AAMC
AUSTRALIAN
ABORIGINAL
MINING
CORPORATION

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SUBIACO WA 6008

PO Box 1918
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Office of the Environmental Protection Authority

File: ....

09 DEC 2014

A:	☐ For Information
fa:	☐ For Discussion
Officer:	☐ For Action
☐ Dir.AC	Response please:
☐ Dir. Bus Ops	☐ GM Signature
☐ Dir. SPPD	☐ Dir for GM (copy to GM)
☐ Dir. Strat Sup	☐ Dir Signature (copy to GM)
☐	☐ Mgr Direct (copy to GM)

5 December 2014

Mr Anthony Sutton
Director
Assessment and Compliance
Office of the EPA
The Atrium
168 St Georges Terrace
PERTH WA 6000

Dear Mr Sutton

AAMC Assessment on Proponent Information Approval

I refer to our previous meetings and briefing regarding the Proposed "Extension" mining operation located approximately 70 km north of Newman, in the Pilbara region of WA. As you are aware, the project is owned by the Australian Aboriginal Mining Corporation Ltd (AAMC). As discussed, AAMC has completed baseline environmental surveys and completed an environmental impact assessment consistent with an Assessment on Proponent Information (API) level of assessment.

Pursuant to Section 38(1) of the *Environmental Protection Act* 1986, please find attached a completed referral form and supporting document for the Proposed Extension Mining operation. The supporting document contains a CD with electronic copies of all relevant documents.

If you have any queries or further requirements please contact Mr Phil Scott or myself:

Phil	9221 0117	0418 954 467	pscott@prestonconsulting.com.au
Fergus	9287 4555	0448 877 862	fergus@aaminingcorp.com.au

Yours sincerely

Fergus Campbell
Director

Environmental Protection Authority

GOVERNMENT OF WESTERN AUSTRALIA

EPA REFERRAL FORM

PROPONENT

Referral of a Proposal by the Proponent to the Environmental Protection Authority under Section 38(1) of the *Environmental Protection Act 1986.*

PURPOSE OF THIS FORM

Section 38(1) of the *Environmental Protection Act 1986* (EP Act) provides that where a development proposal is likely to have a significant effect on the environment, a proponent may refer the proposal to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment under the EP Act. This form sets out the information requirements for the referral of a proposal by a proponent.

Proponents are encouraged to familiarise themselves with the EPA's *General Guide on Referral of Proposals* [see Environmental Impact Assessment/Referral of Proposals and Schemes] before completing this form.

A referral under section 38(1) of the EP Act by a proponent to the EPA must be made on this form. A request to the EPA for a declaration under section 39B (derived proposal) must be made on this form. This form will be treated as a referral provided all information required by Part A has been included and all information requested by Part B has been provided to the extent that it is pertinent to the proposal being referred. Referral documents are to be submitted in two formats – hard copy and electronic copy. The electronic copy of the referral will be provided for public comment for a period of 7 days, prior to the EPA making its decision on whether or not to assess the proposal.

CHECKLIST

Before you submit this form, please check that you have:

	Yes	No
Completed all the questions in Part A (essential).	✓	
Completed all applicable questions in Part B.	✓	
Included Attachment 1 – location maps.	✓	
Included Attachment 2 – additional document(s) the proponent wishes to provide (if applicable).	✓	
Included Attachment 3 – confidential information (if applicable).		
Enclosed an electronic copy of all referral information, including spatial data and contextual mapping but excluding confidential information.	✓	

Following a review of the information presented in this form, please consider the following question (a response is optional).

Do you consider the proposal requires formal environmental impact assessment? ☒ Yes ☐ No ☐ Not sure	
If yes, what level of assessment? ☒ Assessment on Proponent Information ☐ Public Environmental Review	

PROPONENT DECLARATION (to be completed by the proponent)

I, FERGUS GEORGE CAMPBELL, *(full name)* declare that I am authorised on behalf of Australian Aboriginal Mining Corporation (being the person responsible for the proposal) to submit this form and further declare that the information contained in this form is true and not misleading.

Signature	Name (print) Fergus Campbell
Position: Director	Company: Australian Aboriginal Mining Corporation
Date: 5 December 2014	

PART A - PROPONENT AND PROPOSAL INFORMATION
(All fields of Part A must be completed for this document to be treated as a referral)

1 PROPONENT AND PROPOSAL INFORMATION

1.1 Proponent

Name	Australian Aboriginal Mining Corporation
Joint Venture parties (if applicable)	
Australian Company Number (if applicable)	126 497 434
Postal Address (where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State)	Suite B3, 431-435 Roberts Rd, Subiaco, WA, 6008
Key proponent contact for the proposal: • name • address • phone • email	Fergus Campbell – Director Suite B3, 431-435 Roberts Rd, Subiaco, WA, 6008 +61 8 9287 4556 fergus@aaminingcorp.com.au
Consultant for the proposal (if applicable): • name • address • phone • email	Phil Scott – Director Level 3, 201 Adelaide Terrace, East Perth, Western Australia, 6004 +61 8 9221 0011 pscott@prestonconsulting.com.au

1.2 Proposal

Title	Extension Mining Project
Description	Mine iron ore from the superficial Channel Iron Deposit found above the water table. The Proposal will result in the production of approximately 2-4 Mtpa of iron ore.
Extent (area) of proposed ground disturbance.	530 ha
Timeframe in which the activity or development is proposed to occur (including start and finish dates where applicable).	Indicative: Start: 2015 Finish: 2030
Details of any staging of the proposal.	The Proposal will be geared to market conditions.
Is the proposal a strategic proposal?	No
Is the proponent requesting a declaration that the proposal is a derived proposal? If so, provide the following information on the strategic assessment within which the referred proposal was identified: • title of the strategic assessment; and • Ministerial Statement number.	No
Please indicate whether, and in what way, the proposal is related to other proposals in the	Proposal is not related to any other current proposals in the region.

region.	
Does the proponent own the land on which the proposal is to be established? If not, what other arrangements have been established to access the land?	Proponent owns the rights to mine on the land on which mining activities are proposed. Access roads are not on land owned by the proponent. Negotiations currently taking place with owners of land where the access road is proposed to be constructed.
What is the current land use on the property, and the extent (area in hectares) of the property?	Current land use on the Mining Leases is undefined with mineral exploration, mining and pastoral activities over portions of the land. Significant areas of unallocated crown land occur in the Proposal Area.

1.3 Location

Name of the Shire in which the proposal is located.	Shires of Ashburton and East Pilbara
For urban areas: • street address; • lot number; • suburb; and • nearest road intersection.	N/A
For remote localities: • nearest town; and • distance and direction from that town to the proposal site.	Newman Extension Project is located 70 km north of Newman
Electronic copy of spatial data - GIS or CAD, geo-referenced and conforming to the following parameters: • GIS: polygons representing all activities and named; • CAD: simple closed polygons representing all activities and named; • datum: GDA94; • projection: Geographic (latitude/longitude) or Map Grid of Australia (MGA); • format: Arcview shapefile, Arcinfo coverages, Microstation or AutoCAD.	Enclosed?: Yes, provided in Appendix 1 of the Extension Mining Project API document.

1.4 Confidential Information

Does the proponent wish to request the EPA to allow any part of the referral information to be treated as confidential?	No
If yes, is confidential information attached as a separate document in hard copy?	N/A

1.5 Government Approvals

<table>
<tr><td colspan="2">Is rezoning of any land required before the proposal can be implemented?
If yes, please provide details.</td><td colspan="2">No</td></tr>
<tr><td colspan="2">Is approval required from any Commonwealth or State Government agency or Local Authority for any part of the proposal?
If yes, please complete the table below.</td><td colspan="2">Yes</td></tr>
<tr><td>Agency/Authority</td><td>Approval required</td><td>Application lodged
Yes / No</td><td>Agency/Local Authority contact(s) for proposal</td></tr>
<tr><td>DoE (Federal)</td><td>EPBC Act – may be controlled action.</td><td>No</td><td>-</td></tr>
<tr><td>DoW</td><td>Water supply granted for Bulk Sample (GWL179211)</td><td>Yes</td><td>Mr Hermes Medina – DoW, Karratha</td></tr>
<tr><td>DER</td><td>Works Approval – granted for Bulk Sample (W5682/2014/1)</td><td>Yes</td><td>Mr Michael Christensen – DER, North West Region</td></tr>
<tr><td>Shire</td><td>Building licence</td><td>No</td><td>Shire of Ashburton Planner</td></tr>
<tr><td>Shire</td><td>Use of Roy Hill Munjina Road</td><td>No</td><td>Shire of East Pilbara Manager Technical Services</td></tr>
<tr><td>DMP</td><td>Mining Proposal and Mine Closure Plan</td><td>No</td><td>Acting General Manager Minerals - North</td></tr>
</table>

PART B - ENVIRONMENTAL IMPACTS AND PROPOSED MANAGEMENT

2. ENVIRONMENTAL IMPACTS

Describe the impacts of the proposal on the following elements of the environment, by answering the questions contained in Sections 2.1-2.11:

2.1 flora and vegetation;

- Direct loss of Very Good to Excellent condition vegetation
- Potential indirect impacts to vegetation health through a range of mechanisms such as dust, flooding or erosion
- Potential transfer of existing weeds and introduction of new weed species during construction and operation
- Potential poor quality of rehabilitation through poor management of materials or a range of potential failure mechanisms.

2.2 fauna;

- Loss of troglofauna habitat
- General loss of terrestrial fauna habitat
- Decline in habitat quality
- Vehicle strike causing injury or death
- Change in behaviour as a result of noise
- Introduction or encouragement of feral animals

2.3 rivers, creeks, wetlands and estuaries;

- Alterations to surface water flows, causing occasional flooding, erosion and/or sedimentation with potential changes in surface water quality downstream
- Changes to run-off and flow velocity caused by mining activity and roads
- Potential impacts on surface water reliant fauna and flora habitat

2.4 significant areas and/ or land features;

- No conservation significant areas or land features. Gorge habitats generally more diverse but avoided by all but linear infrastructure
- Alteration of existing landforms
- Topsoil loss, soil erosion and sedimentation from disturbed areas

2.5 coastal zone areas;

- N/A

2.6 marine areas and biota;

- N/A

2.7 water supply and drainage catchments;

- Potential for reduction of groundwater availability

2.8 pollution;

- Localised pollution of soil, groundwater or surface water via hydrocarbon spill
- Localised increase in turbidity due to erosion caused by reduced vegetation cover or alteration of surface water flow paths

2.9 greenhouse gas emissions;

- Minor point source air emissions from vehicle and genset exhausts

2.10 contamination; and

- Localised groundwater or surface water contamination via waste or hydrocarbon / chemical spills

2.11 social surroundings.

- Increased noise and vibration levels
- Direct impact to personnel
- Public access will be limited within the mining operational areas

These features should be shown on the site plan, where appropriate.

For all information, please indicate:

(a) the source of the information; and

(b) the currency of the information.

2.1 Flora and Vegetation

2.1.1 Do you propose to clear any native flora and vegetation as a part of this proposal?

[A proposal to clear native vegetation may require a clearing permit under Part V of the EP Act (Environmental Protection (Clearing of Native Vegetation) Regulations 2004)]. Please contact the Department of Environment and Conservation (DEC) for more information.

(please tick) ✔ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section

2.1.2 How much vegetation are you proposing to clear (in hectares)?

530 ha

2.1.3 Have you submitted an application to clear native vegetation to the DEC (unless you are exempt from such a requirement)?

☐ Yes ✔ No **If yes**, on what date and to which office was the application submitted of the DEC?

2.1.4 Are you aware of any recent flora surveys carried out over the area to be disturbed by this proposal?

✔ Yes ☐ No **If yes**, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey(s).

If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.

The following flora survey was undertaken for the Mining Proposal Area and a copy of the report is provided in Appendix 2 of the Extension Mining Project API document:

- Phoenix 2014. Flora and Vegetation survey for the Extension Project. Final report. Unpublished report to AAMC. November 2014.

2.1.5 Has a search of DEC records for known occurrences of rare or priority flora or threatened ecological communities been conducted for the site?

✔ Yes ☐ No If you are proposing to clear native vegetation for any part of your proposal, a search of DEC records of known occurrences of rare or priority flora and threatened ecological communities will be required. Please contact DEC for more information.

2.1.6 Are there any known occurrences of rare or priority flora or threatened ecological communities on the site?

✔ Yes ☐ No **If yes**, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

- No threatened flora, species of national conservation significance, threatened ecological communities or priority ecological communities were recorded in the Mine Proposal Area.
- Two Priority flora species were recorded outside of the edge of planned disturbance within the Mine Proposal Area:
    - o Priority 1 *Sauropus sp.* Koodaideri detritals; and
    - o Priority 3 *Sida sp.* Barlee Range

2.1.7 If located within the Perth Metropolitan Region, is the proposed development within or adjacent to a listed Bush Forever Site? (You will need to contact the Bush Forever Office, at the Department for Planning and Infrastructure)

☐ Yes ✔ No **If yes**, please indicate which Bush Forever Site is affected (site number and name of site where appropriate).

2.1.8 What is the condition of the vegetation at the site?

The condition of the vegetation in the Proposal Area surveyed to date ranges from very good to excellent.

2.2 Fauna

2.2.1 Do you expect that any fauna or fauna habitat will be impacted by the proposal?

(please tick) ✔ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.2.2 Describe the nature and extent of the expected impact.

- Removal of 530 ha of terrestrial fauna habitat
- The vegetation to be cleared is widely represented regionally. General fauna and conservation significant species habitat is well represented outside of the Proposal area
- Removal of 270 ha of potential troglofauna habitat
- Not all troglofauna habitat in the vicinity of the mine proposal area will be impacted and there is evidence of connection of troglofauna habitats at both local and broader regional scales.

2.2.3 Are you aware of any recent fauna surveys carried out over the area to be disturbed by this proposal?

✔ Yes ☐ No **If yes**, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey(s).

If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.

The following fauna surveys were undertaken for the Proposal and a copy of the reports are provided in Appendix 2 of the Extension Mining Project API document:

- Phoenix 2014. Troglofauna Survey for the Extension Project. Unpublished report to AAMC. October 2014.

- Phoenix 2014. Terrestrial Fauna Survey for the Extension Project. Unpublished report to AAMC. August 2014.

2.2.4 Has a search of DEC records for known occurrences of Specially Protected (threatened) fauna been conducted for the site?

✔ Yes ☐ No (please tick)

2.2.5 Are there any known occurrences of Specially Protected (threatened) fauna on the site?

✔ Yes ☐ No **If yes**, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

- Two vertebrate species of conservation significance were recorded in the Mine Proposal Area:
    - Australian Bustard (P4 – DPaW)
    - Western Pebble-mound Mouse (P4 – DPaW)

2.3 Rivers, Creeks, Wetlands and Estuaries

2.3.1 Will the development occur within 200 metres of a river, creek, wetland or estuary?

(please tick) ✔ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.3.2 Will the development result in the clearing of vegetation within the 200 metre zone?

✔ Yes ☐ No **If yes**, please describe the extent of the expected impact.

- The access road options unavoidably will need to cross and follow creek lines and will result in the loss of vegetation within the 200 m zone. The extent of the loss will be defined in an infrastructure plan to be prepared upon completion of studies and detailed definition of route options
- The Mine Proposal Area includes minor drainage lines that are not intersected by any mine pits and will only be intersected by linear infrastructure or borefield.

2.3.3 Will the development result in the filling or excavation of a river, creek, wetland or estuary?

☐ Yes ✔ No **If yes**, please describe the extent of the expected impact.

2.3.4 Will the development result in the impoundment of a river, creek, wetland or estuary?

☐ Yes ✔ No **If yes**, please describe the extent of the expected impact.

2.3.5 Will the development result in draining to a river, creek, wetland or estuary?

☐ Yes ✔ No **If yes**, please describe the extent of the expected impact.

2.3.6 Are you aware if the proposal will impact on a river, creek, wetland or estuary (or its buffer) within one of the following categories? (please tick)

Conservation Category Wetland	✔ Yes	☐ No	☐ Unsure
Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998	☐ Yes	✔ No	☐ Unsure
Perth's Bush Forever site	☐ Yes	✔ No	☐ Unsure
Environmental Protection (Swan & Canning Rivers) Policy 1998	☐ Yes	✔ No	☐ Unsure
The management area as defined in s4(1) of the *Swan River Trust Act 1988*	☐ Yes	✔ No	☐ Unsure
Which is subject to an international agreement, because of the importance of the wetland for waterbirds and waterbird habitats (e.g. Ramsar, JAMBA, CAMBA)	☐ Yes	✔ No	☐ Unsure

The access road options both marginally impinge upon the buffer zone and the Poonda Plain (2b) Management Zone for the Fortescue Marsh (rated as medium level of significance). The impingement is necessary to enable road connection to the Munjina - Roy Hill Road and is nearly 20 km from the Marsh itself.

2.4 Significant Areas and/ or Land Features

2.4.1 Is the proposed development located within or adjacent to an existing or proposed National Park or Nature Reserve?

☐ Yes ✔ No **If yes**, please provide details.

2.4.2 Are you aware of any Environmentally Sensitive Areas (as declared by the Minister under section 51B of the EP Act) that will be impacted by the proposed development?

☐ Yes ✔ No **If yes**, please provide details.

The Proposal Area is outside of the ESA defined by https://www2.landgate.wa.gov.au/bmvf/app/waatlas/

2.4.3 Are you aware of any significant natural land features (e.g. caves, ranges etc) that will be impacted by the proposed development?

☐ Yes ✔ No **If yes**, please provide details.

2.5 Coastal Zone Areas (Coastal Dunes and Beaches)

2.5.1 Will the development occur within 300metres of a coastal area?

(please tick) ☐ Yes **If yes**, complete the rest of this section.

✔ No **If no**, go to the next section.

2.5.2 What is the expected setback of the development from the high tide level and from the primary dune?

2.5.3 Will the development impact on coastal areas with significant landforms including beach ridge plain, cuspate headland, coastal dunes or karst?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.5.4 Is the development likely to impact on mangroves?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.6 Marine Areas and Biota

2.6.1 Is the development likely to impact on an area of sensitive benthic communities, such as seagrasses, coral reefs or mangroves?

☐ Yes ✔ No **If yes**, please describe the extent of the expected impact.

2.6.2 Is the development likely to impact on marine conservation reserves or areas recommended for reservation (as described in *A Representative Marine Reserve System for Western Australia*, CALM, 1994)?

☐ Yes ✔ No **If yes**, please describe the extent of the expected impact.

2.6.3 Is the development likely to impact on marine areas used extensively for recreation or for commercial fishing activities?

☐ Yes ✔ No **If yes**, please describe the extent of the expected impact, and provide any written advice from relevant agencies (e.g. Fisheries WA).

2.7 Water Supply and Drainage Catchments

2.7.1 Are you in a proclaimed or proposed groundwater or surface water protection area?

(You may need to contact the Department of Water (DoW) for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

✔ Yes ☐ No **If yes**, please describe what category of area.

The Proposal is located within the Pilbara Surface Water Area (http://www.water.wa.gov.au/PublicationStore/first/86306.pdf) and the Pilbara Groundwater Area (http://www.water.wa.gov.au/PublicationStore/first/86307.pdf).

26D and 5C licences are in place to support a bulk sample and will be applied for to support operations.

2.7.2 Are you in an existing or proposed Underground Water Supply and Pollution Control area?

(You may need to contact the DoW for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

☐ Yes ✔ No **If yes**, please describe what category of area.

2.7.3 Are you in a Public Drinking Water Supply Area (PDWSA)?

(You may need to contact the DoW for more information or refer to the DoW website. A proposal to clear vegetation within a PDWSA requires approval from DoW.)

☐ Yes ✔ No **If yes**, please describe what category of area.

2.7.4 Is there sufficient water available for the proposal?

(Please consult with the DoW as to whether approvals are required to source water as you propose. Where necessary, please provide a letter of intent from the DoW)

✔ Yes ☐ No (please tick)

2.7.5 Will the proposal require drainage of the land?

☐ Yes ✔ No **If yes**, how is the site to be drained and will the drainage be connected to an existing Local Authority or Water Corporation drainage system? Please provide details.

2.7.6 Is there a water requirement for the construction and/ or operation of this proposal?

(please tick) ✔ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.7.7 What is the water requirement for the construction and operation of this proposal, in kilolitres per year?

