prospectively in the Midwest and Goldfields region

and the preparation of this Interim Status Report are being 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.

The significant biodiversity values identified on the BIF ranges require measures to protect, within conservation reserves, representative areas and flora and fauna species and communities that are restricted to the ranges, consistent with State, national and international policies and agreements on environmental protection and biodiversity conservation. Information on these commitments, an analysis of currently available information on BIF biodiversity values and the criteria used for decision making on reservation recommendations are provided in this report.

1.2 Objectives

The objectives of the DEC (biodiversity) component of the Strategic Review are:

- to the extent that available data allows, compile and deliver a strategic level understanding of the biodiversity values within the banded ironstone ranges;
- to explain the terms ecological and floristic communities and their application;
- to develop a framework and criteria for conservation and reservation decision-making;
- to commence comparative analysis of the relative biodiversity values of the individual ranges; and
- where there is adequate information, provide strategic recommendations identifying options for proposed conservation reserves in the Midwest and Goldfields, based on assessment of banded ironstone areas that warrant protection via reservation in order to meet recognised conservation reserve system criteria for comprehensiveness, adequacy and representativeness.

1.3 Scope

There are estimated to be approximately 50 – 100 banded ironstone ranges in the Midwest and Goldfields regions of the north Yilgarn Craton of Western Australia. For the majority of these ranges there is little or no detailed information available

regarding biological values. Table 1 and Maps 1-4 outline details and locations of the BIF ranges in the Midwest and Goldfields regions where there is some degree of information available and on which the strategic review has focused on for the purposes of this report.

Some ranges in the Koolyanobbing / Mt Manning area are located south-east of what is traditionally regarded as the Midwest region. However these ranges have been included in this review as they share similar biodiversity values and mineral prospectivity characteristics. For the purposes of this report the term 'Midwest' is used when referring to those ranges within the DEC Midwest Region administrative boundary and the term 'Goldfields' when referring to those ranges within the DEC Goldfields Region administrative boundary (Map 2).

This review takes a three-staged approach:

- Stage 1 (documented in this report) uses existing data including the results of the regional flora survey to date, existing herbarium records and proponent data to provide an interim status report;
- Stage 2 will provide an updated status report in the latter part of 2007 when the results of the second year regional survey are available; and
- Stage 3 will involve the preparation of a final status report in July 2008 when the results of third year of the regional flora survey (and additional project level survey work completed by proponents) are available.

This report includes three 'case study' areas (Blue Hills, Mt Gibson and the Mt Manning area) where a greater level of information is available and a more detailed discussion of biodiversity values and mineral development processes to date are provided. The published EPA Bulletin 1256 for the Mt Manning area investigates in detail the biodiversity values and requirements for comprehensive, adequate and representative reservation in that area. Information presented in Bulletin 1256 has been utilised as part of the Strategic Review.

Table 1. Banded Ironstone Formation (BIF) ranges of Strategic Review focus.

BIF Range	Project	Proponent	Phase of Project
Mt Karara/Mungada/Blue Hills* ^	Mungada Ridge Hematite	Gindalbie Metals	Assessment (draft PER) -
	Mt Karara Magnetite	Ansteel Gindalbie Metals	Assessment (draft PER) -
	Direct Shipping Ore Project	Anshan Iron & Steel Midwest Corporation	Proposal in development
Warriedar Hill / Pinyalling* ^	Plateau Prospect	Royal Resources	Exploration
Minjar / Gnows Nest* ^			Exploration
Booylgoo Range*	Booylgoo	Midwest Corporation Mabrouk Minerals	- Exploration
Bulga Downs*			
Helena and Aurora Range (incl. Bungalbin Hill)^	Bungalbin Hill/Aurora	Portman Iron Ore Ltd Polaris Metals NL	Exploration -
Cashmere Downs*	Cashmere Downs	Midwest Corporation Mabrouk Minerals	Exploration Exploration
Diemals / Die Hardy Range*	Evanston Johnston Range	Polaris Metals NL	Exploration
		Leviathan Resources	-
		Polaris Metals NL Golden State	Exploration -
Finnerty Range	Mt Finnerty	Reed Resources Portman Iron Ore Ltd	Exploration -
Jack Hills (incl. Mt Hale, Gould, Taylor) *	Stage 1 Stage 2 Jack Hills	Murchison Metals Murchison Metals Midwest Corporation	Approved Feasibility study Exploration
Koolanooka Hills (incl. Perenjori Hills)*	Removal stockpiled fines Koolanooka Magnetite Koolanooka DSO Hematite Koolanooka South	Midwest Corporation Midwest Corporation Sinosteel Corporation Midwest Corporation	Approved Re-appraisal -
	Feral Prospect	Asia Iron Holdings Red River Resources Devereux Syndicate	Assessment (scoping) Exploration Exploration
Koolyanobbing Range	Koolyanobbing	Portman Iron Ore Ltd	Approved
Lake Austin			
Lake Giles*	Lake Giles	MacArthur	Exploration

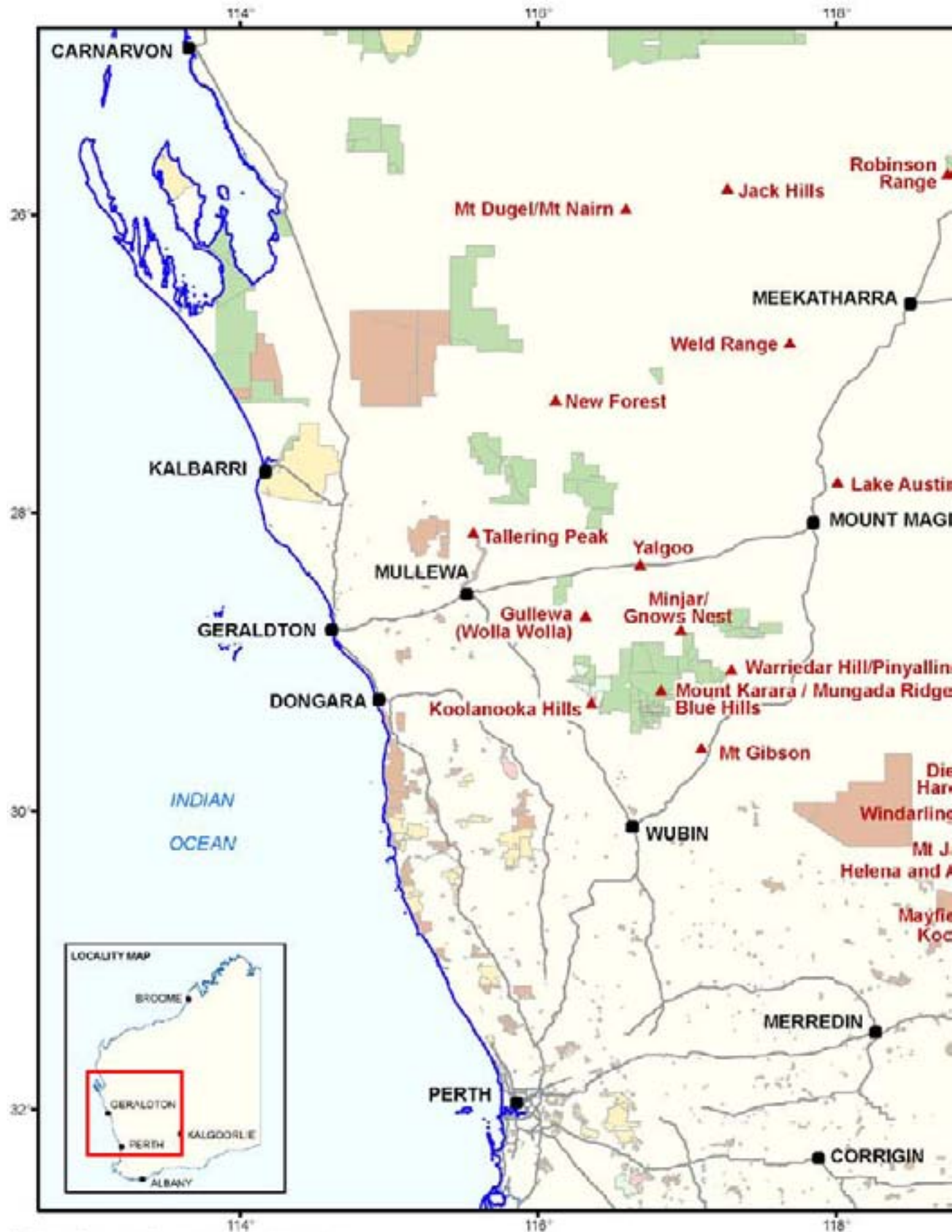
Mayfield	Bullfinch North	Portman Iron Ore Ltd Polaris Metals NL	Exploration -
Mt Dimer			
Mt Dugel/Mt Nairn*			
Mt Gibson* ^	Extension Hill Mt Gibson Extension	Mt Gibson Iron Ltd Asia Iron Holdings Accent Resources Mawson West	Approved - Exploration -
Mt Jackson^	J1	Portman Iron Ore Ltd	Approved
Mt Manning^		Polaris Metals NL	Exploration
New Forest (inc Twin Peaks)	New Forest	Midwest Corporation	Exploration
Perrinvale/Walling Range (incl. Lake Barlee, Brooking Hills and Mt Mason/Mt Hope)*	Mt Ida/Mt Mason/ Mt Hope	Minerals Jupiter Mines Ltd	Exploration
Robinson Range*	Robinson Range	Midwest Corporation	Exploration
Tallering Peak	Tallering Peak Tallering East	Mt Gibson Iron Ltd Royal Resources	Approved Exploration
Weld Range*	Weld Range Weld Range Hematite	Murchison Metals Midwest Corporation Sinosteel Corporation	Exploration Proposal in development -
Wiluna West*	Wiluna West	Golden West Resources	Proposal in development
Windarling Range ^	Windarling	Portman Iron Ore Ltd	Approved
Wolla Wolla/ Gullewa*	Gullewa Wolla Wolla	Batavia Minerals Asia Iron Holdings	Exploration Exploration
Yalgoo*	Yalgoo Iron	Ferrowest Pty Ltd Comet Resources Ltd	Exploration -

* DEC Regional Flora Survey

^ Case Study Range for DEC Strategic Review

For these ranges, the degree of available biological information varies markedly. The DEC regional flora survey has contributed greatly to knowledge of floristic values in targeted BIF ranges, as has survey work completed by proponents at a project specific level of detail.

Map 1. Banded ironstone formation ranges of the Midwest and Goldfields Regions.



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 DEW Map 1991/11_1_1 Topics: geology 1 September 2007



DEC REGIONS

- Goldfields
- Midwest
- Pilbara
- South Coast
- Swan
- Wheatbelt

TOPOGRAPHIC FEATURES

- Centroid of project area
- Locality
- IBRA region
- Yalgoo (Edel)** IBRA region name; subregion name



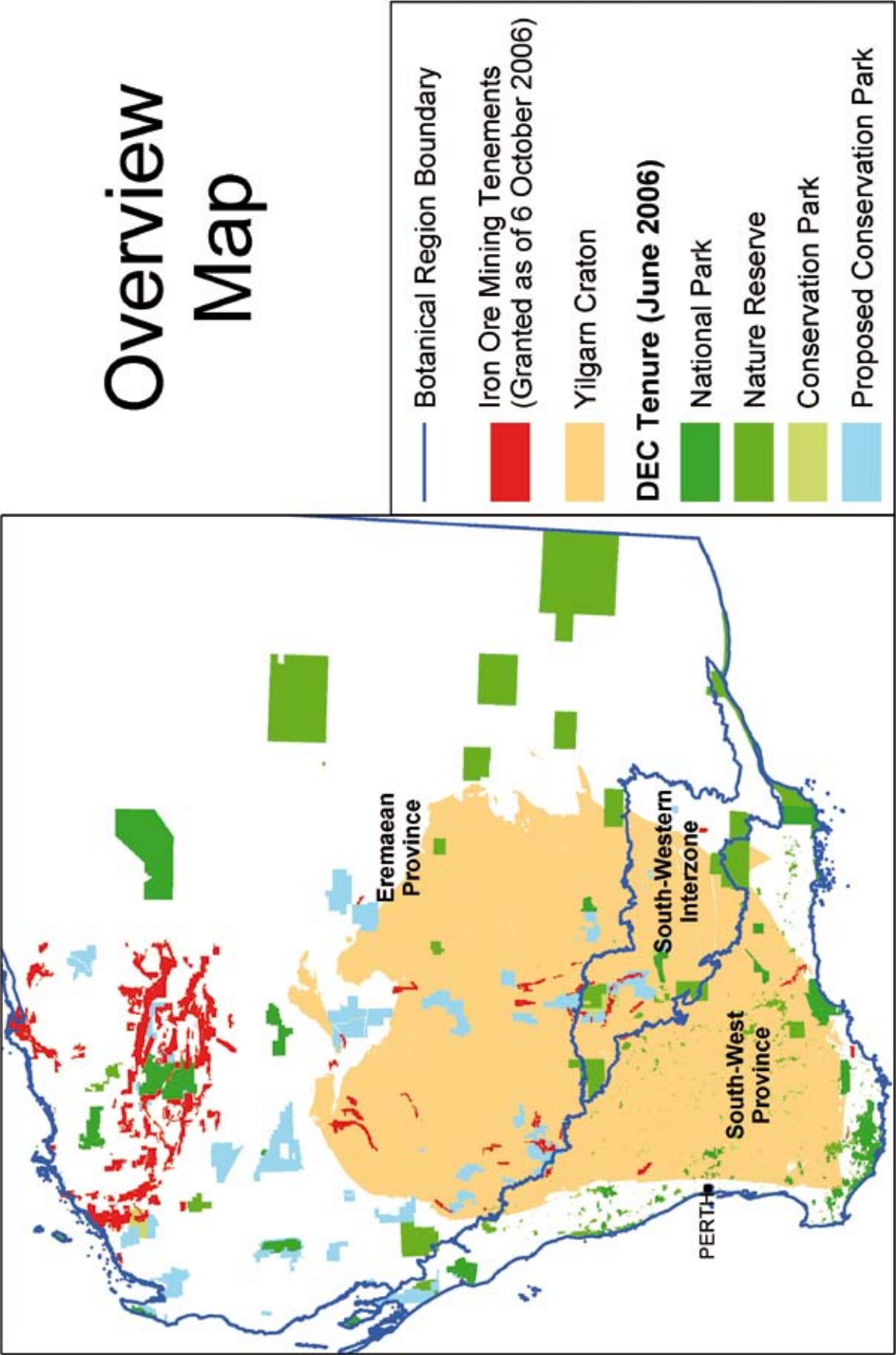
Produced by the GIS Section
under the direction of Krisian McNamara
Director General, Department of
Environment and Conservation

DATA DICTIONARY		
Field	Field Name	Date
IBRA	IBRA	2009
IBRA Subregion	IBRA Subregion	2009
IBRA Locality	IBRA Locality	2007
IBRA Centroid	IBRA Centroid	2007

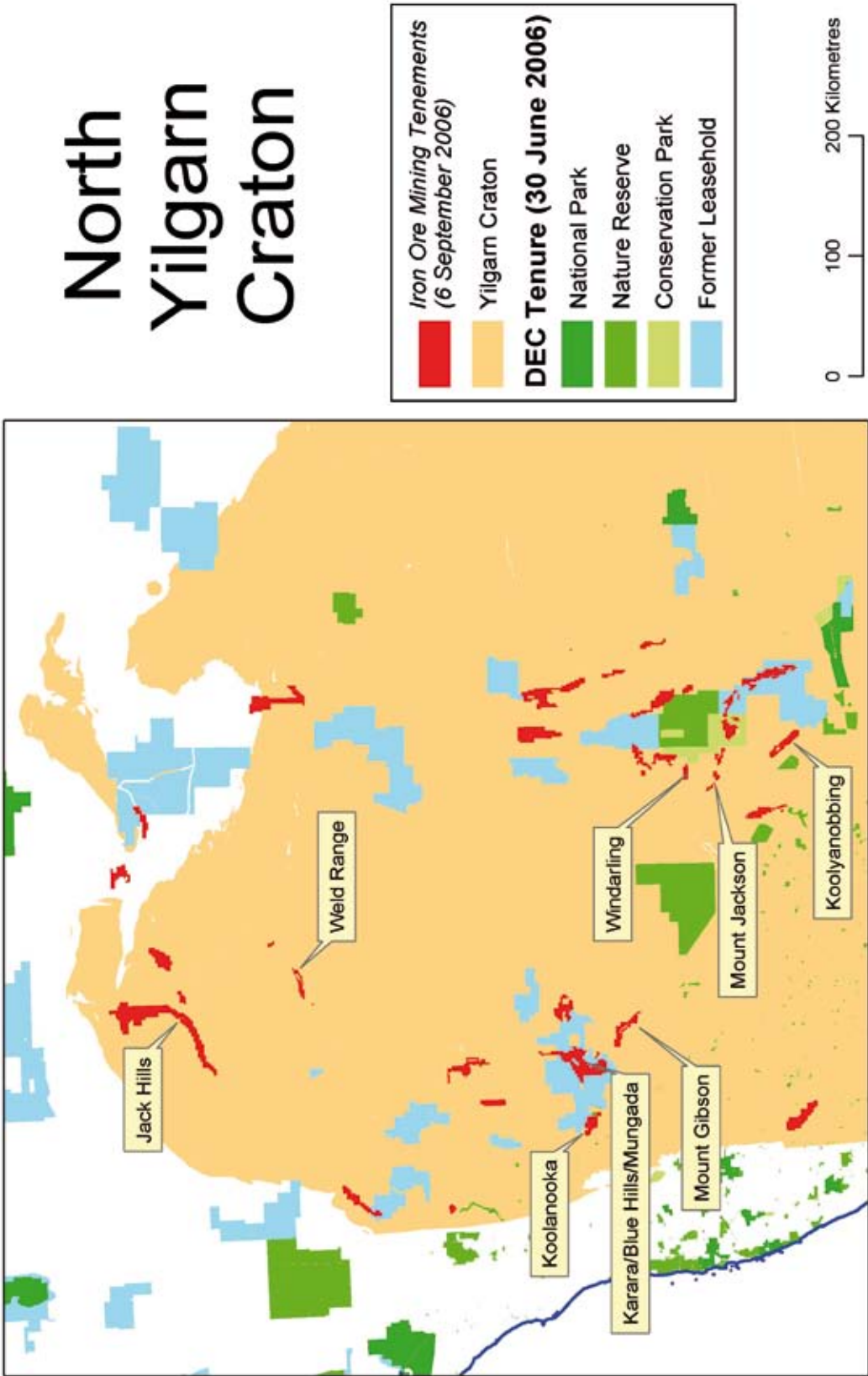
BANDED IRONSTONE FORMATION RANGE OCCURRENCE IN DEC AND IBRA REGIONS

Map 3. The Yilgarn Craton in southern Western Australia.

Overview Map



Map 4. The Banded ironstone formation ranges in the North Yilgarn Craton.



2. Policy context for biodiversity conservation in Western Australia

The recommendations made within this report must necessarily be framed with reference to State, national and international policies and agreements for biodiversity conservation including the Convention on Biological Diversity, the National Strategy for the Conservation of Australia's Biological Diversity, the Australian Guidelines for Establishing the National Reserve System and the draft Biodiversity Conservation Strategy for Western Australia. These include key principles for biodiversity conservation at the scales of genetic, species and ecosystem variation, a key aspect of which is the need for the development of a comprehensive, adequate and representative (CAR) conservation reserve system. This is because conservation of biodiversity at these scales requires the maintenance of a diversity of habitats and ecological processes at various spatial scales, ranging from entire vegetated landscapes to specific localised habitats and ecological communities.

2.1 International agreements, policy commitments and trends

The Convention on Biological Diversity (CBD)

The Convention was opened for signature at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, in June 1992 and entered into force on 29 December 1993. A total of 187 countries and the European Community have subscribed to it, representing a nearly universal participation. Australia is a signatory.

The objectives of the Convention are stated as follows.

"The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of

relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding."

The Convention defines 'biological diversity' as:

"the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems."

The CBD defines 'protected area' as:

"a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives."

The CBD also defines 'ecosystem' as:

"a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit."

Article 6 of the CBD requires each signatory country to:

"(a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned; and

(b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies."

The CBD requires signatories to undertake a range of measures to protect and conserve biodiversity, including;

- "establishing a system of protected areas to conserve biodiversity;
- developing guidelines for the selection, establishment and management of protected areas; and
- promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species."

Conferences of the Parties to the Convention have agreed to a range of measures to assist with the implementation of the Convention including a commitment to achieve a 2010 Biodiversity Target. This seeks to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level, as a contribution to poverty alleviation and to the benefit of all life on earth (IUCN 2002b).

The Parties identified focal areas such as:

- Reduce the rate of loss of the components of biodiversity, including:
 - (i) biomes, habitats and ecosystems;
 - (ii) species and populations; and
 - (iii) genetic diversity;
- Promote sustainable use of biodiversity; and
- Address the major threats to biodiversity.

The Parties have also agreed to establish goals and sub-targets, including:

- Goal 1: Promote the conservation of the biological diversity of ecosystems, habitats and biomes;
 - Target 1.1: At least 10% of each of the world's ecological regions effectively conserved.
 - Target 1.2: Areas of particular importance to biodiversity protected.
- Goal 2: Promote the conservation of species diversity;
 - Target 2.1: Restore, maintain, or reduce the decline of populations of species of selected taxonomic groups.
 - Target 2.2: Status of threatened species improved.
- Goal 3: Promote the conservation of genetic diversity;
- Goal 4: Promote sustainable use and consumption; and
- Goal 5: Pressures from habitat loss, land use change and degradation, and unsustainable water use, reduced.

The "Fourth Congress on National Parks and Protected Areas: Parks for Life", was held in Caracas in 1992. The Caracas Action Plan was produced as a result of this forum, providing a global framework for collective action for protected area management. This plan identified the goal "To extend the PA [Protected Area] network to cover at least 10% of each major biome".

The IUCN Protected Areas Programme

Australia is a member of IUCN (the World Conservation Union) which brings together 83 States, 110 government agencies, more than 800 non-governmental organizations, and some 10,000 scientists and experts from 181 countries in a unique worldwide partnership.

The World Commission on Protected Areas (WCPA) is the world's premier network of protected area expertise. It is administered by IUCN's Programme on Protected Areas and has over 1,200 members, spanning 140 countries.

The IUCN has made the following statement about protected areas:

"The world's protected areas are the greatest legacy we can leave to future generations - to ensure that our descendants have access to nature and all the material and spiritual wealth that it represents."

The IUCN defines a protected area as:

"an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means."

The IUCN estimates that protected areas cover over 13% of the earth's land surface (WCPA Strategic Plan 2005-2012) and has set a key target for all members countries to have "a system of protected areas representing all the world's ecosystems in place" (by the 6th IUCN World Parks Congress, scheduled for 2012).

The 'Brundtland Report'

In 1987 the World Commission on Environment and Development, in a report titled *Our Common Future* (the Brundtland Report), recognised that sustainable development meant adopting lifestyles within the planet's means. The report clearly identified that the current patterns of economic growth could not be sustained without significant changes in attitudes and actions.

Australia's response has been to adopt and further refine the concept of sustainable development, taking

into account our unique natural environment, the aspirations and values of the Australian people and the prevailing patterns of economic production and consumption. The result is the concept of Ecologically Sustainable Development (ESD).

Millennium Ecosystem Assessment

In 2000 United Nations Secretary-General Kofi Annan called for a global ecosystem assessment as a Millennium Ecosystem Assessment (MA). This was to be one of five major initiatives for “Sustaining our Future” put forward in his Millennium Report to the United Nations General Assembly. The MA was initiated in 2001 to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of ecosystems and their contribution to human well-being.

The MA was completed in 2005 and involved more than 1,360 experts worldwide, with 5 technical volumes and 6 synthesis reports published. The main findings of the MA have been summarised by the MA team (2005) as follows.

- *“Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth.*
- *The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.*
- *The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals.*
- *The challenge of reversing the degradation of ecosystem while meeting increasing demands for services can be partially met under some*

scenarios considered by the MA, but will involve significant changes in policies, institutions and practices that are not currently under way. Many options exist to conserve or enhance specific ecosystem services in ways that reduce negative trade-offs or that provide positive synergies with other ecosystem services.”

The MA reported in the ‘Ecosystems and Human Well-being Biodiversity Synthesis’ (2005) that “Protected areas are an extremely important part of programs to conserve biodiversity and ecosystems, especially for sensitive habitats.”

Internationally, the trend over the past 20 years has been to recognise that biodiversity conservation is fundamental to the well being of people and for the future of the planet. The MA above summed this up as follows.

“Biodiversity forms the foundation of the vast array of ecosystem services that critically contribute to human well-being” and “Decisions humans make that influence biodiversity affect the well-being of themselves and others.”

2.2 Australian policy and agreements

2.2.1 National agreements

National Strategy for Ecologically Sustainable Development

The conservation of biological diversity is the cornerstone of ecologically sustainable development and is one of the three core objectives of the National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development Steering Committee 1992):

- to enhance individual and community wellbeing and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations; and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

The Strategy discusses the fact that biological diversity is considered at three levels:

- genetic diversity: the variety of genetic information contained in all of the individual plants, animals and microorganisms that inhabit the earth. Genetic diversity occurs within and between the populations of organisms that comprise individual species as well as among species;
- species diversity: the variety of species on the earth; and
- ecosystem diversity: the variety of habitats, biotic communities and ecological processes.

National Strategy for Conservation of Australia's Biological Diversity

The *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996) has been produced in partial fulfillment of Australia's obligations under the Convention of Biological Diversity. It outlines that biological diversity is best conserved in situ, and it is vital to anticipate, prevent and address at the source the causes of significant reduction or loss of biological diversity.

The National Strategy has been signed by the Commonwealth and all State and Territory Governments, and includes the following key objectives:

"Establish and manage a comprehensive, adequate and representative system of protected areas covering Australia's biodiversity."

and

"Enable Australia's species and ecological communities threatened with extinction to survive and thrive in their natural habitats and to retain their genetic diversity and potential for evolutionary development, and prevent additional species and ecological communities from becoming threatened."

The principles from the National Strategy recognise that:

"Central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including

agricultural and other resource production areas."

In addition to the National Strategy, the Commonwealth and States developed the National Objectives and Targets for Biodiversity Conservation (2001). Refer to Section 2.2.5 for further information on this policy.

2.2.2 Selecting protected areas

Australian Guidelines for Establishing the National Reserve System

The establishment of a CAR system of reserves is a priority activity for the National Reserve System (NRS) Program being administered by the Australian Government Department of the Environment and Water Resources through the Natural Heritage Trust (NHT). Guidelines for this process were developed by the National Reserve System Scientific Taskforce of the Australian and New Zealand Environment and Conservation Council (ANZECC).

The terms "comprehensive", "adequate" and "representative" (CAR) together describe the attributes of an optimal conservation reserve system. The Australian Guidelines for Establishing the National Reserve System (Commonwealth of Australia 1999) describe these terms as:

- **Comprehensiveness:** to include the full range of regional ecosystems recognised at an appropriate scale within and across each bioregion.
- **Adequacy:** to provide reservation of each ecosystem to the level necessary to provide ecological viability and integrity.
- **Representativeness:** areas selected for inclusion in the NRS should reasonably reflect the intrinsic variability of the ecosystems they represent.

In addition to explaining the CAR concept, the Guidelines outline the following principles for the development of a National Reserve System:

- **Threat:** selection of priority additions to the NRS will be based primarily on principles of comprehensiveness, viability and vulnerability to loss. Priority will be given to the addition to the reserve system of ecosystems where there is a high risk of loss and which may foreclose future options for the conservation of biodiversity within the region.
- **Precautionary Principle:** the absence of scientific

certainty is not a reason to postpone measures to establish protected areas which contribute to a comprehensive, adequate and representative national reserve system.

- Landscape context: the protected area system should maximise biodiversity conservation outcomes through the application of scientifically robust reserve design principles.
- Management: it is recognised that regional biodiversity conservation requires a mix of management strategies. These would include statutory protected areas and incentives that encourage voluntary partnerships for off-reserve conservation. Public and private protected areas would include covenanting arrangements, as well as conservation management measures and guidelines for ecologically sustainable land management.
- Decision making: decision making processes should effectively integrate both long term and short term environmental, economic, social and equity considerations. The Guidelines endorse the principle of 'least cost', where an optimal reserve configuration can be established with the minimal economic and social cost to the community.

The NRS Guidelines aim for the reserve system to include samples of all ecosystems identified at an appropriate regional scale. To achieve this, the ecological requirements of rare or threatened species and ecological communities and ecosystems, organisms with specialised habitat requirements and species vulnerable to threatening processes, require particular consideration.

The number of individuals (and hence area) needed for the long-term conservation of species varies appreciably between organisms. The criterion of adequacy can be considered by aiming to conserve at least a substantial proportion of the extent of every ecosystem. As a general rule, the greater the extent reserved, the more likely that the ecological functioning and species composition of an ecosystem will be maintained. However, some ecosystems are much more threatened and less resilient than others and these may need higher levels of and more urgent protection. The principle to apply is that ecosystems are represented within the protected area network at more than one site, hence providing some greater

safeguard against catastrophic events.

Directions for the National Reserve System

In 2005 the Natural Resource Management Ministerial Council released Directions for the National Reserve System: A Partnership Approach. The document was prepared to assist government agencies, non-government organisations and the community in the ongoing development of a common approach to the strategic planning and design, establishment and management of the National Reserve System.

The Directions Statement outlines how bioregions and subregions are used as a basis for assessing gaps and identifying priorities in the current reserve system and presents a standard approach to the establishment of protected areas, according to IUCN categories. The 'Directions' provided in this document include:

- Examples of at least 80% of the number of extant regional ecosystems in each IBRA region are to be represented in the NRS.
- As a priority, critically endangered and endangered species and regional ecosystems in each IBRA subregion are included in the NRS by 2010.
- Significant progress is made towards inclusion of vulnerable species and regional ecosystems in each IBRA region in the NRS.

2.2.3 Australian Terrestrial Biodiversity Assessment

The Interim Biogeographic Regionalisation for Australia (IBRA) was endorsed by ANZECC in 1995 and is widely used as a framework for implementing conservation planning and policy processes. IBRA combines climate, lithology and geology, landform, vegetation, flora and fauna and other data available, to determine 85 biogeographic regions for Australia (Thackway and Cresswell 1995). In 2002 the National Land and Water Resources Audit developed an Australia wide information set on terrestrial biodiversity values. The report uses IBRA bioregions as the framework for the assessment and assesses the condition and trend of wetlands, riparian zones, threatened species and ecosystems and the processes that threaten various elements of biodiversity.

The report found that 42 of Australia's bioregions (approximately half) are a high priority for further reservation actions to ensure Australia has a CAR

system of protected areas. These bioregions were assessed as being poorly reserved (less than 5%) and/or under significant threat leading to the irreversible loss of opportunities for a fully CAR reserve system. Bioregional priorities for consolidating Australia's protected area system were given on a scale of 1 to 5 (1 being the highest priority). It was acknowledged that within these bioregions, some may have particular reservation needs due to a disproportionate level of threat or the number of ecosystems or species requiring protection through reservation.

2.2.4 National Criteria for a CAR Forest Reserve System

The Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia (Commonwealth of Australia 1997) is a joint report by ANZECC and the Ministerial Council on Forestry, Fisheries and Aquaculture National Forest Policy Statement Implementation Sub-Committee. The report, known as the 'Janis Report', was designed to guide the implementation of one element of the National Forest Policy Statement (1992) by establishing nationally agreed criteria for a conservation reserve system for forests. This included Criterion (1):

"As a general criterion, 15% of the pre-1750 distribution of each forest ecosystem should be protected in the CAR reserve system with the flexibility considerations applied according to regional circumstances, and recognizing that as far as possible and practicable, the proportion of Dedicated Reserves should be maximised."

The report acknowledges that flexibility is required when applying the CAR reserve criteria in the light of social and economic factors. The report states that:

"Reductions in the 15% criterion may also be appropriate on a case by case basis where biodiversity conservation objectives can be demonstrated to be met by a lesser area, for example where a forest ecosystem is extensive and relatively uniform or where a forest ecosystem is subject to low intensity use

and has demonstrated resilience and stability."

The Janis Report goes on to state in Criterion (2):

"Where forest ecosystems are recognised as vulnerable, then at least 60% of their remaining extent should be reserved. A vulnerable forest ecosystem is one which is:

- i) approaching a reduction in areal extent of 70% within a biogeographical context and which remain subject to threatening processes; or
- ii) not depleted but subject to continuing and significant threatening processes which may reduce its extent."

The Janis Report states in Criterion (3):

"All remaining occurrences of rare and endangered forest ecosystems should be reserved or protected by other means as far as is practicable."

The report defines a rare ecosystem as one where the geographic distribution is over a total range of less than 10,000 ha, a total area of less than 1,000ha, or patch sizes less than 100 ha, where the patches do not aggregate to significant areas. This approach acknowledges that application is within a bioregional context, i.e. the need to recognise distribution of the ecosystem in adjoining bioregions. The report also defines an endangered ecosystem as one where its distribution has contracted to less than 10% of its former range, or the total area has contracted to less than 10% of its former area, or 90% of its area is in small patches which are subject to threatening processes and are unlikely to persist.

The remaining biodiversity criteria provided in the Janis Report are:

(4) "Reserved areas should be replicated across the geographic range of the forest ecosystem to decrease the likelihood that chance events such as wildfire or disease will cause the forest ecosystem to decline.

(5) The reserve system should seek to maximise the area of high quality habitat for all known elements of biodiversity wherever practicable, but with particular reference to:

- the special needs of rare, vulnerable or endangered species;
- special groups of organisms, for example

species with complex habitat requirements, or migratory or mobile species;

- areas of high species diversity, natural refugia for flora and fauna, and centres of endemism; and
- those species whose distributions and habitat requirements are not well correlated with any particular forest ecosystem.

(6) Reserves should be large enough to sustain the viability, quality and integrity of populations.

(7) To ensure representativeness, the reserve system should, as far as possible, sample the full range of biological variation within each forest ecosystem, by sampling the range of environmental variation typical of its geographic range and sampling its range of successional stages.

(8) In fragmented landscapes, remnants that contribute to sampling the full range of biodiversity are vital parts of a forest reserve system. The areas should be identified and protected as part of the development of integrated regional conservation strategies.”

2.2.5 National objectives and targets for biodiversity conservation

Australia recognised the importance of biodiversity conservation in 1996 with the formal adoption of the National Strategy for the Conservation of Australia’s Biological Diversity (Commonwealth of Australia 1996). A review of this report was completed in 2000, which found that despite significant advances in some areas, a number of objectives had not been achieved. To address this, the National Objectives and Targets for Biodiversity Conservation 2001 – 2005 (Commonwealth of Australia 2001) were developed. Western Australia is a signatory to the document.

This action includes the following targets:

- (by 2001) prevent the decline in the conservation status of native vegetation communities as a result of land clearance;
- (by 2003) have clearing controls in place that prevent clearance of ecological communities with an extent below 30 per cent of that present pre-1750;
- By 2005, a representative sample of each bioregion (as specified by the ANZECC action plan)

is protected within the National Reserve System or network of Indigenous Protected Areas or as private land managed for conservation under a conservation agreement; and

- (by 2003) effective incentive mechanisms, targeted to bioregions, provinces and/or catchments, to support the protection of unreserved biodiversity and all threatened ecosystems.

2.3 Western Australian biodiversity conservation policy and planning

State Sustainability Strategy

The Western Australian State Sustainability Strategy (2003) outlines a vision that:

“Western Australia is contributing to global biodiversity targets to ensure that it has a comprehensive, adequate, and representative and integrated terrestrial, freshwater, estuarine and marine conservation reserve system. Functioning land and seascapes will be conserved and protected, by ensuring that off-reserve conservation areas complement the conservation reserve system and that the intervening matrix of different land use is managed so as to minimise threatening processes.”

The Strategy includes the following objectives:

- To establish a CAR marine and terrestrial reserve system in WA.
- To ensure the effective management of conservation reserves and other recognised special biodiversity conservation areas.
- To ensure the protection and recovery of species and ecological communities that are threatened or in need of special protection.
- To conserve landscape/seascape scale ecological systems.

The Strategy also provides the following actions:

- Continue to identify and acquire land for addition to the terrestrial conservation reserve system so that it is comprehensive, adequate and representative.
- Implement within the State, Australia’s international commitments on environmental protection and biodiversity, and establish a long-

term monitoring and reporting program to demonstrate that the State is fulfilling its global biodiversity conservation obligations.

- Continue to meet global biodiversity conservation objectives and targets to which the State is a signatory.
- Account for biodiversity conservation in all land-use planning, where clearing of native vegetation is involved, and management decisions in WA.
- Ensure that mechanisms are in place for the identification, protection and recovery of WA's threatened and specially protected biota.
- Ensure that all landholders, managers and project proponents take into account the requirements for biodiversity and conservation as a standard and vital component of their planning and management activities.

Better Planning: Better Futures

The WA Department of the Premier and Cabinet produced in 2006 *Better Planning: Better Futures: A Framework for the Strategic Management of the Western Australian Public Sector*. This document details a number of strategic outcomes, including:

- Strategic Outcome 3.2: Biodiversity and ecosystems that are well maintained.
 - The future of Western Australia's unique ecosystems depends upon maintaining our natural assets so that ecosystems and biodiversity are protected. To preserve ecosystems and protect our biodiversity, people need to understand and appreciate its importance, so that all individuals, business and government can contribute to its protection.
- Strategic Outcome 3.4: World class national parks, marine parks and conservation reserves.
 - Western Australia has an international reputation for its unique natural environment. This fragile environment requires careful management to ensure it is accessible, while being preserved for future generations. Identification and protection of our natural heritage connects the environment with our social and cultural heritage.
- Strategic Outcome 4.3: The regional environment is valued and protected.
 - The sustainable management of regional natural resources benefits all stakeholders. Environmental performance across a range of

land uses will be improved and greater participation of Indigenous people in natural resource management will be sought. Areas of natural and built heritage must be conserved and restored.

The State Reservation Process

Several State initiatives have been in place over the last decade that provide guidance on objectives and criteria for reservation processes at a State level. In 1997 the Gascoyne-Murchison Rangeland Strategy, endorsed by Cabinet, stated that:

“it is estimated that 10 to 15 per cent of the Gascoyne-Murchison area will need to be in the reserve system to meet the national criteria.”

The 1998 State of the Environment Report for Western Australia included an objective to:

“ensure that by the year 2010, all ecosystems within WA are adequately and comprehensively represented in the conservation reserve system and appropriately managed to ensure their viability.”

In 1999 the State Government policy *Managing the Rangelands*, included a commitment to protect the environment by:

“identifying and establishing a comprehensive,, adequate and representative conservation reserve system, representing the full range of land forms and biological communities.”

State Cabinet considered the issue of the establishment of a CAR terrestrial conservation reserve system in December 2002 and noted that WA's present terrestrial conservation reserve system does not meet the criteria of comprehensiveness, adequacy and representativeness. Cabinet endorsed a policy (CALM 2003) for the Department of Conservation and Land Management (now Department of Environment and Conservation) to establish a CAR reserve system for WA.

Draft Biodiversity Conservation Strategy for Western Australia

In 2006 the Department of Environment and Conservation produced a draft document titled 'A 100 year Biodiversity Conservation Strategy for Western Australia: Blueprint to the Bicentenary in 2029'. This

draft strategy included a key target of completing the terrestrial and marine conservation reserve system to meet the requirements of comprehensiveness, adequacy and representativeness, including coverage of at least 15 per cent of the State's land area, as well as a network of sanctuary zones in marine parks and reserves that are representative of the full range of habitats, and management of the reserve system to best practice standards.

The draft strategy explains that biodiversity is also likely to have values that are unknown to us today but will present options for future Western Australians, and these opportunities must be protected through the use of precautionary approaches to minimise impacts from today's activities. Conservation of species where they occur (and not just in a botanic garden, zoo or laboratory) is a prerequisite for maintaining ecological and evolutionary processes. Consequently, a central pillar of biodiversity conservation is the establishment of a conservation reserve system that provides security of tenure and purpose in perpetuity, and management of other natural systems.

EPA Policy – Protection of Native Vegetation

A protection level of 30% is increasingly being recognised as the required level of protection of an ecosystem or vegetation community type (pre-European settlement). As discussed in the EPA's Position Statement No. 2 Environmental Protection of Native Vegetation in Western Australia, when assessing a proposal, the EPA's consideration of biological diversity includes the following element: "There would be an expectation that a proposal would demonstrate that the vegetation removal would not compromise any vegetation type by taking it below the 'threshold level' of 30% of the pre-clearing extent of the vegetation type."

Policy Statement No. 2 indicates the goal of the Bushcare Program of the Natural Heritage Trust Partnership Agreements is to reverse the long-term decline in the quality and extent of Australia's native vegetation cover. Important aspects of this goal are stated as:

- no clearing of endangered ecological communities;
- no clearing that would change the conservation status of a community; and
- limit further broadscale clearing to those instances which do not compromise regional biodiversity objectives.

The Policy Statement goes on to discuss that from a purely biodiversity perspective, there are several key criteria now being applied in States where clearing is occurring:

- the "threshold level" below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at a level of 30% of the pre-clearing extent of the vegetation type;
- a level of 10% of the original extent is regarded as being a level representing "endangered"; and
- clearing which would put the threat level into the class below should be avoided.

2.4 Industry policy

The International Council on Mining and Metals (ICMM) has developed a set of 10 Principles for sustainable development performance. The value of biodiversity is demonstrated in Principle No. 7: "Contribute to conservation of biodiversity and integrated approaches to land use planning.

- Respect legally designated protected areas.
- Disseminate scientific data on and promote practices and experiences in biodiversity assessment and management.
- Support the development and implementation of scientifically sound, inclusive and transparent procedures for integrated approaches to land use planning, biodiversity, conservation and mining."

The third dot point above is particularly relevant to the approach that will need to be taken with regard the Midwest BIFs. The ICMM has also developed a Position Statement on Mining and Protected Areas. It includes a number of Recognition Statements, of which the following provide guidance relevant to this review:

"(2)...other avenues are being actively pursued to enhance contributions to biodiversity conservation, including assessments and conservation of unique flora and fauna, research and development and supporting protected area site management programmes.

(3) ICMM members recognise the role of properly designated and managed protected

area in in situ conservation strategies.

(4) Comprehensive and representative lists of various types of designated protected areas are important to ensure that ecosystems, habitats and species are protected from damage and loss, particularly those which are remarkable in terms of richness, rarity, sensitivity and are relatively unmodified by human influence.

(5) ICMM members further recognise that, in some cases, exploration and mining development may be incompatible with the objectives for which areas are designated for protection, even after all technically and economically feasible steps to reduce adverse impacts have been considered.

(6) National and global systems for the evaluation, designation, classification and management of areas listed for protection are needed to ensure consistency of approach to land access decisions.”

At the national level, the Minerals Council of Australia, the peak group representing Australia’s exploration, mining and minerals processing industry, has endorsed the ICMM’s 10 Principles for sustainable development performance, and has listed the 10 Principles and the 46 elements that underpin the Principles in its framework for sustainable development *Enduring Value* (Minerals Council of Australia 2004). The *Enduring Value* policy commits to operationalising the ICMM sustainable development framework through the identification and description of implementation guidance. Member companies of the Minerals Council of Australia are required to commit to *Enduring Value*, including the progressive implementation of the ICMM Principles and Elements.

2.5 Current reservation levels and processes in Western Australia

At 30 June 2007 the State’s terrestrial conservation reserve system covered 17,443,801 hectares or 6.9 percent of WA’s land area. This figure does not meet the benchmark of around 15 percent considered necessary to meet nationally agreed criteria for comprehensiveness, adequacy and representativeness for the reserve system. Nationally,

WA, along with Queensland and the Northern Territory, has the least percentage of their land area within the protected area system.

On 2 December 2002, Cabinet noted that the terrestrial conservation reserve system in Western Australia did not meet CAR criteria, and endorsed a policy proposal, *Establishment of a Comprehensive, Adequate and Representative Terrestrial Conservation Reserve System in Western Australia*, to establish a CAR conservation reserve system in line with the national objectives and targets.

Cabinet further directed relevant State agencies to give priority attention to establishing the new national parks promised in the Government’s *Protecting our old-growth forests* policy, which is in line with the Forest Management Plan (2004-2013) objective to establish a forest conservation reserve system that ‘meets world’s best standards in terms of comprehensiveness, adequacy and representativeness’. The Regional Forest Agreement process aimed to ensure that species that are threatened were assessed for priority inclusion in the reserve system, as were areas important for disjunct and relictual populations, and centres for flora endemism and species richness.

The State Government also provided direction at this time regarding the conversion of pastoral leases already purchased by the Government for formal conservation reserve purposes. The intention of Cabinet in relation to the reservation category of the pastoral leases at that time was to establish some areas as extensions to Kennedy Range and Karijini National Parks with other areas generally to be established as conservation parks.

More generally the State Government has, over a number of years, purchased land through the former Department of Conservation and Land Management (now DEC), to add to the reserve system. As outlined in *Establishment of a Comprehensive, Adequate and Representative Terrestrial Conservation Reserve System in Western Australia* (2003) this has included the whole or parts of former pastoral leases, covering a total area of over five million hectares, with the majority being within the Midwest (Gascoyne Murchison) region as a consequence of the ecological systems within these areas having extremely poor

representation in the reserve system. The lands were selected for purchase because of their high conservation value, including vegetation types and ecosystems not represented or poorly represented in the existing reserve system.

3. Biodiversity conservation in the Midwest region

The Midwest region BIFs, in the context of this review, encompasses three IBRA bioregions – Murchison, Yalgoo and Avon Wheatbelt. The Murchison and Avon Wheatbelt bioregions were assessed as part of the Australian Terrestrial Biodiversity Assessment (2002) as Reservation Priority 1 (Highest) and Yalgoo as Reservation Priority 3 (Medium).

The region in which the Midwest BIFs are found is particularly inadequately represented according to CAR reserve system criteria. BIF ranges occur largely within the Murchison Bioregion, of which only 1.1 % is represented in the conservation reserve system. A portion also occurs in the Yalgoo and Avon Bioregions, with 9.8 % of the Yalgoo Bioregion and only 1.7 % of the Avon Bioregion represented in the conservation reserve system. These are all significantly less than the 15% that is increasingly seen as the benchmark figure.

The Midwest BIF ranges themselves are very poorly represented in the State's reserve system. None of the banded ironstone ranges in the Midwest region that are discussed in this report are represented in A-class conservation reserves. Mt Karara has been purchased by the State Government for inclusion in the conservation reserve system, however the area is now subject to mining proposals and reservation has not progressed.

Prior to this strategic review commencing, the plans for reservation as they relate to BIFs and potential resource development can be described as follows:

- As part of the Government decision to allow the Koolyanobbing Iron Ore Expansion to proceed, the State is progressing the extension of conservation park over a number of BIFs in the Mt Manning area (except where granted mining leases occur);
- The Government has purchased pastoral leases for conservation under the Gascoyne Murchison Strategy. The former Karara pastoral lease is

a notable example of a proposed reserve (conservation park) which has proposed mining of BIF;

- There is also a longstanding proposal for reservation of the area of a TEC in the Koolanooka Hills as this area has no protection at present;
- DEC is aware that BIF is present on Thundelarra pastoral station which has been purchased by the Department for conservation purposes; and
- In the Goldfields region, the ex-pastoral lease Jaudi Station (including Mt Finnerty) and the proposed Ida Valley Mt Forrest conservation park have been purchased by DEC for conservation purposes – exploration is currently occurring at both sites by multiple companies.

It should be noted that the reservation of land as conservation park does not present a legal impediment to exploration and mining activities, subject to appropriate assessment of environmental impacts and best practice management of proposed projects. Any future decision to afford an area of biologically significant BIF a higher level of protection as a

result of this review, would require agreement for reservation for example as A class nature reserve or national park.

Any future reservation proposals and assessments will need to be made based on the appropriate level of site specific and regional biological data, according to recognised national and international criteria and acknowledging the need to balance environmental, social and economic impacts. These concepts are discussed further in this document.

4. Defining and assessing significant species and communities

An ecological community is defined as an assemblage of species occupying a particular area, identified through a combination of parameters including species composition, structure and habitat.

Plant communities are routinely defined by scientists in a number of ways. The most commonly used method for broadscale mapping is as structural



Tetratheca erubescens Photo – Geoff Cockerton

vegetation units (for example shrublands, forest and woodland) which may then be attributed by reference to the dominant taxa. This mapping can be undertaken at a variety of scales. To provide a more detailed analysis a plant community can be defined in terms of the composition of the vascular plants. In this report such plant communities are described as floristic community types and these units are generally defined by analysis of compositional pattern with plots of a standard size.

Vegetation mapping has long been used as one way to identify plant communities using the spatial variability in the structure of vegetation. Examples of this type of mapping are the 1:250,000 and 1:1,000,000 scale mapping undertaken by Beard across Western Australia. However, where very diverse and rapidly changing vegetation is encountered, then vegetation units based on the distribution of a few dominant species can be seriously misleading if these units are being used for conservation planning processes. Such fine-scale changes are also not readily distinguishable at the larger scale of mapping that has been previously undertaken.

Vegetation mapping or species assemblage models at regional or landscape levels are essentially 'coarse filter approaches' and need to be used with more 'fine filter' data for particular biodiversity assets such as threatened species or floristic communities (compositional units) whose distribution pattern may not be well correlated with the coarse scale mapping. A much more robust alternative for regional and finer scale biodiversity assessment is to use plot-based

biological survey.

Plot-based biological survey in WA is providing information for conservation planning at several different scales:

- Broadscale regional surveys provide species assemblage models to inform conservation (including reserve system design) planning decisions such as the Nullarbor, Kimberley rainforest, Carnarvon Basin, agricultural zone (Salinity Action Plan), and Pilbara biological surveys.
- Intermediate scale surveys that allow the identification of floristic communities within a particular part of the landscape and allow assessment of their significance in a regional context such as the Yilgarn BIF and Ravensthorpe range surveys.
- Fine scale sampling at a sub-regional level that allows the identification and mapping of floristic communities and assessment of their conservation value. A good example is the Swan Coastal Plain surveys (Gibson *et al.* 1994) that led to the identification of a number of TECs, allowing for their subsequent listing and made a significant contribution to Bush Forever outcomes.

The statistical techniques used by DEC scientists to analyse the data collected from the plots are commonly used for classifying plant communities throughout the world and have been published in peer reviewed scientific journals for the last 40 years. The interpretations and conclusions are scientifically rigorous and defensible in terms of contemporary ecological theory. Most of the current algorithms used in these multivariate analyses have their origins in the 1960's and 1970's and are now standard components of undergraduate courses across botany, zoology and marine science.

Broadscale survey and species assemblages

Where plot-based regional scale surveys are being undertaken sampling density is generally not sufficient to allow a comprehensive list of floristic communities (plot groups) to be identified. For example, on the Swan Coastal Plain 43 floristic communities were identified from 500 plots (Gibson *et al.* 1994). To achieve the same sampling density in the wheatbelt (Salinity Action Plan) survey would have required the establishment of 45,000 plots compared with the

1,500 established.

The analysis procedure in these regional scale surveys is to classify the species into groups based on similar occurrence patterns (generally referred to as assemblages), then model the distribution of these assemblages across the study area. The scale of pattern displayed in regional assemblages provides a robust basis for reserve planning but it is generally too broad for environmental assessment purposes.

Intermediate to fine scale survey and floristic communities

The identification of floristic communities is based on the classification of plots into groups with similar species composition. It relies on the establishment of a sufficient number of plots to reasonably cover the geology, geomorphology and floristic variability found in the study area. These floristic communities can then be used as the base planning units and have the advantage that any analysis is repeatable, can be analysed at a variety of scales and the classification can be refined as more data become available.

These approaches are particularly advantageous in the very diverse and rapidly changing vegetation systems in Western Australia where there is often little correlation between floristic communities (based on composition) and the coarser scale vegetation maps. In this case reliance on untested vegetation mapping for impact assessment would be unwise. The other significant advantage is that the concentrated collection effort often results in the discovery of new taxa, range extensions and the identification of new populations of threatened and priority taxa.

5. The conservation of significant species and communities

Internationally, conservation planning has increasingly focused at the community level rather than species level over the past 30 or so years. This is in recognition that the complex interactions between species and their habitats in ecosystems can be difficult to replicate and that species survival and biodiversity conservation often depend on the continuation of interactions across many species. Planning at the ecological community level is being used increasingly by conservation and planning bodies across Australia and world-wide.

Across Australia all nature conservation agencies focus increasingly on conserving ecosystems as ecological communities and their non-biological habitat requirements as the best and most sensible means of meeting the challenge of long-term (permanent) conservation of biodiversity.



ABOVE: *Tetratheca paynterae* habitat on Windarling Photo – Andrew Brown

LEFT: *Tetratheca aphylla* at Bungalbin Hill Photo – Ryonen Butcher

5.1 The significant species and communities process in Western Australia

Protection of species diversity is a well established concept, with State threatened species listing occurring under the *Wildlife Conservation Act 1950* since 1972 in the case of fauna, and 1980 in the case of flora. Genetic diversity is considered in the conservation of species, with conservation measures seeking to conserve the full range of a species' occurrence and forms. There are several examples where the EPA has assessed the acceptability of mining proposals in banded ironstone areas that impact on threatened flora, and these are discussed further in the case studies section of this document.

Before flora species are considered by the WA Threatened Species Scientific Committee (TSSC) for addition to the list of threatened flora (formally known as Declared Rare Flora under the *Wildlife Conservation Act 1950*), they need to satisfy the requirements that they are valid entities and have been adequately surveyed. This ensures there is a high level of confidence that any taxon listed as threatened flora is justifiably listed. Prior to consideration by the TSSC, flora species that appear to be rare or threatened are initially referred to the WA Herbarium for confirmation that they are considered to be valid taxa (this is mainly for new or undescribed taxa). Once accepted by the Herbarium, nominated taxa with limited survey are listed on the priority flora list under categories based on the known number of occurrences, and the relative protection of those occurrences. This provides a prioritisation of the species for the urgency of further survey work. Once a species has had sufficient survey work, and it is still considered to be rare or threatened, it may be nominated to the TSSC as threatened flora. If the nomination is supported by the TSSC it is referred to DEC for endorsement, prior to being referred to the Minister for the Environment for formal acceptance and listing as threatened flora in the Government Gazette.

Means to legislatively provide for the effective conservation of ecological communities and ecosystems have developed more recently than the species focus for conservation. There has, however,

been world-wide recognition and development of planning instruments to provide for this scale of conservation.

The Commonwealth has legislation in place through the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the listing and protection of threatened ecological communities (TECs), as do most other States, and it is proposed that complementary legislation will be developed in Western Australia, through the proposed Biodiversity Conservation Act, that is intended to replace the *Wildlife Conservation Act 1950*.

In recognition of the importance of ecosystem protection, an interim non-statutory process of listing TECs has been developed in Western Australia. This process involves the identification of potential TECs through the review of previous regional surveys and carrying out additional surveys to confirm the description, distribution and conservation status of communities. Proposed TECs are then referred to the WA Threatened Ecological Communities Scientific Committee (WATECSC), for assessment in an objective manner based on internationally agreed criteria (Appendix 1).

The WATECSC initially confirms that the community is described appropriately, and that it meets criteria for listing as 'threatened'. TEC nominations that are supported by the WATECSC are referred to DEC for endorsement, and if endorsed, are forwarded to the Minister for the Environment for approval. A number of State-listed TECs have also been referred to the Commonwealth Government, and have been listed under the EPBC Act following review at that level.

Floristic communities are a specific type of community that is described on the basis of the flora present rather than the fauna, or mix of flora and fauna. It should be noted that it does not necessarily follow that significant impacts on floristic communities would represent a fatal flaw to project development. However, strategies to avoid, reduce or mitigate impacts on restricted communities remain a very important factor for impact assessment. Further investigations into the role specific communities play in the local ecology may also be required if significant impact is proposed. Where floristic communities are known to (or could potentially) be integral to ecological



Tetratheca paynterae subsp. *paynterae* Photo – Colin Yates

processes that are important to the conservation of a significant species or genetic resource (e.g. provide key habitat for an obligate pollination vector for a critically endangered species or they form a significant component of an ecosystem under threat), then their

protection becomes a significant consideration. The process of identification and listing of TECs can take some considerable time and resources. Consequently, with a State as large and diverse as Western Australia, it is a significant task to complete. Ecological communities that are identified as potential TECs are first included in an informal list of Priority Ecological Communities (PECs). These communities are given priority rankings in a consistent terminology as used for fauna and flora, with the priority status relating to the need for further survey work.

PECs do not have the same official status as listed TECs. However, PECs remain as communities with a high likelihood of high biodiversity value requiring appropriate protection.

'Ecological communities' can be defined using flora, fauna or other biota (such as microbial) composition and habitat. 'Floristic communities' are described where the flora values are the main values to be protected (refer to Glossary in Section 22 for a full list of definitions).

5.2 The IUCN Red List Categories and Criteria

The IUCN Red List categories and criteria are a widely acknowledged system for classifying species at high risk of global extinction. The general aim of the system is to provide an explicit and objective framework for the classification of the broadest range of species according to their extinction risk. A revised version of the criteria was released in 2001 to improve objectivity by providing users with clear guidance on how to evaluate different factors which affect the risk of extinction. The categories are shown in Figure 1 below. Refer to Appendix 2 for a definition of each of the IUCN Red List categories and a description of the criteria used for their application.

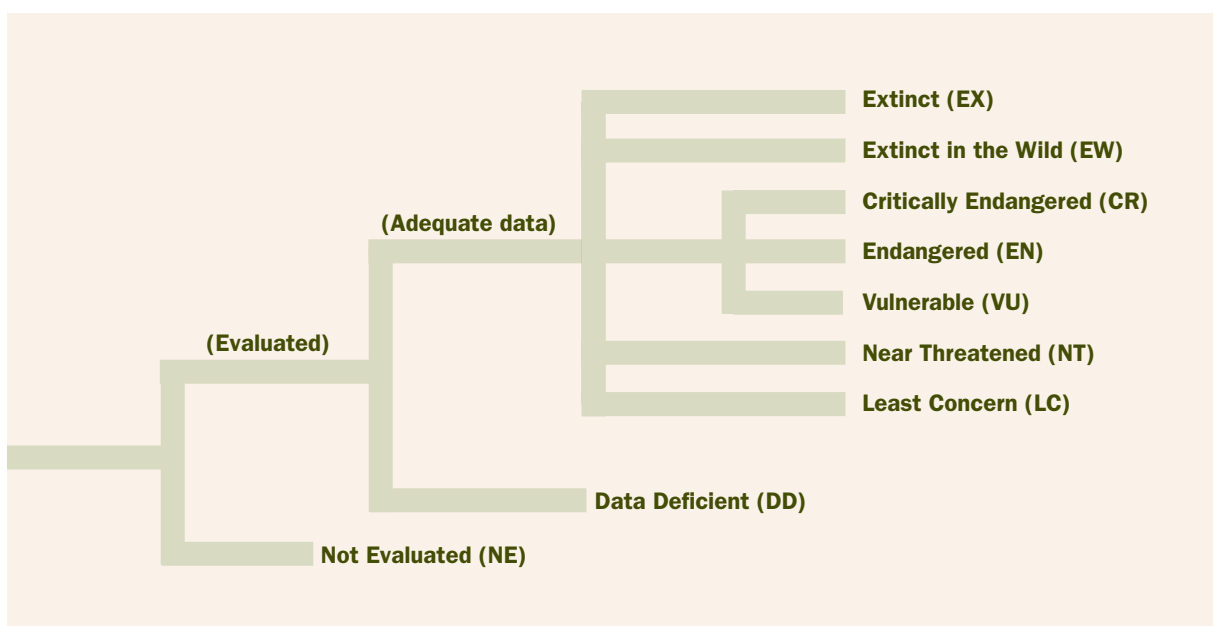


Figure 1. Structure of the IUCN Red List categories (IUCN 2001)

6. Available biodiversity information for the Midwest and Goldfields regions

A number of sources of information specific to the Midwest and Goldfields regions have been utilised for this report. Available information is at varying levels of detail and completeness and includes:

- The 1:250,000 and 1:1,000,000 scale mapping undertaken by Beard across Western Australia;
- WA Museum surveys, with a particular focus on short-range endemic fauna;
- Proponent collected data, generally fine scale data for assessment of individual proposed development projects;
- WA Herbarium data, from multiple sources - quality and completeness of data can be inconsistent;
- Results from the DEC regional flora survey, including full analysis from the 2005 survey work and partial analysis of the 2006 survey work;
- The Goldfields region including the Windarling and Mt Jackson ranges is covered by the joint CALM-WA Museum regional surveys of the Eastern Goldfields, published in 12 parts as Supplements to the Records of the WA Museum (Dell *et al.* 1985).

7. Yilgarn Craton Regional BIF Flora Survey

In March 2005, following discussions between the EPA, the then Departments of Conservation and Land Management (CALM) and Environment (DoE), and the Department of Industry and Resources (DoIR), CALM agreed to fund a regional flora survey program in order to address the lack of a detailed quantitative floristic dataset covering the extent of the BIF ranges. It had been identified that the lack of available data to assess the significance of environmental values of banded ironstone areas at the regional level (and the capacity of proponents to provide this information) was likely to become a significant issue for the proper assessment of individual mining proposals in the Midwest and Goldfields regions.



Helena and Aurora Range Photo – Ryonen Butcher

7.1 Scope of survey program

The scope of the regional flora survey was to undertake plot-based floristic surveys of 18 banded ironstone ranges over three field seasons. To achieve this, an additional two Research Scientists and two Technical Officers commenced work in July 2005. Seven ranges were surveyed in spring 2005, with draft manuscripts and datasets circulated in July 2006. A further six ranges were surveyed in spring 2006, with preliminary findings (but not data analysis) being available at the time of writing of this report. Fieldwork for Year 3 of the survey will commence in spring 2007, with data analysis and reporting to be completed by July 2008.

The process used to select survey areas was to identify the ranges considered most prospective for iron ore exploration & mining in consultation with the Department of Industry and Resources and then to identify other nearby ranges within the sub-region to provide context.

The ranges surveyed in the first two years of the survey were as follows:

- **2005**
 - Jack Hills
 - Weld Range
 - Koolanooka Hills
 - Mt Karara / Mungada Ridge / Blue Hills
 - Minjar / Gnows Nest
 - Warriedar Hill / Pinyalling
 - Mt Gibson

- **2006**
 - Booylgoo Range
 - Bulga Downs
 - Cashmere Downs
 - Wolla Wolla / Gullewa
 - Wiluna West
 - Robinson Range

In 2007 the following ranges will be surveyed:

- Perrinvale / Walling Range (including Brooking Hills and Mt Mason / Mt Hope)
- Yalgoo
- Diemals / Die Hardy Range
- Lake Giles
- Mt Dugel / Mt Nairn

Surveys of the Koolyanobbing & Windarling ranges were carried out by Portman for environmental impact assessment of its mining proposals at Mt Jackson and Windarling Ranges between 1998 and 2001 using comparable methods. There is an active mine on Tallering Peak.

7.2 Survey methodology

A standard plot-based survey methodology for regional and sub-regional flora surveys has been used by CALM and now DEC since the mid-1980s. Plot-based surveys are preferred over structural vegetation mapping as structural mapping does not determine the level of heterogeneity within mapped units, or relate map units across a region. This is consistent with EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*, requiring 'level 2' survey of areas where 'isolated or disjunct

populations and communities are known or are likely to be present.'

Plot placement covered both the BIF and other geologies on the ranges such that distribution of taxa and vegetation communities can be accurately assessed, covering the major geographical, geomorphologic and floristic variation found in each area. Plots of 20 x 20 m in size are established, located in the least disturbed vegetation available in the area being sampled. Survey work is carried out at an appropriate time of the year (i.e. spring or following seasonal rains in the arid zone) to assist in the identification of the species present and maximise the number of species identified. All plots are permanently marked with a steel star bar and three steel fence droppers and their positions determined using a GPS unit.

Comprehensive plot-based plant lists are recorded, in addition to a bulked soil sample being collected. Sufficient voucher collections are lodged in the Western Australian Herbarium, enabling identifications to be confirmed and subsequent changes in plant taxonomy to be correctly applied.

