INVITATION TO MAKE A SUBMISSION

The Office of the Environmental Protection Authority (**OEPA**) invites people to make a submission on this proposal. Both electronic and hard copy submissions are most welcome.

Crosslands Resources Ltd is an emerging iron ore producer. It has a strong, experienced and hands-on management team dedicated to transforming the company into a significant supplier of iron ore. CRL proposes to develop the Jack Hills Expansion Project (**the Project**). The Project is located in the centre of the Jack Hills range, approximately 400 km north-east of Geraldton and 120 km north-west of Meekatharra. The Project is an expansion of the existing mining operation (**Stage 1**) which consists of an open cut mine with one pit. Iron ore is currently crushed and screened on site and transported to Geraldton Port. Stage 1 has a mine life of approximately seven years at a production rate of 1.8 million tonnes per annum (**Mtpa**). The Project will expand the open pit operations and utilise or expand existing infrastructure. A pipeline spur off the Dampier to Bunbury Natural Gas Pipeline, as well as a service corridor from Weld range will be constructed to the mine. The Project has an estimated life of at least 35 years producing iron ore products totalling 35 Mtpa.

In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (**PER**) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for public review for a period of six weeks from Monday the 13th September to Friday 22nd October 2010.

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

WHY WRITE A SUBMISSION?

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

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the *Freedom of Information Act 1992*, and may be quoted in full or part in the EPA's report.

WHY NOT JOIN A GROUP?

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

DEVELOPING A SUBMISSION

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

When making comments on specific elements of the PER:

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

POINTS TO KEEP IN MIND

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

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

Remember to include:

- your name;
- address;
- date; and
- whether or not, and the reason why, you want the submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA. As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

THE CLOSING DATE FOR SUBMISSIONS IS FRIDAY 22ND OCTOBER 2010.

The EPA prefers submissions to be made electronically using the following:

- The submission form on the EPA's website: **www.epa.wa.gov.au/submissions.asp**;
- By email to **submissions@epa.wa.gov.au**; or
- By email to the officer **douglas.betts@epa.wa.gov.au**

Alternatively, submissions can be posted to:

Chairman,
Environmental Protection Authority,
Locked Bag 33, CLOISTERS SQUARE, WA, 6850,
Attention: Douglas Betts

Or delivered to:
Environmental Protection Authority,
Level 4, The Atrium, 168 St George's Terrace, Perth,
Attention: Douglas Betts

Or faxed to (08) 6467 5562.

If you have any questions on how to make a submission, please ring the EPA assessment officer Douglas Betts on (08) 6467 5406.

WHERE TO OBTAIN COPIES OF THIS DOCUMENT

The PER is available for viewing and download on the website **www.crosslands.com.au**

Hard copies of the PER (including key management plans) may be purchased at a cost of A$10 per copy, or a CD-ROM version can be purchased for A$2 from Crosslands on (08) 9483 0500 or info@crosslands.com.au

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

1. EXECUTIVE SUMMARY

Crosslands Resources Ltd (**CRL**) currently operates the Jack Hills Iron Ore Mine Project (**Stage 1**), located in the centre of the Jack Hills Range. Stage 1 was referred to the EPA in May 2006 and was assessed under Part IV of the *Environmental Protection Act 1986.* Ministerial approval for Stage 1 was granted in September 2006 (Ministerial Statement Number 727).

CRL propose to expand and develop the "Jack Hills Expansion Project" (**the Project**), which is the Proposal that is being presented to the Environmental Protection Authority (**EPA**). The Project will consist of open cut mining and associated mine infrastructure being located on the nearby plains of pastoral leases of Mt Hale and Beringarra. The Project will mine and process hematite and magnetite at a rate of up to 35 million tonnes per annum (**Mtpa**), which will be transported via train to Oakajee port for export.

In Western Australia, the *Environmental Protection Act 1986* (**EP Act**) is the primary piece of legislation that governs environmental impact assessment and protection. Projects with the potential to significantly impact the environment are assessed under Part IV of the EP Act, which is administered by the EPA. The Minister for the Environment makes determinations under the EP Act based on advice from the EPA.

The Project requires assessment and approval under Part IV of the EP Act. On 11th of May, 2009, CRL referred the Project to the EPA. The EPA set the level of assessment for the Project as Public Environmental Review (**PER**). A PER level of assessment is typically applied to proposals of local or regional significance that raise a number of significant environmental factors, some of which are considered complex and require detailed assessment. The EPA requires a formal public review and compliance with the EP Act to ensure that such proposals are implemented and managed in an environmentally acceptable manner. The PER document has been prepared in accordance with the EPA guidelines for the preparation of a PER (EPA, 2007).

1.1 PROJECT DESCRIPTION

CRL has reported a resource of 3010 Mt consisting of 110 Mt of Direct Shipping Ore (**DSO**) material and 2900 Mt of lower grade Beneficiation Feed Ore (**BFO**) which will be upgraded to produce a high grade concentrate. CRL's Jack Hills mining and exploration lease has a number of potential ore bodies characterized by high iron content direct shipping ores, which have low phosphorous, aluminium/silica and sulphur, and lower grade banded iron ores which appear to be upgradeable to a high quality iron concentrate. Both the DSO and concentrate are sought after commodities in the steel manufacturing industry.

The Project is planned to commence operation as a three-module concentrator to produce 30.0 Mtpa of concentrate, with a DSO hematite plant producing lump and fines products, for export through the Oakajee Port. Each product will be provided with stockpiling capacity of a minimum eight days production ahead of the train loadout. Each product will have three piles defined, allowing piles to be built and reclaimed to a blended quality, providing space for product to be stacked and stored for train loading at all times. The smallest of the piles will be 27,000 tonnes, equal to the maximum train size envisaged.

Production will ramp up from plant commissioning over the first 12 months, with production from both the DSO and concentrator plants. Additional concentrator module(s) will then be installed and commissioned as the market permits. Additional resource characterisation and infrastructure development in the coming months will provide a greater degree of certainty. Table 1.1 provides a summary of the key characteristics of the Project.

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TABLE 1.1 KEY PROJECT CHARACTERISTICS

Project Component	Description
Life of Project (mine production)	35 years
Area of disturbance (total)	Approximately 7,719 ha, including: • 933 ha: mine pit expansion; • 1,785 ha: integrated waste landform; • 3,301 ha: infrastructure (including buffers, processing plant, drainage, topsoil storage, construction camps, airport, borefield infrastructure, roads and turn-around areas); • 600 ha: services corridor; and • 1100 ha: gas pipeline corridor.
Staging of development	*Phase 1 (first 3 years of mine life)* • Construction and commissioning of facilities for two concentrate modules and a DSO hematite plant. *Phase 2 (minimum 30 years of mine life)* • Construction of facilities to support additional concentrate modules. *Phase 3 (last 5 years of mine life)* • Final decommissioning and closure activities.
Maximum mining rate	150 Mt of feed ore per annum 150 Mt of waste per annum
Major components:	
Pit (x2)	*Footprint:* Two pits with total surface area of 813 ha and 120 ha, excluding buffers *Depth:* Nominally 260 m (160 mAHD)
Integrated Waste Landform (co-disposal of waste and tailings)	Disposal of 3.6 billion tonnes of waste rock and tailings. *Footprint:* 1,785 ha involving four individual waste cells. *Maximum Height:* 600m AHD (230 m above natural surface level). *Total waste volume:* Approximately 1,850 Mm^3 of waste, comprising approximately 775 Mm^3 of tailings and 1075 Mm^3 of waste rock.
Processing Plant	Producing 45 Mtpa DSO lump and fines products and iron concentrates from BFO feed ore.
Power Plant	Natural gas fired power station with 350 MW generating capacity. Diesel back-up.

Accommodation Village	Up to 2,500 occupants during the construction stage and approx.1,200 permanent employees during the operational phase.
Services Corridor	From Jack Hills to Weld Range for possible road, water, gas and power transmission facilities (approx. 120 km long).
Natural Gas Pipeline	Buried pipeline from Jack Hills to the Dampier to Bunbury Natural Gas Pipeline (approx. 220 km long). This corridor will also incorporate a water pipeline.
Roads	Site access for general and heavy traffic, road to accommodation village, airport, mine roads and access roads for infrastructure maintenance.
Additional infrastructure	Production water bore field(s) yielding approximately 37 million Kl (37 Gl) of water per annum during the operational phase; New airstrip (approx. 150 ha) and associated facilities to service Code 3C aircraft; Sewage treatment (package treatment plants) and waste disposal facilities, workshops, stockpile areas, fuel storage area, laydown areas, administration area and explosives magazine.

1.2 PROJECT JUSTIFICATION

Western Australia's economy is heavily dependent on mineral resource projects, and its future growth and development rely on the continued viability of resource development projects. The Project will provide environmental, social and economic benefits for the area through employment, infrastructure and flow-on effects to the non-mining sector. Environmental benefits will include:

- participation in the Department of Environment and Conservation (**DEC**) and Geraldton Iron Ore Alliance partnership to value-add to regional environmental management initiatives;
- on-going local management of feral fauna and weeds; and
- increased knowledge of local environmental values through on-going surveys and research initiatives.

The Project will result in further substantial regional and State economic and social benefits, including:

- investment of capital into Western Australia's regional and state economies;
- major port and rail infrastructure construction in the mid-west region;
- positive contribution to Indigenous training and business opportunities in the mid-west region;
- increasing demands for goods and services creating business and employment opportunities;
- additional Commonwealth and State Government revenues through collection of additional royalties, taxation and other charges; and
- increased export value of Western Australian iron ore to international customers.

From an economic standpoint the Project will provide both direct and indirect employment opportunities in the mid-west region, as well as substantial investment in infrastructure.

1.3 ENVIRONMENTAL CONTEXT

CRL appreciates that as with any proposal, it is important for the Project to be considered within the broader local, regional and State environmental context. In 2007, the Western Australian Government released the "Strategic Review of the Conservation and Resources Values of the Banded Iron Formation of the Yilgarn Craton". This strategic review was undertaken to provide the government information on the banded iron formation (BIF) ranges to allow for a strategic approach to resource utilisation and biodiversity conservation decision making process. The strategic review recognised the need for a balance to the economic, social and regional benefits against the high conservation values of the region.

The Review indicates a predisposition towards allowing development over the Jack Hills area 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.

The Review indicates that, based on the current floristic information at the time of the Review, the Jack Hills and Weld Range have fewer environmental obstacles and should be able to proceed to development with minimal constraints. The EPA has expressed hope for the State to set aside a representative conservation area in the Jack Hills Range.

1.4 ENVIRONMENTAL IMPACT ASSESSMENT

Section 4A of the *Environmental Protection Act 1986* establishes five principles of environmental protection, which have been expanded upon in EPA Position Statement No. 7 (EPA, 2004). CRL have addressed the five Principles of environmental protection in Section 7 of the PER.

The Jack Hills are located within the Murchison Region (Western Murchison sub-region), as defined in the Interim Biogeographical Regionalisation for Australia (IBRA). The region is dominated by mulga (*Acacia aneura*) woodlands, and extensive flats and plains provide optimum conditions for the occurrence of these woodlands (Beard, 1976). *Acacia aneura* generally grows in the form of a tree with a single erect trunk and forms low woodlands. On less favourable soils, such as those present on hill slopes and ridges, it takes the form of a shrub producing shrublands/scrublands (Beard, 1976). The most significant vegetation feature of the Jack Hills Range is the spinifex hummock grasslands.

The key environmental factors relevant to the Project are:

- flora and vegetation;
- closure and rehabilitation;
- fauna;
- surface water and groundwater;
- waste;
- acid and metalliferous drainage;
- hazardous substances;
- air quality (dust);
- greenhouse gas emissions;
- noise and vibration;
- visual amenity; and
- indigenous heritage.

Table 1.2 summarises potential environmental impacts related to the activities of the Project, as well as detailing relevant management measures to eliminate and minimise potential impacts.

It should be noted that the Project has undergone a number of assessments for each of the key environmental factors; many of these studies have been undertaken over several years. As the Project is dynamic in nature and the Project design has been amended as new information has become available, many of the studies refer to Project description information that has since been superseded. In particular, this is relevant when referencing extents of impact. However, these studies have been used to inform the PER, particularly the existing environment. As such, information within the main body of the PER should be referred to for current information on the Project description and the extent of impacts.

1.5 MANAGEMENT AND OFFSETS

CRL commits to implement and operate the Project in accordance with the following environmental commitments:

- CRL operates the current Jack Hills mine under an Environmental Management System (**EMS**) based on the ISO 14001 standard. The EMS will continue to be implemented for the Project. CRL will continually improve the EMS to ensure it is relevant to the specific stage of the Project.
- CRL has developed the following overarching Environmental Management Plan's (**EMP**; Appendix A) for the Project:
  - » Construction EMP;
  - » Operations EMP;
  - » Acid and Metalliferous Drainage Management Strategy; and
  - » Decommissioning and Closure Management Plan.
- CRL will continue, and also promote others, to undertake further studies to expand biodiversity knowledge of the Mid-West Banded Ironstone Formations and in particular the Jack Hills ranges.

CRL concludes that the critical unavoidable impacts necessitating the development of an offset are:

- The upland *Triodia* community, a component of the Priority 1 Ecological Community "Jack Hills Vegetation Complexes", specifically will be directly impacted (approximately 76% local impact and less than 12% regional impact) by the Project. All species within this community are well represented in other community types. However, the specific composition of species that defines the community will be impacted. Similar communities also exist in other ranges in the mid-west region. Additional research is required to determine how similar they are to the Jack Hills upland spinifex community.
- Twelve Priority flora species have been found in the Jack Hills Project area. The species that will be most impacted by the project is *Prostanthera petrophila*. Loss of 87% of the known mapped local population of *P. petrophila* will occur as a result of the Project. On a regional scale, loss of 67% of the known *P. petrophila* plants will occur as a result of the Project.
- The Short Range Endemic (SRE) *Idiosoma nigrum* population at Jack Hills is the largest most northerly population of this species. While only 18% of this species will be impacted, it is not found extensively in conservation areas and is under threat from mining related activities and feral goats. Large numbers of the species have been found by mining companies in the mid-west region. It is becoming more evident that reducing the conservation status of this species should be considered. CRL is working in collaboration with Sinosteel Midwest Corporation and the DEC to determine if this is the case.

CRL recognises that the Project will have some residual impacts that cannot be avoided, minimised, rectified or reduced by its management measures. CRL's intention in this PER is to present an indication of the types of possible offsets, presented in Section 11. CRL will then actively engage with relevant stakeholders to develop its offsets package. CRL considers that the Project's residual environmental impacts can be best addressed through a focus on a range of contributing offsets targeted to the particular environmental factors impacted by the Project. The residual impacts largely relate to biodiversity matters affected by incomplete species knowledge, which therefore show apparently limited distribution. These matters would most effectively be addressed through programs focused on improving knowledge. CLR is exploring opportunities to provide support for these programs through a structure involving relevant stakeholders to achieve the most targeted outcomes.

1.6 CONCLUSION

The proposed Project, described in Section 5, will have a net benefit to the surrounding environment at a local and regional scale. This document has identified the significant environmental factors, potential impacts and management actions. Direct impacts to the environment have been described and will be offset through the development of an offsets package.

CRL will comply with the identified relevant legislation, guidelines and standards in Section 3. CRL has demonstrated compliance with Ministerial Statement No 727 conditions as well as other environmental licence conditions, laws and regulations for the three year period of current mining operations at Jack Hills (Section 4).

CRL has conducted feasibility studies for the Project in a sustainable manner, with considerations of economic, social, and environmental issues. This is summarised in Section 6. CRL have addressed the EPA's six principles of sustainability in the development and implementation of the Project in Section 7.

CRL has commissioned extensive surveys to understand the existing environment over a four year period (Section 8), conducted an environmental impact assessment and identified key environmental factors that require measuring, monitoring and management (Section 9).

CRL's comprehensive EMS is of international standard and will continue to be implemented and continually improved throughout the life of the Project. The EMS and associated Management Plans provide the actions required to prevent and mitigate potential impacts to the health, welfare and amenity of the surrounding environment, as detailed in Section 10.

The development of an offsets package will ensure that implementation of the Project will have a net benefit on the environment to the satisfaction of the relevant stakeholders. The offsets strategy and indicative offsets are detailed in Section 11.

A social impact assessment has been described in Section 12, which identifies potential negative and positive social and economic impacts to the community and associated management commitments.

CRL has an on-going stakeholder consultation program, as detailed in Section 13. CRL intends to continue to work closely with the Environmental Protection Authority, Department of Water, Department of Environment and Conservation, Department of Mines and Petroleum, Department of Indigenous Affairs and Department of Heritage to ensure a high level of environmental management and determine an appropriate offsets package and thus achieve a net benefit to the environment as a result of the Project.

TABLE 1.2 SUMMARY OF ENVIRONMENTAL FACTORS, POTENTIAL IMPACTS, MANAGEMENT AND PREDICTED OUTCOMES.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Flora and Vegetation	To maintain the abundance, diversity, geographic distribution and productivity of flora at the species and ecosystem levels through the avoidance or management of adverse impacts and through improvement in knowledge	Regional vegetation is dominated by mulga woodlands. There are no Environmentally Sensitive Areas (ESAs) within the vicinity of the Project. There is no Threatened Ecological Community (TEC) at the Jack Hills Range. A Priority 1 Priority Ecological Community (PEC), titled 'Jack Hills Vegetation Complexes' and comprising of a spinifex (*Triodia melvillei)* vegetation community, occurs within the Jack Hills Range. No Declared Rare Flora (DRF) is known to occur in the Project area. Twelve Priority flora species have been recorded within the Jack Hills Range. Three weed species have been recorded within the proposed Project area. Four weed species are known to occur along the gas pipeline route, and five along the proposed services corridor, which traverse degraded pastoral lands.	Clearing of 7719 ha of native vegetation will occur as the result of the Project. The majority of this is Degraded pastoral land (approx. 80%). Approximately 273 ha (76%) of a local *Triodia* plant community will be impacted. Similar communities exist regionally. Impact on a regional scale may be as low as 10%. Nine species of Priority flora are located within the Project footprint. Percentage impact of each species is shown as (local, regional): *Acacia* sp Jack Hills (11.5%, 9.95%) *Calytrix verruculosa* (0.55%, 0.23%) *Homalocalyx echinulatus* (82.8%, 82.4%) *Indigofera gilesii* subsp. *gilesii* ms (25%, 2.7%) *Prostanthera ferricola* (62.4%, 22.9%) *Prostanthera petrophila* (87%, 66.6%) *Ptilotus tetrandrus* (100%, 28.6%) *Stenanthemum mediale* (66.2%, 42.5%) *Verticordia jamiesonii* (0.1%, 0.01%)	All activities will be carried out in accordance with CRL Environmental Management Plans. Clearing will be minimised as far as practicable. Disturbed areas will be progressively rehabilitated. Priority flora located along the gas pipeline route and services corridor will be avoided. Dust suppression measures will be implemented. Weeds will be controlled through prevention, monitoring and treatment with the objective of eradication.	All cleared areas will be progressively rehabilitated during the life of mine, or during mine closure. CRL will, as far as reasonably practicable, attempt to re-establish *Triodia* vegetation in areas of rehabilitation.
Vertebrate Fauna	To maintain the abundance, diversity, geographic distribution and productivity of native fauna at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Fifteen native mammal species, 82 bird species and 23 reptile species have been recorded within the Project mine area. The Priority 3 listed Long-tailed Dunnart (*Sminthopsis longicaudata*) and EPBC Migratory listed Rainbow Bee-eater (*Merops ornatus*), have been recorded within the Project mine area. No conservation significant fauna species have been recorded along the proposed gas pipeline route or services corridor. Seven introduced / domestic species have been recorded within the Project area.	Approximately 7719 ha of potential fauna habitat will be progressively cleared. This has the potential to cause fragmentation of fauna habitat. Most of the area to be cleared is degraded. It is likely that there will be local disturbance to fauna and potential loss of individual animals. There will be no significant impact to fauna populations. Other potential impacts include loss of habitat due to fire or weed spread, vehicle strike, predation or competition with feral species and disruption due to increased light, noise or dust.	All activities will be carried out in accordance with CRL Environmental Management Plans. The Project will be designed to minimise clearing of vegetation and fauna habitat. Clearing will be carried out progressively to minimise habitat loss and reduce impacts on fauna. Progressive rehabilitation will be carried out to re-establish fauna habitats. All open trenches will have an egress point and will be checked regularly for trapped fauna.	No significant impacts to conservation significant species at a local or regional scale will occur.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Invertebrate Fauna	To maintain the abundance, diversity, geographic distribution and productivity of native fauna at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	***Short Range Endemic (SRE) Fauna*** Three SRE species have been recorded within the Jack Hills Range. Two of these occur within the Project mine area, including: • *Idiosoma nigrum* (Schedule 1); • *Cethegus* sp. ***Subterranean Fauna*** A single species of Chiltoniid amphipod has been recorded within the Murchison Palaeochannel / Calcrete aquifer. No other stygofauna has been recorded. Several troglomorphic taxa have been recorded within the Jack Hills Range. Within the Project area, species from the following groups have been recorded: • Silverfish species (Zygentoma); • a sucking bug species (Hemiptera); • Pseudoscorpionida; • Isopoda; • Hemiptera: Cixiidae; • Coleoptera: Carabidae; and • Coleoptera: Lathridiidae(?).	***SRE Fauna*** The proposed development footprint for the Project will directly impact on 3899 (18%) of a total 21,000 *I. nigrum* burrows recorded in the Jack Hills region. This species will also be impacted by other mining developments in the region. The cumulative regional impact, of all mining developments in the mid-west region, on the current known number *of I. nigrum* individuals will be approximately 15%. *Cethegus* sp. is widespread and abundant across the Jack Hills Range and will not be impacted significantly by the Project. ***Subterranean Fauna*** There will be localised impact to stygofauna habitat in the area of the water drawdown cone associated with pit dewatering and abstraction of water from the aquifers. There will be direct impact to troglomorphic taxa within the pit areas. However, their habitat is widespread across the Jack Hills Ranges.	***SRE Fauna*** All activities will be carried out in accordance with CRL Environmental Management Plans. Clearing will be minimised as far as practicable. The *I. nigrum* population in the vicinity of Project will be monitored. Regional surveys, in collaboration with the DEC, are underway and an application to reduce the conservation status of this species will be submitted if it is found in conservation estate. ***Subterranean Fauna*** Target aquifers will be selected with consideration of stygofauna and troglofauna. Operation of groundwater production bores and dewatering to be conducted in accordance with the groundwater operating strategy and licence conditions. Hydrocarbon and chemical management procedures will be implemented to minimise potential impacts to groundwater quality.	***SRE Fauna*** Approximately 18% of the known local population of *I. nigrum* will be impacted. No significant impacts on the population of *I. nigrum* at Jack Hills, or on the species as a whole are expected. Research and regional survey work currently underway will value add to the knowledge of this species distribution, taxonomy and potential impacts from mining activities. ***Subterranean Fauna*** Localised impacts to troglofauna and stygofauna will occur. Additional surveys of stygofauna will be conducted within the Murchison palaeochannel.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Surface Water	To maintain the quantity of water (surface and ground) so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that the quality of water emissions does not adversely affect environmental values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards	The mine site is located less than 3 km from the Murchison River. Drainage lines and watercourses in the region are ephemeral, with flows generally associated with major rainfall events. The proposed gas pipeline route crosses the Murchison River approximately 1.5 km from Kalamunda Pool.	Construction of the mine and associated infrastructure has the potential to result in flooding, contamination from Acid Mine Drainage or fuels/chemicals, shadow-effects, erosion and deposition of sediments and increased turbidity of run-off.	Surface water will be considered for the design and engineering of all infrastructure. Surface water management structures will be designed to minimise erosion and maintain drainage flows and reduce scour. Environmental culverts will be installed in areas sensitive to sheet flow. Overflows from the Integrated Waste Landform as a result of extreme weather events will be collected in bunded drains at the toe of the stockpile for detention and controlled release. The gas pipeline will be installed via directional drilling to minimise potential impacts to the Murchison River.	The Project is not expected to significantly impact surface water quality or flows.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Groundwater	To maintain the quantity of water (surface and ground) so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that the quality of water emissions does not adversely affect environmental values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards.	The greenstone belt and underlying basement granites form localised fracture-rock aquifers within the Jack Hills Ranges. A sedimentary aquifer system is formed within the palaeochannel / modern drainage system of the Murchison River. This is the closest proposed borefield to the mine area. The Carnarvon Basin contains large resources of fresh to saline groundwater. The proposed borefield area overlies part of the Byro Sub-basin in the east of the Carnarvon Basin that consists of a Permian and Carboniferous sedimentary sequence possibly up to 3000m thick. Groundwater recharge in the region is largely via rainfall river flows.	Pit dewatering may impact on groundwater levels up to 8.8 km from the mine pit within the fractured greenstone belt units, and between 0.8 km and 2.8 km within the granitic basement. Long term, large-scale abstraction from borefields tapping the calcrete and deeper-seated 'palaeochannel' alluvial aquifer systems is likely to impact other existing users (e.g. domestic or stock bores) and groundwater dependent ecosystems (GDEs). Long term, large-scale abstraction from borefields tapping the Carnarvon Basin aquifer may also impact existing users (e.g. domestic or stock bores) and GDEs. There are no other licensed groundwater users within the expected drawdown zones of either proposed borefield. There is demonstrated low risk of acid and metalliferous drainage associated with Integrated Waste Landform. However, there is potential for AMD to impact on groundwater quality.	CRL will revise and implement the Groundwater Operating Strategy. Groundwater dependent vegetation within the borefield area will be monitored. Baseline data will be collected prior to water abstraction. Minimal amounts of the Project's overall water requirements will be obtained from the Murchison palaeochannel aquifer system. The amount of water abstraction that can be taken from this area without impacting existing users and GDEs will be determined. The larger component of the Project's overall water requirements will be obtained from the Canarvon Basin aquifer system. A water requirement of 37G/L over a 30 year period is estimated to impact on 0.4-0.9% of the Byro Sub-Basin aquifer water storage. It is likely that the borefield will have minimal impact on the GDEs in the area due to the depth and size of the aquifer. The borefield will, however, be designed to ensure potential impacts to GDEs are acceptable. Hydrocarbons and chemicals will be managed to prevent contamination and any spills will be cleaned up and remediated. A monitoring program to identify the potential for AMD will be implemented as a conservative measure to further reduce the likelihood of an AMD incident occurring.	Water abstraction volumes and rates taken from the selected aquifers will be determined based on water drawdown, recharge, and potential impacts on GDEs as indicated by numerical groundwater modelling. Measurement and monitoring of the GDEs will be on-going. A contingency plan will be developed to ensure an immediate response to observed impacts. Groundwater quality will not be affected by the Project.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Solid and Liquid Waste	To maintain the integrity, ecological function and values of the environment. To ensure that emissions do not adversely affect the health, welfare and amenity of people and land uses.	Existing sources of waste generated at the site are limited to the existing Jack Hills Stage 1 mine Project.	Wastes generated by the Project are likely to include: • waste rock and tailings; • general domestic and office refuse; • hazardous wastes; • industrial wastes; and • sewage.	The Integrated Waste Landform (IWL) has been designed as four cells constructed of waste rock to encapsulate tailings materials. Consideration of the surrounding landform and closure is reflected in the design. Inert and putrescible waste will be incorporated into a dedicated section of the IWL. Waste minimisation and recycling measures will be implemented. Sewage will be treated in packaged treatment plants to the meet Department of Health and Department of Environment and Conservation requirements. Potential contaminated wastes will be segregated and disposed of in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004*.	Waste generated during the construction and operational phases of the Project will be managed to ensure that it does not cause detrimental impacts on the health, welfare and amenity of people and land uses.
Acid and Metalliferous Drainage	To ensure that land uses and activities that may emit or cause pollution are managed to maintain: physical and biological environment and the natural processes that support life, the health, welfare and amenity of people and land uses. To ensure that pollutants emitted are as reasonably practicable, and comply with all statutory requirements and acceptable standards.	The tailings geochemistry is dominated by iron, manganese and aluminium. Soluble concentrations of sodium, magnesium, calcium and potassium are relatively low and indicate a limited source of salinity from the tailings solids. The total sulfur concentration is very low at 0.04%. Of the trace elements, barium, copper, nickel, strontium, zinc, thorium and mercury were detected. All of these elements were below average concentrations for basalts and shales. The mineralogy of the tailings indicates that it is composed of silicates, carbonates and oxides. No sulphide minerals were detected. The mineralogy is dominated by magnesium phases, e.g. magnesite, talc and dolomite.	Based on the acid mine drainage study and metallurgical testwork program completed for the Project, the risk of acid or metalliferous drainage are considered low.	Areas classified as ‘Potentially Acid Forming – Low Capacity’ and even less ‘Potentially Acid Forming’ materials will be managed by blending with surrounding high carbonate waste ores. Testing for ‘Potentially Acid Forming’ and metalliferous minerals will occur as a component of the monitoring program. Ongoing monitoring of water quality and sediment in silt traps at the base of the IWL and implementation of further monitoring, and contingency actions if acid leachate is identified.	Waste rock is not expected to generate acid and leachates will contain negligible concentrations of contaminants.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Dangerous and Hazardous Substances	To ensure that land uses and activities that may emit or cause pollution are managed to maintain: physical and biological environment and the natural processes that support life, the health, welfare and amenity of people and land uses. To ensure that pollutants emitted are as reasonably practicable, and comply with all statutory requirements and acceptable standards.	Some dangerous and hazardous substances, namely hydrocarbons and explosives, are currently used at the site for the Stage 1 mining operations.	Possible impacts associated with chemical or hydrocarbon release range from pollution of soil, surface water or groundwater to explosions.	Specific management measures for the storage, transport, handling and disposal of dangerous and hazardous substances are outlined in the Project CEMP and OEMP (Appendix A).	Wastes will be measured and managed to prevent impacts to the surrounding environment. Dangerous and hazardous substances will be managed to prevent their release into the environment. All spills will be cleaned up and remediated as required.
Air Quality (dust)	To ensure that air emissions to air do not adversely affect environmental values or the health, welfare and amenity of people and land users by meeting statutory requirements and acceptable standards.	Existing dust deposition levels are highest downwind of the Stage 1 pit and waste dump. Existing dust levels across the site are much higher than the DEC's recommended guideline of 4g/m^2/month. With the exception of the accommodation village, there are no nearby human communities or sensitive receptors.	Fugitive dust emissions are likely to be generated during construction, mining, ore processing and ore transporting activities. Low levels of fibrous minerals have been identified within the mining envelope. Excessive dust may potentially affect human health, surrounding vegetation and amenity.	Dust and fibre management measures and monitoring requirements are documented in the CEMP and OEMP (Appendix A). The current dust monitoring program will be expanded, reflecting the size of the Project, to monitor vegetation communities in the immediate vicinity of the Project activities. Vegetation health monitoring will be conducted on a six monthly basis for the first five years of mine operations and then on an annual basis thereafter. An ongoing occupational exposure monitoring programme has been implemented to determine dust and fibre exposures and verify effectiveness of controls.	Dust will be measured and managed to protect personnel and the surrounding environment. Dust suppression measures will be implemented to minimise the potential for dust generation. CRL will continue to monitor the impacts of dust deposition on vegetation and implement additional dust suppression measures as required.
Greenhouse Gas Emissions	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.	Greenhouse gases are generated as a result of existing Stage 1 mining operations and surrounding land uses.	The main greenhouse gas emission contributors associated with the Project will be associated with land clearing, vehicles, machinery, power generation and the landfill facility. Total annual emissions for the Project are estimated to be approximately 1,738,586 tonnes of CO_2-e.	A greenhouse gas reduction strategy has been developed to identify possible opportunities to reduce greenhouse gas emissions associated with the Project. Pollutants and greenhouse gas emissions will be measured and monitored, and reported. Targets to reduce emissions will be developed. Cleared areas will be progressively rehabilitated.	Greenhouse gas emissions will be measured and managed to minimise pollutants released into the atmosphere. An assessment of opportunities to minimise greenhouse gas emissions will be undertaken in the first instance during the detailed design phase to identify feasible, sustainable and practical measures to reduce emissions.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Noise and Vibration	To protect the amenity of the community from noise and vibration impacts associated with development or land use by ensuring that statutory requirements and acceptable standards are met.	With the exception of the mine accommodation village, the nearest noise sensitive receiver is approximately 35 km from the mine.	Potential impacts on *Idiosoma nigrum* associated with vibrations from mining activities.	A 25 m exclusion buffer will be maintained around all *I. nigrum* burrows which will not be directly impacted by the Project. Monitoring of effects of vibration on *I. nigrum* over a three year period. Noise mitigation measures will be implemented 1) to ensure compliance with the *Environmental Protection (Noise) Regulations 1997*; and 2) if sensitive receptors are identified.	Noise levels will be managed to ensure compliance with assigned noise levels at all noise sensitive premises. Noise was considered when choosing a location for the accommodation village. Research indicates that there are no immediate or short term effects from vibrations on the survival of *I. nigrum.*
Visual Amenity	To ensure that visual amenity is considered and measures are adopted to reduce adverse visual impacts on the surrounding environment are as low as reasonably practicable.	The proposed Jack Hills Project involves a deposit in the form of a ridge, which in term forms part of a larger ridge system called Jack Hills. The Jack Hills ridges are a linear ridge system running approximately west to east/north east, and also running parallel to the Murchison River drainage system. The dominant and widespread land use within this regional landscape is the pastoral industry. CRL operates the existing Stage 1 mine within the Jack Hills range.	Local change to the landscape is inevitable in the form of partial removal of a ridge and creation of permanent change in the local topography and terrain (notwithstanding mine closure and decommissioning intentions and plans).	Final landform profiles will be designed to conform to the surrounding environment. Cleared areas will be progressively rehabilitated.	The assessment concluded that the Project will not be highly 'visible' – that is, there is in reality and practice, a low likelihood that the mine operations and the visual elements involved will be observable by anyone other than the mine employees themselves, and very low numbers of local pastoralists and other miscellaneous travellers passing close to the mine workings.
Rehabilitation and Mine Closure	To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.	Rugged ranges and ridges supporting *Acacia* shrublands and *Triodia* upland vegetation. Undulating stony plains supporting sparse Mulga vegetation systems.	Clearing will result in the alteration of landforms and ecosystems within the Project footprint. The Project has the potential to result in ongoing impacts to the existing environment if the following factors are not adequately addressed: • water management; • tailings management; • landform design; • revegetation success; and • erosion prevention.	Implementation of the Decommissioning and Closure Plan, CEMP and OEMP during all phases of the Project. Progressive rehabilitation of all areas not required for ongoing operations. Assessment against established completion criteria and KPIs to determine revegetation and rehabilitation meets acceptable standards.	All areas, with the exception of the pit, will be rehabilitated and revegetated to meet completion criteria and satisfy the relevant authorities.

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Indigenous Heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	There are two registered Aboriginal heritage sites within the proposed mine footprint. A number of registered sites potentially occur along the proposed gas pipeline corridor and services corridor.	Two registered sites will be impacted by the mine footprint. There is potential for a previously unrecorded site to be disturbed during construction or mining activities.	Heritage sites will be avoided where possible. The pipeline corridor has been designed to avoid interference with all registered sites. CRL will consult with the relevant Native Title holders. In the event that the parties are unable to reach agreement, CRL will obtain approval under Section 18 of the *Aboriginal Heritage Act 1972* prior to disturbance of known heritage sites. Heritage surveys will cover the entire footprint as per the Mining Agreement. CRL will comply with the heritage management commitments contained within the CEMP and OEMP at all times.	CRL will comply with the *Aboriginal Heritage Act 1972* at all times. CRL and the Native Title Parties will manage heritage issues in a consultative manner with mutually acceptable outcomes.

2. INTRODUCTION

2.1 PROJECT OVERVIEW

Crosslands Resources Limited (**CRL**) currently operate the Jack Hills mining operation (**Stage 1**), located approximately 400 km north-east of Geraldton and 120 km north-west of Meekatharra, in the mid-west region of Western Australia. The Stage 1 open cut mine is currently producing hematite at a rate of 1.8 million tonne per annum (**Mtpa**), which is exported via Geraldton Port.

CRL propose to expand and develop the "Jack Hills Expansion Project" (**the Project**), which will consist of open cut mining and associated mine infrastructure being located on the nearby plains of pastoral leases of Mt Hale and Beringarra. The Project will mine and process hematite and magnetite at a rate of up to 35 Mtpa, which will be transported via train to Oakajee for export.

2.2 MIDWEST STRATEGIC REVIEW

In 2007, the Western Australian Government released the "Strategic Review of the Conservation and Resources Values of the Banded Iron Formation of the Yilgarn Craton". This strategic review was undertaken to provide the government information on the banded iron formation (**BIF**) ranges to allow for a strategic approach to resource utilisation and biodiversity conservation decision making process. The strategic review recognised the need for a balance to the economic, social and regional benefits against the high conservation values of the region.

The major findings of the review which are relevant to this Project are:

"*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 light of current knowledge of biodiversity values (these ranges are quite extensive) and that an adequate level of conservation values can also be achieved taking in account the key principles"* (pg8).

"*The government indicates its predisposition towards development over areas of Jack Hills and Weld Range … Further, the Government will draw to the EPA's attention the Government's predisposition, as set out above, that exploration 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 practice environmental management and mitigation programmes are committed to by developers*" (pg 9).

2.3 THE PROPONENT

CRL is an emerging iron ore producer with a strong, experienced and hands-on management team dedicated to transforming the company into a significant supplier of iron ore.

Key Contacts

Crosslands Resources Ltd
Level 2, 18 Richardson Street
P.O. Box 1454
WEST PERTH WA 6872
Tel: 08 9483 0500
ABN: 38 078 257 799
www.crosslands.com.au

The key contact for the proponent is:
Lara Jefferson
Manager, Environment and Approvals
email: **ljefferson@crosslands.com.au**

2.4 PURPOSE OF THIS DOCUMENT

On 11 May 2009, CRL referred the Project to the Environmental Protection Authority (**EPA**). The EPA set the level of assessment for the Project as Public Environmental Review (**PER**).

A PER level of assessment is typically applied to proposals of local or regional significance that raise a number of significant environmental factors, some of which are considered complex and require detailed assessment. The EPA requires a formal public review and compliance with the *Environmental Protection Act* 1986 (**EP Act**) to ensure that such proposals are implemented and managed in an environmentally acceptable manner.