500,000 KL/yr

2.7.8 What is the proposed source of water for the proposal? (e.g. dam, bore, surface water etc.)

Bore

2.8 Pollution

2.8.1 Is there likely to be any discharge of pollutants from this development, such as noise, vibration, gaseous emissions, dust, liquid effluent, solid waste or other pollutants?

(please tick) ✔ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.8.2 Is the proposal a prescribed premise, under the Environmental Protection Regulations 1987?

(Refer to the EPA's *General Guide for Referral of Proposals to the EPA under section 38(1) of the EP Act 1986* for more information)

✔ Yes ☐ No **If yes**, please describe what category of prescribed premise.

Category 5: Processing or beneficiation of ore. Works Approval W5682/2014/1.

2.8.3 Will the proposal result in gaseous emissions to air?

✔ Yes ☐ No **If yes**, please briefly describe.

Minor point source air emissions from vehicle and genset exhausts

2.8.4 Have you done any modelling or analysis to demonstrate that air quality standards will be met, including consideration of cumulative impacts from other emission sources?

☐ Yes ✔ No **If yes**, please briefly describe.

2.8.5 Will the proposal result in liquid effluent discharge?

☐ Yes ✔ No **If yes**, please briefly describe the nature, concentrations and receiving environment.

2.8.6 If there is likely to be discharges to a watercourse or marine environment, has any analysis been done to demonstrate that the State Water Quality Management Strategy or other appropriate standards will be able to be met?

☐ Yes ✔ No **If yes**, please describe.

2.8.7 Will the proposal produce or result in solid wastes?

✔ Yes ☐ No **If yes**, please briefly describe the nature, concentrations and disposal location/ method.

The Proposal will produce minor quantities of construction waste. A landfill location will be selected and approval sought under Part V of the EP Act to enable local disposal of inert and putrescible wastes or waste will be transported to an approved facility. Other wastes will be managed and disposed of at a suitably licenced landfill facility.

2.8.8 Will the proposal result in significant off-site noise emissions?

☐ Yes ✔ No **If yes**, please briefly describe.

2.8.9 Will the development be subject to the Environmental Protection (Noise) Regulations 1997?

✔ Yes ☐ No **If yes**, has any analysis been carried out to demonstrate that the proposal will comply with the Regulations?

Please attach the analysis.

No analysis has been carried out to demonstrate that the Proposal will comply with the Noise Regulations as the Proposal is located in a remote area with no sensitive premises located in the vicinity.

2.8.10 Does the proposal have the potential to generate off-site, air quality impacts, dust, odour or another pollutant that may affect the amenity of residents and other "sensitive premises" such as schools and hospitals (proposals in this category may include intensive agriculture, aquaculture, marinas, mines and quarries etc.)?

☐ Yes ✔ No **If yes**, please describe and provide the distance to residences and other "sensitive premises".

2.8.11 If the proposal has a residential component or involves "sensitive premises", is it located near a land use that may discharge a pollutant?

☐ Yes ✔ No ☐ Not Applicable

If yes, please describe and provide the distance to the potential pollution source

2.9 Greenhouse Gas Emissions

2.9.1 Is this proposal likely to result in substantial greenhouse gas emissions (greater than 100 000 tonnes per annum of carbon dioxide equivalent emissions)?

☐ Yes ✔ No **If yes**, please provide an estimate of the annual gross emissions in absolute and in carbon dioxide equivalent figures.

2.9.2 Further, if yes, please describe proposed measures to minimise emissions, and any sink enhancement actions proposed to offset emissions.

2.10 Contamination

2.10.1 Has the property on which the proposal is to be located been used in the past for activities which may have caused soil or groundwater contamination?

☐ Yes ✔ No ☐ Unsure **If yes**, please describe.

2.10.2 Has any assessment been done for soil or groundwater contamination on the site?

☐ Yes ✔ No **If yes**, please describe.

2.10.3 Has the site been registered as a contaminated site under the *Contaminated Sites Act 2003*? (on finalisation of the CS Regulations and proclamation of the CS Act)

☐ Yes ✔ No **If yes**, please describe.

2.11 Social Surroundings

2.11.1 Is the proposal on a property which contains or is near a site of Aboriginal ethnographic or archaeological significance that may be disturbed?

☐ Yes ✔ No ☐ Unsure **If yes**, please describe.

2.11.2 Is the proposal on a property which contains or is near a site of high public interest (e.g. a major recreation area or natural scenic feature)?

☐ Yes ✔ No **If yes**, please describe.

2.11.3 Will the proposal result in or require substantial transport of goods, which may affect the amenity of the local area?

☐ Yes ✔ No **If yes**, please describe.

3. PROPOSED MANAGEMENT

3.1 Principles of Environmental Protection

3.1.1 Have you considered how your project gives attention to the following Principles, as set out in section 4A of the EP Act? (For information on the Principles of Environmental Protection, please see EPA Position Statement No. 7, available on the EPA website)

1. The precautionary principle.	✔ Yes	☐ No
2. The principle of intergenerational equity.	✔ Yes	☐ No
3. The principle of the conservation of biological diversity and ecological integrity.	✔ Yes	☐ No
4. Principles relating to improved valuation, pricing and incentive mechanisms.	✔ Yes	☐ No
5. The principle of waste minimisation.	✔ Yes	☐ No

3.1.2 Is the proposal consistent with the EPA's Environmental Protection Bulletins/Position Statements and Environmental Assessment Guidelines/Guidance Statements (available on the EPA website)?

✔ Yes ☐ No

3.2 Consultation

3.2.1 Has public consultation taken place (such as with other government agencies, community groups or neighbours), or is it intended that consultation shall take place?

✔ Yes ☐ No **If yes**, please list those consulted and attach comments or summarise response on a separate sheet.

Refer to Section 3 of the Extension Project API for a summary of consultation undertaken to date.

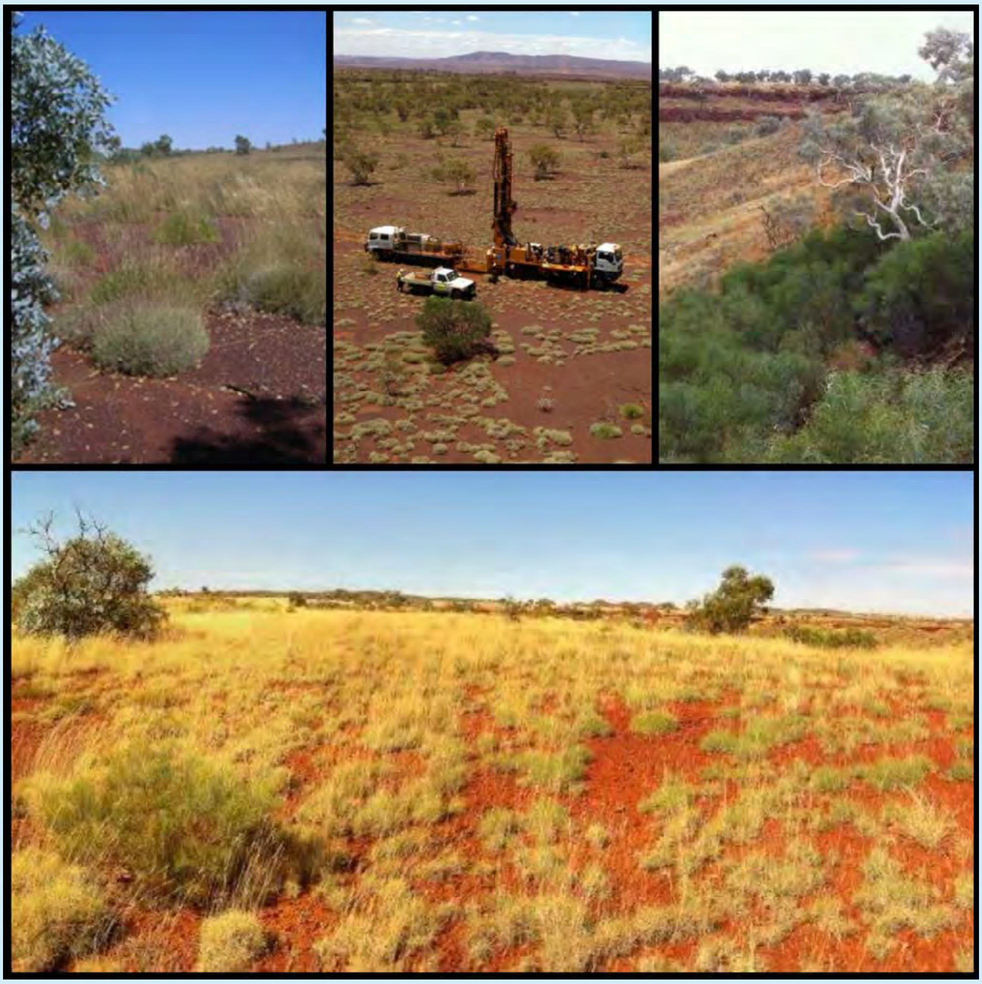
AUSTRALIAN ABORIGINAL MINING CORPORATION LTD

EXTENSION MINING PROJECT

ASSESSMENT ON PROPONENT INFORMATION

SUPPLEMENTARY INFORMATION REPORT

5 DECEMBER 2014



Prepared for: AAMC Ltd
By Preston Consulting Pty Ltd

PRESTON CONSULTING

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EXECUTIVE SUMMARY

Australian Aboriginal Mining Corporation Limited (AAMC) is proposing to develop the Extension Mining Project (the Proposal) which seeks to mine iron ore from the superficial Channel Iron Deposits (CID) found above the water table. The Proposal is located approximately 70 kilometres (km) north-west of Newman in the Pilbara region of Western Australia (WA) (Figure 2). The Proposal will result in the production of approximately 2-4 Mtpa of iron ore.

A brief description of the Proposal is provided in Table ES 1 below.

Table ES 1: Summary of Extension Mining Proposal

Summary of the Proposal	
Proposal Title	Extension Mining Proposal
Proponent Name	AAMC Limited
Short Description	The Proposal is to mine iron ore from the superficial Channel Iron Deposits above the water table at the Extension Deposit. Some or all of the ore may be upgraded through a beneficiation process with solar cells used to consolidate tailings. Waste rock and tailings are to be placed inside the mine pits. The Proposal requires supporting infrastructure including an access road (two options), internal roads, accommodation camp, ore crushing and processing plant with associated conveyors and stockyard, solar drying cells, ROM pad, water supply system and other supporting infrastructure.

AAMC has assessed the potential impacts of the Proposal on the various environmental factors listed in *Environmental Assessment Guideline 8: for Environmental Factors and Objectives* (EPA 2013a). Those that were deemed to be potentially impacted by the Proposal were classed as 'preliminary key environmental factors'. After discussions with the Office of the Environmental Protection Authority of WA (OEPA) and applying *Environmental Assessment Guideline 9: for Application of a Significance Framework in the Environmental Impact Assessment Process*, the following were considered to be potential key environmental factors:

- Flora and vegetation – to address the potential impacts resulting from the direct or indirect loss of flora and vegetation; and
- Subterranean Fauna – to address the potential impacts resulting from the direct or indirect loss of subterranean fauna habitat.

Table ES 2 provides a summary of these preliminary key environmental factors, including information relevant to identifying Environmental Protection Authority (EPA) objectives, potentially significant impacts (without mitigation), environmental aspects, proposed management controls, legal management mechanisms and predicted environmental outcomes that will give the EPA confidence that these factors will be appropriately managed.

Table ES 2: Preliminary Key Environmental Factors Assessment Table

Preliminary Key Environmental Factor - EPA Objective	Potentially Significant Impact (without mitigation)	Environmental Aspect	Management Actions (Mitigation)	Regulation	Predicted Outcomes (Meets EPA Objective – Y/N)
Flora and Vegetation - To maintain representation, diversity, viability and ecological function at the species, population and community level.	Context Flora • No Threatened Flora (TF) or species of national conservation significance recorded in the Mine Proposal Area (MPA) • One Priority 1 and one Priority 3 flora species recorded in the MPA • The Priority 1 species *Sauropus sp.* Koodaideri detritals considered likely to become TF • Five species within the MPA and Western Access Road Corridor represent an extension to the recorded range • Five weed species recorded in the MPA and Western Access Road Corridor Vegetation • Vegetation typical of the Pilbara Bioregion • MPA intersects three land systems – Platform, Robe and Newman • Vegetation is sparse consistent with rocky surface conditions • Nine vegetation associations recorded in the MPA • Four of the vegetation associations have low to moderate local conservation significance • Condition of vegetation in MPA ranges from very good to excellent • No Threatened Ecological Communities (TEC's) or Priority Ecological Communities (PEC's) within the MPA • No Environmentally Sensitive Areas (ESAs), wetlands, permanent water courses or conservation reserves within the MPA Impacts • Direct loss of Very Good to Excellent condition vegetation • Indirect impacts to vegetation health through a range of mechanisms such as dust, flooding or erosion • Transfer of existing weeds and introduction of new weed species during construction and operation • Groundwater drawdown around abstraction bores.	• Ground disturbance – clearing of approximately 530 ha of native vegetation • Earthmoving and construction / operation activities	**Implement the following industry standard controls:** • Implement Project Construction and Operational Environmental Management Plans (EMPs) • Vegetation clearing will be managed through internal ground disturbance procedures • Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries will be provided to dozer operator • Undertake progressive clearing and rehabilitation • Implement weed hygiene and management measures/procedures to prevent spread of weeds and the introduction of new weed species in the Proposal Area • Ensure ground engaging plant and equipment are certified weed free prior to entry to site • Develop the disturbance footprint to the minimum required to ensure safe and adequate construction and operation • Apply water or dust suppressants to disturbed areas and ore transfer/storage areas to minimise dust generation **Implement the following additional Proposal specific controls:** • Offset clearing of up to 530 ha of Very Good to Excellent condition vegetation as areas are disturbed according to the Offset Plan • Where practical install a 20m buffer around known Priority 1 Flora locations. • If TF are located in areas where disturbance cannot be avoided, approval will be sought under the *Wildlife Conservation Act 1950* (WC Act) to disturb the minimum practicable amount of TF • Solar drying cells and backfill will be used instead of a tailings dam. This will reduce overall clearing for the Proposal • Pits will be backfilled with waste rock instead of developing a waste rock dump. This will reduce overall clearing for the Proposal • Mine pits will be developed progressively in incremental areas and will use surface mining methods so that mining will result in low waste rock volumes being produced. This will reduce overall clearing for the Proposal • Complete biological survey work on access road corridors • Prepare infrastructure plan that shows the location of conservation significant features and demonstrates how impacts are avoided or minimised where practicable	• Ministerial Statement (future) • *Environment Protection Act* (EP Act) Part V (authorised clearing) and Environmental Protection (Clearing of Native Vegetation) Regulations 2004 or S45c of EP Act – able to address any future additional clearing outside of boundaries authorised under Part IV of the EP Act • WC Act and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) can address impacts to protected flora if found • Weed management will be in accordance with the requirements of the *Agriculture and Related Resources Protection Act 1976* and controls identified in a Mining Proposal to be approved under the *Mining Act 1978* (Mining Act) • WA Environmental Offsets Policy (2011) • WA Environmental Offsets Guidelines (2014).	• The Proposal will result in the disturbance of 530 ha of native vegetation. The vegetation to be cleared is widely represented regionally and therefore the Proposal is not expected to have a significant effect on the representation of vegetation at a local or regional level. • No TECs, PECs, TF or ESAs will be affected by the Proposal as none have been recorded within the Proposal Area • The access road will be designed to avoid and minimise impacts on conservation significant features • The Proposal will not affect the conservation status of any significant species (including Priority flora species) • Indirect impacts are not expected to be significant as industry standard controls have proven to suitably manage these impacts • Any occurrences of new weed species or the spread of existing weeds due to Proposal activities will be controlled through industry standard measures • Industry standard controls for surface water management will be implemented to minimise the potential for surface water impacts such as erosion and flooding • Groundwater impacts avoided and minimised with no mine dewatering and no tailings dam • Groundwater will be managed under the RIWI Act • Taking into consideration the proposed management actions and the application of offsets, AAMC expects that the Proposal can be implemented to meet the EPA Objective for this factor.
		• Changes to surface water flows	• Incorporate surface water management and erosion protection into Proposal planning and design to minimise disruption to watercourses and riparian vegetation • Implement measures to manage surface water flows to minimise downstream effects	• Mining processes, drainage and water management controls as approved under the *Mining Act 1978*	
		• Groundwater abstraction.	• Groundwater abstraction bores to be located and operated such that groundwater drawdown is minimised within areas of confirmed Groundwater Dependent Ecosystems (GDEs).	• Groundwater extraction operated under licence (*Rights in Water and Irrigation* (RIWI) *Act* 1912).	

Preliminary Key Environmental Factor - EPA Objective	Potentially Significant Impact (without mitigation)	Environmental Aspect	Management Actions (Mitigation)	Regulation	Predicted Outcomes (Meets EPA Objective – Y/N)
Subterranean Fauna - To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	Context • Key areas of interest are mine pits due to habitat removal • MPA includes three deposits– North, East and West • North deposit encompasses the southern limits of a much larger hematite-goethite formation which extends north-east of the MPA • West deposit encompasses part of the northern limits of a larger Robe Pisolite formation which extends south of the MPA • Only bores in the North and West deposits revealed troglofauna in sampling • Forty-seven troglofauna individuals were collected from a total effort of 29 samples • Troglofauna were recorded from 24 out of a total of 31 bores • Ten species of troglofauna identified • Two species only recorded in West deposit • Six species only recorded in North deposit • Two species recorded from both North and West deposits • No subterranean fauna species listed under the Environment Protection and EPBC Act or the WC Act were recorded in the survey • Troglofauna richness estimation indicates that between 11 and 19 species were predicted to occur within the surveyed bores at the time of sampling • Species richness analyses indicated that the survey is likely to have recorded between 50% and 58% of the predicted species richness • Likely that the troglofauna recorded within the North and West deposits also occur within the broader north-eastern and southern extents which are not impacted by the Proposal Impacts • Loss of troglofauna habitat.	• Pit excavation – development of three mine pit(s) over a surface area of 270 ha removing potential troglofauna habitat • Noise and vibration from earthmoving and construction / operation activities.	**Implement the following industry standard controls:** • Develop the disturbance footprint to the minimum required in this Proposal to minimise disturbance to troglofauna habitat • Vegetation clearing will be managed through internal ground disturbance procedures • Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries will be provided to dozer operator • Undertake progressive clearing and rehabilitation **Implement the following additional Proposal specific controls:** • Rehabilitation plans detailing landforms, materials management and rehabilitation prescriptions will be prepared and implemented • Solar drying cells will be constructed instead of a tailings dam to dry out tailings. This will reduce the amount of troglofauna habitat being disturbed • Pits will be backfilled with waste rock instead of developing a waste rock dump. This will reduce the amount of troglofauna habitat being disturbed • Mine pits will be developed in areas and will use surface mining methods so that mining will result in low waste rock volumes being produced. This will reduce the amount of troglofauna habitat being disturbed.	• Ministerial Statement (future) • EP Act Part V (authorised clearing) and Environmental Protection (Clearing of Native Vegetation) Regulations 2004 or S45c of EP Act – able to address any future additional clearing outside of boundaries authorised under Part IV of the EP Act.	• The Proposal will result in the disturbance of approximately 270 ha of potential troglofauna habitat through the excavation of three mine pits. The nature of the orebody results in shallow mine pits (generally less that 20 m deep) that are above the water table. Mine plan results in a low strip ratio for waste rock. Mine pits have been designed to minimise the area of disturbance and will be backfilled with waste rock and rehabilitated. The Proposal is not expected to have a significant effect on the representation of troglofauna habitat at a local or regional scale • No subterranean fauna species listed under the EPBC Act or the WC Act will be affected as none were recorded in the survey • Taking into consideration the proposed management actions, AAMC expects that the Proposal can be implemented to meet the EPA Objective for this factor.

Figure 1 provides a conceptual illustration of the significance framework and how it applies to the preliminary key environmental factors that may be impacted by the Proposal. It illustrates AAMC's view of the level of uncertainty remaining after all available information has been considered. It is expected that the application of conditions (offset and infrastructure plan conditions) will greatly reduce any uncertainty and ensure that the Proposal can meet the EPA's Objectives.

Please note that this figure is conceptual only and is not intended to imply precision in evaluating the significance of impacts.