Methods of recording data from these plots largely follow those outlined in CSIRO's *Australian Soil and Land Survey Field Handbook* (McDonald *et al.* 1998). All vascular plants within each plot are recorded including their average heights and cover estimates.

The following information is also recorded:

- the landform element (morphological type position and element type) that the plot occupies;
- the level of site disturbance;
- the presence of coarse fragments on the surface;
- the presence of rock outcrops (type and abundance);
- soil types (colour, profile, field texture and surface type);
- vegetation structure (scoring three layers for dominance, growth form, height and estimated cover); and
- data on the position, slope, and aspect.

Field survey work is followed by data analysis where plots are classified according to similarities in species composition of perennial taxa, to facilitate comparisons with classifications from other ranges.

Analysis is undertaken to show spatial relationships between groups and to elucidate possible environmental correlates with the classification.

The methods and statistical techniques used for analysis are conservative, standard techniques. Statistical analysis is used to classify plots according to similarities in species composition to facilitate comparisons with classifications from other ranges. The analysis is highly reproducible, if the same parameters are adhered to and the same types of datasets are used. The method of using species presence/absence data is more conservative than using other quantitative measures such as frequency or cover. This is due to other ecological processes (such as succession after fire or factors which influence cover) influencing the data. Some communities can appear to be structurally different (e.g. a woodland versus open low shrubland), but may be compositionally similar.

The regional flora dataset will provide clarity on the regional significance and context of the species and communities affected at specific sites (subject to a development proposal), whereas sub-regional assessment (by a proponent) will provide the local site specific significance. The analysis at the sub-regional level is used to interpret the nature of the main plant communities in the vicinity of the proposed mining development, and forms one component of the data used in the assessment of environmental impact and environmental management requirements to protect and sustain biodiversity. The group level chosen in the statistical analysis will be dependent on the level of variation in the species composition of the vegetation of the site.

7.3 Summary of 2005 survey results

In consultation with DoE and DoIR, the then CALM decided on the following six areas to be targets for the first year of the regional flora survey: Jack Hills, Weld Range, Mt Karara / Mungada Ridge / Blue Hills, Minjar / Gnows Nest, Koolanooka Hills, Warriedar Hill / Pinyalling, and the Mt Gibson area. This was based on potential high biodiversity values and the status of mining proposals. These 2005 surveys were undertaken over three months between August and October using the standard plot-based survey methodology described above. This established an average of 50 plots per range.

Reports for the 2005 surveys were released in July 2006 to a wide range of stakeholders including proponents, consultants and Government agencies. Findings from the 2005 survey work confirmed earlier indications that individual ranges possess high plant endemism and restricted vegetation types. Key findings included:

- the identification of 16 new flora species, 9 of which were collected for the first time;
- 20 new populations of priority flora found; and
- 1750 voucher specimens placed with the WA Herbarium.

An output from the project providing assistance to industry is a freely available fully geo-referenced dataset.

The results of the first year of the DEC regional flora survey, supported by detailed site surveys being undertaken concurrently by iron ore proponents, have indicated that the ranges surveyed have very high biodiversity values. Each range supports significantly different plant communities and species and on some ranges, such as Mt Gibson, Blue Hills and Jack Hills, plant communities are highly restricted. Patterns of high levels of plant endemism have been demonstrated, with significant numbers of species being restricted to individual ranges. In addition to the

Drummondita sp. Koolanooka Hills (R. Meissner & Y. Caruso 69)
Photo - Rachel Meissner



significant number of new species that were identified from the first year of survey, further taxonomic work is required on many other specimens to determine species status.

7.4 Summary of 2006 survey results

Following consultation with DoIR, DEC targeted the following areas for the second year of the survey: Robinson Range, Booylgoo Range, Wiluna West, Cashmere Downs, Bulga Downs and Wolla Wolla / Gullewa. All of these areas are highly prospective for mining development. On each of these ranges approximately 50 plots were established (to a total of 303 plots and 160 staff days).

Key findings from the survey work, conducted between August and October 2006, included:

- the composition of vegetation communities on each range is different from adjoining ranges;
- 4 new taxa were identified, 3 of which were collected for the first time;
- a further 3 taxa require more taxonomic work to determine their status;
- 19 new populations of priority flora found; and
- a major range extension recorded for *Acacia cockertoniana* ms.

In line with the 2005 survey results, each of the range systems surveyed in 2006 appear floristically distinct from one other, confirming patterns found by Beard's large scale mapping work (i.e. the restricted vegetation systems of greenstone and BIF ranges of the South West and South West Interzone), Portman Iron Ore Ltd's detailed plot based surveys of greenstone and BIF ranges south of Mt Manning and Diemals Ranges and the results of earlier CALM surveys in the Bungalbin area.

Most of the ranges surveyed in 2006 were located in more arid climatic zones than those surveyed in 2005. In general the ranges appear less diverse with fewer geographically restricted vegetation units than surveyed in 2005, although detailed analysis of these datasets is still to be undertaken. In addition to surveying in more arid ranges, the 2006 season itself was much dryer than the previous year, impacting on the abundance of the annuals and geophytes in particular.



Tetratheca harperi on Mt Jackson (Photo – Wendy Thompson)

In summary, the ranges appeared to be refugial habitats with localised species and vegetation communities but with a lower diversity than recorded in the ranges surveyed in the previous year. It is important to note that detailed data analysis has not been undertaken as yet for the 2006 survey results, and information provided in this section should be regarded as preliminary.

7.5 Future implications and further information requirements

Results from the regional flora survey provide regional context for individual proposals and will inform decisions on the extent of further survey work required during proposal development within Midwest BIFs. Data collection by DEC and industry should continue to use the same survey protocol so as to facilitate effective assessment of proposed resource developments and to build up regional datasets to be used in future assessment processes. The protocol has been widely circulated by DEC and has been or is being used on at least five different proposals.

Additionally, DEC and DoIR have now developed a survey scope and methodology guideline to assist proponents to decide on the appropriate type and level of survey in banded ironstone areas. This guideline is consistent with EPA Guidance Statement No. 51 (2004), requiring Level 2 survey of areas where 'isolated or disjunct populations and communities are known or are likely to be present' and where high levels of disturbance are being proposed.

Data from the survey work will continue to assist in providing information and context for site specific surveys commissioned by individual development proponents. This will assist industry and government to work towards the achievement of timely assessment outcomes and will allow for an informed approach to strategic decision making that will provide for the appropriate exploration and development of the iron ore resources of the area whilst ensuring adequate protection of their conservation values.

8. Conservation values of flora species

The results of the first year of the DEC regional flora survey, and detailed site surveys being undertaken by iron ore proponents, have identified a significant number of new and potentially new species. This information and other data available from the WA Herbarium are summarised in Table 2 below. Sixteen new species were found in the first year of the regional survey and further taxonomic work is required on many other specimens. Twenty new populations of priority flora were also found. Patterns of high levels of plant endemism have been found, with significant numbers of species being only found on individual ranges. The habitat supporting some of these species is highly restricted.

For example at Mt Gibson, two threatened species, *Darwinia masonii*, and the newly discovered *Lepidosperma* sp. Mt Gibson are only found on the upper slopes, crests and ridges of Mt Gibson range.

A large number of declared rare and priority flora species are being found on the ranges. In addition, many of the newly discovered species are likely to be nominated as declared rare and priority flora

following review of data and consideration by the WA Threatened Species Scientific Committee.

Preliminary findings from the second year of the regional flora survey have found four new taxa (two *Acacia*, an *Indigofera* and a *Pityrodia*), with three of these taxa collected for the first time.

A 400 km range extension for *Acacia cockertoniana* ms (previously thought to be restricted to the Windarling – Mt Jackson area) was recorded in the Jack Hills in 2005. In 2006 this species was also found on the BIF on both Bulga and Cashmere Downs, 150 kilometres to the north of Windarling. Range extensions of this type will have significant implications for design of genetic studies on taxa restricted to BIF undertaken as part of future mining proposals.

Further collections were made of six other taxa that are currently being described by DEC via the Biodiversity Conservation Initiative taxonomy program. In addition 19 new populations of priority flora were found which will assist in the assessment of their conservation significance.

The taxa *Acacia woodmaniorum* sp. nov. B. Maslin and *Acacia karinae* sp. nov. B. Maslin that were identified as restricted to the BIF on DEC-managed land at the former Karara pastoral lease during spring 2005 are currently listed as Priority 2 flora however there is potential for these species to be recommended as threatened flora if and when the survey criteria necessary for listing have been met.

Table 2. Summary of known flora values per range*

BIF Range	No. Native Species	Endemic Species to Range	Endemic to several BIF ranges	Threatened Flora	Priority Flora	New Species (from RFS)	Potential Species/for review status uncertain
Booyigoo Ranges	102	-	-	-	-	-	-
Bulga Downs	69	-	1	-	-	-	-
Cashmere Downs	19	-	-	-	-	-	-
Diemals / Die Hardy Range	149	1	-	-	7	-	1
Finnerty Range	244	-	-	-	3	-	2
Helena Aurora (incl. Bungalbin Hill)	379	6	2	2	12	-	10
Jack Hills	205	-	-	-	4	2	7
Koolanooka Hills	217	5	1	-	9	5	5
Kooyanobbing	211	1	2	1	3	-	-
Lake Austin	272	-	-	-	2	-	-
Lake Giles	-	-	-	-	-	-	-
Mayfield	335	1	-	-	6	-	-
Minjar /Gnows Nest	142	-	-	-	7	1	-
Mt Dimer	212	-	-	-	5	-	-
Mt Dugel / Mt Nairn	-	-	-	-	-	-	-
Mt Gibson	285	2	-	3	13	1	4
Mt Jackson	213	4	1	2	7	-	-
Mt Karara / Mungada / Blue Hills	335	2	1	1 proposed	15	5	11
Mt Manning	117	-	-	-	5	-	-
New Forest (incl. Twin Peaks)	65	-	-	-	1	-	-
Perrinvale / Walling Range	-	-	-	-	-	-	-
Robinson Range	79	1	-	-	1	-	-
Tallering Peak	51	-	-	-	1	-	-
Warriedar Hill / Pinyalling	159	-	-	-	4	1	-
Weid Range	238	-	1	-	7	1	16
Wiluna West	101	-	1	-	-	-	-
Windarling	54	2	-	2	2	-	-
Wolla Wolla / Gullewa	109	-	-	-	3	-	-
Yalgoo	-	-	-	-	-	-	-

* Data from Regional Flora Survey results and proponent surveys where available, all other data from WA Herbarium records

“-” indicates there are no known data for that item at this stage

9. Conservation values of plant communities

The results of the recent DEC regional flora survey in the Midwest have confirmed the patterns in floristic communities first reported in the PER for the Koolyanobbing Expansion Project (2002). In that assessment it was found that the plant communities on the upper slopes and crests of the ranges had very restricted distributions. Results from the first six ranges surveyed in the DEC regional flora survey some 300 km north-west of Koolyanobbing have found similar patterns. As was found at Windarling and Mt Jackson, some plant communities of the ranges in the Midwest have highly restricted distributions even within individual ranges.

These results have been further confirmed by the more detailed surveys undertaken by the consultants for the Mt Gibson and Blue Hills / Mungada projects. The detailed analysis presented in the Mt Gibson

PER showed very strong geographical patterning in floristic composition, with some units having very restricted distributions. Floristic mapping provided for the Mungada assessment also showed strong geographical patterning in floristic composition across the project area.

Given the consistency of these patterns over some 300 km ranging from Jack Hills to Mt Jackson, it is expected that restricted plant communities will be found on most of the ranges in the Midwest, especially on the mid to upper slopes. This patterning largely reflects the unusual geologies and soils of these ranges as well as influences of regional climatic gradients.

The number of community types reported for Mt Karara / Mungada / Blue Hills (Table 3) is drawn from the regional flora survey not the proponent survey, as there were eight communities identified by the DEC and 21 by the proponent survey.

Table 3. Summary of known plant community values per range

BIF Range*	Number Community Types	TEC**	PEC	Community Endemic to Range	Restricted Distribution Within Range
Boolygoo Range					
Cashmere Downs					
Diemals/Die Hardy Range			7		
Helena Aurora (incl Bungalbin Hill)			6	YES	
Jack Hills (incl Mt Hale, Gould, Taylor)	6			YES	YES
Mt Jackson			4	YES	YES
Koolanooka Hills (incl Perenjori Hills)	5	1		YES	YES
Koolyanobbing Range			1		
Minjar/Gnows Nest				NO	NO
Mt Gibson	7		1***	YES	YES
Mt Karara/Mungada Ridge / Blue Hills	8			YES	YES
Mt Manning			1	YES	
Robinson Range					
Weld Range	8			YES	NO
Wiluna West					
Windarling Range			4	YES	YES
Wolla Wolla/Gullewa					

* Absence of a range, in comparison to Table 2 above, indicates no data are available for those ranges.

**A rigorous process applies to the nomination of TECs, and to date no nominations have proceeded since the completion of recent survey work on the BIFs.

*** The level of differentiation of ecological communities within these areas is to be decided by the Threatened Ecological Community Scientific Committee.

10. Fauna values

The ironstone ridges and associated slopes present across the Midwest and Goldfields regions, collectively referred to as BIFs, support a distinct assemblage of fauna in comparison to the surrounding flat areas of sandplain and woodland. A number of fauna species are confined to these slopes and ironstone ridges where they breed, forage and obtain shelter. Other significant species in this region, which previously had extensive distributions in the now largely cleared wheatbelt, primarilyw occupy habitats in the denser vegetation of the ridges and slopes. Many vertebrate species which inhabit BIF have high conservation significance and are listed under the *State Wildlife Conservation Act 1950* as threatened fauna or are listed as priority fauna by DEC because of limited

distribution, few populations or regional declines. The BIF ranges also support short-range endemic (SRE) fauna (primarily invertebrate fauna with naturally small habitats (<10 000km²) prescribed by environmental characteristics (Harvey 2002)).

Limited fauna studies have been performed on the BIF ranges in the Midwest and Goldfields and for the majority of these ranges there is little or no information regarding fauna values. The available information consists almost exclusively of detailed site surveys undertaken for iron ore proponents, although exceptions include the Helena and Aurora range survey (Lyons and Chapman 1997), the Bungalbin Hill survey (EPA 2004a) and the Jasper Hills survey (Cowan, pers. comm. 2007) (Table 4).

Table 4. The Banded Ironstone Formation (BIF) ranges that have been surveyed for vertebrate and invertebrate fauna values.

BIF Range	Vertebrates	Invertebrates
Mt Karara/Mungada Ridge /Blue Hills (incl. Jasper Hills)	Bamford and Wilcox (2004) Bancroft and Bamford (2006) Cowan, pers. comm. (2007)	Bancroft and Bamford (2006) Harvey (2006)
Jack Hills	Wilcox and Davis (2006)	
Helena and Aurora Range (incl. Bungalbin Hill)	Dell and How (1985) Lyons and Chapman (1997) ecologia (2001) EPA (2004a)	
Koolanooka Hills	ATA Environmental (2004a)	
Mt Gibson	Hart, Simpson and Associates (2000) ATA Environmental (2004b) ATA Environmental (2005)	Harvey (2005) Main (2005) Slack-Smith (2006)
Mt Jackson	Dell and How (1985) ecologia (2001) ecologia (2003)	
Windarling	ecologia (2003)	

10.1 Short-range endemic fauna

Short-range endemics (SREs) are those fauna that have a naturally small range of less than 10,000km² (Harvey 2002). In addition, these species possess similar ecological traits including poor powers of dispersal, confinement to specialised often discontinuous habitats, slow growth and low fecundity (Harvey 2002). SREs consist mainly of invertebrates although the term can also refer to some fish, frogs and reptiles (Harvey, 2002).

Western Australia contains short-range endemics from the Diplopoda (Millipedes), Pulmonata (Land Snails), Mygalomorphae (Trapdoor and Funnel Web Spiders) and Onychophora (Velvet Worms) groups (Harvey 2006), although the taxonomy of other groups of invertebrates is poorly known and some are likely to also include SRE's. The Midwest region contains all these groups, excluding Onychophora due to this group's dependence on high rainfall (Harvey 2006). The BIFs of the Midwest harbour a variety of SREs as the formations are relictual and fragmented habitats, hence the potential for localised endemism (ATA Environmental 2004a). More specifically, some species are incapable of moving across the outwash plains of the perimeter of the ranges (ecologia 2001). The lack of immigration or emigration of certain

species increases the fauna value and conservation significance of the BIF ranges.

Very few studies have occurred on the invertebrates that inhabit the BIFs of the Midwest. Invertebrates in general have been excluded from environmental assessments of biological systems in the past due to the high diversity of species and the difficulty associated with classification (Harvey 2006). The most extensive survey of invertebrates of the BIFs of the Midwest has occurred at Mt Gibson. The Western Australian Museum (Harvey 2005, Slack-Smith 2006) and the University of Western Australia (Main 2005) undertook a three month SRE fauna survey in the Mt Gibson area for an iron ore proponent. In addition, a study of Mt Karara / Mungada Ridge / Blue Hills (Harvey 2006) includes further, although less detailed, information on SREs of the Midwest region.

Detailed information is provided on the Millipedes, Land Snails and Trapdoor and Funnel Web Spiders due to the targeted surveys performed at Mt Gibson and Blue Hills (Table 5). These groups form the majority of the available information on the SRE invertebrates of the Midwest region, although to a lesser extent Scorpions were surveyed at Blue Hills and are also included.

Table 5. Short-range endemic invertebrates found at the banded ironstone formation (BIF) ranges in the Midwest region of Western Australia.

BIF range	Group	Short-range endemic species
Mt Gibson	Diplopoda (Order)	<i>Antichiropus</i> 'Mt Gibson 1' <i>Antichiropus</i> 'Mt Gibson 3 <i>Antichiropus</i> 'Mt Gibson 4
	Mygalomorphae (Suborder)	<i>Aganippe</i> sp 1 <i>Eucyrtops</i> sp. 3 <i>Kwonkan</i> sp.
	Pulmonata (Subclass)	<i>Simumelon vagente</i> <i>Succinea</i> sp. <i>Pupoides</i> sp.cf. <i>Pupoides beltianus</i> <i>Bothriembryon</i> sp
Blue Hills	Diplopoda (Order)	<i>Antichiropus</i> sp. nov. 'PM1'
	Mygalomorphae (Suborder)	<i>Idiosoma nigrum</i> <i>Aname</i> sp.
	Scorpions (Order)	<i>Urodacus</i> sp. nov. (Mt Gairdner)

Diplopoda (Millipedes)

Nine different orders of Millipedes occur in Australia (Harvey & Yen 1989 cited in Harvey 2005). The most abundant millipede group in Western Australia is the genus *Antichiropus* (Harvey 2005). *Antichiropus* occur from the southern Pilbara region south to the Eyre Peninsula of South Australia (Harvey 2005). All species of *Antichiropus* are classified as SREs, excluding *Antichiropus variabilis* which inhabits the jarrah forests of south west WA (Harvey 2002).

Mt Gibson was found to accommodate five different species of *Antichiropus* (Harvey 2005). Three species were found on the ridges or slopes of the BIF. The species *Antichiropus* 'Mt Gibson 1' was found on BIFs in a variety of locations including wooded and rocky areas. The species *Antichiropus* 'Mt Gibson 3' occurred at several locations and is widely distributed like *Antichiropus* 'Mt Gibson 1'. These species have overlapping geographic ranges, suggesting they are closely related species (Harvey 2005). The species *Antichiropus* 'Mt Gibson 4' was found at only one location situated on an ironstone slope. This species is distinct from all other members of the genus *Antichiropus*, including those recorded from outside of the Mt Gibson area (Harvey 2005). Other millipedes of the family Siphonotidae were found in this survey, although they were not identified to species level.

At Mt Karara / Mungada Ridge / Blue Hills, Harvey (2006) identified *Antichiropus* sp. nov. 'PM1'. This species is known to occur in the northern wheatbelt (Harvey 2006).

Mygalomorphae (Trapdoor and Funnel Web Spiders)

The trapdoor and funnel web spiders (Mygalomorphae) have ten families that occur in Australia. Of these, eight occur in Western Australia and six are well represented in the Midwest region (Main 2005).

Six families of mygalomorphs were found at Mt Gibson including Actinopodidae, Ctenizidae, Dipluridae, Idiopidae, Nemesiidae and Barychelidae (Main 2005). Three species including *Aganippe* sp. 1, *Eucyrtops* sp. 3 and an unidentified *Kwonkan* species were found to be endemic to the Mt Gibson area (Main 2005). *Eucyrtops* sp. 3 was recorded from a damaged specimen, therefore the assumed endemism may be incorrect (Main 2005). *Kwonkan* is widely distributed across Western Australia although only six species

have been identified to species (Main 1983 cited in Main 2005). The specimen collected was a juvenile, therefore the assumed endemism may also be incorrect (Main 2005).

The survey performed at Mt Karara / Mungada Ridge / Blue Hills (Bancroft and Bamford 2006) resulted in the collection of three species of Mygalomorph including the Shield-backed Trapdoor Spider (*Idiosoma nigrum*), *Gaius villosus* and an undescribed species of the genus *Aname*. The species of Shield-backed Trapdoor spider and the unknown species of *Aname* were found on BIFs.

The Shield-backed Trapdoor Spider *Idiosoma nigrum* is listed as threatened under the Wildlife Conservation Act 1950. The species is distributed from the northern Wheatbelt to the Murchison River (B. Main pers. comm. cited in Bancroft and Bamford 2006).

The unknown species of *Aname* was found to occur on the lower slopes of the Mungada Ridge in the Blue Hills (Bancroft and Bamford 2006). The *Aname* genus is widespread across Australia and has many undescribed species and the species collected in the project area may be a SRE (Bancroft and Bamford 2006).

Pulmonata (Land Snails)

Four species of land snails were collected at Mt Gibson including *Sinumelon vagente*, *Succinea* sp., *Pupoides* sp.c.f. *P.beltianus* and *Bothriembryon* sp. (Slack-Smith 2006). All species were found to occur on the BIF.

Sinumelon vagente is a member of the family Camaenidae which is widespread in northern Australia and in the more arid areas of southern Western Australia, South Australia and western New South Wales (Slack-Smith 2006). *Sinumelon vagente* is endemic to Western Australian.

Succinea sp. is a member of the family *Succineidae* which occurs across Australia (Slack-Smith 2006). This species has not been found to occur in this area before.

Pupoides sp. c.f. *P. beltianus* is from the family Pupillidae which occurs in the central coastal areas of Western Australia and their hinterlands. The species

appears to have a mosaic distribution which may be related to the salinity of the soil (Slack-Smith 2006).

Bothriembryon sp. is from the family Bulimulidae and is represented in Western Australia by the single genus *Bothriembryon*, which is confined to southern Western Australia due to a dependence on rainfall. The Mt Gibson area is the north-eastern limit of the genus *Bothriembryon* and has not been found in this area before.

‘Until surveys are carried out on the native snail fauna of the inland areas of WA, and the taxa are identified and the specimen data collated (and data-based), little can be said about the likelihood of the occurrence of short-range endemic species there. As elsewhere, such taxa could be expected to occur in isolated habitats, particularly those in which shelter from desiccation for both snails and their food supply (probably decomposing plant litter and associated decomposing agents) is available’ (pers. comm. Slack-Smith) (Appendix 3).

Scorpions

The SRE survey conducted Mt Karara / Mungada Ridge / Blue Hills found a single species of scorpion restricted to the BIFs (Harvey 2006), namely *Urodacus* sp. nov. “Gairdner Range”. The specimen found is

only the second record of the species (Harvey 2006). It is likely that the species would only occur in isolated habitats throughout the Midwest, therefore it is classified by Harvey (2006) as a SRE.

10.2 Vertebrate fauna

The BIFs of the Midwest and Goldfields regions provide essential habitat for a range of vertebrate fauna. Many of these species utilise the BIFs to breed, forage and obtain shelter. Species that are dependent on the ranges for habitat are locally significant to the BIF ranges and regionally significant to the Midwest and Goldfields.

Vertebrate species were determined to be significantly dependent on BIFs for habitat if they were found to occur on the slopes and ironstone ridges of a range and were not found to occur in the surrounding area (Table 6). The species found to inhabit the surrounding area, including the flat woodlands and sandplains, are viewed as not dependent on the BIFs for habitat and are excluded from this report. However, future more detailed fauna value assessments should consider species that inhabit the surrounding area as they may be indirectly dependent on the ranges, for example through dependence on the drainage pattern of the area.



Table 6. Vertebrate species likely to be significantly dependent on banded ironstone formation ranges for habitat in the Midwest and Goldfield regions (Table 4).

Vertebrate					Banded ironstone formation range						
Group	Species	Common Name	Wildlife Conservation Act 1950	DEC priority code	B H	H A	J H	K H	M G	M J	W
Birds	<i>Artamus minor</i>	Little Woodswallow			X	X	X	X		X	X
	<i>Eopsaltria griseogularis rosinae</i>	Western Yellow Robin			X	X		X			
	<i>Falco peregrinus</i>	Peregrine Falcon	Specially protected		X	X	X			X	X
	<i>Hylacola cauta whitlocki</i>	Shy Heathwren			X	X				X	
	<i>Pachycephala inornata</i>	Gilbert's Whistler			X						
	<i>Pachycephala pectoralis</i>	Golden Whistler			X						
Mammals	<i>Pseudantechinus woolleyae</i>	Woolley's Pseudantechinus			X	X	X			X	
	<i>Sminthopsis longicaudata</i>	Long-tailed Dunnart	Priority 4		X	X	X				
Reptiles	<i>Cyclodomorphus branchialis</i>	Gilled Slender Blue-tongue	Threatened		X	X		X	X		
	<i>Cyclodomorphus melanops elongatus</i>	Spinifex Slender Blue-tongue			X						
	<i>Delma butleri</i>	Unbanded Delma			X						

BH = Mt Karara / Mungada Ridge / Blue Hills, HA= Helena and Aurora Range (incl. Bungalbin Hill), JH = Jack Hills, KH = Koolanooka Hills, MG = Mt Gibson, MJ = Mt Jackson, W = Windarling.

X = Species likely to be significantly dependent on the identified BIF for habitat.

While the available regional scale information on fauna values in BIF ranges is largely incomplete the relative level of fauna values at some of BIF ranges can be considered through comparison of available data (Table 7) on the total number of native vertebrates, the total number of significantly BIF dependent fauna species and the conservation status of the fauna species occurring at each range.



Table 7. Summary of known fauna values per Banded Ironstone Formation (BIF) range.

BIF Range	Total number of native vertebrate species recorded *	Number of native vertebrate species likely to be dependent on BIF (Table 6)	Number of SRE invertebrate species dependent on BIF (Table 5)	Number of recorded Wildlife Conservation Act 1950 threatened fauna species (Table 6)	Number of recorded DEC priority fauna list fauna species (Table 6)
Mt Karara /Mungada Ridge/ Blue Hills	123	9	5	2	2
Helena and Aurora Range (incl. Bungalbin Hill)	125	7	-	2	2
Jack Hills	153	6	-	1	1
Koolanooka Hills	100	3	-	2	-
Mt Gibson	107	1	10	1	-
Mt Jackson	95	4	-	2	-
Windarling Range	77	2	-	1	-

* Total number of native vertebrate species recorded = the total number of vertebrate species found to occur in the project area, including species found to occur on BIF ridges, BIF slopes, flat woodlands and flat sandplains.

There are many limitations of the fauna dataset that currently exists for BIF ranges. Surveys undertaken for iron ore development proponents have been focused on development project areas, and not the full extent of the affected range, therefore the data from these surveys may be unrepresentative of the range. Overall, the surveys have been performed at various times throughout the year and are often performed individually without consecutive surveys throughout the year. To gain a representative fauna dataset for any given range, multiple surveys conducted in different seasons and repeated over several years, are required to cater for seasonal and temporal variations in faunal assemblages. More specifically, data from the survey performed at Jasper Hills (pers. comm. Cowan 2007) has been included in this report although it is less detailed in comparison to the other surveys. The survey data is likely to be unrepresentative of the full vertebrate assemblage of the Jasper Hills area as it consists primarily of a small list of trapping data.

The following descriptions provide information on fauna species likely to be associated with BIF ranges

Birds

Artamus minor - Little Woodswallow

The Little Woodswallow is of regional significance in the Midwest and Goldfields due to the species' dependence on the BIFs for habitat. This species utilises vertical rock faces for refuges, breeding and roosting sites and is restricted to the BIF within the region (ecologia 2001). The species was found to occur at Mt Karara/Mungada Ridge/Blue Hills (Bancroft and Bamford 2006, Bamford and Wilcox 2004), Mt Jackson (Dell and How 1985, ecologia 2001), Helena and Aurora Range (Dell and How 1985), Windarling (ecologia 2001), Jack Hills (Wilcox & Davis 2006) and the Koolanooka Hills (ATA Environmental 2004a).

Eopsaltria griseogularis rosinae - Western Yellow Robin

The Western Yellow Robin is widespread from the southern Murchison to the Goldfields and parts of the lower south-west although it has disappeared from much of the Wheatbelt due to habitat destruction (Bancroft and Bamford 2006). The species was found to occur in Koolanooka Hills (ATA Environmental 2004a), Helena and Aurora Range (Dell and Chapman

1985, Lyons and Chapman 1997, ecologia 2001) and the Blue Hills (Bancroft and Bamford 2006). The species appears to be restricted to the lower slopes of the BIFs that are associated with vegetation situated along gullies and drainage lines (ATA Environmental 2004a, Bancroft and Bamford 2006).

Falco peregrinus - Peregrine Falcon

The Peregrine Falcon is listed as specially protected fauna under the Wildlife Conservation Act 1950. The Peregrine Falcon occurs throughout most of Australia excluding the extremely dry areas of the country (ATA Environmental 2005). Throughout Australia, this species occurs in low densities (ecologia 2001) and has a patchy distribution (ATA Environmental 2005). Pairs forage over several hundred square kilometres in semi-arid environments including the Midwest and Goldfields regions (Marchant and Higgins 1993 cited in Bancroft and Bamford 2006). The Peregrine Falcon prefers areas near cliffs along coastlines, rivers and ranges and in woodlands situated along watercourses and around lakes (ATA Environmental 2005). It is the species' preference for cliffs along ranges that makes BIFs suitable habitat and is dependent on the rocky ranges of BIFs for roosting and nesting sites (ecologia 2001). The species was found to occur at Jack Hills (Wilcox and Davis 2006), Mungada Ridge (Bancroft and Bamford 2006), Mt Jackson (Dell and How 1985), Helena and Aurora Range (Dell and How 1985, Lyons and Chapman 1997) and Windarling (ecologia 2001).



Peregrine Falcon roosting sites on BIF cliffs in the Helena and Aurora Range
Photo – Mark Brundrett.

Hylacola cauta whitlocki - Shy Heathwren

The Shy Heathwren is listed as a priority 4 species (taxa in need of monitoring) by DEC. The species is known to occur in the south-west and wheatbelt areas of Western Australia (pers. comm. Species and Communities Branch, DEC). The species was found to occur at Blue Hills (Bamford and Wilcox 2004), Helena and Aurora Range (Dell and How 1985, Lyons and Chapman 1997) and Mt Jackson (ecologia 2001) along the rocky ridge and was not found to occur in these surveys in the surrounding areas.

Pachycephala inornata - Gilbert's Whistler

The Gilbert's Whistler is an uncommon, patchily distributed species through the southern Murchison, Wheatbelt and Goldfields areas of Western Australia and in inland areas of south-eastern Australia (Bancroft and Bamford 2006). The species was found to occur on the lower slopes of Mungada Ridge in dense vegetation that was distributed along a minor drainage line, and was not found in the surrounding area.

Pachycephala pectoralis - Golden Whistler

The Golden Whistler is a widespread species in the south of Western Australia and is at the northern limit of its range in the Blue Hills (Bancroft and Bamford 2006). Like other BIF ranges in the region, the species was found to occur in thick shrubland of the lower slopes of the Blue Hills and appears to be regionally restricted to the rocky hills and adjacent rock slopes of the BIF as it was not found in the surrounding flat area (Bamford and Wilcox 2004).

Mammals

Pseudantechinus woolleyae - Woolley's Pseudantechinus

The Woolley's Pseudantechinus is considered regionally significant in the Midwest and Goldfields regions. The species has a disjunct distribution between the Pilbara and Murchison regions (Bancroft and Bamford 2006). The species has a strong habitat preference for rocky hills (Bancroft and Bamford 2006, Strahan 1995 cited in Wilcox and Davis 2006), therefore populations may be fragmented as rocky areas in this area exist as islands within expansive plains (Bancroft and Bamford 2006). The species

habitat consists of deep crevices for shelter and rock faces to forage for insects and small vertebrates (ecologia 2001). This species was found to occur at Mungada Ridge (through a possible sighting and evidence of scats along the ridge) (Bancroft and Bamford 2006), Jack Hills on the laterite breakaways around the edge of the BIF range (an extremely rocky area with numerous cavities of various sizes which may be important for shelter) (Wilcox and Davis 2006), Mt Jackson (ecologia 2001) which represents the most southern record and a significant range extension for the species (ecologia 2001), and at Bungalbin Hill (ecologia 2001).

Sminthopsis longicaudata - Long-tailed Dunnart

The Long-tailed Dunnart is listed as a priority 4 species by DEC. This species occurs in the arid zone across the central part of Western Australia and has a preference for rocky habitat (Wilcox and Davis 2006). The Long-tailed Dunnart was recorded from the rocky slopes in the Jack Hills area (Wilcox and Davis 2006) although it was not found on the surrounding flat areas. The species was also found to occur at Helena and Aurora Range (Lyons and Chapman 1997, ecologia 2001) on the BIF ridge.

Reptiles

Cyclodomorphus branchialis - Gilled Slender Blue-tongue

The Gilled Slender Blue-tongue is listed as threatened under the *Wildlife Conservation Act 1950*. The species occurs across the southern and western area of the Murchison bioregion with the species' distribution fragmented due to the lack of suitable habitat (Bancroft and Bamford 2006). This species is a nocturnal ground-dwelling skink which shelters in spinifex, leaf litter and fallen timber (Bancroft and Bamford 2006). Fauna surveys conducted at Blue Hills have found the species to occur on the ridges of the BIFs and it was not found in the surrounding area (Bamford and Wilcox 2004, Bancroft and Bamford 2006). The species was also found to occur at Helena and Aurora range (Lyons and Chapman 1997) exclusively on the ridge top and in the Koolanooka Hills area (ATA Environmental 2004a) although the fauna assessment does not state in what type of habitat the sighting was made.

Cyclodomorphus melanops elongatus- Spinifex
Slender Blue-tongue

The Spinifex Slender Blue-tongue was found to occur on Jack Hills and Helena and Aurora Range and was not found on the surrounding flat plains in these areas (Wilcox and Davis 2006, ecologia 2001). This species is most probably restricted to the spinifex or Neurachne dominated habitats on the upper slopes of the BIF ranges (Wilcox and Davis 2006, J. Dell pers. comm.).

Delma butleri - Unbanded Delma

The Unbanded Delma was found to occur on Jack Hills and Helena and Aurora Range and was not found on the surrounding flat plains (Wilcox and Davis 2006, Ecologia 2001). This species is probably restricted to the spinifex dominated vegetation on the upper slopes of the range (Wilcox and Davis 2006).

11. Landscape and geoconservation values

It is readily apparent that the BIF ranges in the Midwest region hold significant and potentially unique landscape and geodiversity values, as isolated, ancient ranges set within a predominantly flat landscape. These values are additional to the biodiversity values of the Midwest and Goldfields BIFs and further strengthen the need to provide protection for the unique set of values present. It may be possible to apply geodiversity values as a surrogate for the protection of biodiversity, particularly aspects other than vascular plants and macrofauna. In addition to using the scientifically based CAR reservation criteria, significant landforms and landscape components are also commonly included in parks and reserves, both in Australia and internationally.



Banded Ironstone Formation Photo – Steve Dillon

Geoconservation is an emerging area of study and significant work has been carried out in other parts of the world and Australia (notably Tasmania). Geoconservation is defined by Sharples (2002) as:

‘the conservation of geodiversity for its intrinsic, ecological and (geo)heritage values, where ‘geodiversity’ means: the range (or diversity) of geological (bedrock), geomorphological (landform) and soil features, assemblages, systems and processes.’

Sharples (2002) states that geoconservation is an approach to the conservation management of rocks, landforms and soils which recognises that geodiversity has nature conservation values and that a primary focus of geoconservation is the protection of natural geodiversity in order to not only protect features of direct scientific or inspirational value to humans,

but also in order to maintain the natural ecological (including biological) processes which are the focus of most nature conservation concerns.

The two basic aims of managing geoconservation as defined by Sharples (2002) are:

- Maintenance of geodiversity (to retain significant representative examples of the geodiversity of bedrock, landform and soil features); and
- Maintenance of natural rates and magnitudes of change (to keep ongoing geological, geomorphological and soil processes operating - and changing and evolving - within natural limits both because of the intrinsic value of the geo-processes themselves, and also to maintain a natural balance in broader ecological processes which depend upon geo-processes).



Windaning Hill Photo – Steve Dillon

Pemberton (2001) states there are many examples in Australia where important geological features have been lost or severely impacted by a variety of developments, including road construction, flooding, earth works, agricultural development, residential development and quarrying. Such disturbance or removal of geological features is generally permanent, as features typically develop so slowly that 'degradation is permanent and destruction, or extinction, of an important site can occur with the passing of one bulldozer blade.'

The recommendations made in this report acknowledge that some examples of the Midwest and Goldfields BIFs need to be retained both partially and in their entirety, for protection of their unique geodiversity value.

There is a need to consider environmental harm resulting from permanent loss of landforms, since it is impossible to reconstruct BIF ranges. Rehabilitation of waste rock dumps results in different plant communities that often lack suitable habitat for rare endemic species (EPA 2006 – Guidance Statement 6).



Helena and Aurora Range (www.earth.google.com)

12. Translocations and ecosystem reconstruction

It is unrealistic to consider mining development to be a temporary disturbance to banded ironstone ecosystems. The option of re-establishment of the rare and endemic species and communities found in many Midwest and Goldfields BIF areas proposed for mineral development, via minesite and waste dump rehabilitation (or any other location other than their normal habitat), is a high risk strategy that has yet to be demonstrated as achievable in a sustained manner. A previous rehabilitation attempt at a quartz mine within the Midwest region resulted in the priority flora *Regelia megacephala* initially colonising rehabilitated areas, but it was quickly out-competed by other species better adapted to the modified soils.

In DEC's view, this option is unlikely to be a successful means of achieving conservation of rare and endemic species or communities in natural self-sustaining populations or occurrences. Before re-establishment of species and associated communities could be considered successful, the sustainability of the species would need to be demonstrated over several generations. Relying on this option for proposals currently under assessment would be in the absence of sound scientific evidence regarding likelihood of success.

13. Offsets and 'net environmental gain'

Suggestions have been made regarding the concept of 'net environmental gain' being applied to development projects, to include contributions by mining companies to broader conservation issues than those identified at the source of their mining impacts. The EPA has published Position Statement No. 9, *Environmental Offsets*. This Position Statement suggests that management and mitigation of environmental impacts need to firstly aim at preventing the loss of key biodiversity values and that significant adverse impacts on 'critical assets' should be avoided.

It is the EPA's position that where particular projects are approved by Government following consideration of environmental impact assessment and socio-economic considerations, development and implementation of an acceptable 'comprehensive

offset package' aimed at offsetting unavoidable impacts should be a prerequisite for approval. The EPA has a strong preference for offsets to be 'like for like', but does include offsite reparation of environmental damage as an offset possibility.

In the case of the Midwest BIFs, many of the ranges (including those subject to mining proposals) contain biodiversity values that are unique in that they are found nowhere else, and hence can not be replaced if significantly impacted or destroyed. For example at Mt Gibson, two threatened flora species, *Darwinia masonii* and the newly discovered *Lepidosperma* sp. Mt Gibson are only found on the upper slopes, crests and ridges of Mt Gibson range. Additionally, the results of the regional flora survey and detailed site surveys being undertaken by proponents, have identified that most of the BIF ranges contain unique plant communities only found on that particular range. DEC is of the view that unique and irreplaceable biodiversity values should be conserved *in situ* wherever possible and an approach of net environmental gain is not feasible in this type of scenario.

Notwithstanding this, if the Government approves a proposal that results in significant reduction in the biodiversity values of a BIF for social or economic development reasons, proponents and the Government need to ensure that contributory offset actions are undertaken that lead to enhanced protection (i.e. conservation reserve) and management (i.e. resources) to facilitate the long-term maintenance of the remaining biodiversity values.

14. Sustainability

Under the *Environmental Protection Act 1986*, the EPA assesses only the environmental aspects of proposals. It is the role of Government to assess specific projects or broader strategic processes according to the principles of the 'triple bottom line' of environmental, economic and social costs and benefits. This strategic review and interim status report are an example of this process, in order to address the large number of existing and future potential mining proposals in the Midwest region, which pose an increasingly difficult challenge in strategically addressing cumulative environmental and other impacts.

The EPA has completed formal environmental assessment of the following proposals for mining of BIF ranges in the Goldfields / Midwest:

- Koolyanobbing Expansion (Portman Iron Ore Ltd 2002);
- Jack Hills Range Stage 1 Hematite Project (Murchison Metals Ltd 2005); and
- Mt Gibson (Mount Gibson Mining Pty Ltd).

Formal EPA assessments are currently underway for:

- Mungada Ridge Hematite Project (Gindalbie Metals Ltd);
- Mt Karara Magnetite Project (Gindalbie Metals Ltd); and
- Koolanooka Range & Blue Hills Direct Shipping Hematite Project (Midwest Corporation Ltd).

In addition to impacts on biodiversity values, the proposed Midwest iron ore developments are likely to impose significant demands on local and regional water and energy resources. When combined with other proposed developments in the region, the impact of these demands on scarce resources and environmental values, and the sustainability of these demands will need to be assessed strategically.

15. Case studies

The following case studies have been selected where environmental impact assessment level information is available in order to demonstrate the diversity and complexity of individual BIF ranges and what is likely to be expected more broadly.

15.1 Mount Manning area

Background

For the purposes of this report, the Mt Manning area refers to the following BIF ranges:

- Mt Manning;
- Windarling Range;
- Mt Jackson; and
- Helena and Aurora Range (including Bungalbin Hill).

This area is located in the western part of the Goldfields, north of Southern Cross. The ranges in the area are of interest as they have very high spatial biodiversity due to being located in a transitional zone between the Goldfields and Wheatbelt regions.



TOP: Windarling' from the Die Hardy Range

ABOVE: The Die Hardy Range from 'Windarling' Photos – Colin Yates

Biodiversity values

Flora

There is an inconsistent availability of information on biodiversity values across the Mt Manning area, for reasons such as most flora surveys being focused on development proposals, surveys such as in the Bungalbin area remaining unpublished, and survey work by groups such as the WA Museum not yet being entered into a centrally available database. However, in comparison to other BIF areas, the Mt Manning area remains well surveyed for flora with over 3000 collections in the WA Herbarium for the general area. This is in part due to the survey work of development proponents, past survey work by the then CALM and current taxonomic work by DEC as part of the Biodiversity Conservation Initiative. All of this work shows that the Mt Manning area BIF ranges have high concentrations of rare and endemic flora, with specific habitat requirements.

Threatened and priority flora in the Mt Manning area includes (adapted from EPA 2007):

- Threatened species *Leucopogon* sp. Helena and Aurora Range and *Tetradlea aphylla* subsp. *aphylla*, both endemic (known only at) to Helena and Aurora Range;
- Threatened flora *Tetradlea paynterae* subsp. *paynterae*, endemic to Windarling Range;
- Threatened flora *Ricinocarpos brevis*, endemic to Windarling Range;
- Threatened flora *Tetradlea harperi*, endemic to Jackson Range;
- *Lepidosperma* sp. Jackson Range, endemic to Jackson Range and requiring further taxonomic work;
- *Lepidosperma* sp. Mt Manning, endemic to Manning Range and requiring further taxonomic work;
- *Lepidosperma* sp. Aurora Range, endemic to Helena and Aurora Range and requiring further taxonomic work;
- Priority 1 species *Acacia adinophylla*, endemic to Helena and Aurora Range;
- Priority 1 *Beyeria* sp. Jackson Range, found only at Mt Jackson and the nearby Koolyanobbing Range;
- Priority 1 *Echinopogon ovatus* var. *pubiglumis*, endemic to Helena and Aurora Range;
- Priority 1 *Hibbertia lepidocalyx* subsp. *tuberculata*, found only at Helena and Aurora Range and one other location;
- Priority 1 *Jacksonia jackson*, endemic to Jackson Range;

- Priority 1 *Lepidosperma* sp. Mt Jackson, known only at Mt Jackson and Helena and Aurora Range; and
- Priority 3 *Neurachne* sp. Helena and Aurora, endemic to Helena and Aurora Range.

Recent taxonomic and genetic studies support the conservation significance of isolated species such as *Tetratheca paynteri* on BIF ranges (Butcher *et al.* 2007). Such research and the increased mortality observed in areas next to the Windarling mine (Portman Iron Ore Limited Annual Report 2005) due to the impacts of dust, highlight the potential threat to these populations where a large part of their habitat is proposed to be impacted. Biodiversity impact issues experienced in operating mine development should be considered in the assessment of any future proposals to mine BIF ranges in this area.

Vegetation and plant communities

Detailed vegetation maps were produced for Windarling and Mt Jackson ranges for Portman Iron Ore Limited (Mattiske Consulting 2001) as part of the original Koolyanobbing development. This report identified restricted vegetation communities in both ranges. These highly restricted and unique plant communities are currently recognised as Priority Ecological Communities, and may be listed in the future as Threatened Ecological Communities

Across the Midwest and Goldfields BIFs the highest concentrations of identified endemic floristic communities are the Helena and Aurora Range, Windarling, Mount Jackson Range and the nearby Koolyanobbing and Die Hardy Range vegetation complexes. This position is supported by work conducted by Western Botanical (2003-2006), CALM (2002) and G. Cockerton (pers. com.), all stating that Helena and Aurora and Jackson Ranges in particular provide unique associations of vegetation with a wide range of significant and endemic flora.

Fauna

Significant habitat is also present within the Mt Manning area for bird species and other fauna (including SRE fauna likely to be present in BIF in areas where rock aspect and formation are appropriate) which are poorly reserved and / or

declining in the Wheatbelt region. Significant fauna and faunal assemblages that occur in the Mt Manning area includes (adapted from EPA 2007):

- Bungalbin Hill is very important habitat for animals, with 5 dasyurid marsupials, 51 reptiles, including 13 geckos, recorded in previous survey work;
- outlying populations of Chuditch (*Dasyurus geoffroyi*) occur within the area;
- the Woolley's Pseudantechinus (*Pseudantechinus woolleyae*) appears dependent on BIF ranges in the region for habitat (occupying deep rock crevices), being a disjunct distribution at the southern end of its range;
- the skink species *Ctenotus xenopleura* has a restricted distribution, being known from only from 4 localities, including Bungalbin Hill;
- sightings confirm the area is important habitat for Malleefowl (*Leipoa ocellata*);
- the BIF ranges in the area are important nesting areas for Peregrine Falcons (*Falco peregrinus*); and
- in areas of BIF where rock aspect and formation are appropriate, SRE invertebrate fauna are likely to present – including subterranean fauna, several unidentified land snails (submitted to Western Australian Museum) and a likely high level of SRE insect diversity.

Much of this information indicates how little work has been done on flora and fauna present in the Mt Manning area, however the table below summarises the key biodiversity values of the area.

Table 8. Summary of biodiversity values present in the Mt Manning area Banded Ironstone Formations.

Banded Ironstone Formation	Threatened Flora	Priority Flora	Endemic Flora*	TECs	PECs	Threatened and Priority listed Fauna	Restricted Fauna
Helena & Aurora	2	12	6	-	6	4	7
Mt Jackson	2	7	4	-	4	2	4
Windarling	2	2	2	-	4	1	2
Mt Manning	-	5	1	-	1	-	-

Environmental assessment process for mining at Windarling

In December 2002 the EPA released its advice and recommendations to the Minister for the Environment and Heritage (Bulletin No. 1082) on the environmental factors relevant to the proposal by Portman Iron Ore Limited to expand the existing Koolyanobbing iron ore mine by commencing new mining at Mt Jackson and Windarling Range (114 km to the north) and linking the new minesites to Koolyanobbing by a haul road or railway.

The EPA determined that the conservation of biodiversity and also the conservation of landscape and geoheritage values, as being the two primary environmental factors relevant to the proposal and requiring detailed evaluation. The EPA acknowledged the outstanding conservation significance of the ranges in this area which, because they have been isolated over geological time, are biogeographical “islands” with distinct and often unique species and communities of plants. Both Windarling Range and Mt Jackson had been included in the former CALM’s (1994) recommended western extension of the Mt Manning Nature Reserve.

Extensive flora survey work undertaken by the proponent as part of the assessment process provided a relatively high level of information on the threatened flora species *Tetratheca paynterae* in the Windarling Range as well as the vegetation communities present. Both *Tetratheca paynterae* and the vegetation communities are unique to that range. The consideration of impacts on threatened flora is a responsibility of the EPA in its assessment process, but also a requirement for consideration by the Minister under the Wildlife Conservation Act 1950 and a trigger for assessment under



Helena and Aurora Range Photo – Colin Yates

the Commonwealth EPBC Act. The Commonwealth determined that the proposal was a “controlled action” and accredited the State to conduct the environmental assessment process.

Following release of the PER, a number of modifications to the proposal were made by the proponent, including:

- the reduction of the mine size at Windarling to reduce the impact on the threatened flora *Tetratheca paynterae* from 89% to 60% of the species population; and
- replacement of the railway line between the proposed minesites and Koolyanobbing with a haul road (with rail remaining a future option).

The then CALM informed the EPA during the assessment process that if mining were to proceed in the Windarling Range as proposed, the impacts on the threatened flora would change its conservation status

from “endangered” to “critically endangered” under the IUCN criteria, even in the case of the proponent’s proposed option to reduce the impact on *Tetratheca paynterae* from 89% to 60%. CALM also advised that the impact of the proposal on the unique vegetation communities of the Windarling Range could result in one vegetation community becoming “critically endangered” and two others becoming “endangered” under the IUCN criteria.

The EPA acknowledged in its initial advice that it could not responsibly recommend to the Minister that a proposal be judged to be environmentally acceptable where that proposal would remove plants of a species to an extent that the species would become “critically endangered”.

The EPA recommendations submitted to the Minister for the Environment and Heritage (Bulletin No. 1082) in 2002 included:

- whilst the mining impacts on biodiversity could be managed to meet the EPA’s objectives at Mt Jackson they could not meet the EPA’s objectives at Windarling Range.
- the Windarling Range is the habitat of the threatened flora species *Tetratheca paynterae*, which is only found at Windarling Range and is classified as “endangered” under the internationally recognised criteria established by IUCN and that, if implemented, the proposal would have impacts at Windarling Range which would change the status of *Tetratheca paynterae* to “critically endangered”.
- there are a number of vegetation communities which are unique to Windarling Range, and that these communities would also be substantially impacted by the proposed mining - one community would be classified “critically endangered” and two communities would be classified “endangered” under the criteria established by the IUCN.
- the proponent engaged the Botanic Garden and Parks Authority and the University of Western Australia to undertake studies on *Tetratheca paynterae* with a view to demonstrating that conservation of the species in the wild could be achieved, with the ultimate objective of re-establishing the species in suitable habitats after mining. However, the EPA noted that the research would need to be extended to include

the unique vegetation communities and that, even with an extensive research program, it may not be possible to achieve a successful outcome.

- mining should not be undertaken in the Windarling Range unless, through an appropriate and comprehensive research program, it can be demonstrated to the satisfaction of the Minister on advice from the then CALM that other measures can be adopted to ensure conservation of *Tetratheca paynterae* and the vegetation communities in the wild.
- that mining could take place at Mt Jackson provided conditions were introduced pursuant to the *Environmental Protection Act 1986* to ensure ‘best practice’ in environmental outcomes, including protecting biodiversity values.

Whilst commending Portman Iron Ore Limited for its professional approach in relation to the environmental significance of the Windarling Range, the EPA did not include at that time ‘conditions and procedures to which the proposal should be subject’, due to the EPA view that the proposal as described should not be implemented. The EPA recommended that the Minister not issue a statement that the proposal as described may be implemented.

An additional issue that was raised by stakeholders during the environmental assessment process was the importance of the proposed mining operation to the activities of the Port of Esperance and the wider region. This issue is outside of the scope of the EPA’s role, however it was considered appropriate that the EPA make the Minister aware that there are additional matters which may be relevant to the Government’s decision-making process in relation to the proposal by Portman Iron Ore Limited.

Subsequent to the appeals process, in June 2003 the Minister for the Environment issued a Statement that a Proposal May be Implemented (Statement No. 627) for a modified proposal.

The approval for the project to proceed was on the basis of mining to be totally excluded from part of the Windarling site (Area A) in order to ensure the viability of the *Tetratheca paynterae*. This exclusion zone contains 50% of the total population, of 2,852 plants. A second area (Area B) contained 20% of the known population and requires further approval from

the Minister to access. Mining outside of Areas A and B could proceed, with the direct loss of 30% of the *Tetratheca paynterae* population.

Additional conditions provided with the approval that the proposal may be implemented included:

- development of a *Tetratheca paynterae* Research and Management Plan and Recovery Plan, with implementation of the plans demonstrating that ground-disturbing activity will not affect the viability of the population;
- monitoring of numbers of *Tetratheca paynterae* individuals, their health, viability, and reproductive success;
- provision of secure conservation tenure for the remaining population of *Tetratheca paynterae*;
- development of a detailed risk management plan to avoid indirect impacts on the remaining population of *Tetratheca paynterae*;
- research into the ecology, potential translocation and pollination vectors of *Tetratheca paynterae*;
- implementation of a monitoring program on the health and viability of the restricted vegetation communities and flora and fauna of particular conservation significance, research into the ecology and potential rehabilitation of restricted vegetation communities, and management activities linked to performance criteria aimed to ensure long term conservation and recovery of restricted vegetation communities and flora and fauna of particular conservation significance; and
- development of multiple management plans, including a Malleefowl conservation plan, land clearing management plan, dust management plan and the employment of an environmental coordinator.

Guidance was also given that the relevant Ministers were to collaborate to facilitate the timely implementation of key aspects of the former CALM's Goldfields Regional Management Plan (1994-2000), in particular, the progression of the proposed extensions to the Mt Manning Nature Reserve, incorporating the Helena and Aurora Range, Marda Dam, Pigeon Rock, Deception Hill, Bungalbin Hill, Boodine Hill, Muddaring Hill, Yenyanning Hills, the Yokradine Hills system and the Die Hardy Range.

EPA Section 16(e) Advice on Nature Reserves in the Mt Manning Region

In December 2004 the then Minister for the Environment and Heritage requested advice from the EPA under section 16(e) of the Environmental Protection Act 1986 on the proposed extensions for the Mt Manning Nature Reserve. The request asked specifically for advice on the location of the highest conservation values on the proposed extensions to the Mt Manning Nature Reserve and the surrounding areas which require protection from extractive industries as well as those areas in the proposed extension for which there is potential for environmental offsets.

The EPA (in Bulletin 1256) identified the difficulties in identifying (preferably like for like) offsets for projects such as Koolyanobbing, where each BIF range has unique biodiversity values and also multiple tenement owners.

The objectives of the review were determined to be (from EPA Bulletin 1256):

1. "Compile information about the distribution of rare, priority and other significant taxa from existing flora, vegetation and fauna data and consultation with biological survey scientists.
2. Map spatial information (vegetation types, rare/priority/other significant flora, fauna etc.),
3. Assess significance of rare or possibly endemic fauna and identify key fauna habitats as best possible with existing data.
4. Identify plant communities (associations) landforms and animal habitats that are not well represented in other conservation reserves. This will necessarily occur at the fairly coarse scale of the update of Beard's Vegetation mapping.
5. Use State, National and International criteria for recognising areas of natural and aboriginal heritage significance, geodiversity and scientific importance.
6. Identify areas of highest environmental significance using CAR objectives.
7. Review effectiveness of proposed reserve boundaries for protection from extractive industries and propose additional areas for inclusion if appropriate.

8. Assess appropriate conservation mechanisms for areas of high conservation value, while recognising the existence of mines and mineral leases.
9. Propose a strategy to deal with biological values (especially rare, priority and endemic flora and fauna) in areas of high mineralogical value, as requested by Minister.”

The report notes the Mt Manning area to be of very high biodiversity significance and explains why the area is a ‘Biodiversity Hotspot’ (from EPA Bulletin 1256).

1. “The region has highly diverse landforms, geology, soils, topography and hydrology with granite, woodlands and sandplain areas similar to those in the wheatbelt, as well as typical goldfields habitats such as acacia woodlands, in addition to ranges and salt lakes. This landform/soil/geological diversity equates to biodiversity because each habitat type has characteristic species.
2. The Mount Manning Region is located close to centres of diversity for large families such as the *Asteraceae*, *Chenopodiaceae*, *Cyperaceae*, *Mimosaceae*, *Myrtaceae* and *Myoporaceae*. These families include genera with many species in the region (e.g. *Acacia*, *Eucalyptus* and *Eremophila*), as well as genera with many unnamed taxa (*Baeckea*, *Astartea*, and *Lepidosperma*).
3. The area contains refugia (BIF ranges and hills) where relictual taxa occur, following isolation by a drying climate and/or specialisation to specific restricted habitats (eg BIF). These refugia are “islands” unlinked by effective corridors or long-range seed or pollen dispersal. Examples of relictual taxa include *Tetratheca* and *Lepidosperma* species restricted to a single range.
4. The transitional rainfall zone between the Southwest and Eremaean Botanical Provinces corresponds to the limits of distribution patterns for many plants and plant communities of the goldfields or wheatbelt (Fig. 3).

5. This region also has specialised rare species with narrow distributions in a band running from Geraldton to east of Esperance corresponding to the edge of the south west agriculture and forests region (Fig. 3).
6. As in other WA hotspots, high diversity is also linked to highly infertile soils and a long geological history without major tectonic or glacial disturbance (Hopper & Gioia 2004).”

The report concludes that the core area of the Mt Manning Region, containing most of the BIF ranges, is an area of exceptional biodiversity value of equal importance to any other area of Western Australia. This is due to (from EPA Bulletin 1256):

- “Endemic species including Declared Rare and Priority Flora.
- Endemic species likely to meet criteria to become DRF.
- A number of undescribed or newly described taxa.
- Unique vegetation communities restricted to single BIF ranges.
- A transitional zone between goldfields and wheatbelt vegetation, with many species and communities at range ends.
- Habitats for fauna species, especially those occupying restricted habitats or declining in the wheatbelt.”

The report concludes with Recommendations including (from EPA Bulletin 1256):

- 1) “The Mount Manning Region (MMR) be recognised as a Biodiversity Hotspot for its combination of high levels of species richness, concentration of rare and endemic flora, restricted ecological communities and the threatening processes associated with the mineral potential of the BIF Range environments, which coincide with the highest concentration of threatened and endemic species and communities in the region.
- 2) Areas of the highest conservation value and surrounding areas in the MMR be protected from mining by:
 - Establishing an A Class Nature Reserve to include the highest priority conservation areas, as outlined in Table 13 and Map 4 below.

- Defining temporary exclusions for mining and mining infrastructure in the proposed A Class Nature Reserve in areas where mining is currently approved. These areas should become part of the Reserve after successful rehabilitation (consistent with the approach of Ministerial Statement 627).
 - Proponents be advised that proposals for further mining in areas of the highest conservation value are unlikely to be found environmentally acceptable.
- 3) Renewal of mineral tenements and granting of new tenements should not be supported in the proposed A Class Nature Reserve.
 - 4) The precautionary principle be applied in relation to proposals to offset loss of highly habitat specific BIF endemic species through translocation to other sites, as each BIF range generally has its own endemic species occupying equivalent habitats.
 - 5) The 32 flora taxa considered on existing information to be endemic to small areas in this region be assessed for threatened flora listing, in recognition of the increased threats to species endemic to BIF ranges (these taxa are designated as PR in Table 6). This review should take into account the degree of protection offered by the A Class Nature Reserve, once it is established.
 - 6) Further flora and vegetation surveys be undertaken to better define the status of:
 - a) Apparently rare and endemic flora.
 - b) Large areas of sandplains and woodlands not adequately surveyed within the MMR, and
 - c) Rare flora and communities in Jaurdi and Mt Elvire Conservation Parks.

7) The MMR be surveyed for Short Range Endemic fauna (especially invertebrates)."

"Table 13. Reserve Recommendations listed in order of importance" (From EPA Bulletin 1256).

No. on Map 4	Conservation Reserve or location	Action	Key Factors
1	That part of the Helena & Aurora Range Conservation Park, as shown on Map 4	Reserve area as an A Class Nature Reserve for protection of high concentrations of endemic rare flora and Priority Ecological Communities, exceptional landforms, threatened fauna habitats, mature eucalyptus woodlands that are declining in the Wheatbelt and Aboriginal heritage.	1, 2, 3, 4, 5, 6, 7, 8
2	Part of the Helena and Aurora Range Conservation Park, the proposed Die Hardy Range /Mt Jackson Conservation Park, as shown on Map 4	Reserve as an A Class Nature Reserve for protection of endemic rare flora, extensive ecotone between Eucalypt woodland and Mulga shrubland vegetation demonstrating the interzone between the South-West and the Eremaean Botanic Provinces, as well as exceptional landforms, fauna habitats and Aboriginal heritage. See also separate recommendations for Jackson, Die Hardy and Windarling Ranges below.	1, 2, 3, 4, 5, 6, 7, 8
2a	Part of Jackson Range	Reserve the area of Jackson Range and surrounds identified on Map 4 as an A Class Nature Reserve to protect core areas of threatened and endemic flora and maintain ecological connectivity within ranges for rare flora. 5, 6, 8	1, 2, 3, 4,
2b	Non-mined areas of Windarling Range	Include remaining unmined parts of the Windarling Range within the A Class Nature Reserve, consistent with the requirements of Ministerial Statement 627, to protect remaining populations and habitat for endemic threatened flora and significant landforms.	1, 2, 3, 4, 5, 6, 8
2c	Die Hardy Range and Yorkradine Hills	Reserve the Die Hardy Range and Yorkradine Hills within the proposed A Class Nature Reserve, especially to protect endemic rare flora and significant landscape values.	1, 2, 3, 4, 5, 6, 7, 8
3	Mount Manning Nature Reserve	Reclassify the Mount Manning Nature Reserve as A Class and amalgamate with Reserves established over areas 1 and 2a,2b and 2c as a single A Class Reserve. Investigate the inclusion of the Mount Manning Range in this consolidated Reserve.	1, 2, 3, 4, 6, 7
4	Southern end of Koolyanobbing Range	Reserve at least 5 km of the southeast end of the Koolyanobbing Range in A Class Nature Reserve, with a linkage to Jaurdi Conservation Park via Lake Seabrook, to protect the habitat and populations of endemic threatened flora and outstanding landscape values.	1, 2, 3, 4, 5, 6, 7, 8

5	Yendilberin and Watt Hills/ Proposed Jaurdi Conservation Park	Further investigation of the current Conservation Park recommendations to ensure adequate conservation of rare and endemic flora and other significant factors.	1, 2, 3, 4, 5, 6, 7, 8
6	Proposed Mt Elvire Conservation Park		
7	Parts of Lake Barlee and Lake Seabrook	Extend Jaurdi and Mt Elvire Conservation Parks to include the full catena of landforms and environments, to protect habitats of rare species and particularly Lake Barlee as a wetland of national importance.	2, 3, 4, 5, 6
8	Area of UCL south of Helena & Aurora Range and east of Jaurdi Conservation Park	Consolidate the MMR reserves as identified on Map 4, by including extensive areas of exceptional sandplain vegetation, granite and Eucalyptus woodlands on UCL in areas (outside BIF and greenstone belt) north of the Koolyanobbing Range.	2, 3, 4
9	Remainder of Jackson and Die Hardy Ranges	Further investigate the need to extend the A Class Nature Reserve (recommended in 2 above) to the west and south to include the remainder of the Jackson Range and north to include all of the Die Hardy Range to provide further protection and adequate buffers for rare flora and plant communities.	1,2,4,6

Note: Key reservation factors used above:

1. Rare flora endemic to BIF range.
2. Endemic rare flora in sandplains, woodlands or other habitats.
3. Important habitat for specially protected fauna.
4. Excellent representation of woodland, sandplain and other inadequately reserved vegetation and animal habitats.
5. Aboriginal Heritage sites.
6. Substantial landforms with significant visual amenity.
7. Historical significance.
8. Geoheritage significance.