This document has been prepared in accordance with the EPA guidelines for the preparation of a PER (EPA, 2007). The objectives of the PER, as stated in the guidelines are to:

- place the proposal in the context of the local and regional environment;
- describe all components of the proposal for which approval is sought;
- provide the basis of the proponent's environmental management program, which shows that the environmental impacts resulting from the proposal, including cumulative impacts, are minimised and can be acceptably managed;
- communicate clearly with stakeholders (including the public, native title parties and government agencies), so that the EPA can obtain informed comment to assist in providing advice to government; and
- clearly demonstrate to the EPA and the Minister for the Environment that the project can be managed in an environmentally acceptable manner.

The structure of the PER document, to achieve the above listed objectives, is as follows:

- legislative and policy framework applicable to the project: Section 3;
- current Jack Hills mining operations: Section 4;
- description of the proposed Project: Section 5;
- project justification and alternatives considered: Section 6;
- five Principles of environmental protection: Section 7;
- description of existing environment: Section 8;
- assessment of environmental factors that have the potential to be impacted by the Project: Section 9;
- environmental management commitments: Section 10;
- offsets: Section 11;
- social impact and management commitments: Section 12; and
- stakeholder consultation: Section 13.

Exclusions

This PER does not include requirements for: the existing Stage 1 Jack Hills project which was subject to approval as per Ministerial Statement Number 727 in 2006; drilling activities to characterise the resource within the pit area and adjoining areas that will be the subject of Program of Work applications; and a rail loop to the mine, which will be part of a separate referral by Oakajee Port and Rail (**OP+R**).

3. LEGISLATIVE APPROVALS AND POLICY FRAMEWORK

3.1 STATE GOVERNMENT LEGISLATION

3.1.1 ENVIRONMENTAL PROTECTION ACT 1986

In Western Australia the EP Act is the primary piece of legislation that governs environmental impact assessment and protection. Projects with the potential to significantly impact on the environment are assessed under Part IV of the EP Act. While those projects which are prescribed premises, as listed under Schedule 1, are assessed under Part V of the EP Act. The Project requires assessment and approval under both Part IV and Part V of the EP Act.

Part IV of the EP Act

Assessment of the Project by the EPA under Part IV of the EP Act requires the proponent to prepare an Environmental Scoping Document (**ESD**) which is to be approved by the EPA. The CRL ESD described the proposed scope of works required to provide adequate information for the PER document. The ESD was approved by the EPA on the 21st of October, 2009.

The PER is subject to a review by stakeholders and the general public for a period of six weeks. At the end of this review period, issues raised in written submissions from the public and government agencies are collated and transmitted to the proponent by the EPA Services Unit. An opportunity then exists for the proponent to provide a response to the issues raised in written submissions, which is then submitted for the EPA's consideration. The EPA then finalises its assessment report (EPA Bulletin) and its recommendation for consideration by the Minister for the Environment.

Once the EPA bulletin is released by the Minister for the Environment, the public or any person has the right to appeal against the contents of that report. The Appeals Convenor collates any appeals, consults where required and provides advice to the Minister for the Environment.

The Minister for the Environment is required to consult with relevant Decision Making Authorities (**DMAs**) before making a final determination on whether the Project should be implemented and the conditions under which implementation may proceed.

Part V of the EP Act

Premises listed as prescribed under Schedule 1 of the Environmental Protection Regulations 1987 require a Works Approval from the Department of Environment and Conservation (**DEC**) for construction and operation. The prescribed premises for the Project will be dependent upon the final detailed design, however, they will potentially include:

- ore processing facilities;
- sewage treatment facility;
- landfill facility;
- power generation facility;
- bulk chemical storage; and
- mine dewatering.

The DEC cannot issue a Works Approval until the EPA has completed its assessment of the Project under Part IV of the EP Act and the Minister for the Environment has made a decision that the project is environmentally acceptable.

Table 3.1 outlines the relevant State legislation which must be complied with throughout the Project.

TABLE 3.1 STATE LEGISLATION RELEVANT TO THE PROJECT

Legislation	Responsible Government Agency	Aspect
Aboriginal Heritage Act 1972	Department of Indigenous Affairs	Archaeological and ethnographic heritage
Agricultural and Related Resources Protection Act 1976	Department of Agriculture, Western Australia	Weeds and feral pest animals e.g. goat
Bush Fires Act 1954	Bush Fires Board	Wild fire control
Conservation and Land Management Act 1984	Department of Environment and Conservation	Flora and fauna / habitat / weeds / pests / diseases
Contaminated Sites Act 2003	Department of Environment and Conservation	Management of pollution
Country Areas Water Supply Act 1947.	Department of Water	Water resources supply
Dangerous Goods Safety Act 2004	Department of Consumer and Employment Protection	Dangerous goods management
Environmental Protection Act 1986 (Part IV)	Department of Environment and Conservation	Environmental impact assessment and management
Environmental Protection Act 1986 (Part V)	Department of Environment and Conservation	Licensing, Prescribed Premises
Health Act 1911	Department of Health	Human health management / sewage treatment/ vectors
Heritage of Western Australia Act 1990	Heritage Council of Western Australia	European heritage management
Litter Act 1979	Keep Australia Beautiful Council (WA)	Prevention of litter
Local Government Act 1995	Shire of Meekatharra	Development approvals and management
Local Government (Miscellaneous Provisions) Act 1960	Shire of Meekatharra	Community issues / resources / facilities
Mining Act 1978	Department of Industry and Resources	Land access and management
Mines Safety and Inspection Act 1994	Department of Consumer and Employment Protection	Personnel safety on mine sites
Occupational Health, Safety and Welfare Act 1984	Department of Commerce	Promote and improve standards for occupational safety and health
Rights in Water and Irrigation Act 1914	Department of Water	Access to and use of water resources
Soil and Land Conservation Act 1945	Department of Agriculture	Protection of soil resources
Waterways Conservation Act, 1976	Department of Water	Protection of surface and groundwater
Wildlife Conservation Act 1950	Department of Environment and Conservation	Protection of indigenous wildlife

3.2 COMMONWEALTH LEGISLATION

3.2.1 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (**EPBC Act**) is administered by the Commonwealth Department of Environment, Heritage, Water and the Arts (**DEWHA**).

Under the provisions of the EPBC Act, if a project has the potential to significantly impact on matters of National Environmental Significance (**NES**), the project warrants referral to DEWHA, to determine if the matter is a 'controlled action' requiring assessment. The EPBC Act identifies seven matters of NES.

1. World Heritage;
2. National Heritage properties;
3. Wetlands of international importance (Ramsar wetlands);
4. Threatened species and ecological communities;
5. Migratory species;
6. Commonwealth marine areas; and
7. Nuclear action (including uranium mining).

The assessments undertaken for the development of this PER have not identified any factors which would impact on matters of NES and therefore the Project does not warrant referral to DEWHA for assessment.

3.2.2 OTHER COMMONWEALTH LEGISLATION

Table 3.2 outlines other relevant Commonwealth legislation which must be complied with through approvals during the design, construction and operation of the Project.

TABLE 3.2 COMMONWEALTH LEGISLATION RELEVANT TO THE PROJECT

Legislation	Responsible Government Agency	Aspect
Native Title Act 1993	National Native Title Tribunal	Aboriginal rights
Aboriginal and Torres Strait Islander Heritage Protection Act 1984 and Regulations 1984	Department of Environment, Water, Heritage and the Arts	Preserve and protect places, areas and objects of particular significance to Aboriginal people
National Greenhouse and Energy Reporting Act 2007 and Regulations 2008	Department of Climate Change	Climate change
Energy Efficiency Opportunities Act 2006 and Regulations 2006	Department of Resources, Energy and Tourism	Encourages large energy-using businesses to improve their energy efficiency

3.3 GUIDELINES AND STANDARDS

The key EPA Position Statements and Guidelines that are likely to be of relevance to this project are:

Position Statements

- EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (2000);
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (2002);
- EPA Position Statement No. 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (2004);
- EPA Position Statement No. 6: Towards Sustainability (2004);
- EPA Position Statement No. 7: Principles of Environmental Protection (2004);
- EPA Position Statement No. 8: Environmental Protection in Natural Resource Management (2005); and
- EPA Position Statement No. 9: Environmental Offsets (2006).

Guidance Statements

- EPA Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (2006);
- EPA Draft Guidance Statement No. 8: Draft Environmental Noise (2007);
- EPA Guidance Statement No. 12: Minimising Greenhouse Gas (2002);
- EPA Guidance Statement No. 18: Prevention of Air Quality Impacts from Land Development Sites 2000;
- EPA Guidance Statement No. 19: Environmental Offsets (2008);
- EPA Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (2009);
- EPA Guidance Statement No. 33: Environmental Guidance for Planning and Development (2008);
- EPA Guidance Statement No. 34: Linkages between EPA Assessment and Management Strategies, Policies, Scientific Criteria, Guidelines, Standards and Measures Adopted by National Councils;
- EPA Guidance Statement No. 41: Assessment of Aboriginal Heritage (2004);
- EPA Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (2004);
- EPA Guidance Statement No. 55: Implementing Best Practice in Proposals Submitted to the Environment Impact Assessment Process (2003);
- EPA DRAFT Guidance Statement No.54a: Sampling methods and survey considerations for subterranean fauna in Western Australia (2007);
- EPA Guidance Statement No. 54: Sampling of subterranean fauna in groundwater and caves (2003);
- EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment (2004); and
- EPA Draft Environmental Assessment Guidelines No. 4: Towards Outcome-based Conditions (2009).

Other Guidelines and Standards

Guidelines and Standards published by various State and Commonwealth agencies of relevance to this proposal include:

- WA Government Strategic Review of Banded Iron Formation Ranges in the Mid West and Goldfields (2007);
- DEC Acid Sulphate Soils Guideline Series;
- DEC Contaminated Sites Management Series Guidelines including: Treatment and Management of Disturbed Acid Sulphate Soil; and Dewatering Effluent and Groundwater Monitoring Guidance for Acid Sulphate Soil Areas;
- Draft Code of practice for Rural Landfill management (DEC (formally Department of Environment) 2000);
- Landfill Waste Classification (DEC (formally Department of Environment) 1996);
- Weeds of National Significance: Weed Management Guides – 2003;
- Australian Weeds Strategy 2007;
- Implementation Framework for Western Australia for the Australia and New Zealand Guidelines for Fresh and Marine Water Quality and Water Quality Monitoring and Reporting (Government of Western Australia not dated);
- Environmental Protection in Natural Resource Management;
- Review of Waste Classification and Waste Definitions 1996 (as amended) (DoE 2005);
- Australian Standard AS 2436-1981: Guide to Noise Control on Construction, Maintenance and Demolition Sites 1981;
- Australian Standard AS 1940-1993: The Storage and Handling of Flammable and Combustible Liquids 1993;
- Australian Standard AS 3780-1994: The Storage and Handling of Corrosive Substances 1994; and
- Western Australian Planning Commission Acid Sulphate Soils Planning Bulletin No. 64.

International Agreements

- The Japan-Australia Migratory Bird Agreement (1974) (JAMBA);
- The China-Australia Migratory Bird Agreement (1986) (CAMBA);
- Convention on the Conservation of Migratory Species of Wild Animals (The Bonn Convention) (1979); and
- Republic of Korea Australia Migratory Birds Agreement (RoKAMBA).

International and Australian Standards

- AS/NZS ISO 14001:2004a – Environmental Management Systems – Requirements with Guidance for Use Australian Code for Transport for Dangerous Goods by Road and Rail (6th ed.)(ADG Code);
- Australian Code for the Transport of Dangerous Goods by Road and Rail (7th ed.) (ADG Code);
- Australian Standards AS1940-2004b – Storage and Handling of Flammable and Combustible Liquids;
- Australian Standards AS 2436-1981 – Guide to Noise Control on Construction, Maintenance and Demolition Sites;
- Australian Standards 3580.1.1:2007 – Methods for sampling and analysis of ambient air, part 1.1: Guide to siting air monitoring equipment;
- Australian Standards 3580.9.8:2001: - Methods for sampling and analysis of ambient air, Method 10.1: Determination of particulate matter – Deposited Matter – Gravimetric method; and
- Australian Standard 5667.1:1998 – Water Quality – Sampling Part 1: Guidance on the Design and Sampling Techniques and the Preservation and Handling Samples.

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4. CURRENT JACK HILLS MINING OPERATIONS

CRL currently operates the Jack Hills Iron Ore Mine Project (**Stage 1**), located in the centre of the Jack Hills Range (Figure 4-1). Stage 1 was referred to the EPA in May 2006 and was assessed under Part IV of the *Environmental Protection Act 1986.* Ministerial approval for Stage 1 was granted in September 2006 (Ministerial Statement Number 727).

CRL commenced trucking hematite from its Jack Hills Stage 1 operation to the Port of Geraldton in December 2006, at a rate of 1.5 Mtpa. Production was planned to ramp up to 2.0 Mtpa over a 5-year period. Stage 1 focused on the mining and sale of direct ship ore (**DSO**) only. Stage 1 mining is planned to be complete prior to commencement of the Project with the final date of cessation of mining to be determined on economic, social and operational issues.

The Stage 1 operation includes:

- an open cut pit;
- crushing and screening plant;
- waste dump;
- haul road from the mine to the Beringarra-Cue road;
- diesel power generators;
- accommodation village for up to 190 people;
- water supply from borefield; and
- an airstrip (upgrade of the existing Mileura Station airstrip).

4.1 EPA ASSESSMENT OF STAGE 1

The EPA's assessment of the Jack Hills Stage 1 project (EPA Bulletin 1220) identified three key environmental factors relevant to the project: vegetation and flora, fauna, and closure planning, landforms and rehabilitation.

4.1.1 VEGETATION AND FLORA

- The level of impact from the Stage 1 project on the upland Spinifex community will not pose a significant threat to the continued existence of this community;
- potential indirect impacts to upland Spinifex community, such as dust deposition, runoff from water used for dust control, increased fire frequency or introduction or spread of weeds, need to be monitored and managed; and
- impacts on *Acacia cockertoniana* from the Stage 1 project will not pose a significant risk to the conservation status of the Jack Hills population of this species.

The EPA therefore concluded that the Stage 1 project could be managed to meet the EPA objectives for vegetation and flora with the implementation of the Vegetation Management Plan.

4.1.2 FAUNA

- The EPA is satisfied that two species of reptile, *Delma butleri* and *Cyclodomorphus melanops* are widely distributed and not restricted to the upland Spinifex community;
- Stage 1 is unlikely to have any significant impacts on any species of short range endemic invertebrates or troglofauna which may occur in the area; and
- no significant impacts on stygofauna are expected.

The EPA concluded that impacts on fauna could be managed to meet the EPA objectives, provided that drill holes are capped and no domestic pets are brought to the area.

4.1.3 CLOSURE PLANNING, LANDFORMS AND REHABILITATION

The EPA concluded that the Stage 1 project could be managed to meet the EPA objectives provided that the Decommissioning Closure Plan is implemented, and a final Decommissioning and Closure Plan is prepared at least two years prior to the expected mine closure. The EPA also recommended a condition requiring the installation and maintenance of fencing to prevent access to a rock overhang (shallow cave) in the vicinity of the exploration camp.

4.2 ENVIRONMENTAL MANAGEMENT

4.2.1 ENVIRONMENTAL FACTORS

The key environmental factors currently being managed are:

- significant flora and vegetation (protection);
- dust impact on vegetation;
- groundwater;
- significant fauna (protection); and
- feral animals.

4.2.2 ENVIRONMENTAL MANAGEMENT SYSTEM

CRL has developed an Environmental Management System (**EMS**) to meet the AS/NZS ISO 14001 (2004) Environmental Management Systems standard. This is described in Section 10.

4.2.3 ONGOING ENVIRONMENTAL SURVEYS

CRL as part of the Stage 1 commitments have and continue to undertake botanical and short range endemic (**SRE**) fauna surveys on Jack Hills and surrounding areas.

4.2.4 COMPLIANCE REPORTING

CRL has environmental procedures in place that guide the exploration, planning and design stages of construction, and operations. Government approved management commitments already exist for the Stage 1 project.

CRL undertakes an Annual Environmental Review (**AER**) which considers the compliance reporting requirements of both the Department of Mines and Petroleum (**DMP**) and DEC. CRL commissioned independent reporting of the operation of Stage 1: Annual Environmental Report 2008 (Cardno, March 2009a), which reports:

'CRL has achieved compliance of varying levels to requirements set by industry regulators and associated licences and approvals issued by them. Although there are elements of operations that need to be improved, overall it is illustrated that CRL is proactively addressing these issues and working towards greater levels of compliance and environmental protection around mining activities. As illustrated throughout the compliance report and associated attached reference documents, CRL has shown a willingness to ensure its compliance with its environmental management requirements from both the Ministerial Statement 727, DEC and former DoIR (now DMP) licence requirements. This has included reviews of prepared EMP's, audits of operations and internal checking systems that have been developed by CRL. These management practices and reviews reflect current industry best practice, newly developed techniques and technologies, and CRL commitment to rehabilitating/ revegetating areas of exploration and mining operations.

CRL is continually striving to improve its level of environmental performance as well as concentrating on the needs of stakeholders and traditional owners in the area. CRL has prepared the compliance report as per legislative requirements, but also views this as a management tool to review and improve its environmental operations and encourages input from reviewing regulatory authorities to further improve site operations. CRL *is keen to build on these processes and aims to continually improve compliance ratings for the mine and associated operations.'*

Recently, CRL commissioned independent reporting of the operation of Stage 1: Annual Environmental Report 2009 (Cardno, January 2010), which concludes:

'CRL views this AER as a management tool to review and improve its environmental management, and encourages input from regulatory authorities to further improve environmental management. CRL has been transparent in their reporting of operations and aims to produce high levels of compliance for all elements of work currently carried out at Jack Hills. CRL is confident that the effective implementation of the EMS will maintain and exceed compliance requirements already achieved. CRL are committed to achieving high standards of environmental protection and looking to new ways of operating the Jack Hills site proactively to achieve high regulatory standards for the mid-west region. CRL take pride in this environmental commitment and look forward to future reporting opportunities to illustrate progress made in operations and processes currently being implemented at the Jack Hills mine site.'

The positive comments of the external consultants (Cardno, 2009a, 2010) demonstrate CRL's commitment to protecting the environment in which it operates and continuing to improve environmental management. Specific compliance ratings also demonstrate that the level of environmental performance of the company have continued to improve from the first reporting period (2006). Table 4.1 summarises the 2010 external assessment of CRL's compliance with Ministerial Statement Number 727.

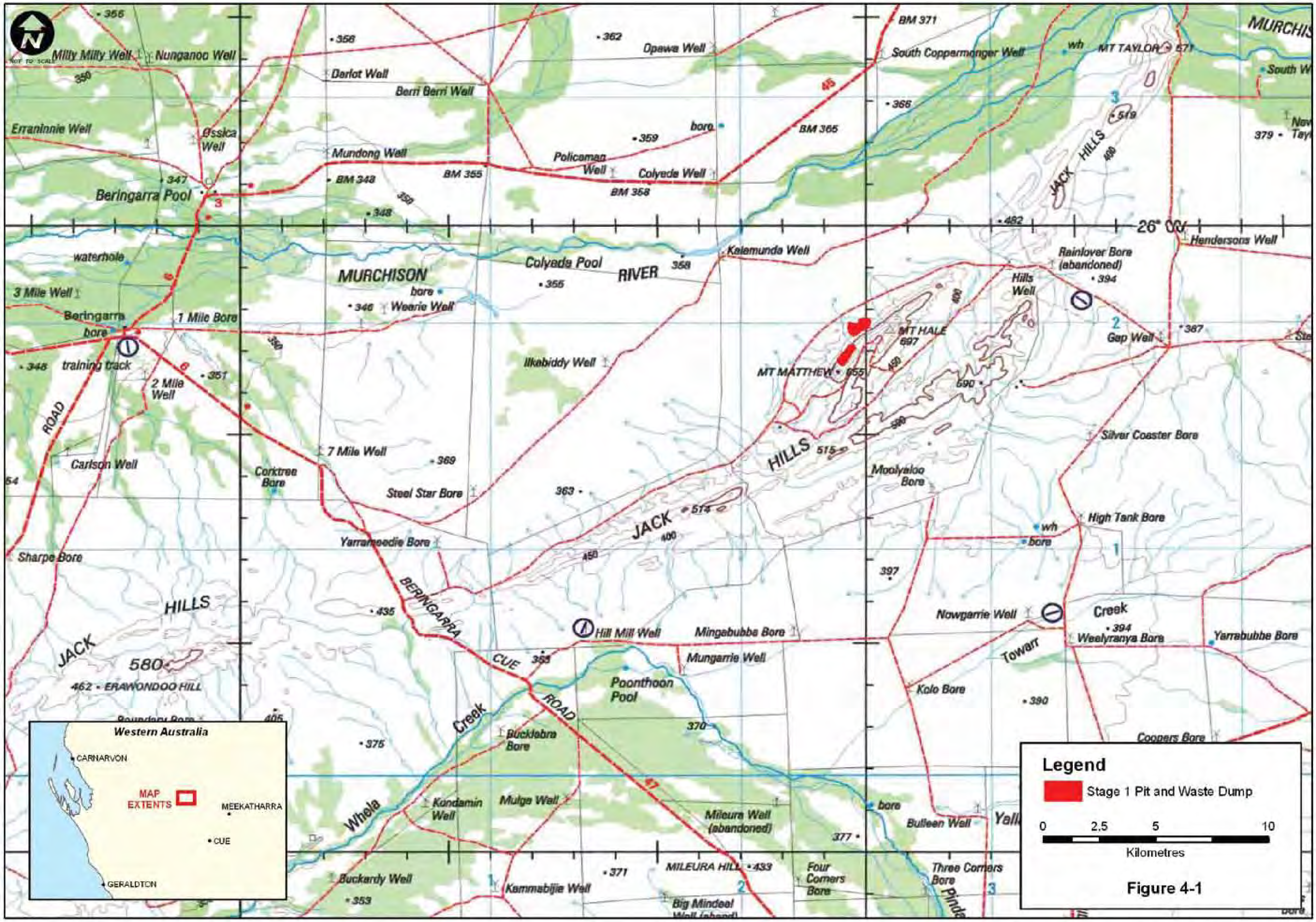
TABLE 4.1 MINISTERIAL STATEMENT NO. 727 COMPLIANCE (AER, JANUARY 2010)

No.	Ministerial Conditions	Compliance Rating		
		Low	Compliant	High
1.1	Proponent (CRL) to implement mining proposal as documented and described in schedule 1, pursuant to conditions, procedures of this statement.		✓	
2.1	CRL nominated by the Minister for the Environment under section 38(6) of the EP Act 1986 is responsible for implementation of proposal.			✓
2.2	CRL is to notify CEO of DEC of any change of name or address for the purposes of delivering correspondence and notices.			✓
3.1	Authorisation to implement proposal provided for in statement shall lapse and be void within 5yrs after the date of this statement if the proposal to which the statement refers is not substantially commenced.			✓
3.2	The proponent shall provide the CEO with written evidence which demonstrates that the proposal has substantially commenced on or before the expiration of the 5yrs from the date of this statement.			✓
4.1	CRL shall submit to the CEO, Compliance Reports in accordance with an audit program developed in consultation with the CEO.		✓	
4.2	Compliance Reports shall be prepared in accordance with compliance monitoring guidelines.		✓	

No.	Ministerial Conditions	Compliance Rating		
		Low	Compliant	High
4.3	CRL will submit an Annual Compliance Report to the CEO by 31 December each year, commencing 2006, outlining compliance with conditions in approval.			✓
4.4	CRL shall make all Compliance Reports publicly upon request.		✓	
5.1	CRL shall submit Annual Compliance Report to address all elements of mine site operation in relation to environmental management.		✓	
6.1	At all times CRL must have a designated employee or a senior employee based on site with lead responsibility for environmental matters.			✓
7.1	At all stages of development, mining operation and decommissioning, CRL will provide an adequate environmental induction for employees and contractors before the commencement of work.			✓
7.2	The environmental induction shall meet all required specifications as set by Ministerial Statement 727.			✓
8.1	Prior to ground disturbing activities, CRL shall implement Vegetation Management Plan.			✓
8.2	CRL in consultation with DEC will implement measures to protect plants and other areas of particular conservation significance.		✓	
8.3	CRL is at all times to ensure that no weed species are introduced into the proposal area.			✓
8.4	In the event of weeds being introduced into the proposal area, CRL shall undertake appropriate weed control measures and should continue these measures as directed by Minister for the Environment and EPA.			✓
8.5	During rehabilitation works CRL shall only use native plant species of local provenance.			✓
8.6	CRL shall construct and maintain roadside drains and other structures as necessary to contain runoff from roads and impact surrounding vegetation.		✓	
8.7	CRL will carry out monitoring of vegetation and take remedial action, when it is required to ensure that native vegetation is not being adversely affected by dust, water used for dust control or other emissions from proposal.			✓
8.8	CRL shall review and revise when appropriate Vegetation Management Plan, on advice from the EPA and Minister for Environment.		✓	
8.9	Any revisions made to the Vegetation Management Plan by CRL, will be made publicly available as approved by DEC.		✓	

No.	Ministerial Conditions	Compliance Rating		
		Low	Compliant	High
8.10	CRL will participate in Regional Studies with the DEC into defining and identifying the extent of plant communities on the Jack Hills Range.			✓
8.11	CRL will provide a report to the EPA on the findings of research carried out in 8.10 to the EPA by March 2010.			✓
9.1	CRL shall cap all open drill holes each day before nightfall to prevent fauna from falling into them.			✓
9.2	CRL will not permit cats, dogs or other domestic pets to be brought onto the site of the proposal, without the prior written approval of the DEC.			✓
9.3	CRL shall develop and implement a feral animal (goats) control program in consultation with the DEC and local Pastoralists.			✓
10.1	CRL shall from commencement of the proposal, implement the Decommissioning and Closure Plan contained within the EPS.			✓
10.2	CRL shall prepare a Final Decommissioning and Closure Plan at least 2 years prior to productive mining, to meet requirements of the DMP, EPA and Minister for the Environment.		✓	
10.3	Final Decommissioning and Closure Plan to include all requirements and standards as set by DMP, EPA and DEC.		✓	
10.4	CRL shall implement the Final Decommissioning and Closure Plan as required, until such time the Minister of the Environment under direction of the EPA, determines that CRL responsibilities have been fulfilled.		✓	
10.5	CRL shall make the Final Decommissioning and Closure Plan required by 10.2, publicly available in a manner approved by the DEC.		✓	
11.1	CRL shall protect rock overhang located at 523,892E / E7119,178 by installing and maintaining fencing at an appropriate setback to exclude human access.		✓	
12.1	CRL shall prepare and implement program to monitor the impacts of radio and electromagnetic radiation from mining activities and the transportation of ore, on the Radio Astronomy Park (RAP)		**Removed**	
12.2	Monitoring to ascertain the extent to which mining activities may have adverse impact on the radio quiet zone at the RAP.		**Removed**	

No.	Ministerial Conditions	Compliance Rating		
		Low	Compliant	High
12.3	If monitoring from requirement 12.2 resulted in impact to research activities at RAP, then CRL would develop and implement in consultation with appropriate authorities an Electromagnetic Radiation Management Plan.		**Removed**	
12.4	Elements of this plan would be developed in consultation with Minister for Energy, Science and Innovation and Western Australian Radio Astronomy Committee.		**Removed**	
12.5	Management Plan required in 12.3 to be implemented and prepared to the requirements of the Minister of Environment and EPA.		**Removed**	


Legend
Stage 1 Pit and Waste Dump
0 2.5 5 10
Kilometres
Figure 4-1
Western Australia
CARNARVON
MAP EXTENTS
MEEKATHARRA
CUE
GERALDTON
Milly Milly Well
Nunganoo Well
Erraninnie Well
Beringarra Pool
MURCHISON
RIVER
Colyeda Pool
Kalemunda Well
MT MATTHEW
MT HALE
JACK HILLS
Hill Mill Well
Mingabubba Bore
Poonthoon Pool
Nowgarrie Well
Yarrabubbe Bore
BERINGARRA CUE ROAD
ERAWONDOO HILL
Rainlover Bore (abandoned)
Gap Well
Hendersons Well
South Coppermonger Well
MT TAYLOR
Silver Coaster Bore
High Tank Bore
Moolyaloo Bore
Wealyranya Bore
Kolo Bore
Coopers Bore
Bulleen Well
Three Corners Bore
Four Corners Bore
MILEURA HILL
Mileura Well (abandoned)
Big Mindeel
Kammabijie Well
Buckardy Well
Kondamin Well
Mulga Well
Bucklebra Bore
Whela Creek
Mungarrie Well
Steel Star Bore
Yarrameedie Bore
7 Mile Well
Corktree Bore
Carlson Well
Sharpe Bore
Ilkabiddy Well
Wearie Well
Beringarra bore
1 Mile Bore
2 Mile Well
3 Mile Well
training track
waterhole
Mundong Well
Berri Berri Well
Darlot Well
Opawa Well
Policeman Well
Colyeda Well
Ossica Well
Boundary Bore
Towarr Creek
Hills Well

5. PROJECT DESCRIPTION

This section has been prepared in accordance with the EPA draft guidelines for the description of a proposal (EPA, 2009).

5.1 OVERVIEW OF THE MINE EXPANSION PROJECT

The Project is located approximately 400 km north-east of Geraldton and 120 km north-west of Meekatharra in the centre of the Jack Hills Range (Figure 5-1). CRL holds mining and exploration leases in the Jack Hills Range at Mt Hale, Noonie Hills and Stewart Bore (Figure 5-2) and further exploration leases in the Weld Range. CRL has reported a resource of 3010 Mt consisting of 110 Mt of DSO material and 2900 Mt of lower grade Beneficiation Feed Ore (BFO) which will be upgraded to produce a high grade concentrate.

The Mt Hale lease has a number of potential ore bodies characterized by high iron content direct shipping ores, which have low phosphorous, aluminium/silica and sulphur, and lower grade banded iron ores which appear to be upgradeable to a high quality iron concentrate. Both the DSO and concentrate are sought after commodities in the steel manufacturing industry.

The Project will expand Stage 1 mining operations and utilise or expand existing infrastructure, such as haul roads, accommodation village, airstrip and the crushing and screening plant. Ore is currently transported to Geraldton via truck, which will likely continue until production of ore is increased significantly. The Project is contingent upon the development of transport infrastructure such as a heavy haul railway and deep water port at Oakajee. The mine is expected to have a life of at least 30 years with a further five years for decommissioning and closure activities. The mine will produce up to 35.0 Mt of iron ore products per annum.

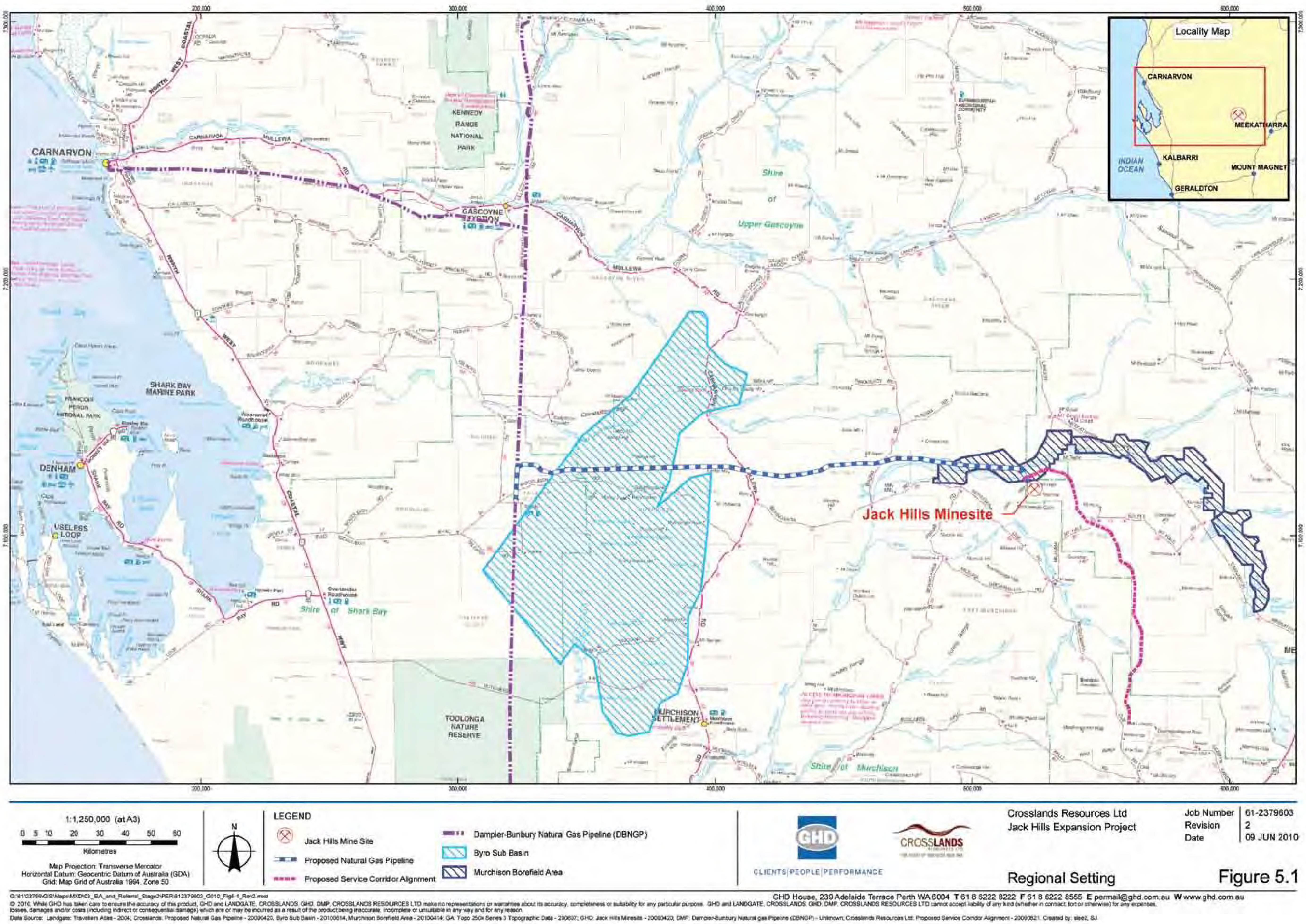
The Project is planned to commence operation as a three-module concentrator to produce 30.0 Mtpa of concentrate, with a DSO hematite plant producing lump and fines products, for export through the Oakajee Port. Each product will be provided with stockpiling capacity of a minimum eight days production ahead of the train loadout. Each product will have three piles defined, allowing piles to be built and reclaimed to a blended quality, providing space for product to be stacked and stored for train loading at all times. The smallest of the piles will be 27,000 tonnes, equal to the maximum train size envisaged.

Production will ramp up from plant commissioning over the first 12 months, with production from both the DSO and concentrator plants. Additional concentrator module(s) will then be installed and commissioned as the market permits.

Two services corridors will facilitate the transport of water and gas to the mine site and the potential for electricity from the power station to Weld range (Figure 5-1).

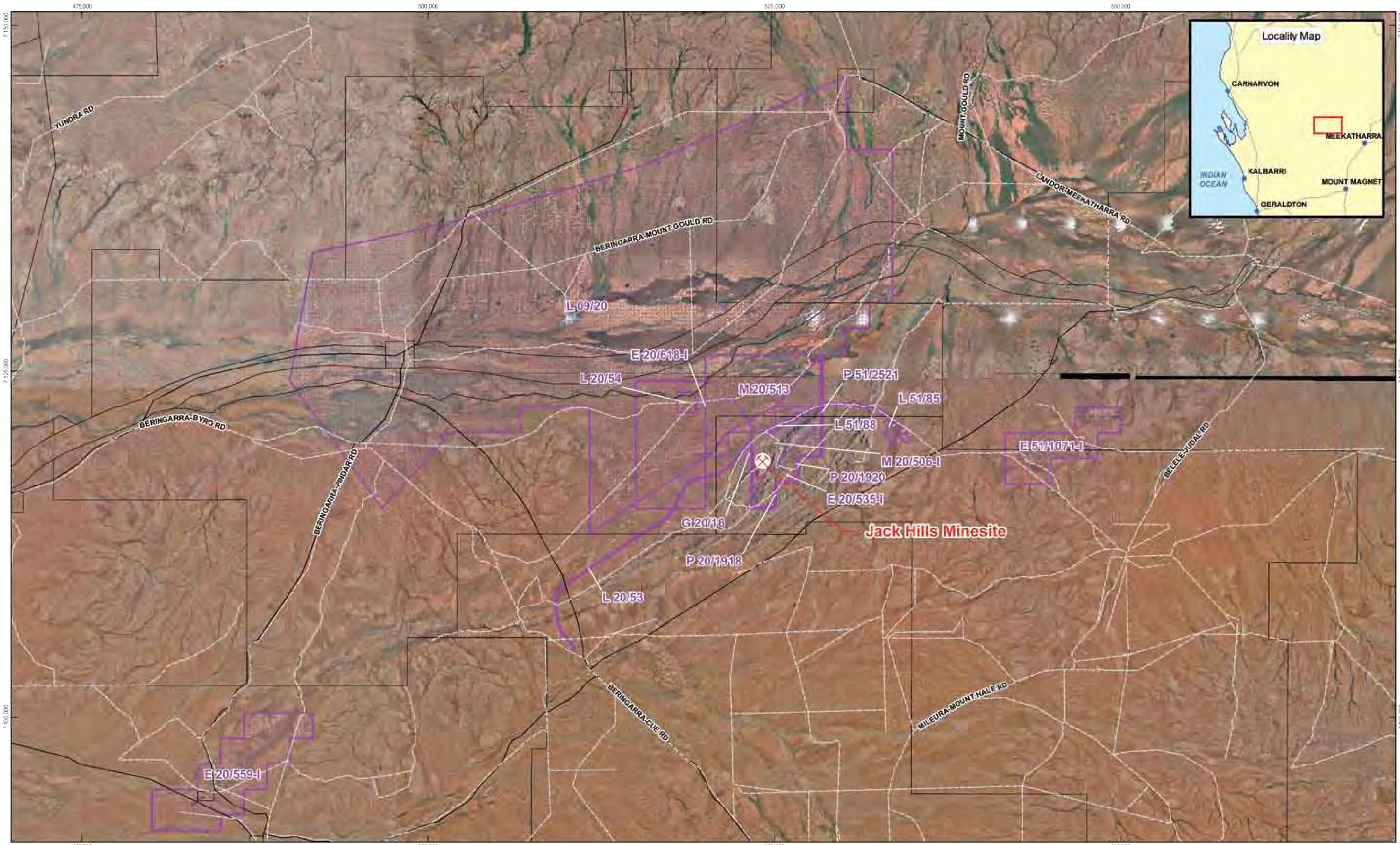
Figure 5-3 shows the layout of the mine site.