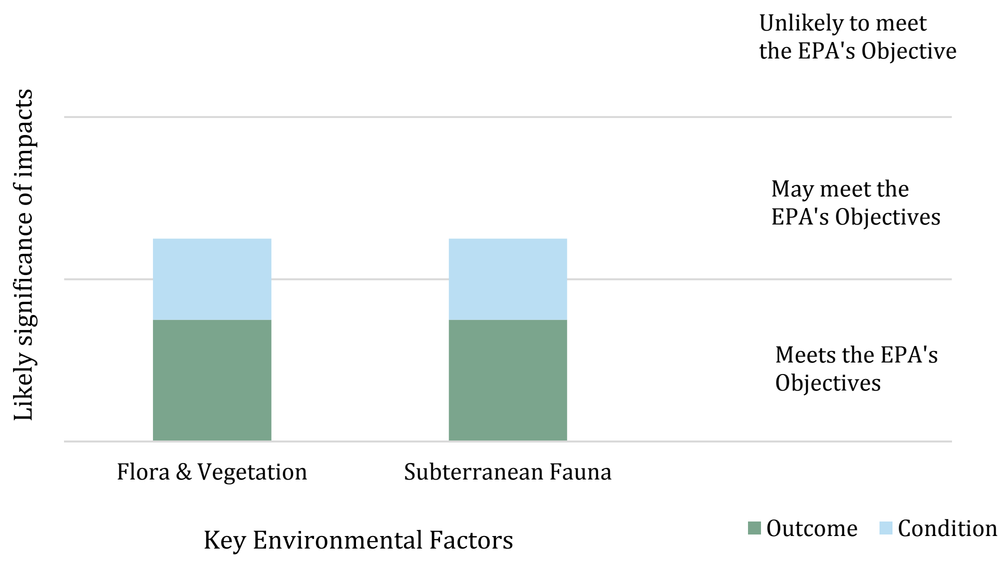

Figure 1: Conceptual Application of the EPA's Significance Framework

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 PROPONENT AND KEY PROPOSAL CHARACTERISTICS

1.1 THE PROPONENT

The proponent is Australian Aboriginal Mining Corporation Limited (AAMC), an emerging Australian iron ore company with the main focus of developing iron ore deposits known as Extension on a group of Mining Leases located adjacent to the existing Yandi mine situated in the Pilbara region of Western Australia (WA). The Extension deposit is 100% owned by AAMC. AAMC is part owned by Carey Mining, Australia's leading Indigenous owned mining and civil contractor, who will be the mining contractor for the operation and will facilitate Indigenous training and participation at the Extension Operation.

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1.2 KEY PROPOSAL CHARACTERISTICS

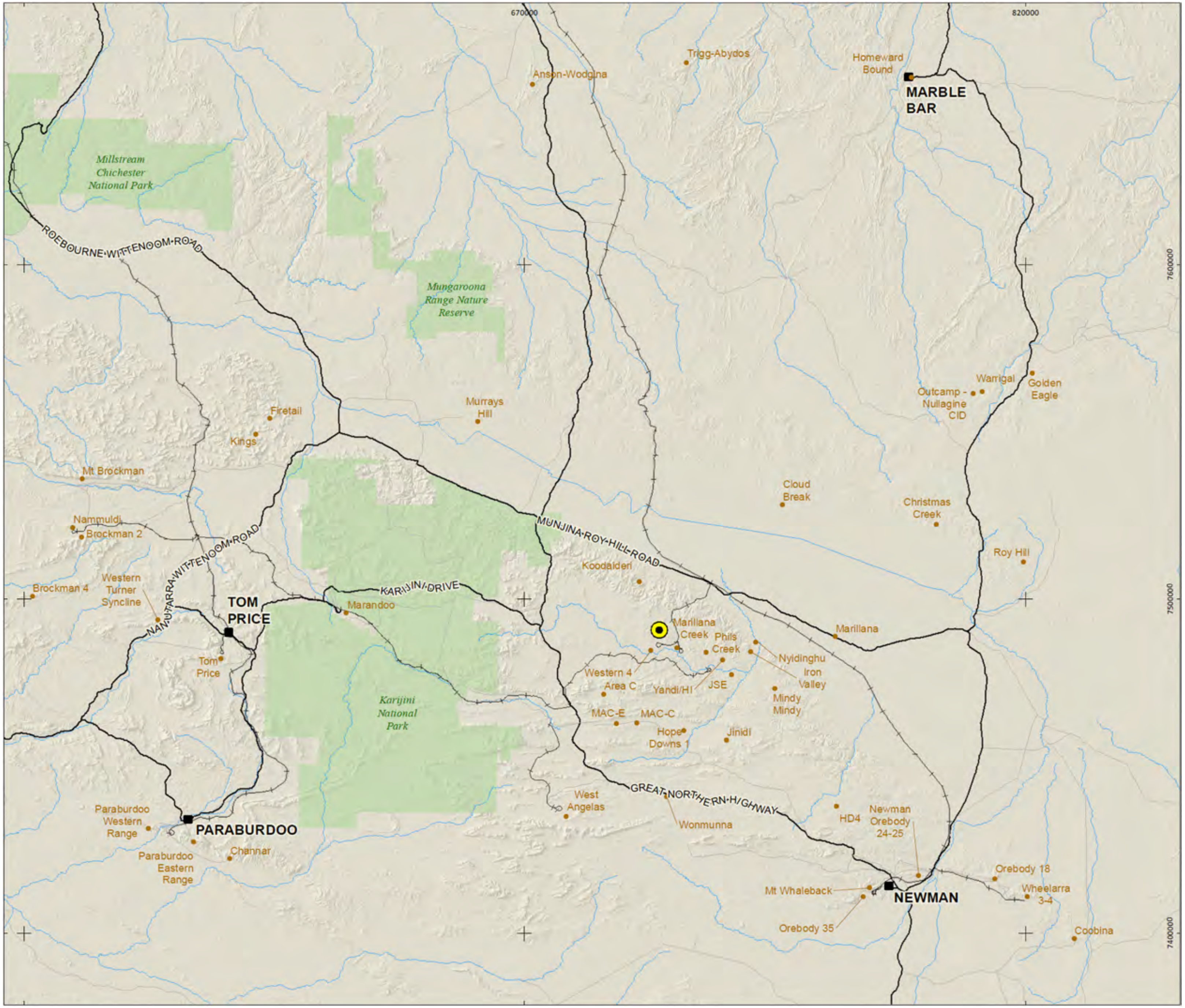
AAMC is proposing to develop the Extension Mining Project (the Proposal) which seeks to mine iron ore from the superficial Channel Iron Deposits (CID) found above water table. The Proposal is located approximately 70 kilometres (km) north-west of Newman in the Pilbara region of WA (Figure 2). The Proposal will result in the production of approximately 2-4 Mtpa of iron ore.

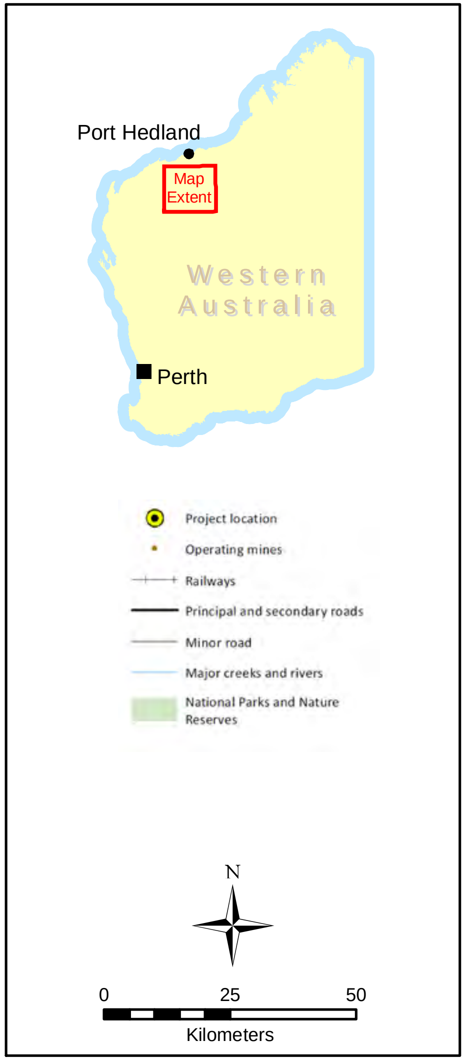
AAMC has considered *Environmental Assessment Guideline 1: Defining the Key Characteristics of a Proposal* (EAG1) (EPA 2012a) - which focuses on how to define the key characteristics of proposals for the purposes of assessment and incorporation into Ministerial Statements. The objective of EAG1 is to assist proponents to identify and provide the key characteristics that capture all key features of the proposal relevant to Part IV of the EP Act. The key characteristics for the Proposal are described in Table 1.

Table 1: Key Characteristics of the Proposal

Summary of the Proposal	
Proposal Title	Extension Mining Proposal
Proponent Name	AAMC Limited
Short Description	The Proposal is to mine iron ore from the superficial Channel Iron Deposits above the water table at the Extension Deposit. Some or all of the ore may be upgraded through a beneficiation process with solar cells used to consolidate tailings. Waste rock and tailings are to be placed inside the mine pits. The Proposal requires supporting infrastructure including an access road (two options), internal roads, accommodation camp, ore crushing and processing plant with associated conveyors and stockyard, solar drying cells, ROM pad, water supply system, contingency for explosives storage and other supporting infrastructure.
Project life span	Expected to be approximately 15 years
Physical Elements	**Proposed Extent Authorised**
Total Disturbance Area	Total disturbance of up to 530 ha within a 5,707 ha development envelope, including up to: • 270 ha for the proposed mine pits; • 110 ha for processing area and other supporting infrastructure; and • 150 ha for access roads
Operational Elements	
Mining, processing and ore transport	Open pit mining using surface miners with conventional mine haulage fleet. Crushing and screening and beneficiation plant. Drying of tailings in solar drying cells. Stockpiling, loading and transport of ore.
Support activities	Maintenance, power generation, water supply, accommodation of workforce, communications, mine rehabilitation and site management.

Figure 3 illustrates the overall Proposal Area including the alignment for the proposed access road options and the disturbance area proposed for the mine pits. Figure 4 illustrates the layout of the proposed mine pits in detail with infrastructure to be located within the Proposal Area. The Proposal Area coordinates and shapefiles are provided in Appendix 1.



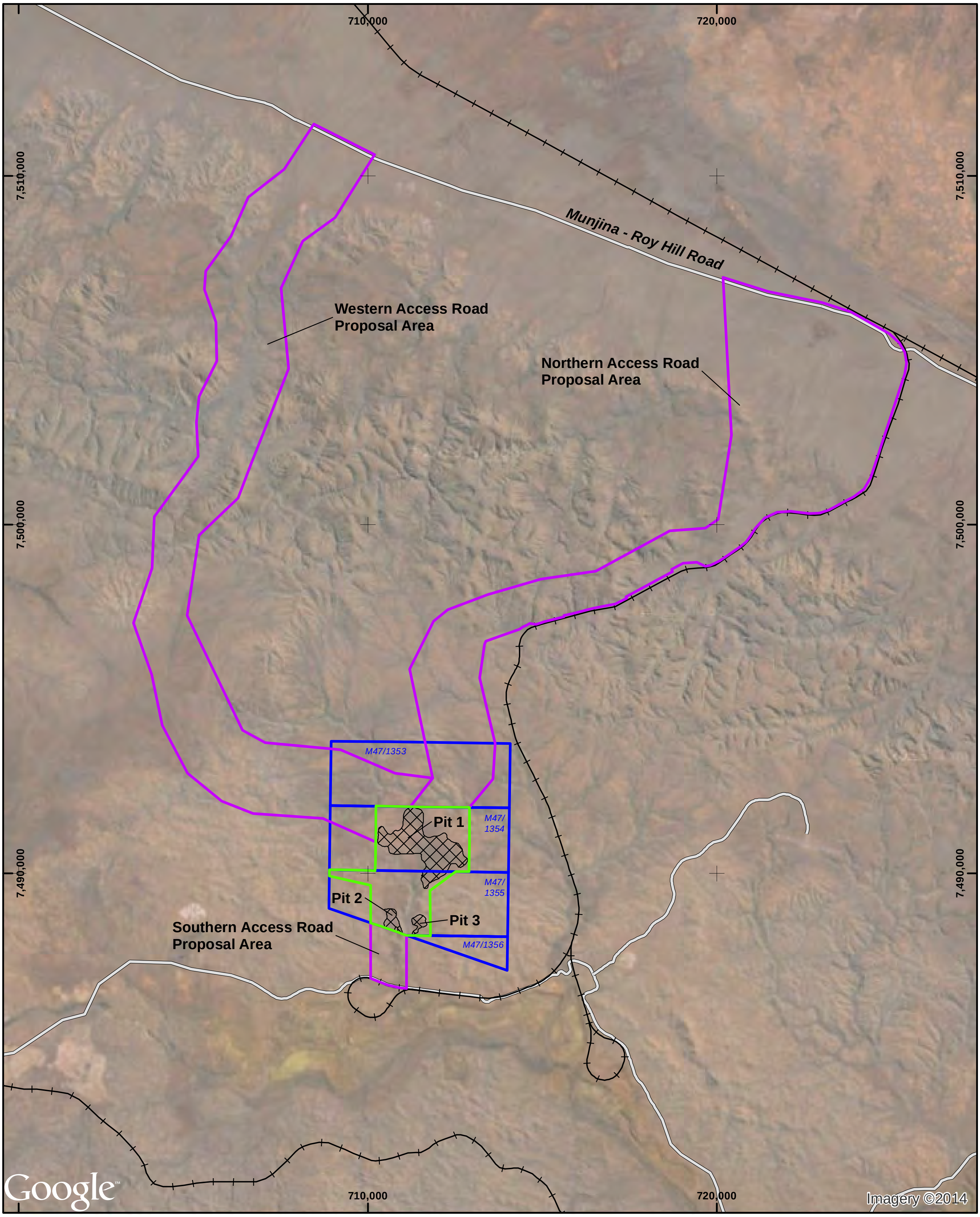


AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Project Location

Figure 2

Scale: 1:1,500,000
Projection: GDA 1994 MGA Zone 50
Date: 5/12/2014
File: 1_Project_Locations.mxd



Legend

- Sealed Road
- Railway
- AAMC Tenements
- Proposed pits
- Mine Proposal Area
- Road Proposal Area

N

0 2,000 4,000

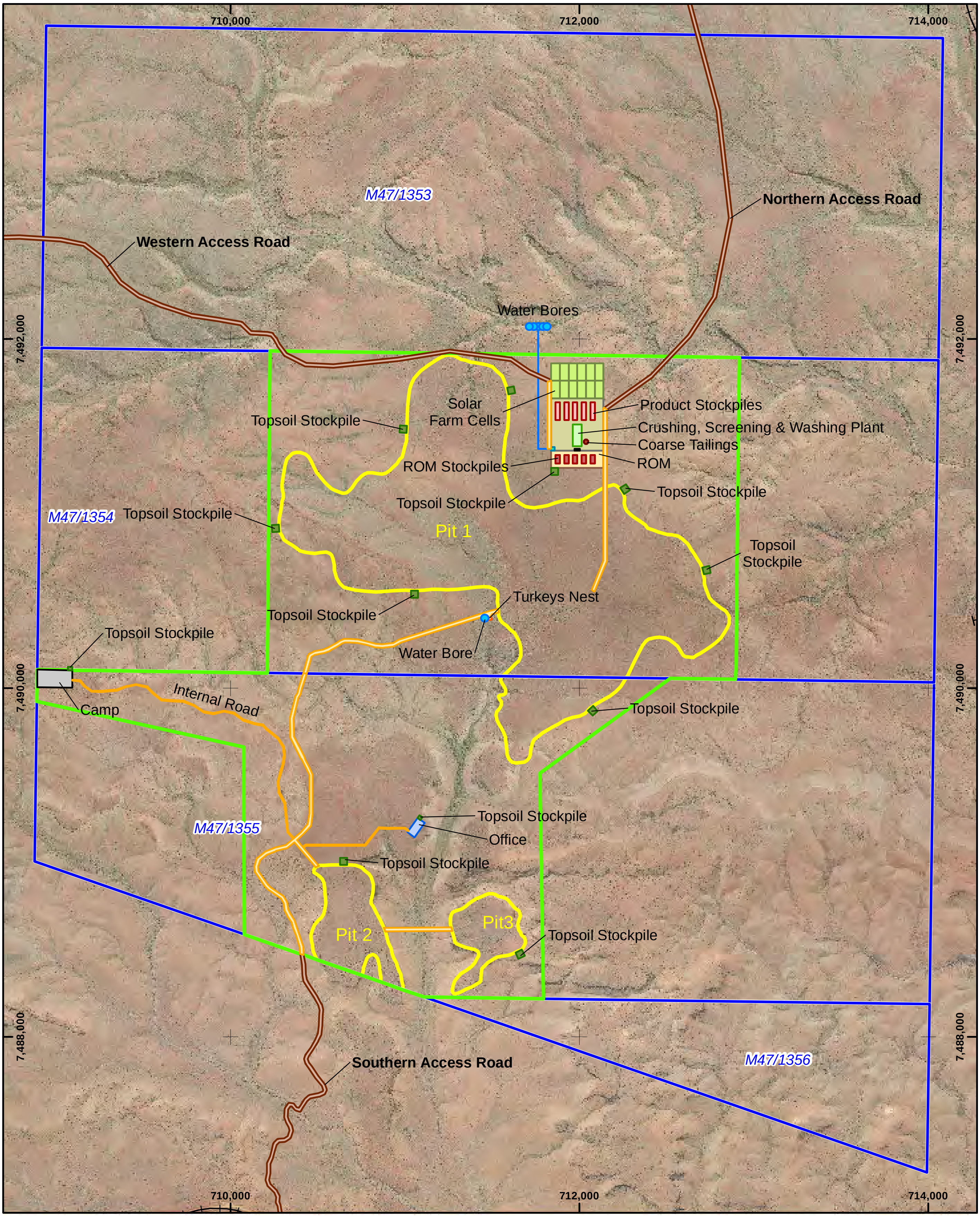
metres

AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Proposal Area

Figure 3

Scale1:150,000	Projection: GDA 1994 MGA Zone 50
Date: 3/12/2014	File: 2_Project_Layout.mxd



Legend

- Water Bore
- AAMC Tenements
- Proposed Pits
- Mine Proposal Area

Proposed Infrastructure

- ROM Stockpile
- ROM Bin
- Process Water Storage
- Ore Processing Area
- Access Road
- Internal Road
- Camp
- Office
- Crushing, Screening & Washing Plant
- Product Stockpile
- Solar Farm Cell
- ROM
- Topsoil Stockpile
- Turkeys Nest
- Coarse Tailings
- Water Pipeline

N

0 500 1,000
metres

AAMC AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Mine Pit Areas
and Indicative Layout

Figure 4

Scale: 1:30,000
Projection: GDA 1994 MGA Zone 50
Date: 4/12/2014
File: 3_Mine_Infrastructure.mxd

2 GENERAL DESCRIPTION OF PROPOSAL

2.1 DESCRIPTION

The Proposal is to mine iron ore from the superficial CID above the water table at the Extension Deposit. Some or all of the ore may be upgraded through a beneficiation process with solar cells used to consolidate tailings. No waste rock or tailings are to be placed outside of the mine pits or solar cells, other than where it is deemed to be suitable for construction purposes.

The Proposal requires supporting infrastructure including an access road (two options), internal roads, accommodation camp, ore crushing and processing plant with associated conveyors and stockyard, solar drying cells, ROM pad, water supply system and other supporting infrastructure. A summary of the activities associated with the Proposal is provided in Table 2.

Table 2: Summary of Proposal Activities

Item	This Proposal
Mine pits	Three mine pits above the water table covering a surface area of 270 ha. Open pit mining using surface miners with conventional mine haulage fleet. Waste rock and tailings returned to mine pits. Pit walls to be battered and rehabilitated upon completion of mining.
Estimated ore production rate	2-4 Mtpa of iron ore. Transported by road or rail to port.
Water abstraction and discharge	Licenced groundwater abstraction for water supply.
Ore processing	Crushing and screening and beneficiation plant. Drying of tailings in solar drying cells. Stockpiling of ore pre and post processing.
Tailings	Tailings dried in designated solar drying cells.
Waste rock	Waste rock will be temporarily stockpiled and then returned to the excavated mine pits for backfilling.
Additional infrastructure	• Access roads; • Internal roads; • Groundwater bores and turkeys nest dams; • Run of mine (ROM) Pad; • Crushing, screening and washing plant; • Solar drying cells; • Accommodation camp; • Administration buildings; • Generators; • Landfill facility; • Workshop areas; • Communications facilities; • Laydown areas; and • Fuel storage and refuelling facility.