Conclusion

The proposal at Windarling originally sought to remove 60% of the population of *Tetratheca paynterae*, a species of very restricted distribution and with a small total number of plants (2,852). The EPA initially advised that this level of impact was unacceptable however, on appeal, a final level of impact deemed acceptable was a loss of up to 50% of the population, with an initial 30% loss to occur, with the remainder subject to research outcomes. In comparison, the Mt Gibson proposal sought to remove 46.5% of the threatened species *Lepidosperma* sp. Mt Gibson, and 10% of the threatened species *Darwinia masonii*. The distribution of *Lepidosperma* sp. Mt Gibson is larger than the *Tetratheca paynterae* at Windarling, and the numbers of rare plants is greater at Mt Gibson, with an estimated 8,200 *Lepidosperma* sp. Mt Gibson and 16,038 *Darwinia masonii* plants. The EPA advised that this level of impact was acceptable on the condition that the remainder of the species habitat is protected, however again this outcome was subject to an appeal process. These two different examples illustrate the difficulties of case by case assessment of biodiversity impacts within the Midwest BIFs.

Key considerations that will need to be addressed in regional and project specific assessment and decision-making are the proportion of each BIF range and the proportion of each individual species population size that needs to be conserved to adequately protect biodiversity values such as unique vegetation types, rare and endemic flora and SRE fauna.



Tetratheca Paynterae subsp. *cremonobata* (Photo – Colin Yates)

However, the focus on *Tetratheca paynteri* at Windarling may have led to a lack of appreciation of other rare species present at the range and may also distract attention from other BIF ranges that will likely have equally rare species. Since the approval of this mine expansion, much more information highlighting the conservation significance of all of the BIF ranges has become available. It is now apparent that any further proposals to mine BIF ranges in the Mt Manning area would most likely result in very severe impacts on threatened species and communities.

Multiple proposals identifying the significance of the Mt Manning area and recommending reservation exist, dating back to the 1960s. These proposals have since been substantially further validated with additional data and knowledge. In particular, many additional rare species and threatened plant communities have been recognised in more recent survey work by development proponents, academic scientists and government agencies, that attest to the extremely high environmental significance of this interzone region.

15.2 Mount Gibson

Background

The Mt Gibson range is located approximately 350 kilometres north-east of Perth, in the central Midwest region of Western Australia. Extension Hill and Extension Hill North are part of a ridge of BIFs within the range. Mount Gibson Mining Limited has proposed to mine and process iron ore (hematite and magnetite) from Extension Hill and Extension Hill North. Relatively extensive flora and vegetation survey work has been completed at Mt Gibson due to the proposed development and it has been recognised that there is the potential for a high degree of impact on biodiversity values. None of the vegetation communities that have been identified at Mt Gibson range are protected within the conservation reserve system.

Flora and vegetation values

The Mt Gibson range occurs in the southern part of the Yalgoo IBRA region, in an area defined as an interzone between south-west bioregions and the Murchison IBRA region. The vegetation communities found on Mt Gibson are unique in several ways:

1. Survey work and analysis conducted by DEC (as part of the regional flora survey) and ATA Environmental Consultants (as part of a development proposal assessment process) have shown that the communities found on the ridges and hilltops of Mount Gibson do not occur on other BIFs within the surrounding areas, such as Yandhanoo Hills or Mount Singleton.
2. Survey work conducted by DEC on the banded ironstone ranges on the Yilgarn Craton to the north and west (Blue Hills, Windanning, Koolanooka Hills etc.) did not locate any communities found on Mount Gibson.
3. Endemic species, namely *Darwinia masonii* and *Lepidosperma* sp. Mount Gibson, are only found in the communities on Mount Gibson, thereby adding to their distinctiveness.

A summary of the unique flora and vegetation values of the Mount Gibson Ranges is as follows (adapted from Meissner and Caruso 2006):

- 233 native taxa determined from the DEC regional flora survey and 285 species present from the proponent data;
- Two threatened flora, *Darwinia masonii* and *Lepidosperma* sp. Mt. Gibson are endemic to (found only at) the Mt Gibson range, occurring across the entire range, growing on rocky crests and upper slopes;
- Seven priority flora:
 - *Acacia cerastes* (Priority 1) is only known from Mt Gibson Range and several granite outcrops near Mt Gibson (close to endemic to the range);
 - *Rhodanthe collina* (Priority 1), a poorly collected species, found growing on the slopes and crests of Yandhanoo Hills;
 - *Dodonaea* sp. Ningham (Priority 1), collected from only two sites on Yandhanoo Hills;
 - *Micromyrtus* sp. Warriedar (Priority 3), known only from 10 records in the WA Herbarium and collected only from BIF ranges in the Yalgoo IBRA region;
 - *Persoonia pentasticha* (Priority 2), previously recorded from Mt Gibson Station and other BIF areas;
 - *Podotheca unisetata* (Priority 3), collected from a single site on Mt Gibson; and
 - *Austrostipa blackii* (Priority 3), recorded from

- only one site on Yandhanoo Hills;
- Four additional species (*Baেকেa* sp. Mt Gibson, *Calandrinia* sp., *Hibbertia* aff. *rostellata* and *Hibbertia hypericoides*) are of interest for further taxonomic review;
- Five species, including the priority species *Austrostipa blackii*, were found to have significant range extensions (>100 km from previous known locations);
- Seven plant community types present, four of which occur only on the Mt Gibson Range, and two of which are restricted to specific parts within the range.

Geographical location was a strong influencing factor in community types and this geographic patterning was largely consistent with those described in the floristic survey conducted by the development proponent.

Nominations are being prepared for some of the communities (those that appear to meet the criteria for listing as TECs) that occur on the ridges and hilltops of the Mt Gibson range, as identified through work conducted by DEC and ATA Environmental (2006). The nominations are for communities for which there are good data from field survey and analysis, and these data indicate that the communities are highly restricted in distribution, and a major proportion of the community is subject to threatening processes such as proposals to clear.

Extension Hill environmental assessment process

The EPA released its report and recommendation (EPA Bulletin 1242) in November 2006 on the Extension Hill iron ore mining project at Mt Gibson.

The EPA report recommended approval for the project as proposed, acknowledging that 47% of the species *Lepidosperma* sp. Mt Gibson would be lost. The EPA recommended that the Extension Hill proposal should proceed on the condition that the remaining ridges of BIFs in the Mt Gibson area with sub-populations or suitable habitat for *Darwinia masonii* and *Lepidosperma* sp. Mt Gibson (both species found only at Mt Gibson), and suitable habitat for the remaining restricted floristic vegetation communities (four plant

communities found only at Mt Gibson) are protected in the formal conservation estate as a class A nature reserve (none of the Mt Gibson ranges are currently in conservation reserves).

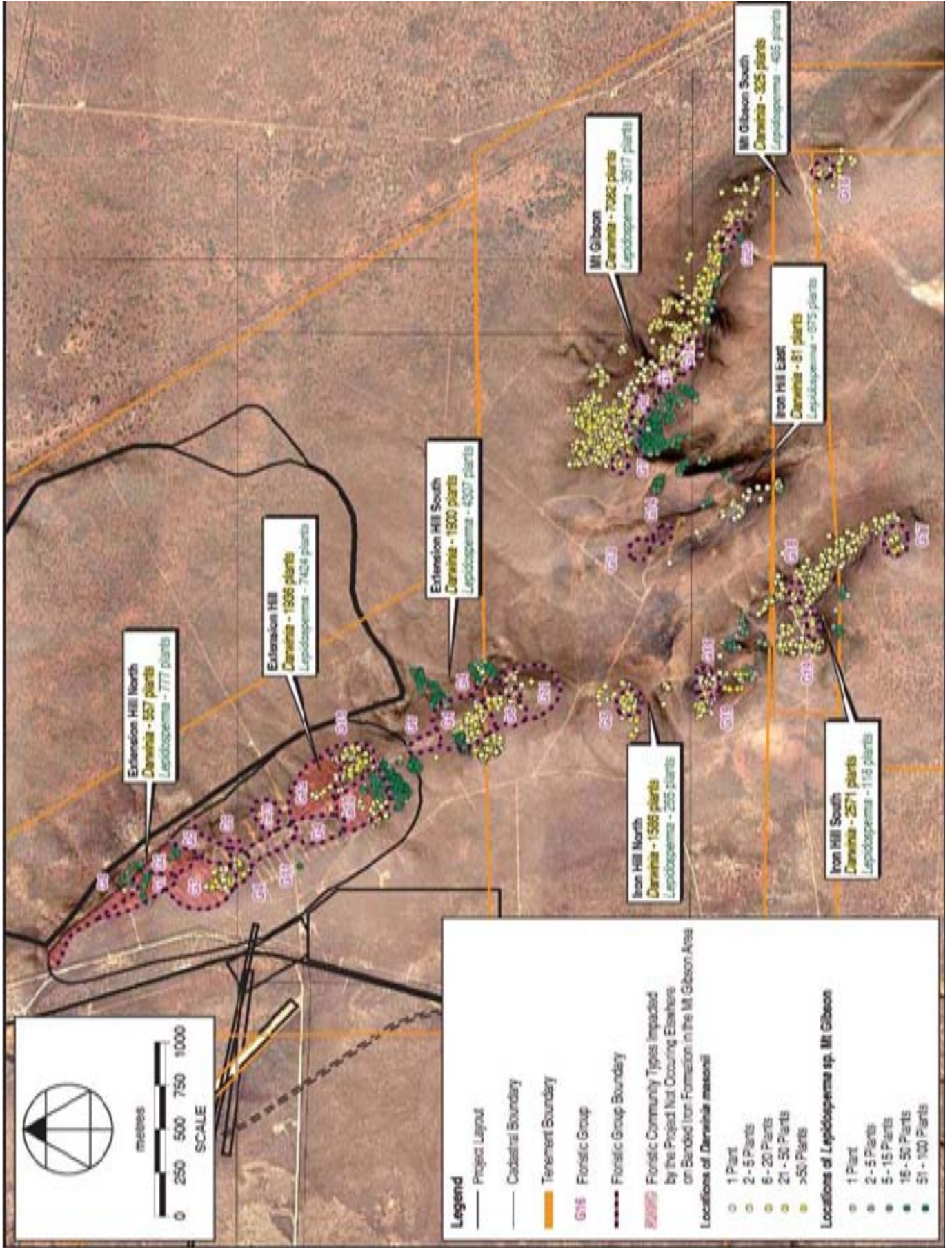
Current estimates indicate that vegetation clearing for the proposed Extension Hill mine footprint would impact on 8,200 plants (about 47 percent of the known population) of the endemic species *Lepidosperma* sp. Mt Gibson. Approximately 12 percent of the known population of the endemic threatened flora *Darwinia masonii* would also be impacted by the project, reducing the known population of 16,038 plants, down to 13,545 plants.

Government agency advice provided to the proponent throughout the environmental impact assessment process was based on the advice from the proponent that the scale of planned development had been reduced in recognition of the environmental values and sensitivities of the area. As such, the assessment process did not consider or allow for a Stage 2 extension to the project.

The Minister for the Environment has recently issued the final environmental conditions for this project following the determination of appeals against EPA Bulletin 1242. The Minister (in consultation with the Minister for Resources) determined that the southern ridges of Mt Gibson and Mt Gibson South require immediate long-term protection and should be reserved as a class 'A' nature reserve.

The Ministerial statement includes a number of conditions aimed at protection of flora and fauna values impacted by the project, including conditions requiring the development and implementation of research and recovery plans for *Darwinia masonii* and *Lepidosperma* sp. Mt Gibson.

Any future proposals for mining or other development within the central ridges of Iron Hill East, Iron Hill South, Iron Hill North and Extension Hill South will be subject to the environmental assessment and native vegetation protection provisions of the *Environmental Protection Act 1986*.



Assessment of threatened flora and floristic communities at Mt Gibson

Mt Gibson was one of seven BIF ranges surveyed in the first year of the DEC regional flora survey. The study area covered the extent of Mt Gibson, Yandhanoo Hills and several smaller hills on the Ninghan pastoral lease. The main aim of the survey was to place the plant communities found at Mt Gibson in a regional context with other ironstone ranges throughout the Yilgarn Craton (Meissner and Curuso 2006).

The DEC regional analysis is not sufficient for site specific environmental impact assessment of a development proposal – far more detailed survey and analysis at a site specific level is required. The DEC data analysis was of a dataset of 50 plots, compared to 100 plots surveyed by the Extension Hill proponent, to create a more detailed site impact dataset. The DEC results supported the findings of the proponent report in that the vegetation of the Extension Hill – Mt Gibson area is not replicated elsewhere in the region. The conclusion from the plot-based survey work is that the Mt Gibson hilltops are important habitat for unique communities of native plants and for at least two endemic species.

The classification of plots into groups (generally referred to as floristic communities) relies on the establishment of a sufficient number of plots to reasonably cover the geology, geomorphology and floristic variability found in the study area. These floristic communities can then be used as the base planning units and have the advantage that any analysis is repeatable, can be analysed at a variety of scales and the classification can be refined as more data become available.

This type of approach is particularly suited to the very diverse and rapidly changing vegetation systems in Western Australia, where there is often little correlation between floristic communities and coarser scale vegetation maps. The other significant advantage is that the concentrated survey effort allows for the identification of new taxa, of range extensions and of new populations of threatened and priority taxa.

The media reported on statements made by stakeholders to the Mt Gibson assessment process that the degree of differentiation of floristic communities is a significant impediment to development and that the methodology used was inappropriate. However, the floristic communities at Extension Hill were shown to be clearly distinct and recognisable communities, using accepted scientific techniques that have been well established internationally and in Australia for over 40 years.

Some variation in floristic community classification can occur, depending on the number of plots sampled, the objectives of the survey and the data analysis methodology. In the case of the Mt Gibson data, it is clear from the different analyses conducted that very strong geographical patterning is present. Analysis based on the available dataset indicates that at least two vegetation units occur on the Extension Hill North area (to be largely removed by the mine footprint) which are not represented anywhere else.

The analysis showed that the three areas of Extension Hill North, Extension Hill East and Iron Hill East had some similarities to one another and were significantly different to all other ranges. Further analysis of the data indicated that Extension Hill North should be separated into two areas (northern and southern sections). This gave four areas in total, with each area shown to be significantly different from one another and from all other ranges in the area. This result was not dependent on the grouping level (i.e. broader or finer groupings) that the proponent data were grouped into.

Regardless of whether the vegetation at Extension Hill North is considered as two vegetation units, or further subdivided to a greater number of floristic communities, it is clear that significant biodiversity values will be lost with development of the proposal, with severe impact on at least two very restricted vegetation communities.

Conclusion

The EPA's recommendation to secure lands within the conservation reserve system was based on protecting the remaining 53% of the entire population of *Lepidosperma* sp. Mt Gibson, the remaining 85% of the entire population of *Darwinia masonii*, and the ecosystems that support these populations (i.e. associated floristic communities). The EPA recommendations for Mt Gibson would still result in the complete loss of a number of floristic communities at Extension Hill.

Determining what constitutes a floristic community is a separate process to that of determining the acceptability or otherwise of impact or loss. The former involves a required level of biological data and a scientifically robust process, whereas the latter involves using this information to make informed judgments about acceptable or unacceptable actions and their impacts. Judgments have to be made on a case by case basis.

In this instance, the interpretation and conclusions drawn from the Mt Gibson dataset are scientifically rigorous and defensible in terms of contemporary ecological theory. The data analysis has been used to form the position that the protection of the rare species over the remaining portion of the Mt Gibson ranges requires commensurate protection of associated floristic communities in order to preserve ecological processes (such as the pollination of flowers) and habitat that may be critical to the long-term survival of these species in the wild. This is notwithstanding a need to preserve an intact portion of the Mt Gibson Range in accordance with recognised conservation principles as outlined in this report.

15.3 Blue Hills area

Background

The Blue Hills area encompasses a number of ranges in the central Midwest area, including:

- Mt Karara / Mungada Ridge / Blue Hills
- Warriedar Hill / Pinyalling
- Minjar / Gnows Nest

The area is subject to multiple mining leases owned by several different companies. The most significant projects currently proposed are Mungada Ridge Hematite (Gindalbie Metals), Mt Karara Magnetite

(Gindalbie Metals) and Koolanooka and Blue Hills Remnant Direct Shipping Ore (Midwest Corporation), although several other projects are either in development or proposed, such as the Plateau Prospect (Royal Resources).

This level of proposed development has led to an increased amount of detailed information becoming available on the biodiversity values of the area, with substantial survey work having been completed to date by Gindalbie Metals as part of the environmental assessment process. The Blue Hills area was also a target area for the strategic level survey work in 2005 as part of DEC's regional flora survey.



Blue Hills (Photo – DEC)

Biodiversity values

Flora

The Blue Hills area occurs on the interface between the South West Botanical Province and the arid Eremaean Province. It has long been known that many undescribed (potentially new) species occur in the area and this has been supported by recent survey work. Many of the potential new species are Acacias (Wattles) and this group is being researched by DEC as part of the Biodiversity Conservation Initiative, with support from Gindalbie Metals. Potential new species include the following (Maslin 2007):

- *Acacia woodmaniorum* ms (Priority 2), a distinctive taxon that is clearly a new species, known only from a small area on top of Mungada Ridge and Jasper Hill;

- *Acacia karina* ms (Priority 2), a distinctive taxon occurring on Mungada Ridge and Mt Karara, and recorded at only one other site 'Mt Gibson Station' in 1984;
- *Acacia* aff. *coolgardiensis*, part of a complex group of species requiring significant taxonomic and geographic distribution investigation;
- *Acacia* aff. *subsessilis*, possibly related to an uncommon species *A. subsessilis*, and of unknown distribution;
- *Acacia* sp. Nov. 3, collected by development proponent consultants, the species has been found on the flats at the southern end and to the west of the Mt Karara, and requires resolution of its taxonomic and distribution position; and
- *Acacia* sp. Murchison, occurs within the former Karara pastoral lease and within the central Tallering land system (the hills and ranges occurring between Tallering Peak and Mt Gibson).

In addition to the Acacias, a number of other undescribed and priority flora that are of special interest occur in the Blue Hills area, including the following (adapted from Woodman Environmental Consulting 2006):

- *Lepidosperma* sp. (A Markey & S Dillon 3468), a new species found by the DEC regional flora survey and a development proponent, it has been recorded at Mungada Ridge, at and north of Mt Karara and at Jasper Hills, and further work is required to better determine local and regional distributions and populations sizes;
- *Calotis* aff. *cuneifolia*, first collected as part of the regional flora survey at Mt Karara, Jasper Hills, Mungada Ridge and near Minjar, *Calotis cuneifolia* was previously known at two other locations in Western Australia, however it has been determined that the Blue Hills populations are a new taxon and is hence of restricted distribution;
- *Drummondita* aff. *microphylla*, recorded as part of the regional flora survey as being present on rocky areas with ironstone outcropping on the slopes and crests of ridges mainly within Mungada Ridge, it is of uncertain conservation status but is likely to be very rare;
- Priority 1 species *Chamelaucium* sp. Yalgoo, *Grevillea subtiliflora*, *Gunniopsis divisia*, *Hydrocotyle* sp. *Warriedar*, *Melaleuca barlowii*, *Micromyrtus cuensis* ms, *Millotia dimorpha* and *Rhodanthe collina*;
- Priority 2 species *Calandrinia kalanniensis* ms; and
- Priority 3 species *Acacia acanthoclada* subsp. *glaucescens*, *Austrostipa blackii*, *Cryptandra imbricata* ms, *Grevillea globosa*, *Grevillea scabrida*, *Gunniopsis rubra*, *Micromyrtus* sp. *Warriedar*, *Persoonia pentasticha*, *Polianthion collinum*, *Stenanthemum poicilum* and *Spartothamnella* sp. Helena and Aurora Range.

For the undescribed species such as *Lepidosperma* sp. (A Markey & S Dillon 3468), it is essential to understand both their taxonomy and distribution so that decisions can be made regarding their conservation status and to allow for informed decision making as part of the environmental assessment process. Many of the species listed above that currently have unresolved conservation status are in the future likely to be nominated for consideration for listing as either threatened or priority flora as a result of information that has become recently available.

Assessment by DEC of floristic information provided as part of a specific assessment process illustrates the types and complexity of issues that are raised during the assessment process. Floristic issues encountered in assessment of proposed development in the Karara/Mungada area included:

- *Acacia* aff. *coolgardiensis*: estimates of percentage of population range to be impacted considered to be underestimated, and more intensive survey is recommended by DEC to ensure design of infrastructure will minimise development impacts on a given species;
- *Acacia woodmaniorum*: more intensive survey being recommended where significant impacts are likely, to determine actual population distribution and density;
- *Acacia karina* ms: recommendation to further justify impact percentages, where the development of a mine pit appears to remove a significant proportion of the species;
- *Austrostipa blackii*: significant local impact due to the only known occurrence at Mungada being totally removed, resulting in a recommendation to better quantify nearby occurrences of the species to allow

- for determination of regional conservation impact;
- *Calotis* aff. *cuneifolia*: significant local and regional impact identified due to all populations in immediate area being impacted by pit or infrastructure development, and southern half of known range being impacted;
 - *Drummondita* aff. *microphylla*: the estimated 1,000 plants in the project area appear to be the main area for the species, indicating it is very rare and significant impact is anticipated, further survey information and population quantification is required;
 - *Grevillea globosa*: DEC is of the view that there is potential for impact to occur, with a Karara occurrence located within a development area and two other occurrences located near infrastructure;
 - *Lepidosperma* sp. (A Markey & S Dillon 3468): percentage of habitat range to be impacted may be underestimated, as distribution shows major concentration of species associated with proposed pit areas, further quantification has been recommended;
 - *Micromyrtus cuensis* ms: potential impact may be underestimated, as species is concentrated around proposed Mungada pits, further quantification has been recommended;
 - *Micromyrtus* sp. Warriedar: potential impact may be underestimated, as species is concentrated around proposed Mungada pits, further quantification has been recommended;
 - *Millotia dimorpha*: one population is entirely located within proposed pit area, hence significant local impact, further quantitative information required to determine regional context of conservation impact; and
 - *Polianthion collinum*: the high potential for local impacts requires further quantification against other regional occurrences of the species.

The DEC regional flora survey (Markey and Dillon 2006) identified a total of 335 taxa within Mt Karara, Windarling Ridge and Jasper Hill survey areas, significantly higher than the 143 taxa previously recorded for the Karara – Windarling area. Twelve taxa of conservation significance were documented in the broader Blue Hills area, four of which had not previously been recorded in the area, and also nine unnamed taxa. Five regional endemic and near endemic taxa were found over the Mt Karara, Windarling Ridge, Jasper Hill area, and several

species with significant range extensions were found.

Vegetation and Plant Communities

The broader Karara – Mungada project area has been extensively investigated by the proponent with respect to floristic community types (FCTs). In this instance, 21 FCTs have been identified, five of which were rated by the proponent to have a moderate to high conservation significance and three rated as high. For these FCTs, varying levels of impact may occur, with up to 43.9 percent of each FCT area proposed to be disturbed by development, including 38.2 percent to be disturbed for one of the FCTs rated as being of 'high' conservation significance.

Eight floristic community types were found in the DEC regional flora survey, strongly associated with topography and with geographical restriction influenced by climatic gradient. The regional flora survey work is of a broader scope and at less intensity than development proponent driven survey work, and the authors suggest that further subdivision of some of the FCTs is possible.

Fauna

The Blue Hills area contains substantial areas of important fauna habitat, a notable example being the western lower slopes of Mungada Ridge. This habitat value is a result of the presence of unique or restricted FCTs and landforms, with fauna species specialising to adapt to these habitat parameters/ecological niches.

Fauna investigations completed on behalf of Gindalbie Metals have identified that 261 species of vertebrate fauna may occur in the Mt Karara/Mungada Ridge/Blue Hills area and survey work confirmed that two frogs, 38 reptiles, 75 birds and 18 mammals were present (Bancroft and Bamford 2006), with some of these species identified as dependent on the ironstone ridges.

Significant fauna present in the area is stated to include:

- 9 vertebrate species of high conservation significance under the EPBC and / or Wildlife Conservation Acts, including Gilled Slender Blue-tongue, Western Spiny-tailed Skink, Malleefowl,

- Peregrine Falcon and Major Mitchell's Cockatoo;
- 8 priority vertebrate species including White-browed Babbler;
- 15 vertebrate species considered to be locally significant due to their distribution including Western Yellow Robin, Gilbert's Whistler, Golden Whistler, and Woolley's Pseudantechinus; and
- the Shield-backed Trapdoor Spider; and
- four short range endemic invertebrates, the millipede *Antichiropus* sp.nov.'PM1', the scorpion *Urodacus* sp.nov.(Mt Gairdner), and two *Mygalomorphs* including the Shield-backed Trapdoor spider (*Idiosoma nigrum*) and an undescribed species of the genus *Aname*.

Many of these species are dependant on the ironstone ridges and dense vegetation associated with the BIFs in this area, with some species potentially less capable of coping with habitat loss and fragmentation than others, such as Gilled Slender Blue-tongue, Woolley's Pseudantechinus and Peregrine Falcon. Other species that would be subject to habitat loss with the development of mining infrastructure and stockpiles are of high conservation significance, such as the Malleefowl and Shield-backed Trapdoor Spider. Additionally, it is not fully understood how species such as the millipede *Antichiropus* PM1 and the Desert Trilling Frog would be affected by changes in hydrology as a result of any mining development in this area.

Current and proposed development at Blue Hills

Three main projects are proposed and / or in progress within the Blue Hills. The Mungada Ridge Hematite and Mt Karara Magnetite projects (Gindalbie Metals), and the Koolanooka and Blue Hills Hematite project (Midwest Corporation) are nearing the commencement of the public review phase of the PER assessment. The area is subject to several other exploration or mining tenements, and other projects may further progress, such as the Plateau Prospect (Royal Resources).

Gindalbie Metals proposes to develop the Mungada hematite deposit first, followed by the more extensive magnetite deposits near Mt Karara. The proponent has adopted a thorough approach to the

environmental approval process and a willingness to provide the level of biodiversity data that is required to allow for informed decision making. The complexities of assessing floristic and vegetation communities in the context of impact assessment have been illustrated with Blue Hills. For example, the use of estimated flora population counts, and area of coverage to represent habitat area, is a valid approach for an initial assessment of potential impact on flora species, where habitat area can demonstrate potential spread and occurrence of a species. However the habitat assessment method is only valid for indicating the general level of impact, and the actual significance of impact will need greater investigation into the quality of habitat and the population density supported within and outside identified impact zones for species where a significant impact appears likely. This area of further investigation is now being pursued by Gindalbie Metals.

The importance of a dialogue between the proponent (and their consultants) and DEC being established early in the commencement of the assessment process and continuing throughout has been clearly established in this instance. Early communication ensures that methodologies being employed are practical, consistent in scientific approach and adequate to meet the information requirements for informed decision making throughout the assessment process.

Multiple proposal issues in the Blue Hills area

With multiple projects proposed for the Blue Hills area, there appears to be a strong likelihood of instances where species being impacted by a proposal being assessed are the same species to be impacted by nearby proposed exploration activity and future mining development projects, that have yet to be put forward for assessment. The impact of exploration activity and mining development in the Blue Hills area needs to be considered in a cumulative or holistic sense. The level of impact created by any given project on a specific biodiversity value may be substantially increased once the impacts on that value from nearby projects are also considered. In many instances this is currently not possible with the 'case by case' assessment of exploration and mining development proposals.

Equally, it is neither fair, nor an appropriate strategic approach by the State, to assess projects chronologically, where later projects are disadvantaged due to prior approvals.

The Blue Hills area has already been subject to a substantial level of exploration drilling, and this is likely to continue. Exploration activity to date has resulted in significant impacts including increased access, loss of landscape amenity, loss of habitat and events such as saline groundwater spills. Drill pads and associated access tracks established in the past have been excessive in size and whilst it is acknowledged that clearing practices by some proponents have been adapted to reduce the size of pads and assist with rehabilitation, the excessive disturbance prior to the introduction of these practices has not been addressed, with limited rehabilitation efforts on impacted areas having been implemented to date.

The scale of impact that is resulting in the Blue Hills area from relatively intensive infill drilling on orebody targets is considered by DEC to be significant, with some target areas appearing to be approaching 50 percent cleared. This is not considered an acceptable level of impact at the exploration stage and DEC has recommended that exploration and mining companies review their clearing and exploration techniques to achieve better outcomes.

DEC acknowledges and supports the approach by proponents such as Gindalbie Metals to report in their Proposal of Works (POWs) the clearing impact on restricted vegetation communities. In this instance the maximum impact to date for one community is 4.4 percent. DEC has recommended that any clearing for exploration purposes that is planned to exceed 5 percent of the extent of any community is subject to special consideration by DEC and the proponent as to its significance and hence acceptability of the proposed activity, including cumulative impacts where known.

It has been acknowledged for some time now that an approach to environmental impact assessment that considers cumulative impacts is of particular importance in the case of the Midwest BIFs. This requires analysis of impacts on significant flora species, FCTs and habitat types to be impacted by

any given proposed project to be conducted in the context of information on the likely impacts of other current proposals in the area. However there is limited evidence to date of this type of approach (i.e. an EPA assessment occurring in parallel with either an EPA assessment of related projects or with all required information about closely located project(s) by different proponent(s)), given the parameters of the current assessment process, namely limitations regarding assessment on a case by case basis.

Conclusion

Floristically, the Blue Hills area is of high species diversity, with many species present at either their southern, western or northern limits of their distribution, with other species documented characteristic of the interzonal area between the South West and Eremaean Botanical Provinces (Markey and Dillon 2006). High levels of endemism are also evident, and ranges located close together display relatively dissimilar communities (e.g. Mt Karara, Pinyalling and Warriedar Hills are located approximately 55 kilometres apart and display differing community types across east-west and north-south gradients).

Impacts on these unique attributes require careful consideration in the face of multiple development proposals that are often directly overlapping biodiversity values. Currently none of the Blue Hills area is protected within formal conservation reserves, although three pastoral leases in the area (Karara, Lochada and Warriedar) have been purchased by DEC for the purposes of inclusion in the reserve system, in large part due to the biodiversity values of the ranges. Most of these ex-pastoral leases are covered by exploration or mining tenements. A significant level of impact has already occurred at some sites and a strategic approach is required, rather than case by case assessment, to ensure that geographically restricted vegetation community types, endemic, priority and poorly known flora species of the Blue Hills area are afforded the appropriate level of protection.

In view of the multiple (environmental, social, economic and equity related) considerations that will likely affect potential approval of any given mining development proposal in the Blue Hills area, a strategic approach to assessments is required as a

matter of priority. The need to address cumulative impacts of multiple proposals and applying a strategic approach to project decision making will not be a simple task and would require some change to the current assessment approach, including consideration of proposed projects in comparison to one another. The capacity for this to occur through EIA processes under the *Environmental Protection Act 1986* may be limited where there are multiple proponents, but warrants further investigation.

Proponents need to be made more aware of the need for a strategic approach when preparing assessment material for an individual project, particularly the need to provide up-front information to the assessing bodies regarding the full extent of proposed or potential future developments within their mineral tenement(s). Failure to do so could result in an individual project being approved for implementation, followed by a future proposal not being approved due to cumulative impacts. Provision of up-front planning information allows proponents to be strategic in their choice of projects for assessment, as well as allowing strategic assessment of impacts on biodiversity.

Applying a strategic approach to cumulative impacts will involve quantifying local and regional biodiversity values and level of proposed impact, and potentially the approval for some proposed projects to proceed on the condition that other areas with similar biodiversity values are to be excluded from mining development. There is likely to be a specific need to establish conservative threshold impact levels for some species and FCTs that will pose consequential constraints on development. There may be a need as an interim step to place conservative limits on acceptable impacts for the proposals currently under assessment, in order to provide some scope for future equity related considerations.

16. Biodiversity conservation principles for the Midwest and Goldfields BIFs

The following principles apply when assessing biodiversity values and utilising the information to make biodiversity conservation and land management decisions applicable to the Midwest and Goldfields BIF ranges:

- Western Australia has an obligation to protect and manage biodiversity values consistent with State, national and international biodiversity conservation commitments.
- To conserve biodiversity requires the maintenance of a diversity of natural habitats and ecological processes at various spatial scales, ranging from entire vegetated landscapes to specific localised habitats.
- The conservation of biodiversity requires the maintenance of viable populations of species.
- Biological diversity is most effectively conserved in situ.
- The establishment of a comprehensive, adequate and representative (CAR) conservation reserve system is integral to the conservation of biodiversity.
- To ensure representativeness, a reserve system should include the full range of biological variation within each ecosystem, particularly remnants in the case of a fragmented landscape.
- Areas that are poorly represented in the conservation reserve system have a relatively low level of conservation protection.
- Ecosystems that are vulnerable due to a reduction in areal extent or being subject to continuing and significant threatening processes require a higher level of formal reservation.
- The reserve system needs to maximise the area of high quality habitat for all known elements of biodiversity, but with particular reference to groupings of organisms with complex habitat requirements, areas of high species diversity, natural refugia for flora and fauna, and centres of endemism.
- Threatened and priority flora, fauna and ecological communities, geographically restricted species and communities, and new species of an unknown distribution are all biodiversity values requiring enhanced levels of protection.
- The listing of species and communities as threatened requires an appropriate level of information to allow objective assessment against a recognised set of criteria.
- Decision-making processes for the definition of a CAR reserve system should effectively integrate both long-term and short-term environmental, economic, social and equity considerations.
- Optimal reserve configurations can be considered aimed at minimising economic and social cost

to the community whilst optimising environmental outcomes.

- Reserves need to be large enough to sustain the viability, quality and integrity of populations, rather than focus solely on the attainment of areal targets.
- Unique biodiversity and landscape values that are found nowhere else can not be replaced if significantly impacted or destroyed, that is, impacts may be irreversible.
- Management and mitigation of environmental impacts need to aim at preventing the loss of key biodiversity values and avoiding significant adverse impacts on critical assets.
- Cumulative environmental impacts are best avoided through strategic assessment as they will not be adequately addressed via case by case assessment.
- Biological data for impact assessment need to be provided both in a regional context and in a more detailed site specific context to allow for adequate assessment of specific biodiversity values and potential impacts.

In order to complete a more detailed assessment of specific areas (in this case Midwest and Goldfields BIF ranges), the National Reserve System guidelines should be used as a basis for identifying and selecting protected areas. These provide a framework for selecting protected areas that is based on national and State policy regarding the selection of comprehensive and representative areas. Table 9 below shows each of the questions that the guidelines state should be considered when identifying protected areas, and a response to each question in the context of the Midwest and Goldfields BIF ranges, based on best available knowledge.

17. Criteria for identification and selection of conservation reserves

The *Australian Guidelines for Establishing the National Reserve System* (Commonwealth of Australia 1999) outlines the following priorities for the development of a reserve system:

- Assessment of gaps or shortfalls in the current system of reserves.
- Assessment of the level of protection for all major ecosystems in each IBRA region, with special attention to comprehensiveness and conservation status.
- Assessment of threatening processes and risks of ecosystem loss which may foreclose future options for the conservation of biodiversity within each IBRA region.

It is clear from Section 3 of this report that the Midwest and Goldfields BIF ranges fall well short of achieving adequate levels of protection when reviewed against these priorities and hence are a key priority for assessment for reservation.

Table 9. Guidelines to be considered as a basis for identifying protected areas (after NRS 1999).

National Criterion	Applicability to Midwest and Goldfields BIFs*
Comprehensiveness	
Does the area: <ul style="list-style-type: none"> increase the comprehensiveness of the NRS at a continental scale, and to what extent? 	Yes, extensively, due to lack of reservation of this type of ecosystem and specific vegetation communities
<ul style="list-style-type: none"> add to the reservation of the full range of ecosystems recognised at an appropriate scale across and within each IBRA region, and to what extent? 	Yes, extensively, due to lack of reservation of this type of ecosystem and specific vegetation communities
Representativeness	
Does the area: <ul style="list-style-type: none"> add to the representativeness of the NRS and to what degree? 	Yes, acknowledging the unique biodiversity values found at each BIF range and hence variability across the Midwest and Goldfields BIFs
<ul style="list-style-type: none"> enable better representation of ecosystems across their geographical or environmental range within the IBRA region? 	Yes, given limited geographic range of many of the values present, and given each BIF range forms a unique ecosystem
<ul style="list-style-type: none"> include the intrinsic variability of the ecosystems it represents? 	Yes potentially, difficult to achieve without extensive reservation across the Midwest and Goldfields BIFs
Adequacy	
Does the area: <ul style="list-style-type: none"> provide long-term security for one or more ecosystems and associated species? 	Potentially yes - difficult to assess until decision making process completed
<ul style="list-style-type: none"> increase the security provided by the protected area system for one or more ecosystems and associated species, and to what degree? 	Potentially yes - difficult to assess until decision making process completed
Ecological importance	
Does the area: <ul style="list-style-type: none"> contain a high diversity or abundance of ecosystems or species? 	Yes
<ul style="list-style-type: none"> represent a centre of endemism, or refugia? 	Yes, to a high degree
<ul style="list-style-type: none"> contain habitat for rare or threatened species? 	Yes, to a high degree
<ul style="list-style-type: none"> contain areas significant for migratory species? 	No

<ul style="list-style-type: none"> • contain one or more areas which are a biologically functional, self sustaining ecological unit? • to what degree has the area been protected from, or not been subject to, human induced change? 	<p>Yes</p> <p>Varies across the Midwest and Goldfields BIFs, from very little to extensive human induced change Yes</p>
<ul style="list-style-type: none"> • does the area capture important geographic attributes such as biological interzones or environmental gradients? 	
Reserve system design	
<p>Is the area:</p> <ul style="list-style-type: none"> • based upon a bioregional assessment of reserve options aimed at maximising the comprehensiveness of the NRS? 	<p>Yes, part of the objectives of the Midwest and Goldfields BIFs Strategic Review</p>
<ul style="list-style-type: none"> • set in a landscape context with strong ecological integrity? Yes, although varies across the Midwest and Goldfields BIFs 	
<ul style="list-style-type: none"> • selected to ensure that a 'core' area is protected with an effective buffer and the provision of adequate connectivity (i.e. linkages/corridors) to other protected areas, or other areas which are managed sustainable for their natural resources? 	<p>Yes, dependent on outcomes of final decision making process</p>
<ul style="list-style-type: none"> • of sufficient extent to ensure that ecological functioning and species composition will be maintained? 	<p>Yes, dependent on outcomes of final decision making process</p>
<ul style="list-style-type: none"> • delineated to minimise 'boundary-to-area' ratio? 	<p>Yes, dependent on outcomes of final decision making process</p>
<ul style="list-style-type: none"> • designed to consider good neighbour policy and implications for on-going management? 	<p>Yes, dependent on outcomes of final decision making process</p>
<ul style="list-style-type: none"> • designed to minimise the impact of key threatening processes? 	<p>Yes, dependent on outcomes of final decision making process</p>
Economic Interests	
<p>Does the area:</p> <ul style="list-style-type: none"> • have current or likely use for the extraction or exploration of resources which may be foreclosed by declaration as a protected area? 	<p>Yes</p>
<ul style="list-style-type: none"> • make an existing or potential contribution to economic value by virtue of its protection, e.g. recreation, tourism, refuge for economically important species? 	<p>Minimal, some potential for ecotourism and recreation</p>

Indigenous Interests	
Does the area: <ul style="list-style-type: none"> contain Indigenous cultural values? 	Unassessed/unknown – some value presumed?
<ul style="list-style-type: none"> have traditional usage and/or current or potential economic value for Indigenous people? 	No?
Scientific Importance	
Does the area: <ul style="list-style-type: none"> have existing or potential value for scientific research and/or environmental monitoring? 	Yes – DEC regional flora survey and potential for far more research/monitoring value
Social Interest	
Does the area: <ul style="list-style-type: none"> have existing or potential value to the local, national or international community because of its heritage, cultural, aesthetic, educational, recreational or economic values? 	Yes, some potential for ecotourism and recreation and extensive potential for resource development
Feasibility	
Is the area: <ul style="list-style-type: none"> available? 	Potentially yes, acknowledging some areas will be contentious due to overlap with resource values
<ul style="list-style-type: none"> cost-effective in terms of acquisition, establishment and management? 	Yes
<ul style="list-style-type: none"> able to be managed to mitigate threatening processes and ensures persistence of ecosystems and species over time? 	Yes, dependent on outcomes of final decision making process

* Note that the response provided in this column is a broad response applicable in a general sense, across all of the Midwest and Goldfields BIFs. Specific responses may vary when applying the criteria to an individual BIF range.

18. Conservation reserve recommendations

18.1 Discussion

If providing recommendations to meet biodiversity conservation requirements only, the Department of Environment and Conservation would seek to add many of the Midwest and Goldfields BIF ranges to the conservation reserve system in order to protect the full suite of species, communities and ecosystems present, particularly those endemic to a specific range, and where representative examples of the landscape have no current protection, as is frequently the case. This is in accordance with recognised conservation frameworks such as those discussed in this report, including the Convention on Biological Diversity, the National Strategy for the Conservation of Australia's Biological Diversity, Australian Guidelines for Establishing the National Reserve System, National Criteria for a CAR Forest Reserve System and the draft Biodiversity Conservation Strategy for Western Australia.

For example, for the seven ranges which were surveyed in the first year of the DEC regional flora survey in 2005, based purely on biodiversity values and CAR principles, efforts would be made to reserve Mt Karara / Mungada Ridge in its entirety, specific representative areas within the remainder of Blue Hills, all of Mt Gibson and Koolanooka Hills, and representative areas of Jack Hills and Weld Range.

It is recognised however that consideration by Government of reserve proposals will seek to achieve a balance between biodiversity requirements and the economic and social benefits of strategically planned resource development. Completion of the Strategic Review (and this Interim Status Report) is a critical aspect of progressing a coordinated Government approach to the establishment of an appropriate system of conservation reserves.

If the Government determines that it will support both the development of a mining industry based on BIF ranges and the conservation of representative areas that provide for the protection of significant biodiversity values of the ecosystems associated with the BIFs, it will need to develop a regional compromise approach to reserve proposals. From the

results available to date, such a compromise outcome will be a difficult task to achieve.

The process to achieve such a compromise includes assessment of regional level plant communities as defined in the DEC regional flora survey and of sub-regional level communities as defined by detailed surveys undertaken by development proponents in consultation with DEC. It is a reality that the level of information availability across the BIF ranges will be a limiting factor in effective decision making in many instances, however the development of this Strategic Review has assisted in highlighting these gaps in the knowledge base.

It should be noted that the pre-European extent of the BIF ranges landform is a very small percent of the Western Murchison subregion (approx. 2.67%) and Yalgoo bioregion (approx. 3.28 %). The pre-European extent of the landform can not be calculated for the Avon Wheatbelt bioregion, Coolgardie bioregion and Eastern Murchison subregion due to the absence of detailed geological maps (pers.comm. DoIR 2007). Such a naturally restricted and vulnerable landform should be regarded as having a high conservation priority. As a consequence of its small area and isolated ecosystems, it would be expected that a high proportion of its total extent should be retained in order to achieve adequate conservation outcomes that provide long-term viability.

It is unlikely that it will be possible to define suitable compromise options in every instance to allow a balance between resource development and conservation of biodiversity values. This is particularly the case for ranges where areas of high biodiversity value overlay and are restricted to areas of high value iron ore resource. These areas are discussed in more detail in the section on specific reserve recommendations. Resolution of these proposals will need to be made by the State Government as part of the assessment of the Strategic Review outcomes and following the formal environmental impact assessment process and advice from the Environmental Protection Authority.

To fully protect rare flora and associated vegetation in a legal sense, the highest level of legal protection is required. This means that critical flora resources should be protected in class A nature reserves or

national parks and currently no BIF range is currently adequately protected, even in part.

Climate change has emerged in recent years as a real and current threat. Planning for biodiversity conservation in the context of climate change predictions is a new and developing science. Precautionary principles will dictate that we take a more conservative approach to the necessary extent of reserves (i.e. make them as large as possible), including in the particular case of ranges, complete altitudinal and aspect coverage, to provide for gradual changes to available habitats with climate change. Intact ranges are important for the long-term survival of rare species, especially in periods of climate change. There is no certainty that protecting parts of ranges, even 60% will be adequate to prevent extinction in the long term. This is especially the case when the most substantial landforms are lost and a range is fragmented.

If Government approves mining based on socio-economic considerations, complementary offset actions are required. In particular the enhanced protection and management of remaining areas of BIF is considered essential.

18.2 Regional reservation recommendations

The formal conservation reserve system plays a pivotal role in conserving Western Australia's biodiversity which, as is well illustrated in the Midwest and Goldfields BIFs, is both rich and with a high degree of plants and animals occurring nowhere else in the world. The State has the opportunity to create a system of parks and reserves that is truly world class.

Given the biodiversity conservation significance of banded ironstone ranges and their vulnerability to the cumulative impacts of multiple iron ore resource proposals, the following regional conservation targets are being recommended:

These criteria are in line with international and national criteria and are suggested as an absolute minimum standard.

1. No development activity to proceed in the Yilgarn Craton BIFs that would result in the IUCN threat category of any given plant or animal taxa increasing, ie. initially not being listed as threatened under any category to being listed (the three IUCN categories for threatened species being Vulnerable, Endangered and Critically Endangered), or increasing from Vulnerable to Endangered, or from Endangered to Critically Endangered.
2. No development activity to proceed in the Yilgarn Craton BIFs that would result in the IUCN Threat Category of any ecological community increasing from not being listed as threatened under any category to being listed, or where already listed (or qualifying for listing) as a threatened ecological community, having its actual or recommended Threat Category increased (ie. from Vulnerable to Endangered, or from Endangered to Critically Endangered).
3. A minimum of 15% and up to 60% of the total number of ranges should be reserved in their entirety, protecting complete examples of the landform and ecosystem. Examples of the most outstanding BIF ranges should be protected in their entirety where development has not significantly progressed, eg Karara/Mungada/Blue Hills and the Helena-Aurora Range (consistent with recommendations in EPA Bulletin 1256). The initial objective should be to conserve 15% of ranges in their entirety. At the end of the three year DEC flora survey program, a further review should be undertaken to further define the list of ranges requiring reservation in their entirety, with the objective of achieving the 60% target.
4. Conservation reserves to include at least 60% of largely contiguous ecosystem/habitat for each of the key banded ironstone species and ecological communities which are restricted to the BIF ranges.
5. Subject to recommendations 1 and 2 above, the aim of detailed mine-site planning and assessment should be to maximise the protected area of any floristic community restricted to the BIF, or dependent on the BIF for its conservation.

This would require that no development should occur in those floristic communities that are likely to be significant for the maintenance of long-term viability of threatened species and threatened ecological communities.

6. Landscape, geodiversity, Indigenous heritage values and potential for nature based tourism should be taken into account in developing a reserve system. State, national and international methodologies and criteria should be used for identifying areas of significant landscape, geodiversity, Indigenous heritage and tourism potential for protection.

Given the biodiversity conservation significance of banded ironstone ranges and their vulnerability to the cumulative impacts of multiple major iron ore resource proposals, a broad target reservation level of at least 60% (recommendation 4) of the total area of restricted banded ironstone formation range ecosystems is deemed appropriate. The precedent of 60% protection of vulnerable ecosystems was established by the 'Janis Report', *The Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia* (Commonwealth of Australia 1997).

This report also states that rare and endangered ecosystems are to be protected 'as much as is practicable'. This acknowledges that the ideal scenario for threatened species and communities is full protection in their entirety. Intact ranges are important for the long-term survival of these ecosystems and their component species including endemic and rare species, especially in periods of climate change. Species and communities restricted to small areas of essential habitat such as BIF ranges, and which are dependent on such ranges as part of their life cycle, are particularly vulnerable to threats.

There is no certainty that protecting parts of ranges, even the 60% suggested in this paper, will be adequate to prevent extinctions in the long term. This is especially the case when the most substantial landforms are lost and / or a range is fragmented. Reservation of largely contiguous unfragmented habitat is considered essential.

Due to the highly restricted distribution of several flora species and plant communities within the BIF ranges recommendation 4 above would ideally be to formally protect 100% of these occurrences. However a 'compromise' criterion of at least 60% has been suggested, that acknowledges that 100% protection of these values would be very difficult given the overlapping occurrence of mineral resources. Protecting 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 limited distribution.

Recommendation 3 above requiring that up to 60% of the ranges be protected from any disturbance in their entirety is to ensure examples of the complete landform are protected and conserved. Reserves also need to be of sufficient size and condition to ensure long-term sustainability and of appropriate tenure to secure ranges from further mining. An initial level of 15% of all ranges should be fully protected with an objective of achieving the 60% target following the final (third) year of the DEC floristic surveys.

All of the recommendations have been made according to the BIF biodiversity values as outlined in this report, the current level of protection afforded to them, and the guiding objectives and targets provided in relevant documentation such as the Convention on Biological Diversity, the National Strategy for the Conservation of Australia's Biological Diversity, Australian Guidelines for Establishing the National Reserve System, National Criteria for a Comprehensive, Adequate and Representative Forest Reserve System and the draft Biodiversity Conservation Strategy for Western Australia.

Refer to Table 10 below for a summary of reservation recommendations made here, in comparison to relevant existing criteria and precedents.

Criteria	Reservation Recommendation
Convention on Biological Diversity	10% each biome protected
National Criteria for a CAR Forest Reserve System	15% each ecosystem protected
	60% vulnerable ecosystems protected
	As much as practicable rare and endangered ecosystems protected
CAR acknowledged benchmark figure	15% overall in protected areas
Current protected area Western Australian	6.9% land area
Murchison Bioregion protected area	1.1%
Yalgoo Bioregion protected area	9.8%
Avon Bioregion in protected area	1.7%
Midwest BIFs protected area*	0%
Recommended area habitat in protected areas, for restricted BIF species and communities	60%
Recommended proportion by area of BIF ranges included in protected areas in their entirety	15% initially with a target of 60%

*Excluding the Goldfields BIFs (such as Mt Manning Conservation Park) as defined in this report.

The IUCN threat criteria should apply whether or not there is a formal threatened species or community listing, where adequate information exists on (often newly surveyed) species and communities.

18.3 Reserve design considerations

The way in which a reserve is designed can influence not only the protection of conservation values, but the efficiency and effectiveness of subsequent management for conservation within the reserve. *The Australian Guidelines for Establishing the National Reserve System* (Commonwealth of Australia 1999, see Section 2.2.2) and the *Nationally Agreed Criteria for the Establishment of a CAR Reserve System for Forests in Australia* (Commonwealth of Australia 1997) both discuss concepts for optimal reserve configuration. The latter document states the criteria influencing reserve design to include:

- boundaries should be set in a landscape context with strong ecological integrity, such as catchments;
- large reserved areas are preferable to small

reserved areas, though a range of reserve sizes may be appropriate to adequately sample conservation values;

- boundary-area ratios should be minimised and linear reserves should be avoided where possible except for riverine systems and corridors identified as having significant value for nature conservation;
- reserves should be developed across the major environmental gradients if feasible, but only if these gradients incorporate key conservation attributes which should be incorporated in the CAR system;
- each reserve should contribute to satisfying as many reserve criteria as possible;
- reserve design should aim to minimise the impact of threatening processes, particularly from adjoining areas; and
- reserves should be linked through a variety of mechanisms, wherever practicable, across the landscape.

18.4 Candidate areas for reservation

Additional analysis of the available dataset is required before informed recommendations can be made regarding the specific delineation of boundaries of areas for reservation. However, adequate information is available to highlight some areas that require reservation in order to ensure adequate protection of high value biodiversity assets, and progress towards the achievement of comprehensive, adequate and representation reservation of BIFs in the Midwest and Goldfields region. The recommendations encompass reservation of selected BIF ranges in their entirety

where appropriate, and portions of ranges in other areas, acknowledging current mining operations, and achieving a balance between protection of high biodiversity values and areas of high resource value.

Table 11 below summarises the candidate priority areas for reservation. Note that this is not intended to be a definitive list and it is likely that further areas could be recommended for reservation as more information becomes available.

The principle of guaranteeing reservation of remaining BIFs once thresholds are approached as a consequence of resource extraction requires further investigation.

Table 11. Priority areas for conservation (based on the criteria listed in this report and using the current available dataset for endemic and / or significant flora values).

a) Highest biodiversity and landscape value sites – intact and protectable

Location	Region	Development Status	Potential to Conserve Intact Range
Diemals/Die Hardy Range	Goldfields	Early exploration.	Intact and protectable; good potential and priority to full conserve.
Helena and Aurora Range (incl. Bungalbin Hill)	Goldfields	Early exploration.	Intact and protectable; high priority for conservation.
Mt Karara/ Mungada Ridge (Blue Hills)	Midwest	Advanced mine planning and EIA commenced; significant investment and high expectations to mine.	Intact and protectable; high priority for conservation.
Mt Manning	Goldfields	No activity.	Intact and protectable.

b) Highest biodiversity and landscape value sites – being mined or approval process advanced

Location	Region	Development Status	Potential to Conserve Intact Range
Jackson Range	Goldfields	Partly mined – advanced mine planning and EIA commenced over part.	Being mined; existing and potential loss of conservation values; part conservation only.
Koolanooka Hills (incl. Perenjori Hills)	Midwest	Partly mined – advanced mine planning and EIA commenced over part.	Being mined; scope to conserve substantial part.

Koolyanobbing Range	Goldfields	Extensively mined, mining ongoing.	Being mined; potential lost; conservation of small portion only.
Mt Gibson Midwest		Mining partly approved.	Potential significantly diminished; existing and potential loss of conservation values; conservation of restricted portion only.
Windarling Range	Goldfields	Partly mined - significant impacts; pressure to expand.	Being mined; significant loss of conservation values from mining already. Ministerial conditions relate to the release of a further 15% of original (27% of remaining) rare flora; final extent of impact dependent on the proponent being able to meet specified conditions relating to threatened flora.

c) Lower biodiversity value sites* - although still providing refugial habitats with localised species and vegetation communities

	Region	Stage of Mine Development & Comments
Finnerty Range	Goldfields	Surveyed by DEC, no known BIF endemics, areas of BIF small.
Jack Hills (incl. Mt Hale, Gould, Taylor)	Midwest	Being mined; significant potential loss through cumulative impacts; part conservation only.
Mayfield	Goldfields	Surveyed in part by Portman and in part by DEC, no known BIF endemics, areas of BIF small.
Minjar/Gnows Nest	Midwest	Early exploration; covered in Central Tallering report; regional sampling suggests communities more widespread than in the Mt Karara and Mungada Ridge area.
Mt Dimer	Goldfields	Surveyed in part by DEC; no known BIF endemics, areas of BIF small.
Tallering Peak	Midwest	Being mined; existing loss; significant mining has already taken place.
Warriedar/Pinyalling	Midwest	Early exploration; covered in Central Tallering report; regional sampling suggests communities more widespread than in the Mt Karara and Mungada Ridge area.
Weld Range	Midwest	Currently being explored; communities in DEC survey area not restricted to specific areas within range; part conservation only.

*These areas may be candidates for reservation (in entirety or part A class or as conservation park) subject to further investigations.

d) Sites requiring further investigation*

Booylgoo Range 2006,	Goldfields	Insufficient information available at this stage; DEC surveyed in currently being analysed.
Bulga Downs	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Cashmere Downs	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Gullewa / Wolla Wolla	Midwest	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Lake Austin	Midwest	No information
Lake Giles	Goldfields	Early exploration; DEC survey in 2007.
Mt Dugel/Mt Nairn	Midwest	No information; DEC survey in 2007.
New Forest (incl. Twin Peaks)	Midwest	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Perrinvale/ Walling Range (incl. Lake Barlee, Brooking Hills and Mt Mason/Mt Hope)	Goldfields	Early exploration. DEC survey in 2007.
Robinson Range	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Wiluna West	Goldfields	Insufficient information available at this stage; DEC surveyed in 2006, currently being analysed.
Yalgoo	Midwest	No information

* These areas may be candidates for reservation (in entirety or part A class or as conservation park) subject to further investigations.

19. Conclusion

It is important to note that the recommendations above have been made according to the best use of available data. Most views and recommendations provided in this report have been based on a high-level approach, with significant gaps in the current dataset and the need for more detailed analysis acknowledged. However, where there is an adequate level of information available and this information indicates very high biodiversity values, this report advocates early decision making regarding affording these areas formal protection. Allowing mineral exploration of such areas to occur, with substantial environmental impacts and proponent costs incurred, in addition to creating significant impact on important values, allows for the presumption that further mining development can proceed. A more strategic approach has been taken in the decision to prepare the strategic review, to assist in more informed and strategic decision making by Government.

The World Resources Institute has produced a report *Mining in Critical Ecosystems: Mapping the Risks*. In 2006 the ICMM provided a review of this document, in which it is stated:

“ICMM agrees that lack of data is not a reason to postpone policy decisions regarding the need for ‘no-go’ zones for mining and is taking steps to pursue this issue with the conservation community.”

DEC supports this view and considers that there is a need for ‘no-go’ zones, where mining is deemed an inappropriate land use due to the presence of high biodiversity values. If a decision is made by Government that a specific biodiversity value warrants protection in perpetuity, this means there would be a presumption against activities such as resource extraction and others that have an impact on biodiversity values. This would be afforded via A class reservation of appropriate areas, as recommended in the section above on specific areas.

It is important to note that these recommendations are made according to currently available data, and may evolve as new data become available via the regional flora survey and site-specific proponent driven survey work.

The ICMM acknowledges in its January 2007 report *Perspective on the IUCN Protected Areas Category Management System*, that:

“National and global systems for the evaluation, designation, classification and management of areas listed for protection are needed to ensure consistency of approach to land access decisions. Such systems should be transparent, rigorous, based on clear scientific, socio-economic and cultural criteria, backed by legal controls, and should contribute to the equitable resolution of competing land use, conservation and development objectives.”

This report has attempted to collate existing international, national and State level policies and criteria on protected area designation; analyse these against the available dataset on biodiversity values; and make recommendations as part of a transparent and rigorous review process. The recommendations made in this interim report are designed to assist Government decision making by beginning to address the complex issues surrounding the development of resources in areas of extremely high biodiversity value, including high levels of species endemism and restricted plant communities.

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22. Glossary

Biological diversity/biodiversity - the variety of all life forms - the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part. Biodiversity is not static, but constantly changing; it is increased by genetic change and evolutionary processes and reduced by processes such as habitat degradation, population decline, and extinction (Commonwealth of Australia 1996). Biome – a geographic area containing similar lifeforms, determined by upper and lower limits of tolerance to temperature. Examples of this include savanna woodland, temperate forest, tundra.

Bioregion – a biogeographic region, or bioregion, is a region in which the boundaries are determined by vegetation cover, climate and the earth's physical features.

Comprehensive, Adequate and Representative (CAR) Reserve System - the development of a CAR reserve system is guided by nationally agreed criteria (Commonwealth of Australia 1999).
1. Comprehensive – includes the full range of

ecological communities recognised by an agreed scientific classification at appropriate hierarchical levels.

2. Adequacy – the maintenance of ecological viability and integrity of populations, species and communities.

3. Representativeness – adequately reserve known species and genotypes to maximise their viability within a bioregion.

Declared Rare Flora (DRF) - under the Western Australian *Wildlife Conservation Act 1950* (Section 23F (2)), the Minister for the Environment may declare any protected (native) flora to be 'rare flora' (threatened flora) if he/she is of the opinion that it is likely to become extinct or is rare or otherwise in need of special protection. Many of these species are also protected under Commonwealth legislation.

Ecological Community - a naturally occurring biological assemblage that occurs in a particular type of habitat. Ecological communities may be described on the basis of flora, fauna, or other type of biota. Floristic communities are a way of doing this where the flora values are the main values to be protected.

Ecological communities may be described at a variety of levels of definition, such as by the amalgamation of fine-scale communities that occur in a unique arrangement at a site. Such higher-level description may be used to facilitate broader mapping of an area, or may be a way of simplifying the description of an area where a number of unique fine-scale communities co-exist. A BIF range with a number of unique communities may therefore be described as a single broad-scale community with a number of discrete elements to it.

Ecosystem - an ecological system formed by the interaction of co-acting organisms and their environment. An ecosystem is therefore the combined biota, abiotic features (such as soil, hydrological conditions), and the processes that operate within the area. A BIF range may therefore be described as an ecosystem due to the characteristic landscape and geological

features. An ecosystem will be comprised of ecological communities, but such communities may not necessarily be unique to that ecosystem.

Endemic - the distribution of an organism is confined to a particular geographic area.

Floristic Community Type (FCT) - a vegetation classification based on species composition. The classification generally derived from a classification of species lists collected from fixed area plots.

Geophyte – a perennial plant that propagates from organs such as bulbs, tubers, or rhizomes that are below ground

Habitat - the natural environment of an organism or a community, including all biotic and abiotic elements; a suitable place for it to live (Commonwealth of Australia 1996). Vegetation can become a reasonable surrogate for outlining habitat when its main components, structure and the associated landform are also described. Interim Biogeographic Regionalisation for Australia (IBRA) – divides the Australian continent into 85 bioregions and 404 sub-regions based on major geomorphic features. These are important reporting units for assessing the status of native ecosystems (www.environment.gov.au/parks/nrs/ibra)

Plant Communities - can be defined in a number of ways ranging from mapping units based solely on the dominant species to units defined in terms of the composition of the vascular plants.

Precautionary principle - where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation. Decision making should be guided by (a) a careful evaluation to avoid serious or irreversible damage to the environment wherever possible and (b) an assessment of risk-weighted consequences of the options (*Environmental Protection Act 1986, 2003*).

Priority Ecological Communities (PEC) - an ecological community that may be rare or threatened, but for which there is insufficient scientific information

to properly evaluate conservation status will be listed as a Priority Ecological Community. There is no specific Western Australian legislation that refers to PECs. However, DEC maintains an informal list of PECs, and known locations of these are included in a database maintained by DEC. Possible threatened ecological communities that do not meet survey criteria or that is not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority flora and fauna - in Western Australia flora and fauna that appear to be rare or threatened, but for which there is insufficient scientific information to properly evaluate their conservation status, are listed as Priority Species. While they do not have the same legal status as Threatened Flora or Specially Protected Fauna they are considered under the *Environmental Protection Act 1986* as enforced by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Species and Communities Branch within DEC maintains priority flora and fauna lists which categorises these species according to their conservation priority. There are four categories:

Priority 1: Taxa which are known from one or a few (generally <5) populations which are under threat.

Priority 2: Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.

Priority 3: Taxa which are known from several populations and taxa not believed to be under immediate threat.

Priority 4: Taxa which are considered to have been adequately surveyed and which, whilst being

rare (in Australia), are not currently threatened by any identifiable factors.

Refugia - a biological community or geographic entity which because of its moderating structural characteristics and/or physical isolation, provides a sanctuary in which species or groups of species have retreated or been confined.

Significant species - consist of:

- Declared rare and priority plant species.
- Newly recognised unnamed plant species.
- Relatively widespread species at limits of distribution.
- Highly variable species expected to be redefined into narrower taxa in the future - especially when populations are highly disjunct.
- Species of extremely restricted distributions.

Short Range Endemic (SRE) - fauna or flora species confined an area less than 10,000 km² (Harvey 2002).

Threatened Ecological Community (TEC) – A

threatened ecological community is an ecological community that has been determined following survey assessment to be restricted and/or at risk, and has been accepted through the formal listing process as such. Communities determined to be TECs must have been described at an acceptable scale, and have been adequately surveyed to ensure that their conservation status is adequately known. TECs are listed by the State Minister for the Environment under Ministerial policy and a list of TECs maintained by DEC, with TECs given special consideration in environmental impact assessment. The protection of TECs is included as a 'clearing principle' for assessing applications for permits to clear native vegetation under the Environmental Protection Act with such areas defined as 'Special Environmental Areas' where exemptions from needing a clearing permit under the Environmental Protection (Clearing of Native vegetation) Regulations 2004 do not apply. Under the Commonwealth EPBC Act those TECs considered to be threatened nationally are included in a schedule to the Act. A number of the Western Australian TECs appear

in this Schedule however a number are awaiting nomination for addition to the Schedule. One of the criteria used to determine the categories of threatened ecological community is an estimate of the geographic range and/or the total area occupied and/or the number of discrete occurrences reduced since European settlement.