Table 5.1 provides a summary of the Key Characteristics of the Project.



Regional Setting

Figure 5.1



1:250,000 (at A3)

0 1.25 2.5 5 7.5 10 12.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Jack Hills Mine Site
- Tracks
- Roads
- Crosslands Resources Mining Tenement
- Cadastral Boundaries

GHD

CROSSLANDS

CLIENTS | PEOPLE | PERFORMANCE

Crosslands Resources Ltd
Jack Hills Expansion Project

Job Number	61-2379603
Revision	1
Date	30 AUG 2010

Locality Plan

Figure 5.2

\\ghdnet\GHD\AU\Perth\Projects\61\2379603\GIS\Maps\MXD\03_EIA_and_Referral_Stage2\PER\612379603_G011_Fig5-2_Rev1.mxd

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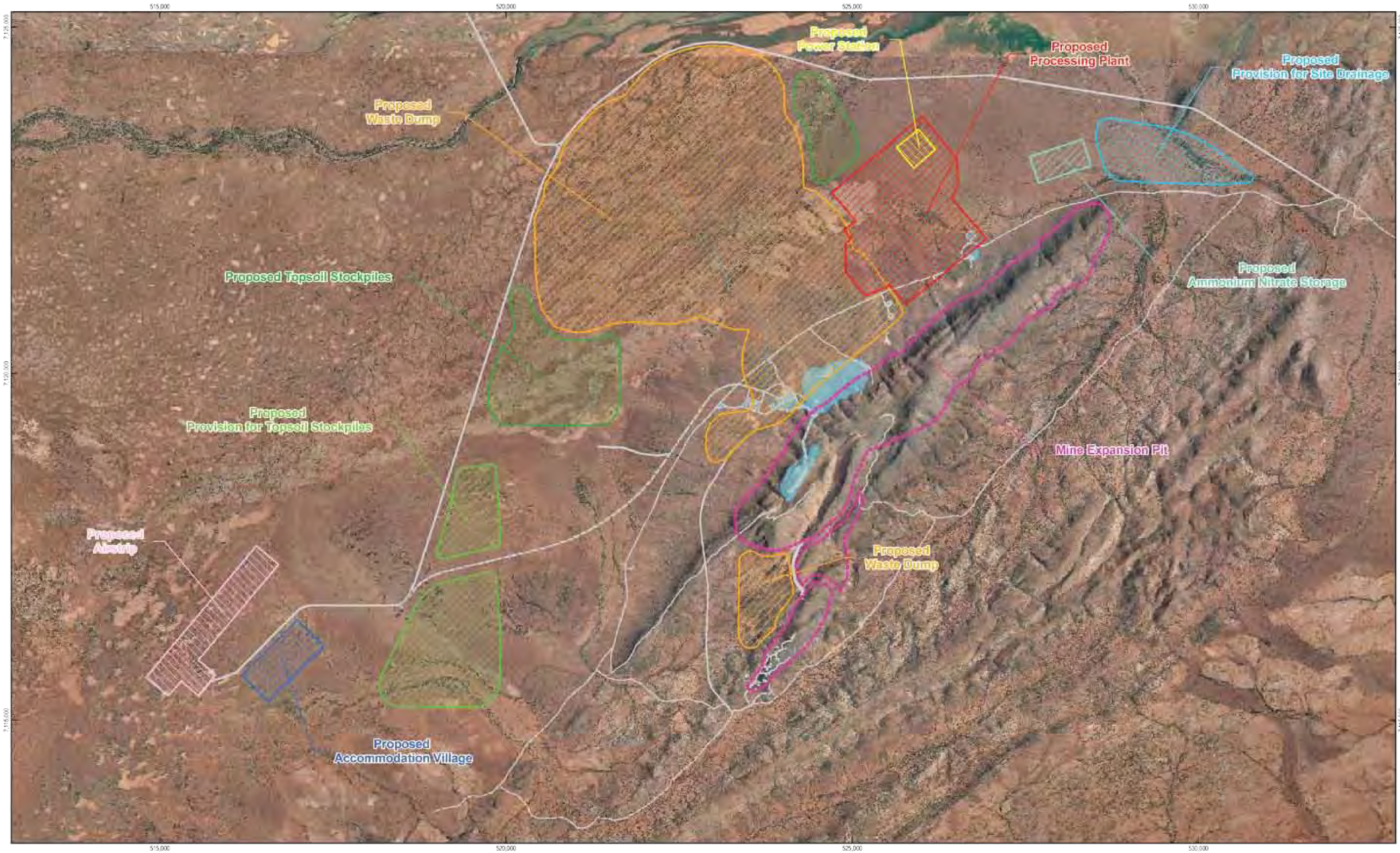
Data Source: Landgate: Travellers Atlas - 2004; GA: Topo 250k Series 3 Topographic Data - 200607; GHD: Jack Hills Minesite - 20090420; Landgate (SLIP): Aerial Mosiacs - Gould, Erong, Milly Milly, Koonmarra, Moorarie - 2005, 2008, Roads & Tracks - 200903, Cadastre - 2009. Created by: slee2, tgoad, slee2



1:50,000 (at A3)

0 0.25 0.5 1 1.5 2 2.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Proposed Topsoil Stockpiles	Proposed Ammonium Nitrate Storage	Proposed Airstrip
Mine Expansion Pit	Proposed Power Station	Proposed Provision for Topsoil Stockpiles
Proposed Accommodation Village	Proposed Processing Plant	Proposed Provision for Site Drainage
Proposed Waste Dump	Stage 1 Approved Areas	

Crosslands Resources Ltd
Jack Hills Expansion Project

Job Number 61-2379603
Revision 3
Date 30 AUG 2010

Project Layout

Figure 5.3

G:\61\23796\GIS\Maps\MXD\03_EIA_and_Referral_Stage2\PER\612379603_G012_Fig5-3_Rev3.mxd

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Data Source: AMEC: Proposed Topsoil Stockpiles - 20100513; Crosslands Resources Pty Ltd: Proposed Waste Dumps, Proposed Ammonium Nitrate Storage, Proposed Provision for Site Drainage, Proposed Processing Plant, Proposed Power Station, Proposed Provision for topsoil Stockpiles, Proposed Airport, Proposed Accommodation Village - 20100621; Crosslands Resources Pty Ltd: Stage 1 Approved Areas - 20091201; Landgate: Gould 2006 Mosaic; Mileura 2005 Mosaic; Existing & Proposed Site Roads & Tracks. Created by: kdinsiu, slee2, SJ, slee2

TABLE 5.1 KEY PROJECT CHARACTERISTICS

Project Component	Description
Life of Project (mine production)	35 years
Area of disturbance (total)	Approximately 7,719 ha, including: • 933 ha: mine pit expansion; • 1,785 ha: integrated waste landform; • 3,301 ha: infrastructure (including buffers, processing plant, drainage, topsoil storage, construction camps, airport, borefield infrastructure, roads and turn-around areas); • 600 ha: services corridor; and • 1100 ha: gas pipeline corridor.
Staging of development	*Phase 1 (first 3 years of mine life)* • Construction and commissioning of facilities for two concentrate modules and a DSO hematite plant. *Phase 2 (minimum 30 years of mine life)* • Construction of facilities to support additional concentrate modules. *Phase 3 (last 5 years of mine life)* • Final decommissioning and closure activities.
Maximum mining rate	150 Mt of feed ore per annum 150 Mt of waste per annum
Major components:	
Pit (x2)	*Footprint:* Two pits with total surface area of 813 ha and 120 ha, excluding buffers *Depth:* Nominally 260 m (160 mAHD)
Integrated Waste Landform **(co-disposal of waste and tailings)**	Disposal of 3.6 billion tonnes of waste rock and tailings. *Footprint:* 1,785 ha involving four individual waste cells. *Maximum Height:* 600m AHD (230 m above natural surface level). *Total waste volume:* Approximately 1,850 Mm^3 of waste, comprising approximately 775 Mm^3 of tailings and 1075 Mm^3 of waste rock.
Processing Plant	Producing 45 Mtpa DSO lump and fines products and iron concentrates from BFO feed ore.
Power Plant	Natural gas fired power station with 350 MW generating capacity. Diesel back-up.

Accommodation Village	Up to 2,500 occupants during the construction stage and approx.1,200 permanent employees during the operational phase.
Services Corridor	From Jack Hills to Weld Range for possible road, water, gas and power transmission facilities (approx. 120 km long).
Natural Gas Pipeline	Buried pipeline from Jack Hills to the Dampier to Bunbury Natural Gas Pipeline (approx. 220 km long). This corridor will also incorporate a water pipeline.
Roads	Site access for general and heavy traffic, road to accommodation village, airport, mine roads and access roads for infrastructure maintenance.
Additional infrastructure	Production water bore field(s) yielding approximately 37 million Kl (37 Gl) of water per annum during the operational phase; New airstrip (approx. 150 ha) and associated facilities to service Code 3C aircraft; Sewage treatment (package treatment plants) and waste disposal facilities, workshops, stockpile areas, fuel storage area, laydown areas, administration area and explosives magazine.

5.2 LOCATION

The Project is located approximately 400 km north-east of Geraldton and 120 km north-west of Meekatharra in the centre of the Jack Hills Range (Figure 5-1). There are no nearby communities or potentially sensitive population groups. The nearest residence is Mileura station located approximately 35 km south of the project area.

The Murchison region has a dry climate, with hot summers and mild winters (Bureau of Meteorology, 2006). The climate of this region is strongly influenced by a band of high pressure known as the sub-tropical ridge, and in the warmer summer months by a trough of low pressure extending southwards from the heat low in the tropics.

The Jack Hills rise up to approximately 300 m above the flat plain of the Murchison River, which is between 400 to 450 m above sea level. The hills extend for approximately 60 km in an arc-shaped structure north-east to south-west.

The Jack Hills are located in the Murchison geological province, in the Narryer Gneiss Terrane of the NW Yilgarn Craton, Western Australia, and comprise a long northeast-trending belt of folded and metamorphosed supracrustal rocks (Wilde et al., 2001).

5.3 TENURE

The Project will be an expansion of the existing mine, Stage 1, located in the Meekatharra Shire of the Murchison Region. The proposed location of the Project will be in the vicinity of 26.4023°S 116.849°E / 25.6599°S 117.596°E.

CRL currently holds Mining License M20/506, and has the consent of surrounding pastoralists to access and operate on the tenement. CRL will access the Project facility via the established Cue-Beringarra access road (held under L51/85) which has been upgraded as part of Stage 1 operations.

Mineral titles currently held by CRL and its associated companies at Jack Hills are shown in Table 5.2. The tenements are located on Pastoral leases.

TABLE 5.2 MINERAL TITLES HELD BY CROSSLANDS RESOURCES LIMITED (CRL) IN THE JACK HILLS AREA

Tenement	Pastoral Lease	Held By
M20/506 (Mt Hale)	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA)	CRL
L20/53 (Haul road)	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA) PL3114/720 (MILEURA)	CRL
L20/54 (borefield, power line, pipeline & road)	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA)	CRL
L51 /85 (airstrip access)	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA)	CRL
L51/88 (road from airstrip road to AMFO shed)	PL3114/732 (JUDAL)	CRL
P20/1918	PL3114/732 (JUDAL)	CRL – Pending application converting to form part of M20/513
P20/1919	PL3114/732 (JUDAL)	CRL
P20/19120	PL3114/732 (JUDAL)	CRL – Pending application converting to form part of M20/513
P51/2521	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA)	CRL – Pending application converting to form part of M20/513
E20/618	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA)	CRL – Pending application converting to form part of M20/513
E20/535	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA)	CRL – Pending application converting to form part of M20/513
G20/16	PL3114/732 (JUDAL)	Pending, Application converting P20/1919, E20/535 held by CRL
M20/513	PL3114/732 (JUDAL) PL3114/941 (BERINGARRA)	Pending, Application converting E20/535, E20/618, P20/1918, P20/1920, P51/2521 held by CRL

The Project will consist of open cut mining within M20/506 and associated mine infrastructure being located on the nearby plains of pastoral leases of Judal and Beringarra (E20/618) (Figure 4-1). The access road to the camp and airstrip lies on a portion of L51/85. The main access to the project area from Cue will be via an existing haul road from the Beringarra-Cue public road. This haul road route is covered by L20/53. Tenement boundaries are shown in Figure 5-2. Note that these formal tenement boundaries often differ from actual fence line boundaries under which the stations are operating.

A new gas pipeline will be constructed from the mine to the Dampier to Bunbury Natural Gas Pipeline (**DBNGP**). Access to the DBNGP corridor will be obtained under the *Dampier to Bunbury Pipeline Act 1997*. CRL will acquire a Miscellaneous Licence under the *Mining Act 1978* and a Pipeline Licence under the *Petroleum Pipeline Act 1969* for the entire length of the proposed route.

No zoning amendments to regional or town planning schemes are required.

5.4 RELATIONSHIP WITH OAKAJEE PORT AND RAIL

CRL, Murchison Metals Ltd and Mitsubishi Development Pty Ltd are developing the independent Oakajee Port and Rail (OP+R) Project. The OP+R Project will provide rail and port infrastructure to iron ore mines throughout the mid-west region. The OP+R multi-user infrastructure will be utilised for the transport of ore products from the CRL Jack Hills Expansion Project.

It should be noted that the OP+R Project is the subject of a separate PER and is not within the scope of the Jack Hills Expansion Project.

5.5 INFRASTRUCTURE BEING PROVIDED BY/ TO OTHER PROJECTS

There are three main areas in which infrastructure may be provided by or to other projects and these are the:

- Square Kilometre Array (**SKA**);
- services corridor to Weld Range; and
- road to Geraldton.

Discussions are being held, with SKA representatives, regarding provision of power and water from the Project, as well as, aspects of Project operations that have the potential to impact the SKA. At present the SKA is planning to use renewable energy to power its operations and information is being exchanged to see if some of these technologies can be used on the Project.

A services corridor is planned between Jack Hills and Weld Range, running immediately east of and adjacent to the corridor reserved for the new railway being installed by OP+R. Current discussions with Sinosteel Midwest are centred on a possible water pipeline to supply water to the Project as a result of Sinosteel Midwest de-watering activities.

The road from the Project site to Geraldton runs through Cue, Yalgoo, etc, on its way to Geraldton. It is anticipated that the road will continue to carry significant heavy haul traffic delivering supplies of equipment and materials to the Project during the construction phase. Once the Project goes into operations the traffic mix will change to supply of consumables and other materials required to support mine operations. This will include significant quantities of diesel, mill balls, explosives and other consumables.

5.6 PROJECT TIMING AND STAGING

Transition from current operations

Current Stage 1 small scale mine operations is anticipated to continue to 2012. Ore (2 Mtpa) will continue to be hauled by truck to the Geraldton Port Facility until completion of the Oakajee port and rail infrastructure. Current mining operations will roll into the start-up of Project Development Phase 1. Decommissioning of the Stage 1 mine infrastructure will also coincide with this timing.

Project Development Phase 1

Phase 1 of the Project will include construction and commissioning of facilities for a three module concentrate plant and a DSO hematite plant, which will support the first three years of the mine life.

It is anticipated that site works will take 18 to 24 months to complete. The Phase 1 development will include:

- pre-strip of the mine;
- construction of waste rock dump;

- construction of mining infrastructure;
- construction and commissioning of the airport and associated facilities;
- construction and commissioning of a 2,500 person accommodation village and facilities;
- construction and commissioning of power plant;
- construction of internal roads;
- construction and commissioning of a fuel storage depot;
- construction of processing plant pads;
- completion of all other earth works;
- commissioning of the processing plant;
- construction and commissioning of process water supply systems;
- construction of offices, warehouses and workshops;
- construction of processing plants;
- construction of the first cell of the tailings dam;
- commissioning of the waste management facilities and all associated procedures;
- commissioning of the rail loading facilities;
- commissioning of the product storage yard and product handling equipment;
- commissioning of the plant management system and all associated procedures (health and safety, environment, process control etc.);
- commissioning all logistics and material control systems;
- commissioning of mining operations;
- ramp up of the processing plant; and
- commissioning of the environment protection equipment and all associated procedures.

Project Development Phase 2

Phase 2 of the project development will involve construction of facilities to support production of additional concentrate. Construction of the Phase 2 will take 12 to 18 months. The Project's production will continue for the remaining life of mine.

Phase 2 will require:

- upgrading of the environment protection equipment and all associated procedures;
- upgrading of the accommodation village and facilities;
- upgrading of the waste management facilities and all associated procedures;
- commissioning of the additional processing plant modules;
- implementing the plant management system and all associated procedures (health and safety, environment, process control etc.);
- upgrading all logistics and material control systems;
- upgrading power supplies;
- upgrading water supplies; and
- ramp up of the third magnetite concentrator module.

5.7 MINING PRE-STRIP

During Stage 1 mining, some of the oxidised banded iron formation (**BIF**) has been excavated and stockpiled in the waste dump for later use in commissioning and plant startup. Upon commencement of construction activities, selected waste material will also be used for the plant infrastructure pad, flood protection bunds, initial construction of the run-of-mine (**ROM**) pad and other infrastructure pads as required. All mining operations will involve drill and blast to break the *in situ* rock, with the material loaded and transported using a conventional hydraulic excavator and truck fleet. As the material from the pre-strip is being used for construction, some of the material will undergo sorting or crushing prior to placement as engineered fill.

The second ramp-up phase of the pre-strip will commence 6 to 12 months prior to the commissioning of the processing plant. This phase of the pre-strip will be completed by the primary mining fleet. Mining operations will be conventional truck and face shovel, with rock breakage achieved by drill and blast activities. Waste material during this phase of the pre-strip will be used to complete the ROM pad infrastructure with the remainder being placed in the walls of the initial tailings cell which will make up part of the IWL.

5.8 MINING METHOD

The mining methodology proposed for the Project is based on current industry practice for a hard rock open pit mining operation, utilising conventional face shovels, front-end loaders and trucking equipment for the primary load and haul fleet. Primary rock breakage is achieved by conventional drill and blast techniques, with secondary breakage completed by either a mobile rock breaker or secondary drill and blast.

The mining method is based on large scale mining equipment for the extraction of BIF and waste materials. The combination of large hydraulic face shovels and large front-end loaders were matched to large off-road haul trucks for the primary load and haul fleet. A second smaller fleet will be utilised to extract the DSO material selectively using smaller hydraulic excavators and medium sized off-road haul trucks. The option to use two mining fleets was selected as the basis for the earthmoving requirements as it provided the flexibility for blending and the lowest technical risk relative to other mining options assessed. Selection of the primary loading unit was dependent on maintaining the required movement of ore and waste while maintaining acceptable levels of ore loss and dilution and keeping equipment levels to a minimum. Other mining options such as in-pit crushing and conveying may be assessed later in the project life to reduce the cost of mining at depth.

The ancillary fleet comprises front-end loaders, tracked and wheeled dozers, graders, water carts and small excavators to maintain safe mining operations.

Dust suppression in the mine will be undertaken using water recovered from mine dewatering activities with make up water from the process water pond. A stabilising agent will be added to water carts used for dust suppression. A small presence of possible fibrous mineral (**PFM**) has been recorded in the lithology log from drilling activities. As the PFM do not appear to be confined to a particular rock type the assumption is that any mining activities will intersect PFM. A management and decontamination plan will be formalised as greater understanding of localised potential is realised. Any encountered asbestos will be buried in the integrated waste landform (**IWL**).

5.9 MINE DESIGN

Ore extraction will take place in a single large open cut pit (Main Pit), and a second open cut pit (Figure 5-3). The pits will be mined as a series of cutbacks in a scheduled sequence designed to meet production rates and feed specifications. Brindal will be ultimately incorporated into the one larger pit within the overall disturbance footprint.

The design of the mine is based on an interpreted geological model after applying dilution parameters for the selected mining fleet. The ultimate pit limit is defined using applicable geotechnical and economic parameters and currently extends to the base of the exploration drilling 250m below surface.

The slope design for the open cut is based on a geotechnical core sampling and testing program conducted in September 2009. The final slope design for the pit may be modified as required to account for local ground conditions or where a greater data density indicates a change in design is required.

The mining sequence for the Project can be split into two phases.

- The first phase of mining will take place in a number of starter pits targeting the DSO ores and is expected to last five to six years.
- The second phase of mining currently incorporates a series of cutbacks that push the wall out to the ultimate pit limits. Initial stripping for this phase will commence in the second year from the Project commencement, with progressive clearing over a period of eight to ten years. Mining will continue within the final phase until cessation of mining operations.

Access to the working areas of the pits will initially be within the ultimate pit limits, on haul roads constructed up the side of the Jack Hills range with a network of mine roads connecting to the processing plant and the IWL. Once the pits are mined below the plain, haulage ramps will be located in the hanging and footwall slopes of the ultimate pit. Haul roads have been designed to 3.5 times the width of the haul trucks in the mining fleet to allow for dual lane access, drains and appropriate bunding.

5.10 ORE PROCESSING

The Jack Hills deposit contains a relatively small proportion of direct shipping ore and a large proportion of beneficiable ore. The direct shipping ore requires crushing, and screening to produce iron ore lump and fines products.

The lower grade beneficiable ore requires crushing, grinding and concentration to produce saleable product(s). The concentration process will involve the use of magnetic separators to produce a magnetic concentrate and gravity concentration equipment to produce a gravity concentrate. The gravity and magnetic concentrates will be separate products.

It is proposed to construct and operate a pilot scale concentrator facility at Jack Hills in order to provide design and operating data relevant to the full-scale operation. This pilot plant will treat around 10 tonnes per hour through a process circuit similar to that of the full scale plant. Tailings from this plant will be stored in a dedicated facility that is designed to ensure that any solid or liquids are not released to the environment. Concentrates produced from the plant will be filtered and stored in bulkabags for possible shipment to offshore customers.

The processing facilities for the Jack Hills Project will include:

- material stockpiles;
- primary and secondary crushing;
- milling/grinding;
- concentration via magnetic separation and gravity separation;
- waste disposal; and
- train loading.

A general layout of the processing plant is provided in Figure 5-4

The ore is ground to liberate the iron minerals from the gangue minerals. The magnetic separation process is based on separating the magnetite minerals from the gangue minerals using differences in mineral particle magnetic susceptibility. Non-magnetic hematite iron mineral particles in the primary magnetic separation tailings stream will be recovered using gravity separation. Gravity separation allows the heavy iron mineral particles to be separated from the lighter gangue particles. No chemicals are used in the magnetic or gravity separation processes. Small amounts of flocculants, (and possibly coagulant), will be used to assist with recycling water from the tailings thickener. Filtration of water from the tailings will be considered as a means of reducing the plant make up water requirement. Flotation may be considered in the future to allow further upgrading of the concentrate quality.

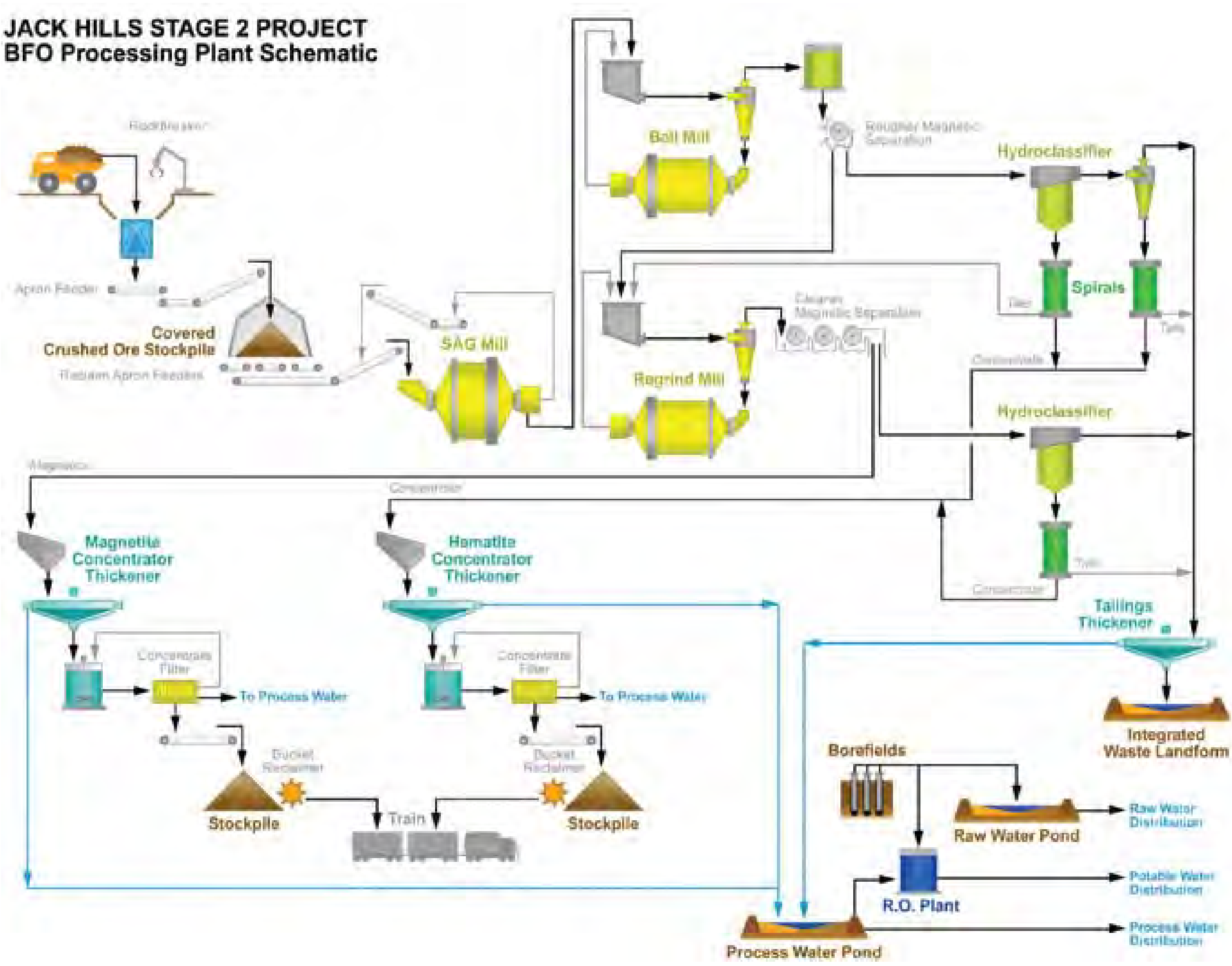
5.10.1 ORE CRUSHING

For both direct shipping ore and beneficiable ore the primary crushers will crush the ore to a nominal -160 mm size. The primary crushers will be fed by ore trucks delivering ore directly from the pit, or the ore may be reclaimed from a mine stockpile using a front end loader or a combination of truck and front end loader. The crushers will be located between the IWL and the main pit, as will stockpiles, waste, roads and laydown areas. The primary crushed ore with then be stored in a stockpile, or bin in order to provide a buffer between the primary crushing and downstream processes, that require steady, continuous operation. The crushing plant will include water sprays, with a dust binding surfactant, and the provision of dust extraction systems to minimise dust emissions.

The direct shipping ore will be fed from the stockpile, or bin, to a conventional crushing and screening plant to produce a lump product, nominally sized -31.5 mm + 6.3 mm and a fines product nominally sized -6.3 mm. The lump and fines products will be separately stockpiled prior to loading into ore cars for railing to the port.

A jig plant is under consideration for upgrading lump and fine material that is sightly below the grade required for direct shipping. Jig plants make a separation based on the differences in specific gravity of iron minerals and gangue minerals. Jig separation is done by using air pulses to stratify a moving bed of material that is supported by a screen, in a bath of water.

FIGURE 5-4 GENERAL LAYOUT



5.10.2 CONCENTRATOR

The concentrator modules will use the following process:

- The beneficiable ore will be reclaimed from the primary crusher/bin and fed to a semi autogenous grinding mill to reduce the ore to 3mm.
- The ore will be ground in a conventional ball mill/cyclone grinding circuit to produce a cyclone overflow.
- The cyclone overflow will be fed to a single stage of primary low intensity wet magnetic separators to produce a primary magnetic concentrate and primary magnetic separation tailings.
- The primary wet magnetic concentrate will be reground in a conventional ball mill/cyclone circuit.
- The reground primary magnetic separation concentrate will be upgraded in a number of stages of magnetic cleaner separation to produce a final magnetite concentrate.
- The cleaner magnetic concentrate will be thickened, filtered and conveyed to a magnetic concentrate stockpile for subsequent reclaiming and railing to the port.
- The cleaner magnetic separation tailings will be fed to a gravity circuit to recover hematite minerals, liberated by finer grinding. The gravity tailings will be delivered to the tailings thickener to allow water recovery prior to pumping the thickened tailings to the tailings containment cell.
- The primary magnetic separation tailings will be fed to a gravity concentration circuit that will produce a high grade gravity concentrate, a gravity middlings and final gravity tailings. The gravity concentrate will be thickened, filtered and conveyed to a gravity concentrate stockpile for subsequent reclaiming and railing to the port. The gravity tailings will be pumped to the tailings thickener for thickening and tailings disposal with the magnetic circuit tailings.
- The gravity middlings will be reground and upgraded in a second stage of gravity separation.

Most circuit water requirements will be met by recycling water recovered from the thickeners. However water make-up will be required to replace water lost from the circuit. Only small addition rates of flocculent and dust suppressant chemicals are required in the process plant as planned. These chemicals are commonly used in industry and are regarded as low toxicity.

5.11 INTEGRATED WASTE LANDFORM (IWL)

5.11.1 CONCEPT DESIGN

The preferred concept for tailings and waste management comprises the storage of tailings in cells constructed from, and ultimately encapsulated by, waste rock to form the IWL. Tailings deposition will only be active in one cell at a time, with each cell progressively constructed, filled, decommissioned and covered with waste rock. The IWL will occupy an ultimate footprint area of 1,840 ha and will store approximately 1,850 Mm^3 of waste, comprising approximately 775 Mm^3 of tailings and 1075 Mm^3 of waste rock. The landform will extend from the base of the Jack Hills, westward onto the Murchison River floodplain. Tailings will be deposited as slurry from multiple spigot locations around the perimeter of each of seven tailings cells.

The tails stream produced from processing the BIF ore consists of inert materials comprising mostly fine particles. Tailings will be pumped to the tailings cells within the IWL and discharged around the perimeter. Water will be recovered from decants located on one of the inner walls within the IWL and returned to the process water circuit. Further options for water recovery will also be examined.

The concept of an integrated waste disposal facility, receiving both the tails stream from processing as well as overburden from the mining operation has been investigated by both geotechnical and environmental specialists. Co-disposal of mine waste and tailings was seen as the most effective solution for encapsulation of tailings and for mine closure. The conceptual design for the IWL broadly follows the Guidelines for the Safe Design and Operating Standards of Tailings Storage (Department of Mines and Petroleum, 1999) and Guideline on Tailings Management (Department of Industry, Tourism and Resources (DITR), 2007).

The creation of a stable landform is an important design criteria for the proposed IWL. A starter embankment, for the tailings deposition, will be constructed from *in situ* borrow materials with subsequent embankments and raises constructed from waste rock generated by the mining operations. The predefined tailings cells for the encapsulation will be constructed using a combination of downstream and centreline embankment raises to a maximum elevation of 470m AHD, corresponding to a maximum height of 105m above the adjacent plain.

Following the decommissioning of each tailings cell, the tailings will be covered with waste rock and the waste rock stockpiles advanced over the cells to form the final IWL. Waste rock will be placed to a maximum elevation of 600m AHD, corresponding to a maximum landform height of approximately 230 m above the adjacent plain.

The inner slopes of the embankments will be constructed with an average upstream (inner) slope of two horizontal: one vertical. Benches will be formed at 20m vertical increments on the inner slopes to assist in the control of tailings deposition. A vertical crushed rock filter zone will be constructed within the embankments to contain the fine tailings within the waste rock embankments.

The IWL will be armoured to resist erosion from flood events and surface water flows resulting from rainfall events up to the Probable Maximum Precipitation. The surface cover, drainage lines and downstream toe of the embankments will be constructed from erosion-resistant hard waste rock. Embankment erosion will also be controlled by the formation of a concave downstream (outer) embankment profile. Both the ultimate height of the IWL and the slope angles are designed to reflect the surrounding ranges. In areas that may be exposed to frequent water action, oversize material (boulders >0.6m) will be used as rip-rap to armour the IWL.

The IWL has been designed to maintain a minimum distance of one kilometre between the Murchison River and the downstream toe of the embankment. The purpose of this offset is to minimise the obstruction of flow from the Murchison River following significant rainfall events. Flood hydrology studies have been undertaken to determine any potential impacts of the IWL on surface water flows for the Murchison River (Appendix B; discussed in Section 9.5). These studies have determined that an offset distance of one from the Murchison River can be accommodated without significant impacts to the surface water flows.

Surface water drains will be constructed around the perimeter of the IWL to assist in drainage and direct surface water flows around the facility. The drains will be designed to accommodate routine surface water flows up to the 2-year Average Return Interval (**ARI**) rainfall event. After larger rainfall events, it is envisaged that the drains will overtop and excess water will be accommodated as sheet flow around the IWL.

The indicative location of the IWL is shown in Figure 5-3. CRL is currently progressing negotiations to access part of the neighbouring tenement, held by Sinosteel Midwest Corporation Limited, for the purpose of the waste landform. The final shape and location of the waste dump may encroach on this tenement. Acquisition of this tenement area will provide opportunities to design a more compact IWL.

5.11.2 WASTE CHARACTERISATION

Waste Rock

Waste Characterisation was undertaken for the Stage 1 Project (MBS, 2005), and it is expected that the waste rock present within the Stage 2 site will have similar properties. Further waste characterisation analysis is underway for the Project, and is due for completion in December 2010. A summary of the results of waste characterisation for Stage 1 is provided below.

Microscopic examination and chemical characterisation has been completed for 18 regolith samples from the Stage 1 pit area. The samples include all weathered and fresh rock materials likely to be mined during open pit operations, excluding the thin veneer of soil material.

Chemical Characteristics:

- Sulphur is extremely low, the content equivalent to <1.0 kg H_2SO_4/tonne. Samples have a strong alkaline reaction and salt contents directly comparable to rainwater. Analytical and microscopic data confirms that most of the sulphur recorded in regolith samples is present as chalcopyrite and water soluble sulphates, not as iron sulphides.

- Sulphide and carbonate content from microscopic examination was so low, that a decision was made not to undertake Acid Neutralisation Capacity or Net Acid Generation. Maximum sulphur content was 0.062%S with an average of 0.025% S.
- "Total" heavy element regolith contents are very low and 5:1 w/w water leachate to sample test procedures, that simulate medium to long term weathering conditions, define no potential problems with any heavy metal.
- Low water-soluble calcium, magnesium and sulphate contents and very low calculated total dissolved solids mean minimum salinity problems and no surface "crusting".

Physical Characteristics: waste material from the pit is separated into four zones and one sub-zone, based on the differing physical properties. No ultramafic materials were microscopically identified in the samples received and the geochemistry confirms that ultramafic rocks are absent.

Zone 1 materials: the three samples examined indicate the grid east to grid west succession is magnetite quartzite followed by interbedded argillic schists and minor BIF and then interbedded mafic schists and BIF.

Zone 2 materials: five samples range from: interbedded argillaceous and chlorite schist with minor BIF; to mafic schist without BIF; to mafic schist with BIF interbeds. Geochemistry indicates the argillaceous rocks are shales and the mafic schist derived sediments from a mafic volcanic source. The BIF is formed by chemical sedimentation.

BIF between Zones 2 and 3: three samples, two with appreciable interbeds of chloritic (mafic) schist. Minor chlorite detected in the third sample. Chips indicate that the chalcedonic silica and iron oxides are chemical precipitates with reaction layers between composed of minnesotaite, the iron analogue of talc. The chlorite occurs as sedimentary interbeds, possibly tuffaceous, of re-crystallised mafic material.

Zone 3 materials: six samples include four ranging from interlaminated chlorite and talc-chlorite schist to mafic schist. The other two are of BIF, one of low iron and one of relatively high iron content. One mafic sample is free of magnetite but all contain ilmenite plus traces of pyrite and chalcopyrite. Chemically and mineralogically, these rocks appear to be derived sediments from a mafic volcanic environment.

The waste characterisation for Stage 1 concluded that there were no environmentally geochemically anomalous zones within the regolith, that there should be no geochemical problems and no Acid Rock Drainage.

Tailings

The tailings are classified as silty sand with low plasticity reflecting the low clay content. The tailings settle quickly with almost all settlement taking place within the first hour of agitation. The settling results demonstrate that relatively clear supernatant water could be decanted from the tailings if a small supernatant pond were maintained.

The tailings geochemistry is dominated by iron, manganese and aluminium. Soluble concentrations of sodium, magnesium, calcium and potassium are relatively low and indicate a limited source of salinity from the tailings solids. The total sulfur concentration is very low at 0.04%. At this concentration, acidity is unlikely to be generated even if sulfur is present in sulphide form. Of the trace elements, barium, copper, nickel, strontium, zinc, thorium and mercury were detected. All of these elements were below average concentrations for basalts and shales.

The mineralogy of the tailings indicates that it is composed of silicates, carbonates and oxides. No sulphide minerals were detected. The mineralogy is dominated by magnesium phases, e.g. magnesite, talc and dolomite. Dissolved magnesium concentrations are unlikely to become highly elevated under circum neutral drainage conditions.

Acid Mine Drainage

A high level Acid and Metalliferous Drainage (**AMD**) study and metallurgical testwork program has been conducted for the Project. SGS Lakefield Oretest (2010) also undertook an extension study to validate the findings of the High Level Study by the distribution of AMD characteristics onto the Resource Block Model, thus providing a more realistic assessment of the expected tonnages of Potential Acid Forming (**PAF**) and Non Acid Forming (**NAF**) materials present (Appendix C; Section 9.8).

The studies determined that there is a very low risk of acid drainage from the potential waste ores and beneficiation tailings for the Project. There is also evidence to suggest a low risk of metalliferous drainage and elevated salinity from waste dump drainage. A few small fringe areas of 'Potentially Acid Forming – Low Capacity' and even less 'Potential Acid Forming' material were identified.