2.1.1 MINE PITS

Mining will be undertaken above the water table in pits expected to be generally 10-20 m deep. The ore is superficial CID and occurs to surface over most of the mining area.

The mine pit area will be developed incrementally as required to support operational activities. The mining area will be cleared of vegetation with available topsoil stockpiled for rehabilitation. As required, the pit walls will be bunded for the duration of mining to ensure no inadvertent vehicle access and to minimise any surface water inflow. The ore will be removed in layers approximately 30 cm deep, with no regular requirement for blasting as surface mining equipment will be used. Ore will be carted from the pit to the ROM area and stockpiled either for direct transport or beneficiation. Waste rock quantities will be minimal with an overall strip ratio of waste to ore of approximately 1.3:1 for the mining areas. As waste rock is mined it will be replaced in mined out pit areas.

Upon completion of mining, the pit walls will be battered down where required to create safe and stable slopes for rehabilitation according to the detailed specifications in the Mine Closure Plan to be prepared and submitted for approval under the *Mining Act 1978.*

2.1.2 Ore Processing Facility

The ore from Extension will require crushing and screening to ensure the product is correctly sized and suitable for market. The ore is able to be marketed without beneficiation, but reduction of the concentration of silica and other impurities expands the market potential and value of the product. Should beneficiation of ore be adopted operationally, ore processing will include the use of wet screens to remove the 1 mm faction that contains elevated levels of impurities.

2.1.3 Tailings Management

The resultant tailings stream will be placed in a series of small solar drying ponds, initially located adjacent to the processing plant, and potentially later within the mined out pit. For the initial solar drying ponds, each pond will be progressively filled to a depth of 1-2 m and allowed to dry. When the material is able to be handled with conventional front end loader and truck, it will be back-loaded and placed in the mined out pit to be covered with overburden and topsoil for rehabilitation. This system avoids the need for a Tailings Storage Facility and creates a post mining landform that is suitable for rehabilitation.

2.1.4 Other Associated Infrastructure

The following associated infrastructure may be required to support the construction and operation of the Proposal:

- Access road;
- Internal roads;
- Groundwater bores and turkeys nest dams;
- ROM pad;
- Crushing, screening and washing plant;
- Solar drying cells;
- Accommodation camp;
- Administration buildings;
- Generators;
- Landfill facility;
- Workshop areas;
- Communications facilities;
- Laydown areas; and
- Fuel storage and refuelling facility.

Power will be provided via diesel generator sets at demand locations to negate the need for power reticulation. Modular designs will be used to allow for gradual expansion of capacity.

Fuel will be stored in self-bunded horizontal tanks, or a designated bunded bulk fuel facility. Diesel fuel delivery will occur by triple road tankers.

The Proposal will produce little construction waste. A landfill location will be selected and approval sought under Part V of the EP Act to enable local disposal of inert and putrescible wastes. Other wastes will be managed and disposed of at a suitably licenced landfill facility.

2.1.5 Construction and Associated Disturbance

AAMC has considered indirect impacts when calculating the maximum disturbance area for the Proposal and has included temporary disturbance for construction and included allowance for temporary laydown areas.

2.2 Proposal Tenure and Land Use

The mine pits and associated mining infrastructure (with the exception of the access roads) are located on Mining Tenements M47/1353, M47/1354 and M47/1355 and (Figure 5). These tenements are under the sole ownership of AAMC.

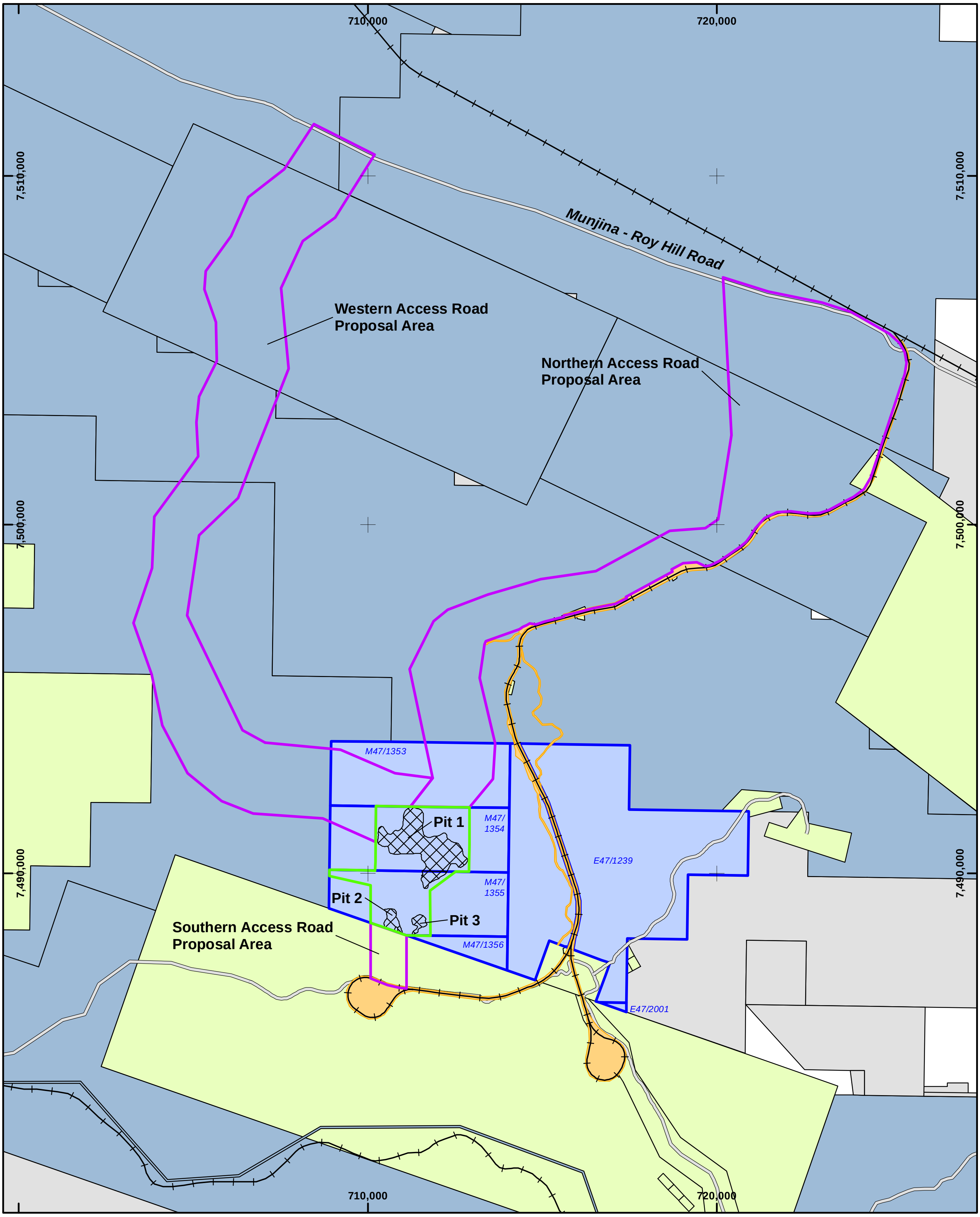
Two options for a site access road (Northern and Western) to connect with the Munjina – Roy Hill Road are identified as part of the Proposal. Both options for the site access road traverse tenure owned by other Companies and hence the access road and route detail are subject to their agreement.

The Proposal Area is located within the Shire of Ashburton and Shire of East Pilbara Local Government Areas.

The Proposal is located on Unallocated Crown Land with small portions also located within the Juna Downs pastoral lease (3114/1191) and the Marillana pastoral lease (3114/984).

None of the Proposal area is located within Department of Parks and Wildlife (DPaW) managed lands or water.

Land use in the Pilbara region was historically dominated by pastoral activities. The current land use in this region is more diverse with pastoral activities, mineral exploration and mining activities, conservation areas and tourism being established.



Legend

- Sealed Road
- Railway
- AAMC Tenements
- Other Tenure
- BHP Tenure
- Rio Tinto Tenure
- BHP General Purpose Lease GE K843924
- Proposed pits
- Mine Proposal Area
- Road Proposal Area

N

0 2,000 4,000
metres

AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Tenure Map

Figure 5

Scale1:150,000 Projection: GDA 1994 MGA Zone 50
Date: 3/12/2014 File: 5_Tenements.mxd

3 STAKEHOLDER CONSULTATION

AAMC recognises the value of consulting with key stakeholders in the development of a Proposal. AAMC has identified and consulted with key stakeholders identified in Table 3.

Consultation with the Office of the Environmental Protection Authority (OEPA) has been completed prior to preparing this API document and included discussion of the Proposal, baseline survey results, potential key environmental factors and approvals requirements.

Consultation with the pastoralists will be completed as part of the route selection and finalisation for the access road.

The consultation results will be used to support the detailed design of the Proposal and will guide approvals processes by demonstrating that key stakeholder issues have been identified and responded to appropriately. The consultation database will be maintained by AAMC and will remain active for the life of the Proposal.

Table 3: Stakeholder Consultation Table

Stakeholder	Dates	Topics / Issues Raised	Proponent Response / Outcome
Office of the EPA	21 February 2014 1 July 2014 9 October 2014 29 October 2014	Initial Proposal briefing – scale and location of Proposal Environmental Baseline survey results Approvals pathways	Advice provided on survey results and potential significance, approvals pathways. Clarification of results and baseline environmental data. Preparation of API document.
Department of Mines and Petroleum	From October 2013 interaction regarding Project including Project Briefings on: 27 June 2014 17 October 2014	Initial Proposal briefings including desktop review of environment and baseline survey outcomes. Exploration approvals requirements. Bulk Sample approval requirements. Approvals requirements and pathways for mining operations.	Exploration approvals. Information provided on Bulk Sample. Bulk sample approval. Information provided on proposed mining operations.
Department of Water	December 2013 to May 2014	Proposal briefing to enable 26D and 5C applications to be lodged. Approval requirements for water exploration and supply.	26D licence to construct wells granted – GWL179210. 5C licence to take water granted – GWL179211.
Department of Environment Regulation	March to September 2014	Application Enquiry Form and information required for approvals for crushing and screening plant.	Works Approval for crushing and screening plant granted – W5682/2014/1.
Department of Parks and Wildlife	31 March 2013	Desktop review results, Bulk Sample and scale of proposal	Completion of baseline survey and Proposal preparation.
Shire of Ashburton	1 December 2014	General Proposal briefing with attention to road transport, accommodation	Familiarity with Proposal.
Shire of East Pilbara	1 December 2014	General Proposal briefing with attention to road transport	Familiarity with Proposal.
Main Roads Western Australia	1 December 2014	General Proposal briefing with attention to road transport	Consideration of road traffic and intersection requirements for Proposal development to be

Stakeholder	Dates	Topics / Issues Raised	Proponent Response / Outcome
			considered in detailed design.
Indigenous – Native Tile Claimants	October 2013 - ongoing	Potential exploration and mining areas, road access, scope and completion of heritage surveys	Proposal layout consideration of heritage locations. Completion of Heritage surveys.
BHP	Ongoing	Proposal briefing, product, access	Proposal familiarity. Ongoing discussions.
Rio Tinto	Ongoing	Proposal briefing, product, access	Proposal familiarity. Ongoing discussions.
FMG	Ongoing	Proposal briefing, product, access	Proposal familiarity. Ongoing discussions.

4 ENVIRONMENTAL STUDIES AND SURVEY EFFORT

In preparation of the Proposal, publically available baseline environmental information was considered and reviewed by Phoenix (2014a).

The surrounding area has been the subject of EPA assessment and approval for the following projects:

- Marillana Creek Yandi Iron Ore Project, EPA Bulletin 1166, Ministerial Statement 679;
- Yandicoogina Marillana Iron Ore Project, EPA Bulletin 738, Ministerial Statement 357;
- Marillana Iron Ore project, EPA Bulletin 1376; and
- Koodaideri Iron Ore Project, EPA Bulletin 1533.

The environmental survey work completed for these projects provides regional context and some local information relevant to this Proposal. These projects provide baseline environmental data and management approaches to key environmental issues and Ministerial Conditions.

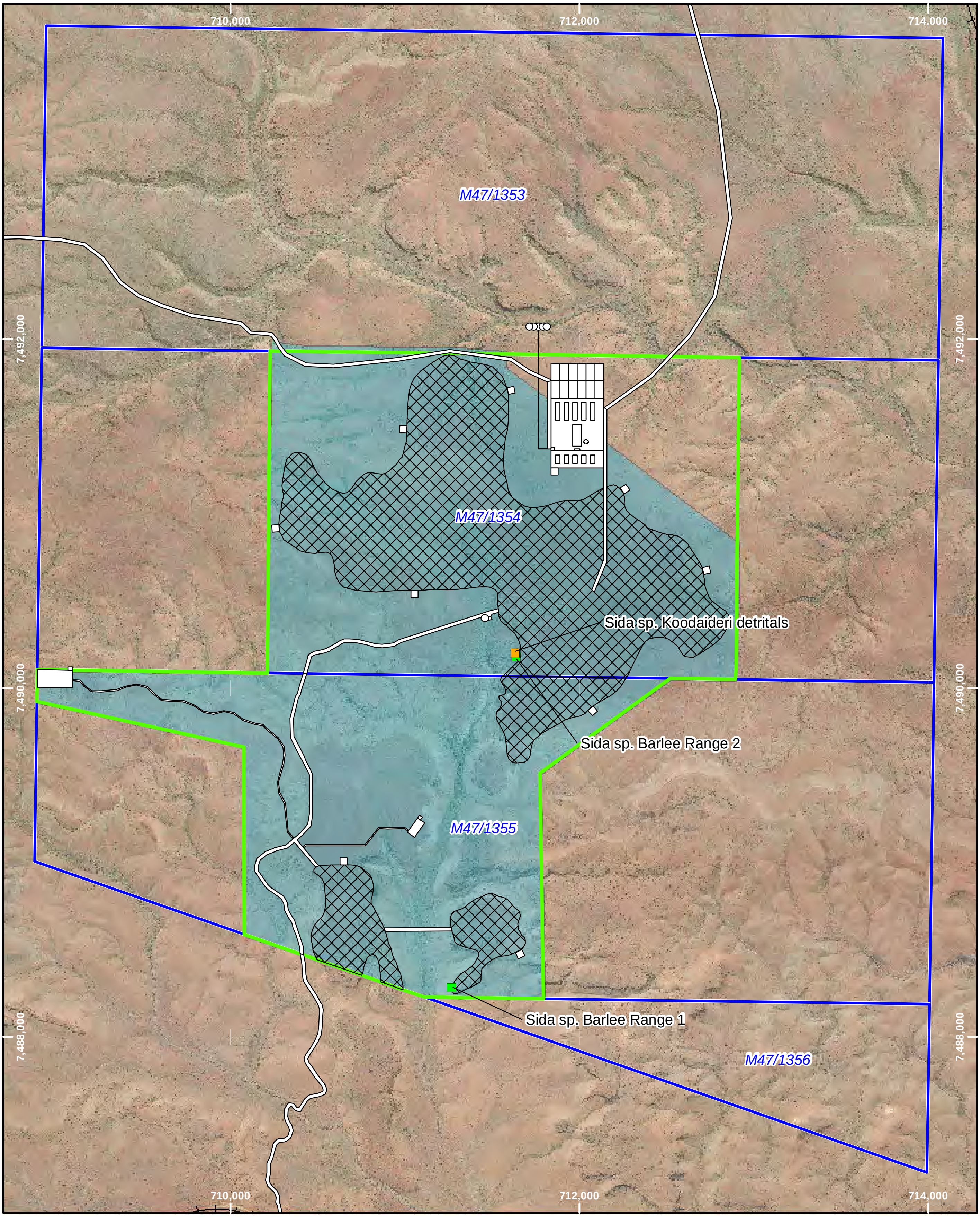
AAMC has also planned and implemented a series of studies and surveys to confirm specific aspects of baseline environmental information and likely impacts associated with the Proposal. These studies are provided in Appendix 2 and include:

- Flora and Fauna Desktop Review (Phoenix, 2014a)
- Flora and Vegetation Survey (Phoenix, 2014b);
- Subterranean Fauna Survey (Phoenix, 2014c);
- Terrestrial Fauna Survey (Phoenix, 2014d);
- Geochemical Assessment (SWC, 2014); and
- Heritage Surveys (ACHM, 2014).

Further details regarding the areas surveyed, timing of the surveys, standards used and limitations encountered are provided in Table 4.

It should be noted that for the flora, vegetation and fauna surveys, two separate study areas were defined by Phoenix (2014b and 2014d). The Mine Study Area (MSA) defined by Phoenix is illustrated in Figure 6 and covers most of the area proposed for the pits and supporting infrastructure. For the purposes of this API document, the proposal boundary for the pits and supporting infrastructure is defined as the Mine Proposal Area (MPA); also illustrated in Figure 6. The North-eastern section of the MPA that has not yet been surveyed will be surveyed prior to any works commencing.

The second survey area defined by Phoenix is the Road Survey Area (RSA). The RSA falls entirely within the Western Access Road proposal boundary as illustrated in Figure 3. No survey work has been undertaken within the Northern Access Road proposal boundary, however if this is the preferred access road option, the area will be surveyed and an infrastructure plan and offset plan will be submitted to the OEPA for approval prior to any works commencing in this area.



Legend

- AAMC Tenements
- Mine Proposal Area
- Mine Study Area
- Proposed Pits
- Proposed Infrastructure

Priority flora survey records (Phoenix 2014)

- Priority 1
- Priority 3

AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Mine Study Area and Location of Priority Flora (Phoenix 2014)

Figure 6

Scale: 1:30,000 | Projection: GDA 1994 MGA Zone 50
Date: 4/12/2014 | File: 4_Study_Area.mxd

Table 4: Summary of Environmental Studies and Surveys

Factor	Consultant	Survey / Investigation Name	Study Area, Type and Timing	Study Standard / Guidance and Limitations	Appendix
Flora and Fauna	Phoenix Environmental Services Pty Ltd	Flora and Fauna Desktop Review for the Extension Project and Bulk Sample	Study undertaken on Extension Mining and Exploration Lease Areas (M47/1353/ M47/1354, M47/1355, M47,1356, E47/2001 and E47/1239) Flora and Fauna Desktop Review Desktop study completed March 2014		Appendix 2 Reference: Phoenix 2014a
Flora and Vegetation	Phoenix Environmental Services Pty Ltd	Flora and Vegetation Survey for the Extension Project	Survey undertaken in Mine Study Area (MSA) and Road Study Area (RSA) collectively referred to as Combined Study Area (CSA) covering 916 ha Level 1 Flora and Vegetation Survey Field Survey undertaken between 28 March to 2 April 2014	EPA Guidance Statement No. 51: *Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia* EPA Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection* (Limitation: Access to some areas constrained, some areas recently burnt, survey conducted over one season)	Appendix 2 Reference: Phoenix 2014b
Subterranean Fauna	Phoenix Environmental Services Pty Ltd	Troglofauna Survey for the Extension Project	Survey undertaken in MSA covering 778 ha Level 2 Troglofauna Survey Field Survey undertaken between 27 March to 5 April 2014	Bore Scraping Sampling Technique EPA Environmental Assessment Guideline 12 (*Environmental assessment Guideline for the assessment of subterranean fauna in environmental impact assessment in Western Australia*) EPA Guidance Statement No. 54a (*Sampling methods and survey considerations for subterranean fauna in Western Australia (Technical appendix to Guidance Statement No. 54)* (Limitations: Access to some bores constrained, shallow bores, no repeat surveys, observed species richness below guideline recommendation)	Appendix 2 Reference: Phoenix 2014c
Terrestrial Fauna and Short Range	Phoenix Environmental Services Pty Ltd	Terrestrial Fauna Survey for the Extension Project	Survey undertaken in MSA and RSA collectively referred to CSA covering 916 ha	EPA Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection*	Appendix 2 Reference: Phoenix

Factor	Consultant	Survey / Investigation Name	Study Area, Type and Timing	Study Standard / Guidance and Limitations	Appendix
Endemic Invertebrates			Level 1 Terrestrial Vertebrate Fauna and Level 2 Short-Range Endemic Invertebrate Survey Field Survey undertaken between 27 March to 5 April 2014	EPA Guidance Statement No. 56: *Terrestrial fauna surveys for environmental impact assessment in Western Australia* *Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* EPBC Act policy statement 3.25: *Referral guidelines for the endangered Northern Quoll, Dasyurus hallucatus* EPA Guidance Statement No. 20: *Sampling of short-range endemic invertebrate fauna for environmental impact assessment (EIA) in Western Australia* (Limitations: Access to some areas constrained)	2014d
Geochemical	Soilwater Consultants	Extension Desktop Geochemical Assessment	Extension ore deposits covering an area of 690 ha Desktop Geochemical Assessment Desktop assessment completed February 2014	Acid Rock Drainage Test Handbook. *Project P387A Prediction and Kinetic Control of Acid Mine Drainage*. AMIRA International, Melbourne, Australia.	Appendix 2 Reference: SWC 2014
Aboriginal Cultural Heritage	Australian Cultural Heritage Management (ACHM)	Aboriginal Cultural Heritage Assessment – Drilling Areas, Road Corridor and Infrastructure Area	Assessment undertaken on Extension Mining and Exploration Lease Areas (M47/1353/ M47/1354, M47/1355 and E47/1239). November/December 2013.	Survey undertaken with Martidja Banyjima Traditional Owners	Reference: ACHM 2013

5 ASSESSMENT OF KEY ENVIRONMENTAL FACTORS

5.1 LIST OF PRELIMINARY KEY ENVIRONMENTAL FACTORS

AAMC has assessed the potential impacts of the Proposal on the various environmental factors listed in *Environmental Assessment Guideline 8: for Environmental Factors and Objectives* (EPA 2013a). Those that were deemed to be potentially significantly impacted by the Proposal were classed as 'preliminary key environmental factors'. The factors that were either not expected to be significantly impacted or can be suitably managed using existing legislation were classed as 'other environmental factors' (refer Section 6). In consultation with the OEPA, the following are determined to be the preliminary key environmental factors to be assessed in this API document:

- Flora and vegetation – to address the potential impacts resulting from the direct or indirect loss of flora and vegetation; and
- Subterranean fauna – to address the potential impacts resulting from the direct or indirect loss of subterranean fauna habitat.