Threatening Process – a process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community.

Threatened (Specially Protected) Fauna - under the *Western Australian Wildlife Conservation Act 1950* (Section 14(2)), the Minister for the Environment may declare any fauna to be fauna which is likely to become extinct or is rare or otherwise in need of special protection as being specially protected fauna. Such fauna is wholly protected throughout the State at all times and may only be taken under an appropriate license issued under the *Wildlife Conservation Act 1950*.

Vegetation Type – vegetation types as defined by Beard (1990) are based on three principle characteristics of vegetation:

1. **Floristic Composition:** the species of plants which comprise vegetation.
2. **Vegetation Structure:** the height of plants in layers, their shape and their spacing
3. **Growth-form:** the morphological characteristics of the component plants, such as woody or herbaceous, annual or perennial, thorny or succulent, evergreen or deciduous, and leaves of a certain texture, size and shape. Beard mapped Western Australia's vegetation types, principally at the level of plant formation and most often at the 1 : 250,000 scale, doing this at the level of plant formation, with minor attention to plant associations where they could be readily distinguished.
4. **Plant Association:** the component species, with particular dominants, of a given area. If the vegetation of another area has the same dominants it is in the same association. The association is the basic unit of vegetation.

5. **Plant Formation:** a vegetation unit that considers plant associations that have a similar physiognomy (a combination of vegetation structure and growth-form), independent of specific floristic composition.

23. Appendices

Appendix 1. Threatened Ecological Community Rankings (DEC)

THREATENED ECOLOGICAL COMMUNITY RANKINGS

DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Ecological Community

A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail available, therefore no particular scale is specified.

Threatened Ecological Community (TEC)

A TEC is one which is found to fit into one of the following categories; “presumed totally destroyed”, “critically endangered”, “endangered” or vulnerable.

Presumed Totally Destroyed (PD)

An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or

- B) All occurrences recorded within the last 50 years have since been destroyed.

Critically Endangered (CR)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as *Critically Endangered* when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting *any one or more of* the following criteria (A, B or C):

- A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% *and either or both* of the following apply (i or ii):

- i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);
- ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

- B) Current distribution is limited, and one or more of the following apply (i, ii or iii):

- i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

- ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;
- iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

- C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C):

- A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii):

- i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);
- ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

- B) Current distribution is limited, *and one or more of* the following apply (i, ii or iii):

- i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);
- ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;
- iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as *Vulnerable* when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long term future. This will be determined on the basis of the best available information by it meeting *any one or more of* the following criteria (A, B or C):

- A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.
- B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Appendix 2. IUCN Red List Criteria and Categories (from IUCN (2001) *IUCN Red List Categories and Criteria*)

THE CATEGORIES

EXTINCT (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A

to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)

A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

THE CRITERIA

CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore

considered to be facing an extremely high risk of extinction in the wild:

- A. Reduction in population size based on any of the following:
1. An observed, estimated, inferred or suspected population size reduction of $\geq 90\%$ over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
 - (a) direct observation
 - (b) an index of abundance appropriate to the taxon
 - (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
 - (d) actual or potential levels of exploitation
 - (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
 2. An observed, estimated, inferred or suspected population size reduction of $\geq 80\%$ over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
 3. A population size reduction of $\geq 80\%$, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.
 4. An observed, estimated, inferred, projected or suspected population size reduction of $\geq 80\%$ over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
- B. Geographic range in the form of either B1 (extent of occurrence) OR
- B2 (area of occupancy) OR both:
1. Extent of occurrence estimated to be less than 100 km², and estimates indicating at least two of a–c:
 - a. Severely fragmented or known to exist at only a single location.
 - b. Continuing decline, observed, inferred or

- projected, in any of the following:
- (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) area, extent and/or quality of habitat
 - (iv) number of locations or subpopulations
 - (v) number of mature individuals.
- c. Extreme fluctuations in any of the following:
- (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) number of locations or subpopulations
 - (iv) number of mature individuals.
2. Area of occupancy estimated to be less than 10 km², and estimates indicating at least two of a–c:
- a. Severely fragmented or known to exist at only a single location.
 - b. Continuing decline, observed, inferred or projected, in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) area, extent and/or quality of habitat
 - (iv) number of locations or subpopulations
 - (v) number of mature individuals.
 - c. Extreme fluctuations in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) number of locations or subpopulations
 - (iv) number of mature individuals.
- C. Population size estimated to number fewer than 250 mature individuals and either:
- 1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR
 - 2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
 - a. Population structure in the form of one of the following:
 - (i) no subpopulation estimated to contain more than 50 mature individuals, OR
 - (ii) at least 90% of mature individuals in one subpopulation.
 - b. Extreme fluctuations in number of mature individuals.
- D. Population size estimated to number fewer than 50 mature individuals.
- E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

- A. Reduction in population size based on any of the following:
- 1. An observed, estimated, inferred or suspected population size reduction of $\geq 70\%$ over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
 - (a) direct observation
 - (b) an index of abundance appropriate to the taxon
 - (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
 - (d) actual or potential levels of exploitation
 - (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
 - 2. An observed, estimated, inferred or suspected population size reduction of $\geq 50\%$ over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
 - 3. A population size reduction of $\geq 50\%$, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.
 - 4. An observed, estimated, inferred, projected or suspected population size reduction of $\geq 50\%$ over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
- B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
- 1. Extent of occurrence estimated to be less than 5000 km², and estimates

- indicating at least two of a–c:
- a. Severely fragmented or known to exist at no more than five locations.
 - b. Continuing decline, observed, inferred or projected, in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) area, extent and/or quality of habitat
 - (iv) number of locations or subpopulations
 - (v) number of mature individuals.
 - c. Extreme fluctuations in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) number of locations or subpopulations
- (iv) number of mature individuals.
2. Area of occupancy estimated to be less than 500 km², and estimates indicating at least two of a–c:
 - a. Severely fragmented or known to exist at no more than five locations.
 - b. Continuing decline, observed, inferred or projected, in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) area, extent and/or quality of habitat
 - (iv) number of locations or subpopulations
 - (v) number of mature individuals.
 - c. Extreme fluctuations in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) number of locations or subpopulations
 - (iv) number of mature individuals.
- C. Population size estimated to number fewer than 2500 mature individuals and either:
1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR
 2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
 - a. Population structure in the form of one of the following:
 - (i) no subpopulation estimated to contain more than 250 mature individuals, OR
 - (ii) at least 95% of mature individuals in one subpopulation.
 - b. Extreme fluctuations in number of mature individuals.

- D. Population size estimated to number fewer than 250 mature individuals.
- E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

- A. Reduction in population size based on any of the following:
1. An observed, estimated, inferred or suspected population size reduction of $\geq 50\%$ over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
 - (a) direct observation
 - (b) an index of abundance appropriate to the taxon
 - (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
 - (d) actual or potential levels of exploitation
 - (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
 2. An observed, estimated, inferred or suspected population size reduction of $\geq 30\%$ over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.
 3. A population size reduction of $\geq 30\%$, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.
 4. An observed, estimated, inferred, projected or suspected population size reduction of $\geq 30\%$ over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

- B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
1. Extent of occurrence estimated to be less than 20,000 km², and estimates indicating at least two of a–c:
 - a. Severely fragmented or known to exist at no more than 10 locations.
 - b. Continuing decline, observed, inferred or projected, in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) area, extent and/or quality of habitat
 - (iv) number of locations or subpopulations
 - (v) number of mature individuals.
 - c. Extreme fluctuations in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) number of locations or subpopulations
 - (iv) number of mature individuals.
 2. Area of occupancy estimated to be less than 2000 km², and estimates indicating at least two of a–c:
 - a. Severely fragmented or known to exist at no more than 10 locations.
 - b. Continuing decline, observed, inferred or projected, in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) area, extent and/or quality of habitat
 - (iv) number of locations or subpopulations
 - (v) number of mature individuals.
 - c. Extreme fluctuations in any of the following:
 - (i) extent of occurrence
 - (ii) area of occupancy
 - (iii) number of locations or subpopulations
 - (iv) number of mature individuals.
- C. Population size estimated to number fewer than 10,000 mature individuals and either:
1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR 2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
 - a. Population structure in the form of one of the following:
 - (i) no subpopulation estimated to contain more than 1000 mature individuals, OR
 - (ii) all mature individuals are in one subpopulation.

- b. Extreme fluctuations in number of mature individuals.
- D. Population very small or restricted in the form of either of the following:
 1. Population size estimated to number fewer than 1000 mature individuals.
 2. Population with a very restricted area of occupancy (typically less than 20 km²) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.
- E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Appendix 3. Western Australian Museum Short-range endemic fauna information (Harvey 2007, Slack-Smith 2007).

SHORT-RANGE ENDEMIC INVERTEBRATES IN THE WESTERN AUSTRALIAN RANGELANDS – A REVIEW

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Despite being largely hidden from view, invertebrate animals dominate most ecosystems of the world. They are ubiquitous elements at many different spatial scales. Within the Rangelands of Western Australia (Fig. 1), they range from large insects (e.g. stick insects, grasshoppers) and spiders (trap-door spiders) to tiny mites and springtails, less than half a millimetre in length. They encompass all trophic zones and ecological niches, and utilize numerous feeding regimes including herbivory, carnivory, detritivory and parasitism. The most conspicuous invertebrate elements of the Western Australian Rangelands include insects and other hexapods (e.g. springtails), myriapods (millipedes and centipedes), arachnids (spiders, scorpions, mites and their relatives), crustaceans (isopods, decapods) and molluscs (snails). Other groups such as nematodes are generally microscopic and difficult to observe.

A guide to the invertebrates of Australia was published by Harvey and Yen (1989) which contains

illustrations and pictorial keys to enable the identification of most invertebrates to Order.

The majority of invertebrate species throughout the Western Australian Rangelands have wide distributions. Many inhabit xeric ecosystems that are interconnected with each other allowing free movement between regions, at least during favourable climatic regimes. Another class of invertebrates inhabit restricted spatial scales and ecological niches. They are generally found in specific micro-habitats and are dependent on humid environments such as deep shaded gullies and gorges, subterranean voids or vine-thickets. These species were termed short-range endemics by Harvey (2002), who noted that they were often found to have distributions of less than 10,000 km², and had many life style traits in common such as dependence on moist environments, lack of mobility, low fecundity and restricted seasonal activity.

The recognition and promulgation of the phenomenon of short-range endemism within invertebrates has enabled the sampling of habitats that are threatened by various perturbations, concentrating on that component of the fauna that is least likely to cope with rapid ecosystem modifications. This is particularly true in the resource sector where the mining of landscapes for ore-bearing rocks has led to the rapid search for elements of the biota that are least likely to be able to cope with loss of habitat. Focusing on short-range endemic invertebrates allows scarce resources to be directed to the most vulnerable biota, and ignoring those faunal elements that are widespread in the landscape and probably in less need of conservation. These surveys can enable rapid assessment of habitats to assess the impact posed by proposed activities. Short-range endemic invertebrates may also be found to be useful in analysis of the impact of climate change.

Snails

Many species of molluscs, particularly gastropods, have highly restricted ranges. Gastropod molluscs occur in many different habitats and within the Rangelands can be found in many terrestrial environments. They are often confined to particular habitats such as vine thickets, shaded gullies or amongst deep rock piles. They are highly seasonal and usually only active during bouts of rainfall when they emerge to feed and mate with

each other. Numerous land-snail genera occur in the Western Australian Rangelands, of which one – the Camaenidae - is particularly dominant, especially in the northern half of the state. Others occur sporadically, and the most important is the Buliminidae in the southern portion of Western Australia where the genus *Bothriembryon* has diversified.

Solem (1991) summarised the Kimberley land snail fauna and found that it comprised 35 species of non-camaenids and 185 species of Camaenidae. Only four species of non-camaenids were restricted to the Kimberley, whilst the remaining non-camaenids were widely distributed outside of the Kimberley, often in other regions of northern Australia or in the Indo-Pacific region. In contrast only a few camaenids were found outside of the Kimberley, usually on the margins of the region. These extremely high levels of short-range endemism found in the Kimberley Camaenidae are replicated in other regions of the Western Australian Rangelands.

Of particular interest in Western Australia is an enormous radiation and diversification of the land snail family Camaenidae. The group has been extensively documented by Solem (1979; 1981a; 1981b; 1984; 1985; 1988a; 1988b; 1991; 1993; 1997) who recognised numerous genera consisting entirely or mostly of short-range endemic species. A few of the more notable examples are noted here.

In summary, the vast majority of camaenid land snails have extremely restricted ranges. The lack of a dispersive stage in their life-cycle, their reliance on suitable habitats for survival and their highly seasonal activity patterns combine to ensure that all are likely to represent short-range endemic species.

Schizomids

The arachnid order Schizomida consists of small (< 1 cm) animals that resemble spiders, but they have a number of modifications including the presence of long, antennae-like first legs that are held out in front of the body, a flagellum at the end of the abdomen and the ability to eject an acidic spray from a pair of glands situated within their body. The flagellum of males is highly modified such that the shape and position of the various setae that cover the flagellum are used to define separate species.

They are predators feeding on a variety of other small invertebrates (Humphreys et al., 1989; Vine et al., 1988).

All Australian schizomid species are thought to represent short-range endemic species. Most schizomid species are found in rainforests or vine thickets where they can be found under logs or rocks, within logs or in leaf litter and soil (Harvey, 1991, , 1992). Many species are restricted to subterranean ecosystems and are characterised by modifications such as an increase in body size, longer legs, pale colouration and lack of eyes or eye-spots.

The Australian fauna consists of seven genera which have been systematically reviewed by Harvey (1988; 1992; 2000a; 2000b; 2001) and Harvey and Humphreys (1995). The Western Australian fauna consists of several species found in subterranean environments: *Apozomus eberhardi* from Old Napier Downs Cave (cave KN-1), Napier Range; *Bamazomus hunti* from The Tunnel (cave KO-1); *Draculoides bramstokeri* from Barrow Island; and *D. vinei*, *D. julianneae* and *D. brooksi* from Cape Range peninsula. Recent research into the subterranean fauna of mesas within the Robe Valley has revealed that each mesa contains a distinct schizomid species, one of which belongs to the genus *Draculoides*, and the other five to a new genus very closely related to *Draculoides*. An additional species of *Draculoides* has been taken from alluvial deposits near Newman (Harvey et al., in press).

All of the schizomids found within the vine thickets of the Kimberley region have been juvenile, and thus we have been unable to identify them or describe them. Intensive sampling is required during the wet season to recover adult specimens to enable the fauna of this region to be named.

The subterranean populations are thought to have evolved from a series of species living in during the Tertiary in humid rainforest habitats when the region was wetter than current conditions. Their ancestors were able to move into interstices and voids, rendering them resistant to the ever-increasing aridification cycles that rendered the surface habitats inhospitable to them.

It is clear that many new species of schizomids await discovery throughout the Western Australian Rangelands, in particular in subterranean environments. The recent upsurge in minerals exploration and interest in troglodfauna has revealed a fauna that was unknown only a few years ago. The majority of named subterranean schizomids are listed as Threatened under the Western Australian Wildlife Conservation Act.

Trap-door spiders

Trap-door spiders of the family Barychelidae are found throughout Western Australia, particularly in the non-mesic regions. Raven (1994) recognised numerous species in the genus *Synothele*, as well as several species of *Aurecocypta*, and one species of *Moruga*. Several species of *Idiommata* are found throughout south-western Australia, but only one species is currently named, and the remainder Raven (pers. comm.). Barychelid spiders dig burrows into the substrate and the entrance is fitted with a tight-fitting lid that renders the burrow extremely difficult to distinguish from soil and litter on the ground. All Western Australian species of Barychelidae represent short-range endemic species, and many are known to occur in the Rangelands.

Other trap-door spiders occur in the Western Australia Rangelands, and whilst many are known from only a few localities, others are thought to be widespread and do not fit the definition of short-range endemism as defined by Harvey (2002). Nevertheless, Main et al. (2000) found 60 species in the Carnarvon Basin, of which 55 were not named in the scientific literature. It should be noted, that representatives of the genera *Aname* and *Kwonkan* were excluded from the analysis due to time constraints. Some species were found over many regions of the survey area, whilst others were highly localised. Also, it is not known whether the localised species are also found outside of the survey area, and until the distributions are more highly circumscribed, it is difficult to assess how many trap-door spiders of this area are actually short-range endemics.

Main (1991) found several species of trap-door spiders from Kimberley rainforests, and once again, the lack of integration with collections outside of this study area make any assessment of their status as short-range endemics difficult to assess.

A few Western Australian trap-door spiders are listed as Threatened under the Western Australia Wildlife Conservation Act. The majority occur in the south-west, but some are found in the Rangelands. These include *Troglo diplura lowryi* which is found in a few caves on the Nullarbor Plain (Main, 1969, , 1993; Main and Gray, 1985).

Pseudoscorpions

The order Pseudoscorpiones comprises small (< 1 cm) arachnids that have large chelate pedipalps, thus resembling scorpions. They differ from scorpions by the lack of a terminal tail and sting. All pseudoscorpions are predators feeding on other small invertebrates. They may be found in leaf litter, in soil, under stones or under the bark of trees. They are common in epigeal habitats and many species are restricted to cave environments where they sometimes attain high levels of troglomorphy such as loss of eyes, lengthened appendages, and pale colouration.

Many Western Australian pseudoscorpion species are widely distributed, occurring in habitats such as tree bark or leaf litter that is relatively continuous throughout the landscape. Some species of the Rangelands and adjacent areas occur in highly specialised habitats such as under rocks on granite or sandstone outcrops. In particular, some members of the genus *Synsphyronus* (family Garypidae) may have highly restricted species (Harvey, 1987), particularly throughout the Western Australian Wheatbelt and Goldfields. These species seem to lack any dispersal capacities, and individual populations may represent genetically isolates.

Of special interest in the Western Australian Rangelands is the presence of members of the family Feaellidae. The highly archaic pseudoscorpions are found in southern Africa, Madagascar, Seychelle Islands, the Indian region, and north-western Australia. Harvey (1989) described the sole Australian species, *Feaella anderseni*, from several rainforest patches in the Kimberley and it has since been found in several more areas (Harvey, unpublished data). A second Australian species has recently been found at Sulphur Springs, south-east of Port Hedland in the northern Pilbara region, where it occurs under slabs of shale in a gully. It is likely that other species of this highly distinctive family occur in relictual habitats in

the Western Australian Rangelands, and all are likely to represent short-range endemic species.

Millipedes

Millipedes are an ancient group of multi-legged invertebrates related to centipedes, symphylans and diplurans. Most species are detritivorous or herbivorous. Nine millipede orders are recognised throughout Australia, and several species have been introduced from overseas, occasionally forming pest populations such as the Portuguese Millipede, *Ommatoiulus moreletii* (family Iulidae).

Polydesmida

Whilst little work has been published on Western Australian millipedes, unpublished research on members of the family Polydesmida has revealed an extensive radiation of the family Paradoxosomatidae. In particular, the genus *Antichiropus* which consists of nine named species – eight in south-western Australia and one on the Eyre Peninsula in South Australia (Attems, 1911; Jeekel, 1985; Shear, 1992) - is now known to comprise over 100 species (Harvey, unpublished data), most of which have small distributions. All indigenous species of Paradoxosomatidae within Western Australia are short-range endemic species. Most species of *Antichiropus* occur within south-western Australia, but several occur within the Rangelands region. The greatest number of samples are from the Shark Bay area, the Pilbara, the Goldfields and the Nullarbor Plain.

Other paradoxosomatids occur in the Rangelands. Species of *Stygiochiropus* occur in caves in the Cape Range region (Humphreys and Shear, 1993; Shear and Humphreys, 1996) and the southern Kimberley (Harvey, unpublished data). *Boreohesperus*, with the single species, *B. capensis*, is restricted to the Cape Range area (Shear, 1992), whilst two species of *Helicopodosoma* are known from the Kimberley.

Spirobolida

Hoffman (1994; 2003) recently described two unusual genera of Spirobolida from the Western Australian Rangelands. *Speleostrophus nesiotes* is found in caves and other subterranean biotopes on Barrow Island (Hoffmann, 1994), whilst *Austrostrophus stictopygus* occurs on the Burrup Peninsula (Hoffmann, 2003). Other spirobolid millipedes are

found in the Pilbara and the Kimberley but their identities are uncertain.

Despite the lack of taxonomic research on the entire Western Australian fauna, it seems fairly certain that each spirobolid will be found to represent a short-range endemic species.

Spirostreptida

Within Western Australia, spirostreptid millipedes are most abundant in the south-western regions where all species are short-range endemic species (K. Edward, unpublished data). They occur in leaf litter, under logs or under stones in moist habitats. A few spirostreptid millipedes have been found in the Western Australian Rangelands and, although their identity has not yet been ascertained, they undoubtedly represent short-range endemic species.

Spelaeogriphaceans

Poore and Humphreys (1998; 2003) have reported the only known Australian species of the crustacean order Spelaeogriphacea from the Millstream aquifer (*Mangkurta mityula* Poore and Humphreys) and the Fortesque River valley (*M. kutjarra* Poore and Humphreys). Both species are short-range endemics.

Thermosbaenacea

The crustacean group Thermosbaenacea occurs in north-western Australia (Poore and Humphreys, 1992) where a single species, *Halosbaena tulki* Poore and Humphreys, occurs in caves on North-West Cape Peninsula. The species are short-range endemics.

Systems

Pilbara mesas

Recent surveys of a series of mesas situated within the Robe Valley has revealed an extensive troglobitic fauna restricted to the mesas. These mesas are composed of pisolite and are riddled with humid voids.

The schizomid fauna was examined by Harvey et al. (in press) who found distinct genetic partitioning between each mesa, consistent with subtle morphological differences, supporting the hypothesis that each mesa contains a separate species of schizomid.

Other troglobitic elements of the mesas include spiders (Harvey and Edward, in press), two new species of the millipede family Haplodesmidae that probably represents a new genus, harvestmen, cockroaches, slaters, etc.

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Memo

to: Executive Director, Collection and Content Development for Ms Amanda Moncrieff, DCE
from: Shirley Slack-Smith, Curator of Molluscs, Western Australian Museum
re: Molluscan fauna of the Banded Ironstone Belt, Western Australia
date: 19 April 2007

No fieldwork directed towards the collection of specimens and data of the snail fauna of the banded ironstone belt of the Yilgarn region has ever been carried out by staff of the WA Museum.

The few pertinent specimens in the Museum's collections that are currently entered into its database have been collected by other collectors and, almost exclusively, belong to species of the families Camaenidae and Bulimulidae – probably because of their relatively large size.

It is possible that some specimens of the smaller species belonging to families other than the Camaenidae and Bulimulidae (such as the Pupillidae, Succineidae, etc.) are also contained in the collections. However the databasing of those families is, unfortunately, incomplete. In addition, the shells of snails belonging to the other families that might inhabit this area are small in size and/or fragile, and so are unlikely to have been noticed during surveys that are more superficial than those conducted by Museum workers.

Some localities within the region of the banded Ironstone belt that extends from near Talling (east of Port Gregory) to east of Southern Cross are: - Talling Peak, Koolanooka, Mt Karara, Blue Hill Range, Mungada, Iron Hill, Windarling, Die Hardy Range, Mt Jackson, Pigeon Rocks, Mayfield, Mt Manning, Bungalbin, Lake Deborah East, Koolyanobbing, Lake Seabrook,

More northern deposits of iron ore in the Yilgarn located east of Shark Bay are at Mt Gould, Mt Taylor, Mt Hale and Weld Range.

From these localities and the areas around them, the Museum's database contains only the following records:

Family Camaenidae

Sinumelon kalgum – Koolyanobbing,
Sinumelon vagente – Mt Jackson

Family Bulimulidae

Bothriembryon sedgwicki – Mt Jackson, Bungalbin,
Bothriembryon sp. nov. "*Coolgardie*" – Lake Seabrook, Koolyanobbing.

Comment

As can be seen from the above, those sections of the Museum's collections currently entered onto its database contain very little information on the molluscan fauna of the "banded ironstone belt".

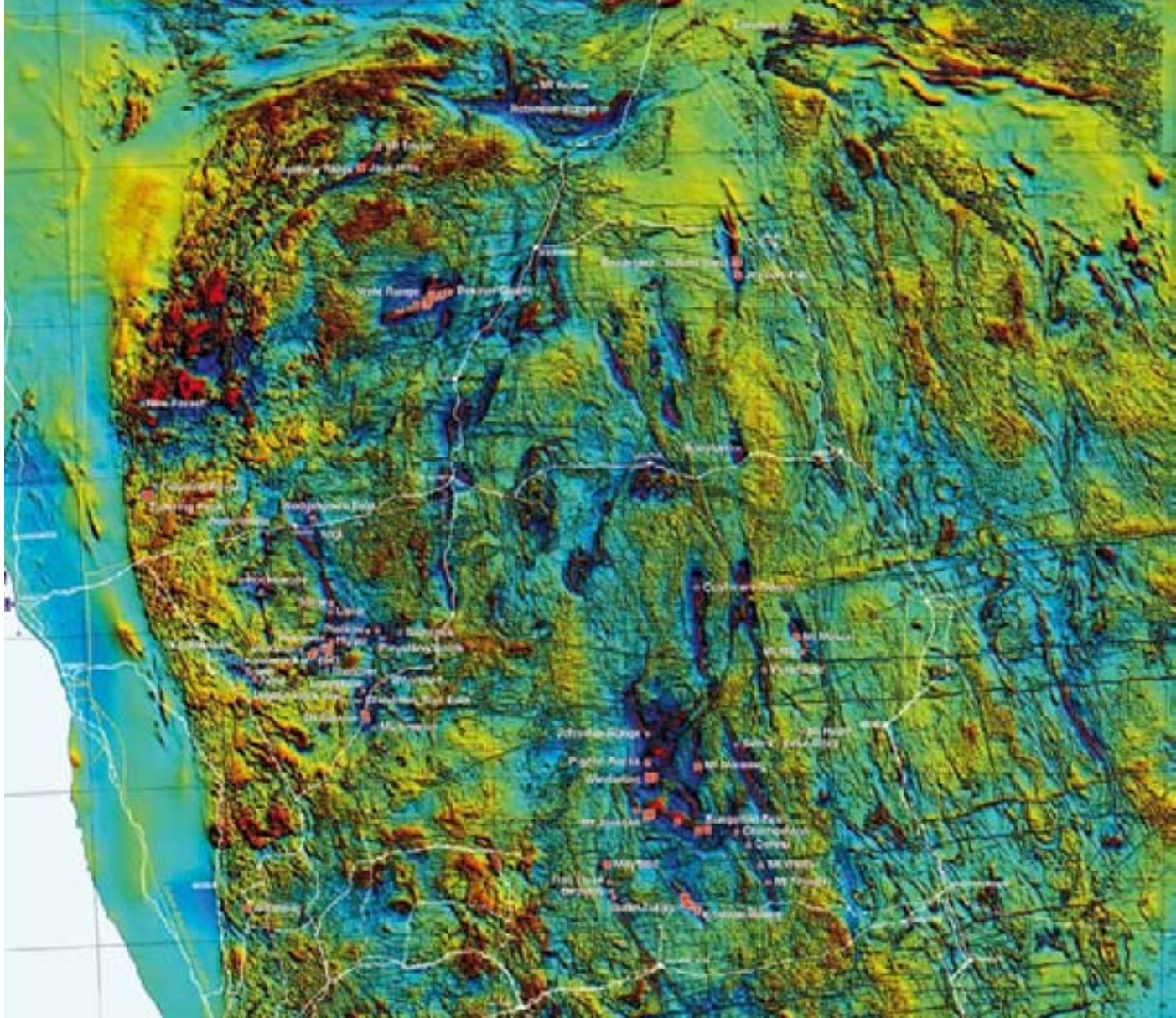
Work carried out during the late 1990s by the late Dr Alan Solem on the family Camaenidae from this region was based only on the Museum's collections at that time. He came to the conclusion that the species *Sinumelon vagente* and *S. kalgum* were each widespread, though not sympatric, throughout inland areas in the southern part of Western Australia. However examination of the Museum's records indicate that they are both species of the plains. It is possible, therefore, that the fauna of isolated habitats, such as those on hills and rocky outcrops, might harbour species showing some degree of endemism, particularly if such species are unable to subsist on in intervening habitats.

Such a possibility seems to be supported by the few bulimulid specimens of the genus *Bothriembryon*

recorded from these areas, although much less is known of their wider distributional range due to the very few specimens known from each taxon.

Until surveys are carried out on the native snail fauna of the inland areas of WA, and the taxa are identified and the specimen data collated (and data-based), little can be said about the likelihood of the occurrence of short-range endemic species there. As elsewhere, such taxa could be expected to occur in isolated habitats, particularly those in which shelter from desiccation for both snails and their food supply (probably decomposing plant litter and associated decomposing agents) is available.

It is unfortunate that many such seemingly-likely habitats are also those of interest to mining and other developments.



Strategic review of an iron ore industry in the Yilgarn Region (with focus on the midwest)

REGIONAL SETTING AND BENEFITS

MINERAL PROSPECTIVITY

ECONOMIC BENEFITS

SOCIAL BENEFITS AND IMPACT

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Disclaimer

Whilst Mid West and Yilgarn Iron Ore Companies provided data to the Department's of Environment & Conservation and Industry & Resources all conclusions and recommendations contained within this Review are those of the respective Departments.

No company has seen the contents of the Review and therefore the recommendations are not necessarily endorsed by the companies or the Geraldton Iron Ore Alliance.

EXECUTIVE SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Future of Region

Mining contributes more than 45% of the Mid West's \$3.5 billion (2005/06) Gross Regional Product ("GRP") with agriculture at 10.5% a distant second and lesser contributions from construction, retail and manufacturing.

Since the beginning of the commodities boom, WA has experienced a considerable increase in the level of investment in WA's resources sector. This increased investment has not, to a large extent benefited the Mid West region.

The Mid West region has an estimated resident population of just over 50,000, 9.1% of regional WA and 2.5% of the State's population. Unlike most of the regions of WA, over the last five years, the Mid West has not experienced a population growth and has in fact experienced a net fall in population. This is a surprising trend for a mining dependent economy given the State's recent growth has largely been associated with mining.

4

The Geraldton area is home to 65% of the region's population. Many rural populations have experienced negative population growth over the last 10 years, notably in a number of shires where significant iron ore mining is being proposed. Whilst there has been an improvement in the unemployment level in the region, it is still almost double the WA average.

Existing and current expansions to infrastructure such as power enhancements is adequate for the current industry and population but if the Mid West is to attract significant growth in mining or as a location to major heavy or manufacturing industry, then significant upgrades in a number of sectors are required. Work undertaken by iron ore project proponents has identified power, water, bulk commodity transport (rail) and large capacity export port capacity as key areas requiring major enhancement or new development. The establishment of a major iron ore industry could realise this infrastructure development not only for itself, but, if geared properly, also for other regional benefits. Industry could also be expected to contribute to road maintenance and enhancement to the benefit of the community and itself, and avoid negative impacts once bulk haulage is committed to rail or other means of transport (slurry pumping). Geraldton port handles a number of significant mineral

commodities and is also a major exporter of grain and other agricultural products. Major expansions have and are taking place to handle the modest output of iron ore to date. The port capacity will increase further, as iron ore exports grow, but, to sustain a major iron ore industry, Oakajee port will be required. This will in turn trigger the potential for the heavy industrial estate, for which suitable land is becoming extremely restricted in the region, and indeed in the whole south- and mid-west region. Attraction of other industrial developments could be significantly enhanced from a combination of iron ore, Oakajee port and resultant partial development of service facilities for the Oakajee industrial estate

The major commodities mined and shipped through the Mid West are gold, mineral sands (titanium and zircon), and base metals; and most recently the increasing amount of iron ore. In 2006, the value of minerals and petroleum produced in the region was \$2.75 billion. Gold production is declining, mineral sands output has been plateaued for some years. Unless these sectors can be supported by significant discoveries then their long term future must be limited, including the Geraldton mineral sands processing facilities. The single base metal producer has a significant long term resource life, but its overall regional impact is limited. Iron ore is the one bright light for long term growth.

Prognosis for the Region

The population of the region is not likely to grow or to maintain current levels without an increase in economic activity.

The region's infrastructure, though it is currently being enhanced, also needs a strong economic driver into the future in order to justify current and proposed future expenditures.

The region's economy will have to rely on its agriculture and mining for the foreseeable future.

Whilst agriculture and fishing have been a long term significant contributors to the region's economy, it is not likely that these industries will increase in size and, given the current climatic conditions, they may struggle to maintain their current rates of production.

Other areas of economic activity, e.g. tourism or

manufacturing industry, do not make significant contributions to the regional economy, in dollar terms, nor are they likely to have a significantly increased impact on the region in the foreseeable future.

Of the major economic drivers in the mining industry, both the mineral sands and gold industries can be classified as mature. Without doubt, the mineral sands industry is at a cross roads and without the discovery of significant new resource, production will decline in the short to medium term. This will have an effect on several communities in the region, including Geraldton. The significance of the mineral sands industry to Geraldton should not be overlooked and a downturn in this industry will have an economic impact on the whole community.

Without the discovery of new resources the gold industry is likely to continue its decline as a major input to the regions GRP. This will be a significant issue in inland shires like Mt Magnet, Cue, Meekatharra and Yalgoo.

Through the production of zinc and copper concentrates, the Golden Grove mine will be a significant contributor to GRP, for a number of years, but its regional impact is limited. This mining operation cannot off-set the impact on the region of a decline in gold and mineral sands. Therefore, unless other minerals are mined in the region to replace gold and mineral sands the region is very likely to experience an economic downturn.

Iron ore is the only mineral, in the foreseeable future, with the potential to attract the level of new investment needed to halt the decline, especially in Shires such as Perenjori, Morawa, Meekatharra and Cue. As shown in the attached Table, the relatively small mining operations at Talling Peak (3Mtpa), Koolanooka (1-2Mtpa) and Jack Hills (1-2Mtpa) could soon be complemented by operations with export potential exceeding 75Mtpa through a capital injection of over \$7B in the period 2007-11. Such an industry would employ directly in excess of 1750 people (sustained over 25-40 years) and underpin the development of regional infrastructure as well as the industrial estate and port at Oakajee.

The only means of growing the prosperity of the region

is undoubtedly the continued development of the iron ore industry.

Iron Ore Opportunities

China is the world's major growth market for the medium to long term. Indications are that Western Australia has a competitive advantage and, to date, a low risk investment climate, to capture a significant percentage of China's growth in demand. Additionally, Western Australia is well placed to make significant inroads into the Indian market, the other likely, but as yet unrealised growth area for imported iron ore.

The Yilgarn region is particularly attractive to market consumers and particularly for Chinese groups. It provides the opportunity for security of supply through investment, which is not generally available through the major Pilbara producers and developers. Having had very significant outlays for the initial development, it provides significant upside for further expansion potential. Thirdly, specifically for Chinese consumers, it provides access to magnetite deposits, ores for which the Chinese have extensive expertise in exploiting and using in its ironmaking operations.

Overseas joint venture partners have been attracted to the region, including major iron and steelmakers and leading trading houses from northeast Asia. These companies are already operating in the region, through underwriting a large part of the substantial expenditures for exploration and feasibility studies. They will arrange the massive investments and already provide commitments to secure long term market outlets.

Yilgarn Iron Ore Prospectivity

Iron ore prospectivity of the region is at a very early immature stage of evaluation. However, all areas prospective for iron ore are currently being actively explored. The market conditions provide a unique opportunity to get an industry established. Such conditions are unlikely to occur again in the foreseeable future.

While many prospects are still at a grassroots stage of exploration, there are a number of advanced projects progressing towards bankability. Mt Karara magnetite, in terms of defined prospectivity, is most

advanced with a substantial bankable resource base and recently completed feasibility study to sustain an economic, large scale long term output. This project also has a secure confirmed market from China's second largest steelmaker, Anshan Iron and Steel, which is currently expanding steel capacity reliant on supplies being sourced from the Mt Karara Joint Venture. Asia Iron's Mt Gibson project is another project with a defined resource base to support a modest 20 year project, with substantial upside if access can be secured to very significant potential in the Mt Gibson Ranges. If such potential cannot be accessed then there is a question over the viability of the first stage development project.

Koolanooka is another area where there are sufficient magnetite resources from two separate project developments to sustain a substantial operation. Other ranges where projects are well on the way to establishing resource bases to sustain substantial long term operations are at the Weld Ranges, Jack Hills and Wiluna West. In parallel to resource definition, most of these projects are progressing pre-feasibility and feasibility studies, including consideration of major infrastructure options.

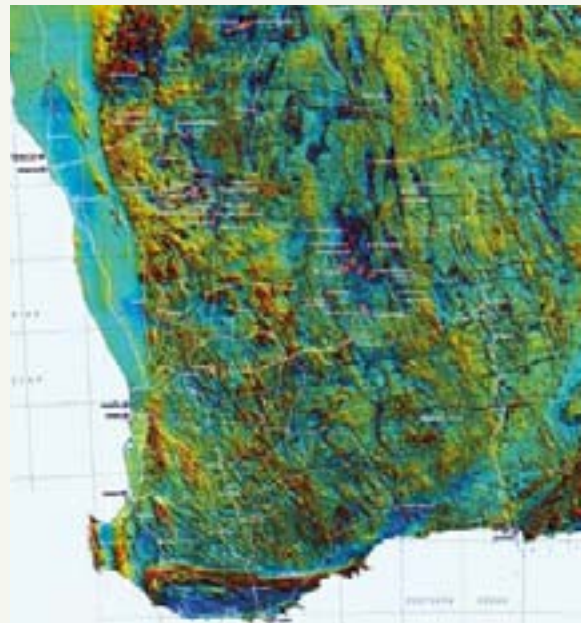
Two projects have or are considering added value processing projects to metallic iron products. These are Koolanooka South and Yalgoo (Yogi) magnetite projects.

There are many other prospects in the Mid West region at a grassroots target definition, and / or reconnaissance drilling stage.

The central Yilgarn region is currently based on one operation centred on Koolyanobbing, with satellite mines at Windarling and Mt Jackson. The operator, Portman Mining, is a major explorer of the region on a number of prospects designed to identify resources to support its long term operation. Such operation is based on blending of a number of complementary quality ore types to allow market acceptable product to continue to be produced. Access restrictions to new areas could significantly impact on existing operations, by rendering the ability to meet market acceptable blended grades extremely difficult, thus effectively sterilising existing operations.

There are a number of other explorers in the central

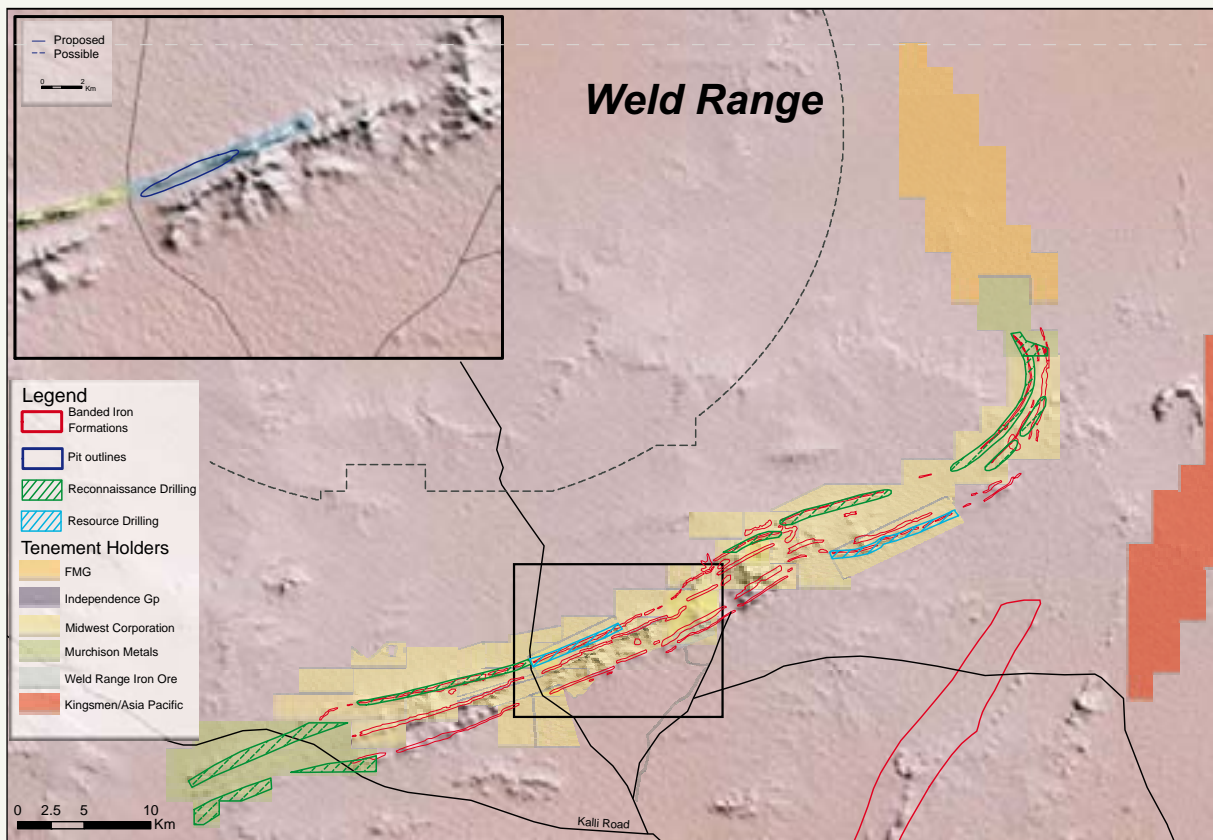
and east – central Yilgarn at the earlier exploration and reconnaissance drilling stages. Some are seen as supplements to Portman's operation, others see the potential for significant projects of an equivalent size to Koolyanobbing. However, these explorers require adequate time and access to properly explore the areas targeted with this potential.



Iron Ore Development Footprint

While forming a series of discrete ranges of isolated hills throughout the Yilgarn region, the length of these individual ironstone ranges can reach up to 80 kms in length comprised of semi-continuous parallel linear ridges. In larger areas, like the Weld Range, these ridges can amass to a combined width of up to 5km. The shorter ones, such as Mt Gibson and Koolanooka, become discontinuous over 10kms in length and may be closer to 0.5km wide.

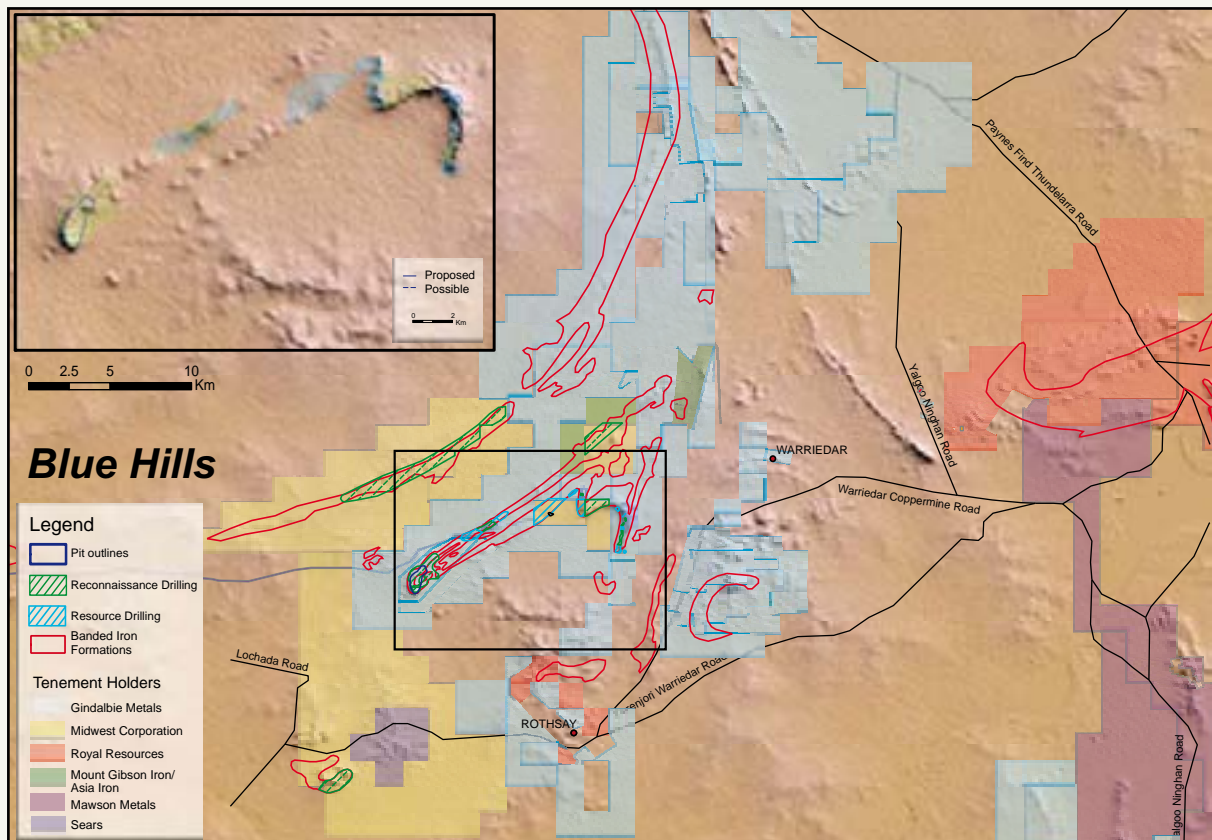
This extent of continuous and semi continuous ironstone ranges is however very large compared to the footprint likely to result from mining development. Some of the larger, long term pits are likely to be between 2 and 6km long and 0.5 to 1.5 km wide. Given that a large percentage of the support facilities will be located on the surrounding plains, with the ranges largely limited to haul road access and waste dumps, then by doubling the footprint area on the range from that of the pit outline, the



overall impact area would be small in the context of the overall extent of the range. Even allowing for say 2 such independent pits within a range, the percentage disturbed would remain small. This needs to be considered, when general statements on high conservation value of particular ranges are put forward. There must be potential for both development and conservation to be managed and in fact, with environmental management and knowledge being progressively improved as part of the mine development commitments, then enhancement of and deep knowledge of the conservation values in the ranges will occur.

While the major stage 2 or large scale projects in the region will result from one or perhaps two deep pit areas in each of the ranges, then their footprint per unit of ore extraction is likely to be significantly smaller than the series of small surface pits required for stage 1 hematite developments. There will be some counterbalancing of this by a higher amount of waste stripping and hence area for dumping with a deeper larger pit.

The smaller hematite operations are often on the surface overlying the planned major development and, because of the genesis of these ores, the small selective nature of extraction cannot be avoided to ensure market acceptable product grades are achieved. The Mungada Ridge high grade hematites are an exception to this rule, where location of many of the pit areas is separate from the Mt Karara magnetite. The Mungada Ridge – Blue Hills area has however the largest tonnage defined of direct shipping ore at about 30Mt. The footprint of this development could be over an area of 6 by 5 km in a number of discrete deposits.



Direct Economic Benefits from an Iron Ore Industry

Most of the advanced projects of the Yilgarn are in the Mid West region. To maintain the current economic base and social wellbeing of the region it is essential that an iron ore industry of substance is established. There is also the potential for iron ore to provide significant regional growth. Small, short term (stage 1) projects will not provide this. Stage 2, large, long term sustainable projects are needed.

Five projects have thus far been identified that could amount to a combined investment of around \$7.5 billion in the region, resulting in major construction and related service and business supplier establishment.

In ground resource value thus far defined is between \$50 and 80 billion dependent on price forecasts. A large percentage of this to date is based on magnetite ores, which bring significant processing plant development and further technology skills to the State.

If these major projects were developed to their first planned phase of capacity, they could result in export revenues of \$3.6 to 5.3 billion per annum, by comparison equating to about 25% of the value of the State's 2006 production value. Given industry multiplier factors this would amount to revenue generation of \$7.7 to 11 billion per annum in the State.

Direct revenues to the State Government could be \$225 to 330 million per annum in royalties, plus payroll tax and other indirect returns through taxation income.

A summary of the economic benefits from the defined iron ore developments in the Mid West region are listed in the table below.

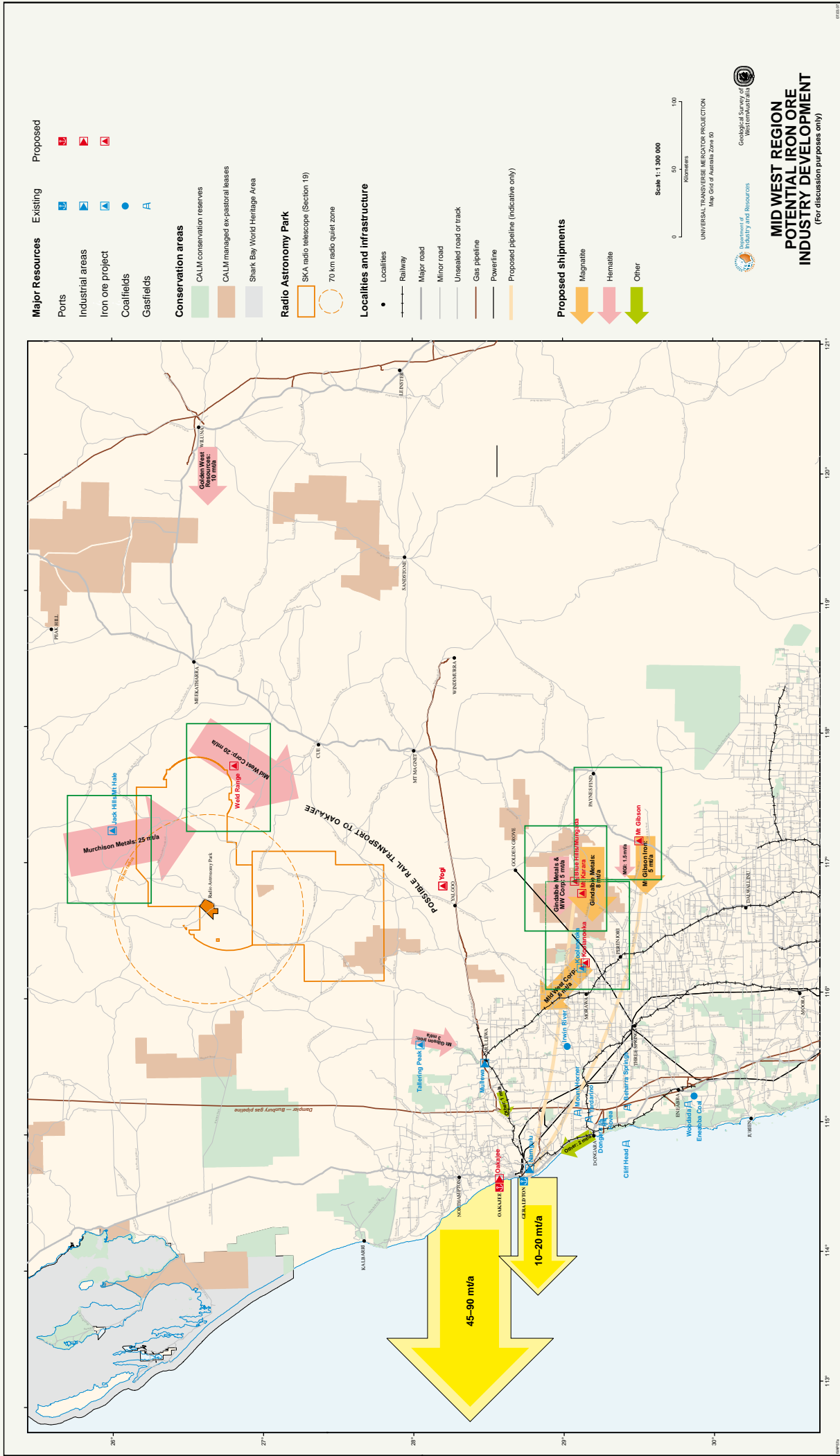
MID WEST IRON ORE ECONOMIC SUMMARY

Stage 1 & Stage 2 Assessments in \$Aus M (@ 0.80 exchange rate); Prices: 2007 & 70% of 2007

	Capital \$ M	Resource Life (Yrs)	Resource Value \$M	Prod Mtpa	Annual Revenue in \$AusM	Revenue with Multiplier (x 2.1)	Royalty revenue
Stage 1 Projects							
Jack Hills	41	4	635 - 445	2	150 - 105	315 - 221	10.4 - 7.3
Tallering Peak	14	8	1690 - 1183	3	215 - 150	451 - 315	14.6 - 10.3
Koolanooka-Mungada	26	5	600 - 420	2	129 - 90	270 - 189	8.4 - 5.9
Mungada Hematite	108	9	1845 - 1291	3	215 - 151	451 - 317	14.2 - 10.0
Mt Gibson Hem	73	7	1355 - 949	2	148 - 104	310 - 218	9.8 - 6.8
Total	262		5966 - 4177	12	850 - 595	1783 - 1250	57.8 - 40.5
State Infrastructure	325						
Stage 2 Projects							
Jack Hills	2251	3*	3444 - 3288*	25	1816 - 1271	3814 - 2669	124.5 - 87.1
Weld Range	2009	6**	6131 - 4291**	20	1401 - 981	2943 - 2061	94.9 - 66.4
Koolanooka Magnetite	1000	25	13671 - 9570	6	558 - 390	1171 - 819	19.3 - 13.5
Mt Karara Magnetite	1050	61	35708 - 22364	8	528 - 325	1108 - 683	26.4 - 16.3
Extension Hill Magn	715	21	7200 - 4510	5	325 - 200	683 - 420	16.3 - 10.0
Yalgoo	?		1921 - 1203				
Wiluna West	?	4	3153 - 2206	10	699 - 490	1468 - 1029	46.2 - 32.5
Total	7495		77228 - 47432	74	5327 - 3657	11197 - 7681	327.6 - 225.8

* Resource not fully defined but the company is proposing to mine at 20-25 Mtpa for a period in excess of 20 years (resource value>20Billion)

**Resource not fully defined but the company is proposing to mine at 20 Mtpa for a period in excess of 20 years (resource value>18Billion)



Other Benefits

The establishment of a substantive iron ore industry would over the next 5 years bring considerable investment in construction and the potential for peak workforce numbers in the order of 5000 people to the region. Should the iron ore market remain buoyant then this activity could be continued for a number of years.

A sustained operational workforce of nearly 2000 would be required, with a range of expertise as new technologies to the State are established in the processing of magnetite ores. Individual projects range from employment numbers of 170 to 550. This could result in additional job generation of a further 6000, largely distributed between the Mid West and Perth regions.

There will, inevitably be an improvement in the rural communities close to the areas of activity, covering population retention and enhancement, job opportunities, new and expanding business, including retail business opportunities, social infrastructure developments all resulting in an overall improvement in the economic and social well being of the communities. The shires of the region are particularly supportive of the growth of the iron ore industry and benefits to the shires would be improved if the workforces were integrated within the regions, although the mine workforces could adopt fly in – fly out arrangements.

Power and water are significant inputs required for the project developments, particularly the magnetite projects. These are issues for the iron ore companies. Investigations by the proponents could not only identify solutions for their projects, but also enhance the overall potential power supply to the region and the availability of quality water. Overall cumulative power needs could amount to 300MW. This could encourage independent power providers or companies own generating capacity. In either case the possibilities of lining in to the South West Integrated Network (SWIN) could provide more stability and robustness to the existing grid and add to additional capacity for other business developments.

While bulk commodity road haulage has created some issues with current iron ore transport, this is a short term issue. The movement of ore by rail and slurry

pipeline will alleviate this. Rail opportunities could open up other possibilities for trade in the region and will provide efficiencies to existing rail operations. Roads for personnel and supply movement will be improved in particular to the more remote areas near to the iron ore mining operations.

Iron ore trade already makes up 34% of cargo volume through Geraldton port. As a result of the iron ore development plans, port capacity is currently being significantly expanded and there are plans for this to expand even further. However it is the triggering of the Oakajee port which is likely to have most impact for industrial development in the Mid West. The establishment of the port gives further export opportunities. The port development plus other services being established for iron ore exports could provide the catalyst for the establishment of the Oakajee Industrial Estate. Not only is there the potential for iron ore based added value projects, but other heavy industrial projects, particularly when the shortage of new heavy industrial areas are in short supply in both the South West and Mid West regions. Oakajee is not only needed because of the Narngulu situation, but would be a natural progression to Kwinana, given the tight situation on land and airshed limits along the Kwinana strip.

The development of support businesses and service centres in and around Geraldton and the establishment of Oakajee would give a major boost to the expansion of the City of Geraldton as an economic and social hub.

Timing, Certainty, Confidence for Developers and Explorers

Stage 1 developments are proceeding, but it is the stage 2 projects which will bring the overall benefits outlined above. These are either in or in preparation for triggering the main government approvals processes. In addition to Mt Gibson, the other four major projects thus far identified in the Mid West region (Mt Karara Magnetite, Jack Hills Stage 2, Weld Range and Koolanooka Magnetite) should be formally into the environmental approvals process over the next 12 to 18 months. Additionally, triggering of the major infrastructure development of the NE railway and Oakajee port should also be forthcoming in this period.

Delays are already being experienced with access for exploration, and projects which are in the approvals process at present. The Ministerial environmental decision for Mt Gibson is a particular instance. A clear statement of Government's position in respect to access to the ranges for development is required to give confidence that the significant sums being expended in exploration and feasibility studies is worthwhile and the major financing arrangements currently being put in place can be brought to fruition through major project developments. Expectations from industry are that developments will take place.

Major overseas companies are actively participating in and largely underwriting each of the significant developments in the Mid West. These cover very large companies and market players from the State's three main trading partners in Japan, China and South Korea. In iron ore these 3 trading nations make up over 90% of the State's current exports.

The overseas companies have over the last year expressed frustration with time delays in accessing land, the slow speed of project development and the overall lack of certainty now emerging. The Mid West region is emerging as a major credibility test for investment risk throughout Western Australia. Low sovereign risk was one of the State's major advantages, but this is now coming into question. Given that major international owned enterprises are involved in the region's iron ore projects, an adverse outcome for the more significant projects could impact on WA's – international business relationships.

A project-by-project assessment does not allow effective policies or strategies to be pursued by either side of the debate and puts in question the confidence and commitments to large investments in the region. Government's attitude to approvals decisions on the most advanced projects of Mt Gibson and Mt Karara will give a clear indicator to industry of Government's position on the Mid West. Government's decisions on these projects will create precedents and impact on the level of confidence in being able to develop a significant sustainable iron ore industry in the Mid West, with further upside potential. These decisions need to be made in the overall context of policies for the ironstone ranges and the need to articulate such policies is very rapidly approaching.

Recommendations

It is recommended that Government:

- indicates its strong support for the economic and social well-being of the Mid West region,
 - acknowledges that, under present known conditions, the current minerals sectors largely underpinning the economy and workforce base of the Mid West, has a limited life,
 - notes that the establishment of a significant iron ore industry in the Mid West is important for maintaining the long term economy of the region and provides the potential for very significant growth in the economy and social welfare of the Geraldton region and rural communities,
 - provides confidence for explorers and investors by indicating its support for the current drive to establish a long term iron ore base in the region, with resultant benefits from major export revenues, direct financial returns and indirect benefits to State and regional development from the construction, services, infrastructure development and additional industries which a major industry base will bring,
 - demonstrates its commitment and provide certainty to developers, by allowing the major development projects with clearly defined significant iron ore resource assets, identified at large cost, to be exploited and for the opportunity of upside potential of these projects to sustain a long term future,
 - ensures that exploitation is carried out sustainably by insisting on best practise environmental management, mitigation and regeneration programmes are committed to by developers,
 - notes that over many of the ironstone ranges of the Yilgarn region the mineral prospectivity is little or only partly defined and the knowledge of the conservation values limited in both a detailed and regional context,
 - commits to, in collaboration with industry, the completion of a major programme to fully define the overall regional conservation values, including the research into mitigation and regeneration of significant species
- in the context of the above, ensures that the legislative processes are applied appropriately only to assess the environmental impact of projects placed before it and recommendations made for management by proponents relevant to the specific impacts of the project.
 - allows adequate opportunity to assess the mineral prospectivity and conservation values of an area before considering the reservation of land into the conservation estate and that this consideration be given through Government policy, after advice from impacted interest groups and appropriate Government Departments (and not part of the legislative approvals processes)
 - approves the establishment of a form of multiple purpose reserve with dual vesting which provides confidence of access for the exploration and mining sector and providing adequate conservation management,
 - provides opportunity to industry and other interested parties to provide comment on the Government's recommendations in this strategic review before finalising its position, and
 - provides clear and firm direction, as a matter of urgency, to maintain confidence and certainty to explorers and developers to ensure their large investment commitment, mainly by overseas companies, can be brought to fruition in an expeditious way to meet current market opportunities.



REGIONAL SOCIAL AND ECONOMIC OVERVIEW

– the need for new industry to sustain the region

The Mid West region covers approximately 466,766 square kilometres (including offshore islands) or nearly one-fifth of the area of Western Australia. The region extends along the coast from Greenhead in the south, where it borders the Wheatbelt region, to beyond Kalbarri in the north where it is bordered by the Gascoyne region. The region also extends more than 800 km east into the mineral rich hinterland where it is bordered by both the Pilbara and the Goldfields-Esperance regions. With an area twice the size of the United Kingdom, the Mid West region embraces a wide diversity of landscapes and land uses.

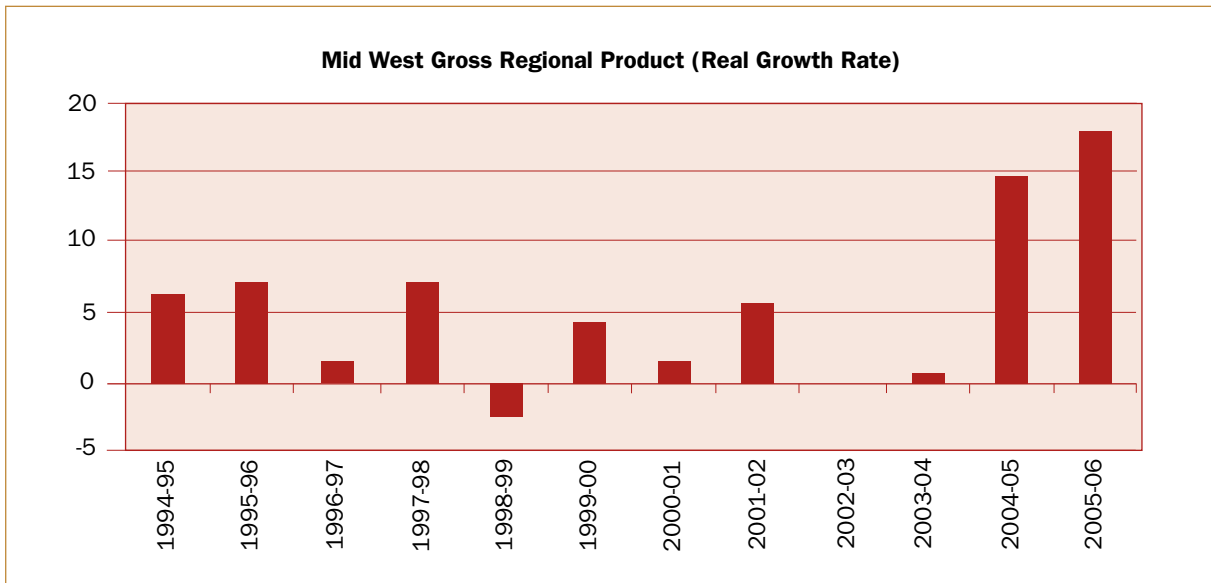
The Mid West region is comprised of 19 local government authorities. The City of Geraldton is the region's major commercial, administrative and service centre. The economy of the Mid West is diversified but the GRP indicates that it is predominantly based on the mining, agriculture and fishing industries, with smaller contributions from manufacturing and tourism.