Overall there appears to be excess neutralising capacity to acid potential at a ratio of 8 to 1 in the waste ore and 10 to 1 in the process tailings. Quantitatively, there is approximately seven million tonnes of excess neutralising capacity in the waste ores and 24 million tonnes of excess in the process tailings. Further work is in progress to provide additional confidence and validation to the findings of the two studies.

5.12 ANCILLARY FACILITIES

5.12.1 ACCOMMODATION VILLAGE

The construction and operations accommodation village will be located about 18 km west of the mine site. The village will accommodate 2,500 occupants during the construction stage and approximately 1,200 permanent employees during the operational phase. The typical configuration of accommodation will be three ensuited rooms per unit for permanent employees. Construction personnel may be housed in five ensuited rooms per unit. Additional units will be required during the construction phase. The village will contain all necessary support facilities, such as laundries, kitchens, dining halls, wet messes, a shop and recreational facilities such as swimming pool, tennis courts, gym and oval.

Sewage from the accommodation village will be treated in package treatment plants to Department of Health requirements and reticulated into landscaping irrigation.

The accommodation village will be designed to the appropriate wind loading codes and a designated section will be constructed as a refuge for the workface in the unlikely case of cyclone events.

5.12.2 HYDROCARBON AND FUEL STORAGE

It is anticipated that approximately 350K litres of diesel fuel will be required per day to sustain the operations. The majority of the fuel will be used for earth moving haulage trucks and supportive mining equipment.

On site fuel storage will have a total capacity of 3,000K litres of diesel fuels. The tanks will be located in a lined and bunded area which has the capacity to hold 110% of the largest tank volume. The tanks will have a suitable fuel transfer pumping system and acceptable fire protection system.

The diesel storage facility will be located adjacent to a refuelling station which is proposed to have two heavy vehicle refuelling points and one light vehicle refuelling point to minimise the interaction of different sized vehicles.

This will be specifically designed to provide space for two large ore trucks to refuel simultaneously whilst other trucks wait in a safe area. There will be adequate safe manoeuvring space for the large trucks and this will be located away from operational areas of the mine.

The following features describe the facility:

- The diesel storage tanks will be a modern design with inbuilt safety and bunding features to protect against overflow and leakages.

- The storage tanks will be above ground allowing easy and regular visual inspections for leaks and early detection of environmental harm.
- Earthworks and drainage channels are proposed to ensure the safe run-off from any leaks or storm water to suitable sumps with pumps from which the water will be treated, and thus in the unlikely event of a leak there will be minimal environmental harm.
- The location of the refuelling station has been selected to: provide required manoeuvring space for modern haulage trucks; allow two trucks to refuel simultaneously; and provide space for other trucks to wait without creating a hazard.
- The proposed facility will permit smaller vehicles to refuel without having to interact with the mining trucks resulting in an increase in safety.
- CRL has conducted ecological and cultural heritage reports which show that the proposed location will not harm local flora, fauna or heritage values.
- The design of refuelling facilities will comply with fire protection regulations and Australian Standard AS1940 -2005: The storage and handling of flammable and combustible liquids.
- An oil and water separation system will be designed to comply with the Environmental Protection (Controlled Waste) Regulations 2004.

Tracked equipment will be refuelled and serviced within the pit. Spillage will be kept to a minimum and any contaminated materials will be cleaned up immediately and taken to the bio-remediation area.

There will be six tanks of Liquefied Petroleum Gas (**LPG**) gas at the village for domestic use. These will be located in a suitably protected area.

All fuel tanks and gas storage containers will be installed and maintained in accordance with regulations and fuel industry codes of practice.

5.12.3 NON-PROCESS WASTE FACILITIES

Non-process waste facilities will be planned, established and operated with regards to guidelines relevant to the predicted size of the facility and with Shire of Meekatharra and DEC approval. General location and management of the facilities will be subject to the following overarching guidelines:

- waste pits will be sited away from drainage lines and other environmental constraints such as Priority flora species;
- pits will be operated in cells and covered daily with a suitable depth of soil;
- hydrocarbon waste (such as oily rags and non-recyclable waste) will be treated separately in a bio-remediation facility; and
- opportunities for treating and recycling organic waste will be considered.

5.12.4 POWER FACILITIES

A generating capacity of up to 350 MW has been estimated for the processing plant and infrastructure. This power will be generated by an on site power station fired with natural gas from the Dampier to Bunbury Natural Gas Pipeline (DBNGP).

Power studies performed for the project have identified a stand-alone gas fired power station as the most economic and environmentally acceptable power solution. This is due to the isolation of the site and thus the high cost of running a 330 kV overhead transmission line from Geraldton. Due to water restrictions, a single cycle gas-fired power station will be utilised to supply the project's power needs. The power station will be modular in nature and will accommodate future expansion requirements as production rates increase.

The generating units will primarily run on gas but will be capable of switching to diesel fuel as and when required. A heat recovery system will be incorporated into the generation side of the power station in order to minimise operating cost.

Power for the camp and borefield will be provided by an overhead transmission line from the power station. Solar power to heat water and provide street lighting for the camp will be investigated as an alternative power option.

5.12.5 AIRPORT

A CASA certified airport will be designed as all weather operating facility, to service Code 3C aircraft carrying approximately 80 passengers. The fully sealed runway will be 2,100 meters in length and the parking apron will have capacity to accommodate two jet aircraft positions.

A prefabricated terminal building will accommodate seating for 50 passengers inside and 50 passengers outside under a shaded area.

5.12.6 LIGHT VEHICLE ROADS

The primary access to the Jack Hills mine will be from the Great Northern Highway, branching at Cue due North and arriving at Jack Hills mine after approximately 205 km. The last 20 km of this road, from Bucklebra Well to the mine site will be sealed.

The all weather road connecting the mine airport and the mine village will be sealed and elevated one metre above the flood plain. The roads from the airport and village to the plant will be built to Main Roads WA standards, with 110 km/hr design speed (although nominated speed limits will be lower) and heavy duty traffic loading. The roads will typically have a 7.4 m pavement and a 3.0 m shoulder on each side. These roads will be designed with culverts for a one in 100 year rainfall event and will be passable even in case of a severe cyclonic condition.

Unsealed roads will be constructed around the mine site to support mining activities and lightly serviced utilities. Unsealed roads are proposed for servicing and maintaining the mine borefields and the gas pipe line. Public access to the mine servicing roads will be discouraged.

5.12.7 SERVICES CORRIDORS

There will be two services corridors from:

1. Jack Hills to the DBNGP; and
2. Jack Hills to Weld Range.

The Project includes a 50m wide pipeline footprint within a 100m wide corridor from the DBNGP to the Jack Hills mine site (Figure 5-5; 220 km). The pipeline corridor will include a buried natural gas pipeline and water pipeline with associated above ground facilities. Options for having above ground water pipeline are being considered to reduce the commercial costs associated with a below ground pipeline. Prior to this option being endorsed, environmental considerations and mitigation measures will be investigated including impacts to surface hydrology and fauna and vegetation.

Additional temporary construction areas may be required for camps, turnaround areas, access tracks, and laydown areas.

A 50m wide services footprint within a 4.1 km wide corridor is proposed from existing services termini at Weld Range traversing north approximately 120 km to the Jack Hills mine. The corridor could potentially support power and water lines and would include an unsealed access track. The corridor will run immediately adjacent to the proposed Oakajee rail route and follows high ground which is not subject to flooding. Additional temporary construction areas may be required for camps, turnaround areas, access tracks, and laydown areas. The proposed location for the corridor is shown at Figure 5-6.

Access within all corridors will be via unsealed service road suitable for 4WD light vehicles. As required for maintenance purposes, the road will be capable of carrying cranes and heavy service vehicles. Where possible, all service roads will be maintained at or near grade and follow the contours of the corridor in order to minimise disruption to natural overland water flow. Once all pipelines are installed there will be minimal physical impact to the land and associated vegetation.

1:750,000 (at A3)

0 3.75 7.5 15 22.5 30 37.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

LEGEND

- Jack Hills Mine Site
- Proposed Natural Gas Pipeline
- Dampier-Bunbury Natural Gas Pipeline (DBNGP)

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CROSSLANDS

Crosslands Resources Ltd
Jack Hills Expansion Project

Job Number 61-2379603
Revision 0
Date 14 JAN 2010

Proposed Jack Hills to DBNGP Services Corridor

Figure 5.5

GHD House, 239 Adelaide Terrace Perth WA 6004 T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

LEGEND

Jack Hills Mine Site

Proposed Service Corridor Alignment

1:500,000 (at A3)

0 2.5 5 10 15 20 25

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Crosslands Resources Ltd
Jack Hills Expansion Project

Proposed Jack Hills to
Weld Range Services Corridor

Job Number	61-2379603
Revision	0
Date	14 JAN 2010

Figure 5.6

G:\61\23796\GIS\... Fig5-6.mxd

GHD House, 239 Adelaide Terrace Perth WA 6004 T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

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Data Source: Landgate: Travellers Atlas - 2004; Crosslands: Proposed Service Corridor Alignment - 20090821; GA: Topo 250k Series 3 Topographic Data - 200607; GHD: Jack Hills Minesite - 20090420. Created by: srlan, crosch2, slee2, adavis, KDIRALU

5.13 WATER

5.13.1 WATER REQUIREMENTS

Water, required to support construction activities, will be sourced via the current operations borefield and Murchison Palaeochannel aquifers located alongside the Murchison River and close to the Project site. Up to 1 GL of water will be required for construction activities. Water investigations have shown that adequate quantities of water are available from the aquifer.

Groundwater is being assessed for potential to supply water to the project during operations. The project's proposed 37 GL per annum water is based on the 'base case' three module processing plant. A Dynamic Water Model is being prepared for the site, which will confirm the water requirements.

The borefields will consist of a network of production bores and associated buried pipelines, access tracks, and potential power generation facilities. A monitoring bore network will also be established. Additional temporary construction areas may be required for camps, turnaround areas, access tracks, and laydown areas.

The projected water requirement will be utilised in the following areas:

- ore processing; and
- potable water for mine, plant, village and airport.

The majority of water required will be used in the ore processing area and a combination of saline and fresh water is expected to be used. Where possible, water will be reclaimed and reused to maximise the most efficient use of water. Small amounts of water (in combination with other dust suppressant products) will be used for dust suppression during ore processing, on stockpiles and roads and for the amenities. Dust suppression in the plant and mine will generally be performed by a combination of fixed water sprays in the process plant and water spray trucks for roads within the plant and mine.

Iron concentrates will be thickened and filtered to remove water prior to stockpiling and train loading. This water will be returned to the process circuit. Tailings will be dewatered either by thickening and filtering or by dewatering in a conventional tailings dam. Water will be recovered and returned to the process circuit. The final water recovery circuit will be the subject of optimisation studies examining costs, geotechnical conditions, topography and water usage.

Wherever possible, water will be recovered and re-used to minimise consumption. The re-use of water will be determined by the quality of the water and by the operation being performed, e.g. dust suppression on roads and ore stockpiles will use saline water while dust suppression of concentrate products will require fresh water.

Potable water for drinking and amenities will be supplied from a small water treatment system directly fed from the bore water system and located in proximity to the camp. Potable water will be required for the mine, plant, village and airport.

To ensure drinking water quality, a package reverse-osmosis plant will be used to produce potable water and this will be piped to all required outlets. The brine produced by the reverse-osmosis process will be mixed with the ore processing water stream. Potable water will be stored in a product tank ready for distribution around the site.

Sewage effluent from the mine, plant, village and airport will be pumped and piped to a central package treatment plant. The treated water from this plant will be used for irrigation as appropriate or re-used as ore processing water. Grey water re-usage will be investigated.

5.13.2 PIT DEWATERING

Groundwater studies indicate that peak groundwater flows will reach 63 L/s when the pit reaches a depth of 50 to 100m below the surrounding plain (Aquaterra, 2010; Appendix B). Pit inflows during the first 12 years of operation will be small, totalling less than 6 L/s from local perched water tables. After 12 years of operation the northern end of the mine will be advanced below the surrounding area with inflows rising to 53 L/s. After 15 years inflow, rates are likely to vary between 52-63 L/s through to the end of the mine life.

The bulk of the dewatering will be undertaken via a number of bores located in and around the perimeter of the pit. Diffuse inflows from walls will be directed to in-pit sumps for transfer to retention ponds where it will be used for dust suppression and the excess will be used in the process water circuit. The sumps will be excavated from areas of the pit floor. These areas will be advanced at least one bench below the current operation. Water from the pit dewatering is estimated to be up to 4 GL per year.

Piezometric pressure in the pit walls will be measured as part of the on-going mining operation and the drainage design developed to ensure pit wall stability.

5.13.3 SITE DRAINAGE AND FLOOD PROTECTION

The Project processing plant pad and its key infrastructure have been located above the 100 year flood level, using selected fill obtained from the mine pre-stripping activities. The processing plant will have a system of water drains to collect excess water and direct it to the raw water pond for further use. The raw water pond will be constructed from compacted mine waste, graded *in situ* and High Density Polyethylene (**HDPE**) lined to provide impermeable containment.

It has been demonstrated through preliminary hydraulic modelling that the IWL facilities will be impacted from regional flooding of the Murchison River for a selected range of ARI flood events (20, 50 and 100 years). The location of the IWL in relation to predicted flood levels is provided in the Golder (2009b) report. However, as flood velocities are expected to be relatively low excessive erosion of the facilities is not expected (Golder, 2009b). The IWL will be armoured to resist erosion from flood events and surface water flows resulting from rainfall events up the PMP. The surface cover, drainage lines and downstream toe of the embankments will be constructed from erosion-resistant hard rock waste. Embankment erosion will also be controlled by the formation of a concave outer embankment profiles that mimic that of the nearby Jack Hills Range.

Drainage structures will be constructed within the tailings cell walls to handle runoff from a 100 year rainfall event. Rain within the tailings dam cell will run off to decantation ponds and returned to the plant processing circuit.

There will be enough capacity in the tailings dam decantation ponds to retain all excess water and return it to the process. There will be no discharge of excess water to the Murchison River or surrounding environment.

As shown in Figure 5-3, there is provision for site drainage in the north east corner of the site. This area supports natural drainage channels that exit the Jack Hills Range towards the area of the processing plant. In addition, linear infrastructure, such as the rail and services corridor, also intersects the area. While specific drainage structures (i.e. culverts) are not designed at this stage it is anticipated that water drainage will likely be redirected to bypass and protect CRL infrastructure, and ensure natural water flow is not obstructed.

6. PROJECT JUSTIFICATION AND ALTERNATIVES

6.1 RATIONALE AND BENEFITS OF THE PROJECT

Australia is the world's largest exporter and the world's third largest producer of iron ore (with 17%) after China (21%) and Brazil (20%). Although iron ore resources occur in all of the Australian States and Territories, almost 90% of identified resources occur in Western Australia.

Iron ore, the raw material used to produce iron and steel provides the foundation for one of Australia's major export industries. During the 2007-08 financial year (**FY**), 290.51 million tonnes of iron ore was expected from Western Australia, accounting for 35% of the total annual value of mineral and petroleum sales (state of Western Australia, 2008). This represented an increase in sales of 13% from the previous year. In the 2008-09 FY Western Australia exported 316 million tonnes of iron ore, representing a 53% increase in sales from FY2007-08 and worth A$33.6 billion. Due to the proximity of Western Australia to the high-growth Asian economies, sea borne trade in iron ore is established and is expected to show continued growth.

Western Australia's economy is heavily dependent on mineral resource projects, and its future growth and development rely on the continued viability of resource development projects. The Project will provide environmental, social and economic benefits for the area through employment, infrastructure and flow-on effects to the non-mining sector. Environmental benefits will include:

- participation in the DEC-GIOA partnership to value-add to regional environmental management initiatives;
- on-going local management of feral fauna;
- increased knowledge of local environmental values through on-going surveys and research initiatives.

The Project will result in further substantial regional and State economic and social benefits, including:

- investment of capital into Western Australia's regional and state economies;
- major port and rail infrastructure construction in the mid-west region;
- positive contribution to Indigenous training and business opportunities in the mid-west region;
- increasing demands for goods and services creating business and employment opportunities;
- additional Commonwealth and State Government revenues through collection of additional royalties, taxation and other charges; and
- increased export value of Western Australian iron ore to international customers.

From an economic standpoint the Project will provide both direct and indirect employment opportunities in the mid-west region, as well as substantial investment in infrastructure.

CRL currently employs approximately 50 people at the Jack Hills mine and a further 320 people in total working on CRL sites (including Cuddingwarra Stockpile Facility at Cue and the Geraldton Port Facility) through major contracts for catering, mining, transport and maintenance.

Construction of the Jack Hills Expansion Project will require a temporary workforce of around 2500 people in total. CRL will employ approximately 1200 people at any one time for on-going operations over the life of mine. An additional workforce will be associated with the transport of the ore and the stockpile facility based at the Oakajee Port facility.

CRL is committed, as part of a social assessment program, to engage with service providers, especially education, accommodation, and health services, in order to afford these organisations the opportunity to prepare for any impacts associated with the proposed development.

6.2 PROJECT ALTERNATIVES

All feasible alternatives have been and will be considered during the design and planning stages of the Project to:

- avoid, and where this is not possible, minimise adverse environmental impact; and
- prevent or minimise pollution (including greenhouse gas emissions).

6.2.1 MINE OPERATIONS

Assessments have been conducted between different mining options. These options included assessment of the following areas to produce the preferred mine plan, which has been assessed in this PER:

- Optimal Production Rates: the three module case was adopted as the base case.
- Ultimate Pit Size.
- Equipment selection.

6.2.2 INFRASTRUCTURE

The mine infrastructure includes a range of ore treatment areas, roads, tailings dam, camp, air strip and storage sites. All of this infrastructure will be located on the northern side of the Jack Hills Range in areas that are considered to have relatively low environmental significance, and out of the 100 yr ARI flood zone of the Murchison River.

6.2.3 WATER SUPPLY

CRL has investigated several water supply options to meet project requirements and further work is planned to confirm the final configuration of water sources. Options considered include:

- three separate Calcrete and Tertiary palaeochannel aquifers of the upper Murchison River in the vicinity of the mine (Figure 5-1 and Appendix B; Aquaterra 2010);
- importation of water from the sediments of the southern Carnarvon Basin, approximately 200 km west of the mine (Figure 5-1 and Appendix B; Global Groundwater 2010); and
- use of pit de-watering water from other mines in the area.

Investigation and modelling of the calcrete and tertiary palaeochannel aquifers has revealed that a significant portion of the project's water requirements could be sourced from these aquifers. In addition, the water quality is acceptable for processing and potentially for final process washing.

The borefields will consist of a network of production bores and associated buried pipelines, access tracks, and potential power generation facilities. A monitoring bore network will also be established. Additional temporary construction areas may be required for camps, turnaround areas, access tracks, and laydown areas.

Investigation work is underway to assess the potential for supply of additional water from the sediments of the southern Carnarvon Basin. This water will be piped to site in a pipeline located within the same corridor as established for the gas pipeline.

Early discussions with other mining companies have indicated a potentially significant water supply from pit dewatering activities. Issues such as water quality, annual volumes and continuity of supply have still to be confirmed. However, should this be confirmed as a viable option for CRL, effort will be put into developing this supply option. Water will be piped to site in a buried pipeline located in the Jack Hills to Weld Range services corridor.

6.2.4 INTEGRATED WASTE LANDFORM

A range of location options have been considered for the mine waste and wet tailings based on topography, ease of construction, potential environmental impacts and aboriginal sites. The location chosen on the plain north of the Jack Hills Range offers the least environmental impact in relation to identified biological features on the range. In addition, processing waste (i.e. tailings fines) storage options were considered as follows:

- integrated waste disposal facility: co-disposal of tailings fines and waste rock;
- dry stacking of tailings (moisture content of fines to be less than 15%); and
- partial back-filling of the pit(s).

Site Selection

As part of the Golder Associates (2010) tailings and waste storage assessment, options for potential IWL sites were identified and assessed. As part of the study nine candidate sites for tailings and waste storage were identified.

Of the nine sites considered, four sites (sites 2, 5, 7 and 8) were ruled out on the basis of their capacity, long distance from the mining operations compared to alternative sites, or their potential to sterilise future resources. The five remaining sites were considered in terms of their potential to accommodate various tailings and waste storage options. The sites were assessed in tandem with various options associated with tailings thickening and transport, coupled with implications on mine waste management.

The assessments considered relative economic, technical risk and each options ability to satisfy the Key design and environmental compliance criteria. These criteria consisted of:

- The release of contaminants should be managed to avoid degradation of the surface water and/or groundwater quality, to the extent that the future uses of this waste may be compromised.
- Impacts on areas of aboriginal heritage, and priority flora and fauna communities should be avoided to the extent possible.
- Dust generation from the landform is to be controlled both during operation and post-closure. This should extend to the ability to implement controls on the liberation of respirable fibres from the surface of the tailings should asbestiform minerals be identified at levels of concern within the tailings.
- The short and long term safety and stability of the waste landform is to be maintained.
- The waste landform is to be designed so that it integrates aesthetically into the surrounding environment, as far as is practicable.

The most favourable site (Site 1) was partially situated on a tenement currently leased by Sinosteel Midwest Corporation (**SMC**). An executive decision was made to relocate the IWL to the next best position (the current proposed location) that did not require gaining access to the SMC tenement to ensure the project proceeded to schedule. This is the current location of the IWL referenced throughout this document and shown at Figure 5-3.

CRL is currently progressing negotiations to access part of the SMC tenement, which was identified as the preferred location for the IWL. Acquisition of this tenement area will provide opportunities to design a more compact IWL. Further studies are underway to determine whether this option will be viable, however relocation of the IWL will not increase the overall Project footprint, and may result in a footprint reduction if the IWL can be compacted. Furthermore, the only additional land outside the current potential impact area is the SMC tenement.

To accommodate the relocation of the IWL the following will be required:

- Relocation of the process plant.
- Relocation of the process plant power station.
- Rerouting of gas supply lines.
- Rerouting of water supply lines.
- Elimination of new process plant access road.
- Relocation of the rail loop and associated train load-out station.
- Acquisition of adjacent tenement from SMC.
- Reorientation of the airport to a more favourable position.

The alternative location of the IWL is shown at Figure 6-1, along with the relocation of infrastructure features.

6.2.5 POWER SUPPLY

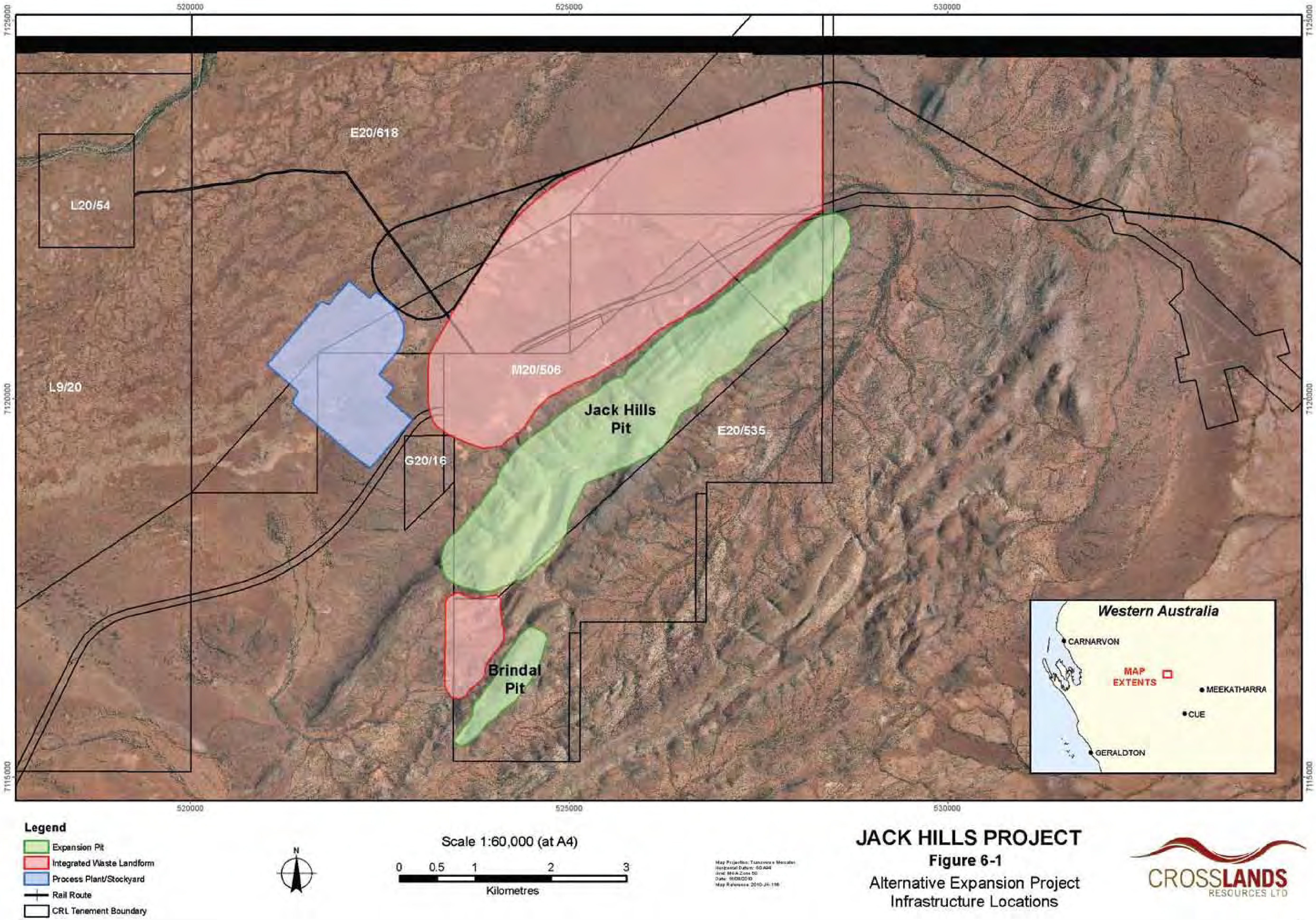
Three fuels, namely coal, diesel and gas, were considered for the generation of power. Carbon dioxide equivalent emissions were calculated and gas was chosen as the most sustainable option to use (Appendix D). This is discussed in Section 9.11.

6.2.6 SERVICES CORRIDORS

Two options for the gas pipeline have been considered, using a desktop and initial engineering assessment. These options are provided at Figure 6-2. The options for the proposed services corridors were considered based on:

- avoiding topographic features;
- avoiding the 70km buffer for the Square Kilometre Array (**SKA**) proposed communications system;
- following station boundaries where possible;
- placing the corridor above drainage areas and potential flood zones;
- consultation with pastoralists;
- avoiding known Registered Aboriginal Heritage sites; and
- heritage surveys.

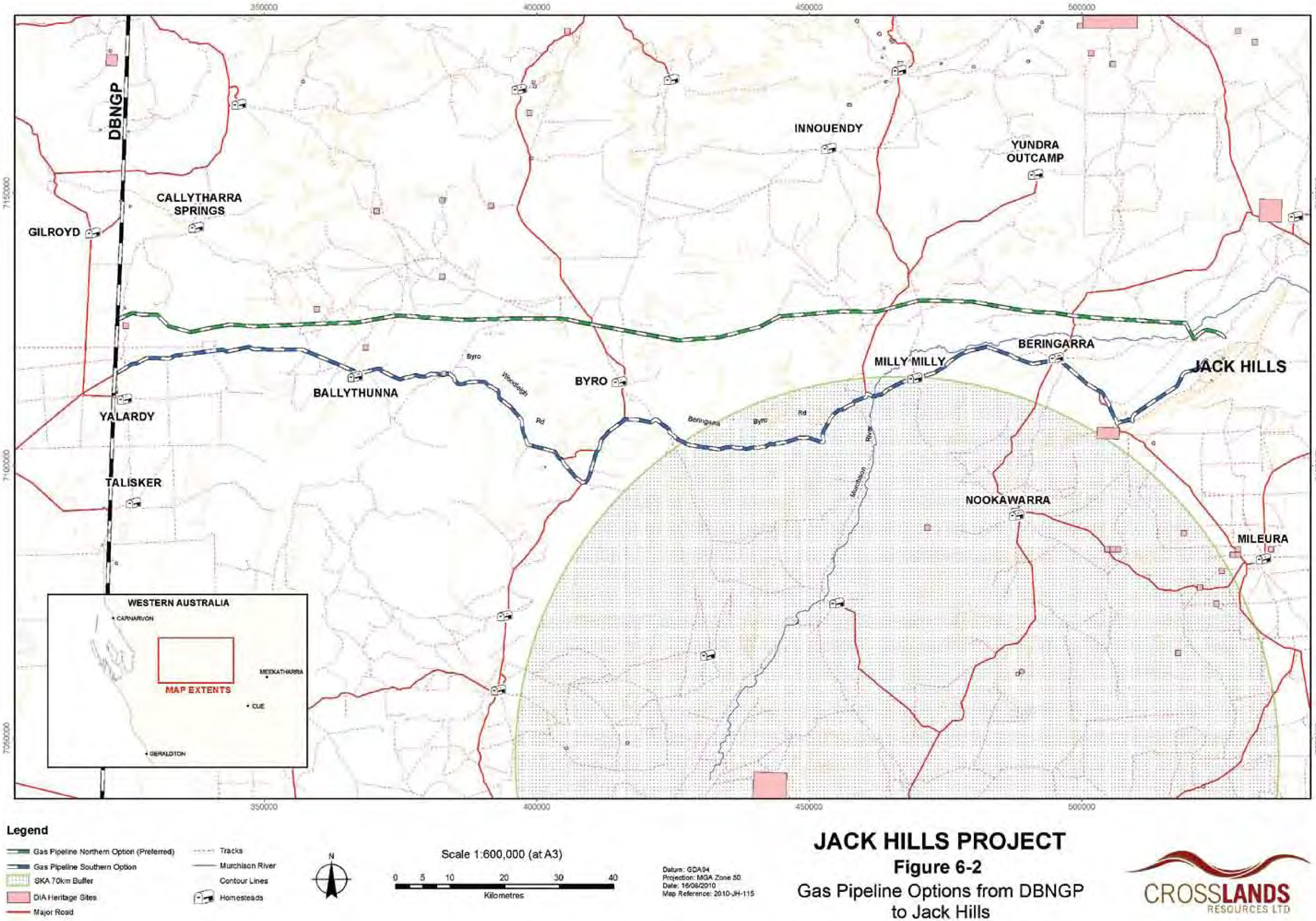
A decision was made to align the Weld Range Services Corridor adjacent to the proposed Oakajee rail. The proposed location for the corridor is shown at Figure 5-6.



JACK HILLS PROJECT

Figure 6-1

Alternative Expansion Project Infrastructure Locations



JACK HILLS PROJECT

Figure 6-2

Gas Pipeline Options from DBNGP to Jack Hills

7. SUSTAINABILITY AND ENVIRONMENTAL PROTECTION

The EPA has developed two key position statements to provide the proponent with direction on incorporating sustainability. These two positions statements are:

- No. 6: Towards Sustainability; and
- No. 7: Principles of Environmental Protection.

The objective of this chapter is to assess the Project design and management measures against the principles of environmental protection.

7.1 PRINCIPLES OF ENVIRONMENTAL PROTECTION

Section 4A of the *Environmental Protection Act 1986* establishes five principles of environmental protection, which have been expanded upon in EPA Position Statement No. 7 (EPA, 2004). Table 7.1 presents these principles and outlines how CRL have addressed, or propose to address, these principles in the development and implementation of the Project.

TABLE 7.1 PRINCIPLES OF ENVIRONMENTAL PROTECTION

Principle of Environmental Protection	Proponent's Response
The Precautionary Principle	CRL have undertaken extensive investigation of the biological and physical environments to ascertain the existing environment, assess risk and identify measures to reduce and/or avoid potential impacts. These investigations demonstrate that impacts can be avoided, or where this is not possible, mitigated to ensure that an acceptable level of impact is achievable.
The principle of intergenerational equity	CRL has demonstrated its commitment to sustainable development through: • measures to protect the biodiversity of the Project area; • progressive rehabilitation of disturbed areas and establishment of stable final land forms; • contribution to weed control and feral animals; and • policies to support commercially competitive local suppliers and contractors, wherever possible.
The principle of the conservation of biological diversity and ecological integrity	The biological and physical assessments CRL have undertaken for the Project have contributed to the understanding and management of the impacts of the mining operations on the biodiversity and ecological integrity of the area. The biological diversity of the region will not be adversely affected as a result of the Project proceeding.

Principles relating to improved valuation, pricing and incentive mechanisms	Environmental factors have played an important role in the decision making process for the Project. Environmental factors have been considered when locating infrastructure, roads and waste disposal facilities.
The principle of waste minimisation	All reasonable and practicable measures will be undertaken to minimise the generation of waste and its discharge to the environment. Waste management principles of avoid, reuse, reduce, and recycle have been applied to the design of the Project.

8. DESCRIPTION OF EXISTING ENVIRONMENT

8.1 CLIMATE

The study area is located within the western Murchison region of Western Australia. This region has a dry climate with hot dry summers that lasts on average five to six months and mild winters (Bureau of Meteorology (**BoM**), 2009). The climate of this region is strongly influenced by a band of high pressure known as the sub-tropical ridge, and in the warmer summer months by a trough of low pressure extending southwards from the heat low in the tropics.

The closest weather recording station to the Jack Hills mine site is at the Meekatharra Airport. This recording station is approximately 100 km to the south east of the Jack Hills project. Recorded climate data for the Meekatharra Airport has been summarised below:

- Mean Maximum Temperature Range: 38.3º C (January) to 19.0º C (July)
- Mean Minimum Temperature Range: 24.3º C (February) to 7.4º C (July)
- Mean Annual Rainfall: 235.8 mm
- Mean Annual Number of Rain days per year: 45.8 days

(Source: Bureau of Meteorology – Climate Averages for Australian Sites: Averages for Meekatharra, 2009)

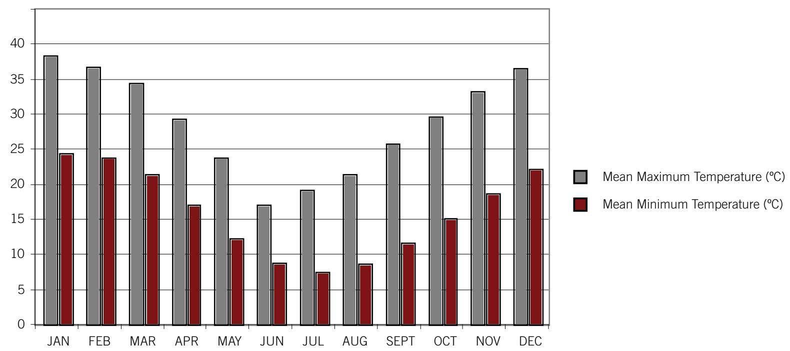


FIGURE 8-1 AVERAGE MONTHLY MAXIMUM AND MINIMUM TEMPERATURE AT MEEKATHARRA AIRPORT

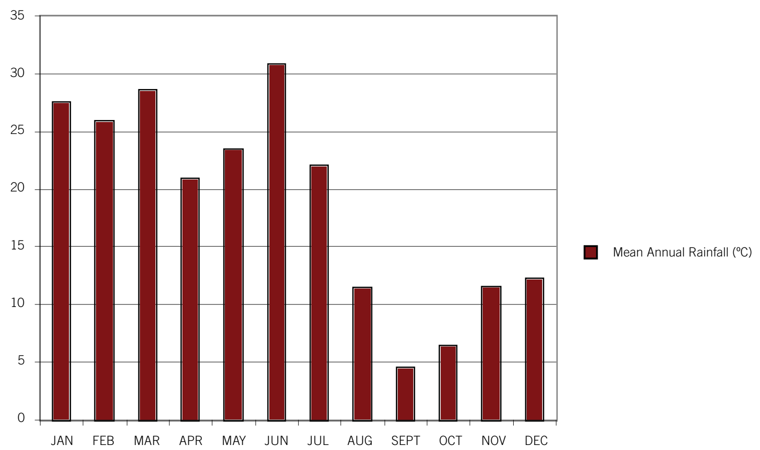


FIGURE 8-2 AVERAGE MONTHLY RAINFALL (MM) AT MEEKATHARRA AIRPORT

For most of the year, the subtropical ridge is located to the south, and east to southeast winds prevail in the area. Summer rainfall, which peaks in January and February, is influenced by cyclonic activity off the Pilbara coast of Western Australia. Cyclones that cross the coast dissipate and develop into rain bearing depressions which often bring heavy rain to the centre of the region. In the cooler winter months, it is possible for the ridge to move far enough to the north that cold fronts are able to pass over the region. Most cold fronts deliver little rain to the area. However, they can be linked to tropical cloud bands that deliver the most reliable rain from May to July.

The available wind rose information from Meekatharra Airport (BoM, 2009) indicates the prevailing winds as:

- Summer: easterly in the morning and easterly, south-easterly in the afternoon;
- Autumn: easterly, north-easterly in the morning and easterly, south-easterly in the afternoons;
- Winter: easterly, north-easterly in the morning and westerly, north-westerly in the afternoon; and
- Spring: easterly in the morning and westerly, north-westerly in the afternoon.

8.2 GEOLOGY, LANDFORMS AND SOILS

8.2.1 REGIONAL GEOLOGY

The Jack Hills rise up to approximately 300 m above the flat plains of the Murchison River, which is between 400 to 450 m above sea level. The hills extend for approximately 60 km, arcing north-east to south-west. The Jack Hills occur along a thin greenstone belt, within the granitic rocks and granitic gneisses of the Narryer Terrane (Aquaterra, 2010). The dominant lithologies include Banded Iron Formation (**BIF**), chert, quartzite, mafic and ultramafic rocks and siliciclastic rocks (Spaggiari, 2007 in Aquaterra, 2010).

The Jack Hills deposit comprises three main groups of rocks: Banded Iron Formation, Massive Iron Mineralisation, and mafic to ultramafic dykes and sills. All of which are flanked to the northwest by a massive granitic body.

The rocks are broadly similar to other Archaean greenstone belts in the Yilgarn Block in structural style and metamorphic grade. Unlike most typical greenstone belts there is little outcrop of mafic/ultramafic or felsic volcanic material, instead significant clastic meta-sedimentary sequences are exposed.

The BIF units and massive iron lenses which make up the Jack Hills ore types form the prominent ridge lines. The ridges rise above the surrounding granite flat lands, ranging from ~530 m RL to ~697 m RL at the highest point at Mt Hale.