Table ES 2 provided a summary of the preliminary key environmental factors, including information relevant to identifying EPA objectives, potentially significant impacts (without mitigation), environmental aspects, proposed management controls, legal management mechanisms and predicted environmental outcomes that will give the EPA confidence that these factors will be appropriately managed.

The following sections provide further information specific to these preliminary key environmental factors, including:

- An outline of the policy context against which the significance of the impacts can be assessed;
- A summary of the potential direct, indirect and cumulative impacts on the environment;
- A summary of the proposed mitigation measures;
- Details of how the proposed mitigation measures can be regulated; and
- An assessment on whether the EPA objectives will be met.

5.2 FLORA AND VEGETATION

The following sections provide a detailed environmental assessment of flora and vegetation for the Proposal.

5.2.1 CONTEXT

Policy Context

The Proposal is located in the Fortescue bioregion (Hamersley sub-region (PIL3)) under the Interim Biogeographic Regionalisation for Australia (IBRA) (DoE, 2014). This sub-region has an area of 6,215,092 ha (Kendrick 2001).

The EPA has recently reviewed the cumulative environmental impacts of development in the Pilbara region (EPA 2014a) and outlined a series of initiatives as recommendations to the

Minister for Environment. One of the initiatives is for the development of a fund for the provision of offsets in the Pilbara – in recognition of the difficulty for proponents to provide offsets in a region with little freehold land. The Government of Western Australia has outlined guidelines and a policy for the provision of environmental offsets (Government of Western Australia, 2014 and 2011 respectively).

A key conservation feature in the region is the Fortescue Marsh. The mining area is located outside of the buffer zone of Fortescue Marsh which is located approximately 2 km northeast of the MPA. In 2013 the EPA identified management zones within the Fortescue Marsh management area (EPA 2013b). The Proposal area for two of the road access road options partially intersect with the buffer zone for the Fortescue Marsh and with Zone 2b (Poonda Plain) of the marsh management zones.

The MSA does not lie within any Environmentally Sensitive Areas, wetlands, permanent water courses or conservation reserves (Phoenix, 2014b). Karijini National Park is located approximately 40 km west of the MPA.

Relevant Standards

The EPA Objective is to maintain representation, diversity, viability and ecological function at the species, population and community level (EPA 2013a).

AAMC has considered EPA Guidance Statement No. 51 (EPA 2004a) which specifically addresses terrestrial flora and vegetation surveys for Environmental Impact Assessment (EIA) in WA. This Guidance Statement:

- Provides the general standards and a common framework for terrestrial flora and vegetation surveys for EIA in WA, the quality and quantity of information that should be derived from these surveys, and the consequent analysis, interpretation and reporting; and
- Is primarily directed at the subset of biodiversity contained in all terrestrial vascular plants.

AAMC has considered EPA Position Statement No. 2 – Environmental Protection of Native Vegetation in WA (EPA 2000). This Position Statement provides an overview of the EPA's position on the clearing of native vegetation in WA with particular reference to clearing within the agricultural area. However, there is an array of additional information at both the National and State levels which is relevant to native vegetation clearing in other parts of WA.

AAMC has also considered EPA Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002) which recognises the fundamental ecological importance of biodiversity protection and the requirements for EIA in WA.

AAMC commissioned Phoenix to undertake a review of flora and vegetation survey data for the surrounding area (Phoenix 2014a) and a Level 1 flora and vegetation survey for the Proposal Area which was undertaken between 28 March 2014 and 2 April 2014 (Phoenix, 2014b).

Key Findings

The following information summarises the major findings of the flora and vegetation survey of the MSA undertaken by Phoenix (2014b).

No Threatened Fauna (TF) listed by the Department of Parks and Wildlife (DPaW) or species of national conservation significance listed under the *Environment Protection and Biodiversity Act 1999* (EPBC Act) were recorded in the MSA during the survey. Two Priority flora species were recorded in the MSA; the Priority 1 *Sauropus sp.* Koodaideri detritals (J. Naaykens & J. Hurter JH

11213) and the Priority 3 *Sida* sp. Barlee Range (S. van Leeuwen 1642) (Phoenix, 2014b) (Figure 6).

Five species within the MPA and Western Access Road proposal boundary represent an extension to the recorded range, *Eucalyptus* ? *aridimontana*, *Flueggea virosa*, *Sauropus* sp. Koodaideri detritals, *Sida* sp. Articulation below and *Tribulopis angustifolia*. Identification of range extensions are a common occurrence in flora surveys in the Pilbara bioregion especially with recently discovered species (Phoenix, 2014b).

A total of five exotic species (weeds) were recorded in the MPA and Western Access Road proposal boundary during the flora survey; *Alternanthera pungens, Bidens bipinnata*, *Lactuca saligna*, *Malvastrum americanum* and *Cenchrus ciliaris*. None are listed as a Declared Plant species under the *Agricultural and Related Resources Protection Act 1976* (Phoenix, 2014b).

The vegetation recorded in the MSA was comprised primarily of native species with negligible weed infestations. The condition of the vegetation within the MSA ranged from very good to excellent (Phoenix, 2014b).

Nine vegetation types (associations) were recorded in the MSA during the field survey (Figure 7). The associations are characterised by three broad floristic sub-formations:

- *Triodia wiseana* dominant hummock grassland;
- Isolated low trees over isolated mid to tall *Acacia* shrubs over isolated low shrubs to mixed low shrubland over *Triodia* hummock grassland; and
- Isolated trees to woodland over tall mixed shrubland over isolated low shrubs over mixed grassland.

All vegetation associations resembled previously defined vegetation types that are common, widespread and represented in nature reserves (Phoenix, 2014b).

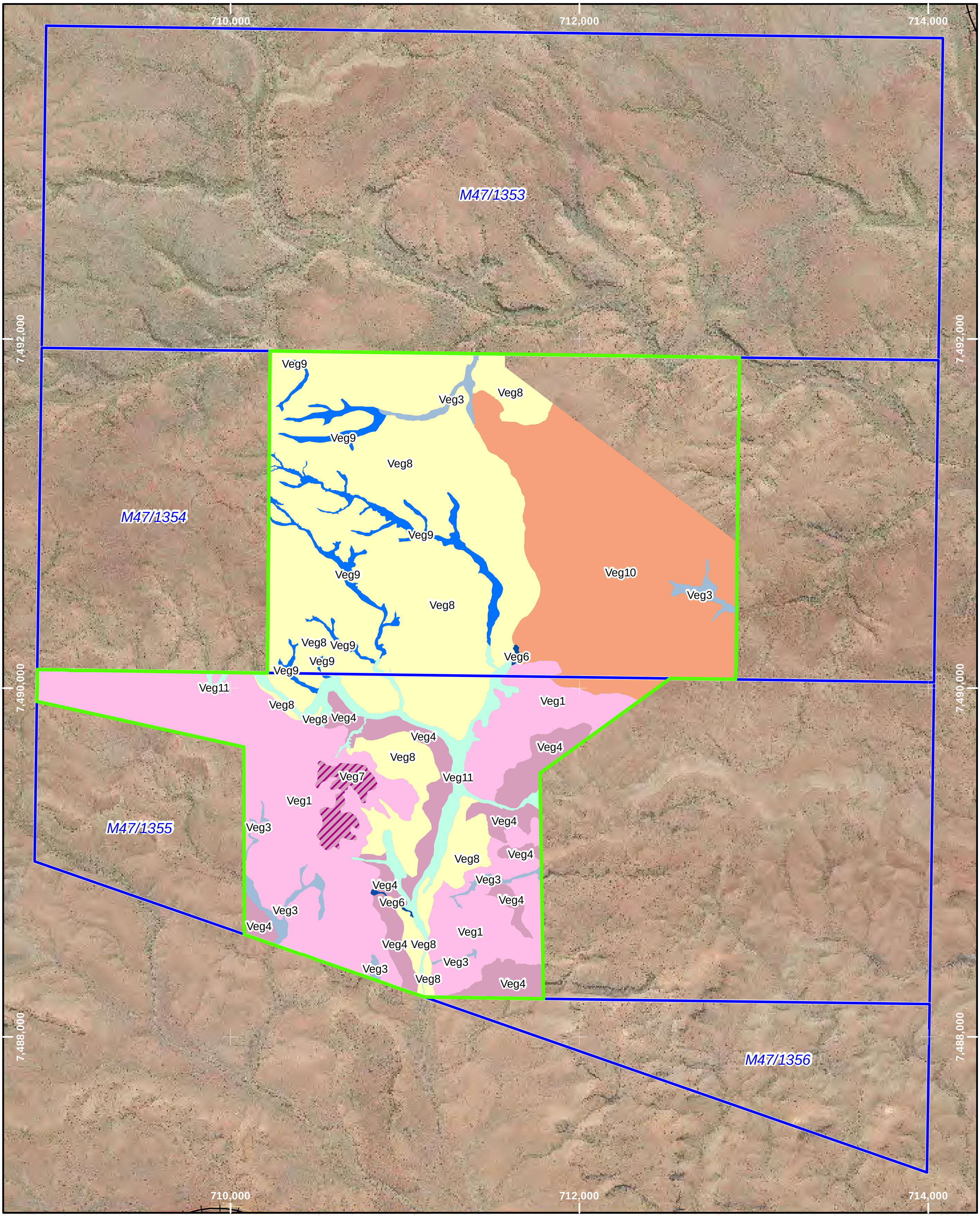
Broad scale vegetation mapping of the area (1:1,000,000) undertaken by Beard (1975) indicates that there are two vegetation communities present within the MSA. These both have greater than 98% of their pre-European extent remaining and are not considered regionally significant. All of the vegetation associations recorded during the current survey resemble widespread vegetation types of van Vreeswyk *et al.* (2004) none of which were considered regionally significant.

No Threatened Ecological Communities (TECs) as listed under the EPBC Act or the *Wildlife Conservation Act 1950* (WC Act) are known to occur within or in close proximity to the MSA and none were identified during the field survey. None of the defined associations resembled Priority Ecological Communities (PECs) recorded for the Pilbara bioregion.

Mitigation Hierarchy in Proposal Design

The following mitigation hierarchy principles have been included in the Proposal design:

- **Avoid**: Where practicable a 20 m buffer will be applied to all known Priority 1 Flora locations;
- **Avoid**: Infrastructure location to avoid known Priority Flora where practicable;
- **Minimise**: Clearing will be minimised to that required for safe construction and operations;
- **Rehabilitate**: Disturbed areas will be rehabilitated using local native vegetation species; and
- **Offset**: Provision of an environmental offset for unavoidable clearing of native vegetation in Good to Excellent condition.



Legend

- AAMC Tenements
- Mine Proposal Area

Vegetation type

- Vegetation 1
- Vegetation 2
- Vegetation 3
- Vegetation 4
- Vegetation 5
- Vegetation 6
- Vegetation 7
- Vegetation 8
- Vegetation 9
- Vegetation 10
- Vegetation 11
- Vegetation 12
- Vegetation 13

N

0 500 1,000
metres

AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Vegetation Types within
Mine Proposal Area

Figure 7

Scale: 1:30,000 Projection: GDA 1994 MGA Zone 50
Date: 2/12/2014 File: 6_Vegetation_Types.mxd

Description of the vegetation types

Vegetation 1: Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over isolated mid *Acacia* spp. shrubs over isolated low shrubs to open shrubland of *Acacia adoxa* var. *adoxa*, *A. hilliana*, *Corchorus lasiocarpus* and *Ptilotus astrolasius* over a low *Triodia wiseana* and *T. epactia* hummock grassland with isolated *Aristida holathera* and *Eriachne pulchella* tussocks and isolated *Tribulus hirsutus* herbs.

Vegetation 2: Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over isolated mid *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over isolated low *Corchorus lasiocarpus* shrubs in a low *Triodia epactia* hummock grassland over isolated *Ptilotus fusiformis* and *Oldenlandia crouchiana* herbs.

Vegetation 3: Isolated low *Corymbia hamersleyana* trees over a tall *Acacia monticola*, *A. tenuissima*, *A. tumida* and *Petalostylis labicheoides* shrubland over isolated low shrubs to low shrubland of *Androcalva luteiflora*, *Jasminum didymum*, *Senna glutinosa* and *Ptilotus astrolasius* over a low *Triodia epactia* and *Themeda triandra* grassland with isolated *Cymbopogon ambiguus* and *Eriachne mucronata* tussocks.

Vegetation 4: Isolated low *Corymbia hamersleyana* trees over isolated mid *Acacia inaequilatera* shrubs over isolated low *Indigofera rugosa* and *Senna artemisioides* subsp. *oligophylla* shrubs over low *Triodia epactia* hummock grassland.

Vegetation 5: Isolated low *Corymbia deserticola* trees over isolated tall *Acacia tumida* shrubs over isolated mid *Grevillea wickhamii* subsp. *hispidula* shrubs over isolated low *Goodenia stobbsiana* shrubs in low *Triodia wiseana* hummock grassland.

Vegetation 6: Isolated low trees to low woodland of *Corymbia aspera*, *Eucalyptus aridimontana* and *E. leucophloia* over a tall *Acacia tumida* shrubland over isolated low *Adriana tomentosa* shrubs and *Duperreya commixta* vines over isolated low grasses to low grassland of *Eriachne mucronata*, *Themeda triandra* and *Triodia epactia*.

Vegetation 7: Isolated low *Goodenia stobbsiana* shrubs over a low *Triodia wiseana* hummock grassland over isolated *Fimbristylis simulans* herbs.

Vegetation 8: Isolated low *Corymbia hamersleyana* and *Eucalyptus leucophloia* trees over isolated mid to tall *Acacia tumida*, *A. maitlandii* and *A. pruinocarpa* shrubs over isolated low shrubs to low shrubland of *Acacia arida*, *A. adoxa* var. *adoxa*, *Corchorus lasiocarpus*, *Gompholobium oreophilum*, *Goodenia stobbsiana* and *Senna glutinosa* subsp. *glutinosa* over a low *Triodia epactia* and *T. wiseana* hummock grassland and isolated *Goodenia triodiophila* herbs.

Vegetation 9: Isolated low trees to low open woodland of *Corymbia hamersleyana* occasionally with low *Eucalyptus leucophloia* trees and *E. gamophylla* mallee over a mid to tall *Acacia tumida*, *Grevillea wickhamii* subsp. *hispidula*, *Petalostylis labicheoides* and *Santalum lanceolatum* shrubland over isolated low shrubs to low open shrubland of *Acacia adoxa* var. *adoxa*, *Bonamia erecta*, *Gompholobium oreophilum*, *Indigofera monophylla*, *Keraudrenia velutina* and *Sida arenicola* over a *Triodia wiseana*, *T. epactia* and *Themeda triandra* grassland with isolated *Aristida holathera* and *Amphipogon sericeus* tussocks.

Vegetation 10: Isolated low *Corymbia deserticola* trees over isolated mid to tall *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over isolated low *Acacia ancistrocarpa* and *Indigofera monophylla* shrubs over a low *Triodia wiseana* hummock grassland with isolated low *Amphipogon sericeus* tussocks and *Goodenia triodiophila* and *Ptilotus calostachyus* herbs.

Vegetation 11: Isolated mid trees to mid-woodland of *Eucalyptus camaldulensis* occasionally with low *Corymbia hamersleyana*, *Atalaya hemiglauca* and *Eucalyptus leucophloia* trees over isolated tall shrubs to tall shrubland of *Acacia maitlandii*, *A. pyrifolia* and *A. tumida* over isolated low mixed shrubs to low open shrubland over isolated low mixed grasses and sedges to low mixed grass-sedgeland with *Triodia epactia*, *Themeda triandra*, *Enneapogon lindleyanus* and *Cyperus vaginatus* prominent over isolated mixed herbs with occasional patches of a tall *Myoporum montanum* shrubland over a tall *Typha domingensis* sedgeland in wet depressions.

Vegetation 12: Isolated mid *Corymbia aspera*, *Brachychiton acuminatus* and *Eucalyptus camaldulensis* trees over isolated low *Atalaya hemiglauca* and *Corymbia hamersleyana* trees over isolated tall *Acacia* spp. shrubs over isolated low to low open mixed shrubland with *Cleome viscosa*, *Senna venusta*, *Tephrosia rosea* and *Trachymene oleracea* prominent over a low open *Cymbopogon ambiguus*, *Eriachne mucronata*, *Eulalia aurea* and *Themeda triandra* tussock grassland with isolated *Yakirra australiensis* bunch grasses and isolated *Amaranthus cuspidifolius*, *A. undulatus*, *Euphorbia coghlanii* and *Gomphrena cunninghamii* herbs and *Cucumis maderaspatensis* vines.

Vegetation 13: Isolated low *Eucalyptus leucophloia* and *Corymbia deserticola* trees over isolated low *Eucalyptus gamophylla* mallee over mid open *Acacia elachantha* and *Bonamia erecta* shrubland over low *Acacia ancistrocarpa* shrubland over a low *Triodia wiseana* hummock grassland over isolated *Goodenia microptera* and *Ptilotus calostachyus* herbs.

Figure 7 Ctd

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

PHOENIX ENVIRONMENTAL SCIENCES

5.2.3 POTENTIAL IMPACTS WITHOUT MITIGATION

This Proposal will result in the clearing of approximately 530 ha of mostly "Very Good" to "Excellent" condition native vegetation which may affect the representation and diversity at the species population and community level. Ground disturbance activities if not controlled could also lead to the direct loss of Priority Flora species (namely *Sida* sp. Barlee Range P3 (2 populations) and *Sauropus* sp. Koodaideri detritals P1 (1 population)).

Vegetation clearing, earthmoving and construction and operational activities have the potential to cause indirect impacts to flora and vegetation via a range of mechanisms such as the generation of dust, flooding and erosion.

Increased vehicular traffic in the area can have the potential to transfer existing weed species and introduce new weed species during the construction and operational phases of the Proposal.