Source: Mid West Development Commission

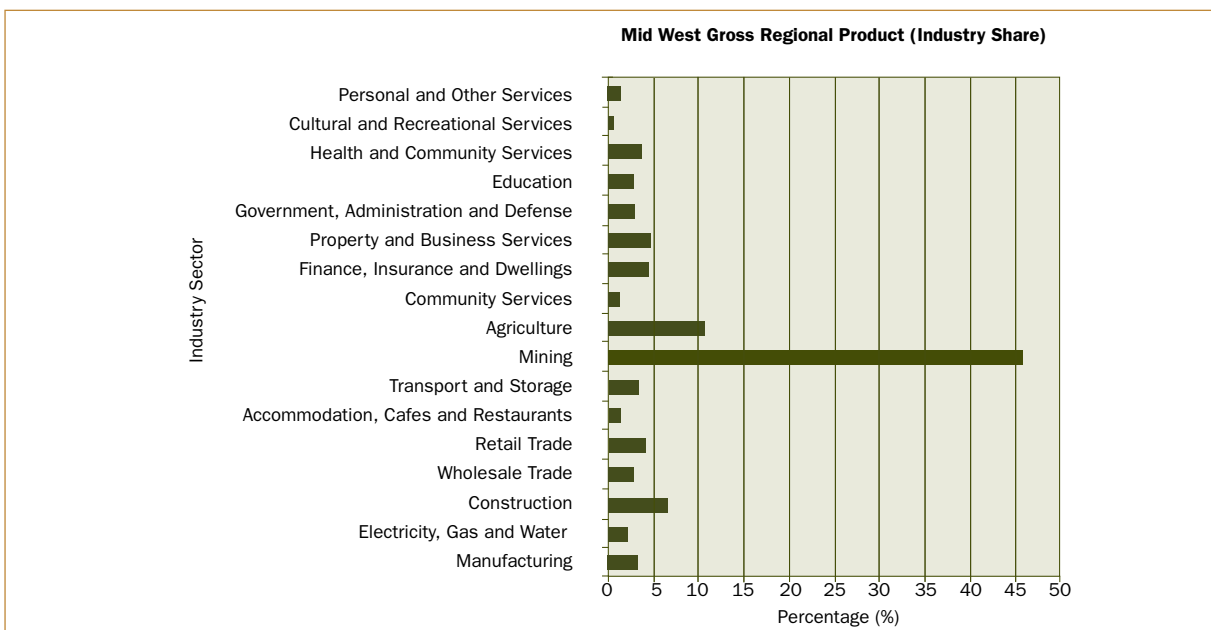
REGIONAL OVERVIEW

In 2005-06, the Mid West's Gross Regional Product ("GRP") was \$3.5B, which represents 3% of the Gross State Product (GSP). Since 2004-05, the region has been experiencing significant growth in its GRP, in real terms, (this is mirrored in other regions of the State) but the trend over the previous 12 years shows that the region has had a fluctuating economy.



Source: Mid West Development Commission

Whilst the Mid West has a broad economic base it is dominated by mining which contributed more than 45% of GRP in 2005-06. The other Major contributions to the economy came from agriculture (10.5%), construction (6.4%), retail (3.9%) and manufacturing (3.2%) industries; tourism has not been a major contributor to the region's economy overall, its impact is primarily felt in the hospitality industries.



Source: Mid West Development Commission

POPULATION

Population Structure and Characteristics

The Mid West region had an estimated resident population of 50,366 as at 30 June 2006, representing an increase of 0.7% on the previous year. Over the same period, the overall population of regional WA grew by 1.9% and the State population grew by 2%. The population of the Mid West makes up 9.1% of the total number of people living in regional WA and 2.5% of the State's population.

Unlike most of the regions of WA, over the last five years, the Mid West has not experienced a population growth and has in fact experienced a net fall in population. Whilst growth in population is only one of the indicators that can be used when measuring the prosperity of a region, given the overall strength of the WA economy and the role of mining in creating that prosperity, it is significant that the Mid West, which to some degree depends on the mining industry, has not experienced sufficient stimulus to grow its population.

Population Distribution

Population within the region is unevenly dispersed; distribution density is related to a number of factors including the intensity of land uses. The higher rainfall areas closer to the coast tend to support more intensive agricultural land uses including horticulture, mixed cropping and livestock farming. Mining is also significant in parts of the coastal region and this contributes to the overall population density. The single most telling factor is that the regional centre of Geraldton, and its outer suburbs in Greenough, is home to 65% of the region's population and this has a significant impact on population distribution.

In a number of coastal communities the populations have increased, driven by the State's overall economic activity and the 'sea change' factor that has seen 'babyboomers' move to the coast. This trend is apparent in communities such as Kalbarri, Port Gregory, Horrocks, Greater Geraldton, Dongara, Leeman and Greenhead.

Estimated Resident Population, Statistical Division, Western Australia

STATISTICAL DIVISION	Population totals					Population change		
	2001	2002	2003	2004	2005	2006	5 years	% change
Pilbara	39,461	39,385	39,482	39,229	39,495	40,132	671	1.7%
South West	194,129	198,681	203,940	211,477	219,937	227,981	33,852	17.4%
Midwest	50,475	50,247	50,011	49,611	50,015	50,366	-109	-0.2%
Great Southern	72,494	72,414	72,304	71,575	72,281	72,868	374	0.5%

Source: Australian Bureau of Statistics, 3218.0 Regional Population Growth, Australia, Table 5.

The inland areas are subject to lower intensity agricultural practices and mining; as a consequence, the population density in these areas is lower. It is evident that the trend that is impacting on coastal communities is not being replicated in inland centres, as indicated in the following table.

Estimated Resident Population 1996 - 2006									
LGA	1996	1999	2002	2005	2006	Share of the Region 2005 (%)	Annual Growth 2005-06 (%)	AAGR 2001-2006 (%)	AAGR 1996-2006 (%)
MID WEST (people)	49,415	49,847	50,247	50,015	50,366	100	0.7	-0.0	0.2
Carnamah	998	857	765	692	671	1	-3.0	-3.6	-3.9
Chapman Valley	836	873	884	983	1,017	2	3.5	3.0	2.0
Coorow	1,444	1,478	1,366	1,278	1,221	3	-4.5	-2.3	-1.7
Cue	491	391	391	352	338	1	-4.0	-3.0	-3.7
Geraldton	20,200	19,945	19,700	19,019	19,018	38	-0.0	-1.1	-0.6
Greenough	10,701	11,909	12,954	13,585	14,022	27	3.2	2.1	2.7
Irwin	2,526	2,898	2,996	3,248	3,350	6	3.1	1.8	2.9
Meekatharra	2,098	1,690	1,466	1,551	1,514	3	-2.4	0.8	-3.2
Mingenew	611	599	585	525	510	1	-2.9	-2.7	-1.8
Morawa	1,059	1,048	963	859	827	2	-3.7	-3.4	-2.4
Mount Magnet	869	798	841	726	707	1	-2.6	-3.6	-2.0
Mullewa	1,146	1,100	1,120	1,057	1,013	2	-4.2	-2.0	-1.2
Murchison	159	157	160	162	141	0	-13.0	-2.5	-1.2
Northampton	3,020	3,244	3,329	3,238	3,302	6	2.0	-0.2	0.9
Perenjori	695	620	589	572	548	1	-4.2	-2.2	-2.3
Sandstone	169	147	143	150	150	0	0.0	2.4	-1.2
Three Springs	839	787	746	722	721	1	-0.1	-0.8	-1.5
Wiluna	1,162	985	924	969	969	2	0.0	1.5	-1.8
Yalgoo	392	321	325	327	327	1	0.0	0.1	-1.8

Source: Australian Bureau of Statistics and the Department for Planning and Infrastructure

Note: The apparent 2006 population rise results from the pre-2006 actual population growth rate being lower than the estimated forward projections.

Population Growth Projections

The growth projections for the region, prepared by the WA Planning Commission, predict that the region will grow over the next 25 years at an average rate of 0.5%. The growth rate is predicated on 'business as usual', so that if the region is to grow at this rate, or even to grow at all, it is imperative that economic activity grow at a sufficient rate to drive it.

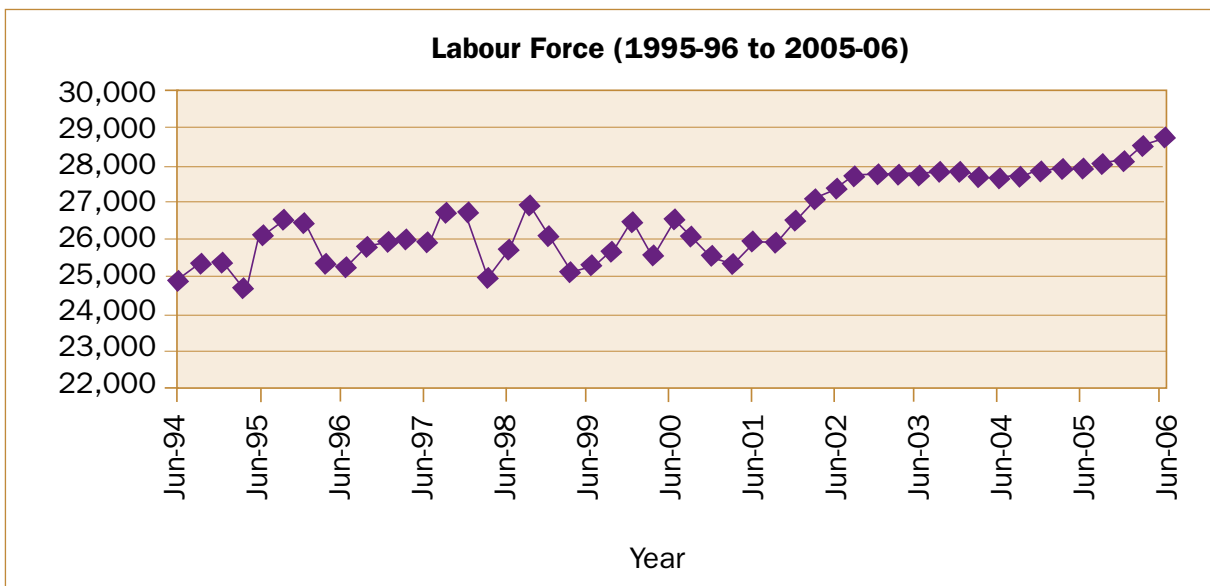
The local government areas that appear to be the most in need of population growth, as can be seen from the above table, are Perenjori, Wiluna, Mount Magnet, Cue and Morawa; these areas have all experienced negative population growth, on average, since 1996. It should be noted that some of these communities are in close proximity to proposed large-scale, long-term iron ore mining projects and are likely to experience a rise in their resident populations, particularly if there is sufficient incentive for workers to relocate with their families to these areas. Even without growth in residential mine workforces, the economic activity associated with fly in/fly out will make some contribution to the demand for local industry and employment. The significance of fly in/fly out, from a regional population perspective, is that the

mine workforce does not contribute directly to life in the community. This means that the multiplier impact of a mining operation on local economic activity is less than could be achieved if the mine used a residential workforce. The reduced local benefit can be off-set to some extent by the size of the mining operation being implemented (level of investment and employment).

WORKFORCE AND EMPLOYMENT.

The Workforce (total employed and unemployed) in the Mid West has increased over the ten-year period to 2005-06, both as a percentage of the population and in absolute numbers. The number of people employed ranged from 25,400 to 26,000 people from 1995-96 to 2000-01, before rising to above 27,000 people in 2002-03.

In the financial year 2005/6, the available workforce in the Mid West increased 3.1% over the previous year to 28,737 people. Those in employment increase by 3.9% to 27,388. This indicates that there has been a decline of 10.7% in the level of unemployment (down from 1,511 to 1,349). Whilst this is an improvement in the unemployment level in the region, it is still almost double the WA average.

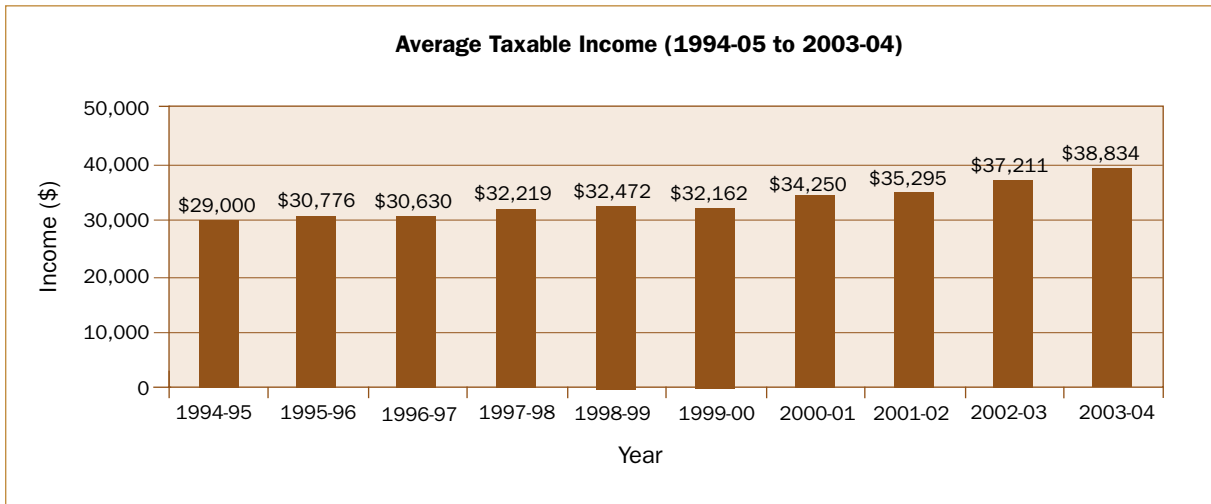


Source: Mid West Development Commission

AVERAGE TAXABLE INCOME.

The average individual taxable income in the Mid West for 2002-03 (most recent figures) was estimated at \$37,211, an increase of 25% over the average taxable income figure of \$29,760 in 1994-95. In comparison, regional WA's average taxable income for 2004-05 was estimated at \$44,142. Given that the figures do not take into account the growth in the economy that has occurred in the last few years, it is difficult to draw an assured conclusion, however, the region may not be benefiting to the same extent as the other regions that are so heavily involved in the mining industry.

In support of this proposition, according to the Commonwealth Government focus paper on industry structure (2001), average incomes tended to be higher in regional areas, reflecting fast employment growth in the mining sector and the need to pay higher wages to recruit workers to regions seen to have low amenity. This could indicate that the wealth of the Mid West is unevenly distributed and that there is a need to increase the level of economic activity in order to improve the overall social /economic attractiveness of the region.



Source: Mid West Development Commission



INFRASTRUCTURE

The region is serviced by a range of infrastructure that supports both the community and industry. The norm is that economic activity leads to an increase in the demand for infrastructure and this in turn drives the development of enhancements and investment in new infrastructure.

Energy - gas

The region is traversed by 4 pipelines carrying natural gas. Three of the lines (DBNGP, GGP and the Parmelia Pipeline) are trunk lines carrying gas from the producer. These lines are critical to the whole State as well as meeting the needs of the region. Whilst the available capacity in these pipelines varies, there is capacity to either loop or duplicate these lines in order to ensure that additional gas can be made available.

The region also has a major gas lateral running from the DBNGP to Mt Magnet. This pipeline is significantly under utilised, particularly since the closure of the Windimurra vanadium mine. New investment and development in the area of the pipeline should benefit from the existence of the pipeline.

Energy – electricity

The region has a mix of electricity generation and distribution systems. A significant part of the region (primarily the coastal shires) is connected to the South West Integrated Network (SWIN). In the inland shires, there are a number of stand alone generators and several of the mining companies generate their own electricity. The availability of electricity is an important part of the future development of the region and if its economy is to grow, the availability of energy will be a key component in the decision-making process.

Currently, the region does not have adequate high tension supply to meet both the existing demand and the possible growth in demand. In response, a new 330kV transmission line is planned to run from the Northern Terminal near Eneabba to a new terminal at Moonyoonooka near Geraldton. The funding decision for this new line has yet to be taken and the cost is estimated to be \$300M. Provided the investment is funded, construction is targeted for completion in 2011.

If electricity is provided from the SWIN, it is usual for a major customer to contribute to the cost of providing

a power supply. This can be achieved with, for example, a non-refundable capital contribution, to off-set the cost of any network enhancements needed to provide the service.

If the Mid West is to remain competitive with other regions of WA, then the electricity network has to be able to handle growth in demand. The opportunity to develop iron ore mining and processing operations, both inland and around Geraldton, will provide a 'demand driven' incentive to enhance the network.

Water supply

The Water Corporation operates reticulation schemes in most of the regions towns and plans to enhance supply are being developed for growth areas. The water is generally sourced from aquifers. The capacity of the major aquifers is not fully understood and this is an issue that will need to be resolved in order to ensure that the future needs of the region can be catered for.

Should the iron ore mining industry in the region expand its capacity, there will need to be new water supplies developed. The development of magnetite mining operations will require a significant amount of water to be made available. The mining companies are working with the State's Department of Water, assessing the capacity of the local aquifers in order to ensure that there is sufficient water available for both the mining operations and the local communities.

Transport – roads

The Mid West region is serviced by a network of sealed and unsealed roads. The major road transport routes between the north and south of WA pass through the region. These roads handle a significant amount of traffic and are well serviced. The east/west road network, however, has been of concern to the community for many years and government has committed significant funding to enhance its serviceability.

As examples of the improvements to the east/west road network, the Mt Magnet/Leinster road has now been sealed and \$88M has been expended on the Southern Transport Corridor which services the Geraldton Port. Further work is required to the regions roads to ensure that they meet the long term aspirations of the community and industry. If the iron ore industry is developed to its potential in the Mid West, the industry will undoubtedly make a significant financial contribution to the cost enhancing and maintaining the road network.

Transport – rail

The Mid West has a rail network that is primarily used for the transport of agricultural products. The mineral sands industry uses rail to transport concentrate from Eneabba to Narngulu and the fledgling iron ore industry is also using some rail transport.

If there is a significant increase in the volume of bulk commodities to be transported, as would be the case if an iron ore industry grows to its potential, the rail network will have to be enhanced. The volume of product to be exported will require a significant overhaul of some of the existing rail network as well as the construction of new, purpose built, heavy duty rail. This will be essential if the Oakajee Industrial Estate and associated port is to proceed. Rail infrastructure will be a major investment in the future of the region with the expenditure required likely to exceed \$1B.

Transport – port

The Port of Geraldton is a major regional port in WA. Last year, 5.2 million tonnes of cargo passed through the port, the vast majority of which was export cargoes. The single largest product, by volume, was iron ore and the volume of ore passing through the port should increase significantly in the next few years. To handle this growth in demand, the Port Authority is investing in new berths, loading and handling equipment and storage. In order to justify this level of expenditure, the industry will need to export through the port for a significant period of time. The current estimate is that the port could be handling up to 15 million tonnes of product per annum as early as 2009.

Whilst it is likely that the Port of Geraldton can handle this volume of product, there are major constraints on the Port developing further. Its location in the centre of Geraldton is very likely to be an issue as the volume of cargo increases. This will inevitably lead to a significant increase in the Port's impact on the community through loss of amenity, noise and increased traffic flows.

The Port also has limits on the size of vessels it can handle. It is current capable of handling Panamax size vessels (nominally 65 000 tonnes capacity). Whilst this capacity is adequate for a number of commodities, it is an impediment to the development of the iron ore industry which uses cape size vessels for a significant proportion of its cargos (up to 175 000 tonnes capacity).

Oakajee

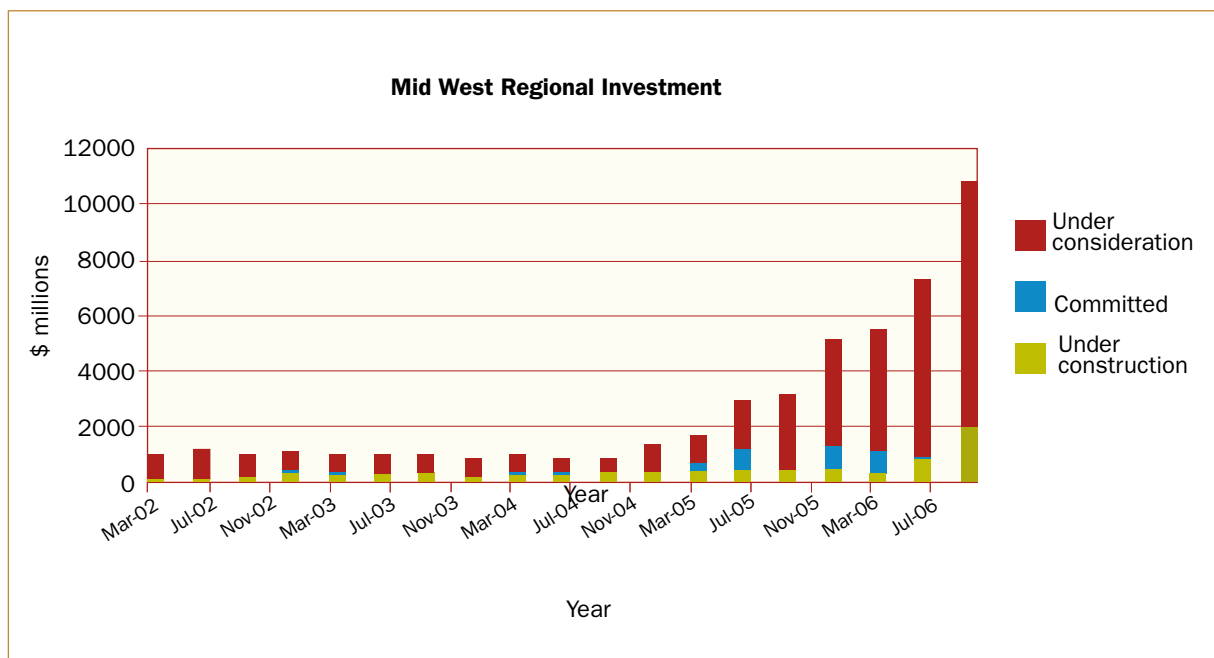
If the region is to become a major iron ore province, the Oakajee Industrial Estate and associated port facilities will have to be developed at a cost of more than \$1B. Oakajee offers the capacity to invest in minerals processing, as well as providing a suitable site for the management of large volumes of export cargo such as the initial 45Mt proposed by the foundation customers, Murchison Metals and Midwest Corporation. The associated port would also provide the region with access for cape size vessels thereby improving the ability of the mid west iron ore industry to penetrate the market.

REGIONAL INVESTMENT IN THE MINING INDUSTRY

Since the beginning of the commodities boom, WA has experienced a considerable increase in the level of investment in WA's resources sector. This increased investment has not, to a large extent benefited the Mid West region.

Investment within the Mid West which is vital to the region's future social and economic prosperity has occurred, particularly in the last two years, but it is a fraction of the level of investment needed to sustain the regional economy. In the March quarter of 2002, the value of investment under consideration was estimated at \$962M and this has increased to \$10.9B by the September quarter of 2006. Whilst the value of projects under consideration has remained in the many billions of dollars, the region will only benefit if the projects at the exploration stage move through feasibility to construction and operation. The evidence is that a number of proposed projects do not reach the construction phase.

Mining and related projects in the "under consideration" phase had a combined value of \$8.9B in the September quarter of 2006. This is an increase of 38.3% over the June quarter and it suggests that mining retains its potential as a strong economic driver in the region. There were seven projects "under construction" in the same quarter worth an estimated \$1.96M. This is a huge increase of 131% over the previous quarter but this level of investment has to be maintained for the region to retain its current level of economic activity. It is, therefore, important that the widest range of investment opportunities are give every possible chance of success in order to try and ensure the economy does not go into decline.



Source: Mid West Development Commission

REGIONAL COMMODITIES

The major commodities mined in the Mid West are gold, mineral sands, iron ore, nickel and base metals; the region is also home to the production of crude oil and natural gas. In the calendar year 2006, the value of minerals and petroleum produced in the region was \$2.75B. This figure represents a significant increase over the previous year due to:

- A very significant increase in the value of most resources; and,
- An increase in production (particularly iron ore) from some of the mining operations.

Whilst this increase in value is a boost to the region's GRP, it should not be interpreted as a portent of long term economic security for the region. Each of the commodities produced has its own expectations for the future and this should be taken into account when assessing the future prospects of the region.

Gold – in long term decline

The Mid West region has an active gold mining industry. In 2006, just over 16 tonnes of gold was produced valued at \$422 million. This level of production is, however, only half of the volume produced in as late as 2000. A continuation of the trend to lower production and a reduction in the number of producers will inevitably lead to a reduction in the total workforce.

The contraction in the gold industry can only be offset by exploration for, and the discovery of, new resource. Unfortunately, the level of exploration for gold has fallen significantly across WA and the Mid West region has experienced an equivalent reduction.

Mineral sands – in long term decline

The region is a significant producer of mineral sands. The total value of production from the region reached \$416 million in 2006. The major commodities produced by the industry are zircon and Ilmenite, which is primarily converted to synthetic rutile at Narngulu before being exported. The industry is based on resource that is found on the coastal plain and it has a significant economic impact on some regional centres; the industry is also the largest single employer in Geraldton/Greenough.

Unlike most of the commodities produced in WA, the mineral sands have not benefited to the same extent as other commodities have from price increases. Furthermore, an important aspect to this industry is that it is dependent on gaining access to resource located close to the coast and this is becoming increasingly difficult. It is unlikely that the industry can continue to mine resource at the current levels without there being both new discoveries and continuing access to ground to enable mining.

In the coming years, given the probable reduction in the volume of ilmenite being mined, the major producer of synthetic rutile, Iluka, will have to source feedstock for its Narngulu plant from either inter state or from overseas. The importing of resource into WA will need to occur within the next few years in order to maintain production levels from the Narngulu plant. If this is not achieved, the production of synthetic rutile will have to be reduced and this will have a significant impact on employment.

Zinc - Copper – moderate long term future

Oxiana Limited is the sole producer of zinc and copper in the region. Its Golden Grove operations export zinc and copper concentrate through the Port of Geraldton. This mine employs over 700 workers and is capable of producing up to 150 000 tonnes of zinc in concentrate. In 2003, the Golden Grove mine produced 47 000 tonnes of zinc in concentrate valued at \$36M. This had risen to 138 000 tonnes in 2006 with a value of \$353M. Golden Grove is, as a consequence, a significant component of the GRP. The company has reported that it's current operation has a significant long term mine life and is undertaking exploration to identify additional reserves.

Nickel – of little relevance to the region

The region's only significant nickel producer is BHPB from its Mt Keith mine. The ore is concentrated on site before being transported to either Kalgoorlie for smelting or to Esperance for export as concentrate. The value of this operation has increased significantly in the last two years due to the increase in both the nickel price and the rate of production.

There are opportunities for this industry to increase its level of production but unlike most other commodities e.g. mineral sands, zinc and iron ore,

current nickel operations have literally no impact on the western areas of the region. It is not likely that this situation will change in the future without a significant improvement in the region's transport network and infrastructure.

Iron ore – hope for the future

Whilst WA's first iron ore exports came from the Mid West Region (Koolanooka), until recently, the region has not had an operating iron ore mine.

The new development in the iron ore industry in the Mid West recommenced in 2003-04. Mount Gibson began exporting haematite iron ore from its Talling Peak operation north of Mullewa in January 2004. This mine alone currently accounts for 34% of the total trade volume exported from the Geraldton Port, and its contribution is anticipated to grow even further in the future. The company is intending to increase production to 3 Mtpa.

Midwest Corporation is also exporting 1 Mtpa of iron ore fines from old remnant Koolanooka dumps and proposes to produce 2 Mtpa of iron ore from its Koolanooka and Blue Hills hematite project from early 2008 for 3-5 years.

Murchison Metals is now mining the Jack Hills deposit and is trucking ore to Geraldton for export.

In some cases, the mine life of the projects, based on the available hematite ores is comparatively short and, without being able to expand to 20-25 Mtpa (eg Murchison Metals) or into the large magnetite resources in most cases underlying the hematite, it is unlikely that the industry will have sufficient ore to sustain it beyond the next decade.

Other Minerals

Other commodities produced in the region in 2006 included copper concentrates (\$78.15M), talc (\$12.6M), and silver (\$30.8M), as well as natural gas production (\$19.7M) and crude oil (\$188.6M). It is not likely that production of these products will grow significantly in the near future.

Square Kilometre Array (SKA) – the only other alternative

Pre cursor projects to the possible development of the Square Kilometre Array Radio Telescope (SKA) are currently being established on Boolardy Station. The Murchison Radio Astronomy Observatory is being set up by CSIRO, the Massachusetts Institute of Technology (MIT) and Berkeley University. The "precursor" projects are valued at \$120M.

Western Australia and South Africa are vying for the SKA project and an investment decision on the preferred site is 3-5 years away. If the decision is in favour of the project in WA, it will require an investment of \$1.8B with half of the capital being spent in WA. Once it is operational, the facility only requires a small workforce at the site of the SKA (10 -20 people), however, it will have a scientific workforce of up to 400 scientists and technicians located possibly in Geraldton.

There remains uncertainty about the SKA investment proceeding and the benefits of the precursor projects are difficult to calculate. But if the decision is to build the facility in the Mid West, it will place this State at the forefront of radio astronomy and there are likely multiplier benefits, over time, which will make this a significant contributor to the regional economy.

By way of contrast with the proposed iron ore industry, if all of the projects proceed, the level of investment in iron ore will approach \$10B and direct employment will exceed 2000. It is, therefore, reasonable to conclude that the SKA might not have the same overall economic impact on the region that the iron ore industry could if it develops to its' potential.



IRON ORE INDUSTRY: PROSPECTIVITY AND ECONOMIC POTENTIAL

– significant development potential, with upside growth and benefits

INTRODUCTION

The first chapter has put the economic and social future of the Mid West region into context, and has spelt out a lower than average share of the current mining boom and, in the medium term, a progressive economic decline of the region, based on the current industry spread.

The establishment of a long term iron ore industry can certainly offset the likely decline in other sectors to the economy and social well-being of the region. It also has the potential to bring very significant economic growth, establishment of a major infrastructure framework and improve the social conditions within the region. This can only be achieved through confidence being generated for the market to invest in the region to allow a long term iron ore industry to be realised and sustained. Individual operations of 1 to 4Mt/a of high grade ore production over the short to medium term will not provide the sustained framework to benefit the region.

This chapter is designed to describe the overall setting of iron ore market potential, specific interest in Mid West investment by major steel companies, the urgent need to ensure market confidence to retain and

capture the opportunity and finally to outline the iron ore prospectivity and massive economic returns that this could bring to the region.

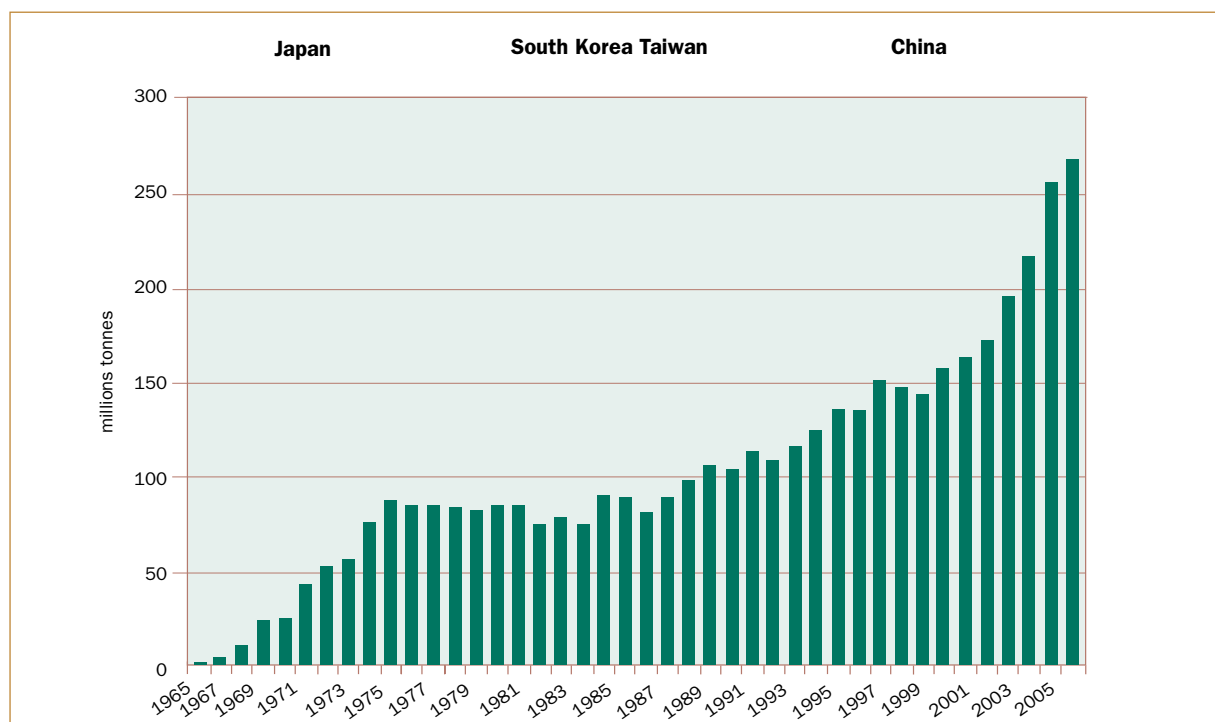
IRON ORE INDUSTRY FUTURE – THE MID WEST, AN IMPORTANT COG

Phases of rapid growth driven by China demand

Western Australia's iron ore industry has undergone a number of phases of growth since exports commenced in 1965. These phases of growth parallel the development of the North East Asian steel industries and have significantly benefited the State over the last 40 years, as seen below.

The latest growth is a response to massive growth in imported ore demand from China, not only from steel industry expansion, but also from a realisation of the efficiency and cost effectiveness of high grade imported ore supplies over its lower quality domestic ores.

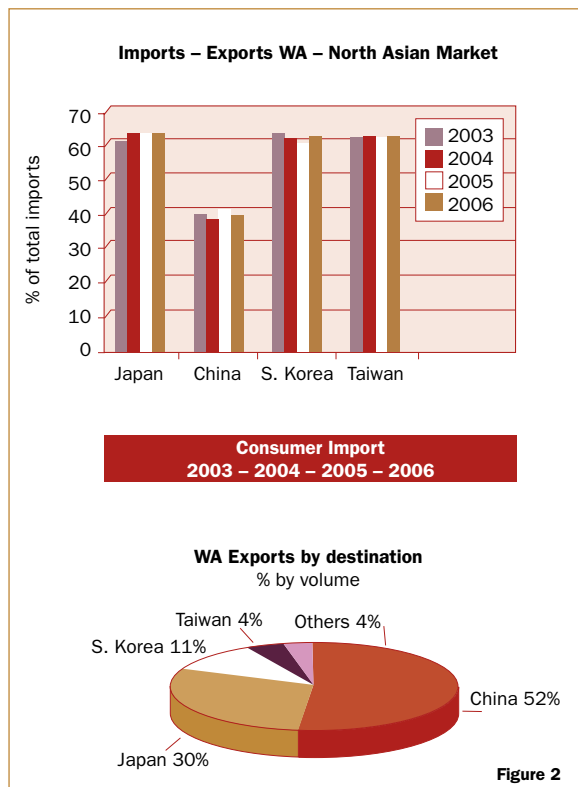
Steel growth in China has been running at over 20% per annum for the last 6 years. It was only slightly below that average in 2006 (18.5%), but has well exceeded the 20% barrier in the first part of 2007. A similar growth is being experienced in imported iron ore supply.



China has clearly emerged as the world's largest steelmaker and consumer and accounts for over half of the world's iron ore demand. WA's immediate future growth is integrally linked with that of China and all of the Mid West projects have a China connection either through investment or market; the significance of which will be discussed below.

China – a major opportunity now for further WA economic growth

Greater than 95% of Western Australia's exports are destined for North East Asia. China makes up 52% of all exports (Figure 2) and, for growth to continue, will exceed at least 70% within 5 years.



A stable supply and slight growth to Japan, South Korea and Taiwan are predicted. These countries rely on Western Australia for around 60% of their total iron ore imports, whereas China's imports are limited to around 40% of its imported ore demand (Figure 3).

China is the major target where Western Australia's competitiveness suggests that WA companies can increase the percentage of China's imports by capturing a more significant proportion of the growth either by long term contract and / or by investment.

Investment by China is predominantly the focus of Mid West development plans. This would provide the necessary added security to both ore consumers and new ore suppliers, but requires confidence in being able to rely on access to the resource.

Sustained Market Growth – Increasing competition for Western Australias

It is reasonable to assume that any significant growth in iron ore demand will be driven by China's continuing economic growth. Industry analysts are optimistic that this country's economic growth will be sustained in the medium to long term, but the exponential growth in steel demand and production (20%) will slow, but still remain at buoyant levels. A growth in the range 7 to 9% per annum is projected.

Based on Chinese steel growth being controlled within GDP planned parameters and, Western Australian suppliers potentially growing from 40% of China's imports to somewhere between 50 and 60%, in line with other mature consumers in the region, the results would allow WA's iron ore exports to achieve somewhere between 430 and 520Mt/a by 2015 (Figure 4). This compares with around 250Mt of total exports from the State in 2006.

Western Australia's growth potential is large and capacity could conceivably be double in less than a 10 year period. The market is rife for securing a proportion of this growth by commitments now, in the face of increasing worldwide competition.

WA Iron Ore Production Potential – towards 2015 & beyond

Compared to defined projects in Western Australia, currently being evaluated at pre-feasibility or feasibility study stage, there is a reasonable match in the range of supply – demand forecasts. A WA supply of 520 – 565Mt/a over a similar timeframe is suggested from these projects. There are of course some of the larger players conceptually projecting massive increases to capture an increased portion of the predicted demand. If realised these could flood the market and create difficulties for some of the more modest greenfields developments. However, there are other market issues, and not just economics, which could limit such expansions, notably diversity of suppliers and secured supply through investment.

It is inconceivable that all projects will achieve their development plans. Given this situation, there is a reasonable prospect that WA can achieve a significant growth in each of the regions.

It is suggested that allowing for a substantial Pilbara growth and a modest number of projects in other regions, there is still the potential for 75 to 85 Mt/a to be sourced from the Mid West region by 2015 (Figure 5). Diversity of suppliers and investment opportunities to secure supply in the Mid West are key issues. If the Mid West projects do not ensure

such tonnages, it is by no means certain that the Pilbara will attract the equivalent amount.

Huge Investment Needed to Support Growth

While investment in incremental expansion of existing operations is large, in the order of \$ 4.7 billion to achieve a State output capacity level of 370Mt/a, the needs for greenfields projects, involving major infrastructure, is a level higher. For the five more advanced major Mid West projects around \$7.5 billion in investment could be expected or over \$100 per annual tonne of capacity.

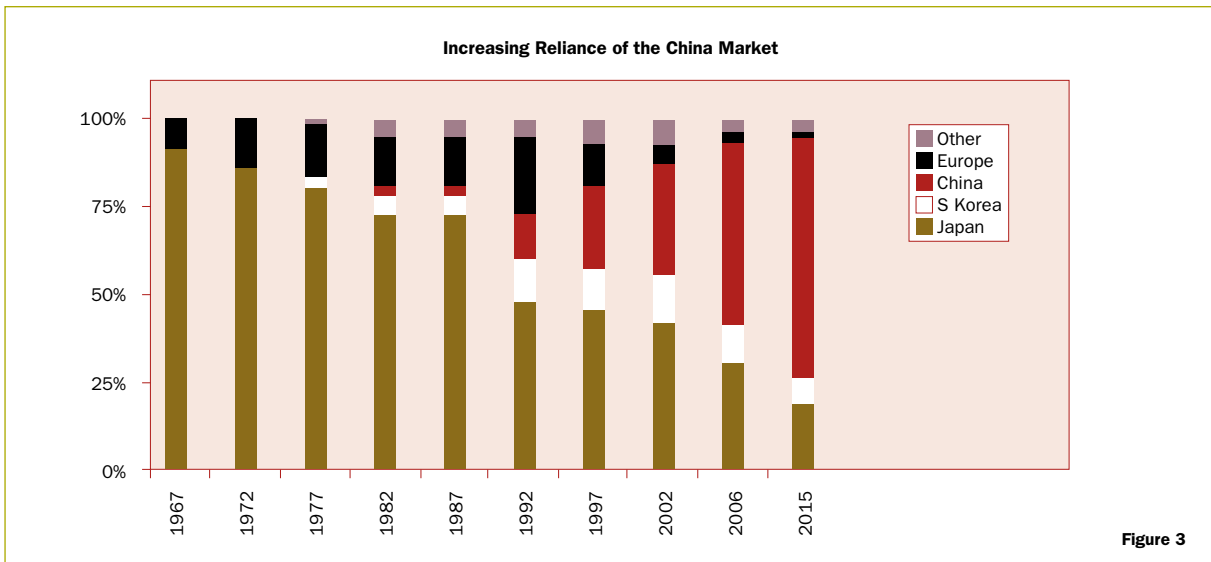


Figure 3

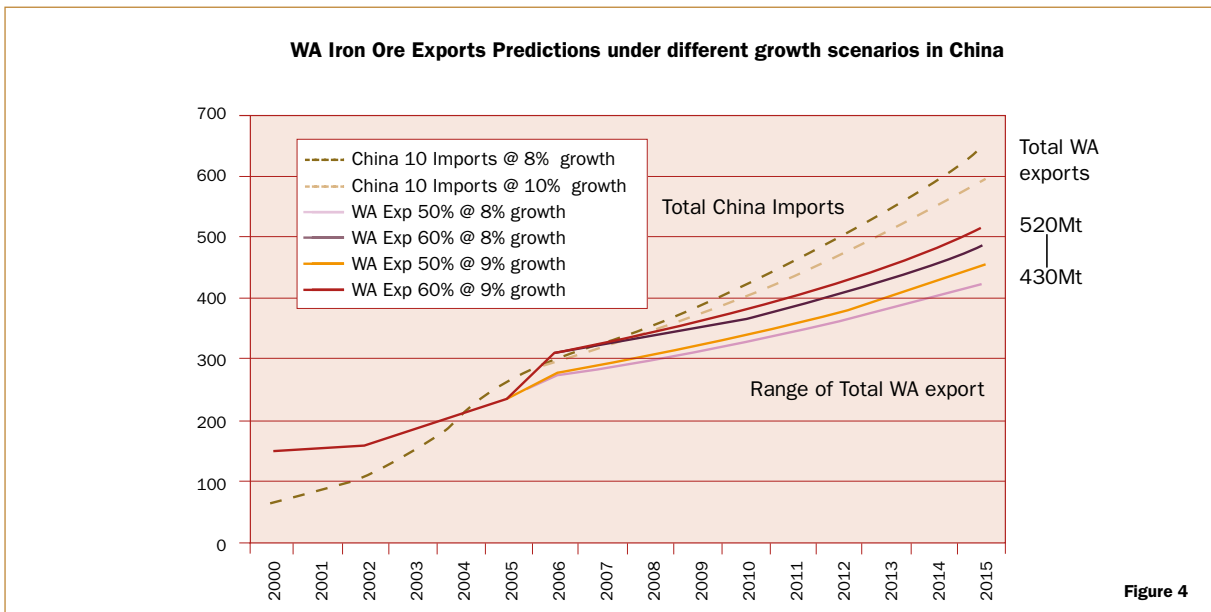
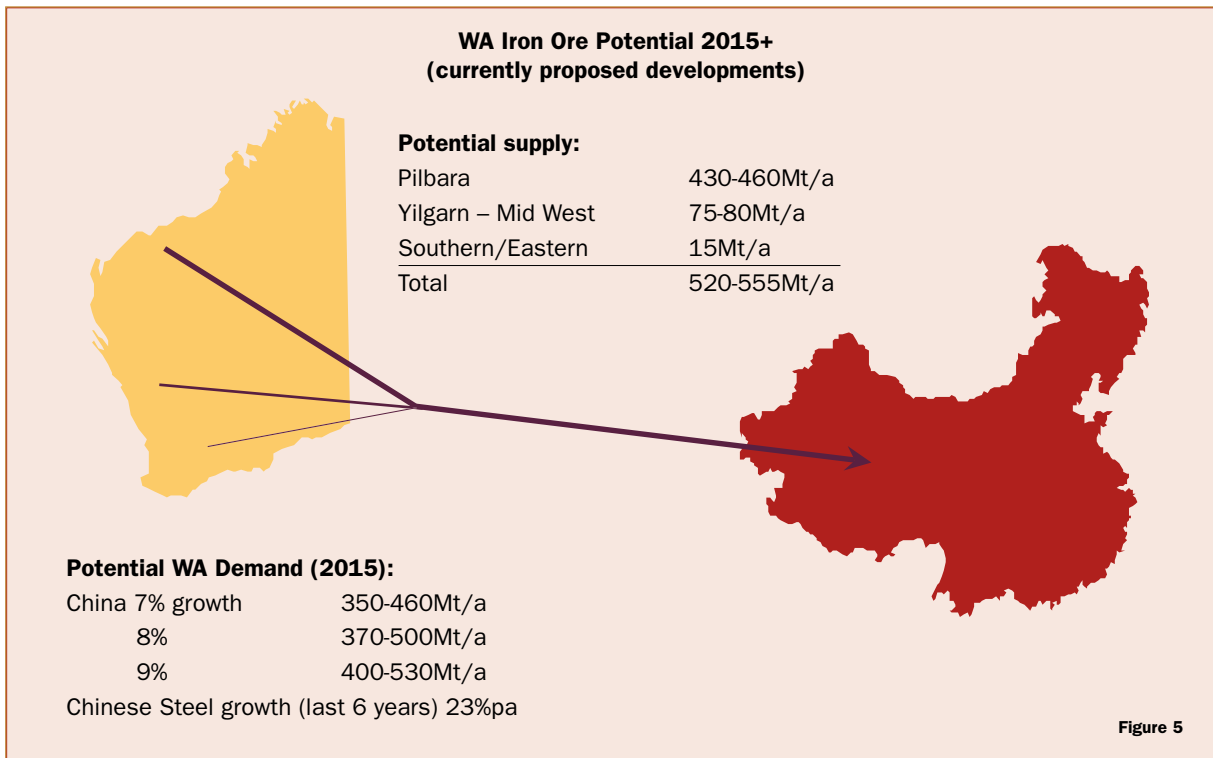


Figure 4



Western Australia's Competitiveness – Mid West, a Good Fit for Consumers

The competitiveness of Western Australian ores into both China and Japan is clearly demonstrated in Table 1. Chinese import price figures had an advantage of between \$US 8 and 15 per tonne delivered into China in 2006 and between \$US 3 and 16 into Japan over its three major competitors of Brazil, South Africa and India.

\$US/t (average 2006 delivered prices)	China	Japan
Australia	56.9	47.1
South Africa	65.2	63.6
Brazil	72.1	62.2
India	64.6	50.0

While in absolute numbers China figures will come down, as it establishes long term shipping arrangements similar to Japan, in comparative terms the freight differential will continue to provide a major advantage to WA because of its proximity to its major markets. This price advantage cannot be overstressed and, together with the reputation of consistency and reliability, Western Australia has been acknowledged by the long term arrangements with the more mature markets of Japan, Taiwan and South Korea. The Mid West developers can take advantage of this reputation and freight advantage over overseas competitors.

The imbalance between supply and demand has fuelled a major drive for consumers to secure markets. Spot prices compared to annually contracted supply prices have varied by up to a factor of 3 in the last 2 years and spot sales have regularly fetched 1.5 to 2 times that of the annually negotiated price. In addition new plant construction in China without secure supply has meant that figures of between 50 and 80 Mt of annual blast furnace capacity has not been able to be commissioned in timeframes being planned because of physical lack of supply.

These situations have led consumers to place an emphasis on security of supply through investment and diversification of supply sources to restrict the growing strength of the big 3 suppliers, CVRD of Brazil, Rio Tinto and BHP Billiton. Add to this familiarity with use of, and expertise in extraction from, magnetite ores, then the Mid West region provides a specific attraction to the growing market consumers in China. To others it provides a business opportunity for investment in a profitable commodity sector very lucrative for investors at the present time. Such opportunities for investment are limited with the major Pilbara operators.

These objectives, largely built round security of supply, can only be achieved through major investment commitments in a reasonable timeframe to meet companies' needs. Certainty of access for evaluation and development is critical to the consumer – investors and to the realisation of a long term sustainable industry in the Mid West.

MID WEST IRON ORE DEVELOPMENTS – URGENCY AND DIRECTION

Regional Setting & Limits

Banded ironstone formations of varying thickness and continuity can be found in various isolated ranges throughout the western half of the Yilgarn region (Figure 6).

These formations are not only hosts for iron ore deposits, but also have hosted significant gold mineralisation, particularly in the Murchison (eastern Yilgarn) and Southern Cross (central Yilgarn regions).

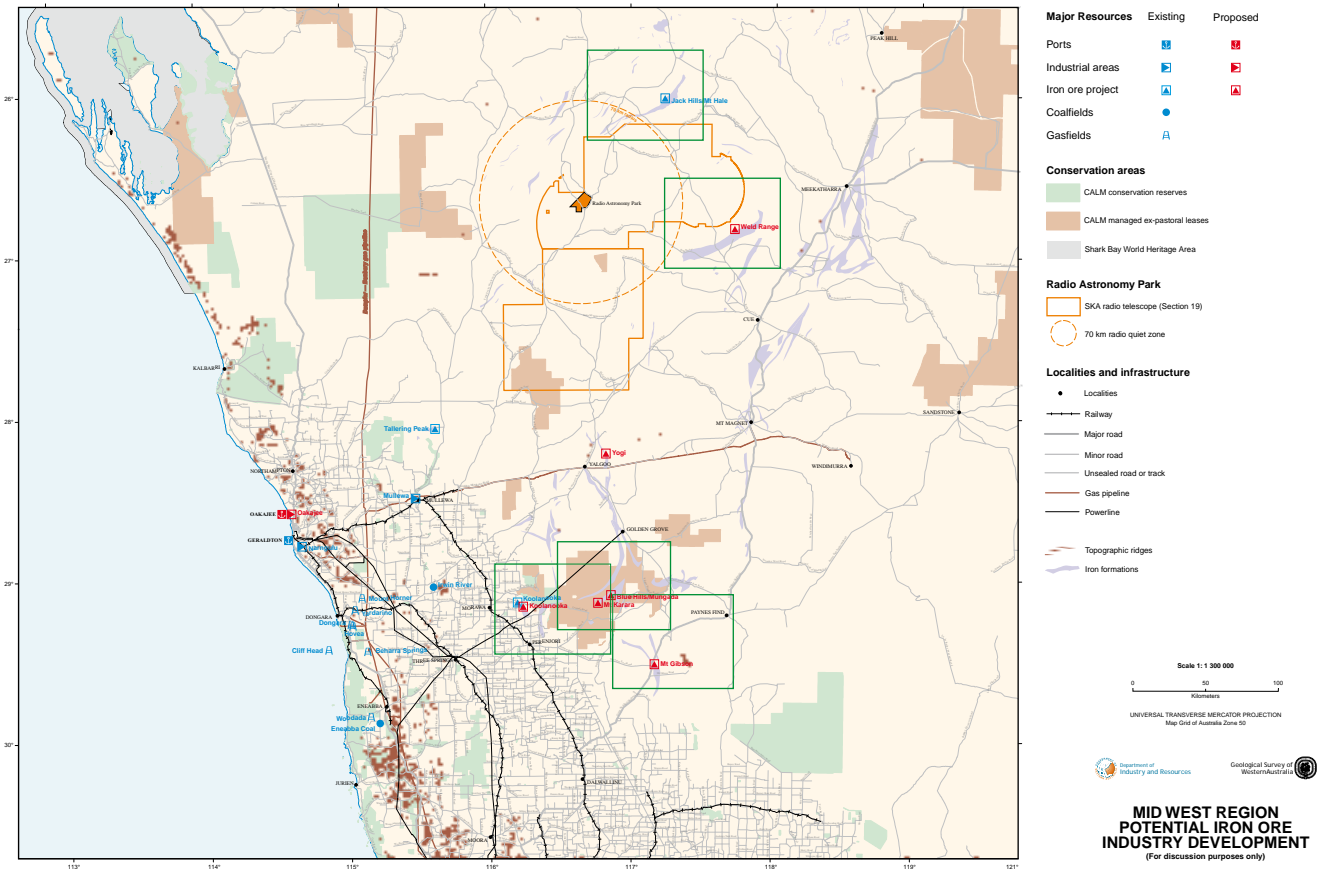
Iron ore prospects are largely found to the north of the Great Eastern Highway and to the west of a line stretching north from Coolgardie. The Darling Fault / Scarp forms the western boundary. Geologically the region covers the Western Gneiss Terrane (WGT) and the Murchison and Southern Cross Provinces. For this evaluation the focus will largely be on the WGT and Murchison Province, commonly referred to as the Mid West region. Mention will be made of the Southern Cross Province or central Yilgarn region for which the southern corridor, as opposed to the Mid West, is the most logical export route.

Yilgarn Iron Ore – history & 4 developments to date

There is a proliferation of iron ore prospects currently being explored throughout the region (Figure 7), many of which were discovered in the 1960 and 70s and some even earlier.

WA Iron Ore Provinces

Figure 6



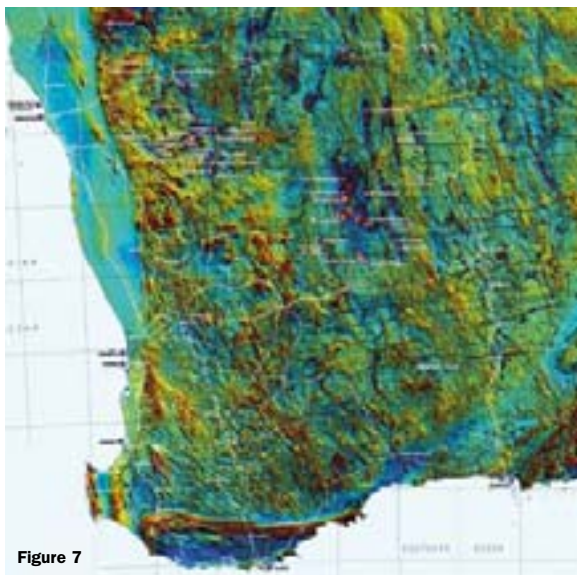


Figure 7

Early developments were largely restricted to Koolanooka (plus supplementary ore from Mungada) and Koolyanobbing. Koolanooka was the first operation to export iron ore from Western Australia, commencing in 1965. The mine closed on completion of the contract with a Japanese steel mill in 1973. Koolyanobbing was developed by 2 groups in 1950 and the late 1960s to provide ore for domestic ironmaking operations at Wundowie, Kwinana and in the Eastern States. Mining stopped in 1983 as a result of the closure of the Kwinana blast furnace. The Koolyanobbing region was subsequently developed as an export project by Portman Mining in 1994 in joint venture with Chinese steel major, Anshan Iron & Steel. Subsequently Portman has developed Windarling and Mt Jackson deposits to provide blended product with Koolyanobbing ore. The operation has grown to a capacity of 8 Mt/a, shipping blended products through Esperance.

Producers in the Mid West region (part of the Yilgarn hinterland which is serviced by the Geraldton coastal region) now total 3, all developed during the current boom. The first was Mt Gibson Iron, who developed the Talling Peak deposit, after plans for an integrated steelmaking project by Kingstream Steel had failed. In February 2006 Midwest Corporation commenced reworking and shipping of Koolanooka remnant fine ore stockpiles and in January 2007 Murchison Metals started shipments from Jack Hills. All of these projects can be seen as starter stage 1 developments for larger projects being planned by these companies and their associates.

While there was significant iron ore exploration of various Yilgarn ironstone ranges during the 1960s and 1970s, most of these areas have remained dormant, at least in respect to iron ore since that time. It has only been in the last 3 to 4 years that they have again been subject to serious exploration and evaluation. In addition there are many other areas now being considered with potential. The distribution can be seen on Figure 7 above with the number of iron ore projects and prospects amounting to at least 27, with many other areas being under tenement application, with exploration plans to focus on iron ore.

Prospects are at various stages of exploration. Exploration, concept planning, & feasibility studies are being undertaken in parallel as new players strive to establish themselves with short term cheaply won high grade ore, while considering major long term sustainable developments. Rapid development schedules are being pushed, in order to take advantage of the iron ore boom created by China.

Staged development plans – stage 2, the ultimate goal

Of the plethora of prospects, some 8 projects are sufficiently progressed to the pre-feasibility or feasibility study stage of evaluation. These projects are shown in Table 2. Generally the companies are promoting a two stage development, with the first either already started or planned to start within a year or so and the second stage on a timeframe ranging between 2008 and 2012.

The stage 1 projects are usually of limited duration 3 to 8 years and are geared to establishing a cash flow from limited capital outlay, using existing infrastructure wherever possible. This cash flow, together with funding from major overseas joint venture interests is allowing drilling, studies and planning to be progressed on the major and more State and regionally significant, stage 2 projects.

Broadly, all stage 1 developments are of natural high grade direct shipping ores (DSOs) at limited sizes of 1 - 4Mt/a, with modest returns in revenue to the State and to regional development.

Stage 2 projects fall into two main categories. To the northeast of Geraldton the developments are of high grade hematite ores, requiring new rail infrastructure

Portman	(Koolyanobbing)	8Mt lump & fines	Operating
Mt Gibson	(Tallering) (Mt Gibson)	3Mt lump & fines 2-3Mt lump & fines	Operating 2008
Asia Iron	(Mt Gibson)	5 - 10Mt concs./pellets	2008/09
Gindalbie Metals	(Mt Karara)	3-4Mt lump & fines 8Mt pellets/concs.	2008/09 2009/10
Midwest Corp.	(Koolanooka) (Koolanooka) (Weld Range)	1 - 2Mt lump & fines 6Mt pellets / concs. 15 – 20Mt lump & fines	Started 2006 2011/12? 2011
Murchison Metals	(Jack Hills)	1-2Mt lump & fines Up to 25Mt lump & fines	Started 2007 2011

Red: magnetite projects

to link into a new port at Oakajee. The projects are based on the Jack Hills and Weld Range areas.

To the southeast, after development of stage 1 near surface high grade hematite ores, the main developments are focussed on low grade magnetite ores requiring beneficiation (processing) to produce high grade concentrates at suitable sizes potentially for slurry pipeline transportation, and initially planned for export through Geraldton. One company at least is re-evaluating the use of slurry pumping in favour of a rail option, to provide increased flexibility for scaling up output. Additionally when Oakajee port is developed, there is a strong likelihood that some of the southeast projects will consider relocation, primarily to take advantage of Cape-size shipping and port throughput.

Context Setting – securing & diversifying supply; overseas investments

The promotion of a prospective iron ore industry in the Mid West region was initiated by junior players, either explorers or new entrants into the resources sector. Initial fund raising was generally through stock exchange floats. In recent years companies with a

portfolio including prospective iron ore areas have had little difficulty in raising \$6M on the market. Often they have been oversubscribed within a few days. These companies have limited access to other funding, and need to establish an early cashflow from early stage 1 project developments. The cost of time delays is very significant to such companies.

As the iron ore asset potential firms, there has been a substantial attraction to overseas parties to get involved in the projects, either as equity ownership of the companies, as joint venture partners to continue studies with a view to entering development joint ventures, and / or through major sales offtake arrangements. The prime purpose for involvement is to secure and diversify supplies for the company's own consumption, in respect to steelmakers, in a very tight marketplace or for strategic positioning as a key market supplier. Mid West companies provide a better opportunity for equity interest by overseas consumers than do the major players in the Pilbara. Additionally, the steel industry consumers are keen to diversify supply sources and have a paranoia of concentrating the strength of the major world players even further.

Investor Confidence and Credibility of Mid West for Business

A significant portion of the resource evaluation, feasibility studies and development financing is being or will be raised and underwritten by the overseas partners. The growth in the industry requires long term producer – consumer partnerships for success. Certainty and confidence in continuing to invest is being sought by the partners, predominantly operating in an approvals environment which is largely alien to them and in which their understanding is limited. This message is regularly being relayed by visiting groups and from overseas visits.

Western Australia has throughout its history attracted overseas investment in the resources sector. The overseas partners in the Mid West are very significant players in the world steel industry and an ability to proceed with development of their projects in this region is being re-looked at as a credibility test for doing business in Western Australia at present, compared to other overseas locations. A list of these companies and joint venture arrangements is set out in Table 3 below.

Overseas players – an important cog in Mid west developments	
Koolanooka (Midwest Corp)	50% Sinosteel
Weld range (Midwest Corp)	50% Sinosteel
Mt Gibson (Asia Iron)	74% Sinom
Jack Hills (Murchison metals)	12% POSCO (in MML) 50% Mitsubishi (Proposed)
Mt Karara (Gindalbie)	50% Anshan iron & Steel
Sinosteel major Chinese Government trading company	
Sinom-significant & successful Asian trader	
Anshan-2 nd largest Chinese steelmaker	
POSCO-South Korea's largest steelmaker & world trader no4	
Mitsubishi-major Japanese steelmaker & trader	

Table 3 Red: Magnetite projects

While there is a market opportunity to establish sustained supply from the region with its inherent benefits, competition from elsewhere is increasing with time and unless a clear policy is developed on accessing the resource potential, there is a likelihood that the region could miss out on a once in a lifetime major boost to regional development.

In themselves the stage 1 projects have limited long term benefits for the State and region, but their ability to get approved and developments established is a very significant factor in providing certainty to retain interest and sustain funding for the major stage 2 projects.

Development Timing and Certainty – a matter of urgency

The Mid West iron ore industry is at various stages in the development cycle, with many projects moving along parallel paths of resource definition, feasibility and Government approvals all at the same time. It is not the classic sequential process of project development, but the players are responding to an industry that currently has an insatiable demand for product as quickly as possible.

Feasibility studies are moving working capital requirements into the 10s of millions of dollars. Very large investments in the \$1 billion plus range are shortly to be outlaid, but are dependent on certainty and confidence being established for access to long term resources and development.

Of particular relevance to this discussion is the triggering of environmental assessment processes. Environmental survey work has been undertaken and is ongoing such that most of the stage 1, direct shipping 'starter' project developments have been or are about to be triggered. Two of the stage 2 projects are into the process, and others are likely to be coming along through 2007. The bar chart below, Figure 8, portrays this position.

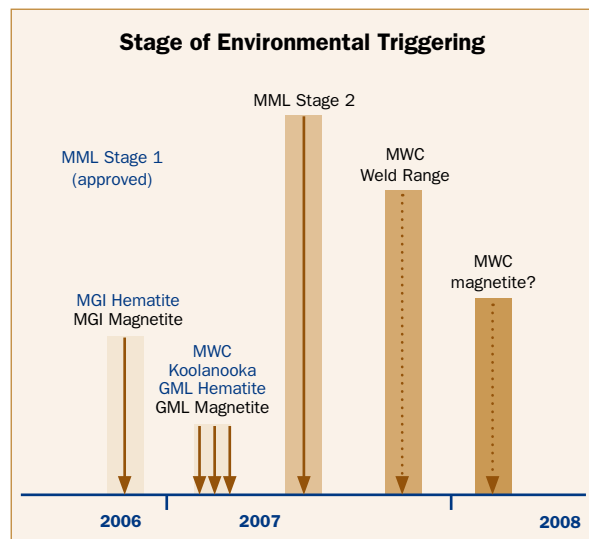


Figure 8

Traditionally, such projects are assessed on a case by case basis. The method of assessment is inefficient and can be distortionary from an environmental viewpoint. Additionally, because of the perceived high conservation value, and possible uniqueness of each formation, there is a likelihood that significant and potentially adverse recommendations could be made by the EPA. This will put an additional onus on Government to then make individual decisions for each project, weighing up the criteria of economic and social benefits against the environmental impacts. Such a process provides little confidence to companies planning investments in the hundreds of millions and, in some cases billions, of dollars. It is evident, given the number of projects in or about to enter the Government approvals system, that clear Government policy guidance is needed for the establishment of such an industry and to allow effective conservation management to be put in place.

Given this timing there is an urgent need to establish such a policy. It is becoming increasingly evident through considerations to date, where conflicts are already being highlighted by high conservation value, against socio-economic and regional benefits.

Need for Clear Policy Direction from Government

Case-by-case consideration will not allow an effective policy or strategy to be developed for either side and could have severe repercussions for infrastructure commitments and confidence for doing business in the region.

The difficulties at present are being monitored by the important joint venture partners and could very well impact on investment decisions, effecting the economic development potential and regional implications. Significant decisions, like the potential for restricting access to the major ranges at Mount Gibson, will have severe precedent-setting implications for the region. It could well result in the significant partners, critical for the development of a major sustained industry, looking for alternative sources of supply and investment. Mid West projects would be put on the 'back-burner', with perhaps the small capital, shorter term developments proceeding, where there is an adverse impact on existing infrastructure and facilities, rather than advancement of the whole social and infrastructure framework of the region.