Massive Iron Mineralisation (**MIM**) occurs in outcrop as pods and veins as ridges or bands within the BIF stratigraphy. Iron enrichment zones are observed locally at surface and within the oxidised surface domains.

In the Mt Hale sequence, rocks that intervene with the BIF units are predominantly mafic and ultramafic rocks and dominated by intrusive dolerites, which appear to be largely conformable with the BIF rocks.

The weathering profile thickness through the deposit is highly variable, influenced by lithology and the intensity of folding, and becoming more pervasive within the altered ultramafic, mafic and meta-sedimentary units.

A number of Tertiary, younger weathering products and colluvium deposits occur in the Jack Hills area and drape off the flanks of the ridges. Cemented canga deposits are developed near, and down slope from the massive hematite outcrops.

Perched water tables have been intersected during exploration drilling.

An overview of the geology is provided at Figure 8-3 and a schematic geological section through the project area is presented in Figure 8-4.

FIGURE 8-3 JACK HILLS GEOLOGY

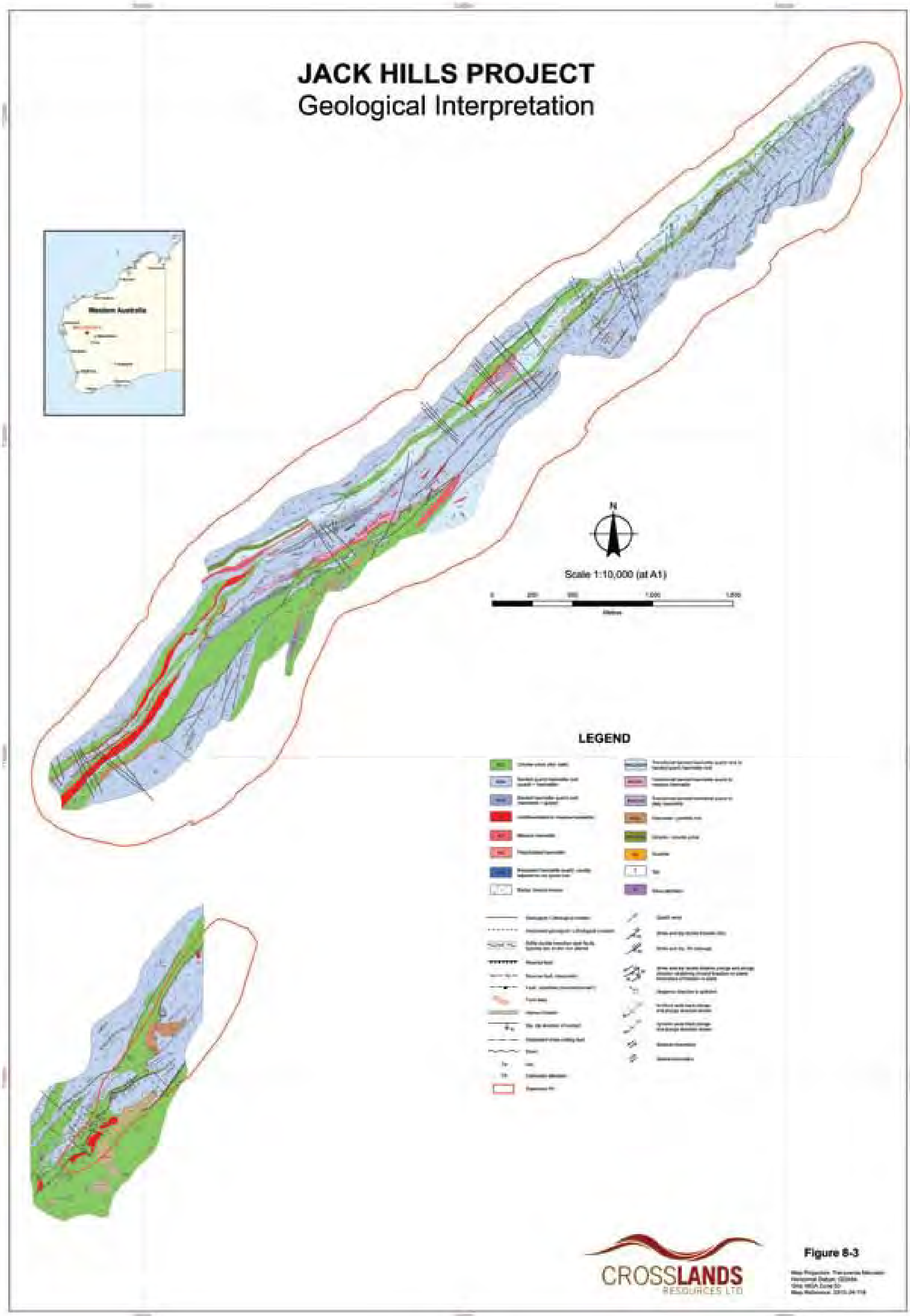
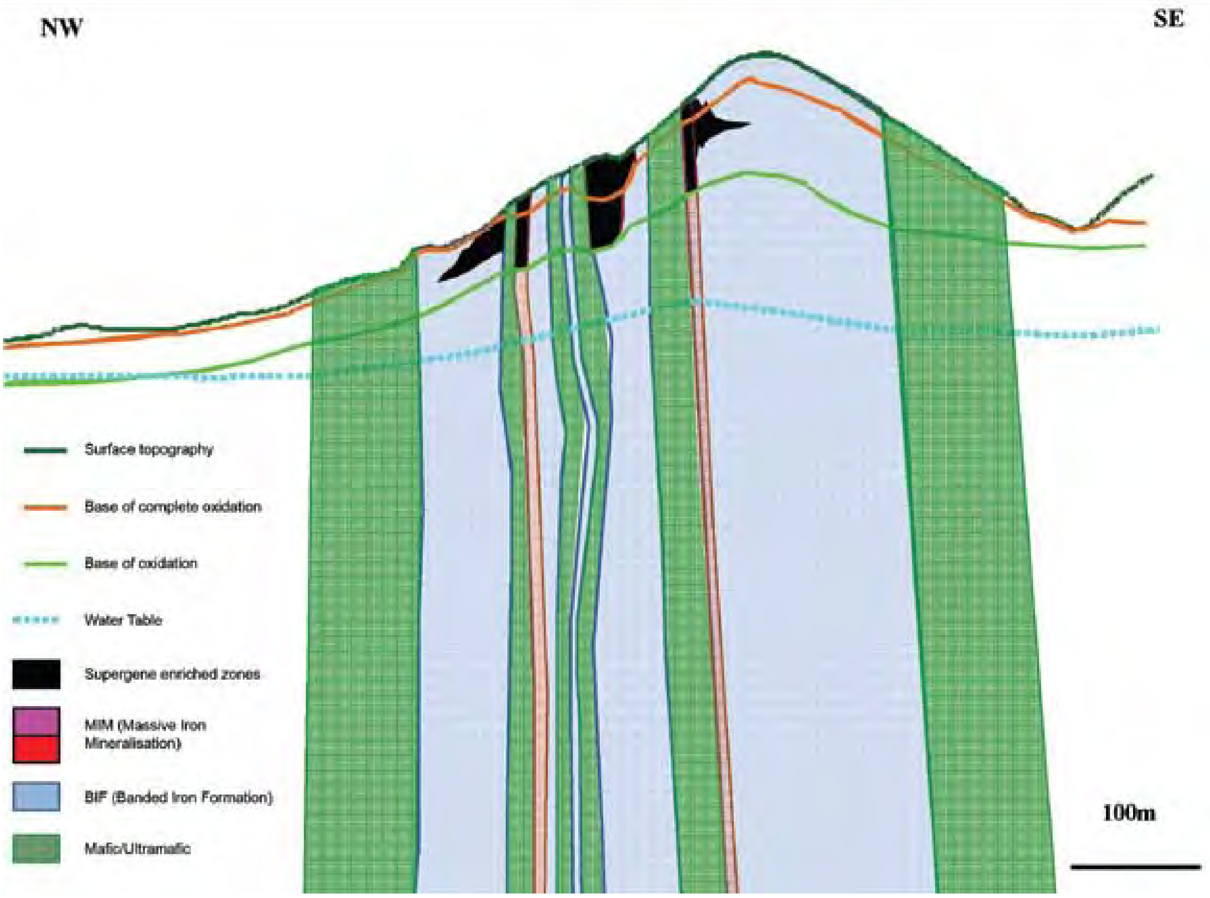


FIGURE 8-4 SCHEMATIC GEOLOGICAL CROSS SECTION



8.2.2 LAND SYSTEM CLASSIFICATION

The Project is situated across three land systems mapped by Curry et al. (1994):

- Weld Land System,
- Yarrameedie Land System; and
- Flood Land System.

These land systems are described in Table 8.1.

TABLE 8.1 SUMMARY OF LAND SYSTEMS OCCURRING IN THE PROJECT AREA

Land System (Total area in Murchison)	Land Type	Description	Landform Units and Proportion (%) of Land System
Weld (350 km^2)	1: Rough hills with Acacia spp. shrublands.	Rugged ranges and ridges of mainly Archaean metamorphosed sedimentary rocks; supports Acacia spp. shrublands; major system of the Weld Range and Jack Hills.	(1) Mountain ranges, peaks and summits (50%) (2) Footslopes and interfluves (40%) (3) Valley floors (10%)

Yarrameedie (519 km^2)	3: Low hills and quartz strewn plains with mulga shrublands	Undulating stony interfluves, drainage floors and pediment (foothill) plains below major ranges of crystalline rocks (mainly Weld Land System) supporting sparse mulga shrublands.	(1) Footslopes and hill spurs (40%) (2) Stony plains and interfluves (50%) (3) Alluvial fans (5%) (4) Drainage floors and creeklines (5%)
Flood (439 km^2)	13: Wash plains and sandy banks on hardpan, with wanderrie and mulga shrublands	Hardpan wash plains with long, interconnected wanderrie banks supporting mulga and wanderrie shrublands; mainly in catchment of Wooramel River and further north.	(1) Sandy banks (30%) (2) Sand sheets (10%) (3) Hardpan plains (50%) (4) Drainage tracts (10%)

The majority of the Project falls within the Weld Land System (Ecologia, 2009a). The Weld Land System is composed of three major landform units, all of which occur within the Project area (Ecologia, 2009a). These are described below:

- Mountain ranges, peaks and summits – characterised by rugged ironstone and jaspilite ranges occurring as parallel strike ridges; extensive outcropping of ironstone and jaspilite and dense mantles of stones and cobbles on slopes; soils predominately skeletal lithosols confined to pockets of dark red loamy or clayey sands with infrequent clay subsoil's less than 50cm deep, overlying metamorphic parent material.
- Footslopes and interfluves – characterised by broad concave inclines; minor interfluvial slopes between parallel drainage lines; generally covered with dense quartz or ironstone mantles; soils are reddish-brown or dark red shallow earths less than 50 cm deep with varying metamorphic rock fragments.
- Valley floors – occurring between ridges; creek channels incised into bedrocks; soils are red earthy sands overlying various metamorphic substrates less than 50 cm deep (Curry *et al.*, 1994).

8.2.3 SOILS

The soils of the Project area vary considerably from the rocky, ironstone of the range to unconsolidated colluvium on the plain below. The dominant soil types in the Project area are as follows (Geological Survey, 1983):

- Mine pit area - Banded iron formation (Aiw) and banded chert (Aic).
- Waste dump and processing area – Adamellite and granodiorite gneiss (Ang) on the northern footslopes of the range; laterite with massive and pisolitic ferruginous duricrust (Czl) on the outwash areas below the range; colluvium, quartz and rock fragments in loam, unconsolidated, forming scree and talus slopes (Qc) further out from the range; and colluvium and alluvium, unconsolidated sand and silt in sheetwash plains, with low windblown sandbanks (Qw) towards the Murchison River.

Particular soils which may be of environmental concern are discussed below.

8.2.3.1 ACID SULPHATE SOILS

Acid Sulphate Soils (**ASS**) are naturally occurring soils containing iron sulphides. These soils are typically benign within an anaerobic environment. However, when they become oxidised through disturbance, acidification of soil and groundwater can occur. The resulting sulphuric acid can also break heavy metal bonds, releasing metals such as aluminium, iron and arsenic into the groundwater.

A review of the Australian Soil Resource Information System (CSIRO, 2009) indicates that there is low to extremely low probability of ASS occurring within the Project area. The risk of ASS occurrence in the vicinity of the Murchison River across which the gas pipeline is proposed to be constructed, is considered low.

The geology of the area comprises unconsolidated silt, sand and gravels associated with watercourses (Alluvium). Field surveys along the gas pipeline route indicate that the Murchison River at the location of the proposed gas pipeline crossing is predominantly dry throughout the year with limited permanent pools. Given the limited excavation works required and the proposed pipeline installation methodology, using directional drilling, the risk of ASS occurrence at the Murchison River crossing site is considered inherently low.

8.2.3.2 ASBESTIFORM MINERALS

CRL's drilling program has confirmed the presence of asbestiform minerals below, and adjacent to Stage 1 mining operations. The presence of fibrous mineral (**FM**) is recorded in the lithology log. Some of this material has been identified as chrysotile and some as actinolite. CRL commissioned Golder Associates to complete a high-level review of the extent and geological setting of asbestiform material at the mine site in 2009 (Golder Associates, 2009a). The majority of FM identified to date is located within the central axis of the Project pit area. Exclusion of this area from the final pit design would have a very significant impact on the pit size. The majority of FM intervals are associated with magnetite along the north-northeast trending deposit. Approximately two-thirds of the chrysotile and actinolite-chrysotile are associated with talc shears. The FM intervals associated with hematite are actinolite (Golder Associates, 2009a).

Intersections of FM are limited in extent i.e. <1-2m, with the logged percentage of FM within those intersections being generally less than 1% and not more than 5%. Extent of intersections indicates that FM should be managed in accordance with standard dust control measures for mining. However, as it is likely that FM will be mined the CEMP and OEMP define what actions are to be undertaken to minimise risk of exposure of personnel where FM has been identified. A PFM register, including a 3-D map, for JHEP has been developed from CRL's extensive drilling database to identify the locations where FM have been intersected. This will enable predictive controls to be put in place in those areas where FM's are likely to occur.

Further work is required to determine whether actinolite intervals are asbestiform or non-asbestiform and whether the fibrous nature depends on the host iron mineral or proximity to talc shears. A management and decontamination plan including encapsulation within the IWL will be formalised as a greater understanding of localised potential for presence of asbestiform minerals is realised.

Monitoring during trial processing at Crosslands' Pilot Plant will be conducted to gain further understanding of the likely exposures to airborne dust and fibres prior to full-scale processing being undertaken.

8.2.3.3 ACID AND METALLIFEROUS DRAINAGE

Acid Rock Drainage (**ARD**) or Acid and Metalliferous Drainage (**AMD**) refers to the risks associated with the reaction of sulfide bearing minerals to air, water and microorganisms. Activities such as mining involve the excavation of rocks comprising sulfide minerals, and therefore have ARD risks. The drainage produced from ARD is generally acidic with significant concentrations of dissolved heavy metals.

SGS Lakefield Oretest (2009) completed a high level AMD study for the Project (Appendix C). The aim of the high level assessment was to determine the quantity of acid generating and acid neutralising minerals in the ore deposit, to indicate a net risk of acid drainage. The metallurgical test work program aimed to provide a reasonable validation to the high level assessment results. The study determined that there is a very low risk of acid drainage from the potential waste ores and beneficiation tailings for the Project (SGS Lakefield Oretest, 2009). There is also evidence to suggest a low risk of metalliferous drainage and elevated salinity from waste dump drainage (SGS Lakefield Oretest, 2009). A few small fringe areas of 'Potentially Acid Forming – Low Capacity' and even less 'Potential Acid Forming' material were identified.

SGS Lakefield Oretest (2010) undertook an extension study to validate the findings of the High Level Study by the distribution of AMD characteristics onto the Resource Block Model, thus providing a more realistic assessment of the expected tonnages of PAF and NAF materials present. The study involved analysis of a leading version of the potential mining Pit Shell (**PS**) (PS11). The waste material and Beneficiation Feed Ore were analysed for a suite of parameters: these are detailed in the full extension report contained at Appendix C.

The results of the extension study were consistent with the high level study:

- A very high proportion (99.8%) of total waste is NAF, and these are distributed widely across the resource. Therefore, it can be reasonably expected that this type of material will be consistently laid down on waste dumps and generally provide excess neutralising capacity.
- A very small proportion (0.2%) of total waste is PAF. These appear to be localised in discrete areas and may need to be specifically identified during removal to ensure they are adequately blended with excess neutralising capacity waste in the IWL.
- A very high proportion (97.5%) of the total process tailings is likely to be NAF and because of its widespread availability, should generally provide excess neutralising capacity in the tailings.
- A very small proportion (2.5%) of the total process tailings is likely to be PAF. These appear to be localised in discrete areas and may require special handling during processing to ensure excess neutralising capacity is available at the time.

Overall there appears to be excess neutralising capacity to acid potential at a ratio of eight to one in the waste ore and ten to one in the process tailings. Quantitatively, there are approximately seven million tonnes of excess neutralising capacity in the waste ores and 24 million tonnes of excess in the process tailings over the life of the mine.

The results of the extension study confirm that there is a very low risk of acidic drainage from the potential waste ores and beneficiation tailings for the Project. Further work (as outlined in the Acid and Metalliferous Drainage Management Strategy, Appendix A) is in progress to provide additional confidence and validation to the findings of the two studies.

8.3 HYDROLOGY

8.3.1 SURFACE WATER

Mine Site

Drainage within the Jack Hills area is dominated by the westerly flowing Murchison River and its tributaries. The Murchison River is located approximately 8 km to the north and north-west of the proposed Project pit at its closest point and approximately 1 km from the toe of the proposed waste dump. Surface runoff from the Jack Hills ridge enters the Murchison River via minor drainage lines and across the flat valley floor (Aquaterra, 2010). The surface water patterns are shown at Figure 8-5.

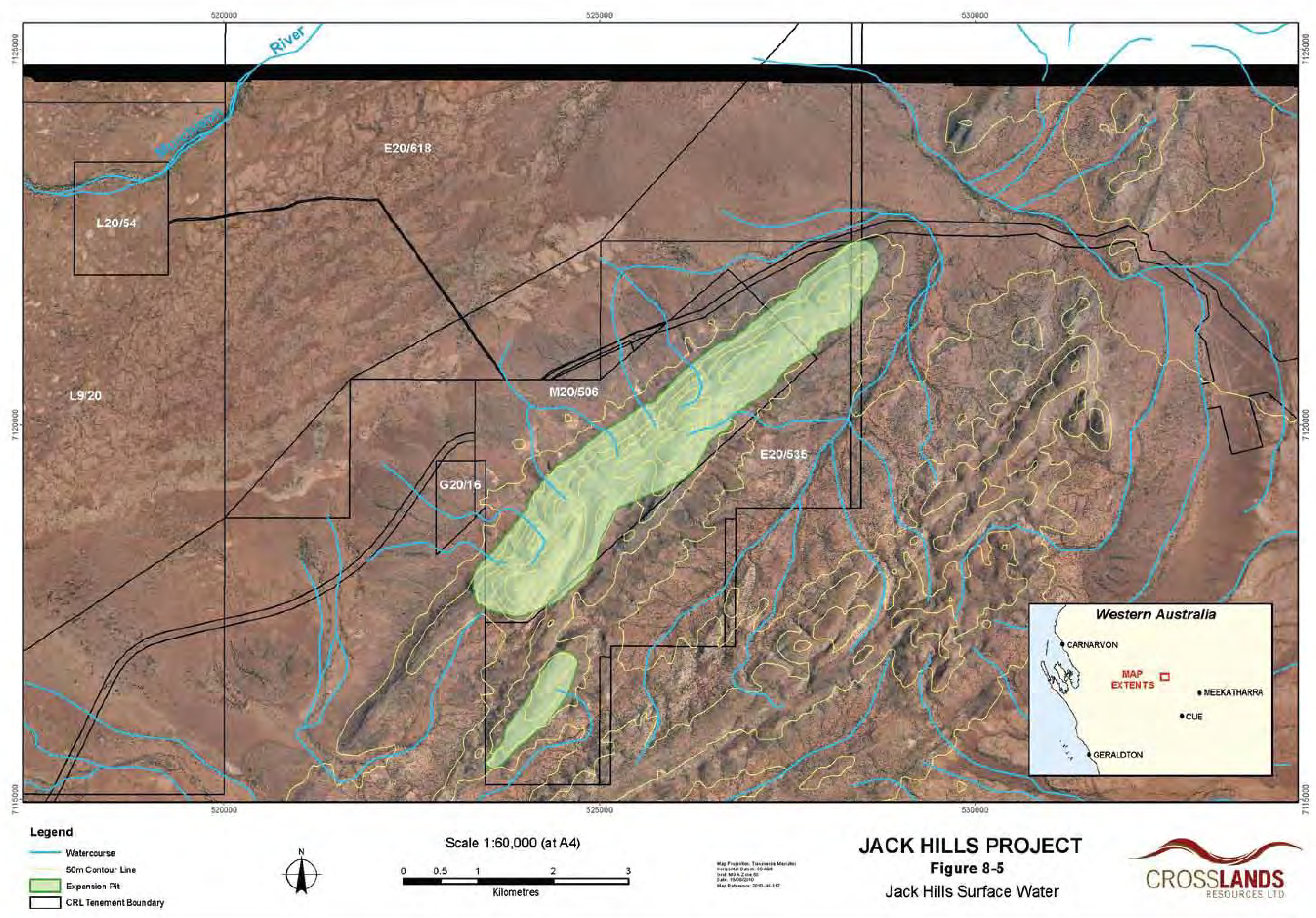
Ephemeral flow patterns leave rivers and creeks in the region dry for most of the year with occasional persistent pools occurring along watercourses. The Murchison River flows periodically, generally in response to intense rainfall, often associated with tropical lows between January to June (Golder Associates, 2009b) (Appendix B). Within the vicinity of the mine site, the Murchison River is not a single, defined channel, rather it is a highly dendritic drainage form (Golder Associates, 2009b). The Murchison River enters the valley defined to the east by Mt Gould in the north and Mt Taylor in the south as a braided river system. In the centre of the valley the extensive drainage network associated with the river converges to a single defined channel for approximately 15 km which is adjacent to the mine area. Within this area of the Murchison River, large disconnected pools exist within the channel. The flood plain of the river is extensive, with evidence of over-bank scouring and debris marks exceeding one to two kilometres either side of the river channel.

The Project is not located within a surface water area proclaimed under the *Rights in Water and Irrigation Act 1914*.

Gas Pipeline and Haul Road

Watercourses along the proposed gas and water pipeline route are ephemeral streams with variable flows predominately affected by seasonal conditions. One major watercourse is crossed by the pipelines, the Murchison River. All other watercourse crossings are minor ephemeral creeks. A desktop assessment identified two areas with potential for sheet flow to occur (Golder Associates, 2010; Appendix B). Most of the extensive hardpan alluvial plans are subject to intermittent sheet flow and have very low surface gradient.

The Jack Hills to Weld Range service corridor will require eight water crossings, which are expected to carry large flows of water across the corridor during flood events (Golder Associates, 2009b, 2010; Appendix B).



JACK HILLS PROJECT
Figure 8-5
Jack Hills Surface Water

8.3.2 HYDROGEOLOGY

The Jack Hills Mine is located on a northeast-southwest trending Archaean greenstone belt that is wedged between the Archaean granitic and gneissic basement. Calcrete and alluvial sediments infill the palaeochannel and modern drainage system of the Murchison River located to the north and northeast of the Project. The greenstone belt and underlying granitic basement form localised, relatively low-yielding fracture-rock aquifers. The calcrete and palaeochannel alluvium represent relatively narrow, continuous, moderate- to high-yielding aquifer systems (Aquaterra, 2010).

The aquifer systems in the vicinity of the Jack Hills area are thought to be recharged directly via rainfall. Given the arid climatic conditions of the area, the rate of groundwater recharge is likely to be very low, with the exception of the alluvial aquifers developed along the Murchison River, where stream water is likely to infiltrate during periods of flooding (Aquaterra, 2010). Generally, groundwater flows from the higher lying areas towards the main drainage lines and the regional groundwater flow is from east to west (Aquaterra, 2010).

Groundwater levels vary notably within the fractured-rock aquifers in BIF and greenstone belt making-up the Jack Hills range. Groundwater levels within the local area have been encountered at elevations of up to 500 m AHD, more than 120m above the levels in the surrounding lower-lying flood plains (Aquaterra, 2010; Appendix B).

CRL are investigating two groundwater sources to meet the projects water requirements (discussed in Section 5.13):

1. Calcrete and Tertiary palaeochannel aquifers of the upper Murchison River in the vicinity of the mine; and
2. Sediments of the southern Carnarvon Basin sediments approximately 200 km west of the mine.

8.3.2.1 QUATERNARY TO TERTIARY CALCRETE AND PALAEOCHANNEL ALLUVIAL AQUIFER SYSTEMS

Groundwater investigations have been undertaken along a 44km long strip of calcrete and alluvial sediments that infill the palaeo- and modern- drainage system of the upper Murchison River to the north and north-east of the Jack Hills mine. Exploration drilling showed the palaeo-channel to comprise a variable sequence of alluvial sediments consisting of clayey sand interbedded with silt or clay, and calcrete within the upper 80m. These sedimentary deposits are underlain by Archaean and Proterozoic granitic basement rocks. In the eastern section of the study area, the ‘upper’ calcrete aquifer is semi-confined and appears to be laterally continuous, but is of variable thickness. Permeable sand and clayey sand were found at the base of the palaeo-channel in the western areas. In the study area, the upper calcrete aquifer does not appear to be in direct hydraulic connection with the underlying semi-confined, ‘palaeo-channel’ aquifer. Pumping-tests indicated that production bores with yields in the order of 10 to 15 L/s could be developed in both the calcrete and underlying palaeo-channel sediments. For long term water supply borefields, it is probable that production bores would only be developed in the less environmentally sensitive basal ‘palaeo-channel’ aquifer system, even though pumping from this aquifer is still likely to result in some vertical leakage (and thus drawdown) in the upper calcrete aquifer.

The shallow alluvium is seasonally recharged from surface water flow along the Murchison River. Large disconnected pools form along the river in the valley to the north of Jack Hills. These pools retract during the drier months and are recharged during the wet months which typically occur after large rain events associated with cyclonic activity or tropical lows from the north (Aquaterra, 2006).

Preliminary results suggest that approximately 7 GL per annum of the project water requirements could be met from a network of 12 production bores developed along the 44km strip of calcrete and alluvial aquifer systems (Aquaterra, 2009). Numerical flow modelling indicated maximum water level declines of 4 to 6.5m would occur near the production holes after 15 years of continuous abstraction. Water level drawdown of approximately 0.8m was predicted near Kalamunda Pool, a semi-permanent pool of water within the Murchison River and in close proximity to the mine. Further review suggested that this and other similar palaeochannel systems near the mine may be able to provide between approximately 17 and 20 GL per annum (Aquaterra, 2009). Investigations into the yield potential of these aquifer systems are continuing with additional drilling, test-pumping, flow modelling and assessment planned.

The groundwater quality of the calcrete and palaeo-channel alluvial aquifer systems is highly variable. The groundwater is brackish to highly brackish and of a sodium-chloride type, with TDS concentrations ranging between 1,600 to 7,000 mg/L. The groundwater quality decreases with depth below surface. It is expected that this salinity profiling is largely density driven with seasonal 'flushing' of the system maintaining a fresh water interface above the more saline water.

8.3.2.2 CARNARVON BASIN AQUIFERS

The Carnarvon Basin contains large resources of fresh to saline groundwater. The potential of these groundwater resources is being investigated by CRL in parallel to the palaeo-channel investigations (Global Groundwater, 2010). The investigation will assess the potential of aquifers within the eastern portion of the Southern Carnarvon Basin (Byro sub-basin) to meet the project requirements or part of the project requirements subject to the results of the palaeo-channel investigation. The onshore Carnarvon Basin covers a very large area extending from around Geraldton in the south to the mouth of the Fortescue River in the north. It extends offshore to the west and has an onshore thickness of several thousand metres. The eastern boundary of the Byro sub-basin is located approximately 110 km west of Jack Hills.

Groundwater in the southern Carnarvon basin is generally unconfined in the east. It flows toward the west where the aquifers become confined by overlying low permeability units and in this area the groundwater is free flowing from uncapped bores. The western or artesian section of the southern Carnarvon Basin is well known from historic groundwater and petroleum exploration drilling and more recently from the Carnarvon Artesian Basin bore capping program designed to reduce losses of groundwater from uncontrolled, free flowing bores (DoW, 2007). However, there have been few systematic groundwater exploration drilling programs in the Byro sub-basin of the southern Carnarvon Basin and correspondingly there is a paucity of groundwater data for the area.

The area of CRL Carnarvon Basin groundwater investigation centres on the site of the proposed off-take from the Perth to Bunbury gas pipeline and along the proposed pipeline route from the off-take to the mine. The investigation will first concentrate on areas within approximately 60 km north and south of the proposed pipeline route, but the investigation area may extend further north, south and west of the primary target area depending on the early investigation results. The area overlies part of the Byro sub-basin in the east of the Carnarvon Basin that consists of a Permian and Carboniferous sedimentary sequence possibly up to 3000m thick (Mory, 2000 cited in Global Groundwater, 2010). A number of sandstone units within the Byro sub-basin sequence are considered prospective for groundwater and will form the primary target(s) for the investigation.

8.4 VEGETATION AND FLORA

8.4.1 SURVEY EFFORT

A number of flora and vegetation surveys have been commissioned by CRL for Stage 1 and the Project (Appendix F). Table 8.2 provides a summary of the surveys carried out-to-date.

TABLE 8.2 KNOWN FLORA SURVEYS IN THE JACK HILLS AREA

Contact	Report/Survey/Scope
Mattiske Consulting Pty Ltd	• Flora and Vegetation on the Jack Hills Project Area. Mattiske, 2005. Included detailed vegetation mapping of part of the Jack Hills range and adjacent plains. • Targeted survey of the proposed haul road from the Jack Hills to the Cue-Beringarra Road and the proposed pit area. Mattiske Consulting Pty Ltd., March 2006. • Review of regional triodia surveys 2009 and 2010.
Ecologia Environment (Ecologia)	• Jack Hills Rare and Priority Flora Survey. Ecologia, 2006. • A Declared Rare and Priority Flora survey undertaken on specific locations of CRL tenements by Ecologia, March/April, 2006. The surveys comprised a grid search system of 30 m by 30 m quadrats at 186 proposed drill pads, and foot traverse surveys, 10 m wide, along approximately 11 km of existing track and drill lines. • Phase 1 of Environmental Impact Assessment work was completed in June/July 2006 by Ecologia. 104 sampling sites, 20 m by 20 m for standard areas and 400 m^2 for drainage lines, were established in the survey area. Quadrat size was selected to allow comparison of data with the work previously carried out by the DEC at Jack Hills. (report in press, Priority flora mapping available). • Phase 2 of Environmental Impact Assessment work was completed in September 2007 by Ecologia. 84 new sites were established and 67 of the Phase 1 sites were revisited. (report in press, Priority flora mapping available).
Department of Environment and Conservation (DEC)	• Flora and vegetation of banded ironstone formations of the Yilgarn Craton: Jack Hills, DEC, 2006.

Contact	Report/Survey/Scope
GHD Pty Ltd	• Floristic surveys of the Jack Hills to satisfy Ministerial Commitments (Statement 727, Commitment 8 -10), with the objectives of identifying rare and priority flora restricted or occurring as range extensions, and identify the extent of Spinifex communities on the Jack Hills, Robinson Ranges and Mt Gould. Local and regional searches for *Triodia mevillei* communities were also completed to quantify impacts of the Project. • A two-phase Level 2 flora and vegetation survey along the proposed gas pipeline corridor from Jack Hills to DBNGP. This was undertaken in May 2009 and following winter rain in August 2009. The phase 1 survey was undertaken by vehicle and on foot and the phase 2 survey undertaken using a helicopter to access areas not otherwise accessible. The field assessment involved a combination of sampling of 20m x 20m quadrats, relevès and traversing the project area. The surveys were undertaken to provide a description of the dominant vegetation types, vegetation condition, flora species and to determine the presence or likelihood of DRF and Priority flora along the proposed pipeline route. • A Level 2 flora and vegetation survey of the proposed Jack Hills to Weld Range services corridor was undertaken in September/October 2009. The field assessment involved a combination of sampling of 20m x 20m quadrats, relevès and traversing the project area. The survey assessed the composition, extent and condition of flora and vegetation along the proposed services corridor, and to determine the likely potential impacts of the Project of flora and vegetation. • A Level 2 flora and vegetation survey and Level 1 fauna assessment in the areas proposed for the location of the waste dump, two airstrip options, accommodation village, power station and iron ore processing plant (hereafter referred to as the Project Area' or 'Associated Infrastructure'). The field assessment involved a combination of sampling of 20m x 20m quadrats, relevès and traversing the project area. The survey assessed the composition, extent and condition of flora and vegetation along the proposed services corridor, and to determine the likely potential impacts of the Project of flora and vegetation. Note: GHD assessments focused on mapping vegetation communities and confirming the presence/potential presence of conservation significant species. Statistical analysis was not undertaken as surveys involved one season only, and there were no expected threatened ecological communities/priority ecological communities present, and therefore comparison analysis was not required.

8.4.2 VEGETATION DESCRIPTION

8.4.2.1 JACK HILLS MINE AREA

The Jack Hills are located within the Murchison Region (Western Murchison sub-region), as defined in the Interim Biogeographical Regionalisation for Australia (IBRA). The region is dominated by mulga (*Acacia aneura*) woodlands, and the extensive flats and plains provide optimum conditions for the occurrence of these woodlands (Beard, 1976). *Acacia aneura* generally grows in the form of a tree with a single erect trunk and forms low woodlands. On less favourable soils, such as those present on hill slopes and ridges, it takes the form of a shrub producing shrublands/scrublands (Beard, 1976).

A feature of the Jack Hills vegetation is the hummock grasslands of *Triodia melvillei*, and although not afforded statutory protection through state or federal legislation, is a significant complex of regional conservation significance (Cardno, 2006).

The flora of the Murchison region is diverse with about 830 recorded vascular species. A high percentage of these species are considered endemic or near endemic. Mulga (*Acacia aneura*) and Cotton bush (*Ptilotus obovatus*) are the most ubiquitous perennials (Curry et al. 1994). Arid shrublands make up the vast majority of vegetation types encountered in the Murchison region.

Vegetation communities within the Jack Hills have been described by Mattiske (2005), the DEC (Meissner & Caruso, 2008) and Ecologia (2009a). The vegetation communities mapped by Ecologia (2009a) are described in Table 8.3.

TABLE 8.3 VEGETATION COMMUNITIES WITHIN THE JACK HILLS MINE AREA (ECOLOGIA, 2009A)

Vegetation Community and Description		Habitat
C:	***Acacia cyperophylla* tall woodland over mixed shrubs on major flow lines.**	
	Acacia cyperophylla var. *cyperophylla* woodland with scattered *A. citrinoviridis* and *A. pruinocarpa* medium trees over mixed open shrubland over mixed tussock grassland.	Major flow lines.
D:	***Acacia* shrubland / woodland predominantly on drainage lines.**	
D1:	*Acacia aneura* var. *aneura* and *A. rhodophloia* high open shrubland with isolated *Grevillea berryana* trees over *Calytrix desolata* and *Dodonaea petiolaris* mid open shrubland over *Ptilotus obovatus* var. *obovatus* low sparse shrubland over isolated clumps of *Aristida contorta* tussock grass.	Minor drainage channels and protected hill slopes.
D2:	*Acacia citrinoviridis* low open woodland with *A. aneura* var. *aneura* scattered low trees over *A. rhodophloia* and *A. ramulosa* var. *linophylla* tall open shrubland over *Dodonaea petiolaris*, *Solanum ashbyae*, *S. centrale* and *Hibiscus sturtii* var. *forrestii* low sparse shrubland and *Ptilotus obovatus* var. *obovatus* open shrubland over *Cymbopogon ambiguus* isolated tussock grass.	Minor drainage channels and occasionally on low ridges
A:	***Acacia* high shrubland**	
A1:	Mixed *Acacia* spp. tall sparse shrubland over *Eremophila* glutinosa, *E. phyllopoda* subsp. *phyllopoda* and *Dodonaea petiolaris* mid sparse shrubland over *Ptilotus obovatus* var. *obovatus* low sparse shrubland over mixed tussock grasses.	Mid to upper slopes of low hills and areas of quartzite scree.
A2:	Mixed *Acacia* spp. tall sparse shrubland with emergent *Grevillea berryana* low isolated trees over *Ptilotus obovatus* var. *obovatus* and *Solanum ashbyae* low isolated shrubs over mixed low sparse tussock grasses.	Flat plains with quartz stones and boulders, and ironstone gravel scree.
A3:	*Acacia rhodophloia* or *A.* sp. Jack Hills (R. Meissner & Y. Caruso 4) (Priority 1) tall sparse shrubland with *Grevillea berryana* scattered low trees over *Ptilotus obovatus* var. *obovatus*, *Halgania gustafsenii* subsp. *gustafsenii* and *Aluta aspera* subsp. *hesperia* low sparse shrubland.	Low gravely hills and undulating plains, occasionally occurring on the upper slopes of BIF ridges.
A4:	*Acacia rhodophloia* high sparse shrubland occasionally with *A. citrinoviridis* scattered low trees over mixed mid sparse shrubland over *Ptilotus obovatus* var. *obovatus* low open shrubland over *Aristida contorta* sparse tussock grassland.	Upper slopes and ridgetops on an array of substrates including BIF, schist and quartz.
A5:	*Acacia* sp. Jack Hills (R. Meissner & Y. Caruso 4) (Priority 1) and *Thryptomene decussata* tall open shrubland over *Hibiscus sturtii* var. *forrestii*, *Eremophila margarethae* and *Halgania gustafsenii* subsp. *gustafsenii* mid sparse shrubland over *Ptilotus obovatus* var. *obovatus* and *Sida* sp. Golden calyces glabrous (H.N. Foote 32) low open shrubland.	Mid to upper slopes and ridgetops of ranges, with BIF and non- banded ferrous stones and boulders
A6:	*Acacia ramulosa* var. *linophylla* high sparse shrubland over *Abutilon otocarpum* mid shrubland over *Corchorus crozophorifolius*, *Ptilotus obovatus* var. *obovatus* and *Solanum lasiophyllum* open low shrubland over mixed closed tussock grasses and herbs.	Flood plains of major flow lines.