5.2.4 PROPOSED MANAGEMENT (MITIGATION)

The following management strategies have been or will be employed by AAMC to avoid, minimise and/or mitigate potential direct and indirect impacts to flora and vegetation:

- Implement Project Construction and Operational Environmental Management Plans (EMPs);
- Vegetation clearing will be managed through internal ground disturbance procedures;
- Boundaries of areas to be cleared or disturbed will be identified by Geographical Positioning System (GPS) coordinates and maps of boundaries will be provided to dozer operator;
- Undertake progressive clearing and rehabilitation;
- Incorporate surface water management and erosion protection into Proposal planning and design to minimise disruption to watercourses and riparian vegetation;
- Implement measures to manage surface water flows within the Proposal area to minimise downstream effects;
- Groundwater abstraction bores to be located and operated such that groundwater drawdown is minimised within areas of confirmed Groundwater Dependent Ecosystems (GDEs);
- Implement weed hygiene and management measures/procedures to prevent spread of weeds and the introduction of new weed species in the Proposal Area;
- Ensure ground engaging plant and equipment are certified weed free prior to entry to site;
- Develop the disturbance footprint to the minimum required to ensure safe and adequate construction and operation;
- Apply water or dust suppressants to disturbed areas and ore transfer/storage areas to minimise dust generation;
- Solar drying cells will be constructed instead of a tailings dam to dry out tailings. This will reduce overall clearing for the Proposal;
- Pits will be backfilled with waste rock and dry tailings instead of developing a waste rock dump. This will reduce overall clearing for the Proposal;
- Mine pits will be developed in areas and will use surface mining methods so that mining will result in low waste rock volumes being produced. This will reduce overall clearing for the Proposal to meet target production levels;
- Provision of an offset of $750 per ha for native vegetation in Good to Excellent condition cleared as a requirement of implementing the Proposal;
- Where practical install a 20 m buffer around known Priority 1 Flora locations;
- If TF are located in areas where disturbance cannot be avoided, approval will be sought under the WC Act to disturb the minimum practicable amount of TF.
- Complete biological survey work on access road corridors; and

- Prepare infrastructure plan that shows the location of conservation significant features and demonstrates how impacts are avoided or minimised where practicable.

AAMC will ensure that all staff, contractors and visitors are made aware of obligations and objectives regarding the protection of native vegetation.

5.2.5 REGULATION

The Proposal will be regulated by the conditions of approval set by the Minister for the Environment under Part IV of the EP Act. Clearing and impacts on native vegetation for the Proposal will also be regulated by:

- Mining Act – Adherence to approved footprint and detailed Proposal design;
- EP Act (Part V) – Works Approval for processing facility, waste water treatment plant. Native Vegetation Clearing Regulations for any additional clearing; and
- RIWI Act – Sustainable extraction of groundwater.

5.2.6 MEETING OF EPA OBJECTIVE

After the application of management and mitigation measures, the Proposal is expected to result in the progressive removal of up to 530 ha of vegetation over the life of the Proposal. No direct impact on Priority Flora will occur as a result of the Proposal in the MPA. Potential impacts on Priority Flora will be assessed following survey and design of the access road. The Proposal is not expected to alter the conservation status or viability of Priority Flora species or have a significant effect on the representation of vegetation at a local or regional level.

No TECs, PEC's ESAs or TF species will be affected by the Proposal as none have been recorded within the Proposal Area.

The occurrence of new weed species and the spread of existing weeds will be controlled through the implementation of industry standard weed control measures.

The implementation of vegetation protection measures from indirect impacts will further ensure impacts on flora and vegetation are minimised.

The residual, unavoidable impacts on flora and vegetation from this Proposal is expected to be addressed via the provision of an offset in accordance with EPA requirements.

The Proposal is expected to meet the EPA objective for flora and vegetation.

5.4 TROGLOFAUNA

The following sections provide a detailed environmental assessment of subterranean fauna for the Proposal. As the proposal does not require pit dewatering, subterranean fauna consideration is limited to troglofauna.

5.4.1 CONTEXT

Policy Context

The Proposal is located in the Fortescue bioregion (Hamersley sub-region (PIL3)) under the Interim Biogeographic Regionalisation for Australia (IBRA) (DoE, 2014).

Relevant Standards

The EPA Objective is to maintain representation, diversity, viability and ecological function at the species, population and community level (EPA 2013a). AAMC has considered EPA Guidance in relation to subterranean fauna in Western Australia. Two statements provide the general standards and a common framework for subterranean fauna surveys for EIA in WA:

- EPA Guidance Statement 54a (Technical appendix to Guidance Statement 54) (EPA 2007). The Guideline outlines sampling methods and survey considerations for subterranean fauna in Western Australia; and
- EPA Environmental Assessment Guideline 12. (EPA 2013c). This Guideline provides a policy framework outlining how subterranean fauna should be considered in EIA and is designed to promote a more consistent approach to assessment and subsequent approval outcomes.

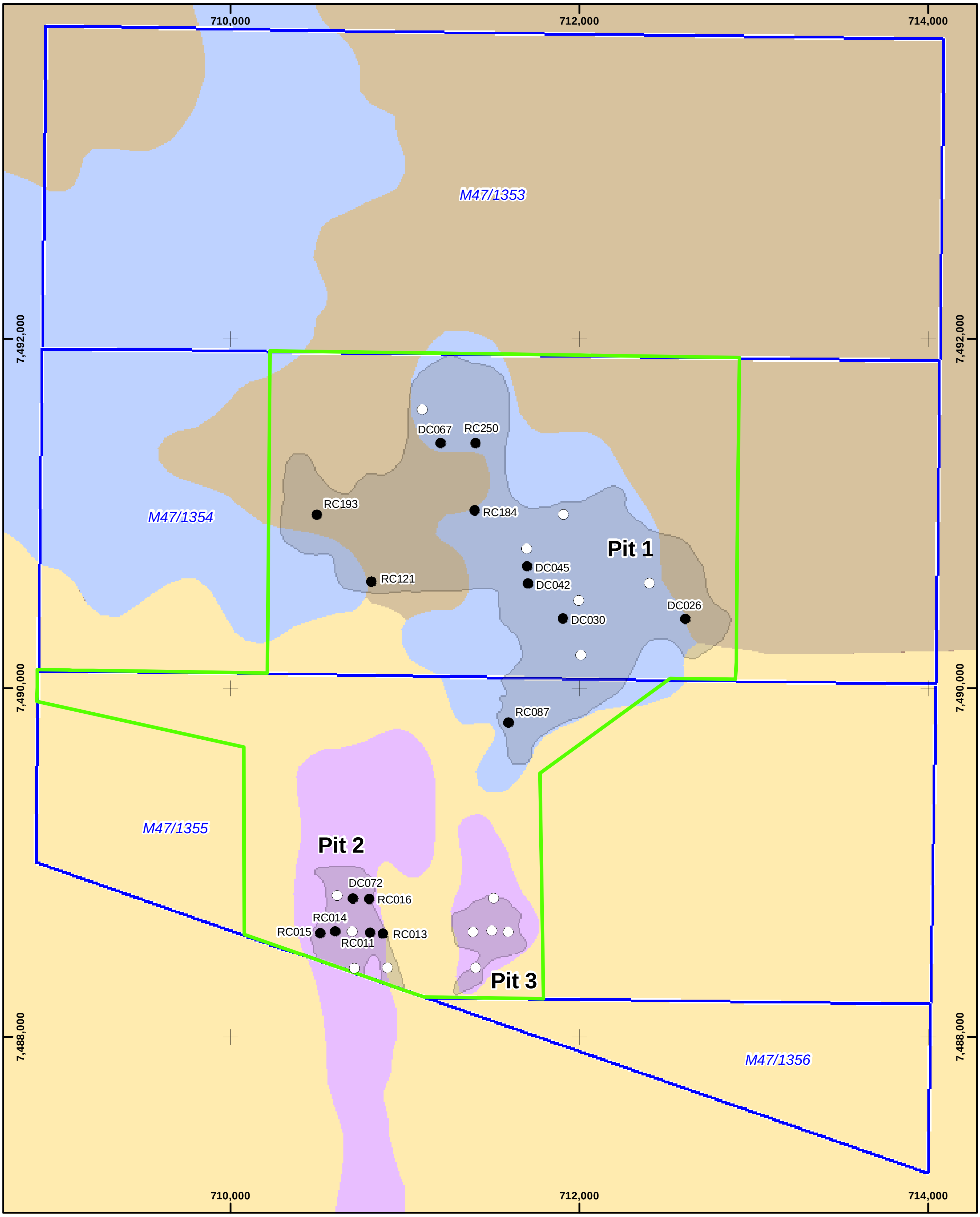
AAMC commissioned Phoenix to undertake a review of troglofauna survey data for the surrounding area and sampling programme (Phoenix 2014c) which was undertaken between 27 March 2014 and 5 April 2014 and solely utilised the bore scraping sampling technique.

Key Findings

The following information summarises the major findings of the review and troglofauna survey of the MPA undertaken by Phoenix (2014c).

The MPA encompasses three iron ore deposits (North deposit, West deposit and East deposit) and is comprised of five geology types (GSWA, 1996) (Figure 8):

- Hematite-goethite (Czr) – hematite-goethite deposits on banded iron formation and adjacent scree deposits;
- Robe Pisolite (Czp) – pisolitic limonite deposits developed along river channels;
- Colluvium (Czc) – partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits ;
- Weeli Wolli Formation (PLHj) – banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills; and
- Alluvium (Qa) – unconsolidated silt, sand and gravel in drainage channels and on adjacent floodplains.



Legend

- AAMC Tenements
- Mine Proposal Area
- Proposed Pits
- Bores with troglofauna
- Bores without troglofauna

Surface Geology

- Czc: Colluvium - partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
- Czp: Robe Pisolite - pisolitic limonite deposits developed along river channels
- Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
- PLHj: Weeli Wolli Formation - banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills

N

0 500 1,000

metres

AAMC AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Troglofauna survey bores
and bores yielding troglofauna

Figure 8

Scale: 1:30,000 | Projection: GDA 1994 MGA Zone 50

Date: 2/12/2014 | File: 7_Troglofauna_Bores.mxd

All surface geology types present within the MPA are known to support troglofauna (EPA 2007, 2012b, 2013c). Thirty-one bores were surveyed by Phoenix (2014c), spanning all three deposits. Five survey bores in the East deposit were much degraded and none deeper than 3 m. These bores yielded no troglofauna and were therefore excluded from the survey analysis, leaving 26 valid survey sites - 16 in the North deposit and 10 in the West deposit (Figure 8).

Forty-seven individuals were collected from a total sample effort of 29 samples. Ten species of troglofauna were recorded and are identified below and in Table 5 (Phoenix, 2014c). All are troglobites:

- Two species were only recorded from the West deposit:
  - *Atelurinae* 'marillana' , a type of silverfish, a likely Short Range Endemic (SRE); and
  - *Draculoides* 'SCH30', a schizomid, a potential SRE.

- Six species were only recorded from the North deposit:
  - *Enchytraeus* 'marillana', a segmented worm, a potential SRE;
  - *Isotomidae* 'marillana', a collembolan , a potential SRE;
  - *Prethopalpus* 'marillana', a goblin spider, a likely SRE;
  - *Palpigradi* sp. indet., a palpigrade, a likely SRE;
  - *Stenoniscidae* 'marillana', a slater, a likely SRE; and
  - *Trinemura* 'marillana', a silverfish, a likely SRE.

- Two species were recoded from both North and West deposits:
  - *Cyphoderus* 'marillana', a springtail, a potential SRE; and
  - *Nocticola* 'pilbara1', a cockroach, a widespread species.

Table 5: Troglofauna recorded during the field survey (Phoenix, 2014c)

Species	Number of sites / survey bores	Abundance	SRE status
Enchytraeus 'marillana	8	20	Potential
Prethopalpus 'marillana'	2	2	Likely
Palpigradi[1] 'marillana'	1	1	Likely
Draculoides 'SCH30'	1	1	Potential
Stenoniscidae[1]'marillana'	2	2	Likely
Cyphoderus 'marillana'	6	9	Potential
Isotomidae[1] 'marillana'	1	2	Potential
Nocticola 'pilbara1'	4	7	Widespread
Atelurinae[1] 'marillana'	1	1	Potential
Trinemura 'marillana'	1	2	Likely

[1] Represents unresolved classifications, the name of the lowest clear taxon rank was used.

No subterranean fauna species listed under the EPBC Act or the WC Act were recorded in the survey.

Only three of these species were recorded from more than three sample bores enabling some interpretation of their distribution pattern: *Enchytraeus* 'marillana' (eight bores), *Cyphoderus* 'marillana' (six bores) and *Nocticola* 'pilbara1' (four bores). Both *Cyphoderus* 'marillana' and *Nocticola* 'pilbara1' have been recorded elsewhere in the Hamersley Range of the Pilbara. All of the remaining species were only recorded from one or two bores.

Surface geology data indicates that the North deposit is at the southern limit of a much larger hematite-goethite formation which extends north-east of the MPA. Similarly, the West deposit encompasses part of the northern limits of a larger Robe Pisolite formation which extends south of the MPA. It is therefore likely, independent of connectivity between the three deposits, that the troglofauna recorded within the North and West deposits, are also likely to occur within the broader north-eastern and southern extents of the geology units (Phoenix, 2014c). These areas are not part of the Mining Proposal Area. Figure 9 illustrates the likely extent of troglofauna habitat in the MPA and surrounds based on surface geology.

The troglofauna composition of the MPA is consistent with more comprehensive surveys in the vicinity of the MPA. Wider contemporary or historically recent connectivity of the troglofauna of the MPA with that of neighbouring projects is suggested by the presence of the *Draculoides* 'SCH030' complex. This complex is known from both the BHPBIO' s Yandi Mine just south of the MPA and Rio Tinto's Koodaideri Project approximately 15 km to the north of the MPA (Phoenix, 2014c).

The troglofauna richness estimation undertaken by Phoenix (2014c) estimated that between 11 and 19 species are likely occur within the surveyed areas. With 10 troglofauna species recorded from the survey, the percentage of species sampled relative to extrapolated species richness ranges from 50% to 58% (Phoenix, 2014c).

In summary, the MPA appears to be rich in troglofauna species, with evidence of habitat extension to areas outside of the MPA. In addition, genetic analysis provides supporting evidence for habitat connectivity with sites outside of the MPA where troglofauna sampling has been completed.

Mitigation Hierarchy in Proposal Design

The following mitigation hierarchy principles have been included in the Proposal design:

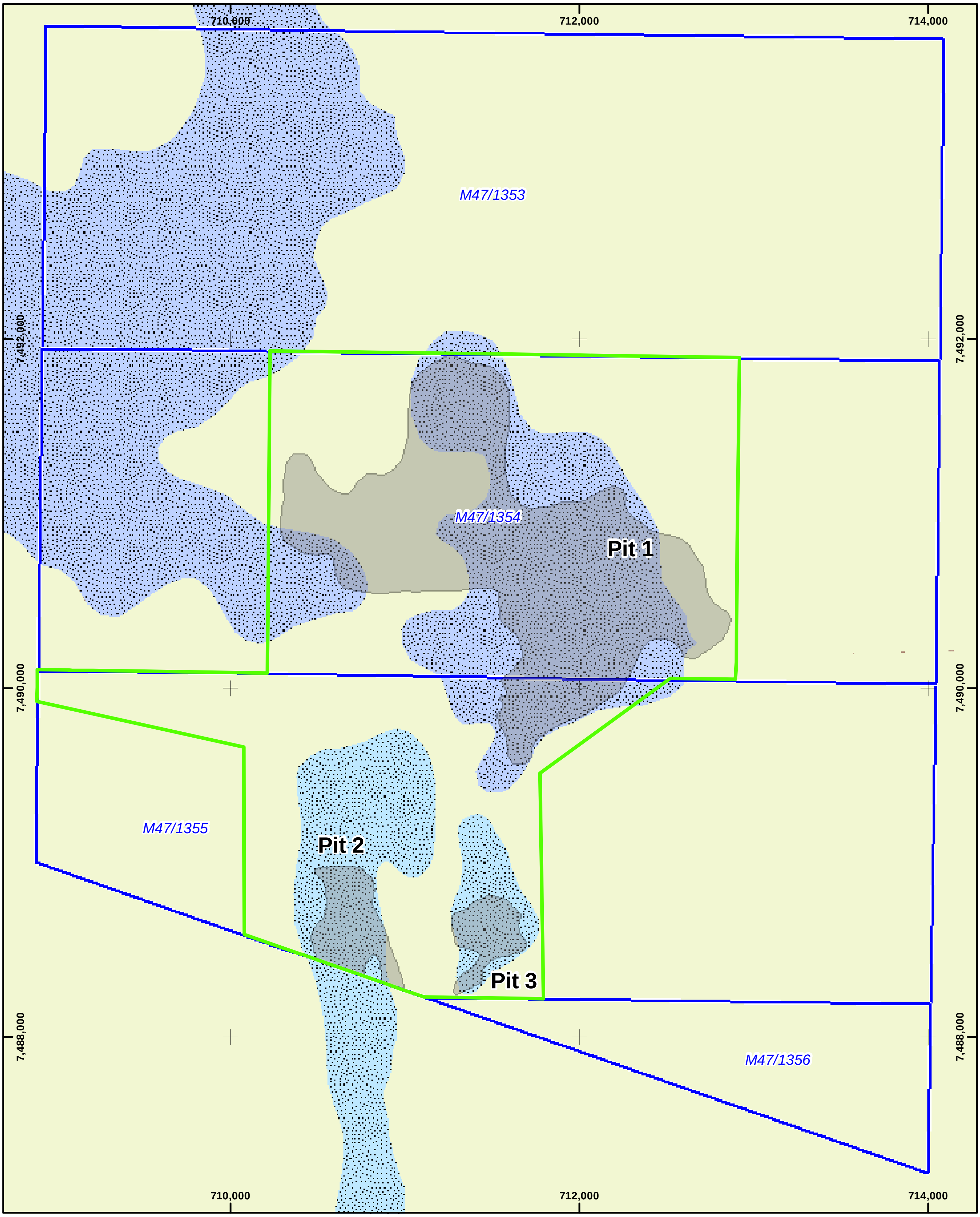
- **Minimise**: Mine pits will be developed in areas and will use surface mining methods so that mining will result in low waste rock volumes being produced. This will reduce overall disturbance of troglofauna habitat for the Proposal
- **Minimise**: Disturbance will be minimised to that required for safe mining of the orebody; and
- **Rehabilitate**: Disturbed areas will be rehabilitated using replaced local materials.

5.4.2 POTENTIAL IMPACTS WITHOUT MITIGATION

This Proposal will result in the mining of ore from above the water table on approximately 270 ha of land within the MPA. The mining of the ore represents removal of potential troglofauna habitat. Without control mechanisms there is potential for removal of troglofauna habitat outside of approved areas.

Secondary impacts could occur from activities that affect the physicochemical properties of subterranean habitats. There are four secondary impacts that may be relevant to the Proposal (Phoenix, 2014c):

- Depletion of an aquifer leading to altered relative humidity;
- Alteration to nutrient balance;
- Contamination; and
- Siltation.



Legend

- AAMC Tenements
- Mine Proposal Area
- Proposed Pits
- Potential troglofauna habitat

Surface Geology

- <all other values>
- Czp: Robe Pisolite - pisolitic limonite deposits developed along river channels
- Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

N

0 500 1,000
metres

AUSTRALIAN ABORIGINAL MINING CORPORATION

Extension Project
Likely extent of troglofauna habitat based on surface geology

Figure 9

Scale: 1:30,000 | Projection: GDA 1994 MGA Zone 50
Date: 2/12/2014 | File: 8_Troglofauna_Extent.mxd

Of the secondary impacts listed above, depletion of an aquifer leading to altered humidity is not likely to occur as no dewatering is proposed. The water table has been detected in exploration work and was recorded at depths of 30-40 m. The maximum depth of the orebody is expected to be 10-20 m.

Alteration to nutrient balance is typically associated with large scale vegetation removal and will occur over the mine pits. Other disturbance areas are limited in extent and many are linear and hence not expected to generally impact on nutrient contribution to habitat. At the completion of mining, the disturbed areas are to be rehabilitated which would be expected to gradually re-establish a nutrient balance typical for the soils and geology of the region.

There is potential for contamination from hydrocarbons, including diesel and hydraulic fluid spills, and for impacts from the mobilisation of sediment and fine materials associated with disturbance.