Equally, if Government was to decide that the conservation values of the region were such to severely limit or require extensive survey work and analysis to significantly delay development, then it is incumbent to advise industry of such risks of projects proceeding.

The regional importance of establishing an iron ore industry cannot be overstated in the discussion. Without stage 2 projects there will be no strategic infrastructure, and the economic flow-on benefits from such a substantial industry will be foregone.

MINERAL PROSPECTIVITY

A more detailed discussion on each of the ironstone ranges in the Yilgarn is covered in the following chapter. This section is designed to summarise the overall prospectivity of the region, acknowledging that exploration / evaluation is largely at a very early or immature stage in the overall process.

The iron ore boom has provided the impetus for a multitude of players entering into a market, which erstwhile had been the provenance of a small number of major international companies, largely focussed on their production bases in the Pilbara. In the current climate all areas with a modicum of geological interest for iron ore occurrences have become foci of activity. The Pilbara and Yilgarn are the two major areas of focus.

The western half of the Yilgarn is a region well known for iron-rich banded iron formations. Iron ore specific exploration work was undertaken in the 1960s and 1970s, clearly identifying immediate deposits to target during the current boom. Also banded iron formations are in certain areas host rocks for gold mineralisation and the geology and distribution of these has received attention since the early 1980s when a major resurgence began in the Western Australian gold sector. Finally the distinct, discrete, isolated ranges dotted around a relatively flat, granitic peneplain landform of the Yilgarn are formed as a result of the more resistant banded iron horizons in a number of discontinuous sedimentary and volcanic sequences (referred to as greenstone belts). As a consequence iron ore targets have been identified throughout the western half of the Yilgarn.

In addition to just the intense demand for iron ore, there are added factors which have resulted in the region's revival in interest for iron ore, after around 25 years of relative dormancy. The first is the Chinese familiarity in use of magnetite ores and hence significant interest in these deposits. The second is the progressive acceptance of changing cut offs of marketable grades of hematites, where lower iron grades and higher phosphorus tolerances are being accepted in the current marketplace.

While continuity and enrichment of banded iron formations in the Yilgarn do not compare to the Hamersley Basin in the Pilbara, there are areas of primary banded iron formation of considerable thickness, uniformity and continuity in extent to support large scale magnetite operations.

However, in general, the enriched hematites tend to be less extensive, quite variable and in a number of small individual discrete pockets. Blending across a number of deposits to achieve requisite marketable grades and sufficient tonnages to underwrite a project development is likely in most ranges except for Jack Hills and Weld Ranges, in the north east of the area. In these deposits there appears to be sufficiently large tonnages of higher grade hematite to support large scale operations. However, exploration to resource definition stage is still a work in progress.

Aeromagnetic surveys, aerial photography, historical data searches and follow up ground truthing have delineated most of the areas with prospectivity for iron ore. Detailed mapping and surface (rock chip) sampling have, in most of the region's prospects, identified areas for follow up investigation through drilling.

Only a limited number of prospects have advanced beyond the reconnaissance drilling phase of exploration. Overall, the region can be classed as very immature in respect to evaluation of its iron ore prospectivity. Many of the ranges are therefore classified with geological prospectivity for iron ore, but as yet undefined resources or exploitation potential. For this reason it would be premature to lock up areas at this stage and a policy which provides for access for progressive exploration and evaluation is called for.

A summary of the exploration and evaluation status of the ranges considered in this report is given below and their economic potential discussed in the next section.

Mid West Region

The Mid West region covers those ranges that would naturally form the hinterland of the Geraldton coast for shipping product.

Robinson Range: No clear identification of targets, grassroots prospect.

Jack Hills – Mt Gould: Over 100 km in strike length of prospective ground, of which 70km is of continuous ranges. A series of banded iron formation lenses identified throughout the ranges. More prospective zones of Fe enrichment and thickness and up to 6-8km strike length being evaluated at reconnaissance exploration stage. A central zone of about 8km covering Mathew Ridge, Mt Matthew and Mt Hale being evaluated to maintain existing stage 1 operation and define resources for major stage 2 projects of Murchison Metals and Midwest Corporation. This central area is highly prospective. Areas of low prospectivity are likely to occur within the ranges, but until reconnaissance exploration is undertaken these are yet to be defined.

Weld Range: The Weld Range is over 60km in strike length of a series of lenses of banded iron formations. Two clearly defined areas, Madoonga and Beebyn, are at the resource definition stage of evaluation and form the basis of Midwest Corporation's feasibility study. Reconnaissance drilling is being undertaken over zones up to 10km in strike length. There are likely to be areas within the ranges with low prospectivity, with two clearly emerging iron formations of high grade resource potential, the Madoonga and Wilgie Mia Formations. In addition the Wilgie Mia Aboriginal Reserve, in the centre of the range, is inaccessible for exploration, but could potentially be an area with high conservation value that needs to be investigated.

Lake Austin: Banded iron formation has been identified under this salt lake. Little to no range manifestation. No active exploration for iron ore is known.

New Forrest – Twin Peaks: Grassroots exploration stage, with no clearly identified targets at this stage. Talling Peak: Mt Gibson is currently mining within the Central and Southern Ridge areas of Talling Peak. The North Ridge banded iron formation area has significant magnetic signature to suggest it to provide prospective iron ore. Other parties are interested in the exploration potential to the NE of the existing operation. Both of these areas are at grassroots stage of evaluation.

Yalgoo: The Yalgoo area is at various stages of evaluation from reconnaissance exploration to resource definition work, within the central zone of banded iron formation. A magnetite resource of 11.2Mt (9.5Mt of fresh magnetite) has been announced over the Yogi deposit, an important stage in the finalisation of the company's pre-feasibility study. A significant part of the 25km strike of banded iron formation has not been explored beyond the mapping aeromagnetic survey (reconnaissance stage). There are likely to be significant areas of these ranges unprospective for iron ore. Such areas are yet to be defined.

Wolla Wolla – Gullewa: The area is largely at a grass roots stage in respect to exploration although some reconnaissance work has identified targets on which to follow-up. Limited defined prospectivity at this stage.

Koolanooka Hills – Perenjori Hills: The Koolanooka Hills contain the site of the first iron ore exported from Western Australia. Drilling has defined a limited extension of enriched hematite mineralisation to the south and south-east of the existing pit. Plans are to exploit this resource in conjunction with detritals identified on the lower scree slopes of the Koolanooka deposit, and resources from Mungada. Blending of ores from these different areas will be critical to establish marketable product qualities and an adequate resource base.

Koolanooka magnetite resources are defined in two areas, one immediately underlying the existing pit and the other 6-8 km to the SE. The major developments at Koolanooka are based on these magnetites, where in the order of 750 million tonnes can be expected from the two identified project areas.

There are areas of banded iron formation hills continuing to the south and the Perenjori Hills. These areas have been subjected to limited exploration – aeromagnetics, mapping, and rock chip sampling.

Blue Hills – Mungada – Mt Karara: The Blue Hills – Mungada area is being explored by a number of groups and covers a number of banded iron formation ranges / hills, essentially grouped into the Blue Hills, Mungada, west / north west of Blue Hills (including Jasper Hill & Minjar), Warriedar and Pinyalling.

The Mungada Ridge – Blue Hills is being comprehensively drilled to define hematite resources; so far nearly 30Mt defined in a number of small discrete deposits along the range. The potential is estimated at double this number. Gindalbie has completed a bankable feasibility study on a 27Mt resource for 3Mt/a output.

The southern part of the Blue Hills is a thickened sequence and contains the major Mt Karara deposit where 1.43 billion tonnes of magnetite has been defined, which formed the basis of Gindalbie's recently completed bankable feasibility study. This is the most extensive resource defined in the region to date. North from Mt Karara, further discrete hematite deposits have been identified, but the extent of these still remain to be delineated.

On the basis of work to date, the whole of the Mungada and Blue Hills Ranges, including Mt Karara, must be considered to have very high prospectivity and the most extensively undeveloped resource defined and economically evaluated in the whole region.

Iron ore exploration has been limited on the other areas. Reconnaissance mapping and rock chip has identified hematite potential at Warriedar, while reconnaissance drilling has indicated areas of channel iron mineralisation at Pinyalling Hills. The resource potential on these areas is very much at the early stage of evaluation.

Mt Gibson: Resources at Extension Hill have been delineated to support limited hematite development and a significant magnetite project. However magnetics and limited amounts of reconnaissance drilling on the other hills within the Mt Gibson Ranges suggests that the total resource potential of the ranges could be a factor of ten higher than the proposed Extension Hill development. This indeed could provide the base for a substantial sustained output for many years from these ranges. The whole of Mt Gibson Ranges is considered to have very high magnetite resource potential. The banded iron formations extend to the north and south of the ranges with much subdued relief for the most part. Reconnaissance mapping and surface sampling have indicated enriched iron formation, but the areas are still at the grassroots – reconnaissance exploration stage.

Central & Eastern Yilgarn Region

The central and eastern Yilgarn would most likely move any product through the Eastern Goldfields corridor or Transcontinental railway for exports through Esperance. Apart from the operations of Koolyanobbing – Windarling and Mt Jackson, exploration and resource evaluation appears to be generally at an earlier stage than the more defined projects of the Mid West.

Wiluna West: About 30% of a 50 km belt consisting of a number of parallel lenses of banded iron formation have been subjected to reconnaissance drilling, with some infill to define an initial resource of 50Mt of high grade hematite. Current work is aimed at firming up and considerably extending the resource to perhaps 150Mt to support a significant output shipping either through Esperance or Geraldton.

Booylgoo Ranges: Initial indications of iron ore interest on the ranges, but focus activity appears to be concentrated on base and precious metals.

Cashmere Downs (Bulga Downs): Iron ore project being promoted by private company. No publicly available information.

Diemals – Johnston Range: Prospect at reconnaissance exploration stage in which gravity interpretation and field mapping has outlined bedrock iron ore targets for further investigation. A reconnaissance drilling programme has been approved to proceed.

Evanston – Die Hardy Ranges: Prospect at reconnaissance stage exploration. Aeromagnetics, field mapping and surface sampling has identified both bedrock and detrital iron ore targets for further investigation. Drilling of these has been delayed on account of rare flora occurrences.

Ennuin – Mayfield: Prospect is at reconnaissance stage of exploration, with hematite potential seen as possible supplement to existing Portman operations. Company also targeting magnetite potential together with Johnston Range and Evanston to provide a single project base.

Windarling – Mt Jackson: The two mining operations are integral parts of Portman Mining's blending operations to maintain marketable quality products

from its Koolyanobbing mining centre. Indications of further similar high grade mineralisation has been identified through reconnaissance drilling along strike to the east of the Mt Jackson operations extending to near Bungalbin. The 20 km strike length between areas J4 Deposit and J5 is mineralised and significant areas of mineralisation are being infilled drilled to resource definition stage at these areas. The areas are primarily seen as supplementary to Portman Mining's operations. Grassroots exploration prospects also occur to the west of Mt Jackson mine and at Windarling East. Iron ore targets for further testing identified at these locations. Access to nearby resources is critical to the longevity of Portman's operations, as ore blending of very variable qualities is necessary to maintain market quality and ensure that the geological resources are properly husbanded to ensure optimised resource exploitation.

Mt Manning: The iron ore potential of the Mt Manning Range was looked at in the 1960s – early 1970s. Reconnaissance exploration suggested limited high grade hematite potential, but possibly significant magnetite prospectivity. No further evaluation has been undertaken.

Bungalbin (Helena & Aurora Ranges): The iron ore potential at Bungalbin has been known since the 1960s. Bungalbin was part of the BHP Agreement area covering Koolyanobbing. Mineralisation was thought to be thin and generally relatively low grade, although covering a wide distribution in areas referred to as the Central and Eastern Deposits. Mapping of the ranges has been undertaken in recent times, but beyond this limited further evaluation has been made of these ranges. The company with interests in these ranges has indicated that its prime interest is in the Bungalbin East deposit and not in the main range centred on Bungalbin Hill.

Hunt Range - Mt Dimer – Yendilberin Hills: Outcrop mapping and surface sampling has identified a number of targets to drill in and adjacent to this linear N – S and NW – SE trending ranges. Two particular areas have been identified with substantial surface area of enriched, high grade hematite and hematite-goethite mineralisation on which drilling is planned in the near future. The areas are largely at a reconnaissance stage of exploration.

Watt Hills – Mt Finnerty: Mapping and rock chip sampling identified a number of targets for follow up reconnaissance drilling. Results to date suggest thin banded iron lenses in the southern part of the area. Progressive reconnaissance drilling to the north are yet to identify any significant prospective zones. However geological models suggest that the area could have channel iron potential adjacent to the main ranges.

Koolyanobbing: The Koolyanobbing Ranges are known to contain a number of deposits over the length of the ranges. These are progressively being reconnaissance drilled and followed up by resource definition infilling drilling. These deposits will support the long term operations at Koolyanobbing. Many of the other areas in the region are under option to Portman Mining on the basis of supporting the existing 8Mt/a operation. Extensions of the banded iron formations to the south of the main Koolyanobbing Ranges are potential exploration targets.

Lake Giles: Drilling of the aeromagnetic anomalies in the Yergilgee Greenstone Belt has identified 3 distinct areas ranging between 2.5 and 5 km in strike length of magnetite ore potential. Reconnaissance drilling has indicated continuity and testwork indicated

that acceptable concentrate grades could be made. Resource definition drilling is being proposed.

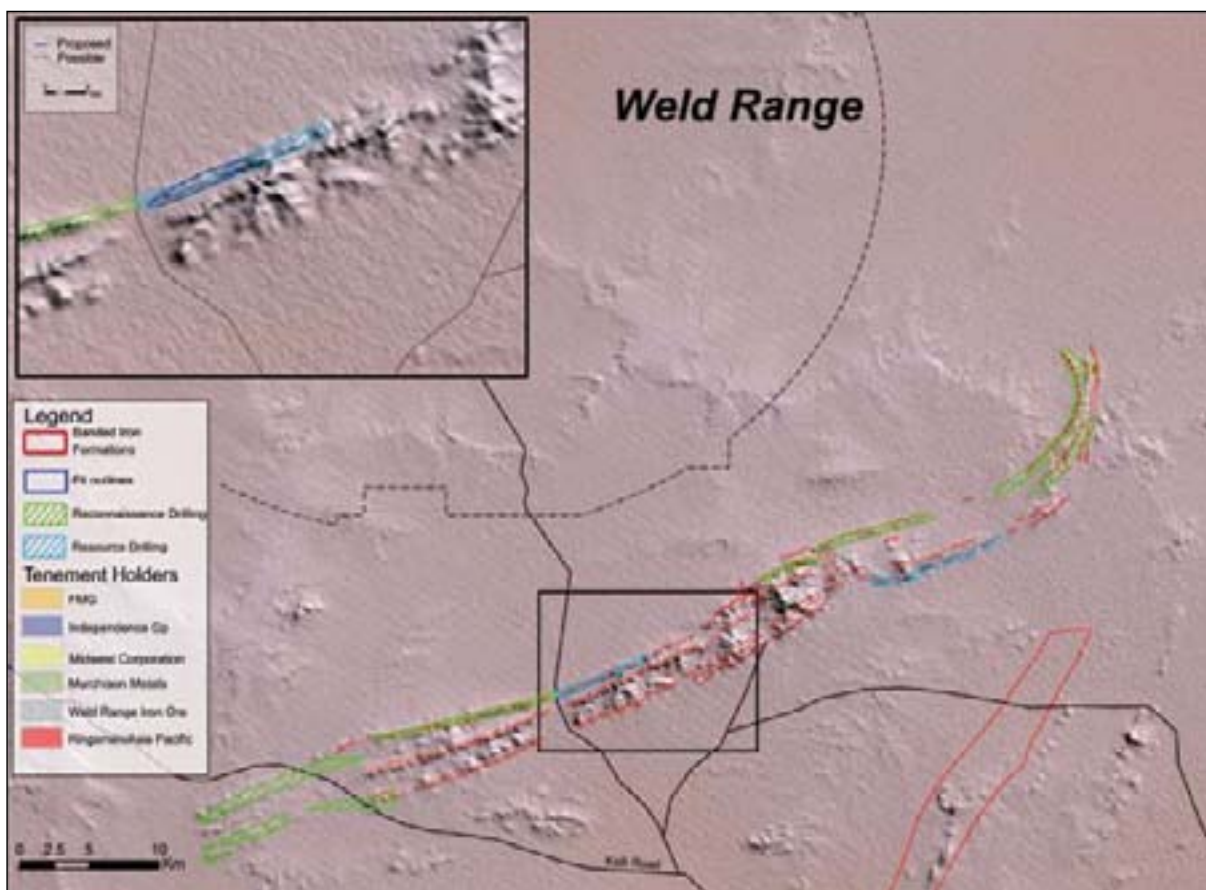
Perrinvale – Brooking Hills: The prospect area is at the early reconnaissance mapping stage of exploration.

Walling Rock – Mt Ida – Mt Mason – Mt Hope: Over 16km of banded iron formation strike between Mt Mason, Mt Ida and Mt Hope has been reconnaissance mapped and surface sampled, identifying enriched hematite lenses. Focus is being put on Mt Mason, where chip sampling has given high grade iron results. Preparation for drilling is underway at Mt Mason.

IRON ORE DEVELOPMENT FOOTPRINT

While forming a series of discrete ranges of isolated hills throughout the Yilgarn region, the length of these individual ironstone ranges can reach up to 80 kms in length comprised of semi-continuous parallel linear ridges. In larger areas, like the Weld Range, these ridges can amass to a combined width of up to 5km. The shorter ones, such as Mt Gibson and Koolanooka, become discontinuous over 10kms in length and may be closer to 0.5km wide.





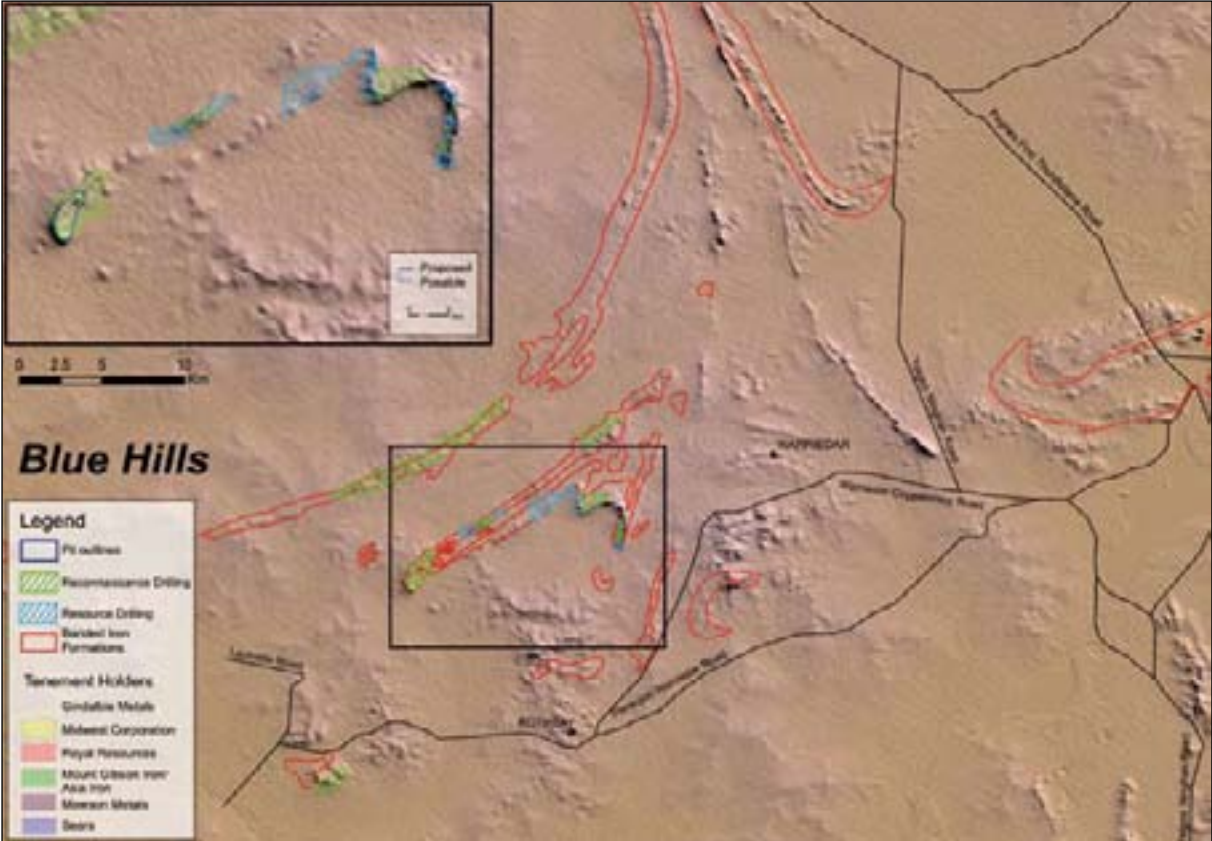
A preliminary summary of the individual range characteristics is outlined below:

	Range length	Ridges/Range Width	Pit Developments
Weld Range	80kms	4 linear ridges; 5 kms across	2 Madoonga 6 km x 0.6 km Beebyn 6-7 km x 0.5 km
Jack Hills	55kms	3 significant linear ridges 1.5 – 4kms across	MML 1 km x 0.5 km MML Stage 2? MWC?
Wadgingarra – Yalgoo Wolla Wolla	20kms 10kms	2 kms 2 kms	? ?
Yalgoo – Gnows Nest to Blue Hills	2 BIF ranges 80 & 100km	1 – 2 kms	-
Mungada – Blue Hills - Karara	6 x 5 kms 20kms	1- 1.5kms wide ridges	7-8 pits 3km x 1km
Koolanooka with Perenjori Hills	14 kms > 30 kms	1 – 1.5 kms 0.5 - 1 km	3 pits 3.5kms x 1.5 kms 2kms x 1km (2 pits) -
Mt Gibson	10 kms (MGI) Discontinuous 13 – 15 kms to NW Other BIF ridges offset to N, NE & SE	0.6 – 0.8 kms	2.5 kms x 1 km (Extension Hill) 3 to 4 others - potential

This extent of continuous and semi continuous ironstone ranges is however very large compared to the footprint likely to result from mining development. Some of the larger, long term pits are likely to be between 2 and 6km long and 0.5 to 1.5 km wide. Given that a large percentage of the support facilities will be located on the surrounding plains, with the ranges largely limited to haul road access and waste dumps, then by doubling the footprint area on the range from that of the pit outline, the overall impact area would be small in the context of the overall extent of the range. Even allowing for say 2 such independent pits within a range, the percentage disturbed would remain small. This needs to be considered, when general statements on high conservation value of particular ranges are put forward. There must be potential for both development and conservation to be managed and in fact, with environmental management and knowledge being progressively improved as part of the mine development commitments, then enhancement of and deep knowledge of the conservation values in the ranges will occur.

While the major stage 2 or large scale projects in the region will result from one or perhaps two deep pit areas in each of the ranges, then their footprint per unit of ore extraction is likely to be significantly smaller than the series of small surface pits required for stage 1 hematite developments. There will be some counterbalancing of this by a higher amount of waste stripping and hence area for dumping with a deeper larger pit.

The smaller hematite operations are often on the surface overlying the planned major development and, because of the genesis of these ores, the small selective nature of extraction cannot be avoided to ensure market acceptable product grades are achieved. The Mungada Ridge high grade hematites are an exception to this rule, where location of many of the pit areas is separate from the Mt Karara magnetite. The Mungada Ridge – Blue Hills area has however the largest tonnage defined of direct shipping ore at nearly 30Mt. The footprint of this development could be over an area of 6 by 5 km in a number of discrete deposits.





ECONOMIC, TECHNOLOGY & SOCIAL BENEFITS FROM A YILGARN IRON ORE INDUSTRY

DIRECT BENEFITS

The previous section clearly indicated that the prospectivity of the Yilgarn region is very much a work in progress. Overall there are many more advanced projects at the deposit definition and project planning stage in the Mid West than the central / eastern Yilgarn. However there are a multitude of early reconnaissance stage prospects in both regions. A number of the central Yilgarn prospects are seen as potentially supplying additional ore to sustain the existing operations centred on Koolyanobbing, as opposed to standalone projects. This section only assesses those projects with clearly defined prospectivity, through resource definition, or where projects are sufficiently progressed in their exploration

and planning to at least the pre-feasibility stage of evaluation. While figures will inevitably change or be refined as the project is advanced, they are the best estimate at this point in time. No assessment has been made of the 'blue sky' potential resource value of areas.

The establishment of a sustainable long term iron ore industry in the Mid West region could have substantial benefits to the State and the region in particular. Table 4 provides an overview of the economic benefits if the potential scale of output of 12Mt/a from stage 1 projects and a further 74Mt/a if all 5 identified stage 2 projects are realised.



MID WEST IRON ORE ECONOMIC SUMMARY

Stage 1 & Stage 2 Assessments in \$Aus M (@ 0.80 exchange rate); Prices: 2007 & 70% of 2007

	Capital \$ M (Yrs)	Resource Life	Prod Mtpa \$M	Resource Value	Annual Revenue in \$AusM	Revenue with Multiplier (x 2.1)	Royalty revenue
Stage 1 Projects							
Jack Hills	41	4	635 – 445	2	150 – 105	315 – 221	10.4 – 7.3
Tallering Peak	14	8	1690 – 1183	3	215 – 150	451 – 315	14.6 – 10.3
Koolanooka Mungada	26	5	600 – 420	2	129 – 90	270 – 189	8.4 – 5.9
Mungada Hematite	108	9	1845 – 1291	3	215 – 151	451 - 317	14.2 – 10.0
Mt Gibson Hematite	73	7	1355 – 949	2	148 – 104	310 – 218	9.8 – 6.8
Total	262		5966 – 4177	12	850 – 595	1783 – 1250	57.8 – 40.5
State Infrastructure							
	325						
Stage 2 Projects							
Jack Hills	2251	3*	3444 – 3288*	25	1816 – 1271	3814 – 2669	124.5 – 87.1
Weld Range	2009	6**	6131 – 4291**	20	1401 – 981	2943 – 2061	94.9 – 66.4
Koolanooka Magnetite	1000	25	13671 – 9570	6	558 – 390	1171 – 819	19.3 – 13.5
Mt Karara Magnetite	1520	61	35708 – 22364	8	528 – 325	1108 – 683	26.4 – 16.3
Extension Hill Magnetite	715	21	7200 – 4510	5	325 – 200	683 – 420	16.3 – 10.0
Yalgoo	?		1921 – 1203				
Wiluna West	?	4	3153 – 2206	10	699 – 490	1468 – 1029	46.2 – 32.5
Total	7495		77228 – 47432	74	5327 – 3657	11197 – 7681	327.6 – 225.8

* Resource not fully defined but the company is proposing to mine at 20-25 Mtpa for a period in excess of 20 years (resource value>20Billion)

**Resource not fully defined but the company is proposing to mine at 20 Mtpa for a period in excess of 20 years (resource value>18Billion)

Table 4

Capital Investment

Even for the modest stage 1 projects there has been an investment of \$81M for the three operations developed thus far, plus a substantial upgrade to Geraldton and the port, not exclusively for iron ore, but largely in planning for the predicted iron ore trade. These Geraldton-based infrastructure developments come to a combined investment level of \$325M to cover the Southern Transport Corridor, channel dredging and Berth 5 shiploader. A further \$180M in investment can be expected for Gindalbie and Asia Iron's stage 1 developments. Wherever possible stage 1 projects make use of existing facilities to keep capital outlays at as low a level as possible.

However, the development of the 5 identified stage 2 projects will require very large investments, primarily purpose built for the projects. For all 5 projects to be developed an investment in the order of \$7.5 billion could be required, and would include a new heavy duty rail linking the deposits in the northeast (Jack Hills and Weld Range) and initial development of Oakajee port. At least one of these projects is now studying a larger scale than originally planned, which could further add to the investment needs and perhaps provide a basis for further enhancement of regional infrastructure. Even if all of these projects did not go ahead, an injection of \$1 to 2 billion in investment funds per single project is very significant. No doubt support industries and spin off investments will

also result from the establishment of a substantial long term industry base of iron ore and through the triggering of the establishment of Oakajee port and potentially the Oakajee industrial estate. These factors are considered later.

There is a significant proportion of the investment going into infrastructure. Unless the prospect of access for long term, substantial developments required to underwrite this infrastructure is forthcoming, then much of the investment will not proceed. An industry based on enhanced stage 1 principles, impacting on existing infrastructure will result, without substantially enhancing the facilities for others. This will not foster a significant regional development infrastructure and industrial framework, as would a sustained 20 year plus industry based on stage 2 project developments.

Resource Value

Resource definition can largely be termed work-in-progress. Resources to date are largely defined for stage 1 projects for lives of 3-8 years. Only Extension Hill, Mt Karara and Koolanooka magnetite projects have defined resources to Joint Ore Reserves Committee (JORC) standards to support the scales proposed for their stage 2 project developments (See Table 5). The other project developers are currently drilling on their deposits to delineate and underwrite their major project plans.



Table 5 YILGARN IRON ORE VALUE				
	Resource Mt	Resource Value \$US M	Prod Plan Mt/a	Products
MIDWEST REGION Mt Gibson/Asia Iron				
Tallering Peak	23.95 @ 60.7%	1352 – 946	3	1.7l + 1.3sf
Mt Gibson Hematite	18.8 @ 60.3%	957 – 670	2	1.2l + 0.8sf
Extension Hill Magnetite	248 @ 32%	5760 – 3608	5	5pf
Murchison Metals				
Stage 1 Hematite	8.5 @ 63%	508 – 356	2	1.3l + 0.7sf
Stage 2 Hematite	50.5 @ 60.7%* 46.5 @ 42.6%	2756 – 2630*	25	15l + 10sf
Gindalbie Metals				
Mungada Hematite	27.1 @ 61.7%	1476 – 1033	3	1.7l + 1.3sf
Mt Karara Magnetite	1426 @ 36.3%	28566 – 17871	8	4pf +4p (8pf)
Midwest Corp				
Koolanooka Mungada	9.84 @ 57.7%	480 – 336	2	0.8l + 1.2sf
Koolanooka Magnetite	430 @ 35%	10937 – 7656	6	6p
Weld Range Hematite	114.4 @ 58.7%	4905 – 3433	20	11l + 9sf
Ferrowest				
Yogi (Yalgoo)	95.3 @ 25.3%	1537 – 962		
CENTRAL YILGARN REGION				
Golden West Resources				
Wiluna West Hematite	50.1@ 61.1%	2522 – 1765	1	0.5l + 0.5sf
Stage 1				
Stage 2			10	
Portman Mining				
Koolyanobbing, et al	146.5 @ 61.94%	7482 – 5237	8	4l + 4sf

* Resource not fully defined but the company is proposing to mine at 20-25 Mtpa for a period in excess of 20 years (resource value>20Billion)

Legend for products: lump – sinter fines – pellet fines – pellets

Even at an early stage of the evaluation process, the in-ground resource value of the region is significant. At envisaged recoveries and assessed at a range of prices based on 2007 settlements and discounted by 30% on the current annually negotiated price, in ground resource values of the whole region amounts to between \$58 billion and \$92 billion. This is a small proportion of what could eventuate, once resource definition is further advanced and there is the encouragement to establish a substantial industry base in the Mid West region.

Annual Revenues & Royalty Returns

At the proposed saleable product output levels of the nine projects currently being put forward in the Mid West region (13Mt/a stage 1 projects and 74Mt/a stage 2), a gross annual revenue of \$Aus 3.7 – 5.3 billion could be envisaged, dependent on the range of price assumed. If stage 1 project operations overlapped for a certain period with stage 2, a further \$Aus 1- 1.6 billion could be expected. This equates to about one-third of the value of Pilbara production, which has taken 40 years to reach this level of output.

This is based on the minimum project development levels being evaluated at this stage. However, there are indications from the companies that, in some cases, these are just starter production targets and ultimate aspirations are significantly higher. Given the very large investments for these greenfield projects and backing by major overseas companies, it would be reasonable to expect that production ramp up would quickly proceed to maximise the size and scale of initial investments in infrastructure facilities.

Well established industry output multipliers of 2.1 would result in revenue generation achieved and underpinned by this industry of between \$7.5 and \$11.2 billion, excluding stage 1 operations.

These figures would provide for the State direct revenues from royalties of between \$225 and \$330M per annum. This compares to \$775M collected from the whole iron ore industry in 2006 i.e. a very significant increase.

Other substantial, but as yet unquantified revenues would accrue to the Commonwealth, State and Local Governments.

Overall, these numbers dwarf the current revenues received from the region, as discussed in section 1, and would provide for a very significant growth potential as well as the establishment of added value processing developments and support-industry sectors, as discussed later.

Additions to the State's Resource Inventory and Technology

Magnetite ore exploitation is significant in the development profile for Mid West iron ore. The ore has not yet been mined in Western Australia, but can provide a high grade product for a wider range of applications than current ore qualities produced in the State. This refers to direct reduction and other alternative ironmaking techniques as opposed to the traditional blast furnace smelting process.

China has long experience in developing magnetite operations and using this product in its ironmaking plants. Accordingly, there is a significant attraction from China for developing this type of ore, particularly when it is generally of higher grade than its domestic ore sources. The introduction of these technologies into Western Australia will enhance the processing base and experience of operators in WA. One of the major Chinese players in the region, Anshan Iron & Steel has long experience in the production and processing of magnetite ores and will bring significant technical know-how in the effective treatment of these types of ore. Developments of these low grade ores will provide confirmation of the economic exploitation potential of magnetites and hence significantly enhancing the resource wealth of the State.

Restrictions on access to substantial resource bases could render uneconomic some of these projects, and potentially label the region as being too hard for development. As such many of the economic benefits set out above will not be realised.

OTHER BENEFITS

Introduction

Chapter 3 has discussed the direct economic and technology returns that a substantial iron ore industry in the Yilgarn, and particularly the Mid West region, could bring. Chapter 1 provided the economic and social framework of the Mid West region and enhancements required to support economic growth from the region, for which iron ore is the major hope.

This chapter elaborates on some of these requirements and benefits in more detail, based on a sustained iron ore industry in the form outlined above. It outlines the benefits which these could ultimately bring to this region. It cannot be overstressed that any of the benefits discussed below are reliant on a substantial iron ore industry in the region.

Infrastructure to support Iron Ore Developments

Power

A critical requirement of most of the iron ore developments in the region is power. This is particularly so for the magnetite processing projects where grinding alone can require consumptions in the order of 15-25Kwh per tonne of feed. Dependent on the scale of the projects, provision for power requirements of 60 to 100MW are being considered for the magnetite projects. Power demand for the high grade hematite projects, where ore is merely crushed, screened and blended is considerably less. Taking all of the proposed development projects outlined in the previous section, total power requirements for a 65 - 75Mt per annum industry could be in the order of 300MW.

Chapter 1 outlined the current generation and enhancement plans for power reticulation to a region at the upper end of the South West Integrated Network (SWIN). The \$300M grid expansion of a 300Kv line first to Eneabba and then to a new Moonyoonooka substation near Geraldton could partially service new iron ore demand, although it is largely based on serving existing demand from the Geraldton region and supplying some new mining and industrial projects. It has not been geared to specifically service the iron ore industry. It is evident that a significant increase in generating power will be required to service this growth industry.

Iron ore proponents have been looking at on site generation, as well as vendor generation through independent power producers (IPPs). Verve / Horizon, Aviva – ERM and Alinta have all shown an interest in supplying power to the potential developers. While the Mid West region is well served by gas pipelines, on site generation has been an issue because of inability to secure long term gas supplies. Mid West coal deposits have emerged as distinct options for both iron ore producers generating their own power and IPPs). The Irwin River and Eneabba coalfields are two areas identified as potential sources of coal.

There is significant potential for IPPs to get established on a baseload of supplying the iron ore producers while looking for other opportunities to enhance their business. This, in turn, could provide a trigger for attracting other industries to the region.

While dedicated standalone on site power gives security to a specific iron ore project, it provides little benefit to others in the region. However, by linking into the grid or through IPP's linked into the grid, it could provide a significant enhancement to the supply, reliability and robustness to the whole network in the region. A spin off which would benefit both the community and business.

Water

Water is identified as another critical input to the development of iron ore projects. Again this is most serious in respect to magnetite projects where quantities in the range 5 to 10GL per annum are required, primarily in wet processing of the ore and slurry transportation. More precise requirements are still to be refined.

Given the large allocation levels currently prevalent from the Perth Basin sedimentary aquifers, availability from defined sources is an issue for the mining companies. Companies are prepared to put significant capital into water exploration to ensure adequate supplies. They have also explored other aspects in respect to collaborative approaches to allocation, and identification of supplies from other mining operation or abandoned mines in the area.

While supply is a significant issue to the iron ore companies at present, their efforts in exploration and supply utilisation could ultimately assist in a better

identification of aquifer potential, sustainability and water utilisation. Allocations of 70%+ and utilisations of 30 to 40% are prevalent at present throughout the State.

Transportation

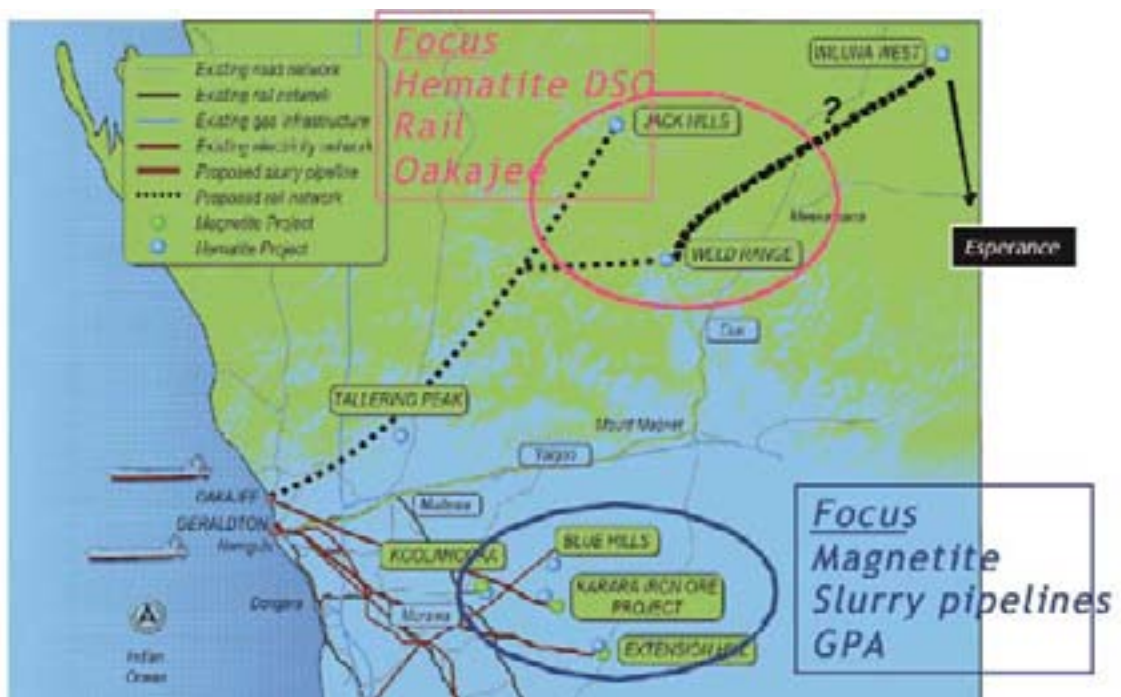
Rail transport is likely to play a dominant role in the development of the iron ore industry in the region. A new northeast heavy duty railway is needed for the proposed development of major hematite deposits in the Jack Hills and Weld Range. This railway, although specifically geared to service these two developments, would be established on multiuser principles and could provide a base for other bulk transport options from both the north east and eastern hinterland in general.

Golden West, with its Wiluna West project in the North Eastern Goldfields, is seriously considering the link up to Weld Range and Jack Hills, once the initial rail development is in place. This, in turn, could provide further NE Goldfields development opportunities and transport alternatives for existing producers. One of the potential infrastructure providers for the development, Yilgarn Infrastructure, sees the rail as having significant regional development potential for the whole Mid West hinterland. Gindalbie Metals has been discussing with Yilgarn Infrastructure the option of a south east linkage to its Mt Karara project area.

An upgrade of the existing east-west / north-south Geraldton – Mullewa – Perenjori line has already been initiated through stage 1 iron ore project developments at Talling Peak and Koolanooka. There is a significant potential to bring further efficiencies and upgrades to this line if, not only the additional stage 1 developments (Koolanooka expansion, Mungada and Mt Gibson), but also stage 2 magnetite developments were to utilise this rail system. One project proponent is certainly looking at a rail option, but the preferred option for magnetite transport to date is by dedicated slurry pipeline. Slurry pipelines are considered efficient means of fine concentrate transport for the projects, but have little flow-on benefits to the region in general.

Integration or linkages of the rail systems and a linkage between Geraldton and Oakajee could ultimately provide significant value to the whole region.

Bulk ore transport from the initial stage 1 developments has had an impact on existing roads and road users. This is acknowledged as being an interim measure until the ore is transferred onto rail, as planned. The longer term, major developments are designed for either slurry pumping or rail haulage, with road usage restricted to the construction phases, personnel movement and supplies to the mine sites.



Companies are cognisant of the need for contributions to existing road upgrades and maintenance, for which mining traffic has adversely effected. Road upgrades by the companies are likely to be required, particularly in the more remote areas, to ensure efficient and safe transport of personnel. The local communities will get the benefits of such improved road conditions.

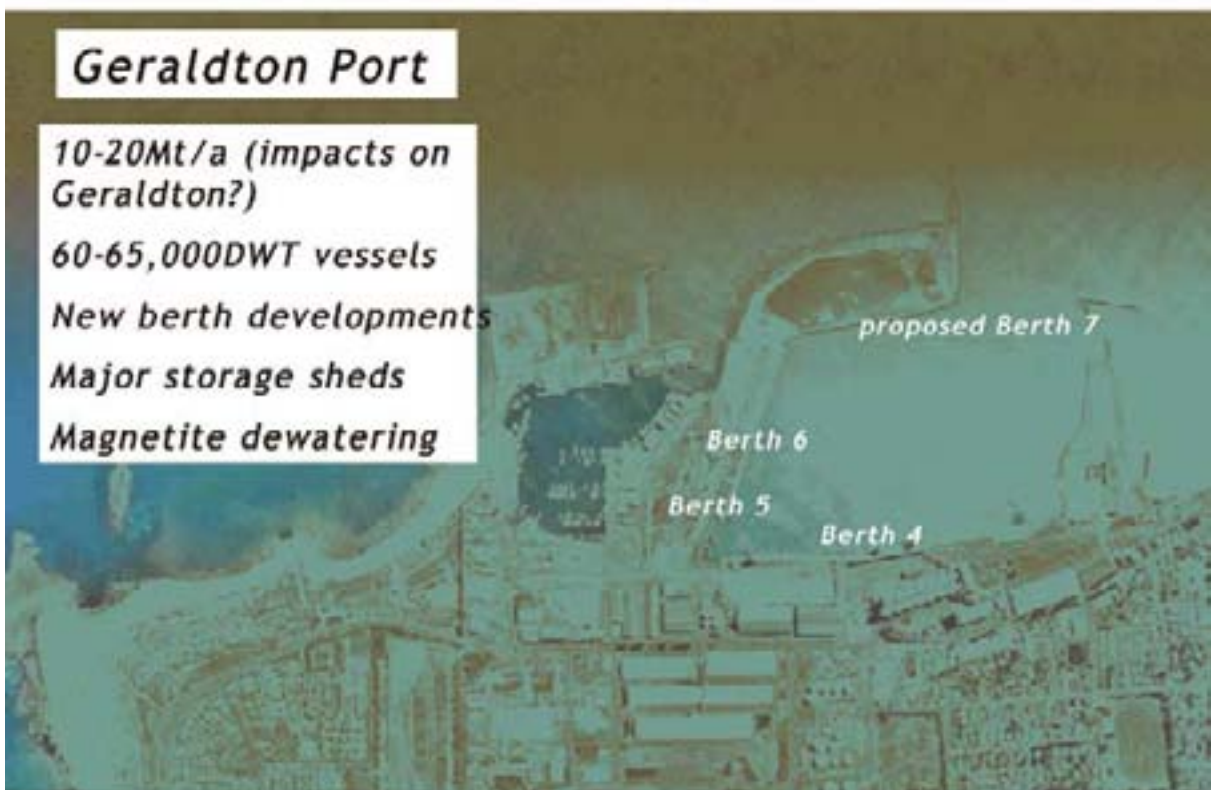
Overall the flow-on effect of road enhancements, particularly in the more remote areas, will be of benefit to the community, businesses and other visitors to the region.

Ports

Efficient and adequate port facilities are necessary to maintain a major iron ore export industry. The port of Geraldton is well established to handle a variety of bulk mineral commodities, grain and other agricultural products. The commencement of iron ore shipments in 2004 from Tallering Peak has substantially increased the throughput of the port, so that in 2006 iron ore contributed 34% of the total cargo volume.

In response to the expected increasing iron ore trade within the region, a major upgrade to Berth 5 is in progress. This upgrade will establish Berth 5 as a dedicated iron ore berth capable of handling about 10Mt/a, and is expected to be completed by the end of 2007. This is sufficient to meet the needs of stage 1 projects being planned.

Consideration is being given to the construction of a new rail unloader and a new Berth 7 as a dedicated magnetite facility for Gindalbie Metals and / or Asia Iron. The project is crucial if the port is to reach ultimate design limits of iron ore capacity of 15 to 20Mt per annum. Whether the constraints related to proximity to the city centre will limit this capacity are yet to be tested. Limitations on Geraldton port's enhancement include proximity to town centre, extent of covered shed storage, berth limitations, and shipping channel limitations on movements, depth and the potential for further dredging.





To support a substantial iron ore industry, the current or even an expanded Geraldton port cannot deliver the capacity. A new deepwater facility with appropriate stockpiling and handling facilities will be required. Oakajee has long been identified as the preferred location for a new port and more recently been endorsed by Government as the appropriate site. It could in fact be considered as an outer harbour to the port of Geraldton as it is little more than 20km distance from Geraldton.

Substantial foundation users are necessary to trigger initial development of the port, an investment in excess of \$1 billion. The developers at Jack Hills and Weld Range, together with construction of a new heavy duty railway, are seen as the key at this stage for Oakajee to be realised. However, this must be seen as a starter phase of the Oakajee port, with upside expansion potential and other developers in the region potentially diverting development to Oakajee or switching to Oakajee from Geraldton.

An established Oakajee port could be the conduit for other substantial export developments in the region and generally for the overall long term growth of the Mid West.

Oakajee Industrial Estate and Further Industrial Development

The port development is a fundamental factor in the establishment of an industrial estate at Oakajee. The plan of the iron ore companies to trigger Oakajee port for their iron ore exports has led to a rejuvenation of

plans for the industrial estate development. These were put into abeyance when the Kingstream Steel project did not proceed.

A structure plan is currently being developed and iron and steelmaking and gas processing projects are considering Oakajee as a possible site for their developments. The port, power supply, the initiation of other essential services for iron ore handling and port operations and a structure plan for the estate are catalysts which could attract the establishment of other industries to Oakajee and the Mid West region in general.

The availability of heavy industrial land in the South West is becoming harder to find, the Pilbara is generally thought of too expensive to construct and operate as a place of choice. The Mid West is within reasonable proximity for travel to the South West, the coast has generally amenable climate and lifestyle to attract a workforce and is less expensive to develop in than the Pilbara. It is therefore potentially seen as a viable proposition for industrial and manufacturing development. The current industrial area at Narngulu is increasingly being hampered by an expanding Geraldton city, airshed and noise limitations. Oakajee, based on the iron ore trigger, will establish an industry ready / partially ready status in the medium term and provide 1100ha of land being sought after by industry. This will be further enhanced when the proposed corridor link between Oakajee and Geraldton / Narngulu is established, as part of Oakajee's development plan.

Iron & steelmaking has long been a goal of successive State Governments. The establishment of iron ore operations could provide an incentive for this to be realised. Various combinations of the ingredients of iron ore, industrial area, non-coking coal, gas pipelines and alternative ironmaking technologies have attracted studies into ironmaking in the region. The Koolanooka South and Yalgoo iron ore promoters are considering or have considered ironmaking integrated within their projects, while others have looked at iron and steelmaking based on iron ore supplies provided by developers in the Mid West.

Services & supply sector

The establishment of an iron ore production and export base in the Mid West will provide opportunities for local business suppliers, new business and expanded business services in the region. Standard industry multipliers of 2.1 could add \$3.5-5 billion in additional industry revenue earning capacity, some in the Mid West and inevitably some in the Greater Perth region. The level to which the Geraldton area attracts this activity is a function of the integration of the industry within the region.

Industries such as equipment supply, maintenance, flight services, catering / sanitation, administrative supplies, building, accounting, and legal services will all directly benefit to some degree, while other social, entertainment, amenity business and local retail businesses could significantly benefit.

Employment, Social Facilities and Local Communities

Major iron developments are likely to need peak construction workforces in the order of 600 to 1500 people dependent the scale and level of processing and infrastructure requirements of the individual projects. Given that many of the stage 2 project developments are geared to being on stream over a two year window, then combined peak construction workforce requirements in the region could approach 5000 people.

Operating workforces, should the proposed developments be realised, are in the order of 2000 direct employees or direct contractors. Again dependent on scale and configuration of project the

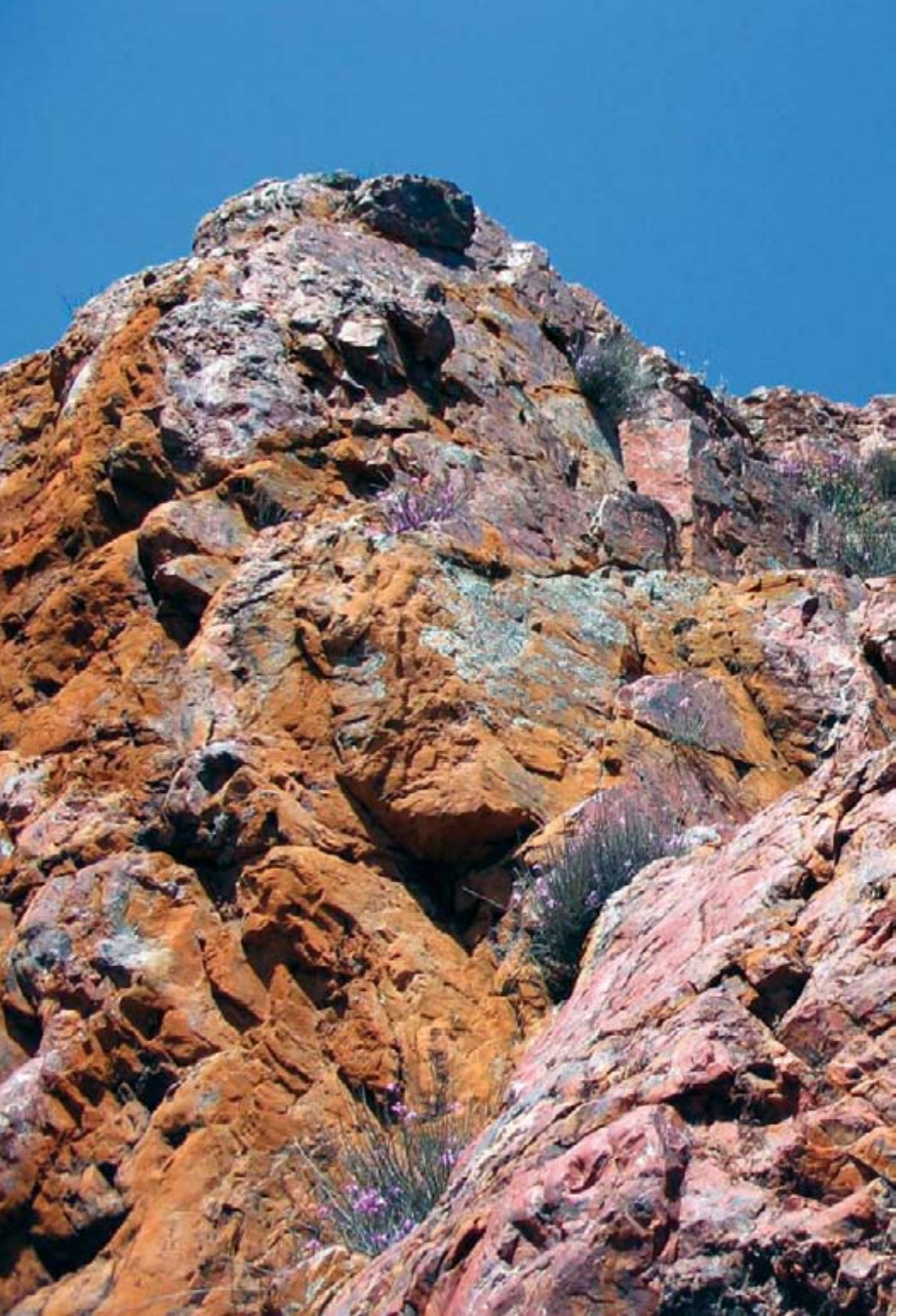


range is 170 to 550 for individual developments. Overall this could create over 8000 jobs distributed between the Mid West and the South West.

Companies are committed to the region with offices being established and some recruitment for exploration and evaluation stage activities already taking place in Geraldton and from among the Mid West communities.

While Geraldton and the coastal area has lifestyle attractions, there is the likelihood that much of inland mining area developments are based on mine camp, fly in – fly out (FIFO) arrangements. This will inevitably have some impact on the level of integration with local communities. When the Golden Grove base metal operation was developed, despite a FIFO camp, development recruitment was primarily focussed on the immediate region. The region's employment potential and attractiveness is being demonstrated by Rio Tinto Iron Ore operating a FIFO out of Geraldton for its Pilbara workforce. Obviously maximisation of benefits in the region will be gained through encouragement of operations to integrate into, recruit from and utilise the services of the communities as much as possible.

The level of integration and use of local businesses and retail outlets will directly impact on the retention and increase in population of local communities and its overall well-being. Given the declining population levels of areas such as Perenjori, Wiluna, and Cue, iron ore developments within close proximity could provide a boost to these shires. Also the difficult and varying economic times being experienced by pastoralists and other agricultural activities could provide alternatives for employment over limited periods and reverse the trend for many of the younger generation from these areas migrating to Perth or other major mining centres. It could mean the survival of the farming communities. Already it is evident that a number of businesses and their future development are being planned in the assumption that iron ore mining will come to their areas. There is already a level of frustration that this is not happening quick enough. The shires in the region are unanimously supportive of the establishment of a significant iron ore base. Iron ore developers will support social infrastructure development, community facilities and activities to varying degrees. This can only be good for the well-being of a number of communities in this region and for the economy of the region overall.



A REVIEW OF THE YILGARN IRONSTONE RANGES

Mid West Region

Robinson Range

Location

Located in the historical gold mining region of Peak Hill, approximately 100km north of Meekatharra.

Players

Robinson Range temporary reserve was formerly part of Murchison State Agreement, inherited by Midwest Corporation after recovery from administration of Kingstream Steel.

There are many other tenement holders exploring for other minerals than iron ore in this region.

Prospectivity

Little exploration has been undertaken for iron ore within the Robinson Ranges. Banded iron formation lenses are thought to be numerous, thin and discontinuous. The iron ore exploration is restricted to early stage field mapping and sampling. Midwest's focus is on Weld Range as a priority. Exploration in the area has primarily focused on manganese ore, base metals and precious metals.

Economic Potential

Not defined

Projects

Robinson Range Midwest Corporation

Jack Hills – Mt Gould

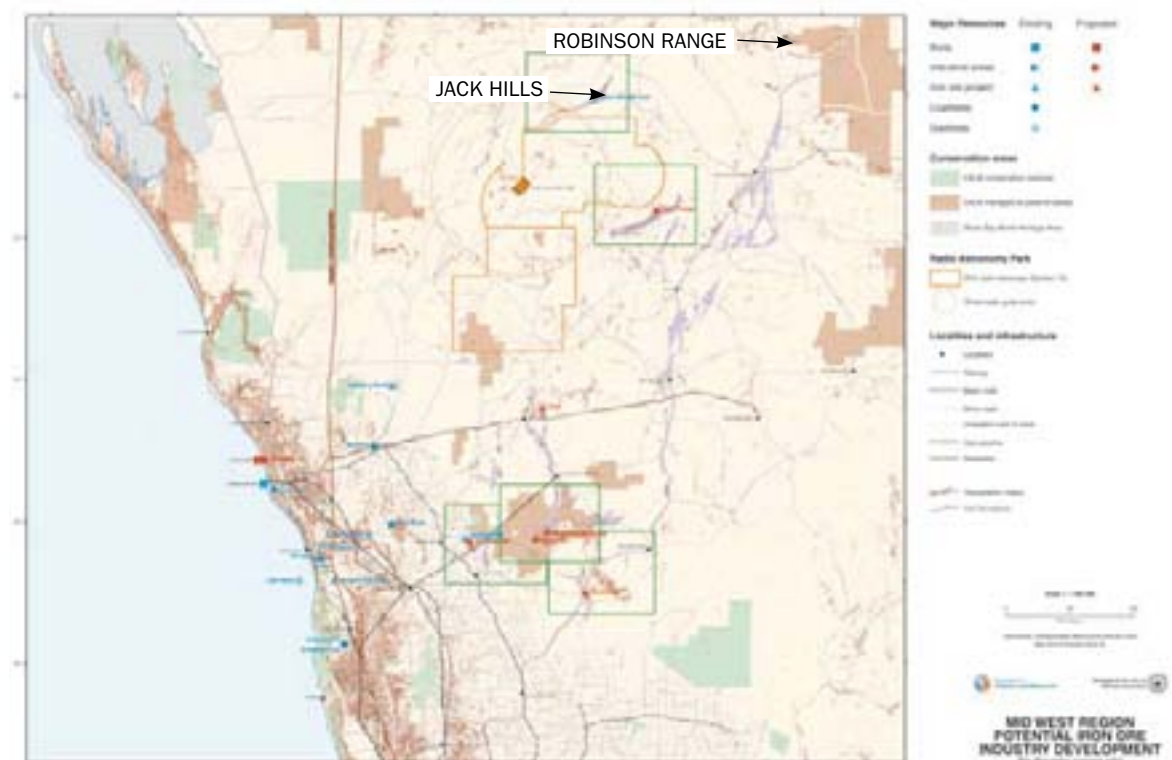
Location

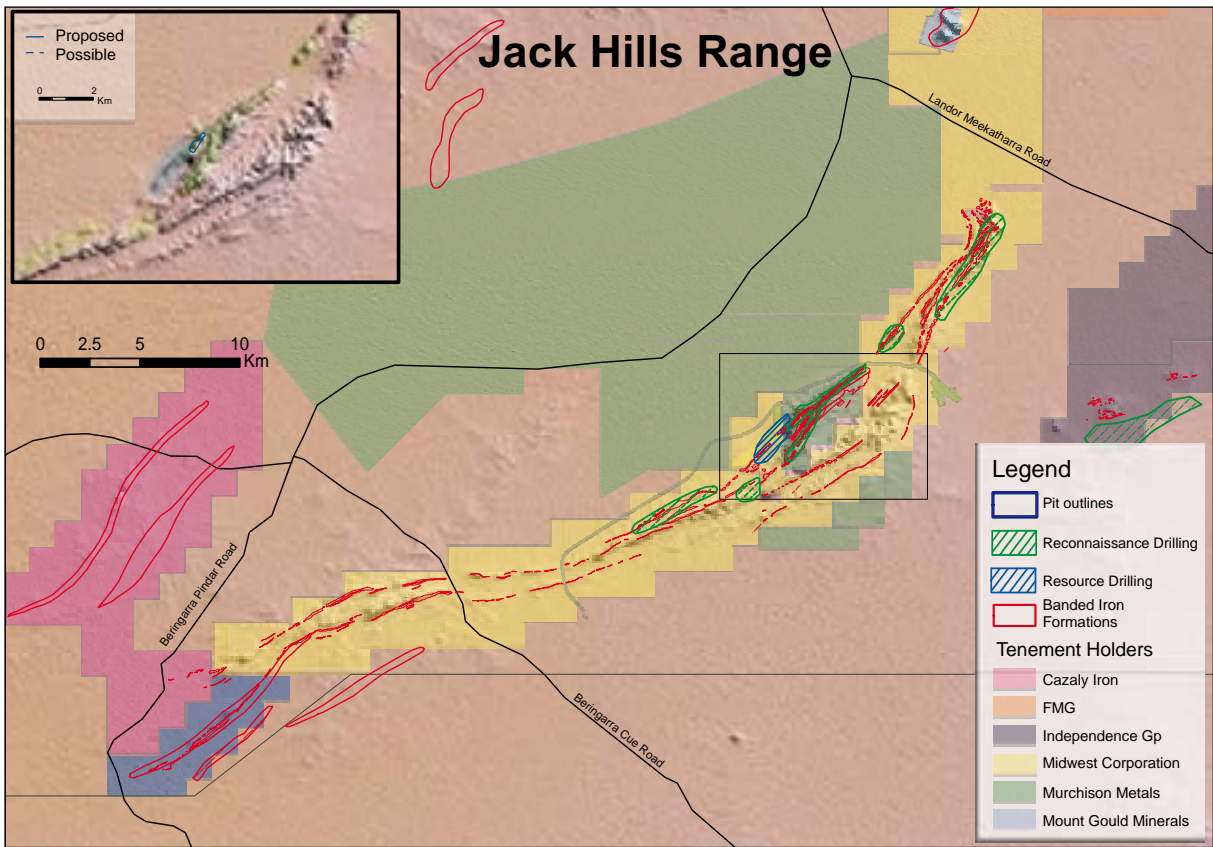
The Jack Hills Ranges, approximately 380km NE of Geraldton and are some 70 km in length, with a separate isolated hill, Mt Gould, at the northern extremity.

Players

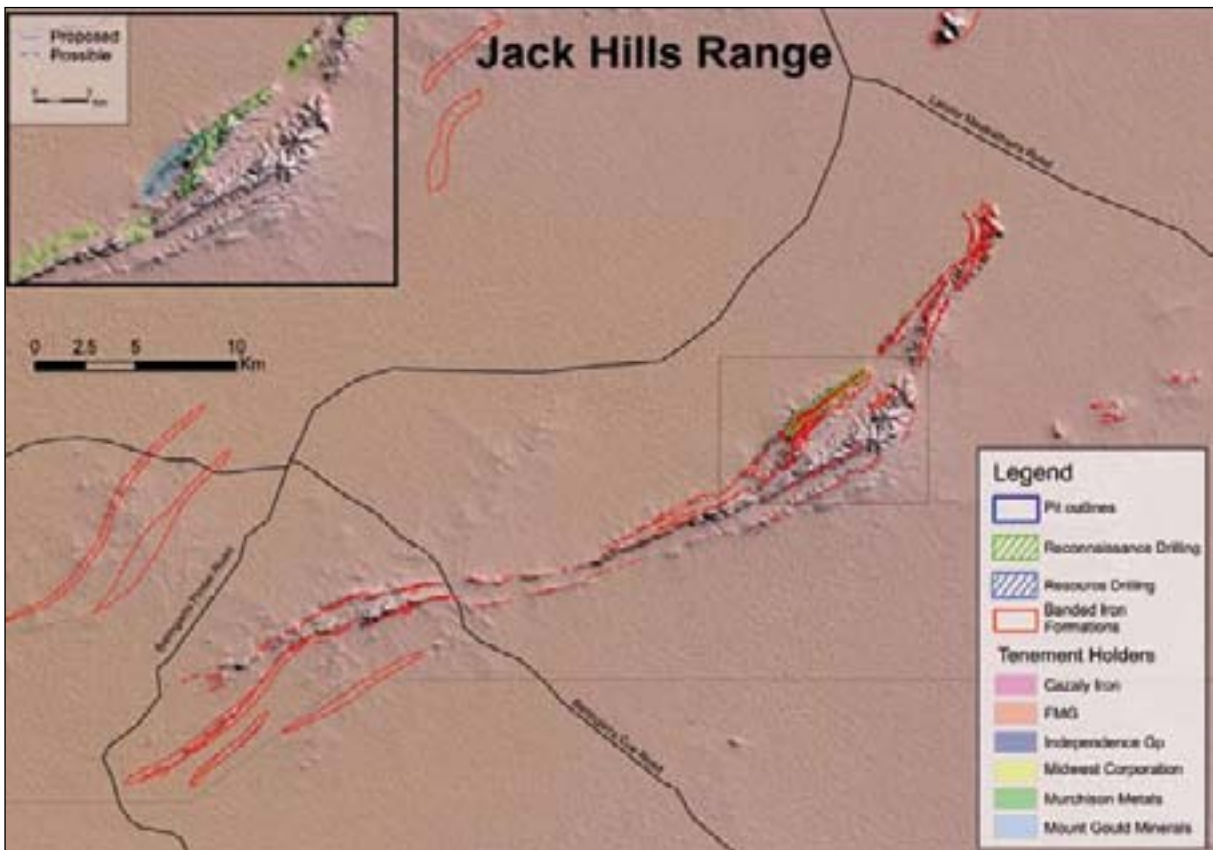
The majority of the Range is under titles held by Midwest Corporation, but the main developer at present is Murchison Metals, which holds a central portion of the Range at Mt Matthew / Mt Taylor.