Vegetation Community and Description		Habitat
T:	***Triodia melvillei* hummock grassland on BIF ridges.**	
T1:	*Grevillea berryana* scattered trees over *Halgania gustafsenii* var. *gustafsenii* and *Ptilotus obovatus* var. *obovatus* isolated low shrubs over *Triodia melvillei* hummock grassland.	Mid to upper slopes of rocky ridges and gully sides between steep ridges.
T2:	*Acacia pruinocarpa* scattered trees over *A. thoma* open tall shrubland over *Prostanthera ferricola* (**Priority 3**), *Philotheca brucei* subsp. *cinerea* and *Ptilotus obovatus* var. *obovatus* isolated clumps of low shrubs over *Triodia melvillei* hummock grassland.	Steep rocky slopes of BIF ridges.
T3:	*Acacia citrinoviridis* isolated clumps of trees occasionally with *Grevillea berryana* scattered trees over *A.* sp. Jack Hills (R. Meissner & Y. Caruso 4) (Priority 1) tall open shrubland over *Eremophila margarethae*, *E. latrobei*, and *Hibiscus sturtii* var. *forrestii* isolated clumps of mid shrubs over *Ptilotus obovatus* var. *obovatus* low sparse shrubland over *Triodia melvillei* tussock grassland.	Ridge tops and upper slopes of steep ridges
W:	***Acacia* low woodland.**	
W1:	*Acacia aneura* var. *aneura* or *A. aneura* var. *microcarpa* low sparse woodland over *A. rhodophloia* and *A. ramulosa* var. *linophylla* tall sparse shrubland over *Dodonaea petiolaris*, *Hibiscus sturtii* var. *forrestii* and occasionally *Eremophila phyllopoda* subsp. *phyllopoda* sparse mid shrubland over *Corchorus crozophorifolius* and *Ptilotus obovatus* var. *obovatus* low open shrubland over mixed sparse tussock grassland.	Upper slopes, hill crests and ridge tops, and scree plains along with occasional minor drainage channels and the bases of breakaways
W2:	*Acacia aneura* var. *aneura* low open woodland / tall sparse shrubland over *A. cuthbertsonii* subsp. *cuthbertsonii* tall sparse shrubland over *Solanum ashbyae*, *Ptilotus obovatus* var. *obovatus*, *Eremophila glutinosa* and *Halgania gustafsenii* subsp. *gustafsenii* low sparse shrubland over *Monachather paradoxus* low isolated clumps of tussock grasses.	Hill crests, flat ferrous scree plain and footslopes
W3:	*Acacia citrinoviridis* low open woodland over *A.* sp. Jack Hills (R. Meissner & Y. Caruso 4) (Priority 1) or / and *A. rhodophloia* high sparse shrubland over *Solanum centrale, Philotheca brucei* subsp. *cinerea* and *Dodonaea petiolaris* mid sparse shrubland over *Ptilotus obovatus* var. *obovatus* low open shrubland over *Cymbopogon ambiguus* and *Eriachne pulchella* subsp. *pulchella* isolated tussock grasses.	Rocky upper and mid slopes of steep ridges, gullies and occasionally on lateritic breakaways
W4:	*Acacia citrinoviridis* low open woodland over *Philotheca brucei* subsp. *cinerea*, *Thryptomene decussata* and *Dodonaea pachyneura* mid sparse to open shrubland over *Ptilotus obovatus* var. *obovatus* low open shrubland occasionally with *Triodia melvillei* hummock grass.	Steep rocky mid to upper slopes of ridges.
S:	**Mixed low shrubland.**	
S1:	*Acacia citrinoviridis* scattered trees over mixed mid scattered shrubs over *Ptilotus obovatus* var. *obovatus* low shrubland over *Cymbopogon ambiguus* and *Aristida contorta* sparse tussock grassland.	Upper slopes and gully sides.
S2:	*Acacia citrinoviridis* scattered trees over *Acacia rhodophloia* tall scattered shrubs over *Philotheca brucei* subsp. *cinerea* and *Dodonaea petiolaris* mid scattered shrubs over *Ptilotus obovatus* var. *obovatus* and *Eremophila jucunda* subsp. *jucunda* low open shrubland over *Neurachne minor* isolated tussock grass.	Flat plains, gentle slopes and ridge tops, gully sides and breakaways with BIF, quartz and laterite rocks and boulders.

8.4.2.2 JACK HILLS TO DBNGP SERVICES CORRIDOR

GHD completed flora and vegetation surveys of the proposed corridor route in May and August 2009. Seventeen vegetation types were identified by GHD along the corridor, which are described in Table 8.4. There is considerable overlap between mapped vegetation types due to the similarity of underlying geology and landform and regional dominance of certain species such as Mulga (*Acacia aneura*), *Senna* and *Eremophila* spp. A copy of the full flora and fauna study is included in Appendix F.

TABLE 8.4 VEGETATION TYPES RECORDED ALONG THE GAS PIPELINE CORRIDOR (GHD, 2009A)

Mapped Unit	Vegetation Description
1	Sparse *Eucalyptus victrix* woodland over sparse shrubland of *Scaevola spinescens*, *Acacia sclerosperma* subsp. *sclerosperma* and *Melaleuca glomerata* over sparse grassland of *Eragrostis dielsii, Leptochloa digitata* and *Dichanthium sericeum* subsp. *humilius* over sparse sedgeland of *Cyperus gymnocaulos* over sparse herbland of *Pluchea rubelliflora*, Euphorbia spp. and Papilionaceae spp.
2	Open woodland of *Acacia aneura* spp with sparse *Acacia grasbyi, Hakea lorea* subsp *lorea* and *Acacia tetragonophylla* over a spare open shrubland of *Senna artemisioides* and *Eremophila fraseri, i spathulata, Eremophila macmillaniana* and *Eremophila fraseriana* over a sparse herbland of *Indigofera chamaeclada, Boerhavia coccinia* and *Goodenia havilandii* over a sparse grassland of *Eragrostis cunninhamii, Eriachne aristidea, Eragraostis dielsii* and *Aristida contorta.*
3	Sparse *Acacia ramulosa* var *linophylla, Acacia sclerosperma* subsp *sclerosperma* and *Acacia murrayana* open shrubland with isolated *Eremophila forrestii Ptilotus schwartzii* and *Ptilotus polystachyus* over isolated clumps of *Austrostipa elegantissima* and isolated herbs of *Goodenia tenuiloba* and a sparse grassland of *Eriachne helmsii, Aristida,* and *Eragrostis* spp.
4	Open shrubland of *Acacia aneura* cf. var. *tenuis, Eremophila pterocarpa* subsp. *pterocarpa* and *Senna artemisioides* subsp. *petiolaris* over sparse chenopod shrubland of *Sclerolaena* spp., *Salsola tragus, Rhagodia eremaea, Eremophila tiekensii* and *Atriplex* sp. (insufficient material) over sparse grassland of *Eragrostis dielsii* over sparse herbland of *Angianthus cornutus, Streptoglossa cylindricepts* and *Calandrinia lehmannii.*
5	Sparse *Acacia citrinovirdis* open shrubland with isolated *Senna artemisioides* subsp *filiolia*, *Melaleuca interioris* and *Acacia grasbyi* with isolated shrubs and herbs.
7	Woodland of *Acacia rhodophloia* and *Acacia xiphophylla* over sparse shrubland of *Dodonaea viscosa* subsp. *mucronata, Ptilotus obovatus* and *Senna artemisioides* subsp. *helmsii* x *oligophylla* over sparse grassland of *Eriachne aristidea* over sparse herbland of *Euphorbia drummondii* subsp. *drummondii, Goodenia berardiana* and *Boerhavia coccinea*.
9	Shrubland of *Acacia victoriae, Acacia tetragonophylla* and *Hakea preissii* over sparse chenopod shrubland of *Atriplex vesicaria, Enchylaena tomentosa* and *Rhagodia eremaea* over sparse grassland of *Eragrostis dielsii, Enteropogon ramosus* and **Cenchrus ciliaris* over sparse herbland of *Euphorbia* spp, *Pterocaulon sphacelatum* and *Waitzia acuminate.*
10	Open woodland of *Acacia pruinocarpa* over open shrubland of mixed *Acacia* species and *Eremophila forrestii* subsp. *forrestii* over a sparse grassland of *Eragrostis eriopoda* and *Aristida* sp. (insufficient material) over sparse herbs of *Goodenia* sp. (insufficient material).

11	Open shrubland of *Acacia synchronicia, Hakea preissii, Senna* sp. *Meekatharra* (E. Bailey 1-26) *Eremophila forrestii* and *Scaevola spinescens* over sparse chenopod shrubland of *Enchylaena tomentosa, Salsola tragus* and D*issocarpus paradoxus* over sparse grassland of *Eragrostis dielsii* and **Cenchrus ciliaris* over sparse herbland of *Trianthema triquetra, Boerhavia coccinea* and *Euphorbia drummondii* subsp. *drummondii.*
13	Sparse shrubland of *Acacia* spp., *Malvaceae* spp. and *Santalaceae* spp. over sparse chenopod shrubland over sparse grassland of *Eragrostis dielsii* and *Aristida contorta* over sparse herbland.
14	Sparse shrubland of *Acacia* spp., *Eremophila pterocarpa* subsp. *pterocarpa* and *Scaevola spinescens* over open chenopod shrubland over sparse grassland of *Eragrostis dielsii* and *Austrostipa elegantissima* over open herbland of *Cratystylis subspinescens*.
15	Woodland of *Acacia aneura* over sparse shrubland of *Acacia kempeana, Abutilon lepidum* and *Eremophila forrestii* over closed grassland over sparse herbland.
16	Open shrubland of *Acacia xiphophylla, Senna* spp. and *Eremophila* spp. over sparse chenopod shrubland of *Maireana melanocoma, Sclerolaena eriacantha* and *Atriplex* sp. (insufficient material) over sparse grassland of *Enneapogon caerulescens*.
17	Woodland of *Eucalyptus victrix* over open shrubland of *Acacia ramulosa* var. *linophylla, Acacia tetragonophylla, Acacia murrayana* and *Grevillea stenostachya* open herbland of *Pityrodia paniculata* and *Stylobasium spathulatum* over sparse grassland of *Aristida* sp. (insufficient material) and *Eragrostis* sp. (insufficient material) over sparse herbs of *Goodenia* sp. (insufficient material).

8.4.2.3 JACK HILLS TO WELD RANGE SERVICES CORRIDOR

A flora and vegetation and fauna assessment of the proposed services corridor, between the Weld Range and Jack Hills, was completed by GHD in September – October 2009. The survey identified 18 vegetation types along the corridor, which are described in Table 8.5. A copy of the full flora and fauna study is included in Appendix F.

TABLE 8.5 VEGETATION TYPES RECORDED ALONG THE SERVICES CORRIDOR (GHD, 2009B)

Mapped Unit	Vegetation Description
B1	Low Open Shrubland of *Acacia* sp. Weld Range (A. Markey & S. Dillion 2994), *Dodonaea pachyneura* and *Philotheca* aff. *tubiflora* over Very Open Grassland of *Eragrostis* sp.
B3	Tall Open Shrubland of *Acacia tetragonophylla* and *Acacia xanthocarpa* to 2.5m over Low Shrubland of *Abutilon oxycarpum* subsp. prostratum ms, *Marsdenia graniticola* and *Senna artemisioides* subsp x *sturtii* to 1.6m over Very Open Grassland of *Cymbopogon ambiguus* to 0.6m and ephemeral herb land of *Asteraceae* spp. to 0.07m.
BP	Tall open shrubland of *Acacia demissa* and *Acacia grasbyi* over low open shrubland of *Ptilotus obovatus* and *Solanum lasiophyllum* over an Open Herbland of *Maireana carnosa* and *Sclerolaena densiflora.*
C1	Open Forest of *Acacia aneura* and *Eucalyptus victrix* to 15.0m over Low Open Forest of *Acacia burkittii* to 7.0m over Tall Open Shrubland of *Eremophila platycalyx* subsp. *platycalyx* to 2.2m over Low Open Shrubland of *Senna* spp. to 1.2m and an Ephemeral Herbland of *Duperreya commixta* with Very Open Grassland of *Themeda triandra* to 0.7m.

F1	Low Open Forest of *Acacia aneura* var. 1 or *Acacia aneura* var. *microcarpa* and *Acacia craspedocarpa* x *aneura* to 8.0m over Tall Shrubland of *Acacia speckii* (P3) and *Acacia tetragonophylla* to 3.5m over Low Shrubland of *Abutilon cryptopetalum* and *Senna artemisioides* subsp. helmsii to 1.1m over a Closed Grassland of Aristida contorta, *Eriachne aristidea*, *Eriachne helmsii* and *Paspalidium gracile* to 0.4m.
FP1	Low Woodland of *Acacia aneura* var. *microcarpa* and *Eucalyptus victrix* to 5.0m over an Open Scrub to Tall Shrubland of *Acacia kempeana*, *Acacia ramulosa* var. *linophylla* and *Acacia cuthbertsonii* subsp. *cuthbertsonii* to 3.0m over a low Open Shrubland of *Eremophila forrestii* and *Senna artemisioides* subsp. *artemisioides* to 1.5m with a Very Open to Open Sedgeland of *Fimbristylis* sp. to 1.0m and/or Ephemeral Herbland of *Boerhavia coccinea* and/or Open Grassland of *Eriachne benthamii* to 1.0m.
FP4	Low Open Woodland of *Acacia aneura* var. 1 to 5.0m over Low Open Shrubland of *Ptilotus obovatus*, *Senna artemisioides* subsp. *helmsii* x *oligophylla* and *Senna artemisioides* subsp. *oligophylla* to 1.4m over Open Grassland of *Aristida contorta, Eriachne aristidea, Eriachne helmsii* and *Monacather paradoxus* to 1.0m.
FP5	Tall Open Shrubland of *Acacia tetragonophylla* and *Acacia synchronicia* to 3.0m over Tall Shrubland of *Eremophila fraseri* subsp. *parva, Eremophila macmillaniana, Eremophila spathulata* to 3.0m over Low Open Shrubland of *Senna artemisioides* subsp. *oligophylla* and *Senna glutinosa* subsp. x *luerssenii* to 1.5m with a Very Open Grassland of *Aristida contorta, Eragrostis eriopoda* and *Eriachne aristidea* to 0.45m
FP6	Tall Open Shrubland of *Acacia kempeana* and *Acacia ramulosa* var. *linophylla* to 2.4m over Low Shrubland of E*remophila latrobei* x *margarethae* to 1.4m over Grassland of *Aristida holathera* var. *holathera, Eriachne aristidea* and *Eriachne helmsii* to 0.75m over an Open Herbfield of *Muelleranthus trifoliolatus*.
C2	Low Closed Forest of *Acacia aneura* var. 1 and *Acacia craspedocarpa* x *aneura* to 6.5m over Tall Shrubland of *Acacia speckii* (P3) and *Acacia tetragonophylla* to 3.5m over Tall Open Shrubland of *Acacia kempeana*, *Acacia sclerosperma* subsp. *sclerosperma*, *Acacia ramulosa* var. *linophylla* to 3.5m over Low Open Shrubland of *Eremophila macmillaniana*, *Eremophila forrestii, Eremophila maitlandii* and *Senna artemisioides* subsp. *helmsii* and *Abutilon cryptopetalum* to 0.5m over Very Open Grassland of *Aristida contorta, Aristida holanthera* var. *holanthera* and *Eriachne helmsii* to 0.7m.
P1	Tall Open Shrubland of *Acacia aneura* var. *argentea, Acacia aneura* var. *microcarpa, Acacia kempeana* and *Acacia ramulosa* var. *ramulosa* to 3.2m over Low Shrubland of *Eremophila forrestii, Eremophila fraseri, Eremophila compacta, Ptilotus obovatus* and *Senna glutinosa* subsp. *chatelainiana, Senna glaucifolia, Senna artemisioides* subsp. *oligophylla, Senna* sp. Meekatharra (E. Bailey 1-26) and *Ptilotus obovatus* to 0.5m over Very Open Grassland of *Aristida contorta, Aristida holathera* var. *holathera, Monacather paradoxus* and *Eragrostis eriopoda* to 0.4m.
P12	Low Open Woodland of *Acacia aneura* var. *aneura* over Tall Open Shrubland of *Acacia cuthbertsonii* subsp. *cuthbertsonii, Acacia burkittii, Acacia demissa* and *Acacia aneura* var. *conifera* to 2.2m over Low Open Shrubland of *Eremophila glutinosa, Eremophila spathulata, Eremophila spathulata, Senna* sp. Meekatharra (E. Bailey 1-26), *Acacia xanthocarpa, Calytrix desolata, Eremophila macmillaniana* and *Senna glaucifolia* to 1.4m.
P3	Open Scrub of *Acacia ramulosa* var. *linophylla* over Low Shrubland of *Eremophila forrestii* over an Open Grassland of *Eragrostis eriopoda.*

P6	Open Scrub of *Acacia aneura* var. *argentea, Acacia craspedocarpa, Acacia tetragonophylla* and *Grevillea nematophylla* subsp. *supraplana* to 4.0m over Low Open Shrubland of *Eremophila forrestii* and *Eremophila metallicorum* to 1.2m over Very Open Grassland of *Eriachne helmsii* to 0.5m.
QP1	Tall Open Shrubland of *Acacia craspedocarpa* x *aneura, Acacia tetragonophylla, Acacia aneura* var. 1 to 4.0m over Tall Shrubland of *Eremophila macmillaniana* to 2.5m over Low Open Shrubland of *Eremophila fraseri* subsp. *parva, Eremophila macmillaniana, Eremophila spathulata, Senna* spp. and *Senna* sp. Meekatharra (E. Bailey 1-26) *Eremophila forrestii* and *Ptilotus obovatus* to 1.5m over Very Open Grassland of *Aristida contorta* to 0.15m and an Ephemeral Herbland of *Boerhavia coccinea*.
S1	Low Open Woodland of *Acacia citrinoviridis* to 5.0m over Low Shrubland of *Acacia* sp. Jack Hills (P1), *Acacia aneura* var. *argentea* and *Acacia ramulosa* var. *linophylla* to 2.5m and *Ptilotus obovatus* to 1.4m over an Open herbland of *Sida* sp. Golden *calyces glabrous* (H.N.Foote 32) *Goodenia berardiana* to 0.3m over Very Open Grassland of *Eriachne mucronata* to 0.35m.
S2	Low Open Woodland of *Acacia aneura* var. *microcarpa* to 5.0m over Tall Shrubland of *Acacia ramulosa* var. *linophylla, Acacia rhodophloia* and *Acacia cuthbertsonii* subsp. *cuthbertsonii* to 3.5m over Low Open Shrubland of *Aluta aspera* subsp. *hesperia* to 0.4m over Very Open Grassland of *Aristida contorta* to 0.1m over an Open Herbland of *Goodenia berardiana* to 0.3m.
P2	Tall Shrubland of *Acacia synchronicia* and *Acacia tetragonophylla* to 3.0 over Low Shrubland of *Maireana georgei, Scaevola spinescens* and *Senna* sp. Meekatharra to 1.3m.

8.4.2.4 PROPOSED INFRASTRUCTURE AREAS

Vegetation assessments on the locations of a range of infrastructure and facilities were undertaken by GHD in September to December, 2009 (GHD 2009d). These facilities are all situated north of the Jack Hills Range. The vegetation types and distributions found in these areas are provided in Appendix F.

The majority of the vegetation north of Jack Hills is considered Degraded. The land systems in these areas are characterised by flood plains and 'wanderrie country' (discrete sand pockets and ridges) and in seasons of good rainfall, support higher densities of perennial grasses such as *Eriachne helmsii*, *Monachather paradoxus*, and *Eragrostis eriopoda*. Disturbance from grazing stock (cattle) and feral goats was highly visible in these areas which are also in close proximity to the Murchison River where there is permanent water i.e. Kalamunda Pool.

8.4.2.5 BOREFIELDS

The vegetation of the Murchison Palaeochannel, which is being targeted for water extraction, has been broadly assessed to consider vegetation types with more detailed reports available for potential new track work and drill pad clearing areas. The area is within the flood zone of the Murchison River and includes large denuded areas which have been impacted by grazing and flood levels. Part of the proposed bore field (1A) is located north of the Murchison River, approximately 15 kilometres from the Jack Hills mine site. Two major creeks, the Gould and Bedaburra dissect the bore field from the North and drain into the Murchison River in a south west direction.

Broad vegetation descriptions are as follows:

1. Open Shrubland of *Acacia synchronicia*, *Senna* sp. Meekatharra (E.Bailey 1-26), Scaevola *spinescens* and *Stylobasium spathulatum* over Low Open Shrubland of *Enchylaena tomentosa*, *Salsola tragus* and *Dissocarpus paradoxus* over an Ephemeral Herbland of *Trianthema triquetra*, *Boerhavia coccinea*, *Maireana* spp. and *Euphorbia drummondii* subsp. *drummondii*.
2. Tall Shrubland of *Acacia aneura*, *Acacia kempeana* and *Grevillea striata* over Low Open Shrubland of *Abutilon lepidium* over Grassland of *Eragrostis pergracilis*.

3. Closed Heath of *Frankenia* sp.
4. Low to Low Open Woodland of *Acacia aneura* var. *aneura* over Tall Shrubland of *Acacia tetragonophylla*, *Senna artemisioides* subsp. *helmsii x oligophylla* and *Eremophila fraseri* over Low Open Shrubland of *Scaevola spinescens* over Open Grassland of *Aristida contorta* and *Eriachne pulchella* over an Ephemeral Herbland of *Sclerolaena* spp. and *Maireana* spp.
5. Tall Shrubland of *Acacia synchronicia* and *Hakea preissii* over a Very Open Grassland of *Poaceae* spp. and Ephemeral Herbland.
6. Tall Open Shrubland of *Acacia aneura* var. *aneura*, Acacia synchronicia, *Eremophila fraseri* and *Grevillea striata* over Low Open Shrubland of *Scaevola spinescens*, *Senna* spp. and *Stylobasium spathulatum*.
7. Open Forest of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over Tall shrubland of *Acacia* spp. and *Melaleuca glomerata* over an Open Sedgeland of *Cyperus* spp.

Vegetation types 1, 4, 5 and 6 occur on the plains and hardpans in relative proximity to the Murchison River. Soils are predominately red loamy clays however some areas also feature overlays of silty sands. Vegetation type 2 is located on minor creeklines and flow lines and the soils are characteristically of red clays. Vegetation type 3 is restricted to saline flats next to the Murchison River floodplain. Vegetation 5 is identified as a flood plain community and the soil substrate is of hardpan origin and red loamy clays. The final vegetation type is restricted to the Murchison River and upland banks.

An additional borefield is proposed for the Byro sub-basin in the Carnavorn Basin, approximately 100 km west-south-west of the Project area. The proposed drill pads and associated tracks are primarily on Byro and Tallisker stations, with the majority being already cleared for existing station use. Drill pads have been chosen in areas of highly degraded land, supporting minimal vegetation.

8.4.3 VEGETATION EXTENT AND STATUS

A vegetation type is considered under represented if there is less than 30 per cent of its original distribution remaining. From a purely biodiversity perspective, and not taking into account any land degradation issues, there are several key criteria now being applied to vegetation in States where clearing is still occurring (EPA, 2000):

- 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-European/pre-1750 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.

Such status can be delineated into five classes, where:

- *Presumed Extinct:* Probably no longer present in the bioregion;
- *Endangered*:* <10% of pre-European extent remains;
- *Vulnerable*:* 10-30% of pre-European extent exists;
- *Depleted*:* >30% and up to 50% of pre-European extent exists;
- *Least Concern:* >50% pre-European extent exists and subject to little or no degradation over a majority of this area.

* Or a combination of depletion, loss of quality, current threats and rarity give a comparable status.

Native vegetation types represented in the Project mine area, pipeline corridor and services corridor, their extent and reservation status are generally drawn from Shepherd *et al.* (2002), and Shepherd pers. comm. (2005), which are in turn based on broad scale mapping undertaken by Beard (1979). These are shown in Table 8.6.

TABLE 8.6 VEGETATION EXTENT AND STATUS FOR BEARD (1979) VEGETATION ASSOCIATIONS WITHIN THE PROJECT AREA

Vegetation Association Number	Association Description	Pre-European Extent (Ha)	Current Extent (Ha)	% Remaining (within Western Australia)	% Current Extent in IUCN[1] Class I-IV Reserves
18	Low woodland; mulga (*Acacia aneura*)	19892436.97	19890348.34	100.0	2.1
28	Open low woodland; mulga	395898.951	395898.951	100.0	0.0
29	Sparse low woodland; mulga, discontinuous in scattered groups	7904064.481	7904064.481	100.0	0.3
39	Shrublands; mulga scrub	6613602.164	6613496.393	100.0	7.2
160	Shrublands; snakewood & *Acacia victoriae* scrub	1111587.357	1111587.357	100.0	0.0
182	Low woodland; mulga & bowgada (*Acacia ramulosa*)	93936.072	93936.072	100.0	3.4
183	Low woodland; mulga, *Acacia victoriae* & snakewood	369239.844	369239.844	100.0	0.0
187	Succulent steppe with open scrub; scattered *Acacia victoriae* & snakewood over various species	4353.988	4353.988	100.0	0.0
188	Shrublands; mulga & *Acacia sclerosperma* scrub	25640.463	25640.463	100.0	0.0
200	Mosaic: Low woodland over scrub; mulga over bowgada scrub / Shrublands; bowgada & grevillea scrub on sandhills	2331.211	2331.211	100.0	0.0
202	Shrublands; mulga & Acacia quadrimarginea scrub	448534.001	448534.011	100.0	0.0
205	Shrublands; Acacia sclerosperma & bowgada scrub	294723.757	294556.039	99.9	0.0
266	Mosaic: Shrublands; bowgada scrub / Succulent steppe; saltbush & bluebush	134814.326	134814.326	100.0	0.0
269	Low woodland over scrub; mulga over bowgada scrub	180496.609	180496.609	100.0	0.0
285	Mosaic: Shrublands; Acacia victoriae & snakewood scrub patches / Scattered groups of succulents	14923.706	14923.706	100.0	0.0

349	Mosaic: Shrublands; bowgada scrub with scattered mulga / Shrublands; bowgada & grevillea scrub	129318.696	129318.696	100.0	0.0
2081	Shrublands; bowgada and associated spp. scrub	1331749.333	1321057.855	99.2	4.3

8.4.4 VEGETATION CONDITION

The majority of the Murchison bioregion has been extensively grazed for agriculture over the last 100 years. This, along with increasing numbers of feral goats, has seen the steady decline in the condition of native vegetation in the region.

8.4.4.1 MINE AREA

Recent flora surveys undertaken in the area have demonstrated that the Jack Hills vegetation communities are in a fair to healthy condition. A number of the assemblages surveyed displayed evidence of moderate grazing. Many smaller shrubs have been reduced to woody stumps.

Above average rainfall during the past two seasons has led to an increase in goat populations within the Murchison region. The increased grazing pressure on certain vegetation assemblages due to increases in goat populations has resulted in the degradation of a number of areas.

Recent flora surveys of the Mount Hale area (within the Project pit area) recorded that a large percentage of sample sites were moderately impacted by goats. Many understorey shrubs and herbaceous species could not be identified due to the lack of leaves or flowers left on the specimens.

8.4.4.2 MINE ASSOCIATED INFRASTRUCTURE AREAS

The vegetation condition of the infrastructure areas range from good to degraded. Much of the area has been severely impacted by long term grazing of stock. Previous flood events have added to the decline of the bushland condition with topsoil washing away taking with it the understorey.

8.4.4.3 JACK HILLS TO DBNGP SERVICES CORRIDOR

Vegetation condition along the gas pipeline corridor route ranges from good to completely degraded. The area has been impacted by grazing with substantial sections of the corridor heavily grazed by stock and feral animals. The rocky plateaus in particular appear to be extremely impacted by heavy grazing. This is most likely to be due to a preference of goats and kangaroos to congregate in high rocky areas (GHD, 2009a).

8.4.4.4 JACK HILLS TO WELD RANGE SERVICES CORRIDOR

The majority of the vegetation north of Jack Hills is considered degraded as a result of grazing by cattle and feral goats. The vegetation condition along the proposed service corridor through the Jack Hills range is also degraded with the exception of valley creek lines which are considered to be in very good condition. Native species richness in these vegetation communities is relatively high and vegetation structure is intact and shows minimal disturbance from grazing animals. However, vegetation on the lower slopes to upper slopes of the Jack Hills Range, north-east of the existing Jack Hills mine site, is degraded (GHD, 2009b).

8.4.4.5 BOREFIELDS

The area has been heavily impacted by grazing stock and the vegetation of the area was considered Degraded to Completely Degraded.

8.4.5 SIGNIFICANT ECOLOGICAL COMMUNITIES

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English and Blythe, 1997). Threatened Ecological Communities (**TECs**) are ecological communities that have been assessed and assigned to one of four categories related to the status of the threat to the community, i.e. Presumed Totally Destroyed, Critically Endangered, Endangered, Endangered and Vulnerable.

Some TECs are protected under the EPBC Act. Although TECs are not formally protected under the *State Wildlife Conservation Act 1950*, the loss of, or disturbance to, some TECs trigger the EPBC Act. The EPA's position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment.

Possible TECs that do not meet survey criteria are added to the DEC's Priority Ecological Community (**PEC**) Lists under Priorities 1, 2 and 3. These are ecological communities that are not adequately known; are rare but not threatened, not meet criteria for Near Threatened. PECs 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.

8.4.5.1 MINE AREA

A search of the DEC's TEC database and the EPBC Protected Matters Search Tool indicate that no TECs occur at or in the vicinity of the Project mine area (Ecologia, 2009a). However, the DEC has identified a Priority 1 PEC, the "Jack Hills Vegetation Complexes on Banded Ironstone", occurring on the Jack Hills range. Mattiske (2005) defined and mapped four *Triodia* communities within the Jack Hills. One vegetation complex in particular, the hummock grassland community of *Triodia melvillei* and associated species, was considered to be restricted, due to altitude and habitat (Mattiske, 2005 and Meissner and Caruso, 2008). Mattiske, and Meissner and Caruso indicated in their vegetation mapping and discussions, that the *Triodia melvillei* community could be delineated into three or four separate sub-communities. However, EPA Bulletin 1220 indicates that the Department of Conservation and Land Management (CALM, now DEC), did not consider the classification of the *Triodia* community into separate sub-community types to be valid, hence it was DEC's view that the consideration of impacts should be based on the upland Spinifex (*Triodia melvillei*) community as a whole (EPA Bulletin 1220, p4).

CRL engaged GHD Pty Ltd (GHD) to undertake floristic surveys of the *Triodia melvillei* communities as part of their Ministerial Commitments (Statement 727, Commitment 810) for the Jack Hills Stage 1 Project. Commitment 810 states:

> '*The proponent shall by no later than 31 December 2009 participate in and contribute to integrated regional studies in conjunction with the Department of Environment and Conservation, with the key aim of defining the extent of plant communities on Jack Hills Range. The objectives of that study are to:*
>
> 1. *identify rare and priority flora and flora which is restricted to or occurs as range extensions; and*
> 2. *identify the extent of Spinifex communities on the Jack Hills, the Robinson Ranges and Mt Gould.*'

GHD also completed local and regional floristic surveys of *Triodia melvillei* communities, to quantify the impacts of the Project (Appendix F).

The study involved three phases:

- Searches for *Triodia melvillei* communities outside of the mine impact area, including aerial searches by helicopter of the south-eastern part of the Jack Hills range and Mt Gould;
- Groundtruthing the extent of *Triodia melvillei* communities mapped by Mattiske (2005) and Ecologia (2009a); and
- Mapping of the regional extent of *Triodia melvillei* communities across the Kennedy Ranges, Glengarry Ranges, Mt Puckford, Mt Laboucher, Robinson Ranges and Mount Gould.

Vegetation and flora field surveys were undertaken with regard to the EPA's Guidance Statement No. 51, where possible.

Local *Triodia melvillei* community extent

The extent of the *Triodia melvillei* community within the Stage 1 and Project area has been assessed and mapped by three consultants: in 2005 by Mattiske Consulting, 2006 by Ecologia and in 2009 by GHD. There is some discrepancy between the maps produced by each of the three consultants. This is likely to be due to the scale at which the mapping was undertaken and differences in the interpretation of low level cover *Triodia* communities. The mapping methodology of both Mattiske (2005) and Ecologia (2008) relied on interpretation of flora quadrat data and aerial photography. GHD groundtruthed the extent of the *Triodia* community, by walking along the boundary of the *Triodia* community, and using a GPS unit to collect latitude and longitude coordinates (Figure 8-6). Mapping of *Triodia* communities by Mattiske (2005), Ecologia (2008) and GHD (2009) is shown in Figure 8-7.

From the extensive groundtruthing and surveying of the *Triodia melvillei* communities in the Project area and adjacent parts of the Jack Hills range, GHD botanists calculated that approximately 76% of the *Triodia melvillei* community on Jack Hills is located within the proposed Project impact area and 24% is located outside of the impact area.

Regional *Triodia melvillei* community extent

GHD undertook surveys of similar upland habitats which support the *Triodia melvillei* community within the Murchison Region. These focussed on identifying ranges and high ground which could support the community, and visiting known locations of *T. melvillei* (from WA Herbarium records) within the region. A number of *T. melvillei* communities were identified and quantified during these surveys. Details of the work undertaken to map this community are provided in Appendix F.

The extent of *T. melvillei* communities mapped by GHD (2009c) within the region is summarised in Table 8.7 and illustrated in Figure 8-6. The regional extent of the *Triodia* communities was mapped by using a helicopter and hand held GPS to capture waypoints to delineate the extent.

TABLE 8.7 EXTENT OF REGIONAL TRIODIA MELVILLEI COMMUNITIES MAPPED BY GHD (2009C)

Location	*Triodia melvillei* community area (ha)
Mt Puckford	360
Mt Gould	9.3
Glengarry Range	885
Robinson Range	143
Mt Laboucher (Nth Robinson)	530
Jack Hills (Total Extent)	359
Approximate Total Regional Extent	2,286 ha

In order to consider the similarities between the local and regional *Triodia* communities Mattiske Consulting Pty Ltd was commissioned by CRL to review the definition of the plant communities and in particular the *Triodia* communities on the Project Area. The resulting report (2009) (Appendix F) identified four main issues that are associated with the definition of the *Triodia* communities within the areas of Jack Hills, Mt Gould, Glengarry Hills, Kennedy Ranges and Robinson Ranges. A concise outline of the report is provided below.

Information regarding *Triodia* communities and associated species has been collected during numerous surveys conducted by MBS Environmental (2005), Mattiske Consulting Pty Ltd (2006), Meissner and Caruso (2008), Ecologia Environment (2009), and GHD (2009). The survey effort between the groups involved several seasons with multiple trips and therefore the merged data sets provide a substantial amount of local and site specific data as well as regional data to place the values at Jack Hills into a wider context.

The range of taxa included within the data sets was reviewed against Florabase (Department of Environment and Conservation 2009a). As required, names were updated to align with current taxonomic nomenclature. As the *Triodia* information was collated from a range of surveys a database based on presence/absence data was created. This avoided differences in the determination of percentage cover due to different authors and allowed for the fact that some data sets only relied on presence/absence data. All species have been included (i.e. annual and perennial species) in the data analyses.

The sites containing *T. melvillei* were then extracted and reviewed using clustering techniques as available through PATN (Austin and Belbin 1982, Belbin 1995) and flexible UPGMA technique (Blatant Fabrications Pty Ltd 2006). It should be recognized that the PATN analysis is only one of a range of tools utilized in the interpretation of the plant communities and the patterns evident in the project area. Generally in ecological studies it is used to inform interpretations rather than used as the only interpretative tool.

The Mattiske review (2009) assessed the PATN outputs, as illustrated in Appendix F, against the Mattiske and Ecologia mapping codes, and as a result highlighted the following main points:

- It is not feasible to justify on the basis of presence/absence data the split between the delineated *T. melvillei* communities. As indicated in the previous assessments, there is some consistency in the pattern of species associated with *T. melvillei*, but not necessarily in the alignment of grouping with local variations in quantities of associated species. On the basis of the findings it is apparent that one option is to define the communities at a higher level of definition and to merge the *Triodia* communities.
- A range of sites with *T. melvillei* present in the community do not associate with those communities dominated by the *T. melvillei*. These communities have been coded by Mattiske as P1, P2, A3 and B1 and by Ecologia as Fa, Da, A5 and A4.
- Some of the regional sites from the nearby ranges. These associations challenge the argument that the Jack Hills ranges are in some ways ecological and botanically different from other areas in the region.
- Other sampling points from the nearby ranges were separated from those on the Jack Hills on the dendrograms. This conflicts with the above point.

On the basis of Mattiske's (2009) results, there appears to be an indication that, on the basis of presence/absence data, that the Jack Hills *Triodia* communities can be grouped at a higher level. In reviewing the possibility of grouping some of the other sites it appears logical that one could also scale up the communities based on the dominance of species, site parameters and soil types, position in the landscape and the PATN dendrograms. This merging tends to rely on the typographical position and dominance rather than on the inherent diversity and associated species in some of the more finely separated communities. In a regional context the merged and higher scale degree of definition is logical as there will always be subtle differences in sites, recorders, seasons and interpretation.