5.4.3 PROPOSED MANAGEMENT (MITIGATION)

The following management strategies have been or will be employed by AAMC to avoid, minimise and/or mitigate potential direct and indirect impacts to troglofauna:

- Develop the disturbance footprint to the minimum required to minimise disturbance to troglofauna habitat;
- Clearing for the pits will be managed through internal ground disturbance procedures;
- Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries will be provided to dozer operator;
- Pit boundaries will be identified by GPS coordinates and maps prior to clearing commencing;
- Incorporate surface water management and erosion protection into Proposal planning and design to minimise disruption to watercourses and riparian vegetation;
- Spill clean-up material readily available at work sites and on mobile service trucks of vehicles, where hydrocarbons and chemicals are stored and/or used;
- A spill response procedure will be developed and implemented prior to construction;
- Solar drying cells will be constructed instead of a tailings dam to dry out tailings. This will reduce the amount of troglofauna habitat being disturbed;
- Pits will be backfilled with waste rock and dry tailings instead of developing a waste rock dump. This will reduce the amount of troglofauna habitat being disturbed;
- Mine pits will be developed in areas and will use surface mining methods so that mining will result in low waste rock volumes being produced. This will reduce the amount of troglofauna habitat being disturbed;
- No dewatering of the mine pits is proposed;
- Clearing and rehabilitation will be undertaken progressively; and
- Rehabilitation plans detailing landforms, materials management and rehabilitation prescriptions will be prepared and implemented.

5.4.4 REGULATION

The Proposal will be regulated by the conditions of approval set by the Minister for the Environment under Part IV of the EP Act. Potential impacts on troglofauna for the Proposal will also be regulated by management of footprint for mining operations and controls on groundwater abstraction by:

- Mining Act – Adherence to approved footprint and detailed Proposal design; and
- RIWI Act – Sustainable extraction of groundwater.

5.4.5 MEETING OF EPA OBJECTIVE

The EPA Objective is to maintain representation, diversity, viability and ecological function at the species, population and community level (EPA 2013a). The Proposal is expected to result in the unavoidable progressive removal of up to 270 ha of potential troglofauna habitat via mining over the life of the Proposal.

Survey work and assessment has shown that excavation works associated with mine pit development will not disturb all of the troglofauna habitat in the vicinity of the deposits (Figure 9) and that there is evidence of connection of habitats at a broader regional scale. Other legislation will assist to ensure that potential indirect impacts on troglofauna habitat are appropriately managed.

The Proposal is expected to meet the EPA objectives for subterranean fauna.

6 OTHER ENVIRONMENTAL FACTORS

The other environmental factors for this Proposal are to those not considered preliminary key environmental factors as defined in this document. Due to their low level of impact, and the application of industry standard controls and other regulatory mechanisms, these other factors are not expected to be required to be assessed in detail by the EPA. Table 6 provides the relevant EIA information for the other environmental factors, to ensure the EPA has a high degree of confidence that the potential impacts are not significant and are manageable using standard industry controls and other regulatory mechanisms. AAMC understands the importance of compliance with the relevant statutes that will be used to regulate these other environmental factors.

Table 6: Other Environmental Factors

Factor - EPA Objective	Relevant Existing Environment	Environmental Aspect	Potentially Significant Impact (without mitigation)	Management Actions (Mitigation)	Regulation	Predicted Outcomes (Meets EPA Objective – Y/N)
Terrestrial Fauna - To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	**Fauna Habitat** • The MPA is largely homogenous in terms of fauna habitat, represented mostly by hummock and tussock grassland on a plateau of gently rolling hills • Five broad fauna habitats defined within the MPA: o Hummock and tussock grassland o Open and closed shrubland o Mesa and rocky hill slope o Gully o Minor creek and drainage line • The major habitats of the MPA, (hummock and tussock grasslands and mixed shrubland) provide limited vegetation structure and complexity and do not readily retain water in the landscape • All fauna habitats in the MPA have the potential to support fauna of conservation significance • Hummock and grassland habitat is widely represented regionally and the conservation significant species recorded here, such as the Western Pebble-mound Mouse, are widespread. Similar assessments are valid for open/closed shrublands and mesas and rocky hill slopes, of which the latter is habitat for the widely distributed Australian Bustard • Potential Habitat exists in the MPA for a further 12 species of conservation significance identified during the desktop assessment: o Gane's Blind Snake (P1 – DPaW) – may possibly occur o Pilbara Olive Python (VU – EPBC Act; S1 – WC Act) – likely to occur o Fork-tailed Swift (Migratory) – likely to occur o Eastern Great Egret (Migratory) – may possibly occur o Cattle Egret (Migratory) – may possibly occur o Grey Falcon (S1 – WC Act) – may possibly occur o Peregrine Falcon (S4 – WC Act) – may possibly occur o Night Parrot (EN – EPBC Act, S1 – WC Act) – may possibly occur o Rainbow Bee-eater (Migratory) – likely to occur o Star Finch (P4 – DPaW) – may possibly occur o Northern Quoll (EN - EPBC Act; S1 - WC Act) – may possibly occur o Ghost Bat (P4 – DPaW) – may possibly occur o Pilbara Leaf-nosed Bat (VU – EPBC Act, S1 – WC Act) • Migratory waterbird species may infrequently be recorded after heavy rainfall when water is abundant within the MPA, however no suitable	• Ground disturbance – clearing of potential fauna habitat • Noise from construction and operation activities • Proposal workforce, putrescible waste materials and feral animals • Groundwater abstraction • Changes to surface water flows.	• General loss of fauna habitat • Loss of conservation significant fauna habitat • Decline in habitat quality • Vehicle strike causing injury or death • Change in behaviour as a result of noise • Introduction or encouragement of feral animals.	**Implement the following industry standard controls:** • Implement a Project Construction and Operational EMP • Develop the disturbance footprint to the minimum required to ensure safe and adequate construction and operation • Identify areas of significant habitat to be avoided prior to ground disturbance • Fauna egress mechanisms at all turkey nest dams and trenches • Progressive rehabilitation of any areas cleared for construction purposes that are not required during operations (borrow pits and access tracks etc.) • Implement a ground disturbance permit (GDP) process for all proposed clearing • Provide training to ensure that native or introduced fauna are not fed by site personnel • Store food wastes in bins that are not easily accessible to fauna • Develop borrow pits such that they are free-draining to avoid water pooling • Control introduced fauna around camps and other work areas • Use low noise equipment where practicable • Internal reporting of all incidents involving fauna death • Enforce vehicle speed limits **Implement the following additional Proposal specific controls:** • Solar drying cells will be constructed instead of a tailings dam to dry out tailings. This will reduce the amount of fauna habitat being disturbed • Pits will be backfilled with waste rock instead of developing a waste rock dump. This will reduce the amount of fauna habitat being disturbed • Mine pits will be developed progressively in incremental areas and will use surface mining methods so that mining will result in low waste rock volumes being produced. This will reduce the amount of fauna habitat being disturbed • Complete biological survey work on access road corridors • Prepare infrastructure plan that shows the location of conservation significant features and demonstrates how impacts are avoided or minimised where practicable.	• Ministerial Statement (future) • EP Act Part V (authorised clearing) and Environmental Protection (Clearing of Native Vegetation) Regulations 2004 or S45c of EP Act – able to address any future additional clearing outside of boundaries authorised under Part IV of the EP Act. • WC Act and EPBC Act can address unauthorised impacts to protected fauna	• The Proposal will result in the disturbance of approximately 530 ha of native vegetation. The vegetation to be cleared is widely represented regionally. Habitat with highest fauna values are also well represented outside of the Proposal area. Proposal is therefore not expected to have a significant effect on the representation of broad fauna habitat or habitats of highest fauna values. • The access road will be designed to avoid and minimise impacts on conservation significant features • The Proposal will not affect the conservation status of any conservation significant species. • The SRE taxa recorded from the survey are typical of the gorge habitat that is characteristic of and widespread in most of the land systems present within and outside the Proposal Area. • In addition, the management controls proposed and other regulation will ensure that the Proposal will effectively meet the EPA objective.

Factor - EPA Objective	Relevant Existing Environment	Environmental Aspect	Potentially Significant Impact (without mitigation)	Management Actions (Mitigation)	Regulation	Predicted Outcomes (Meets EPA Objective – Y/N)
	permanent habitat for these birds was identified during the survey **Fauna** • Two vertebrate species of conservation significance recorded in the MPA: o Australian Bustard (P4 – DPaW) o Western Pebble-mound Mouse (P4 – DPaW) **Short Range Endemic Invertebrates** • 29 individual specimens in SRE target groups; representing at least 12 individually recognised taxa from six orders, nine families and at least 11 genera • Two taxa (both recorded in Northern section of Western Road Access Corridor) considered to include potential SREs: o Wall Crab Spider (*Karaops 'marillana'*) o Land Snail (*Camaenidae gen. nov. sp. nov.*) • Both SRE taxa recorded from typical gorge habitat that is characteristic of and widespread in most of the land systems present within and outside the Proposal Area • Proposal generally avoids potential SRE habitat – access road unavoidably has linear disturbance near some gorges.					
Landforms - To maintain the variety, integrity, ecological functions and environmental values of landforms and soils	• Pilbara Bioregion • MPA intersects three land systems – Platform, Robe and Newman • MPA comprises of three deposits – North, East and West • North deposit encompasses the southern limits of a much larger hematite-goethite formation • West deposit encompasses part of the northern limits of larger Robe Pisolite formation • Orebodies are within the extent of mesa-like landforms with no "breakout" into valley landforms • MPA is comprised of five geology types: o Hematite-goethite (Czr) o Robe Pisolite (Czp) o Colluvium (Czc) o Weeli Wolli Formation (PLHj) o Alluvium (Qa).	• Landform shape and visual presentation • Landform ecological functions and environmental values • Soil quantity and quality.	• Alteration of existing landforms creates strong visual impact • Alteration of landforms impacts upon significant ecological function or unique environmental values • Topsoil loss, soil erosion and sedimentation from disturbed areas.	**Implement the following industry standard controls:** • Implementation of sediment and erosion control measures • Rehabilitation plans detailing landforms, materials management and rehabilitation prescriptions will be prepared and implemented • Post-closure landforms will be planned and constructed so that their shape, size, soil profiles, ability to support native vegetation and response to surface water flows are safe, stable and comparable to natural landforms in the area **Implement the following additional Proposal specific controls:** • Solar drying cells will be constructed instead of a tailings dam to dry out tailings. This will reduce the impact on existing landforms • Pits will be backfilled with waste rock instead of developing a waste rock dump. This will reduce the impact on existing landforms • Mine pits will be developed progressively in incremental areas and will use surface mining methods so that mining will result in low waste rock volumes being produced. This will reduce the impact on existing landforms.	• Ministerial Statement (future) • Mining areas and rehabilitation plan identified in a Mining Proposal and Mine Closure Plan to be approved under the Mining Act.	• Land systems and ecological functions are not unique on a local or regional scale • The nature of the orebody results in shallow mine pits (generally less that 20 m deep) that are above the water table • Mine plan results in a low strip ratio for waste rock. Mine pits have been designed to minimise the area of disturbance and will be backfilled with waste rock and rehabilitated. This minimises the impact on landforms and the ecological function of the soils • The area to be mined is the surface of a broad and extensive, undulating plateau. The rehabilitated mine pits will create additional landform diversity • The Proposal can meet the EPA objective.

Factor - EPA Objective	Relevant Existing Environment	Environmental Aspect	Potentially Significant Impact (without mitigation)	Management Actions (Mitigation)	Regulation	Predicted Outcomes (Meets EPA Objective – Y/N)
Hydrological Processes - To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.	• Plateau areas have insignificant drainage features • The most significant drainage feature is the valleys that host minor drainage lines which contain unnamed minor ephemeral creeks • Outside of the MPA, water from the unnamed minor ephemeral creek directs water south of the MPA into the Yandicoogina Creek • Surface flows in the MPA are typically intermittent and of short duration • Groundwater is fresh at depths typically 30 to 40 m beneath surface • No Groundwater Dependent Ecosystems identified in the MPA • No significant groundwater users known in the area.	• Ground disturbance – clearing of approximately 530 ha of native vegetation • Development of three pits and associated mining infrastructure • Road construction, including creek and river crossings • Abstraction of up to 0.5 GL/yr of groundwater for water supply • No pit dewatering required – all mining above the water table.	• Alterations to surface water flows, causing flooding, diversions, erosion and/or changes in surface water quality downstream • Changes to run-off and flow velocity caused by mining activity and roads • Impacts on surface water reliant fauna and flora habitat • Reduction of groundwater availability.	**Implement the following industry standard controls:** • Install environmental or engineering culverts where natural drainage features are interrupted by the development • Divert surface water flows to maintain natural drainage patterns, where practicable • Mine pits will be bunded to prevent inflow of surface water from areas upstream of the mine pits. Water collecting within the pit will be allowed to infiltrate or evaporate • Undertake progressive rehabilitation of disturbed areas that are not required for ongoing operations • Drill and abstract groundwater in accordance with 26D and 5C licences administered by the Department of Water.	• Ministerial Statement (future) • EP Act Part V (authorised clearing) and Environmental Protection (Clearing of Native Vegetation) Regulations 2004 or S45c of EP Act – able to address any future additional clearing outside of boundaries authorised under Part IV of the EP Act • Mining processes, drainage and water management controls identified in a Mining Proposal to be approved under the Mining Act • Groundwater extraction operated under licence (*Rights in Water and Irrigation Act* 1912 (RIWI Act)).	• Vegetation clearing and rehabilitation will be progressive • Industry standard controls for surface water management will be implemented to minimise the potential for surface water impacts such as erosion and flooding • Groundwater impacts avoided and minimised with no mine dewatering and no tailings dam • Groundwater will be managed under the RIWI Act • This factor can be managed using industry standard management controls and existing legislation. This will ensure that the Proposal will effectively meet the EPA objective.
Terrestrial Environmental Quality - To maintain the quality of land and soils so that the environment values, both ecological and social, are protected.	• The majority of the MPA is relatively undisturbed with some evidence of grazing and mineral exploration • No areas of potential contamination are located in proximity to the MPA • Land and soils support vegetation and fauna habitat that extends well beyond the MPA and is extensive within the Pilbara • Geology and soils are leached and not enriched in elements of environmental concern.	• Disturbance of rock and soils • General domestic waste (e.g. paper, cardboards, some plastics and food scraps) • Industrial wastes (e.g. pallets, packaging, scrap metals and tyres) • Hazardous wastes (e.g. hydrocarbons and contaminated material) • Hydrocarbon or chemical spills.	• Localised contamination of soil, groundwater or surface water and subsequent impacts on surrounding ecosystems • Creation of hazards for native fauna and personnel • Attraction of feral animals that may impact upon native fauna.	**Implement the following industry standard controls:** • Waste will be segregated and either removed from site via an authorised waste contractor or disposed of onsite to a landfill licensed under Part V of the EP Act • Hydrocarbons and chemicals bunded and stored in accordance with Dangerous Goods Safety (Storage and Handling for Non-explosives) Regulations 2007 and AS1940: Storage and Handling of Flammable and Combustible Liquids • Re-fuelling bays at bulk fuel storage facilities equipped with concrete aprons or suitable lining (e.g. heavy duty plastic) • Spill clean-up material readily available at work sites and on mobile service trucks of vehicles, where hydrocarbons and chemicals are stored and/or used • A spill response procedure will be developed and implemented prior to construction.	• *Dangerous Goods Safety Act 2004* (storage of hazardous materials) • Dangerous Goods Safety (Storage and Handling for Non-explosives) Regulations 2007 • Part V EP Act (Approval and Licence for landfill) • General provisions of the EP Act.	• The potential for impacts on this factor are relatively low and can be appropriately managed via existing legislation. The Proposal therefore can meet the EPA objective.
Inland Waters Environmental Quality - To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.	• Plateau areas have insignificant drainage features • The most significant drainage feature is the valleys that host minor drainage lines which contain unnamed minor ephemeral creeks • Outside of the MPA, water from the unnamed minor ephemeral creek directs water south of the study area into the Yandicoogina Creek • Surface flows in the MPA are typically intermittent and of short duration • Groundwater is fresh at depths typically 30 to 40 m beneath surface • No Groundwater Dependent Ecosystems identified in the study area • No significant groundwater users known in the area.	• Generation of waste on site (as described in Terrestrial Environmental Quality Section) • Hydrocarbon or chemical spills • Surface water runoff from cleared areas • Alteration of surface water flows.	• Increased turbidity due to erosion caused by reduced vegetation cover or alteration of surface water flow paths • Groundwater or surface water contamination via waste or hydrocarbon / chemical spills.	**Implement the following industry standard controls:** • Manage waste and hydrocarbon / chemical spills as per management actions listed in the factor 'Terrestrial Environmental Quality' • Manage surface water flows in accordance with the management actions listed in the factor 'Hydrological Processes'.	• *Dangerous Goods Safety Act 2004* (Storage of hazardous materials) • Dangerous Goods Safety (Storage and Handling for Non-explosives) Regulations 2007 • Part V EP Act (Approval and Licence for landfill) • General provisions of the EP Act.	• The potential for impacts on this factor are relatively low and can be appropriately managed via existing legislation. The Proposal therefore can meet the EPA objective.

Factor - EPA Objective	Relevant Existing Environment	Environmental Aspect	Potentially Significant Impact (without mitigation)	Management Actions (Mitigation)	Regulation	Predicted Outcomes (Meets EPA Objective – Y/N)
Air Quality - To maintain air quality for the protection of the environment and human health and amenity.	• The MPA is located in a remote area with the nearest sensitive receptor being the BHP Yandi mining camp (6 km East of the MPA) • Mining activities are currently prevalent in the area • No significant sources of air pollution are in proximity to the Proposal.	• Dust generated from surface mining operations • Dust lift from bare ground / cleared areas • Construction and operational activities such as the mechanical disturbance of rock and soil, and use of vehicles on unsealed roads • Use of machinery, gensets and light and heavy vehicles.	• Increased levels of airborne dust • Minor point source air emissions from vehicle and genset exhausts.	**Implement the following industry standard controls:** • Vegetation clearing will be progressive, and areas not required for operations will be rehabilitated at the completion of the construction period • Dust suppression will occur in areas that have high potential to generate dust, such as surface mining operational areas, areas that receive heavy traffic and key construction areas • Vehicle speeds will be restricted • The performance of dust suppression equipment will be monitored by regular site inspections • Where practicable and cost effective, dust suppressants may be used to reduce the volume of water required to effectively minimise dust generation.	• Occupational Safety Regulations 1996 • General provisions of the EP Act.	• The potential for impacts on this factor are relatively low, with dust being the main emission. No sensitive receptors are in close proximity to the Proposal Area. The Proposal therefore can meet the EPA objective.
Amenity - To ensure that impacts to amenity are reduced as low as reasonably practicable.	• The BHP Yandi mining camp is located approx. 6 km East of the MPA • The Proposal Area is not used by the public • There are no public facilities in proximity to the MPA.	• Earthmoving activities • Vehicle movements • General construction and operation activities / traffic • Use of machinery.	• Direct impacts such as noise and vibration to sensitive receptors • Direct impact to personnel • Public access will be limited within the mining operational areas.	**Implement the following industry standard controls:** • No blasting is proposed for mining operations • Equipment used will be maintained in accordance with manufacturers' specifications and relevant standards • Vehicle speeds within the MPA will be restricted • Internal combustion engines fitted with a suitable muffler in serviceable condition.	• Environmental Protection (Noise) Regulations 1997 • General provisions of the EP Act.	• The potential for impacts on this factor are relatively low given the remote location, and can be appropriately managed via existing legislation. The Proposal therefore can meet the EPA objective.
Heritage - To ensure that historical and cultural associations are not adversely affected.	• Aboriginal Heritage surveys have been completed for the MPA in accordance with the *Aboriginal Heritage Act 1972* • The MPA has been archaeologically cleared subject to conditions • No European Heritage sites are located within the Proposal Area.	• General ground disturbance	• Disturbance of Aboriginal Heritage sites.	**Implement the following industry standard controls:** • Conditions imposed as a result of heritage surveys will be complied with • Heritage surveys will be completed for the remainder of the unsurveyed areas in accordance with the Aboriginal Heritage Act • Aboriginal sites will not be disturbed without authorisation • All aspects of the Proposal will be carried out in accordance with EPA Guidance Statement No. 41 (EPA 2004b) through the implementation of a Cultural Heritage Management Plan and relevant agreements with native title claimant groups, thereby avoiding impact to Aboriginal sites of significance • Ground disturbance will be subjected to an internal ground disturbance approval process • Section 18 process will be undertaken if sites are required to be disturbed.	• *Aboriginal Heritage Act 1972* • *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* • *Native Title Act 1993.*	• AAMC is well aware of their responsibilities under the *Aboriginal Heritage Act 1972* and Native Title Agreement. The potential for impacts on this factor can be appropriately managed via existing legislation. The Proposal therefore can meet the EPA objective.
Human Health - To ensure that human health is not adversely affected.	No risk to human health is anticipated. Noise and vibration is covered in the Amenity section.					
Rehabilitation and Closure - To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner,	• The majority of the area surrounding the Proposal is currently unallocated crown land, with some areas used for pastoral activities and mineral exploration • The Proposal Area is in close proximity to existing operating mines • Topsoil layer is shallow and vegetation in existing condition is sparse.	• Ongoing use of / responsibility for infrastructure • Hydrocarbon / chemical storage areas • Disturbance areas	• Hydrocarbon contamination • Alteration of landforms impacting surface water flow • Increased erosion associated with unstable landforms	• Topsoil will be stripped and stored onsite for rehabilitation • Management procedures for the recovery, storage and utilisation of topsoil will be developed and implemented • Topsoil is to be stored for the shortest time period possible to maintain viability of the seed bank and soil fertility	• Ministerial Statement (future) to include requirement for rehabilitation of areas not required for operations • Mining areas and rehabilitation plan identified in a Mining	• Any areas not required during operations will be progressively backfilled, landformed and rehabilitated • Post-closure landforms to be safe, stable and comparable to natural