Cazaly Iron has tenement applications over banded iron stringers to the west of the main ranges, while FMG and the Independence Group hold tenure to the east and in a northerly extension to the Ranges. Atlas Iron has also recently indicated involvement in farm-in arrangements around these ranges.





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Prospectivity

The Ranges were identified as containing high grade hematite on or near surface, as far back as the late 1960s – early 1970s. For many years occupancy rights over the areas were held pursuant to the Murchison State Agreement.

The banded iron formations form a distinct linear set of hills within the range formed over much of its projected length

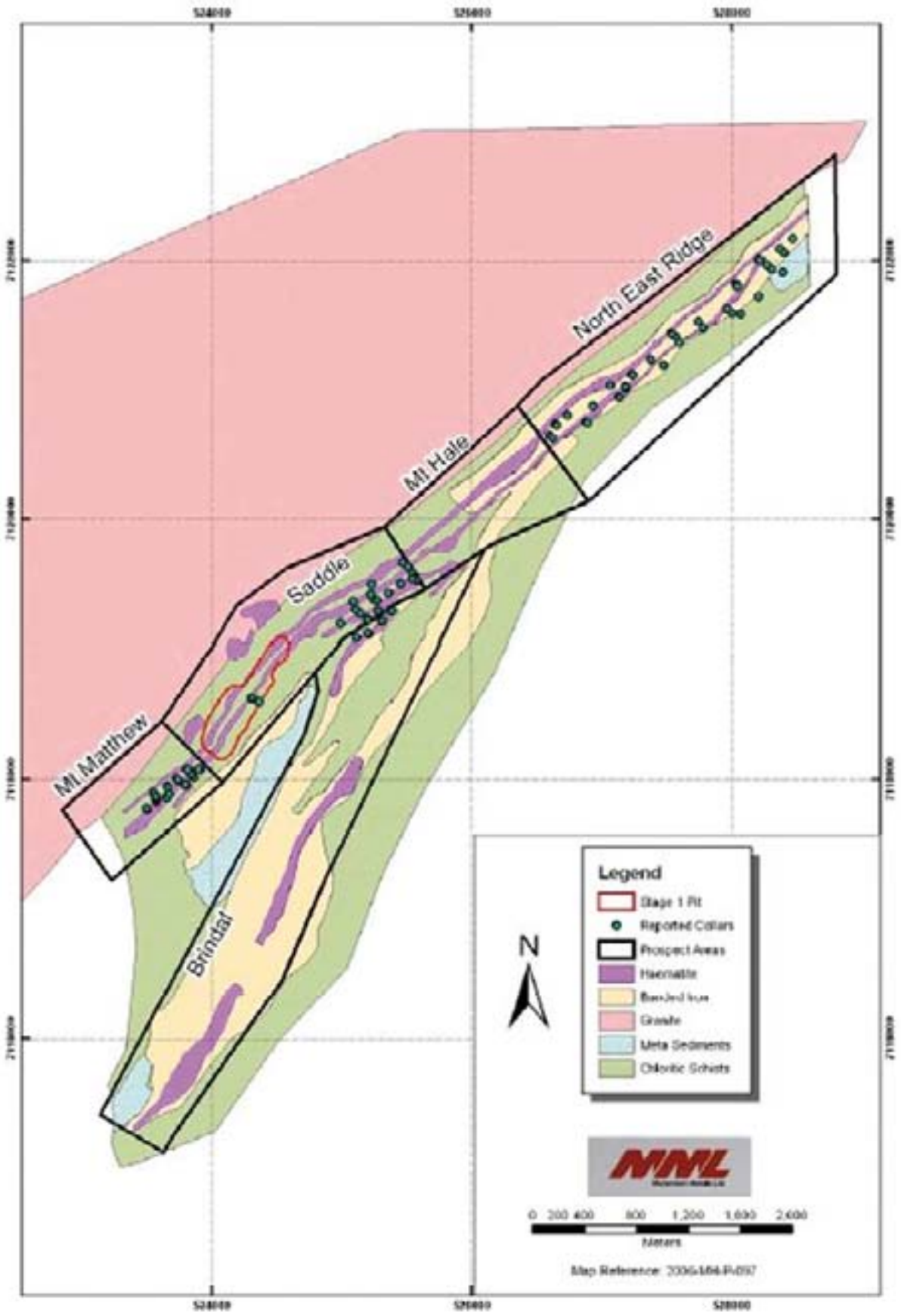
Midwest Corporation inherited the areas, after Kingstream Steel was put into administration. Murchison Metals was formed to explore and exploit the central area, after the ground was picked up by prospectors, after non-renewal of some of Midwest Corporation's leases.

This latest exploration by Murchison Metals has defined that high grade hematite extends down to plain level and considerably below. Exploration has focused on the development of a stage 1 starter project of 1 to 2Mt/a, which commenced in December

2006 and should be at 2Mt/a by 2010. The first shipment of ore was made in late January 2007. This is based on reserves supporting a 4 to 5 year operation, before start up of its major operation of up to 25Mt/a. Resource definition for stage 2 is underway, with initial resource estimates recently announced of 50Mt of high grade direct shipping ore and 46Mt of low grade beneficiatable ore. At the same time of resource definition work a definitive feasibility study is underway to cover all aspects of the mine and infrastructure, which includes a NE heavy duty railway and new port at Oakajee.

Midwest Corporation has commenced exploration at a number of lenses along the range. To date this is considered to be at the reconnaissance exploration drilling stage. A second operation may be a possibility following development of its Weld Range project.

The resource potential of the Jack Hills Ranges would appear to be very large, but the level of continuity along strike and down dip is still to be defined.



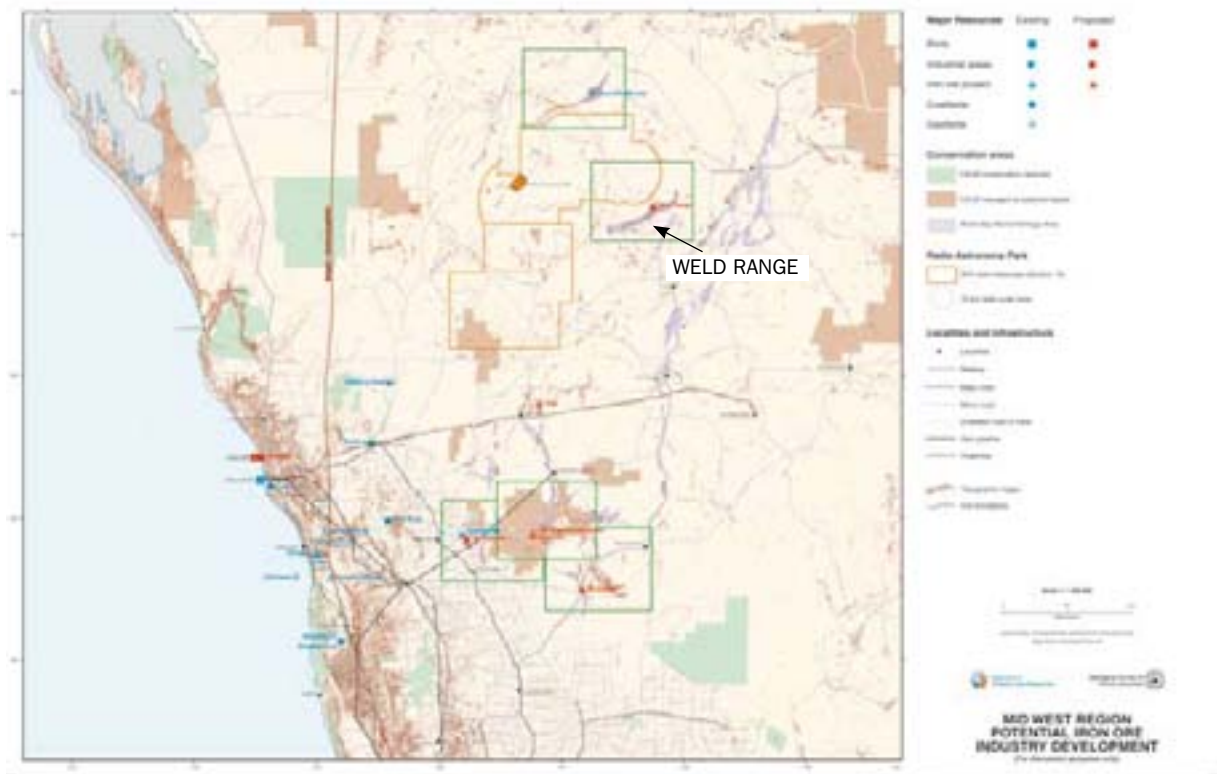
Economic Potential			
	MML	MML	MWC
	Stage1	Stage 2	
Stage of Devt.	Operating.	Drilling F/S	Exploration drilling
Output / Years	2Mt / 4yrs	25Mt / 20+yrs	tbd
Resource Value	\$0.4 – 0.6B	\$3.3 – 3.4B	tbd
Annual Revenue	\$105 - 150M	\$1.3 – 1.8B	tbd
Revenue with multiplier	\$315 – 221M	\$2.7 – 3.8B	tbd
Royalty Revenue	\$7.3 – 10.4Mpa	\$87 - 125Mpa	tbd
Capital	\$41M	\$2250M	tbd
Employment			
Constr.	30	1400	tbd
Operating	200	550	tbd
Projects			
Jack Hills Stage 1	Murchison Metals Ltd Operating		
Jack Hills Stage 2	Murchison Metals Ltd Feasibility study		
Jack Hills	Midwest Corporation Exploration		
Mt Gould	Mt Gould Minerals Care and maintenance (Atlas Iron)		



Weld Range

Location

Weld Range is located approximately 350km NE of Geraldton and 50 km ENE of Cue.



Players

Weld Range tenure is largely held by Midwest Corporation, who has farm-in arrangements with other adjacent titleholders. Murchison Metals holds tenure at the southern (Noonie Hills) and northern extensions of the Weld Range. FMG also has tenement applications covering further extensions with limited relief to the north.

Weld Range Iron Ore Pty Ltd currently holds the small intermittently-mined ochre quarry on the southern side of the Range. The central southern area also contains the Wilgie Mia aboriginal reserve. Wilgie Mia is considered to be the first mining operation in WA, some 40,000 years ago. Aboriginal people extracted the ochre for paintwork.

More recently Giralia Resources (at Beebyn) and Atlas Iron has indicated involvement in the region.

Prospectivity

The Weld Range forms a distinct range of hills, with numerous parallel lenses of banded iron formation.

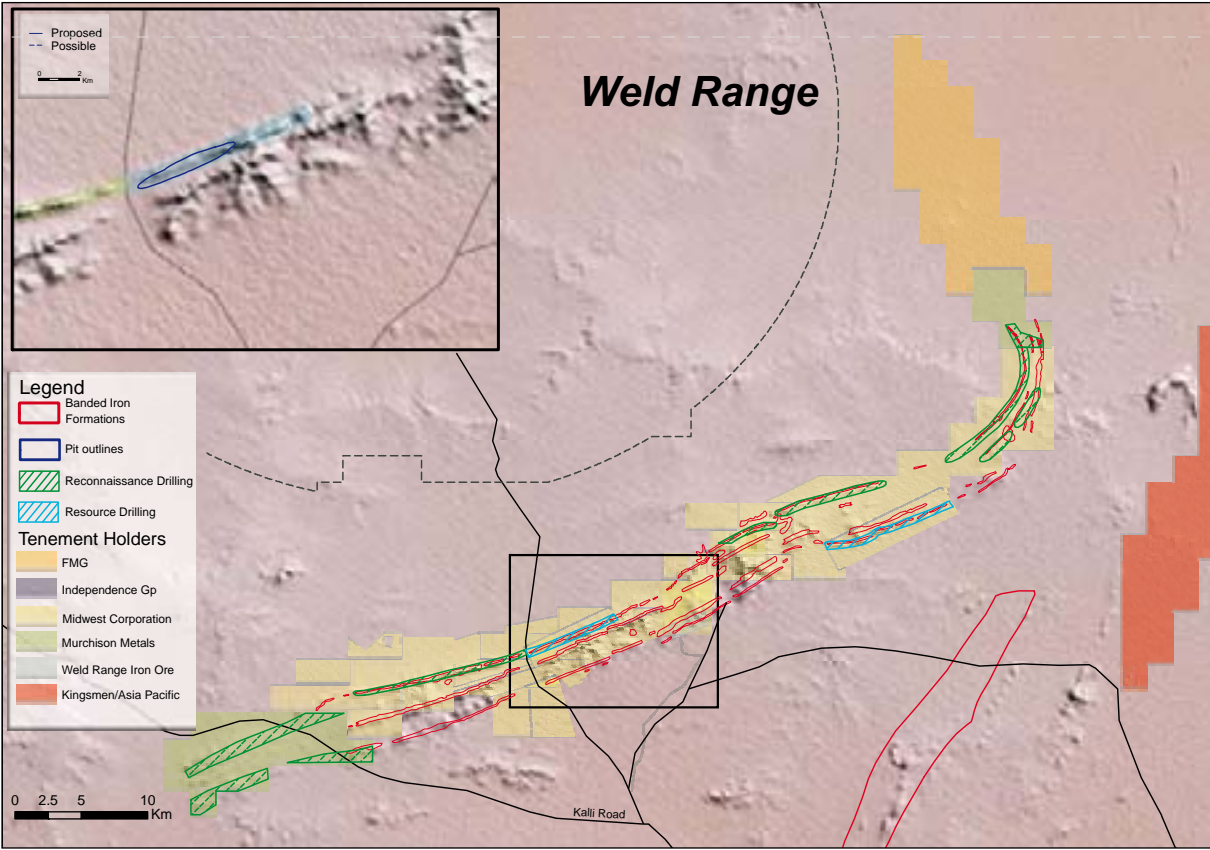
Pre-feasibility and feasibility studies were conducted in the 1970s and early 1980s on these Ranges and included integrated steelmaking as the major focus of the Murchison State Agreement. These developments did not come to fruition.

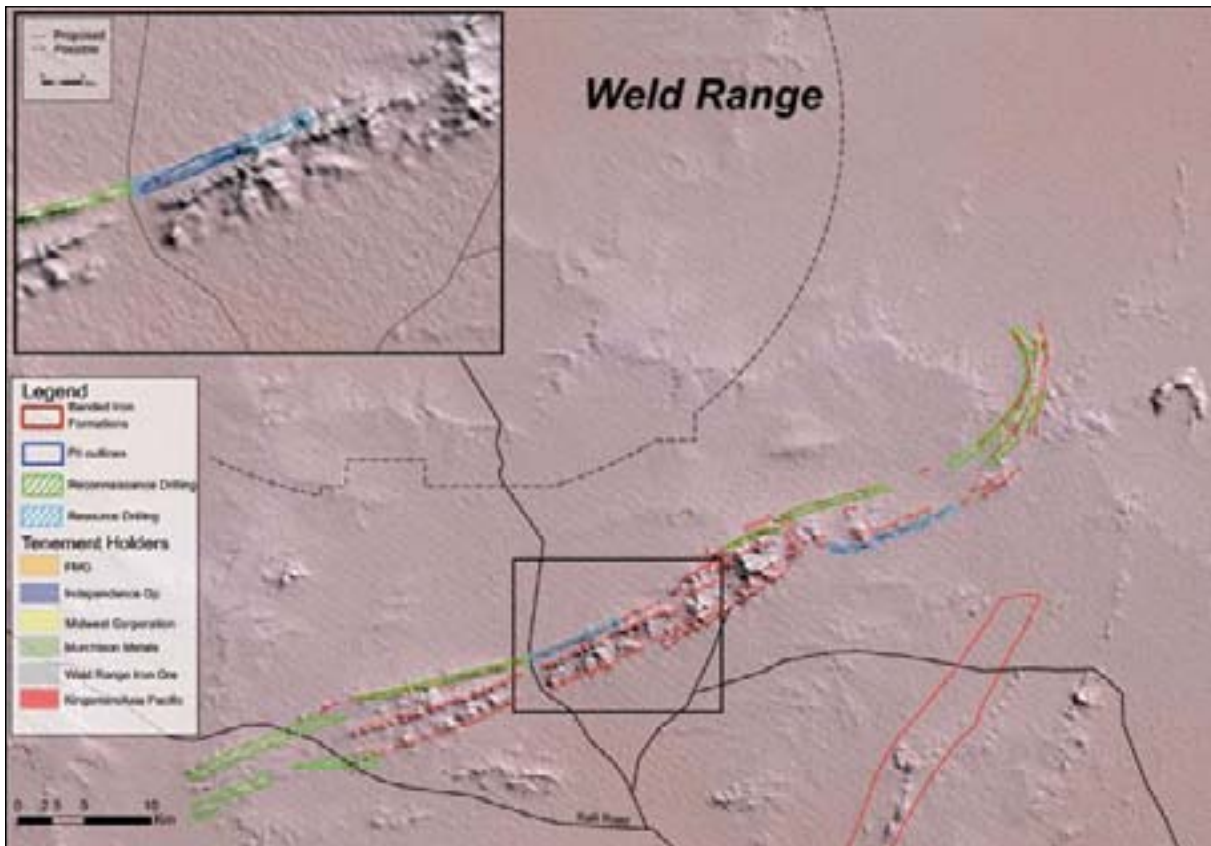
The Weld Range has become the prime focus of Midwest Corporation for its large scale development. A studies joint venture with Sinosteel Corporation is undertaking the work. The company is concentrating resource definition drilling on the two major areas studied in the 1970s – 80s, namely Madoonga and Beebyn. The initial resource estimates recently announced are 64.3Mt at 58.4%Fe for Madoonga and 50.1Mt at 59.2%Fe for Beebyn. The potential of the areas and the Range overall is significantly higher. The Joint Venture proposes to develop a 15-20 Mtpa operation. The JV is currently carrying out resource definition drilling (new resource estimates estimated in the second half of 2007) leading into its feasibility study scheduled for completion in early-2009. On this schedule it would be aiming for project start-up in 2011.

While the focus of activity has been on the two areas of Madoonga (Lens W14) and Beebyn (Lenses W7-12), other lenses with resource potential are identified in the Ranges, some on farm-in tenure of the Hampton Hill Mining JV. Reconnaissance drilling is underway or planned over many of these lenses.

Two formations, the Madoonga and Wilgie Mia Formations have been identified as the Formations with high grade resource potential.

Murchison Metals and FMG activities are largely at the reconnaissance drilling / exploration and early exploration stages respectively.





Economic Potential

	Weld Range Iron	MWC	MML etal
Stage of Devt.	Operating?	Drilling	F/S Exploration
Output /Years	Min.	20Mt / 15+yrs	tbd
Resource Value	Min.	\$4.3 – 6.1B	tbd
Annual Revenue	Min.	\$1.0 – 1.4B	tbd
Revenue with multiplier	Min	\$2.1 – 2.9B	tbd
Royalty Revenue	Min.	\$66 -95Mpa	tbd
Capital-		\$2010M	tbd
Employment			
Constr.	-	900	tbd
Operating	2	225	tbd
Projects			
Weld Range Hematite	Midwest Corporation Sinosteel Corporation		Exploration / feasibility study
Noonie Hills	Murchison Metals		Reconnaissance exploration
Little Wilgie Mia Pigment Atlas Iron	Weld Range Iron		Operating (intermittent)
Giralia Resources Kingsmen / Asia Pacific			Exploration prospects

Lake Austin

Location

Lake Austin is located adjacent to the Great Northern Highway between Cue and Mt Magnet.

Players

There are no known iron ore explorers at present.

Prospectivity

Prospectivity for iron ore is little known. The area has been the focus of gold operations and exploration.

Economic Potential

Not known

Projects

None known

New Forest – Twin Peaks

Location

The area is located close to the Mullewa – Carnarvon road, straddling the Murchison River, about 150km N of Mullewa.

Players

Midwest Corporation holds tenure. There are no other iron ore players known.

Prospectivity

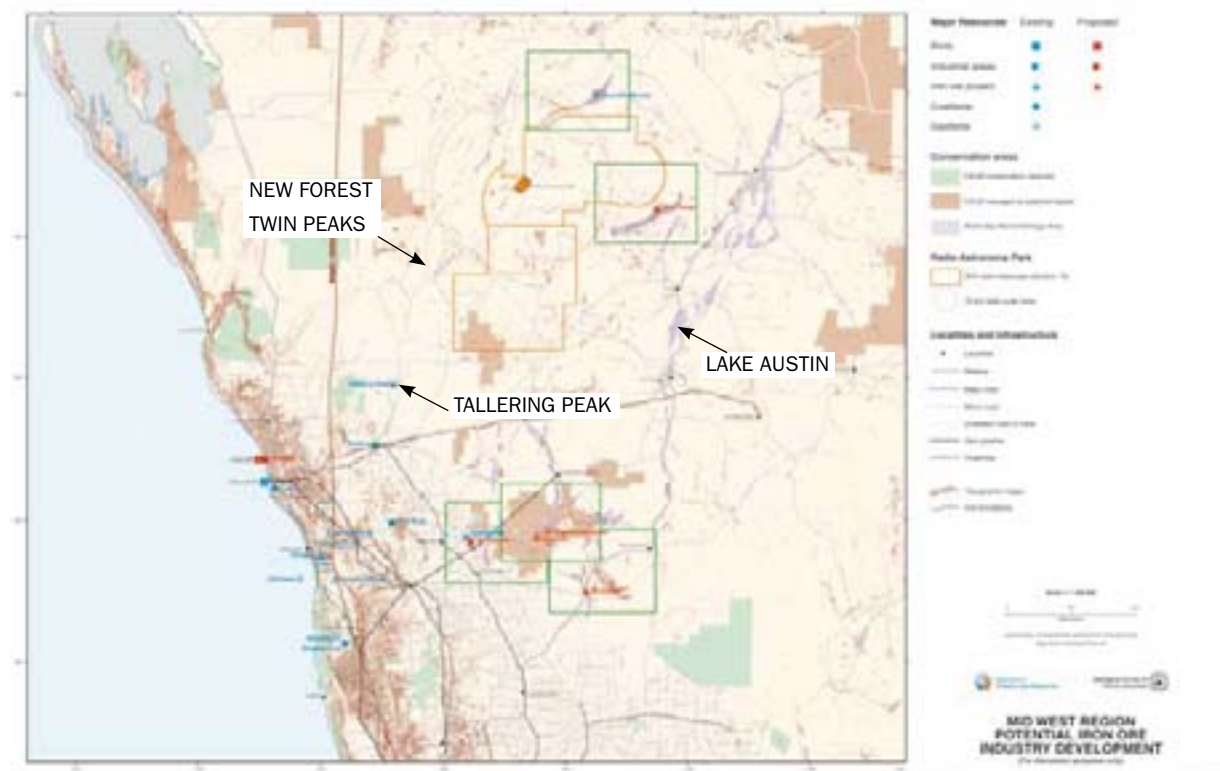
The New Forest / Twin Hills areas are at a reconnaissance exploration stage.

Economic Potential

Not known.

Projects

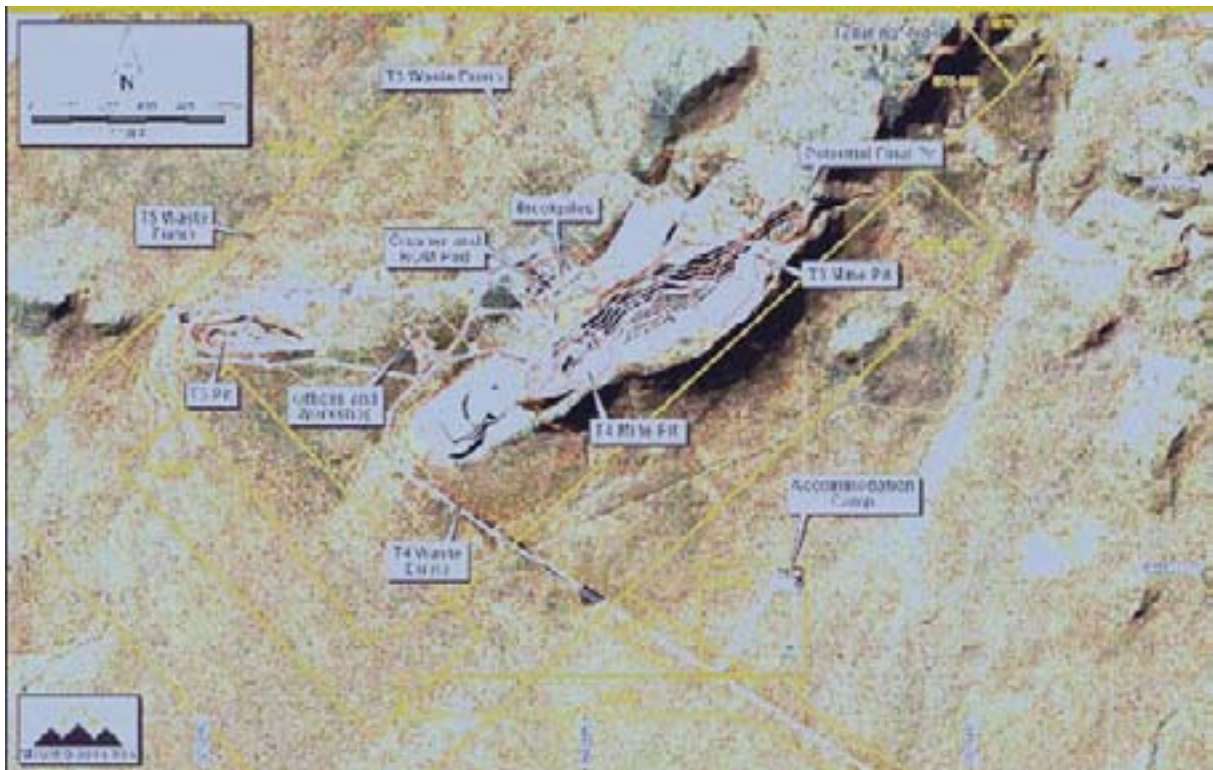
New Forest Midwest Corporation
Reconnaissance exploration



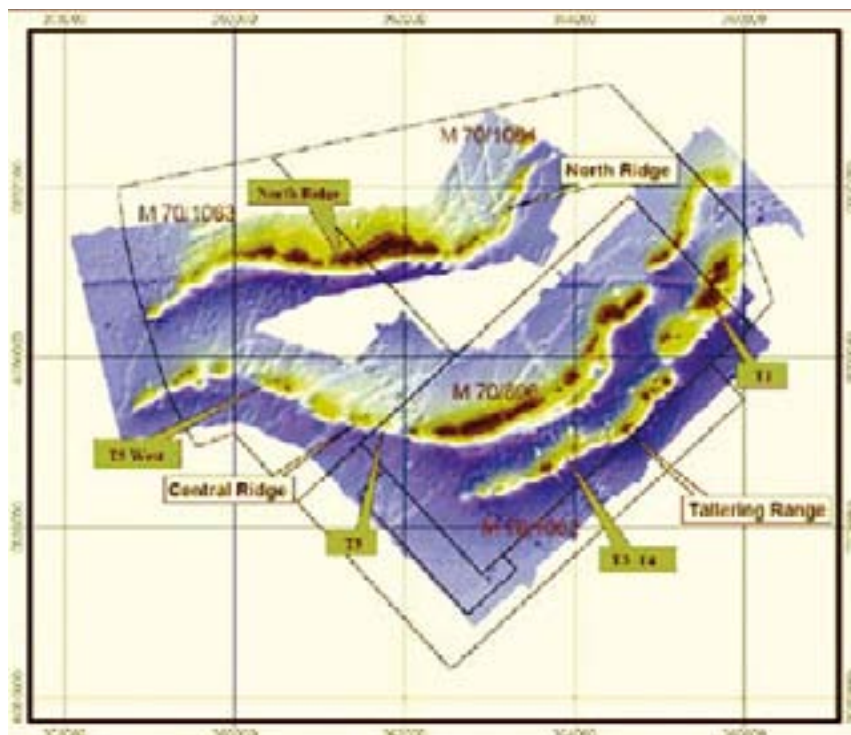
Tallering Peak

Location

Tallering Peak is located 65 km N of Mullewa, adjacent to the Mullewa – Carnarvon road.



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Players

The Tallering Peak orebodies were evaluated by Kingstream Steel, as the feedstock for its proposed integrated steelworks at Oakajee. Following the move of Kingstream into receivership, Mt Gibson Iron acquired the titles from the administrator. Mt Gibson Iron has operated the Tallering Peak mine for about 4 years and holds areas of further potential along the North Ridge, although limited exploration has been completed to date. Royal Resources holds tenure to the NE of the mining operation, referred to as the Tallering East prospect.

Prospectivity

Mt Gibson Iron produces 3 Mt/a from a series of complexly folded lenses to the west of the Tallering Peak. Remaining resources are 18.6 Mt @ 63.8%Fe to support a minimum of a further 6 years of operation.

There are prospective areas to extend this resource base. The company eventually plans to extend to the east, adjacent to Tallering Peak.

The North Ridge area has had little exploration conducted on it, but as can be seen from the strong aeromagnetic anomaly has potential for magnetite. The signature is similar to the mining area, so high grade hematite lenses could also occur within the North Ridge.

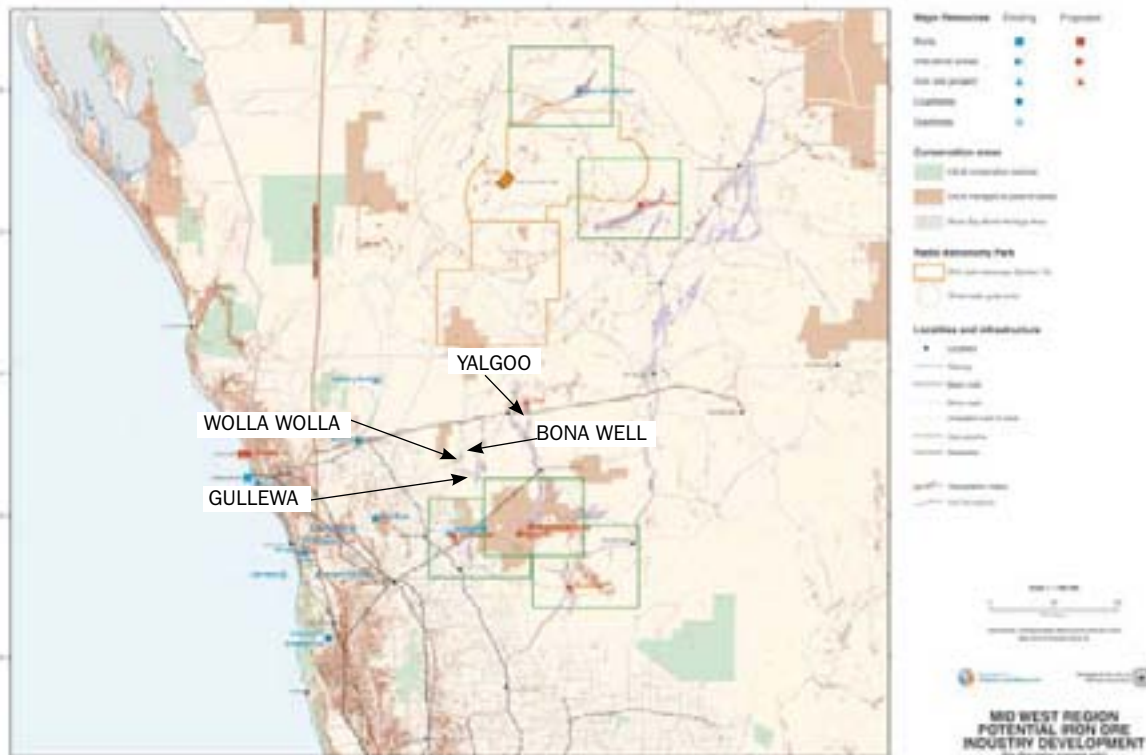
Airborne magnetic and radiometric anomalies defined by Royal Resources has indicated complex geology and follow up reconnaissance mapping and drilling has indicated a wide banded iron formation unit comparable to that being mined at Tallering Peak. This has a significant 50m wide magnetite unit and also enriched hematite potential over 4km of strike. Exploration is at reconnaissance stage.

Economic Potential		
_ MGI	Tallering Peak	Tallering East
Stage of Devt.	Operating.	Grass roots exploration
Output / Years	3Mt / 8yrs	tbd
Resource Value	\$1.2 – 1.7B	tbd
Annual Revenue	\$150 - 215M	tbd
Revenue with multiplier	\$315 - 450M	tbd
Royalty Revenue	\$10.3 – 14.6Mpa	tbd
Capital	\$14M	tbd
Employment		
Constr.	30	tbd
Operating	90	tbd
Projects		
Tallering Peak	Mt Gibson Iron	Operating
Tallering North Ridge	Mt Gibson Iron	Grassroots prospect
Tallering East	Royal Resources	Reconnaissance exploration

Yalgoo

Location

The Wadgingarra greenstone belt contains a series of largely north – south aligned banded ironstone lenses between 11-14 km to the east and northeast of the town of Yalgoo, located 230 km east of Geraldton.



Players

Ferrowest has acquired ownership of tenements over the Yogi prospect from Comet Resources. A sales and purchase agreement has been entered into with Prosperity Resources to acquire ferrous mineral rights over its tenements in the area.

Aurox owns tenements at Wadgingarra East lying to the west of the Yogi prospect.

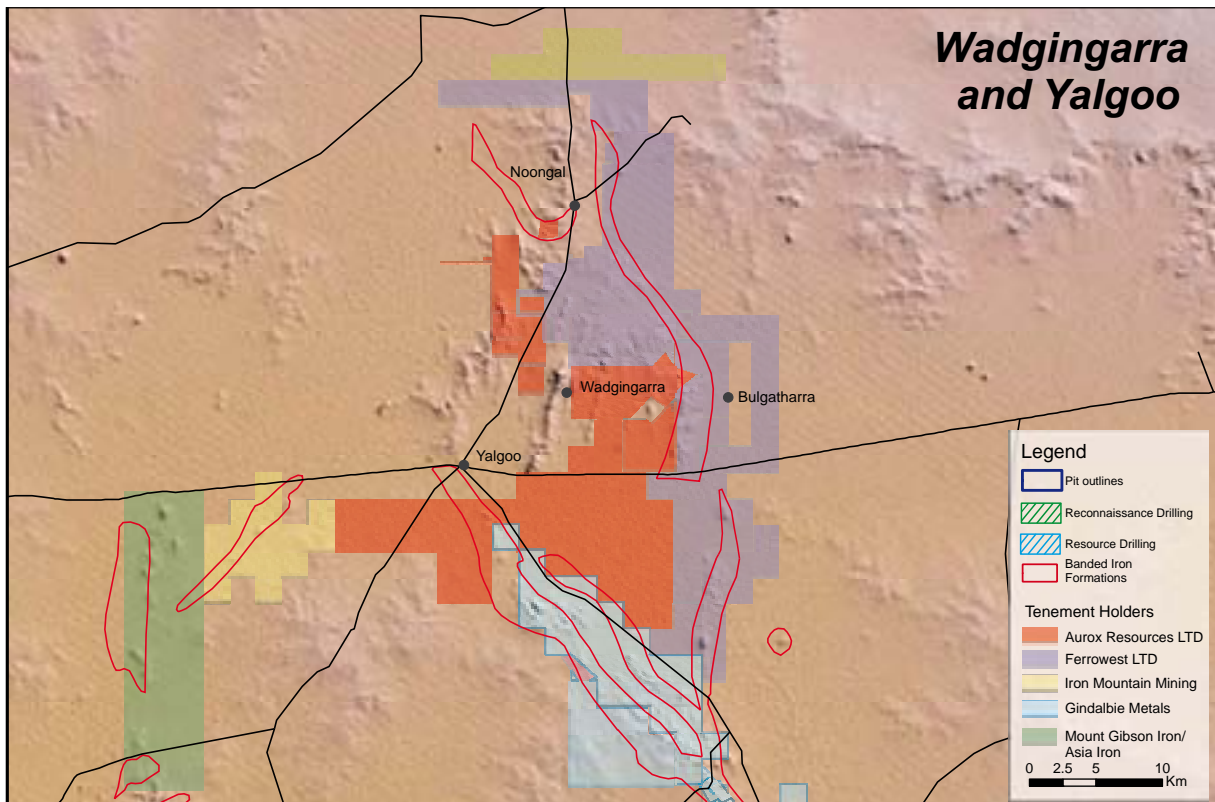
Prospectivity

Ferrowest holds a strike length of 27 km of banded iron formation based on magnetic and surface evaluation. Reconnaissance drilling has been completed (January 2007) on the initial target area within the central zone and confirmed the presence of magnetite corresponding to the geophysical results. Stage 2 infill drilling has progressed with the definition of an inferred resource of 112.5Mt @ 25.3%Fe, of which 95Mt is of fresh magnetite. The drilling has so far only covered about one third of the prospective iron formation.

The project is based on magnetite concentrate being processed through to metallised pig iron, using the alternative ITMk3 ironmaking technology. A pre-feasibility study is underway based on the production of 770,000 tpa magnetite concentrate to produce 500,000tpa merchant pig iron for more than 30 years. This is expected to be completed by the end of July 2007. Drilling is continuing through the rest of 2007. Approximately 2 years are envisaged to reach the bankable feasibility study stage.

There is a significant amount of the 25km strike length of banded iron lenses only explored to the mapping and aeromagnetic survey stage.

At Wadgingarra East, the Aurox prospect covers a potential 7 km strike length of banded iron formation. Initial rock chip results, reported in March 2007, gave some values in the 55-59% Fe range. The project is at the early stage of exploration.

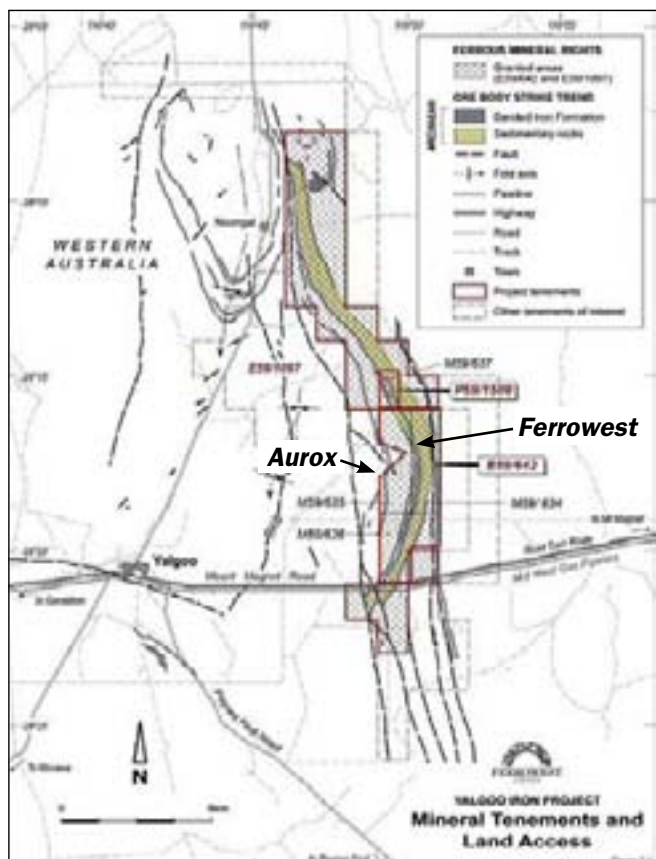


Economic Potential

Ferrowest is planning an added value project through to metallic iron. Project economics are not yet announced.

Projects

Yalgoo Iron (Yogi)	Ferrowest Pty Ltd
Wadgingarra East	Aurox Resources Ltd



Wolla Wolla – Bona Well - Brandy Hill

Location

Wolla Wolla is located adjacent to the Mullewa – Mt Magnet Road, about 100km east of Mullewa. Bona Well occurs between Yalgoo and Wolla Wolla. The Brandy Hill prospect is in the Gullewa greenstone belt lying some 40km south of this road, as an extension of the same greenstone belt.

Players

Asia Iron holds titles over the Wolla Wolla prospect.

Iron Mountain Mining holds tenure over the iron formation between Wolla Wolla and Yalgoo, referred to as Bona Well.

Batavia Resources has title over the Brandy Hill prospect.

Prospectivity

To date only reconnaissance exploration has been undertaken over these areas. Two distinct aeromagnetic targets have been identified at Wolla Wolla.

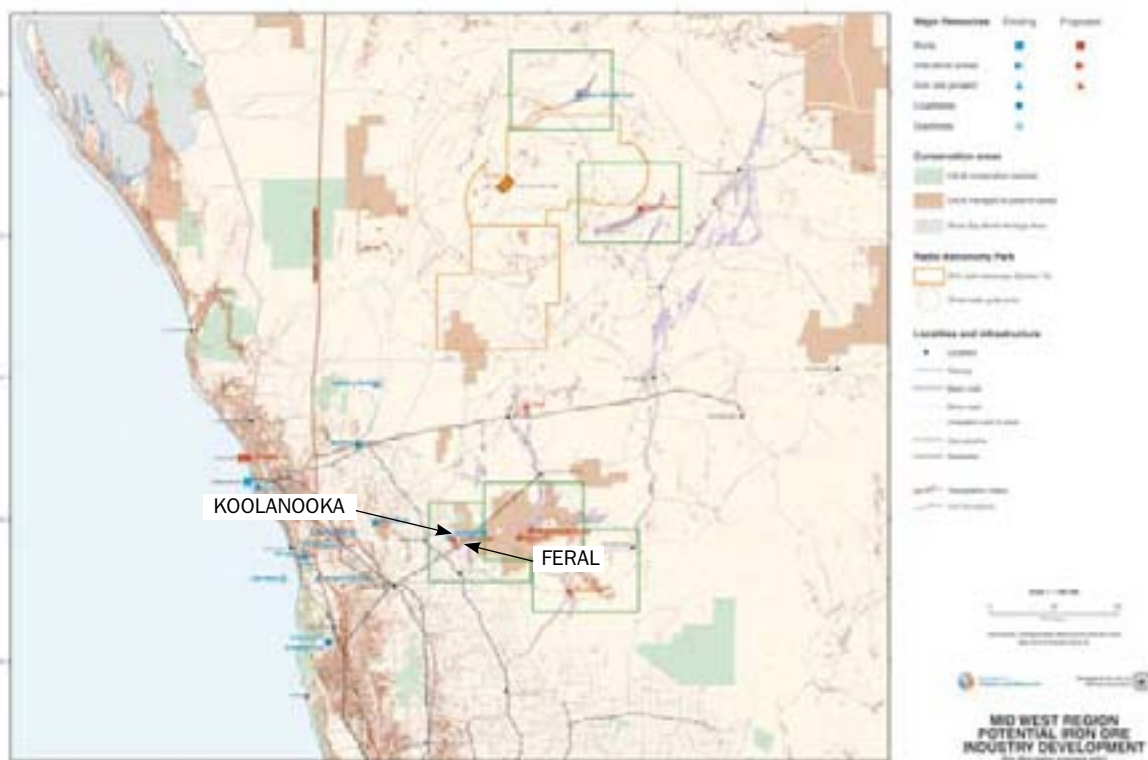
The southern extensions of the ranges to Gullewa are more noted for their gold operations and prospectivity for vanadiferrous, titaniferrous magnetites. Initial reconnaissance drilling at Brandy Hill has intersected enriched hematite mineralization.

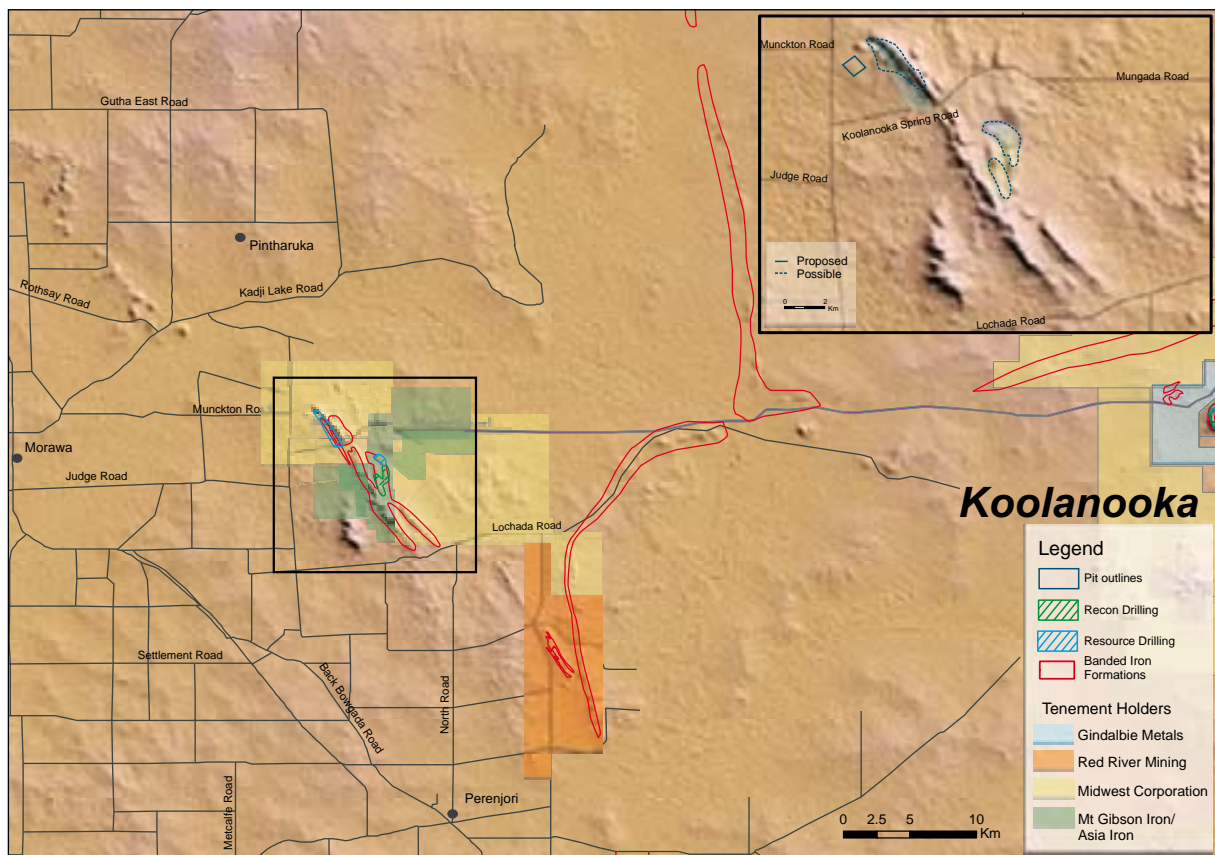
Economic Potential

Not defined.

Projects

Wolla Wolla	Asia Iron (formerly owned by Mt Gibson Iron)
Bona Well	Iron Mountain Mining
South Murchison (Brandy Hill)	Batavia Mining





Koolanooka Hills – Perenjori Hills

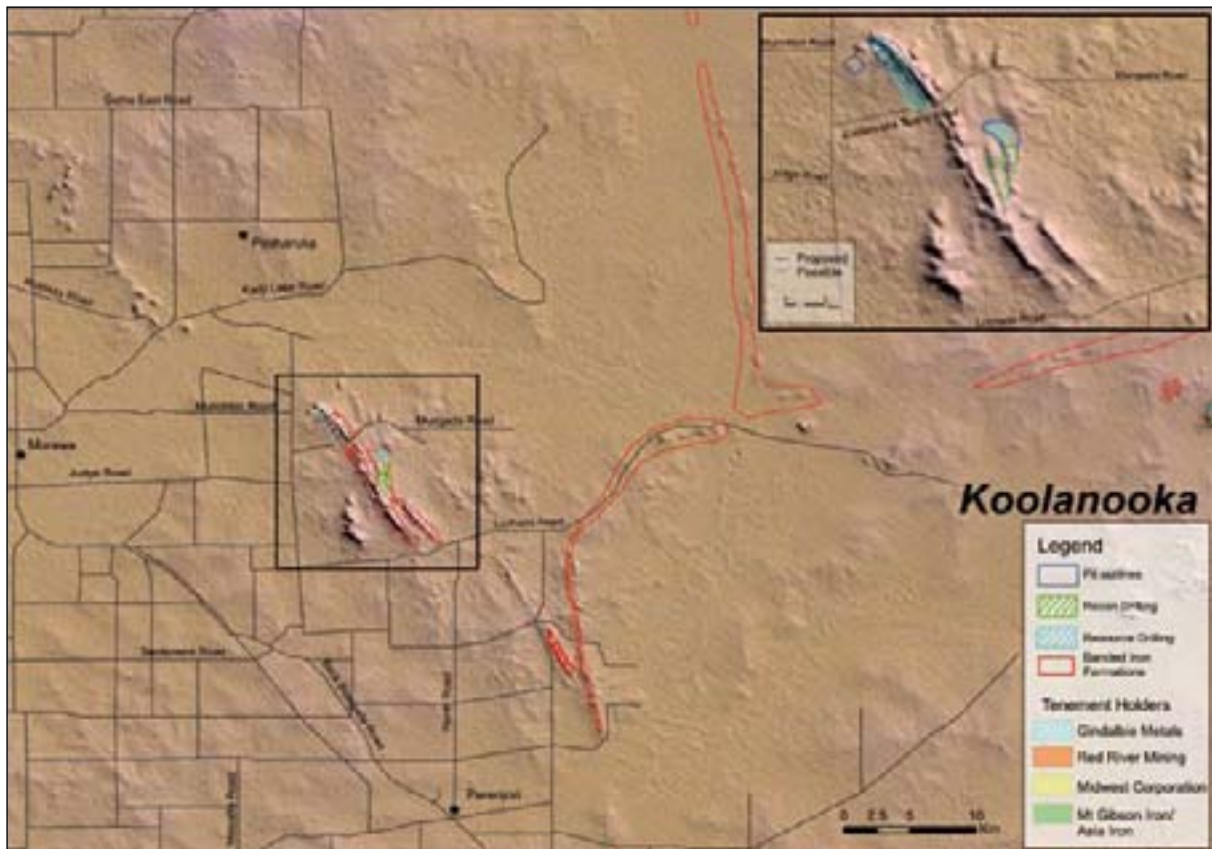
Location

The Koolanooka tenements are located approximately 160km east-south-east of Geraldton and 19km east of the town of Morawa. Perenjori Hills are immediately to the SE of the Koolanooka Hills.

Players

Midwest Corporation holds the titles over the existing Koolanooka pit and immediate surrounds. It also holds tenure over an area to the SE of the Ranges. Asia Iron has titles in the southern part of the Ranges and immediately south of Midwest’s Koolanooka pit area.

Red River Resources is earning 75% rights to tenure further to the south in the Ranges. Red River Resources signed a heads of agreement to earn up to 75% equity in the Devereux Syndicate’s exploration licence. The Devereux Syndicate is comprised of Hermitage Holdings Pty Ltd, Paloma Holdings Pty Ltd, Pinecroft Pty Ltd and Devereux Nominees.



Prospectivity

The Koolanooka mine was operated between 1965 and 1973. Its redevelopment is the focus of Midwest Corporation's stage 1 development involving reworking of fines dumps left from the former operation (in production since February 2006) and planned direct shipping ore developments involving an extension of the existing Koolanooka pit, development of nearby detritals and extension of the formerly worked pits at Mungada (Blue Hills).

These stockpiles together with further exploration activities have confirmed a remaining direct shipping hematite, JORC-compliant resource of 9.8 million tonnes at 57.7% Fe at Koolanooka and Blue Hills. Stockpiled fines reserves are 1.12Mt, bedrock cutback resources at Koolanooka are 1.3Mt, detrital reserves 1.3Mt and the 2 pits at Blue Hills / Mungada cutback bedrock resources of 4.4Mt. Blending of all ore types will be required to meet market specifications. The company is continuing to drill the bedrock and detrital hematite resources at Koolanooka and Blue Hills and increased resource estimates are expected to be announced in late 2007.

The fines stockpile is expected to be worked out by late 2007 – early 2008, with the company planning to follow with re-opening the Koolanooka and Blue Hills hematite iron ore mines for approximately 7 years at an initial rate of 1 Mt/a (commencing hard rock mining at Koolanooka early 2008 and at Blue Hills later in 2008) targeting an increase to 2Mt/a.

Midwest Corporation is studying the development of the magnetite resources, as stage 2, in joint venture with Sinosteel Corporation. Further test work is ongoing to establish metallurgical characteristics for process plant design. This development has a lower priority than the joint venture's Weld Range development. The total indicated magnetite resource is quoted at 430 million tonnes at 35%Fe (magnetite). Further review of the resource and the recovery characteristics is underway. The eventual plan is to produce 6Mt/a of magnetite concentrate and/or pellets, with a project life anticipated to be in excess of 20 years. Magnetite production is considered for commencement in 2011 / 2012, following the successful completion of pre-feasibility and bankable feasibility studies being carried out with Sinosteel.

Asia Iron (formerly Mt Gibson Iron) is the second group with interests at Koolanooka. Its pre-feasibility evaluation work has linked its Koolanooka South magnetite with coal deposits it holds in the region, as base inputs for a potential ironmaking facility. The synergy of the iron ore and steaming coal for use in alternative ironmaking technologies has been considered, particular as subsidiary company Westralian Iron holds titles at the Irwin River coalfield. No resource estimate has been announced for Koolanooka South, but resources and development potential could be similar to that of Koolanooka.

of weathered hematite has been undertaken, showing enriched grades of +50% Fe and some exceeding 60% Fe. Over 7 km of strike length has been surface sampled identifying zones of supergene enrichment. Drilling is planned by Red River, initially targeting a DSO hematite resource. In 2007, an aeromagnetic survey is planned to define potential magnetite targets.

The Feral Prospect, being explored by Red River Resources, is 20km SE of Koolanooka and on the same geological strike extension of Koolanooka deposits. Outcrops display similar banded iron assemblages to Koolanooka and have strong magnetic anomalies. So far only rock chip sampling

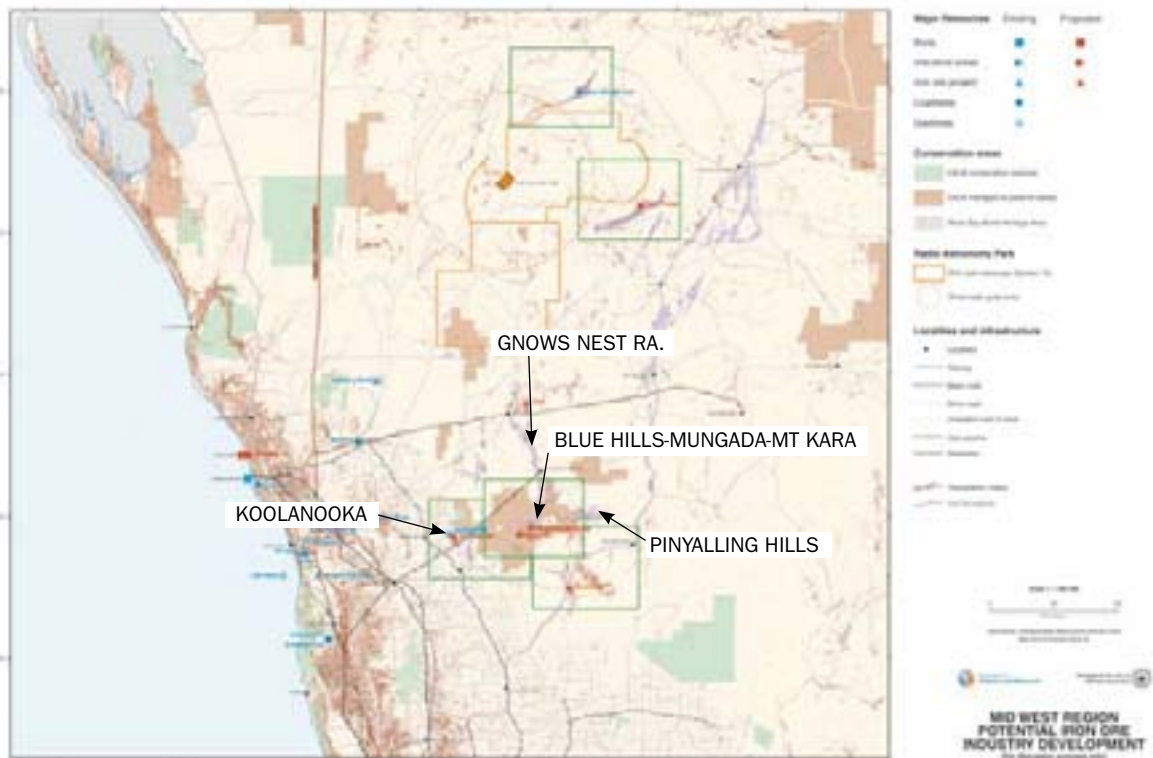
Economic Potential					
	MWC Dumps	MWC Koolanooka Hematite	MWC Koolanooka Magnetite	Asia Iron Koolanooka S Magnetite	Red River Feral
Stage of Devt.	Operating	Approvals	Testwork Pre F/S	Exploration Pre-feasibility	Exploration
Output / Years	1Mt/2yrs	2Mt/5rs	6Mt/20+yrs	tbd	tbd
Resource Value	\$420 - 600M		\$9.6 – 13.7B	tbd	tbd
Annual Revenue	\$90 – 130M		\$390 – 560M	tbd	tbd
Revenue with multiplier	\$190 – 270M		\$0.8 - 1.2B	tbd	tbd
Royalty Revenue	\$5.9 - 8.4Mpa		\$13.5 - 19.3Mpa	tbd	tbd
Capital	\$26M		\$1 billion	tbd	tbd
Employment					
Constr.	40	1200		tbd	tbd
Operating	60	270		tbd	
Projects					
Koolanooka DSO (Hematite)	Midwest Corporation			Operating/development	
Koolanooka Magnetite	Midwest Corporation Sinosteel Corporation			Pre-feasibility, testwork	
Koolanooka South	Asia Iron			Pre-feasibility	
Feral Prospect	75% Red River Resources Devereux Syndicate			Reconnaissance exploration	

Blue Hills

Including Mungada – Karara, Warriedar Hill – Pinyalling, Minjar – Gnows Nest Range

Location

The Blue Hills – Mungada – Mt Karara project area is located 60km east of Koolanooka, 220km ESE of Geraldton.



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Players

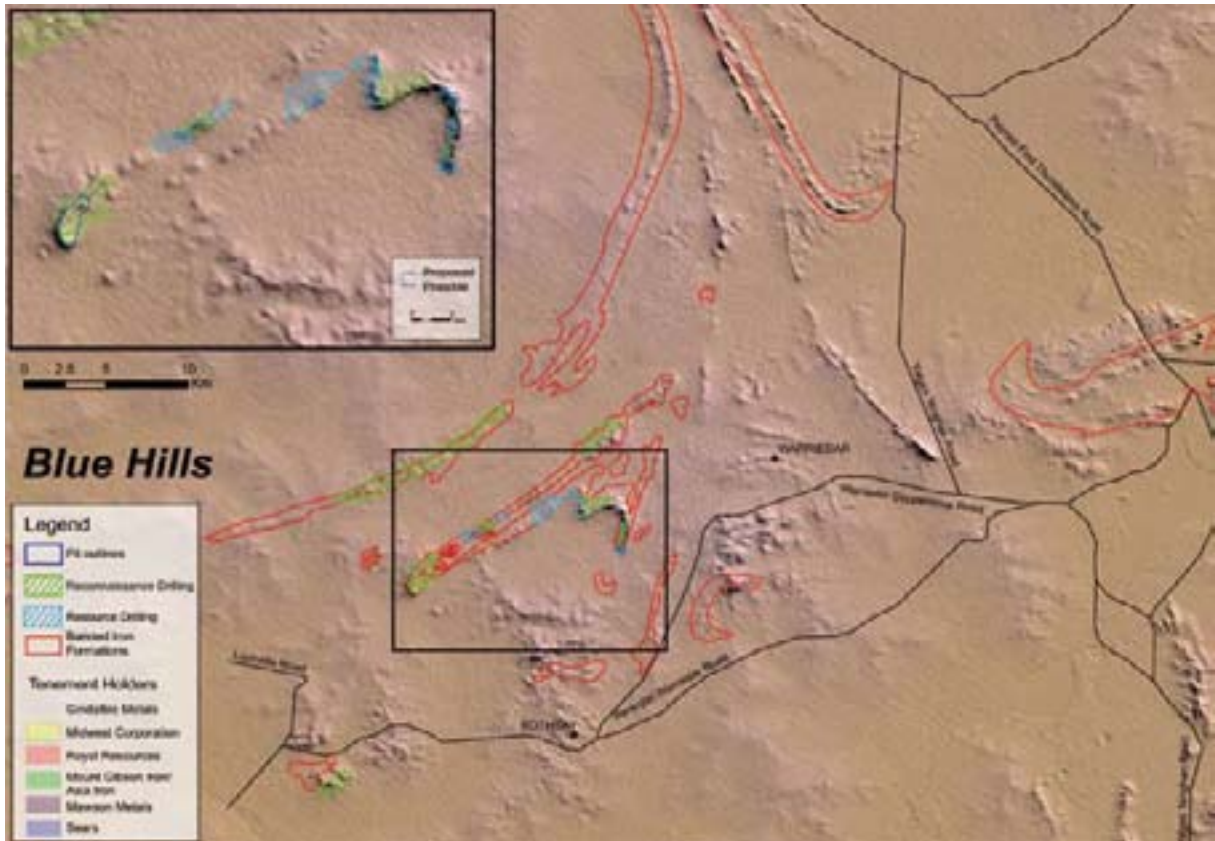
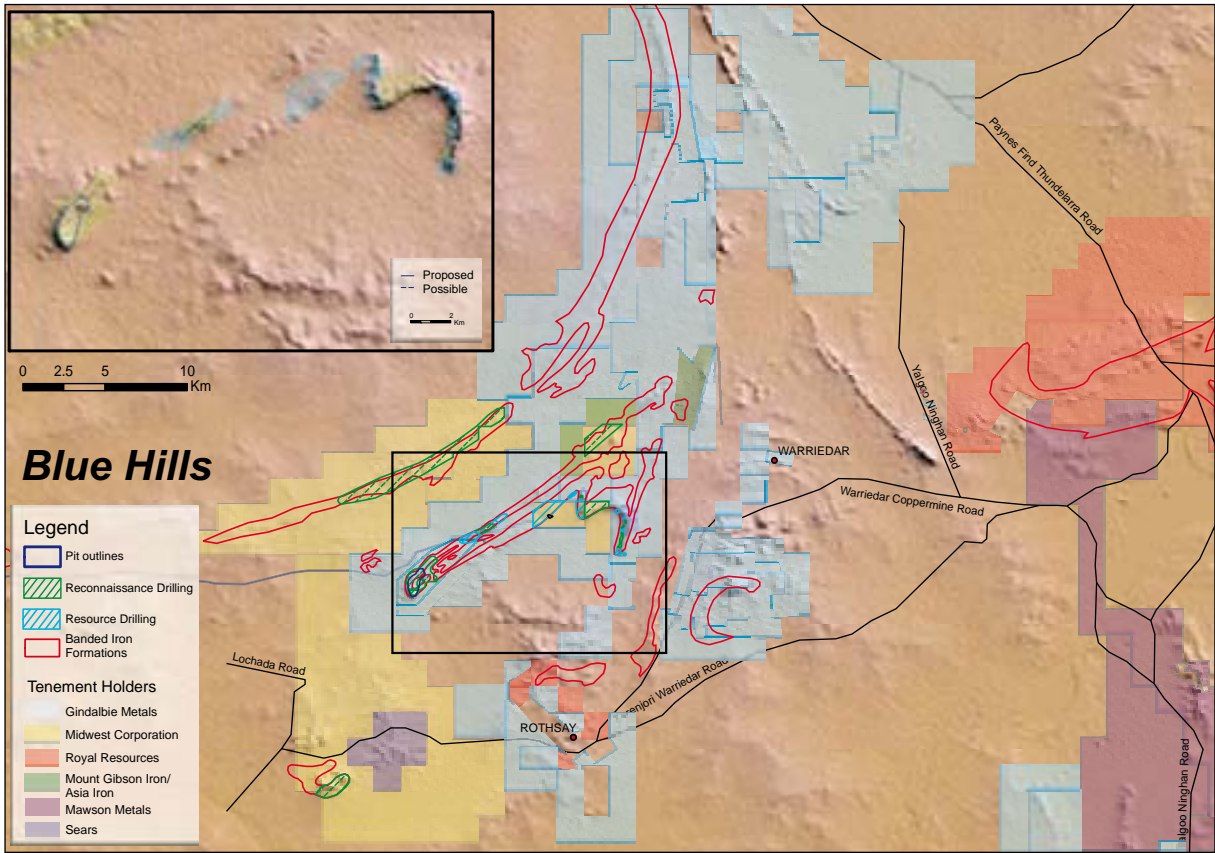
There are a number of intermeshing tenement interests in the area, further complicated by various farm-in arrangements. The area is probably the most intensely explored of all of the Mid West banded iron hosted greenstone belts. The whole focus of Gindalbie Metals' activity in the Mid West region is on Blue Hills / Mungada hematites and Mt Karara magnetite. The company, as well as operating on its own tenure, has farm-in arrangements with others. It formerly operated the Minjar Gold mine in the district. Gindalbie operates in joint venture with Anshan Iron & Steel.