8.4.5.2 GAS PIPELINE CORRIDOR

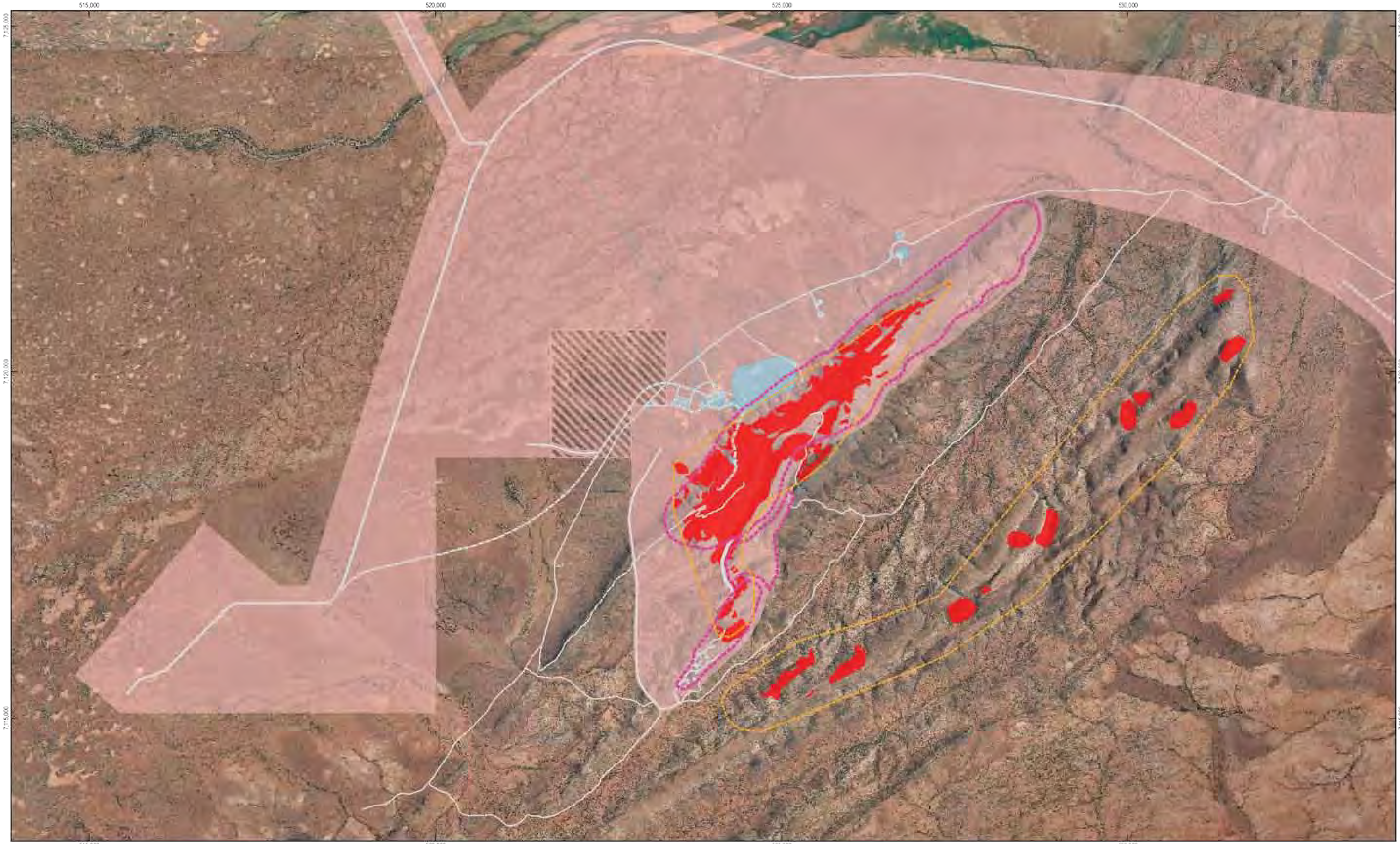
The proposed gas pipeline route intersects the buffers of two PECs, the Beringarra Calcrete PEC and the Jack Hills PEC. The Beringarra Calcrete PEC is focused on the subterranean fauna of the calcrete formations in the area and is highly unlikely to be impacted by pipeline construction. The Jack Hills PEC complexes comprise the uplands of the Jack Hills range, in particular the *Triodia* dominated complexes. No *Triodia* communities are present along the pipeline route (GHD, 2009a).

8.4.5.3 SERVICES CORRIDOR

The proposed service corridor intersects the buffers of two PECs, Jack Hills (P1) and Weld Range (P1). However, the services corridor is not believed to support the vegetation types defined by the PECs (GHD, 2009b).

8.4.5.4 BOREFIELDS

The Murchison Palaeochannel borefield intersects the buffer of the Jack Hills Vegetation Complexes (P1 PEC) but is well outside any of the Jack Hills vegetation types. The Byro borefield vegetation does not occur within any known PECs.



1:50,000 (at A3)

0 0.25 0.5 1 1.5 2 2.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Roads
- Tracks
- Mine Expansion Pit
- *Triodia* Community
- Approximate *Triodia* Survey Area
- Stage 1 Approved Areas
- Potential Impact Area
- Potential Impact Area (Sinosteel Midwest Tenement)

CLIENTS PEOPLE PERFORMANCE

Crosslands Resources Ltd
Jack Hills Expansion Project

Job Number	61-2379603
Revision	3
Date	30 AUG 2010

Extent of *Triodia* Communities Mapped within the Jack Hills

Figure 8.6

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GHD House, 239 Adelaide Terrace Perth WA 6004 T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

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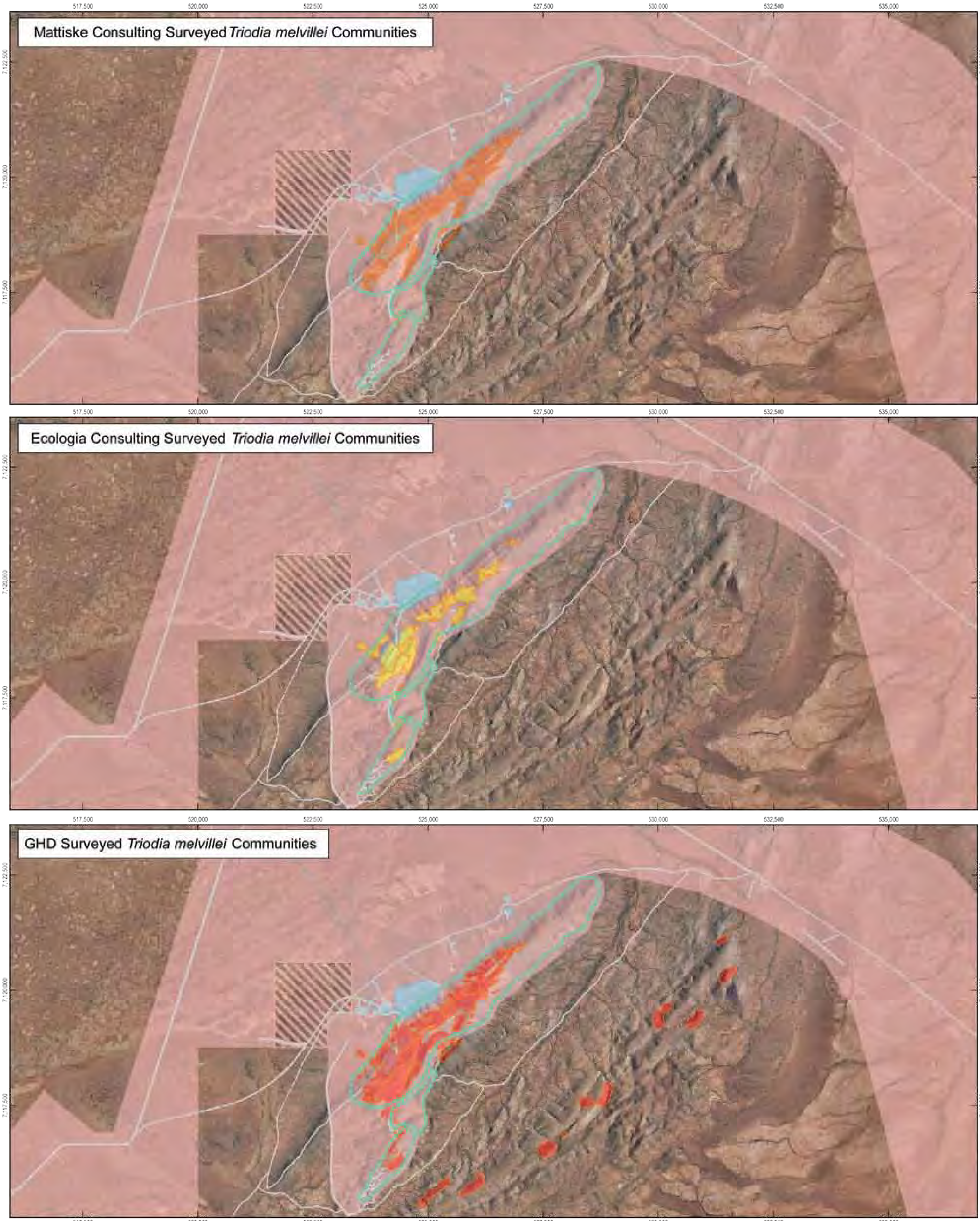
Data Source: GHD: Approximate Survey Area & Triodia Locations - 20100609; Landgate: Roads - 20090525; Landgate: Mileura 2005 Mosaic; Gould 2006 Mosaic - 2005-2006; Crosslands Resources Ltd: Existing & Proposed Site Roads & Tracks - 20100521, Stage 1 Approved Areas - 20100112, Potential Impact Area; Mine Expansion Pits - 20100521. Created by: mjthompson, wdavis, xntan, slee2, smhendrie, tgoad



LEGEND

Road	Ecologia Surveyed *Triodia* Community	Stage 1 Approved Areas
Track	GHD Surveyed *Triodia* Community	Potential Impact Area
Mine Expansion Pit	Mattiske Surveyed *Triodia* Community	Potential Impact Area (Sinosteel Midwest Tenement)

1:75,000 (at A3)
0 0.375 0.75 1.5 2.25 3 3.75
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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Crosslands Resources Ltd
Jack Hills Expansion Project

Triodia Communities Mapped by Mattiske, Ecologia and GHD

Job Number 61-2379603
Revision 3
Date 30 AUG 2010

Figure 8.7

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Data Source: Mattiske Consulting: MH Triodia Community - 2009; Ecologia Consulting: 692_Poly Vegetation Types - 2009; GHD: Triodia Communities - 20090714; Landgate: Mt Hale Mosaic - 2008, Cadastre - 20090525, Roads - 20090525; Crosslands Resources Ltd: Indicative Haul Road - 20100107, Haul Road Corridor - 20100107, Mine Expansion Project Pits (incl. Brindal Pit) - 20100107, Stage 1 Approved Areas - 20100112. Created by: xntan, slee2

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8.4.6 SIGNIFICANT FLORA

Species of conservation significant flora are protected under both State and Commonwealth Acts. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act 1999 and the *Wildlife Conservation Act 1950* can trigger referral to the DEWHA and/or the EPA. A description of Conservation Categories delineated under the EPBC Act is detailed in Appendix F.

In addition to the EPBC Act, significant flora in Western Australia is protected by the *Wildlife Conservation Act 1950*. This Act, which is administered by DEC, protects Declared Rare Flora (**DRF**) species. The DEC also maintains a list of priority listed flora species. Conservation codes for flora species are assigned by the DEC to define the level of conservation significance. Priority listed flora are not currently protected under the *Wildlife Conservation Act 1950*. Priority listed flora may be rare or threatened, but cannot be considered for declaration as rare flora until adequate surveys have been undertaken of known sites and the degree of threat to these populations clarified. Special consideration is often given to sites that contain priority listed flora, despite them not having formal legislative protection. A description of the DEC's Conservation Codes that relate to flora species is provided in Appendix F.

Database searches indicate that there is one EPBC Act listed Endangered flora species, Victoria Desert Smokebush (*Conospermum toddii*) and two state listed DRF species (*Conospermum toddii* and *Eremophila rostrata* subsp. *rostrata*) known from the Murchison region. None of these species have been recorded in the Project area during baseline flora and vegetation surveys.

According to DEC records, 154 species of DRF and Priority flora occur within the Murchison botanical region. No DRF have been recorded during the baseline surveys completed for the Project. Twelve species of Priority flora have been recorded within the Jack Hills range during surveys completed by Mattiske (2005), Meissner (2005), Ecologia (2006) and GHD (2009). These species are listed in Table 8.8. Four Priority flora species were identified by GHD (2009a) along the proposed pipeline route, and eight Priority flora species have been recorded from the proposed services corridor (GHD, 2009b).

The locations of Priority flora recorded within the mine Project area are shown in Figure 8-8 and further details of the Priority species in the main Project area are found in Appendix D.

The proposed disturbance area associated with the Project will not impact on any recorded populations of *Calytrix verruculosa*, *Dodonaea amplisemina*, *Gunniopsis propinqua*, or *Gunniopsis divisa*. Discussion of impacts to Priority flora is provided in Section 9.1.

Range Extensions

Flora surveys have identified the presence of 20 range extensions within the Project site and services corridors. The occurrence of range extensions in the area is not considered as uncommon, as the Murchison area has not been extensively surveyed.

Mine Area (Ecologia, 2009a)

- *Acacia coolgardiensis*
- *Acacia minyura*
- *Centipeda minima subsp. minima*
- **Cyperus hamulosus*
- *Enneapogon cylindricus*
- *Eremophila flaccida*
- *Indigofera gilesii subsp. gilesii*
- *Ixiochlamys cuneifolia*
- *Paraneurachne muelleri*
- *Portulaca intraterranea*

- *Ptilotus tetrandrus*
- *Sauropus crassifolius*
- *Senna notabilis*
- *Tribulus hirsutus*
- *Trichodesma zeylanicum var. zeylanicum*

DBNGP Corridor (GHD, 2009a)

- *Rhodanthe manglesii*
- *Plantago turrifera*

Weld Range Services Corridor (GHD, 2009b)

- *Indigofera gilesii subsp. gilesii*
- *Vittadinia sulcata*

Infrastructure Area (GHD, 2009d)

- *Sauropus ramosissimus*
- *Senna glutinosa subsp. glutinosa*
- *Paraneurachne muelleri*
- *Portulaca intraterranea*
- *Ptilotus tetrandrus*
- *Sauropus crassifolius*
- *Senna notabilis*
- *Tribulus hirsutus*
- *Trichodesma zeylanicum var. zeylanicum*

DBNGP Corridor (GHD, 2009a)

- *Rhodanthe manglesii*
- *Plantago turrifera*

Weld Range Services Corridor (GHD, 2009b)

- *Indigofera gilesii subsp. gilesii*
- *Vittadinia sulcata*

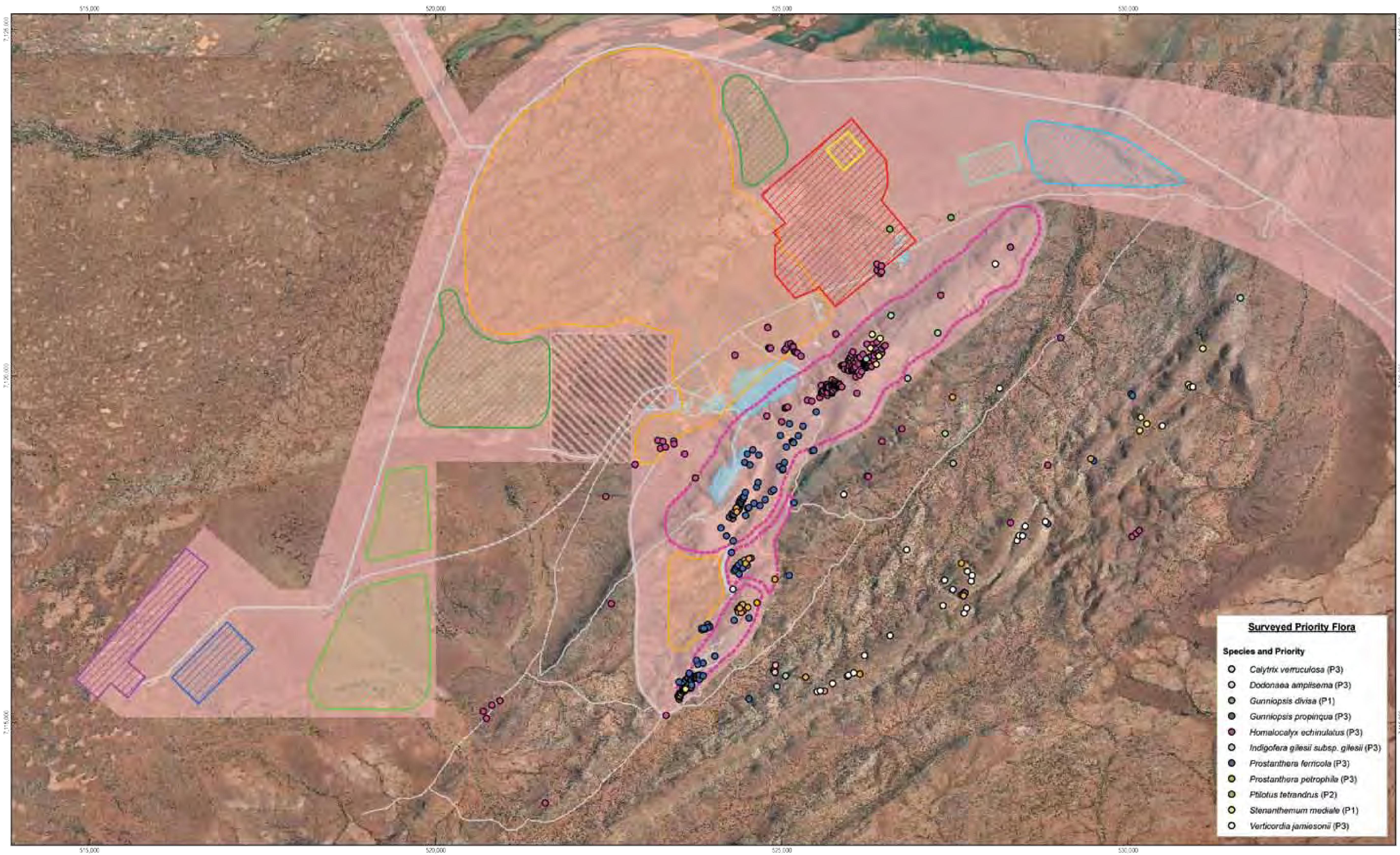
Infrastructure Area (GHD, 2009d)

- *Sauropus ramosissimus*
- *Senna glutinosa subsp. glutinosa*

TABLE 8.8 PRIORITY FLORA KNOWN TO OCCUR IN THE PROJECT AREA

Species	Conservation category	Project Mine Area	Jack Hills to DBNGP Services Corridor	Jack Hills to Weld Range Services Corridor
Acacia sp. Jack Hills	P1	✓		✓
Acacia speckii	P1			✓
Calytrix uncinata	P3			✓[1]
Calytrix verruculosa	P3	✓		
Chthonocephalus muellerianus	P2		✓	
Dicrastalis linearifolia	P3		✓	
Dodonaea amplisemina	P3	✓		✓
Eremophila petrophila subsp densa	P1		✓	
Grevillea stenostachya	P3			✓
Gunniopsis divisa	P1	✓		
Gunniopsis propinqua	P3	✓		
Homalocalyx echinulatus	P3	✓		
Indigofera gilesii subsp. gilesii ms	P3	✓		✓[1]
Petrophile pauciflora	P3			✓
Philotheca citrina	P1		✓	
Prostanthera ferricola	P3	✓		
Prostanthera petrophila	P3	✓		
Ptilotus astrolasius var. luteolus	P3			✓
Ptilotus tetrandrus	P1	✓		
Stenanthemum mediale	P1	✓		
Verticordia jamiesonii	P3	✓		

[1] Recorded outside of the services corridor during survey.



1:50,000 (at A3)

0 0.25 0.5 1 1.5 2 2.5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

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LEGEND

- Road
- Track
- Mine Expansion Pit
- Stage 1 Approved Areas
- Proposed Airstrip
- Proposed Provision for Site Drainage
- Proposed Accommodation Village
- Proposed Provision for Topsoil Stockpiles
- Proposed Ammonium Nitrate Storage
- Proposed Power Station
- Proposed Processing Plant
- Proposed Waste Dump
- Proposed Topsoil Stockpiles
- Potential Impact Area
- Potential Impact Area (Sinosteel Midwest Tenement)

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Crosslands Resources Ltd
Jack Hills Expansion Project

Job Number	61-2379603
Revision	3
Date	30 AUG 2010

Priority Flora Locations

Figure 8.8

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Data Source: GHD: Surveyed Priority Flora - 20100808, Crosslands Resources Pty Ltd: Proposed Waste Dumps, Proposed Ammonium Nitrate Storage, Proposed Provision for Site Drainage, Proposed Processing Plant, Proposed Power Station, Proposed Provision for topsoil Stockpiles, Proposed Airport, Proposed Accommodation Village, Existing & Proposed Site Roads & Tracks - 20100521, Crosslands Resources Pty Ltd: Stage 1 Approved Areas - 20091201, Landgate: Gould 2006 Mosaic, Mileura 2005 Mosaic, AMEC: Proposed Topsoil Stockpiles - 20100513. Created by: kdiralu, slee2, SJ

8.4.7 WEEDS

Weeds that are, or may become, a problem to agriculture can be formally classified as Declared Plants under the *Agriculture and Related Resources Protection Act 1976*. The Department of Agriculture and Food and the Agriculture Protection Board maintains a list of Declared Plants for Western Australia. If a plant is declared for the whole of the State or for particular Local Government Areas, all land holders are obliged to comply with the specific category control.

Baseline flora and vegetation surveys completed for the Project identified a number of weed species occurring within the Project area, as shown in Table 8.9.

TABLE 8.9 WEED SPECIES RECORDED IN THE PROJECT AREA

Scientific Name	Common Name	Project Mine Area	Jack Hills to DBNGP Services Corridor	Jack Hills to Weld Range Services Corridor
Cyperus hamulosus		✓		
Portulaca oleracea	Pigweed	✓	✓	✓
Sonchus oleraceua	Sow Thistle	✓		✓
Sisymbrium erysimoides	Smooth Mustard		✓	
Cenchrus ciliaris	Buffel Grass		✓	
Sonchus asper	Flatweed		✓	
Bidens bipinnata	Beggars Tick			✓
Heliotropium europaeum	Common Heliotrope			✓
Emex australis	Doublegee			✓
Cuscuta planiflora	Dodder	✓		

No weed species recorded within the Project area are Declared Plants pursuant to Section 37 of the *Agriculture and Related Resources Protection Act 1976. Emex australis* is listed as a Declared Plant for many municipal districts within the south-west of Western Australia; however it is not a Declared Plant within the Shire of Meekatharra, Shire of Murchison or Shire of Cue. Weed management measures to be implemented by CRL are outlined in Section 9.1.

8.4.8 PLANT PATHOGENS

Phytophthora cinnamomi threatens over 2,300 (40%) different plant species in Western Australia. Once the pathogen infects the roots, the plant may begin to show symptoms of 'dying back', hence the common name used for the pathogen: Dieback. However, for many species 'sudden death' is a better description. Introduced following European settlement, *Phytophthora cinnamomi* is a soil-borne pathogen that kills a wide range of native plant species in the south west of Western Australia by attacking their root system. *Phytophthora cinnamomi* can also survive and reproduce on a wide range of native plant species without killing them. It has a widespread but discontinuous range in areas of the south west with an annual rainfall above 500 mm (Dieback Working Group, n.d.).

Indigenous species most affected by *Phytophthora cinnamomi* belong to four families: *Proteaceae, Epacridaceae, Papilionaceae, and Myrtaceae*. Not all genera within a family or all species within a genus are necessarily susceptible.

There are no records of Dieback occurring in areas receiving less than 400 mm annual rainfall (Dieback Working Group, 2000). Therefore, it is not considered that the Project is within an area that is susceptible to the development of the *Phytophthora cinnamomi* pathogen.

8.5 FAUNA

8.5.1 SURVEY EFFORT

In order to assess the impact on vertebrate and invertebrate fauna as a result of the Project, CRL commissioned a number of desktop assessment and field fauna surveys. The survey methodologies were developed in consideration of the Environmental Protection Authority's (EPA) Guidance Statement No. 56 (EPA, 2004) and Position Statement 3 (EPA, 2002).

Table 8.10 summarizes the vertebrate fauna surveys that have been conducted to date in the area around Jack Hills since 2005.

TABLE 8.10 KNOWN RECENT FAUNA SURVEYS IN THE JACK HILLS

Contact	Report/Survey/Scope
Martinick Bosch Sell (MBS) Pty Ltd	• MBS Environmental, 2005. A Vertebrate Fauna Survey of the Jack Hills Area, Murchison Region, Western Australia. A follow up to the reconnaissance survey (MBS Environmental 2005*b*) to evaluate vertebrate fauna of the Jack Hills area and comment on the potential impacts of the Stage 1 project. This study consisted of a short trapping program from 14- 20 September 2005 over nine sites. • MBS Environmental, 2005*b*. Jack Hills Iron Ore Project, Murchison Region, Western Australia: Vegetation and Fauna Assessment. A reconnaissance level survey, conducted in October 2004 and follow up targeted surveys in June 2005. The survey consisted of opportunistic bird surveys, intensive searching and foraging for tracks, scats, burrows, and evidence of vertebrate fauna and reptiles, spotlighting for nocturnal animals/birds/reptiles and ultrasonic recordings to detect bat calls.
Western Wildlife	• Western Wildlife, 2006, Jack Hills Project Area: 2006 fauna survey. This report discusses the findings of the autumn fauna survey in March 2006 at the Jack Hills Project Area. This survey was a repeat of the MBS September 2005 survey, with some additional work carried out on bats.
Ecologia	• Ecologia conducted phase one of a two phase fauna survey in Spring 2006. The survey builds on Stage 1 data conducted by Western Wildlife (2006) and MBS Environmental (2005*a, b*) and complements previously collected regional data. The survey consisted of six trapping sites each open for 10 nights. • Phase 2 of the fauna survey was conducted in Autumn, 2007 and involved re-visiting the original six sites sampled in Phase 1. During the Phase 2 survey, two sites established by MBS for the Stage 1 project (Sites R3 and R4) were located and opened. • A short range invertebrate fauna survey was conducted by Ecologia using conventional trapping and foraging methods, over a 90 day period between July-October 2006. 29 sites within a range of habitats were surveyed, focussing on areas where SRE species were most likely to occur. • Ecologia conducted a 2-phase troglofauna survey for the Project in 2007-2008. A total of 105 samples were taken from the proposed impact area.

GHD Pty Ltd	• GHD conducted a Level 1 fauna survey along the gas pipeline corridor over a 9-day period in May 2009. The assessment included a desktop investigation and opportunistic fauna field survey (vertebrate only) and a habitat assessment, undertaken in conjunction with the vegetation and flora survey. • A Level 1 survey of the proposed service corridor was conducted in conjunction with the Level 2 flora and vegetation survey, over 9 days in May 2009, and 4 days in August 2009. • A regional stygofauna survey was conducted by GHD to determine the presence and diversity of stygofauna within the Jack Hills region. Stygofauna were sampled using modified plankton nets in accordance with the Environmental Protection Authority Guidance Statement 54 and 54a. • GHD completed Phase 3 and 4 of the Troglofauna sampling within the Brindal Deposit in 2009 to provide adequate sampling to comply with Environmental Protection Authority Guidance Statement 54 (Phase 1 and 2 completed by Ecologia). Reference sampling was undertaken for reference areas Stuart Bore and Noonie Hills in Phase 4. • GHD completed Phase 5 and 6 sampling for troglofauna in reference areas Stewart Bore and Noonie Hills to provide regional context for troglofauna diversity and distribution within the Jack Hills Range. • GHD completed targeted surveys for *Idiosoma nigrum* totalling 500 person hours, over five separate trips to the Jack Hills. The surveys aimed to determine the local distribution of *I. nigrum* within the Jack Hills range, and determine the size of the local population outside of the Project area.

8.5.2 VERTEBRATE FAUNA

8.5.2.1 MINE AREA

The Project area encompasses the eastern and south eastern slopes of Jack Hills (incorporating Mt Hale and Mt Matthew), and the valley plain to the east of the ranges. Three main fauna habitats were observed in the Project mine area, namely:

- Ridges – the dominant range at Jack Hills extends SW-NE for approximately 12 km. Vegetation on the ridge crests and slopes is variable, but generally comprises Mulga (*Acacia aneura*) low woodland or *Triodia* hummock grassland. Substrate is rocky with skeletal soils;
- Valley Plains – the valley plains support mixed Acacia woodland, generally dominated by Mulga (*Acacia aneura*). The ground storey is variable, but generally supports annual herbs and soft grasses. The substrate is generally deep to shallow sandy loam; and
- Drainage Lines – a major drainage line runs parallel to the range on its eastern side. It supports mixed Acacia woodland over small shrubs and soft grasses. Smaller drainage lines from minor gullies on the eastern slopes of the ranges feed into larger drainage line at the valley centre (Ecologia, 2009b).

A total of 15 native mammal species, 82 bird species and 23 reptile species have been recorded during surveys undertaken for Stage 1 and the Project (Ecologia, 2009c). Four of the 23 reptile species recorded within the mine area were new records for the Jack Hills (Ecologia, 2009c). These species were:

- Yellow-faced Whipsnake (*Demansia psammophis*);
- Hooded Scaley-foot (*Pygopus nigriceps*);
- Pygmy Spiny-tailed Skink (*Egernia depressa*); and
- *Lerista macropisthopus.*

8.5.2.2 JACK HILLS TO DBNGP SERVICES CORRIDOR

The gas pipeline corridor traverses a number of fauna habitats, including Acacia shrubland, rocky breakaways, minor rocky drainage lines with dense vegetation, and a permanent water hole (Kalamunda Pool at the Murchison River Crossing). None of these habitats are considered to be specific to the Project area or an important habitat type for any significant or threatened fauna species.

GHD completed a desktop investigation and limited opportunistic fauna field survey (vertebrate only) and a habitat assessment in conjunction with the vegetation and flora survey in May 2009. Ten bird species, one native mammal species and two reptile species were recorded along the proposed gas pipeline route (GHD, 2009a). Four introduced mammals, the feral cat, sheep, donkey and feral goat, were also recorded.

8.5.2.3 JACK HILLS TO WELD RANGE SERVICES CORRIDOR

Seven primary habitats have been identified along the proposed services corridor. These were based on the predominant landforms and vegetation structure in the region, and include:

- Creek lines and minor drainage channels;
- Low hills and slopes, including rocky outcrops and breakaways;
- Mulga woodlands;
- Sandplain;
- Floodplain;
- Open stony ground; and
- Calcrete/quartz outcrops.

Permanent water sources are located in close proximity to the northern section of the proposed corridor.

The Level 1 vertebrate fauna survey completed by GHD in September-October 2009 identified five native vertebrate species along the services corridor route. These included the White Faced Heron (*Ardea novaehollandiae*), Wedge-tail eagle (*Aquila audax*), Western Galah (*Cacatua roseicapilla*), Ring-tailed Dragon (*Ctenophorus caudicinctus mensarum*) and Red Kangaroo (*Macropus rufus*). The low number of vertebrate fauna species observed during the survey is thought to be attributed to the cold and wet weather conditions at the time of the survey (GHD, 2009b).

8.5.2.4 SIGNIFICANT FAUNA

The conservation status of fauna species is assessed under the State and Commonwealth Act; in particular the *Western Australian Wildlife Conservation Act 1950* and the EPBC Act 1999.

The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (**IUCN**). A description of Conservation Categories delineated under the EPBC Act is detailed in Ecologia (2009a) (Appendix F). These are applicable to threatened flora and fauna species. The WA *Wildlife Conservation Act 1950* uses a set of Schedules but also classifies species using some of the IUCN categories. These categories and Schedules are described in Ecologia (2009a) (Appendix F).

The EPBC Act also protects migratory species that are listed under the following International Agreements:

- Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;
- The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (**CAMBA**);
- The Republic of Korea Australia Migratory Birds Agreement (**RoKAMBA**); and
- The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (**JAMBA**).

Listed migratory species also include species identified in other international agreements approved by the Commonwealth Environment Minister.

The Act also protects marine species on Commonwealth lands and waters.

In Western Australia, the DEC also produces a supplementary list of Priority Fauna, these being species that are not considered Threatened under the Western Australian *Wildlife Conservation Act 1950* but for which the Department feels there is a cause for concern. These species have no special legislative protection, but their presence would normally be considered. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. Levels of Priority are described in Appendix F.

Fauna surveys for the Project included database searches using the EPBC Act Protected Matters Report and the DEC's Threatened Fauna database. From the DEWHA, DEC and WA Museum databases, a number of protected fauna species were identified as potentially occurring within the survey area, these species are detailed in Table 8.11.

It should be noted that some species that appear in the EPBC Act Protected Matters Search Tool are often not likely to occur within the specified area, as the search provides an approximate guidance to matters of national significance that require further investigation. The records from the DEC searches of threatened fauna provide more accurate information for the general area; however some records of sightings or trappings can be dated and often misrepresent the current range of threatened species.

An assessment of the likelihood of occurrence of each of the protected fauna species identified through database searches is included in Table 8.11.

TABLE 8.11 CONSERVATION SIGNIFICANT FAUNA POTENTIALLY OCCURRING IN THE PROJECT AREA

Species	Conservation Significance			Habitat	Likelihood Of Occurrence		
	EPBC	WCA	DEC		Project Mine Area	Gas Pipeline Corridor	Services Corridor
Mammals							
Long-tailed Dunnart (*Sminthopsis longicauda*)			P3	Rocky habitat with grass hummocks or open mulga habitats	High – recorded during survey	Very low – no suitable habitat	Very low – no suitable habitat
Greater Bilby (*Macrotis lagotis*)	VU	S1		Shelters in burrows. Occupies a range of habitats from spinifex grassland to mulga scrub and woodlands.	Very low – no previous records	Very low – no suitable habitat	Very low – no suitable habitat
Black-flanked Rock Wallaby (*Petrogale lateralis lateralis*)	VU	S1		Steep, complex rocky habitats providing caves and crevices for shelter. Granitic outcrops in remnants of mallee scrubs.	Very low – no previous records		
Pilbara Leaf-nosed Bat (*Rhinonicterus aurantia*)	VU	S1		Requires deep, warm and humid caves or mines.	Very low – no suitable habitat		
Brush-tailed Mulgara (*Dasycercus blythi*)			P4	Sandy areas with moderately dense spinifex with ‘runways’ between clumps	Very low – no suitable habitat		
Ghost Bat (*Macroderma gigas*)			P4	Caves, rock piles, abandoned mine shafts, and deep rock fissures.	Low – no previous records. Possible transient forager.		
Western Pebble-mouse (*Pseudomys chapmani*)			P4	Spurs and lower slopes of rocky hills with small pebbles, vegetated by spinifex.	Very low – historically occurred but now thought to be absent from region	Very low – no suitable habitat	Very low – no suitable habitat

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SPECIES	CONSERVATION SIGNIFICANCE			HABITAT	LIKELIHOOD OF OCCURRENCE		
	EPBC	WCA	DEC		Project Mine Area	Gas Pipeline Corridor	Services Corridor
Birds							
Peregrine Falcon (*Falco peregrinus*)		S4		Coastal cliffs, riverine gorges and wooded water-courses.	High – previously recorded	Moderate – species is widespread. No significant habitat	Moderate – species is widespread. No significant habitat
Bush Stone-curlew (*Burhinus grallarius*)			P4	Lightly wooded country next to daytime shelter of thickets or long grass	High – previously recorded		
Australian Bustard (*Ardeotis australis*)			P4	Open or lightly wooded grasslands, chenopod flats, low heathland.	Moderate – likely during suitable conditions	Moderate – species is widespread. No significant habitat	Moderate – species is widespread. No significant habitat
Malleefowl (*Leipoa ocellata*)	VU, M	S1		Dry Inland scrub, mallee: dense litter-forming vegetation on sand to construct mounds.	Very low – no suitable habitat		
Slender-billed Thornbill (west-ern) (*Acanthiza iredalei iredalei*)	VU			Samphire near salt pans, semi-deserts, sandplain and heaths.	Very low – no suitable habitat		
Major Mitchell's Cockatoo (*Lophochroa leadbeateri*)		S4		Sporadic distribution throughout arid and semi-arid Australia, in lightly wooded grasslands near water, tall eucalypts, shrublands and rocky outcrops.	Low – no recent records, little suitable habitat	Moderate – Potential suit-able nesting trees near river pool.	Low – no fresh water sources along corridor route
Crested Bellbird (southern) (*Oreoica gutturalis gutturalis*)			P4	Drier wheatbelt mallee woodland and heaths of southern part of WA	Very low – not within cur-rent distribution	Moderate – suitable habitat but outside known range.	Moderate – suitable habitat but outside known range.

SPECIES	CONSERVATION SIGNIFICANCE			HABITAT	LIKELIHOOD OF OCCURRENCE		
	EPBC	WCA	DEC		Project Mine Area	Gas Pipeline Corridor	Services Corridor
Migratory Birds							
Rainbow Bee-eater (*Merops ornatus*)	Ma, Mi			Open country in most vegetation types.	High – recorded during survey	Moderate – species is widespread. No significant habitat	Low – species is wide-spread. No significant habitat
Fork-tailed Swift (*Apus pacificus*)	Ma, Mi			Arid areas, avoiding areas with strong winds.	Moderate – likely to overfly area. Non-breeding visitor	Moderate – likely to overfly area. Non-breeding visitor	Moderate – likely to overfly area. Non-breeding visitor
Eastern Great Egret (*Ardea modesta*)	Ma, Mi			Floodwaters, rivers, shallows of wetlands, intertidal mudflats	Low – requires significant standing water	Low – requires significant standing water	Low – requires significant standing water
Cattle Egret (*Ardea ibis*)	Ma, Mi			Pasture, shallows of freshwater wetlands.	Very low – requires significant standing water	Very low – requires signifi-cant standing water	
Oriental Plover (*Charadrius veredus*)	Ma, Mi			Dry plains, coastal.	Very low – very few inland records	Very low – very few inland records	Very low – very few inland records
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Ma, Mi			Coastal and riverine environments		Low- generally present in near coastal environments	
Reptiles							
Lerista eupoda			P1	Leaf litter in *Acacia* shrublands. Restricted distribution in the vicinity of Cue and Meekatharra.	Low – not recorded at Jack Hills, restricted distribution to south.		
Western Spiny-tailed Skink (*Egernia stokesii badia*)	EN	S1		Dark form occurs in granitic outcrops where suitable cracks and crevices are present.	Low – lack of suitable granite outcrops		

Note:

EPBC = *Environment Protection and Biodiversity Conservation Act 1999*
WCA = *Wildlife Conservation Act 1950*
DEC = DEC Priority fauna list

Under the EPBC Act:

EN = Endangered
VU = Vulnerable
Ma = Marine
Mi = Migratory

Under the WCA

S1 = Schedule 1
S4 = Schedule 4

Under DEC

P1 = Priority 1
P3 = Priority 3
P4 = Priority 4

GOLDEN GECKO
2010 AWARD RECIPIENT

Three conservation significant species were recorded during fauna surveys undertaken within the Project mining areas:

- The Long-tailed Dunnart (*Sminthopsis longicaudata*): DEC – P3;
- Rainbow Bee-eater (*Merops ornatus*); DEWHA Marine and Migratory; and
- Nankeen Kestrel (*Falco cenchroides*): DEWHA Marine.