Midwest Corporation holds significant tenure in the area. Its developments are based on blending product in an integrated project with its Koolanooka direct shipping ore.

Royal Resources are another main player, with tenure in the vicinity and to the NE of Blue Hills, under the name of the Warriedar Joint Venture, but also operating in its own right in the Pinyalling Hills – Fields Find area to the east of Blue Hills. Mawson Pacific / Accent Resources, and prospector Sears are also active tenement holders.

Prospectivity

The iron formations in the region are complexly folded and faulted and give rise to a series of low forming hills throughout the area. The Mungada - Blue Hills area is being actively progressed as the basis of Gindalbie Metals – Anshan Iron & Steel's stage 1 direct shipping ore (hematite) and stage 2 magnetite projects. Stage 1 is based on the Mungada Ridge – Blue Hills and Stage 2 Mt Karara. Anshan brings to the joint venture considerable experience in operating magnetite orebodies.



The drill results by Gindalbie Metals have identified a very significant resource of magnetite at Mt Karara. Resources have recently been upgraded to 1.43 billion tonnes within a single orebody. The resource tonnage and value makes up a substantial proportion of that defined to date to JORC standards within the whole Mid West region.

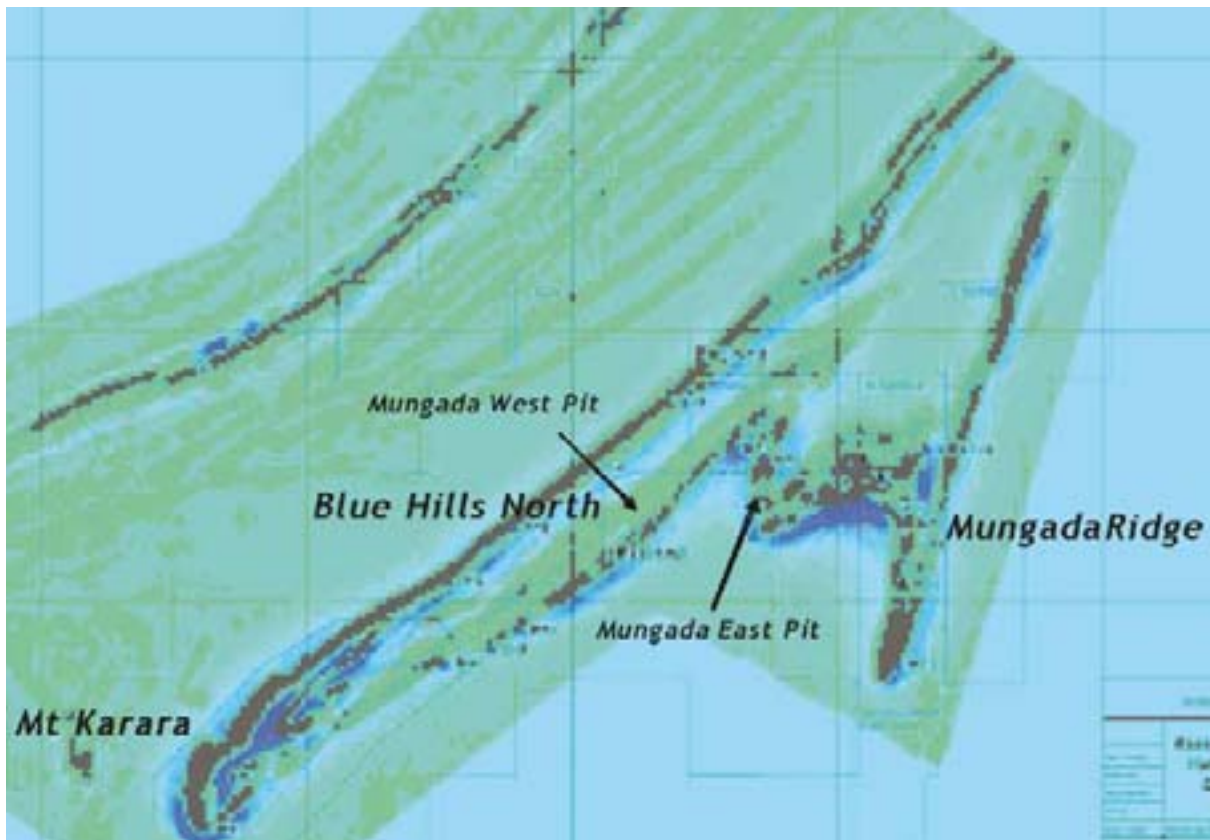
Gindalbie Metals, together with Thiess and Anshan, has recently completed definitive, bankable feasibility studies for the development of a magnetite mine, concentrator, transportation system and port based on its Mt Karara deposit and for hematite direct shipping ore from Mungada. The studies each showed positive outcomes to support economically sound developments. The projects are being progressed through the environmental approvals process at a Public Environmental Review (PER) level. Gindalbie anticipates that shipments of hematite would commence in 2008 and magnetite in 2009/10.

While the magnetite forms the main project, Gindalbie has subsequently supplemented the magnetite

resource by a number of discrete hematite near-surface pockets to support a stage 1 direct shipping ore project which could support production initially of around 3Mt/a of hematite, with consideration to raise output to between 6 and 8Mt/a. Resources to date are 27Mt, but drilling and evaluation continues and a figure of 40Mt is being targeted to support in excess of 10 years of operation at the initial output level.

Midwest Corporation also holds significant title in the area and at this stage is being planned for the latter part of the stage 1 direct shipping (hematite) development in conjunction with Koolanooka. Midwest Corporation's tenements contain the former workings at Mungada and the development essentially involves the push back of the two small slots which were developed in 1973/74. Resources defined as extensions to Mungada East and West pits are 3.25Mt and 1.19Mt respectively. Midwest Corporation is a major tenement holder in the region, and is currently undertaking systematic exploration of most of other areas within its tenement holding in the Blue Hills Ranges.





Royal Resources is at a much earlier stage of exploration with mapping, magnetic interpretation, surface sampling and preliminary drilling at its Plateau prospect in the Pinyalling Hills, near to the old gold mining area of Fields Find. Royal has identified 4 target prospects in the area, Thatcher, Three Sisters, Pinyalling South, and Plateau.

Warriedar JV area gave 55-65% Fe preliminary results at 4 new prospects called Lister, Gap, Shine, and Hippo.

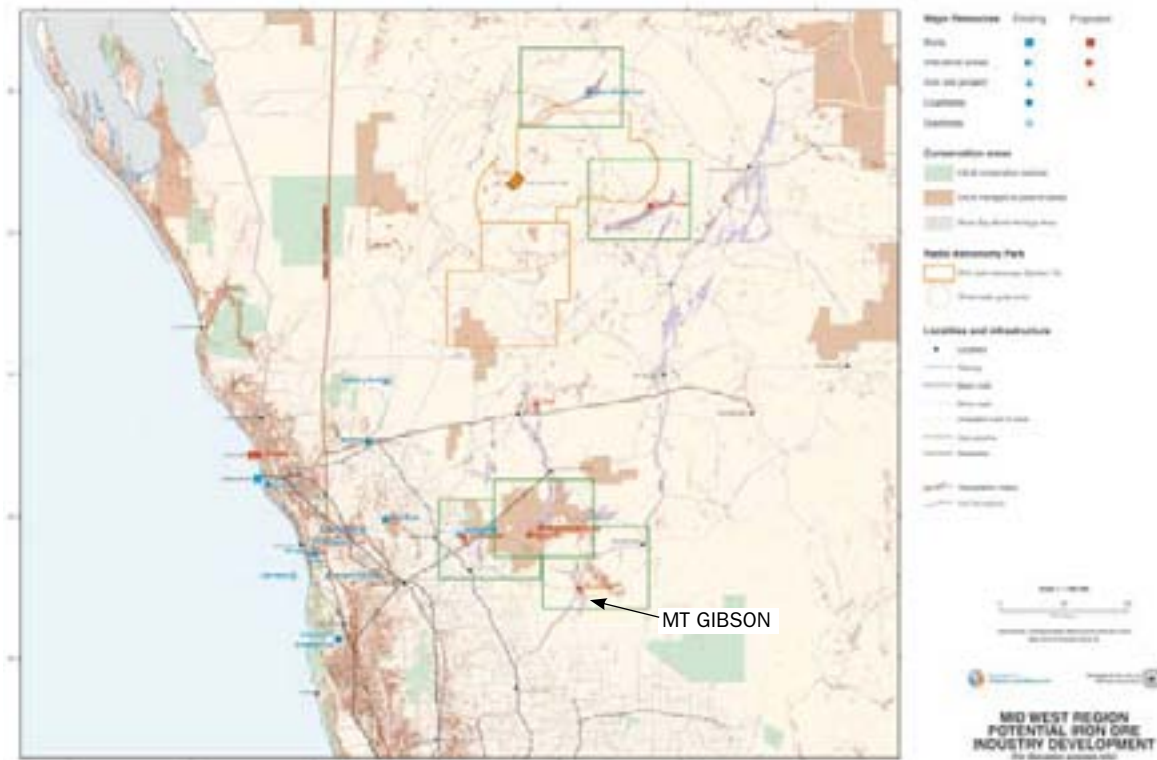
Reconnaissance drilling was completed at Plateau in June 2006 identifying prospective channel iron mineralisation of 8-10metres thick. Results indicate grades of low to mid-50% Fe. This was followed up in October with further more intense drilling over 1 km² area to confirm near surface enriched hematite – goethite direct shipping quality material. Low P highly hydrated ore was identified. The company has also entered farm in arrangements at nearby Damperwah Hills with gold and nickel being targeted, as well as iron ore. Within the Warriedar region the company also holds the Baron Project, with iron ore potential in the Bismarck prospect and other areas in JV managed by Gindalbie Metals. Recent rockchip sampling in the

Economic Potential			
	Gindalbie Hematite	Gindalbie Magnetite	Royal Pinyalling
Stage of Devt.	Approvals	Approvals F/S	Exploration drilling
Output/Years	3(8?)Mt/9yrs	8Mt/60+yrs	tbd
Resource Value	\$1.3 – 1.85B	\$22.4 – 35.7B	tbd
Annual Revenue	\$150 - 215M	\$325 – 530M	tbd
Revenue with multiplier	\$320 – 450M	\$680 – 1100M	tbd
Royalty Revenue	\$10 - 14Mpa	\$16.3 – 26.4Mpa	tbd
Capital	\$108M	\$1520M tbd	
Employment			
Constr.	600		
Operating	410	tbd	
NB Midwest Corporation Mungada Hematite project included in Koolanooka DSO			
Projects			
Mungada Ridge - Blue Hills Hematite		50% Gindalbie Metals Ltd 50% Ansteel	
Mt Karara Magnetite (and Pellet) Project		50% Gindalbie Metals Ltd 50% Anshan Iron & Steel	
Mungada Hematite (as part of Koolanooka DSO project)		Midwest Corporation	
Pinyalling Hills – Plateau Prospect		Royal Resources	

Mt Gibson

Location

The Mt Gibson Ranges are located 320km SE of Geraldton, adjacent to the Great Northern Highway. Further smaller banded iron hills occur to the NE of Mt Gibson and banded iron formations also extend below surficial cover to the south of the main Ranges.



Players

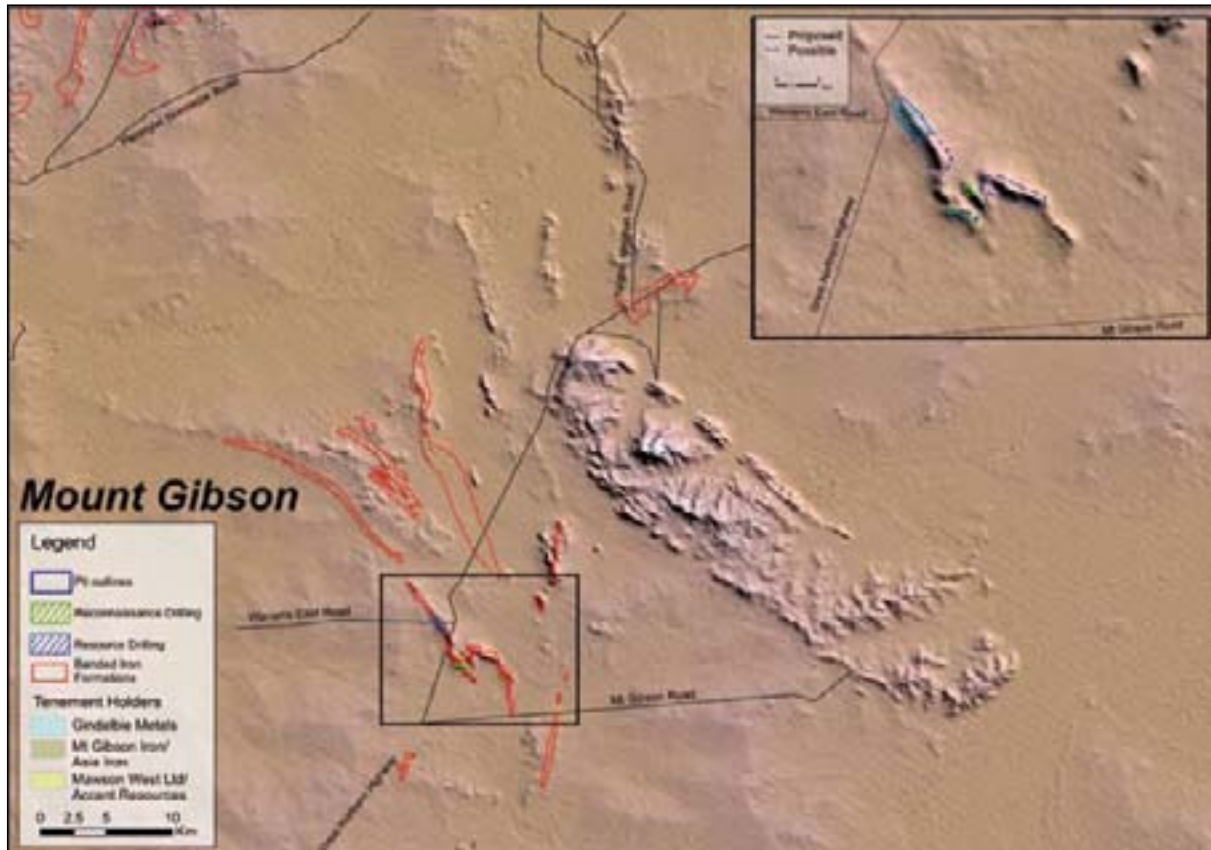
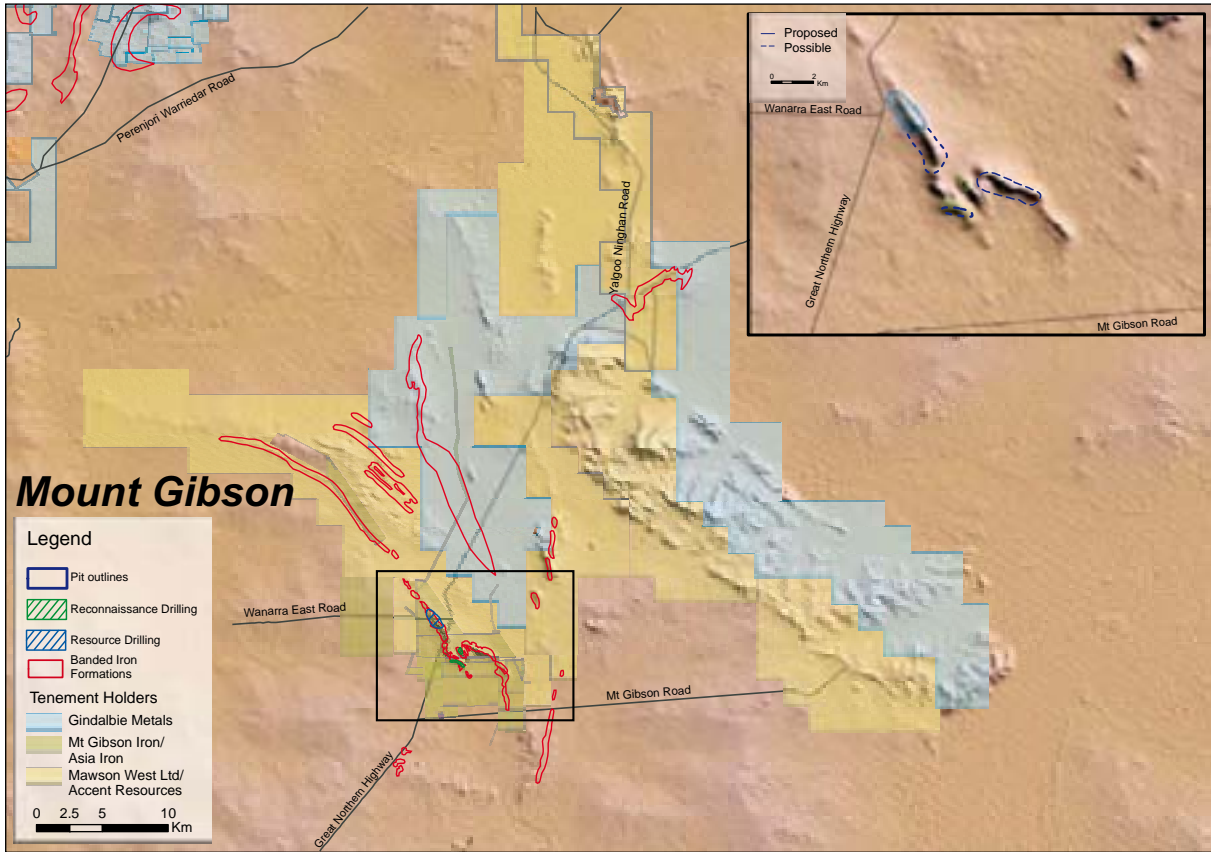
Mount Gibson Iron / Asia Iron Holdings hold tenure over the main Mount Gibson Ranges, with northerly extensions held by Mawson Pacific / Accent Resources. Mawson / Accent and Prosperity Resources also hold areas to the NE, as too do Gindalbie Metals. To the SE Prosperity Resources holds tenements over banded iron formations.

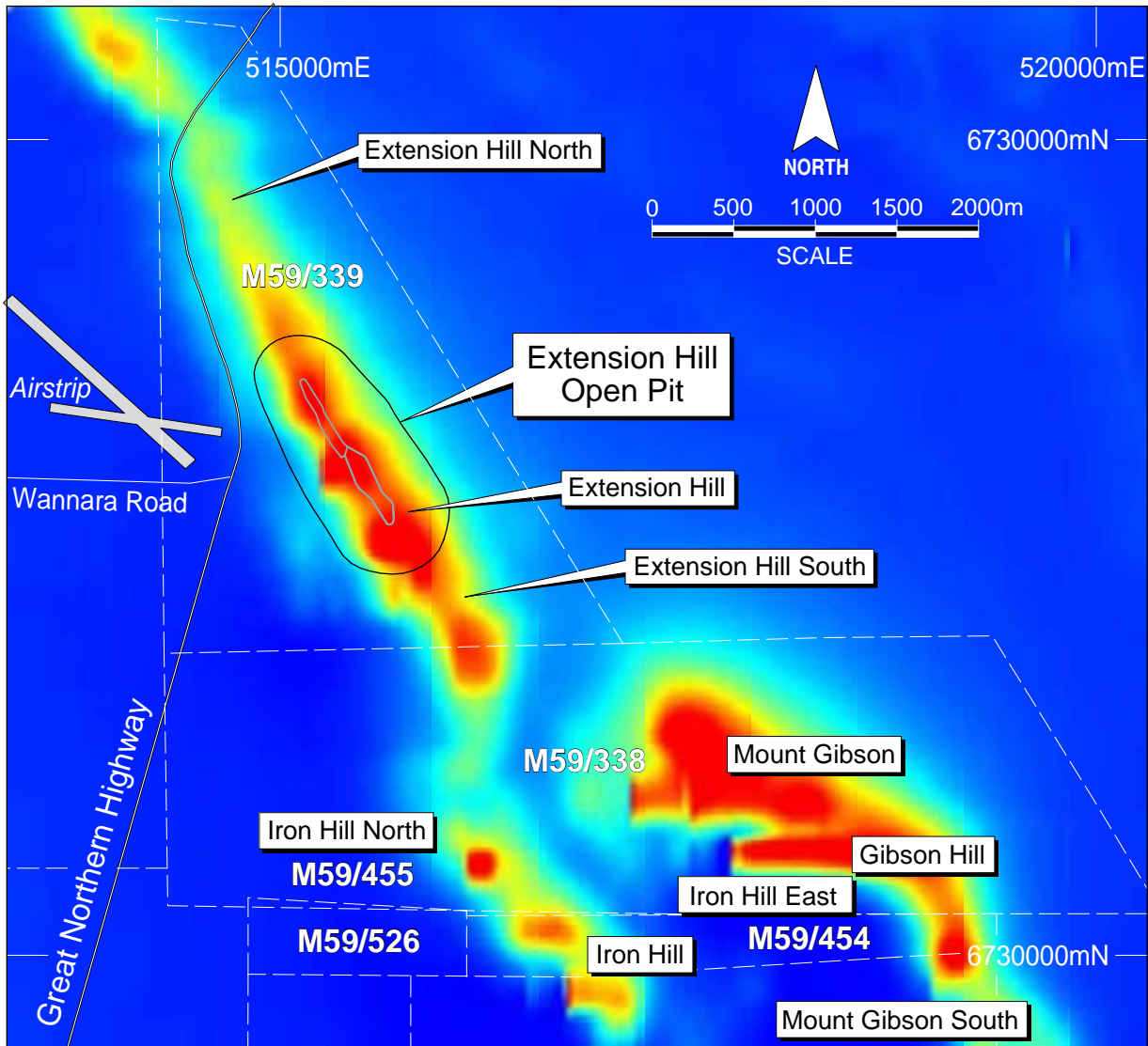
Prospectivity

The Mount Gibson Ranges were evaluated in the early 1970s by Kokan Mining, where significant work (drilling and adits) was concentrated on Iron Hill, as well as some evaluation of Extension Hill. Mount Gibson Iron has been the most active explorer in the region in recent years. It has retained access to the hematite resources, but has relinquished control of the magnetite to Chinese group Sinom Ltd, as majority shareholder in Asia Iron. The focus of effort has been on Extension Hill in the Mt Gibson hills area.

The Extension Hill DSO and magnetite projects are the most advanced of the Mid West projects in their approvals and have recently been approved through the environmental process, after a long period of appeal consideration. However, during the environmental process for Extension Hill, other areas in the Mount Gibson Ranges have been brought into the consideration and recommended that a significant resource potential of Mt Gibson and Mt Gibson South be included as A Class conservation reserves, thus precluding their development potential for a larger project in the Mount Gibson Ranges.

The hematite ores overlie the magnetite and so would logically be developed as an integrated development, under 2 ownership entities. Mount Gibson Iron has indicated that it can proceed with a development plan for the hematite, while for Extension Hill magnetite





resources, owned by Asia Iron, the company has not indicated its intent. Initially it was planned to develop Extension Hill, sufficient to support a 20 year magnetite project at 5 Mt/a of concentrate product (248Mt of magnetite ore), but with this being the first stage of a more significant development. Asia Iron was looking at a second stage to take the development to 10Mt/a quite quickly, and potentially even higher. The restriction on access to a significant part of the upside resource potential may require further consideration on the initial development, with evaluation of the remaining accessible areas, before proceeding with Extension Hill.

The relatively high grade and coarseness of the magnetite ore indicates that grinding and high recoveries from the Mount Gibson ore are likely to make it very competitive with other magnetite deposits.

Hematite resources overly the Mount Gibson magnetite deposits and consist of resources of 18.8 Mt at 63% Fe at Extension Hill and Iron Hill. A further 2-3Mt/a of hematite will be mined and exported by Mount Gibson Iron, over an expected 8 year life. In respect to the number of other deposits in the Mount Gibson hills held under the Mount Gibson Iron / Asia Iron title, these are less defined than Extension Hill, but, from the limited amount of exploration, indications are that they have similar characteristics and continuity of mineralisation to that of Extension Hill. There are 8 distinct areas with mineralisation potential of varying sizes, including Extension Hill North & South, Iron Hill North, Iron Hill, Iron Hill East, Mount Gibson, Gibson Hill, and Mount Gibson South. They offered substantial expansion potential. It has been suggested that in total this could be almost ten times that of the planned Extension Hill project, if projected to 0 metres datum level. Mt Gibson itself, the range with the largest resource potential,

could alone be three times larger than Extension Hill resource. With the prospect of Mt Gibson and Mt Gibson South to A Class conservation reserves it has been suggested that about half or 1 billion tonnes of resource potential has been lost. If production was limited to Extension Hill, then Asia Iron could not develop above 5Mt/a, a figure questionable in underwriting an investment which could approach \$1 billion.

Gindalbie Metals, Mawson Pacific / Accent Resources and Prosperity Resources are at a reconnaissance stage of exploration.

The Mawson Pacific / Accent Resources area is located adjacent to and along strike to the NW of Mt Gibson's Extension Hill iron ore deposit. Exploration was commenced in 2006 with aeromagnetic interpretation, mapping and drilling targeting small surface hematite and potential of underlying banded iron hosted magnetite. Mawson's tenements cover 15 km of strike length of banded iron with a number of parallel lenses, identified by mapping, sampling and aeromagnetic interpretation. Initial reconnaissance drilling has identified magnetite (around 35%Fe) with thicknesses varying from 10 – 70m. Prosperity Resources has also identified target areas at the Woolshed and Mummaloo prospect to both north and south of the main Mt Gibson hills.

Economic Potential			
	Mt Gibson Extension Hill Hematite	Asia Iron Extension Hill Magnetite	Extension deposits, Asia Iron, Gindalbie & Mawson West/Accent
Stage of Devt.	Approved	Approved	Exploration x 4
Output/Years	2Mt/7+yrs	5Mt/20yrs	tbd
Resource Value	\$0.95 – 1.4B	\$4.5 – 7.2B	tbd
Annual Revenue	\$105 -150M	\$200 - 325M	tbd
Revenue with multiplier	\$220 – 310M	\$420 – 680M	
Royalty Revenue	\$6.8 – 9.8Mpa	\$10.0 - 16.3Mpa	tbd
Capital	\$73M	\$715M	tbd
Employment			
Constr.	1000		tbd
Operating	280		tbd
Projects			
Mt Gibson – Extension Hill	Asia Iron / Mount Gibson Iron (Sinom Ltd is the major shareholder of Asia Iron) (Shougang & Hong Kong associate has acquired a significant shareholding in Mt Gibson)		
Mt Gibson – Other prospects	Asia Iron		
Mt Gibson Extension	Mawson West Ltd 20% Accent Resources NL 80%		
Woolshed (Mt Gibson North) Prosperity Resources Mummaloo (Mt Gibson South)			

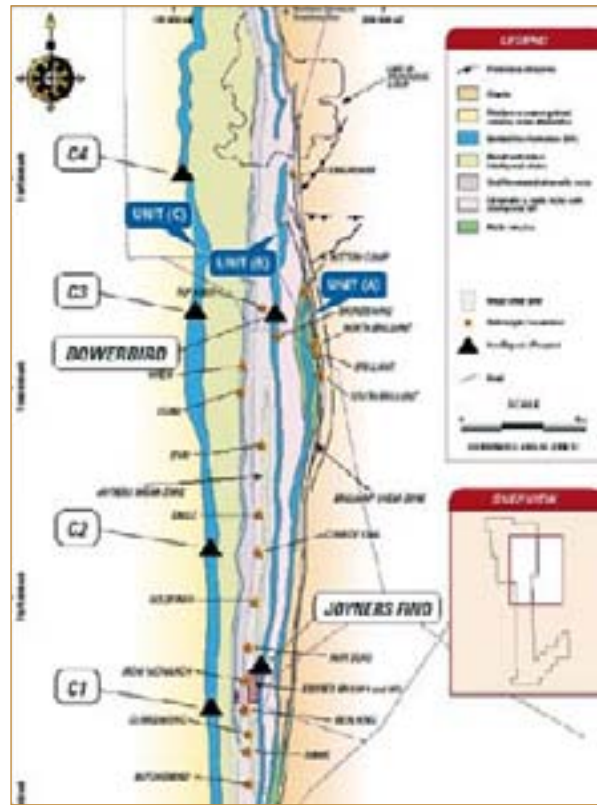
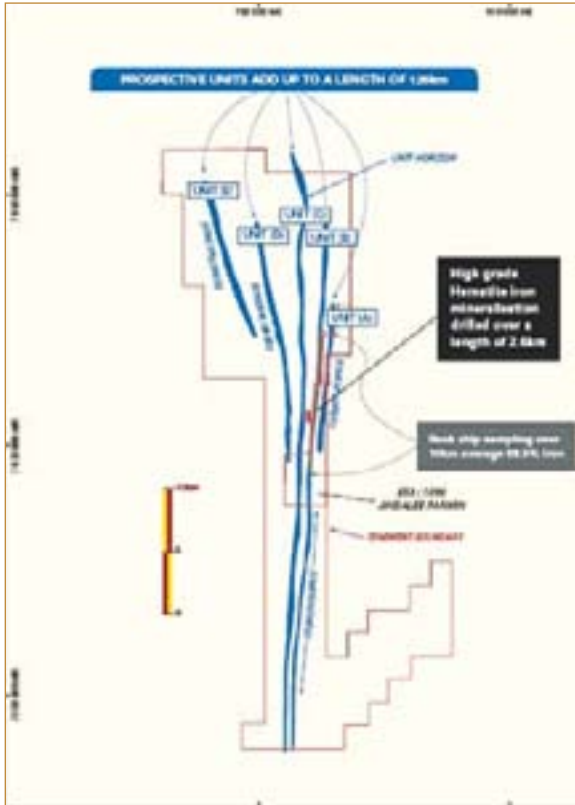
at 61% Fe were released in April, 2007, distributed through 6 deposits. The C4 Deposit contains half of this tonnage. Additional resources are expected from 4 further prospects. Golden West state that only 30% of the prospective strike length has been tested to date.

A desktop / scoping study was completed on the project, which identified two development stages. Stage 1 will involve the mining of direct shipping hematite (high grade hematite scree mineralization) at a rate of 1 Mtpa and exported via the port of

Esperance (900 km distance), for a few years while defining a resource to underpin a larger stage 2 project requiring major infrastructure.

Start up of stage 1 production is anticipated before mid-2008. Stage 2 would consider Esperance as a long term outlet or require the construction of a railway to link into the proposed railway serving Weld Range or Jack Hills iron ore developments to Oakajee (700km distance). Tonnages of 10 -12 Mtpa are envisaged, given success in ore resource definition.





Economic Potential

	Wiluna West Stage 1	Wiluna West Stage 2
Stage of Devt.	Resource Definition	Exploration
Output/Years	1Mt /4yrs	10-12Mt/?
Resource Value	\$2.2 – 3.2B	
Annual Revenue	\$50 - 75M	\$490 – 700M
Revenue with multiplier	\$110 – 1525M	\$1 – 1.5B
Royalty Revenue	\$3.4 – 4.9Mpa	\$32.5 – 46.2M
Capital	?	tbd
Employment		
Constr.	?	tbd
Operating	?	tbd
Projects		
Wiluna West	Golden West Resources	Exploration/evaluation

Booylgoo Ranges

Location

The ranges lie to the north of the Sandstone Leinster road, about 80km west of Leinster. The location is approximately 550km east of Geraldton.

Players

Titles over the Booylgoo Ranges are held by Mabrouk Minerals

Prospectivity

There has in the past been interest in the Ranges for iron ore, but it is understood that focus may currently be on base and precious metals. No published information is available on the prospect.

Economic Potential

Unknown

Projects

Booylgoo Mabrouk Minerals Pty Ltd

Cashmere Downs / Bulga Downs

Location

The Cashmere Downs prospect is to the east of the homestead, approximately 175km NW of Menzies and 500km E of Geraldton to the north of Lake Barlee.

Players

Mabrouk Minerals holds titles for iron ore over the area.

Prospectivity

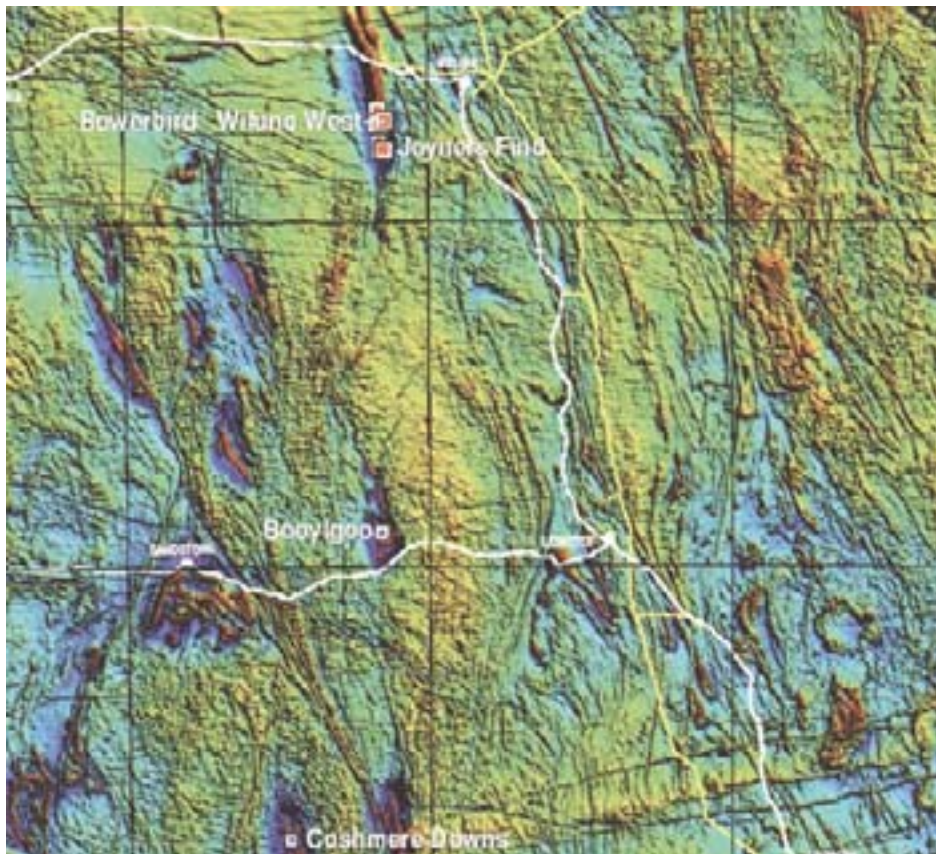
The iron ore prospect is being promoted and marketed by a private company. It is understood that both hematite and magnetite mineralization is present. No published information is released on the deposit.

Economic Potential

Unknown

Projects

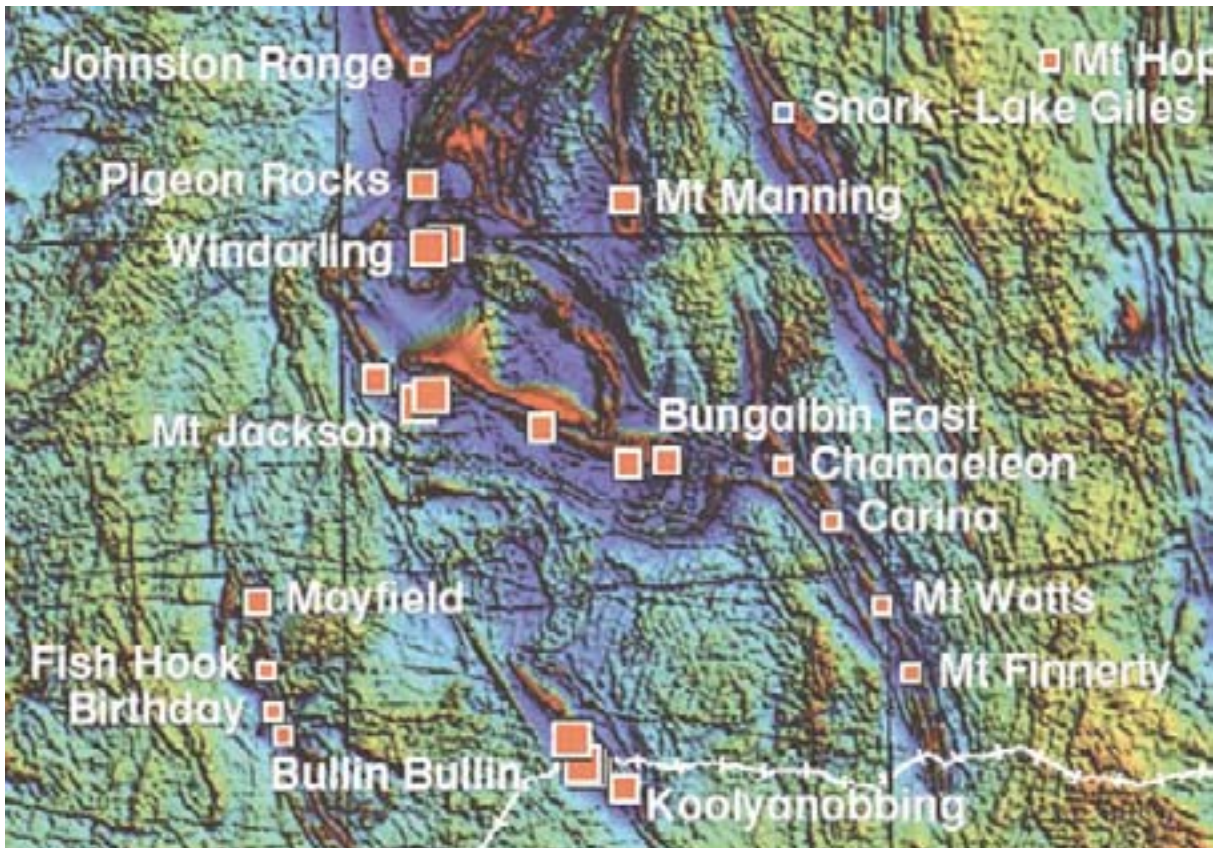
Cashmere Downs Mabrouk Minerals Pty Ltd
Resource evaluation /
market promotion?



Diemals – Johnston Range

Location

The Johnston Ranges lie immediately to the north and north-west of Portman Mining’s Windarling operation, about 140km N of Southern Cross.



Players

Polaris Mining with various farm-in arrangements, most notably with Golden State Resources.

Portman Mining also holds title on the Johnston Range

Prospectivity

Polaris initially evaluated the potential of the Mayfield area, north of Bullfinch and found that they needed to extend its exploration to other areas, notably the Johnston Ranges and Evanston to support a project big enough to develop in the isolated area of the Central Yilgarn.

Both enriched hematite and magnetite potential occurs on these prospects. Five target areas have been identified by Polaris from gravity, thermal imagery and field mapping. Reconnaissance drilling is scheduled to

proceed in the middle of 2007. The project is in the early exploration phase.

Portman has also identified enriched and strongly deformed iron formation with high grade hematite – goethite mineralisation. Again drilling has been planned in 2007. Obviously Portman sees the area as supplementary to its Windarling production, being approximately 30km to the north.

Economic Potential

Not defined

Projects

Evanston – Johnston Range

Polaris Mining NL 70% (earning)
Golden State Resources 30%

Evanston – Die Hardy Ranges

Location

Located to the north-east of Portman Mining’s Windarling operation, about 140km N of Southern Cross.

Players

Polaris Mining is farming into Leviathan Resources tenements. It has exercised options to 70% ownership in some areas and has other areas still open to options.

Prospectivity

This is another of Polaris’ prospects to potentially support a Central Yilgarn project initiated on its Mayfield prospect.

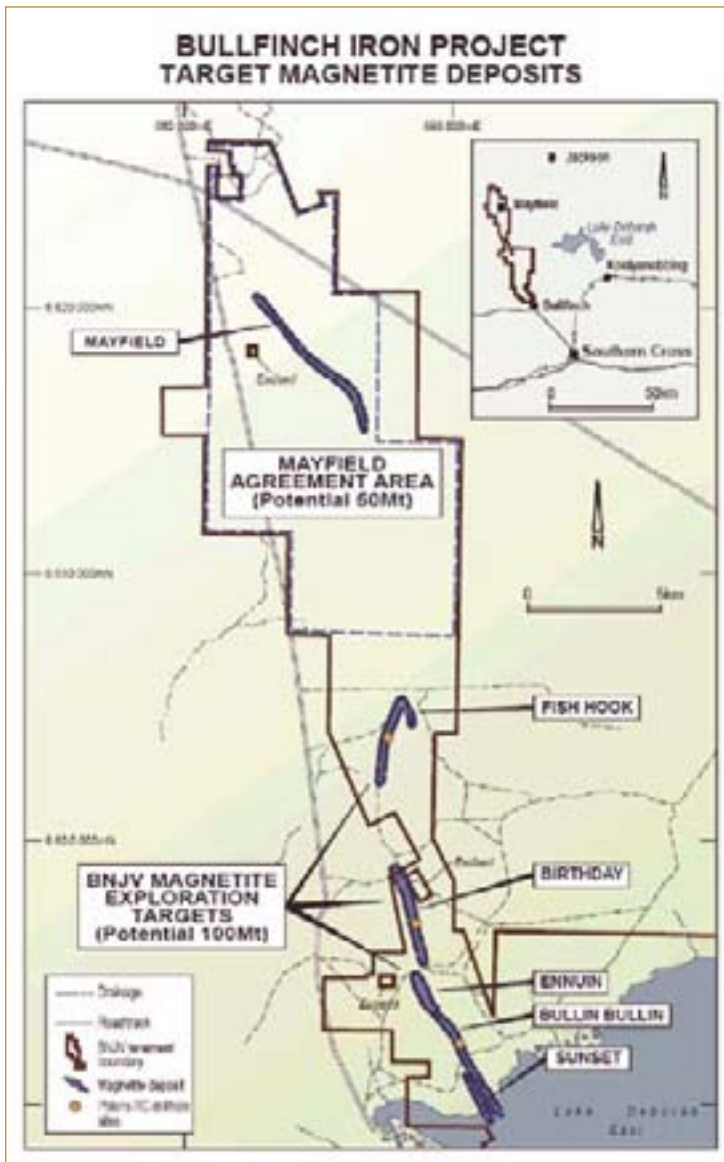
The prospect is in the reconnaissance exploration phase, in which aeromagnetics, field mapping and surface sampling has identified both bedrock and detrital iron ore target areas for follow up exploration. Drilling is being delayed as rare flora is known to occur within the tenement areas.

Economic Potential

Not defined.

Projects

Evanston	Polaris Mining NL 70% (earning) Leviathan Resources 30%
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Ennuin – Mayfield

Location

The area is located to the north of the old gold mining centre of Bullfinch and is approximately 85km N of Southern Cross.

Players

Polaris Mining, with farm out of the hematite potential to Portman Mining.

Prospectivity

WMC evaluated the enriched surface potential at Mayfield in the early 1970s, with results from surface chip samples indicating only moderate grade ore (upper 50s%Fe). Gravity anomalies, mapping and rock chip sampling have been undertaken to date. High grade, hematite - goethite direct shipping ore, with variable phosphorus content is indicated from the outcrop sampling programme. Hematite continues to be a target and potential for feed into Portman’s operations or alternatively for separate development for raiing and shipping out of Kwinana. A target for 40Mt to provide 2.5Mt/a is being suggested.

Polaris’ initial focus was on the magnetite resource, where reconnaissance evaluation considered a resource in the range 70-90Mt could

Bungalbin (Helena and Aurora Ranges)

Location

Bungalbin is located 50km N of Koolyanobbing. It is made up of the Helena & Aurora Ranges.

Players

The area was formerly part of the BHP Steelworks State Agreement, under which Koolyanobbing was developed.

Heron Resources held the areas as part of its lateritic nickel areas of prospectivity, as well as considering its iron ore potential. This project was the main iron ore focus of the Heron Groups prospects, until it sold off its iron ore interests to Polaris Metals. The tenements were let out on option to Portman Mining for a period.

Prospectivity

Bungalbin was part of the BHP Steelworks State Agreement Act which was linked to its Koolyanobbing mining operations in the 1970s and early 1980s and the AIS Kwinana blast furnace operation.

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Initial exploration by BHP indicated limited potential for high grade hematite ore. The grades were largely of surface enrichment with 50 – 55% Fe, generally lower grade to that of Koolyanobbing. An inferred resource figure of 65.7Mt @ 57.9%Fe was quoted for Bungalbin in 1998. Limited additional work has been carried out.

There is particular interest in retaining the Bungalbin East deposit, in preference to the central area around Bungalbin Hill.

Significant high grade intersections of comparable quality to those of Koolyanobbing and adjacent deposits are being reported from the later work. Prospect referred to J 4 and 5 has been the subject of recent drilling and is indicating high grade mineralisation open along strike in both directions. (this has been included in Mt Jackson – Windarling section).

Economic Potential

Not defined.

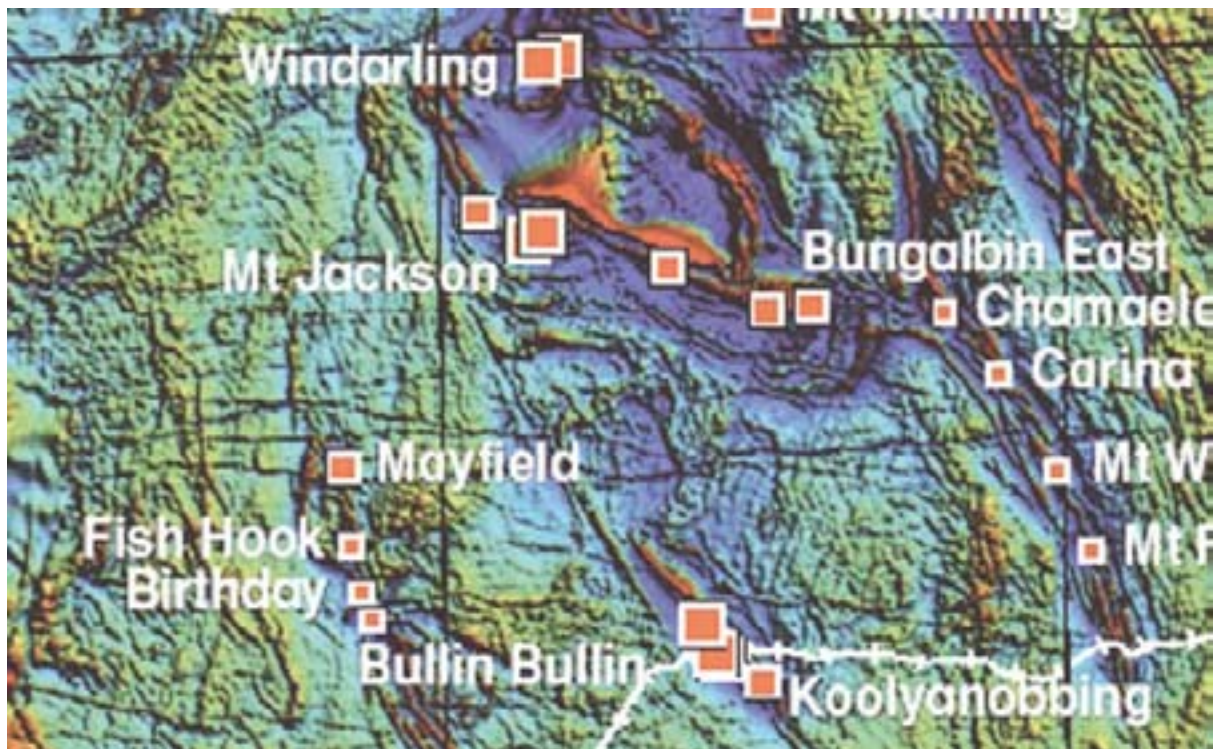
Projects

Bungalbin – Aurora Polaris (Portman?)

Koolyanobbing

Location

50km NNE of Southern Cross, adjacent to the Transcontinental Railway



Players

Portman Mining holds the majority of land over the Koolyanobbing Ranges.

Echelon Resources holds tenure on the trend of the south easterly extension of the Ranges.

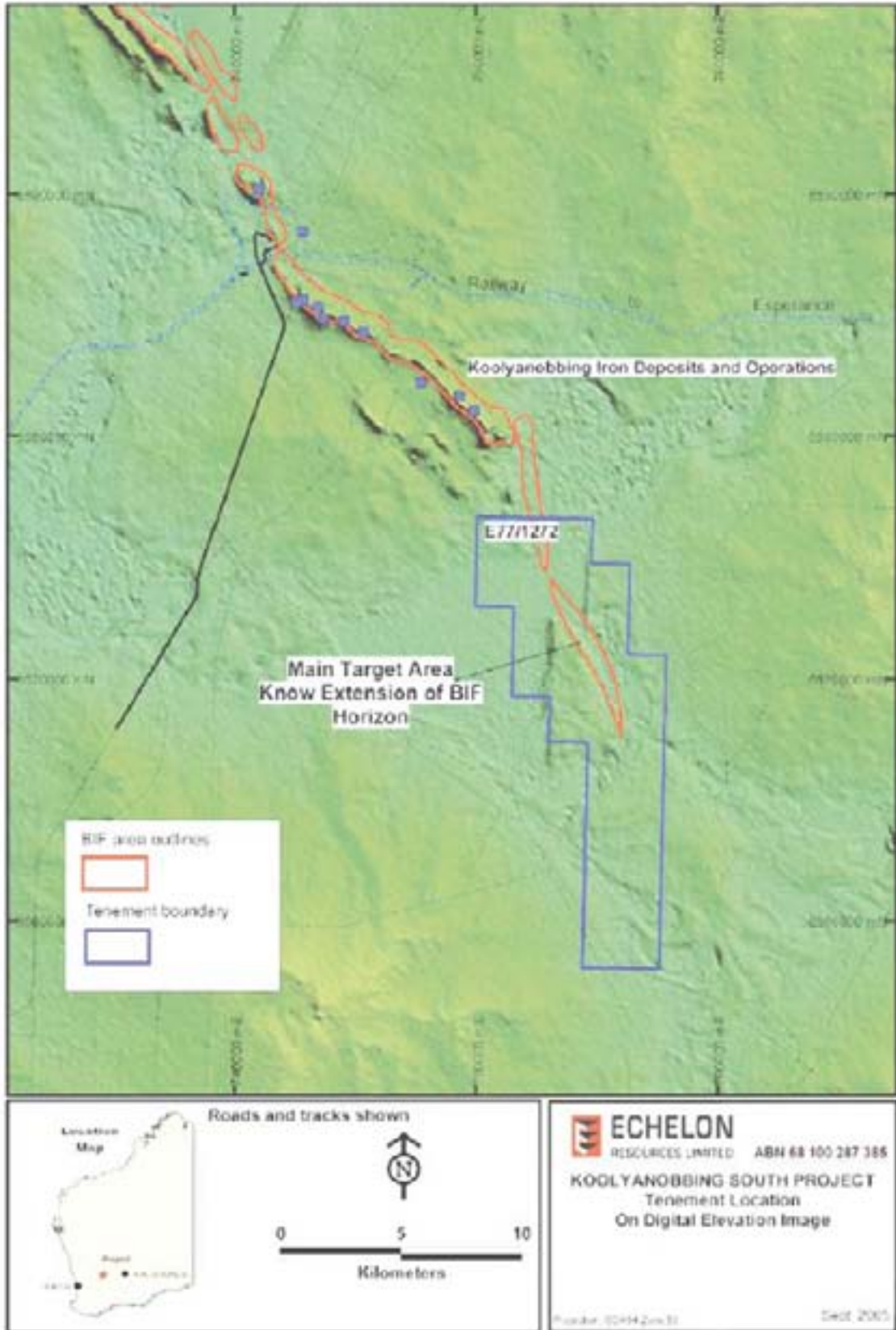
Prospectivity

Exploitation of the Koolyanobbing Ranges has been undertaken since the 1950s, initial as feedstock to Wundowie, by Bell Brothers from Deposit A, and from the early 1970s to feed Australian Iron & Steel's (BHP) blast furnace. BHP's operation was predominantly

focused on the Dowd's Hill (Deposit K), but also resulted in faces being opened at Deposits A & D.

Koolyanobbing is the centre of Portman's current operations. Remaining resources are spread over a number of deposits throughout the length of the Koolyanobbing Ranges totaling 35.4Mt@ 61.7%Fe. The resource covers Deposits A, to F and K. A further 8.2Mt of higher phosphorus material is held on stockpile.

Further potential occurs to the SE of the currently defined deposits.



Economic Potential		
	Koolyanobbing Windarling Mt Jackson	Evanston, Die Hardy Diemals Johnston Ra
Stage of Devt.	Operating	Grass roots exploration
Output / Years	8Mt/16yrs	tbd
Resource Value	\$6.5 -9.4B	tbd
Annual Revenue	\$400 – 570M	tbd
Revenue with multiplier	\$835 – 1200M	tbd
Royalty Revenue	\$26.5 -37.9Mpa	tbd
Capital	\$?	tbd
Employment		
Constr.	?	tbd
Operating	?	tbd
Projects		
Koolyanobbing	Portman Mining	Operating
Koolyanobbing South	Echelon Resources	Reconnaissance exploration

Mt Manning

Location

100 km N of Koolyanobbing

Players

No iron ore applications for tenure

Prospectivity

The iron ore potential of the Mt Manning Ranges was looked at in the 1960s. At that time it was concluded that there was limited potential for high grade mineralization, but possibly significant magnetite prospectivity.

Due to high conservation values considered on the ranges, limited work has been undertaken in subsequent years.

Hunt Range - Mt Dimer – Yendilberin Hills

Location

Located between 60 and 90km to the NE of Koolyanobbing are the Hunt Range extending into the Yendilberin Hills. They are about 20 km E of the Helena & Aurora Ranges, aligned in a N-S direction (in the north) and NW – SE in the south.

Players

Polaris Metals

Prospectivity

Outcrop mapping and surface sampling has identified a number of targets for iron ore in the N-S aligned Hunt Range and NW-SE aligned Yendilberin Hills. High grade hematite- goethite mineralization has been identified on surface. Two particularly favourable prospects have recently been announced, referred to as Chameleao and Carina deposits. The prospects are still at the exploration stage of evaluation.

Economic Potential

Not defined

Projects

Part of Polaris' Bungalbin – Aurora project area
Polaris Metals

Watt Hills – Mt Finnerty

Location

The prospect is in the Watt Hills, north of the Transcontinental Railway line, approximately 120km W of Kalgoorlie and 65 km E of Koolyanobbing, in the central Yilgarn.

Players

After initial exploration by Reed Resources, a farm-in arrangement was made with Consolidated Minerals. This was subsequently terminated and joint venture was agreed with Portman Mining in July 2005. Portman has been managing the exploration.

Prospectivity

The north-south banded iron formation trend in the Mt Finnerty – Watt Hills extends for 30km. Channel surface sampling of higher grade hematite has been undertaken over 4 km of this strike length. Grades of between 58 and 65%Fe, with mostly low to medium-low phosphorus content have been recorded (potentially blending feedstock for Portman).

Portman commenced reconnaissance drilling on a 6.5km strike length target in April 2006. Seven areas were targeted

The prospectivity of 5 areas in the south of the ranges was largely discounted due to the thinness of the enriched bands after drilling, and exploration is now focussed to the northern end of the project area, where better results are being reported. Prospect FIN 9 is the one occurrences of subsurface mineralisation being considered for follow up detailed mapping in 2007.

Discoveries at the Chameleon and Carina prospects on the same greenstone belt further north has created extra interest in further evaluating the potential of the Watt Hills. Additionally geological modelling and sampling has identified interest in the channel iron potential adjacent to the ranges.

At this stage any evaluation any consideration of development of Mt Finnerty is likely to be an extension of Portman's blending operations centred on Koolyanobbing.

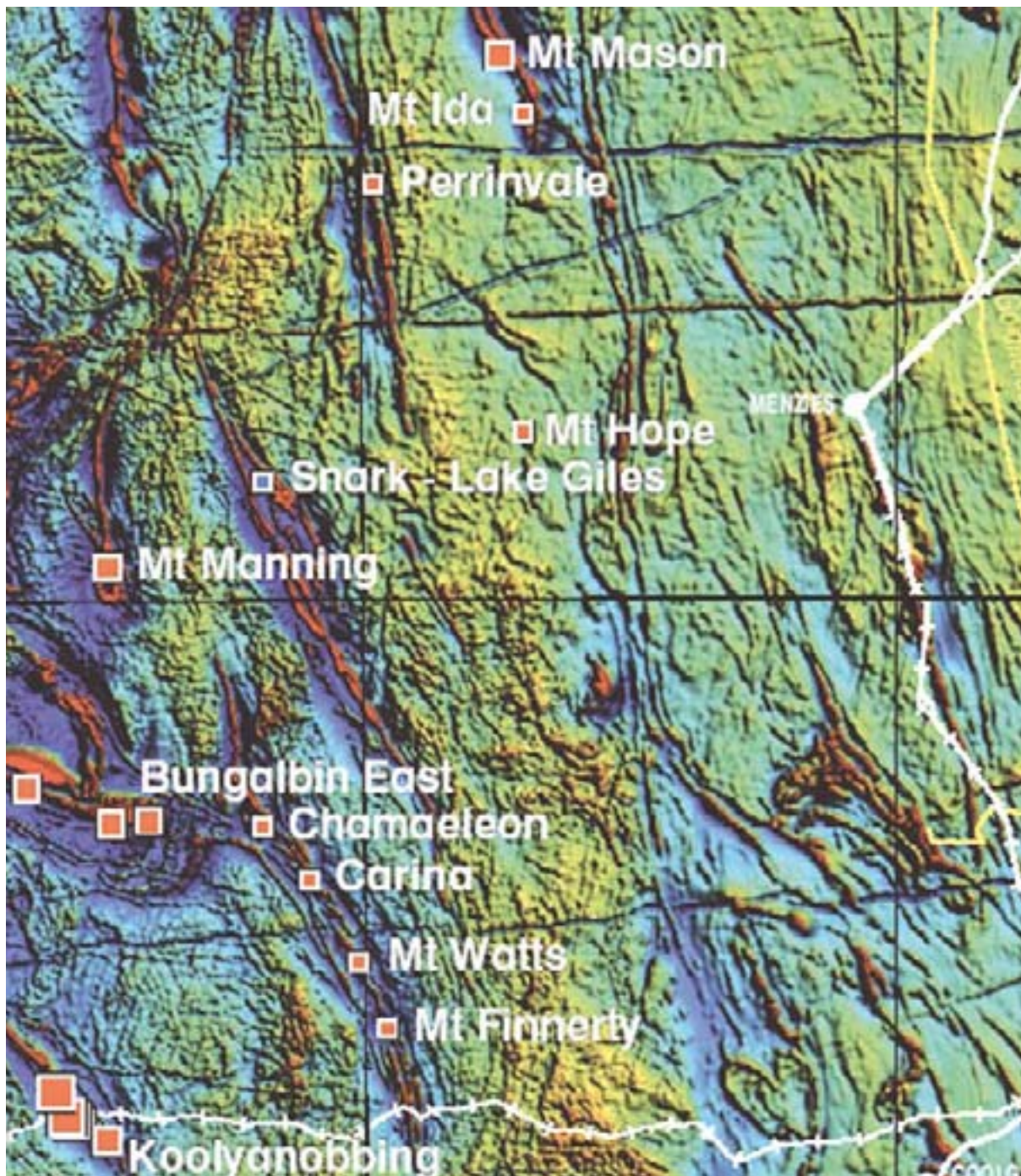
Portman has the rights to iron ore only. The tenements are prospective for nickel and gold.

Economic Potential

Potential for small supplementary tonnages to support Portman's Koolyanobbing operations.

Projects

Mt Finnerty	Reed Resources 80% (farming-in) Portman Mining
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Lake Giles

Location

The Lake Giles prospect is located approximately 150km NW of Kalgoorlie in the central Yilgarn region, within the Yerilgee greenstone belt.

It is located to the E of Lake Giles, adjacent to the Mt Manning Conservation Reserve.

Players

The area was initially held by InterNickel, becoming InterCoal and has now been acquired by MacArthur Minerals of Canada.

MacArthur Minerals purchased the prospects from InterCoal in mid 2006.

Prospectivity

The Lake Giles prospect is targeted for iron ore, nickel and gold.

Initial drilling carried out on aeromagnetic anomalies in the second half of 2006 has indicated significant thicknesses (18-105m) of magnetite mineralisation with very high indicative weight recoveries of 50% to produce 64-70%Fe in Davis Tube concentrates. Three distinct prospects have been identified ranging from 2.5 to 5km in strike length for each.

Resource definition drilling is being proposed.

Economic Potential

Not yet defined.

Projects

Lake Giles MacArthur Minerals Ltd

Perrinvale – Brooking Hills – Mt Richardson

Location

The Perrinvale prospect area is located 90 km W of Menzies.

The Brooking Hills - Mt Richardson is to the north, about 125 km NW of Menzies

Players

Portman Mining
Iron Mountain Mining

Prospectivity

Geological mapping and surface sampling by Portman Mining has identified a number of enriched goethite – hematite targets warrant further evaluation over a 45 km strike length. Reconnaissance drilling is being proposed for 2007.

Iron Mountain Mining has commenced reconnaissance mapping and surface sampling, recovering high grade hematite mineralization.

Economic Potential

Not defined

Projects

Perrinvale Portman Mining
Mt Richardson Iron Mountain Mining

Walling Rock - Mt Ida – Mt Mason – Mt Hope

Location

Mt Mason is 112km NW of Menzies and is adjoined by Mt Ida to the S & E. Mt Hope is 60km SW of Menzies.

Players

Jupiter Mines Ltd is the tenement holders. Sinosteel entered into an MOU in May 2006, but did not exercise its option and withdrew in July 2006. In November 2006 Jupiter entered arrangements with Wuhan Giant Economic Development Co. for a targeted 1 – 3 Mt/a offtake MOU. Other opportunities also continue to be considered.

Prospectivity

A 16 km strike length of banded iron formation has been identified extending through Mt Mason, Mt Ida and Mt Hope. The areas were initially mapped and sampled by BHP in 1969.

A 12km strike of potential enriched pods of hematite has been identified between Mt Mason and Mt Ida. Inferred resources over 170m strike identified at Mt Mason of 1.8Mt @ 60.3%Fe, 2.7% Al₂O₃, 8.5% SiO₂, 0.051% P.

Exploration is limited to mapping and surface sampling at Mt Ida.

Economic Potential

Jupiter is looking to bring the project into early production in 2008.

Projects

Mt Ida / Mt Mason / Mt Hope Jupiter Mines Ltd
Kununalling Iron Mountain Mining