The Nankeen Kestrel was also recorded during surveys along the proposed gas pipeline route. No other conservation significant species have been recorded during baseline surveys completed for the Project, however, as indicated in Table 8.11, there is potential for other species of significant fauna to occur.

8.5.2.5 INTRODUCED FAUNA

A total of seven introduced mammal species have been recorded within the Project area, namely:

- Goat (*Capra hircus*);
- Feral Cat (*Felis catus*);
- Dingo/Wild Dog (*Canis familiaris*);
- House mouse (*Mus musculus*);
- Fox (*Vulper vulpes*);
- Domestic cattle (*Bos indicus*); and
- European rabbit (*Oryctolagus cuniculus*).

Grazing has been highlighted as an issue for established vegetation surrounding the Project area. An agreement with local pastoralists was previously developed for the Stage 1 mining operation and resulted in the culling of thousands of goats. Since this time the number of goats has increased with an estimated population of 600 goats recorded in the local area during summer, 2009 and a reported 150 goats currently in the local area (pers. comm. Kevin Mahoney, Judal Station).

8.5.3 INVERTEBRATE FAUNA

8.5.3.1 SHORT RANGE ENDEMIC FAUNA

Endemism refers to the restriction of species to a particular area, whether or not it is at a continental, national or local level. Short range endemism refer to endemic species with restricted ranges, which in Western Australia is currently defined as less then 10,000 km^2 (i.e. 100 km x 100 km). Such taxa are usually invertebrates, as these are more likely to display poor dispersal abilities and display a more defined or restrictive biology which would promote their isolation and eventual speciation (Harvey, 2002).

A conventional trapping and foraging programme for the Project, over a 90 day period (July to October, 2006), was undertaken (Ecologia, 2009c). The methodology for the surveys was developed and approved in consultation with Mark Harvey from the West Australian Museum (**WAM**). The short range endemic surveys were designed to complement regional data for the area. At the time of undertaking the survey (2006) the EPA's Guidance Statement No. 56 and Position Statement No. 3 provided no specific instructions on the expected design of SRE surveys (Ecologia, 2009c). The survey methodology used by Ecologia conformed with the subsequent release of methodology for short range endemic (**SRE**) surveys in EPA Guidance Statement No. 20 Sampling of Short Range Endemic Fauna for Environmental Impact Assessment in WA.

Targeted sampling for SRE invertebrates involved review of aerial photography for the south-facing slopes, gullies, dense patches of trees and permanent water bodies. On arrival at site, further refinements were made governing the placement of traps in shaded areas of low shrubs and in areas of litter accumulation. The survey was undertaken using a combination of sampling techniques, including pitfall trapping (systematic) and foraging (opportunistic) (Ecologia, 2009c).

A total of 87 sites were selected in and around the Project area. The site selection focused on a range of habitats where SRE species were most likely to occur. Full details of the survey method and sampling techniques are provided in the Jack Hills Mine Expansion - Short-range Endemic Invertebrate Report (Appendix F; Ecologia, 2009c).

Potential SRE species recorded in the mine area are summarised in Table 8.12.

TABLE 8.12 RESULTS OF THE JACK HILLS SRE INVERTEBRATE SURVEY (ECOLOGIA, 2009C)

Species of Conservation Significance				
Class	**Order**	**Family**	**Genus**	**Species**
Arachnida	Mygalomorphae	Dipluridae	*Cethegus*	sp.
		Nemesidiae	*Aname*	Species 2
		Idiopidae	*Idiosoma*	*nigrum*
			Eucyrtops	sp.
		Actinopodidae	*Missulena*	sp.
Arachnida	Pseudoscorpionidae	Garypidae	*Synsphyronus*	sp.
		Olpiidae	*Austrohorus*	sp.
			Beieropium	sp.
			Indolpium	sp.
	Scorpion	Buthidae	*Lychas*	*splendens*
			Lychas	'MML1'
			Lychas	'MML2'
Insecta	Isopoda	Armadillidae	*Buddelundia*	sp.
			Spherillo	sp.
			Cubaris	sp.

Three species recorded during the SRE surveys are considered to be SRE species and/or protected at state level:

- *Cethegus sp* (*Cethegus fugax* species complex) presents an extension to the distribution of the complex.
- *Eucyrtops* sp. presents a range extension, as this species has previously only been identified from a survey at the Carnarvon Basin.
- *Idiosoma nigrum* is listed as a 'Schedule 1' species under the *Wildlife Conservation Act 1950*.

Ecologia (2009c) reported that of the species recorded during the SRE surveys, *Cethegus* sp. and *Idiosoma nigrum* are the most important given their likely narrow geographical ranges and high levels of endemicity.

***Cethegus* sp. (*Cethegus fugax* sp. Complex)**

Cethegus is known to inhabit areas ranging from tropical rainforests to semi-arid environments where it survives under embankments and logs by constructing a web of vertical strands over a shallow burrow. The population collected at Jack Hills presents an extension to the complex geographic distribution (Ecologia, 2009c). Genetic studies planned by Ecologia (2009c) did not proceed and currently the species status of the *Cethegus* sp. from Jack Hills is unknown. This species is widespread and abundant in the greater Jack Hills range and adjacent floodplains and will not be significantly impacted by the Project.

Eucyrtops sp.

Eucyrtops sp. has a large body that superficially looks like a tarantula. The presence of *Eucyrtops sp.* at Jack Hills marks an extension in the range of a species identified in the Carnarvon Basin Survey (Ecologia, 2009c). The range extension of *Eucyrtops* sp. indicates that the species is considerably more widespread than initially thought and does not represent a SRE species, and will not therefore be significantly impacted by the Project.

Idiosoma nigrum

The Shield-back Trapdoor Spider (*Idiosoma nigrum*) was first discovered at Jack Hills in 2006. *Idiosoma nigrum* is considered to be one of the most arid-adapted mygalomorph spiders in Australia. This is due to a combination of morphological and behavioral attributes (Ecologia, 2009c). The spider is long lived, with females possibly reaching 20 years or more of age. Male and female spiders reach maturity between a minimum of 5 to 6 years. The males undergo a final moult, reproduce and then subsequently die. Females are capable of reproducing every second year. Generally the spiderlings will establish burrows within several centimeters of the matriarch female, thus forming a family cluster typical of all mygalomorph spiders (Ecologia, 2009d).

The regional distribution of *I. nigrum* includes several ranges within the Murchison, including Weld Range and Karara Range, along with historical populations throughout the Wheatbelt (GHD, 2009e).

Following the initial discovery of *I. nigrum* in the Jack Hills, a targeted survey was conducted which covered high risk areas southeast of Mt Hale and Mt Matthew (Ecologia 2009d; Appendix F). A total of 497 recently active *I. nigrum* burrows and burrow clusters, comprising 3,665 individual burrows, were recorded.

A detailed ecological study of *I. nigrum*, concentrating on the effects of vibration from resource drilling and mine activities on spiders, was also conducted. This study identified an addition of 796 recently active *I. nigrum* burrows (Phoenix Environmental, 2009; Appendix F).

In 2009, GHD completed a detailed targeted survey for *I. nigrum* within and outside of the proposed Project area to determine the local distribution of the species within the Jack Hills range, and the size of the local population outside of the Project impact area. GHD identified 16,035 burrows of *I. nigrum* in the drainage lines and low hills to the south east of the Project, with a total population at Jack Hills of 21,000 individuals in the areas searched (GHD, 2009e). The proposed development footprint for the Project will directly impact on 3899 burrows identified during targeted surveys for this species. This represents 18.57% of the total local population identified to date (Plate 1).

PLATE 1 IDIOSOMA NIGRUM BURROW

8.5.3.2 SUBTERRANEAN FAUNA

Subterranean fauna include stygofauna and troglofauna. Stygofauna are aquatic subterranean animals found in a variety of groundwater systems, while troglofauna occupy the air spaces above the water table. The Western Australia *Wildlife Conservation Act 1950* protects all species in Western Australia at the population level.

Stygofauna are known to occur in a variety of rock types including karst (limestone), fractured rock (i.e. granite) and porous rock (i.e. alluvium). Stygofauna diversity in Western Australia includes a range of crustacean taxa (often the most abundant of the fauna), platyhelminthes, oligochaeta, water mites and beetles.

Troglofauna

Troglofauna occur in the strata between the superficial soil layer and water table, where suitable space is available. Historically they have been collected primarily from karstic limestone systems in Western Australia, but are now known to occur in a wide variety of geologies including BIF, Channel Iron deposits and other fractured rock where suitable subterranean voids are present.

A two-phase troglofauna survey was undertaken in summer 2007 and winter 2008. The surveys identified three potentially troglobitic invertebrate species within the Project area, a silverfish species (Zygentoma), a sucking bug species (Hemiptera), and a larval beetle species (Coleoptera) (Ecologia, 2009f; Appendix F;)

All three species are considered to possess characteristics that infer a troglobitic existence, however, due to the poor taxonomic knowledge of each group, the three species could not be identified further (Ecologia, 2009f; Appendix F).

Additional troglofauna surveys were completed across Matthew Ridge, Dead Goat Hill and Taylor Range in summer 2008 (Phase 1, February - April) and winter 2008 (Phase 2, September - October) (Ecologia, 2009d). Phase one sampling yielded over 1300 invertebrate specimens and confirmed the wider presence of troglofauna within the Jack Hills region (Ecologia, 2009d; Appendix F). Of the six orders recorded by Ecologia, two orders, isopods (slaters) and oligochaeta (worms) were considered to be truly troglobitic. Phase two sampling did not record any troglobitic specimens.

Additional sampling was also undertaken both within the Project Area, and in reference areas to the east (Stewart Bore) and south (Noonie Hills) of the Jack Hills Range (GHD 2009f, GHD 2010; Appendix F) between May 2009 and February 2010. This further sampling identified an additional nine (9) taxa that showed some degree of troglomorphism (morphological adaptation to subterranean habitats) (Table 8.13).

Phase 3 troglofauna sampling was conducted within the Brindal deposit, located at the southern end of the Project area, between May and July 2009. A total of 30,994 invertebrates were collected during the phase 3 survey, however only 12 individuals were considered to represent troglofauna (GHD, 2009f; Appendix F). Troglomorphic individuals were recorded from the following groups: Pseudoscorpionida (1), Isopoda (2), Hemiptera: Cixiidae (4), Coleoptera: Carabidae (4), and Coleoptera: Lathridiidae? (1) (GHD, 2009f; Appendix F).

Phase 4 sampling was completed in October 2009, covering two areas outside of the Project impact area, at Noonie Hills and Stewart Bore. This phase collected 8,891 invertebrates, although only eight individuals were considered to represent troglofauna (GHD, 2009f; Appendix F). Troglomorphic individuals were recorded from Isopoda: Polyxeniidae (6 individuals) and Hemiptera: Cixiidae (2 individuals) (GHD, 2009f; Appendix F).

GHD (2010) conducted Phase 5 (October 2009 to December 2009) and Phase 6 (December 2009 to February 2010) sampling for troglofauna in reference areas Stewart Bore and Noonie Hills to provide regional context for troglofauna diversity and distribution within the Jack Hills Range.

Phase 5 sampling of the Noonie Hills and Stewart Bore collected 22,069 and 11,350 invertebrates, respectively. However, all specimens were terrestrial invertebrates colonising litter traps from the surface and showing no troglomorphic characteristics.

Phase 6 sampling of the Noonie Hills and Stewart Bore areas recorded two troglomorphic taxa, both previously recorded from the Jack Hills Range in previous phases. The collection of troglomorphic polyxeniid millipedes from Stewart Bore is significant as previously this taxa had only been recorded from Noonie Hills, approximately 60 km to the south west. The collection of additional specimens of the pseudoscorpion *Tyrannochthonius*sp. *nov*. from Stewart Bore is also significant as this species was previously only known from the Brindal area.

The Project area forms a broadly continuous geological unit with the main Jack Hills Range, uninterrupted by major faults or other obstructions. The range extends beyond the Project area to both the south west and north east. The size of the proposed mine expansion is less than 10% of the entire Jack Hills Range, which extends from Noonie Hills in the south west to Mt Taylor in the north, thus the amount of direct subterranean habitat destruction is relatively minor.

The Jack Hills Range covers a distance of over 50 km, from Noonie Hills in the far south, through Dead Goat Hill and to the Taylor Range at the northern most extent of the range, with regional geological mapping indicating that troglofauna habitat occurs along strike of the entire range (GHD 2010). Sampling for troglofauna has occurred, in some form, along almost the entirety of the range with troglofauna communities detected in multiple lithologies along strike, indicating that suitable habitat for troglomorphic taxa is actually widespread throughout the entire 50 km length of the range. This suggests that troglofauna are unlikely to be restricted to specific lithologies, such as those targeted for proposed mining activities.

TABLE 8.13 TROGLOMORPHIC TAXA FROM JACK HILLS COLLECTED DURING SAMPLING PHASES 1 – 6.

Taxa	Drill holes Recorded	Morphology	Area	Impact Area	Reference Area
Annelida: Oligochaeta	NHRC002, NHRC010, JHRC050 (SinoSteel)	Undetermined	Noonie Hills, Taylor Range		X
Crustacea: Isopoda: Oniscoiid	JHRC110 (SinoSteel)	Undetermined	Dead Goat Hill		X
Crustacea: Isopoda: Armadillidae sp. 1	MHRC327	Troglobite	Brindal	X	
Crustacea: Isopoda: Armadillidae, Spherillo sp. 1	NHRC013	Troglobite	Noonie Hills		X
Myriapoda: Diplopoda: Polyxenid	SBRC017, SBRC022, NHRC009	Troglobite	Stewart Bore, Noonie Hills		X
Arachnida: Pseudoscorpionida: Chthoniidae	MHRC335, SBRC018	Troglobite	Brindal, Stewart Bore	X	X
Insecta: Zygentoma: Nicoletiidae	MHRC145	Troglobite	Mine expansion area	X	
Insecta: Hemiptera: Cixiidae	MHRC316, MHRC326, MHRC145, SBRC018	Troglobite	Mine Expansion Area, Brindal, Stew-art Bore	X	X
Insecta: Coleoptera: Cantharidae	MHRC376	Edaphophile	Mine expansion area	X	
Insecta: Coleoptera: Rhizophagidae	MHRC187	Undetermined	Mine expansion area	X	
Insecta: Coleoptera: Carabidae	MHRC327, MHRC335	Troglobite	Brindal	X	
Insecta: Coleoptera: Lathridiidae	MHRC326	Undetermined	Brindal	X	

Stygofauna

A study of the Mt Hale fractured rock aquifer was undertaken (GHD, 2009g) to assess the likelihood of stygofauna presence within the Project Area. The survey sampled five (5) bores and no stygofauna was detected within the Project Area aquifer.

A regional stygofauna survey was conducted to determine the presence and diversity of stygofauna within the Jack Hills region. The survey included sampling from 19 bores from five areas. A single species of Chiltoniid amphipod, representing a new genus and new species, was recorded from two of the bores within the Murchison Palaeochannel / Calcrete aquifer. No other stygofauna was recorded (GHD, 2009g).

Regional stygofauna sampling within the Murchison calcrete aquifers is underway and will be on-going until early 2011.

8.6 ENVIRONMENTALLY SENSITIVE AREAS

The DEC's online Native Vegetation Viewer was searched to determine the location of any Environmentally Sensitive Areas (ESAs) within the vicinity of the Project, as declared by a Notice under Section 51B of the *Environmental Protection Act 1986*.

There are no ESAs within or in close proximity to the Project area.

8.7 RESERVES AND CONSERVATION AREAS

There are no reserves or conservation areas within or in close proximity to the Project area. The nearest conservation area is over 100 km away (Figure 8-9).

8.8 HERITAGE

8.8.1 INDIGENOUS HERITAGE AND NATIVE TITLE

The Native Title Parties in the Project area are the Wajarri Yamatji and Malgana Shark Bay Peoples. CRL has an existing Mining Agreement with the Wajarri Yamatji Native Title Party. This Native Title Party consists of two local indigenous groups, being the Ngoonooru Wadjari and the Wajarri Elders. The Mining Agreement was signed in August 2005 and has provisions for review within five years of this date.

The Aboriginal Sites Register is held under the State's *Aboriginal Heritage Act 1972*. It protects places and objects customarily used by, or traditional to the original inhabitants of Australia.

Where an activity disturbs an Aboriginal site or object an application for permissions to disturb those sites will need to be submitted to the Department of Indigenous Affairs (DIA) under *Section 18* of the *Aboriginal Heritage Act 1972*. Where a site of previously unknown Aboriginal heritage is to be disturbed, it is advised that a detailed anthropological and archaeological heritage survey is undertaken to determine an acceptable management strategy. Any sites or objects of significance in the area will require negotiated management strategies and ensure compliance under the *Aboriginal Heritage Act 1972*, as it is an offence to disturb any Aboriginal Heritage sites, even those not contained on the Aboriginal Heritage Site Register. In the event that Aboriginal archaeological or ethnographic sites are discovered during construction, there will be a need to meet the requirements of the *Aboriginal Heritage Act 1972*.

Historical heritage survey's have been carried out over all existing disturbances and have identified areas that are registered or have some significance to the Wajarri Yamatji people.

A search of the Register of Aboriginal Sites maintained by the Department of Indigenous Affairs (DIA) on tenements: M20/506; L20/53; L20/47; L51 /85; P20/1918; P20/1919; P20/1925; and P51/252 revealed that there are several registered Aboriginal sites on the tenements.

The registered Aboriginal sites located on M20/506 (this includes an artefact relocation site) will be impacted by the project. The current Mt Hale exclusion zone is shown in Figure 8-10. This exclusion zone has both the relocated artefact site # 24132 and a newly registered mythological site # 25560 (registered in September 2008):

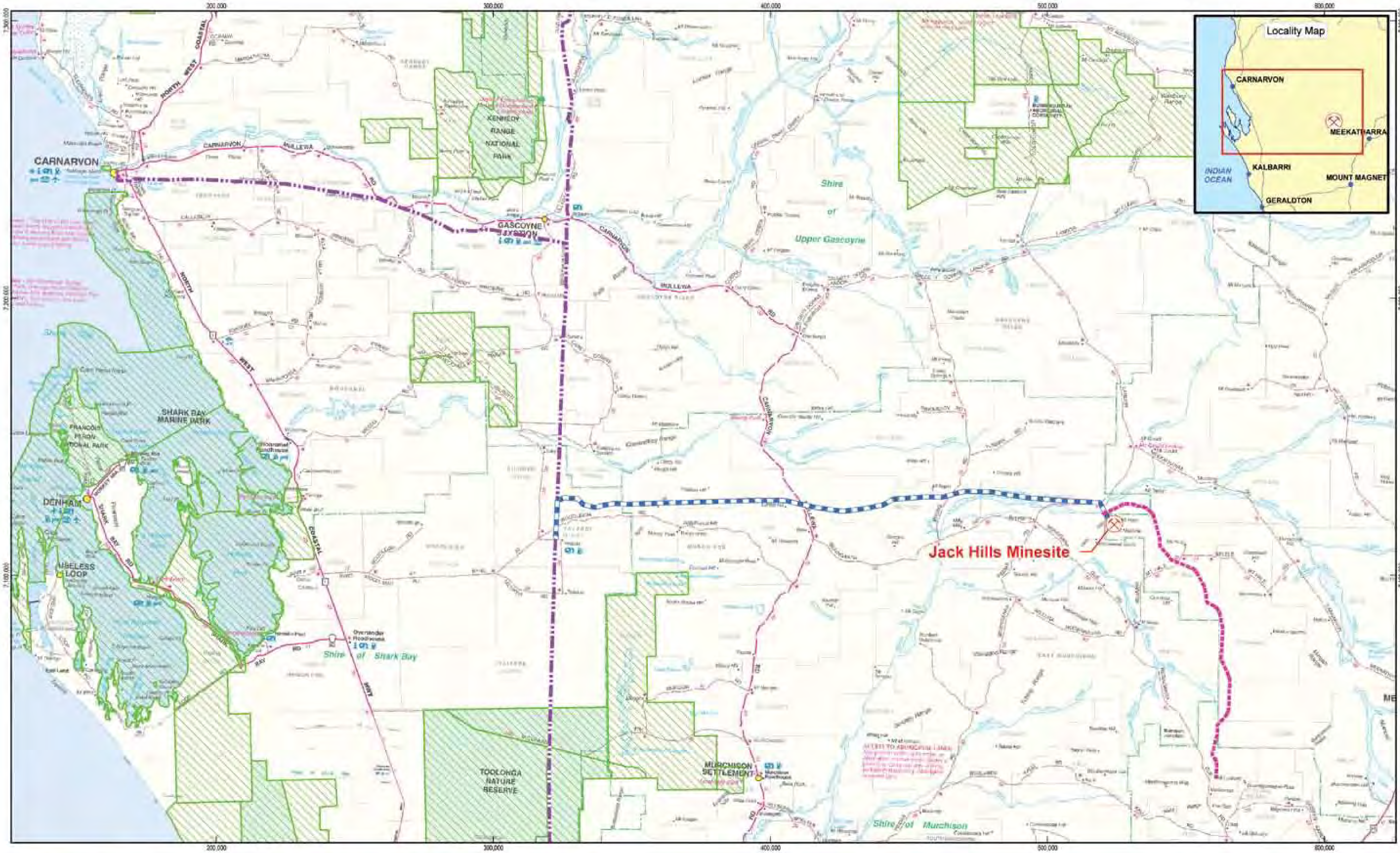
- Site # 24132 is a relocated scatters site and is currently fenced off to ensure no access is made to the area.
- Site # 25560 – Gudgeemia is a recently registered mythological site. This has a site radius of 230 metres (encompasses the site # 24132). Consultation is currently being undertaken with relevant traditional owners with a view to accessing this area through consultation with the relevant indigenous group and a Section 18 approval process. No access will be undertaken within this area without authority of both the traditional owners and DIA.

Extensive consultation is being undertaken with the Wajarri Yamatji group in an effort to avoid all recorded sites. It is important to note that the mine and infrastructure will require both an ethnographic and archaeological heritage survey over the nominated area/s. Given the number of already recorded sites it is highly likely that further sites will be identified during this process.

Consultation with the group will be required at all stages in an effort to reduce any damage to sites or to ultimately avoid them if possible. Should avoidance not be possible Section 18 applications under the *Aboriginal Heritage Act* may be required. At all times throughout this process consultation will be ongoing with the Wajarri Yamatji group.

The Gas Pipeline corridor from the Dampier to Bunbury Natural Gas Pipeline (DBNGP) to Jack Hills will require consultation with two Native Title Parties. The western end of the Jack Hills to DBNGP services corridor falls within the Malgana Shark Bay People's Application (first 50km) and then within the Wajarri Yamatji Native Title area for the rest of the route east to the Jack Hills mine site. Much of this proposed route has never been surveyed and as such there are limited known sites in the near vicinity of the proposed pipeline. The desktop survey has ascertained that there is one known registered site within a one kilometre radius of the preferred pipeline route. This may require a specific management action, such as building a fence to protect the site.

Ethnographic and archaeological surveys have been completed on the Registered Sites on Mount Hale and CRL has obtained Ministerial conditional consent to carry out exploration activities within the site under Section 18 of the *Aboriginal Heritage Act*. All ground disturbing works at Jack Hills require Heritage Clearance and this is an on going process completed in consultation with the Native Title parties. Continuous coverage by Heritage Monitors on all ground disturbing activities at CRL operations also addresses any risks associated with the Heritage process.



1:1,250,000 (at A3)

0 5 10 20 30 40 50 60

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Jack Hills Mine Site
- Proposed Service Corridor Alignment
- Proposed Natural Gas Pipeline
- Dampier-Bunbury Natural Gas Pipeline (DBNGP)
- DEC Estate

GHD CLIENTS | PEOPLE | PERFORMANCE

CROSSLANDS RESOURCES LTD

Crosslands Resources Ltd
Jack Hills Expansion Project

Job Number	61-2379603
Revision	0
Date	09 JUN 2010

Conservation Areas

Figure 8.9

GHD House, 239 Adelaide Terrace Perth WA 6004 T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

G:\61\23796\GIS\Maps\MXD\03_EIA_and_Referral_Stage2\PER\612379603_G018_Fig8-9_Rev0.mxd

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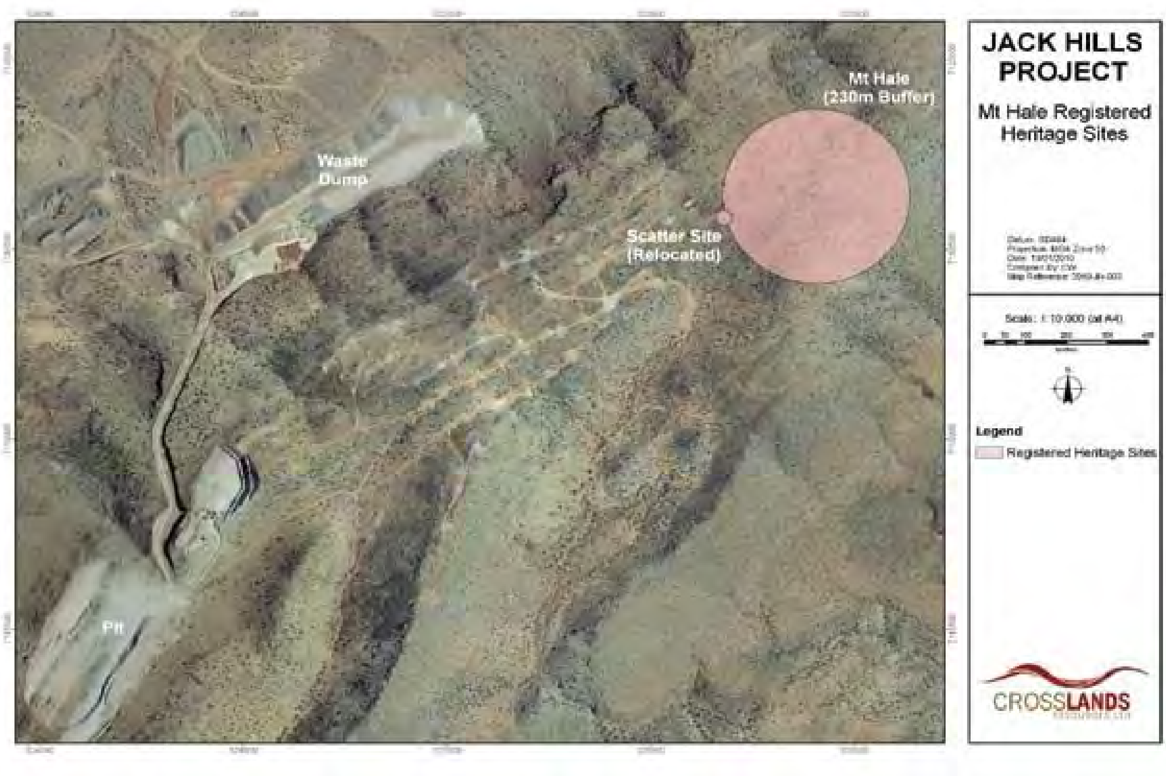
Data Source: Landgate: Travellers Atlas - 2004; Crosslands: Proposed Natural Gas Pipeline - 20090420; GA: Topo 250k Series 3 Topographic Data - 200607; GHD: Jack Hills Minesite - 20090420; DMP: Dampier-Bunbury Natural gas Pipeline (DBNGP) - Unknown; Crosslands Resources Ltd: Proposed Service Corridor Alignment - 20090821; DEC Estate - 20090601. Created by: slee2, mdalton2

FIGURE 8-10 INDIGENOUS HERITAGE



Extensive consultation with both Native Title groups will be required and the entire pipe line route will be subject to both ethnographic and archaeological surveys. CRL will attempt to realign the route to avoid any damage to indigenous sites in consultation with the relevant groups.

If avoidance of impacts to a registered site is not possible then Section 18 applications to the DIA may be required.

8.8.2 NON-INDIGENOUS HERITAGE

Jack Hills is recognised by the National Trust as having natural heritage value and was listed on the 'interim list' of the Register of National Estate when the Australian Heritage Commission was abolished. The Register of National Estate was frozen in February 2007, meaning that no new places can be added or removed. From February 2012, all references to the Register of National Estate will be removed from the EPBC Act and the *Australian Heritage Council Act* 2003. Within this five year period, heritage places will be assessed and transferred to the appropriate Local, State or Commonwealth heritage registers.

8.9 VISUAL AMENITY

The Jack Hills are situated in the remote Murchison region of Western Australia, located approximately 300km inland from the southernmost part of Shark Bay, and approximately 200km northwest of Meekatharra.

The proposed Jack Hills Project involves a deposit in the form of a ridge, which in term forms part of a larger ridge system called Jack Hills. The Jack Hills ridges are a linear ridge system running approximately west to east/ north east, and also running parallel to the Murchison River drainage system, in the vicinity of Beringarra bore, which is at the intersection of Beringarra Pindar Road and Beringarra Cue Road. The proposed mine location lies between two high points on a northerly 'east-west' running ridge, these being Mt Matthew and Mt Hale and then further extends to the north-east of Mt Hale.

GHD completed a visual impact appraisal using field data, field photography, helicopter photographic survey, fly-though computer generated images of the proposed mine site and mine operations, and a range of mapping (topographic, contour, land use and cadastre, geology). A systematic assessment process was applied, as recommended in “Visual Landscape Planning in Western Australia: A Manual for Evaluation, Assessment, Siting and Design” (Department for Planning and Infrastructure, November 2007).

8.9.1 REGIONAL LANDSCAPE DESCRIPTION

The dominant region is identified as occurring within the Meekatharra Plateau landscape character type (“Reading the Remote”, page 91, Department of Conservation and Land Management, 1994). This regional landscape character type covers a large portion of central inland Western Australia, and is the denuded remnant of an extensive former upland plateau, now featuring an ancient and eroded landscape with gently undulating plains, and recurring rounded rock outcrops and rugged ranges and hills, that feature strongly in a wide horizontal landscape. The regional landscape is dominated by Mulga vegetation. The western and northern portions of the Meekatharra Plateau feature the shallow drainage lines and upstream flow of westward flowing watercourses including the head waters of the Murchison River.

8.9.2 DISTINGUISHING LANDFORM

The dominant gently inclined plains ‘under big skies’ are distinguished by warm terracotta to rich maroon shades which typify the soils and rocks of the region, and creating significant contrast with the rounded, olive Mulga, green-blonde Spinifex tussocks, and the wide azure skies.

Alluvial and floodwash plains with broad saline plains form an extensive part of this landscape, which is dominated by low, shrubby plants scattered across the level, often stony surfaces, and occasionally fringed by low, red sandy mounds. The more defined watercourses, such as the Murchison River, are critical features in the landscape, with their associated mud flats, shallow floodways through to defined creek lines which strongly dissect the plains in the western areas of this regional landscape and are particularly pronounced in the lower slopes of the distinct ridgelines, such as Jack Hills.

Open and far reaching views are dominant throughout this regional landscape. The long horizontal skyline is interrupted by the occurrence of various ‘ridge’ type features, ranging from flat-topped mesas, vertical buttes, through to low elongated irregular ranges and ridges.

The dominant and widespread land use within this regional landscape is the pastoral industry, featuring much dispersed livestock (mainly cattle) grazing within the scrubby native vegetation on the extensive pastoral properties. Signs of old and now declining pastoral activity are interspersed throughout the landscape, ranging from fencing to windmills, to old homesteads and corrugated iron water tanks, to tracks and old livestock enclosures.

8.9.3 PROJECT PROPOSAL – VISUAL ELEMENTS AND IMPLICATIONS

The intended mine workings will extend on a roughly ‘west to east/south west to north east’ alignment along the existing ridgeline that forms a northerly portion of the overall ridge landscape. This will include Mount Matthew and Mount Hale, which are approximately 620 m in height. The mine excavation will progressively form a deep mine pit over the life of the proposed operation creating a pronounced void where there is currently a low but pronounced ridge feature (Plate 2). Adjacent and to the north of the pit/void will be the mine work site (ROM, stock piles, depots and administration, etc) and an extensive mine waste disposal site. The latter will rise to approximately 230 m in height above the surrounding plain over the life of the operation (Plate 3). Over this operational period the waste disposal and overburden tip will be progressively formed through a series of bunded cells, to form one large overburden/waste mound (Plate 4).

The mine operation will also feature access roads and haul roads, a new airport, and a self-contained accommodation camp at some distance from the mine.

PLATE 2 EXISTING JACK HILLS STAGE 1 MINE FROM THE SOUTH-WEST (MINE ACCESS ROAD VISIBLE)

PLATE 3 SIMULATION OF THE FINAL LANDFORM

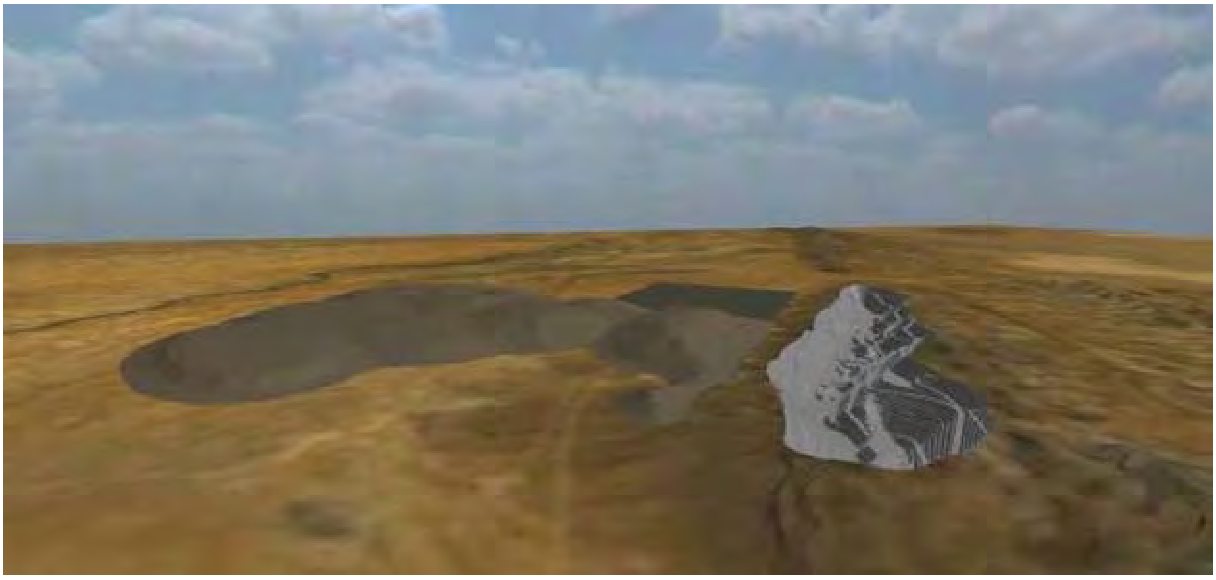
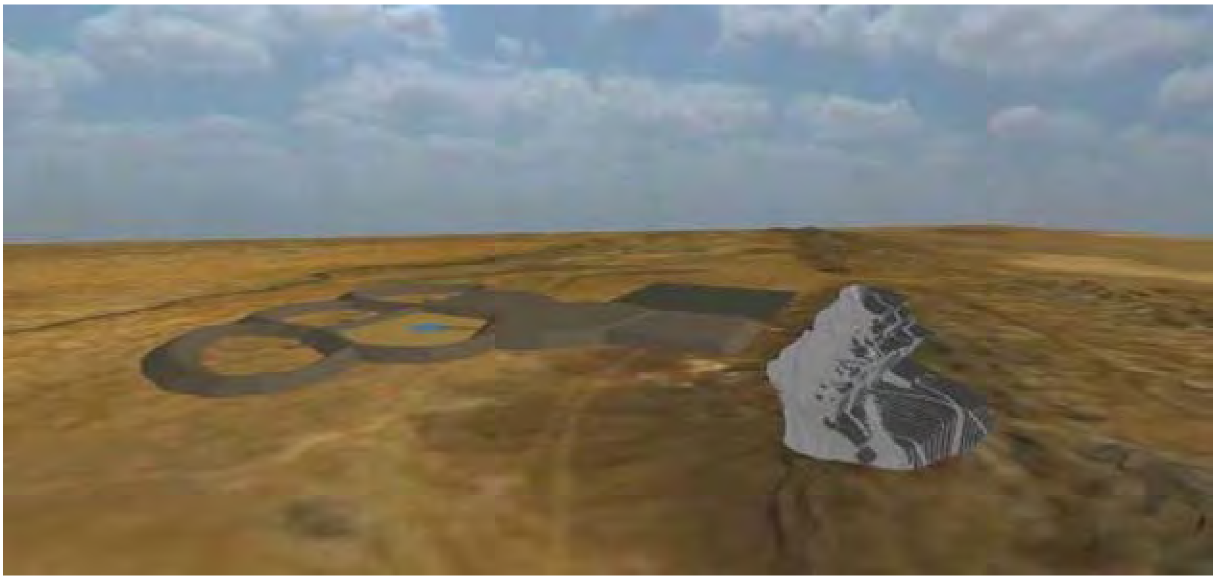


PLATE 4 SIMULATION OF THE LANDFORM AFTER 20 YEARS OF MINING SHOWING BUNDED WASTE DUMP CELLS



8.10 LOCAL AIR QUALITY

CRL commenced dust deposition monitoring in the vicinity of the Jack Hills Stage 1 mine in January 2007, to satisfy the requirements of the Dust Management Plan. Dust is monitored at five dust gauges around the site, including one control gauge. Monitoring data collected throughout 2008 indicates that dust deposition levels (total solids) are highest downwind of the pit and waste dumps (Cardno BSD, 2008; Appendix D).

Dust deposition levels across the site, including at the control site, are much higher than the DEC's recommended guideline of $4g/m^2$/month.

There are no nearby communities or potentially sensitive population groups in close proximity to the Project. The nearest residence is Mileura station located approximately 35km south of the project area. The available wind rose data from Meekatharra Airport from the Bureau of Meteorology indicates that the predominant wind direction is from the east and north-east in the morning and south-east in the afternoon (Cardno BSD, 2008). This means that the majority of dust generated by the Project would be directed away from the closest sensitive receptors (i.e. Mileura station).

8.11 NOISE AND VIBRATION

Given that the area surrounding the Project is sparsely populated (the nearest residence is Mileura station located approximately 35 km south of the project area) the background noise is expected to be low.

Current mining operations associated with the Stage 1 project are likely to be the most significant source of noise and vibrations in the area.