Factor - EPA Objective	Relevant Existing Environment	Environmental Aspect	Potentially Significant Impact (without mitigation)	Management Actions (Mitigation)	Regulation	Predicted Outcomes (Meets EPA Objective – Y/N)
consistent with agreed outcomes and land uses, and without unacceptable liability to the State.		• Mine pit excavations • Inadequate rehabilitation and closure planning.	• Rehabilitation not suitable as fauna habitat • The spread of weeds and increased dust.	• Any areas cleared for construction purposes that are not required during operations (borrow pits, access tracks etc.) will be rehabilitated • A Rehabilitation Procedure will be developed for the Proposal in accordance with EPA Guidance Statement No. 6 Rehabilitation of Terrestrial Ecosystems (EPA 2006), which sets out the general expectations about re-establishing biodiversity values where a site is to be rehabilitated back to native vegetation • Rehabilitation plans detailing landforms, materials management and rehabilitation prescriptions will be prepared and implemented. • Comply with the requirements of the Contaminated Sites Act 2003 if contamination occurs • Soil stockpiles will be inspected for evidence of erosion and weeds and remediated accordingly.	Proposal and Mine Closure Plan to be approved under the *Mining Act 1978* • *Contaminated Sites Act 2003* will manage any potential contamination.	landforms in the area • Backfilling, landforming and rehabilitation of disturbed areas using industry standard management actions is able to achieve a safe and stable landform. Timely application of topsoil, earthworks and native vegetation seed can re-establish vegetation suitable as fauna habitat. The Proposal therefore can meet the EPA objective.
Offsets - To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.	• No TF or species of national conservation significance recorded in the MPA • One Priority 1 and one Priority 3 flora species recorded in the MPA • Condition of vegetation in MPA ranges from very good to excellent • No TEC's or PEC's within the MPA • No ESAs, wetlands, permanent water courses or conservation reserves within the MPA • All fauna habitats in the MPA have the potential to support a limited number fauna of conservation significance but are widespread locally and regionally • Survey work to be completed on access road.	• Ground disturbance – clearing of approximately 530 ha of native vegetation • Earthmoving and construction / operation activities.	• Direct loss of vegetation • Direct loss of fauna habitat • Indirect impacts through a range of mechanisms • Transfer of existing weeds and introduction of new weed species during construction and operation.	• The Proposal designed to avoid and minimise serious or irreversible damage to the environment • Offset to be applied to clearing of native vegetation in very good to excellent condition • Implement an Offset Plan for the Proposal in liaison with the OEPA, Department of Environment Regulation (DER) and Department of the Environment (DotE) • Survey work to be completed on access road • Prepare infrastructure plan that shows the location of conservation significant features and demonstrates how impacts are avoided or minimised where practicable.	• Ministerial Statement (future) • Mining areas and rehabilitation plan identified in a Mining Proposal and Mine Closure Plan to be approved under the *Mining Act 1978* • WA Environmental Offsets Policy (2011) • WA Environmental Offsets Guidelines (2014).	• Recent application of offsets policy enables offset process to be simplified • Offsets are proposed which will ensure that the Proposal will effectively meet the EPA objective.

7 PRINCIPLES OF ENVIRONMENTAL PROTECTION ACT

The EP Act identifies a series of principles for environmental management (Section 4a, EP Act, as amended). AAMC has considered these principles in relation to the development and implementation of the Proposal. Table 7 outlines how the principles relate to the Proposal.

Table 7: EP Act Principles

Principle	How it will be addressed by the Proposal
1. Precautionary principle Where there are threats of serious irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: a. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and b. an assessment of the risk-weighted consequences of various options.	The Proposal setting and scale is such that serious irreversible damage to the environment is unlikely. The Proposal has considered existing regional and local environmental data and site specific survey data in design. Where detailed route selection has not been completed, the Proposal commits to a process to complete survey work, and avoid and minimise potential impacts. The Proposal provides and evaluation of steps taken to avoid, minimise and offset impacts to date in Section 5.
2. Intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The Proposal can be implemented without significant impacts on the health, diversity and productivity of the environment. The Proposal will enable economic and social benefits to flow from the Proposal including increased Indigenous participation in mining. Mine closure and rehabilitation will enable post-mining land use consistent with the surroundings.
3. Conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integration should be a fundamental consideration	The existing baseline data from the MPA and surrounding region indicate that there are not likely to be significant biodiversity or ecological integrity impacts at local or regional scales.
4. Improved valuation, pricing and incentive mechanisms a. Environmental factors should be included in the valuation of assets and services b. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. c. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste d. Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which benefit and/or minimise costs to develop their own solutions and responses to environmental problems	An evaluation of the preliminary key environmental factors is presented in Section 5. The costs of all pollution and waste management, and site rehabilitation are incorporated into the feasibility investigations for the Proposal and hence the cost of the product. Environmental management costs have been considered in the Proposal costing phases and this will continue through the Bankable Feasibility Study stage.
5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment	Waste will be minimised by adopting the hierarchy of controls; Avoid, Minimise, Re-use, Recycle and Safe Disposal.

8 CONCLUSION

AAMC is proposing to develop the Extension Mining Project (the Proposal) which seeks to mine iron ore from the superficial CID found above the water table. The Proposal is located approximately 70 kilometres (km) north-west of Newman in the Pilbara region of Western Australia (WA). The Proposal will result in the production of approximately 2-4 Mtpa of iron ore. Some or all of the ore may be upgraded through a beneficiation process with solar cells used to consolidate tailings. Waste rock and tailings are to be placed inside the mine pits. The Proposal requires supporting infrastructure including an access road (two options), internal roads, accommodation camp, ore crushing and processing plant with associated conveyors and stockyard, solar drying cells, ROM pad, water supply system, contingency for explosives storage and other supporting infrastructure.

Information gathered from biological surveys completed by Phoenix in 2014 have been considered in relation to Proposal design and have been used to determine key and other environmental factors consistent with *Environmental Assessment Guideline 8: for Environmental Factors and Objectives* (EPA 2013a). Those that were deemed to be potentially impacted by the Proposal were classed as ‘preliminary key environmental factors’. The factors that were either not expected to be significantly impacted or can be suitably managed using existing legislation were classed as ‘other environmental factors’.

Environmental Impact Assessment has been completed on the following preliminary key environmental factors:

- Flora and vegetation – to address the potential impacts resulting from the direct or indirect loss of flora and vegetation; and
- Subterranean Fauna – to address the potential impacts resulting from the direct or indirect loss of subterranean fauna habitat.

A series of management actions have been proposed to ensure that potential environmental impacts to key and other factors are controlled so as to meet the EPA Objectives. Based on the Proposal design and the information gathered during environmental studies, the Proposal is not expected to cause significant environmental impacts and the potential impacts identified are able to be effectively managed within existing condition setting frameworks and other legislation.

AAMC has identified and consulted with key stakeholders in preparing the Proposal concept and Proposal. AAMC will continue to progress stakeholder consultation as the Proposal proceeds into detailed design, construction and operational phases.

The key and other environmental factors have been assessed against EPA Objectives and relevant guidelines. The Proposal has been prepared with design, layout and management controls identified to avoid, minimise or manage the potential environmental impacts using both industry standard and Proposal specific controls. Given the configuration of the Proposal to avoid significant impacts, location in relation to significant environmental assets and values, and the management actions and controls to protect the environment, the Proposal is expected to meet the EPA Objectives.

9 GLOSSARY

Term	Meaning
AH Act	*Aboriginal Heritage Act 1972*
API	Assessment on Proponent Information – the level of assessment relevant to this Proposal
DG Act	*Dangerous Goods Act 2004* (WA)
DAA	Department of Aboriginal Affairs
Disturbance Envelope	The envelope within which disturbance associated with the Proposal will occur. The envelope provides the spatial extent to enable detailed engineering and construction some flexibility to implement the Proposal
Disturbance Area	The actual area of disturbance required to implement the Proposal. The Disturbance Area will be within the Disturbance Envelope
DMP	Department of Mines and Petroleum
DoW	Department of Water
DSD	Department of State Development
EAG1	Environmental Assessment Guideline 1: Defining the key characteristics of a proposal
EAG6	Environmental Assessment Guideline 6: Timelines for Environmental Impact Assessment of Proposals
EIA	Environmental Impact Assessment
EMPs	Environmental Management Plans
EPA	Environmental Protection Authority (WA)
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ha	Hectare
km	Kilometres
m	Metres
Mtpa	Million tonnes per annum
MW	Megawatt
OEPA	Office of the Environmental Protection Authority of Western Australia
PEC	Priority Ecological Communities – plant communities listed as being potentially threatened under the *Wildlife Conservation Act 1950*
The Project	The Extension Project
Proposal	As defined under the EP Act - a project, plan, programme, policy, operation, undertaking or development or change in land use, or amendment of any of the foregoing, but does not include scheme.
The Proposal	Australian Aboriginal Mining Corporation Limited (AAMC) is proposing to develop the Extension Mining Project (the Proposal) which seeks to mine iron ore from the superficial Channel Iron Deposits found above the water table. The Proposal is located approximately 70 kilometres (km) north-west of Newman in the Pilbara region of Western Australia. The Proposal will result in the production of approximately 2-4 Mtpa of iron ore.
Proposal Area	The area that forms the basis for the Proposal. It is effectively the area within which baseline environmental data was acquired.
SRE	Short-range Endemic species
TEC	Threatened Ecological Communities – plant communities listed as being threatened and legally protected under the *Wildlife Conservation Act 1950*

Term	Meaning
TTS	Temporary Threshold Shift – the effect of sudden or cumulative noise exposure, causing temporary loss of hearing sensitivity
UCL	Unallocated Crown Land
WA	Western Australia
WC Act	*Wildlife Conservation Act 1950* (WA)

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11 APPENDICES

The following Appendices are provided on the attached CD:

Appendix 1: Proposal Area Shapefiles
Appendix 2: Biological Reports and Surveys

Flora and fauna desktop review for the Extension Project and Bulk Sample

Prepared for Maiden Iron Pty Ltd

March 2014

Final Report

Flora and fauna desktop review for the Extension Project and Bulk Sample

Prepared for Maiden Iron Pty Ltd

Final Report

Author/s: J. Clark, E. Volschenk, N. Dight, B. Sadlo

Reviewer/s: V. Framenau, K. Crews

Date: 27 March 2014

Submitted to: Phil Scott (Preston Consulting on behalf of Maiden Iron Ltd)

Chain of authorship and review			
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J. Clark	Draft for technical review	0.1	5 February 2014
M. White	Editorial review	0.2	19 February 2014
V. Framenau	Technical review	0.4	6 March 2014
K. Crews	Draft for client comments	0.3	7 March 2014
P. Scott	Client comments	0.4	20 March 2014
K. Crews	Final submitted to client	1.0	27 March 2014

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Project code: 1041-MN-MI-ECO

Contents

List of Figures

List of Tables

List of Appendices

EXECUTIVE SUMMARY

Maiden Iron Pty Ltd is seeking to obtain environmental approvals for the development of a small scale operation to mine and transport a Bulk Sample of approximately 130,000 t of haematite ore (Bulk Sample), and subsequently develop a small scale (1-2 Mtpa) mining operation on an area formerly known as the Marillana North Project, currently called the Extension Project (the Project). The Project is located in the Hamersley Ranges approximately 130 km northwest of Newman, Western Australia.

In January 2014, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned to undertake the first phase of biological investigation for the Extension Project - a flora and fauna desktop review. The scope of the desktop review included flora and vegetation, vertebrate fauna, terrestrial short-range endemic (SRE) invertebrate fauna and troglofauna. Methods entailed:

- a review of existing environmental information relevant to the biological values of the study area including base environmental datasets, searches of relevant biological databases and literature review of available technical reports from projects adjacent to the study area, or within the area of the desktop review
- assessment and mapping of broad-scale vegetation/fauna habitats
- assessment of 'likelihood of occurrence' of listed species and communities.

The study area for the desktop review focused on approximately 47 ha that represents the area within which the Bulk Sample operations will be conducted. The proposed disturbance footprint for the Bulk Sample is approximately 17 ha with a proposed pit area of approximately 2 ha.

The Extension Mining operations will be conducted on the four granted Mining Leases (M47/1353-1356), on landforms and geology similar to the focus area of the Bulk Sample. Thus the information presented in this review is considered generally applicable to the broader area of the Mining Leases, although likelihood of occurrence assessments for listed species and communities have specifically considered the Bulk Sample area.

The desktop review is not only intended to inform environmental management for the Bulk Sample and subsequent Extension Mining operations, but to guide the planning for field investigations to gather baseline environmental data for support planning, approvals and management of the Extension Mining operations.

FLORA AND VEGETATION

Key findings of the desktop review in relation to flora and vegetation were:

- no threatened ecological communities or priority ecological communities are considered likely to occur
- no Threatened flora species are considered likely to occur
- 13 Priority flora species were assessed as possibly occurring including one P1 species (*Euphorbia inappendiculata* var. *queenslandica*), three P2 species (*Isotropis parviflora*, *Vigna* sp. central (M.E. Trudgen 1626), *Euphorbia inappendiculata* var. *inappendiculata*), seven P3 species (*Acacia subtiliformis*, *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727), *Gymnanthera cunninghamii*, *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479), *Rostellularia adscendens* var. *latifolia*, *Sida sp.* Barlee Range (S. van Leeuwen 1642), *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)) and two P4 flora species (*Goodenia nuda*, *Rhynchosia bungarensis*)

- the vegetation of the study area is classified as 'Least Concern' in terms of extent of vegetation remaining within the Hamersley subregion (PIL 3) compared to pre-European extents
- there are no wetlands or conservation areas managed by DPaW in the study area and none that are in close proximity that could be directly or indirectly impacted by the proposed clearing of native vegetation.
- no Environmentally Sensitive Areas (ESAs) or named watercourses are located within or in close proximity to the study area.

FAUNA

Key findings of the desktop review in relation to fauna were:

- the study area is largely homogenous in terms of fauna habitat, represented mostly by spinifex grassland on plateau of gently rolling hills, intersected by very small extents of minor drainage line, minor creek line and mixed shrubland; there are no distinguishing features that suggest any isolated or rare habitats are present that may be critical for listed vertebrate species.
- two Threatened vertebrate species were assessed as potentially occurring, Grey Falcon and Orange Leaf-nosed Bat
- three Priority vertebrate species were assessed as potentially occurring, Australian Bustard, Western Pebble-mound Mouse, Ghost Bat
- three other listed species were assessed as potentially occurring, including Fork-tailed Swift and Rainbow Bee-eater, both migratory and the Peregrine Falcon, Schedule 3 under the WC Act
- a further seven listed vertebrate species identified as occurring in the area of the desktop review are considered unlikely to occur in the study area due to lack of suitable habitat
- none of the potentially occurring listed vertebrate species are likely to be highly dependent on the habitats of the study area
- the Bulk Sample area avoids major prospective features that provide typical habitat for SRE taxa
- database searches identified 21 terrestrial invertebrate fauna taxa with potentially restricted ranges that have been recorded in the habitat types that are present within the study area; however, based on the small size of the Bulk Sample area, few of these may occur there and all these taxa are from habitat that is well-represented in the region
- the Bulk Sample is entirely encompassed by one of two Hematite-geothite deposits (Czr1) within the study area; this geology type is known to support troglofauna
- a single troglobitic schizomid record, *Draculoides* sp. (WAM database no. T119498) was identified from within the study area in the Czr1 deposit. Assuming that Czr1 represents the smallest potential troglofauna habitat unit for this species, the Bulk Sample represents 0.8% of the surface area of the Czr1 outcropping within which it falls; therefore the potential for impacts is considered to be negligible.

Potential impacts to the greater population of any listed flora or terrestrial fauna present in the study area is expected to be low to negligible due to the very small proposed disturbance footprint of the Bulk Sample.

1 INTRODUCTION

In January 2014 Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Maiden Iron Pty Ltd (Maiden Iron) to undertake a flora and fauna desktop review Extension Project (the Project) and Bulk Sample (Bulk Sample). This report presents the results of that review.

1.1 PROJECT OVERVIEW

The Extension Project is located in the Hamersley Ranges in the Central Pilbara region of Western Australia, approximately 130 km northwest of Newman (Figure 1-1). It includes four mining leases (M47/1353, M47/1354, M47/1355, M47/1356) containing the 'Extension' deposit, a superficial channel iron deposit (CID; Figure 1-2).

Maiden Iron is seeking to develop the Project in a staged manner, commencing with a small scale Bulk Sample of approximately 130,000 t of haematite ore to confirm product characteristics and marketability. Assuming satisfactory results from that stage, the second stage would see the development of a small scale mining operation on the Extension deposit.

Initial approvals are being sought under the *Environmental Protection Act 1986* and the *Mining Act 1978* (Mining Act) to mine and transport the Bulk Sample. This desktop review has been prepared to support the planning, approvals (small Mining Proposal) for the Bulk Sample and Extension Project. It will also be used to guide the development of the field work programme to secure baseline environmental data for the Extension Project.

The Bulk Sample will be secured from surface to no more than 10 m depth over an area of approximately 100 x 200 m. Neither the Bulk Sample nor the Extension Mining Project will involve mining below water table or dewatering. The proposed Bulk Sample operation includes a single mine pit, ore handling plant, haul road, stockpiles and mobile camp (Figure 1-2). The proposed disturbance footprint is approximately 17 ha, with a proposed pit area of approximately 2 ha. Detailed planning of mining and infrastructure for the Extension mining project has not yet commenced.

The focus area for the Bulk Sample is approximately 47 ha. The Extension tenements are surrounded by a number of projects which have been extensively surveyed for flora and fauna in the last ten years (Figure 1-2). Considerable biological information therefore exists and was drawn upon for this review.

1.2 OBJECTIVES AND SCOPE OF WORK

The objective of the desktop review was to define the potential flora and fauna values of the study area to support planning and appovals for the Bulk Sample and Extension Project.

Accordingly, the scope of work comprised:

- desktop review to define the potential flora and vegetation values of the study area
- desktop review to define the potential vertebrate fauna values of the study area
- desktop review to define potential terrestrial terrestrial short-range endemic (SRE) fauna values of the study area

- desktop review to assess the potential for troglofauna[1] to be present in the study area
- risk-based impact assessment to consider the potential impacts of the Bulk Sample on any listed flora, vegetation or fauna
- compilation of all desktop reviews and impact assessment into a single technical report.

[1] stygofauna were not included in the scope as the project is above water table and very small scale, therefore significant impacts to stygofauna are highly unlikely to occur.

Figure 1–1 Location of the Extension Project and Bulk Sample and adjacent projects

Operating mines

Pilbara Biological Survey sites

Railways

Principal and secondary roads

Minor road

Major creeks and rivers

National Parks and Nature Reserves

0 10 20 40 Kilometres

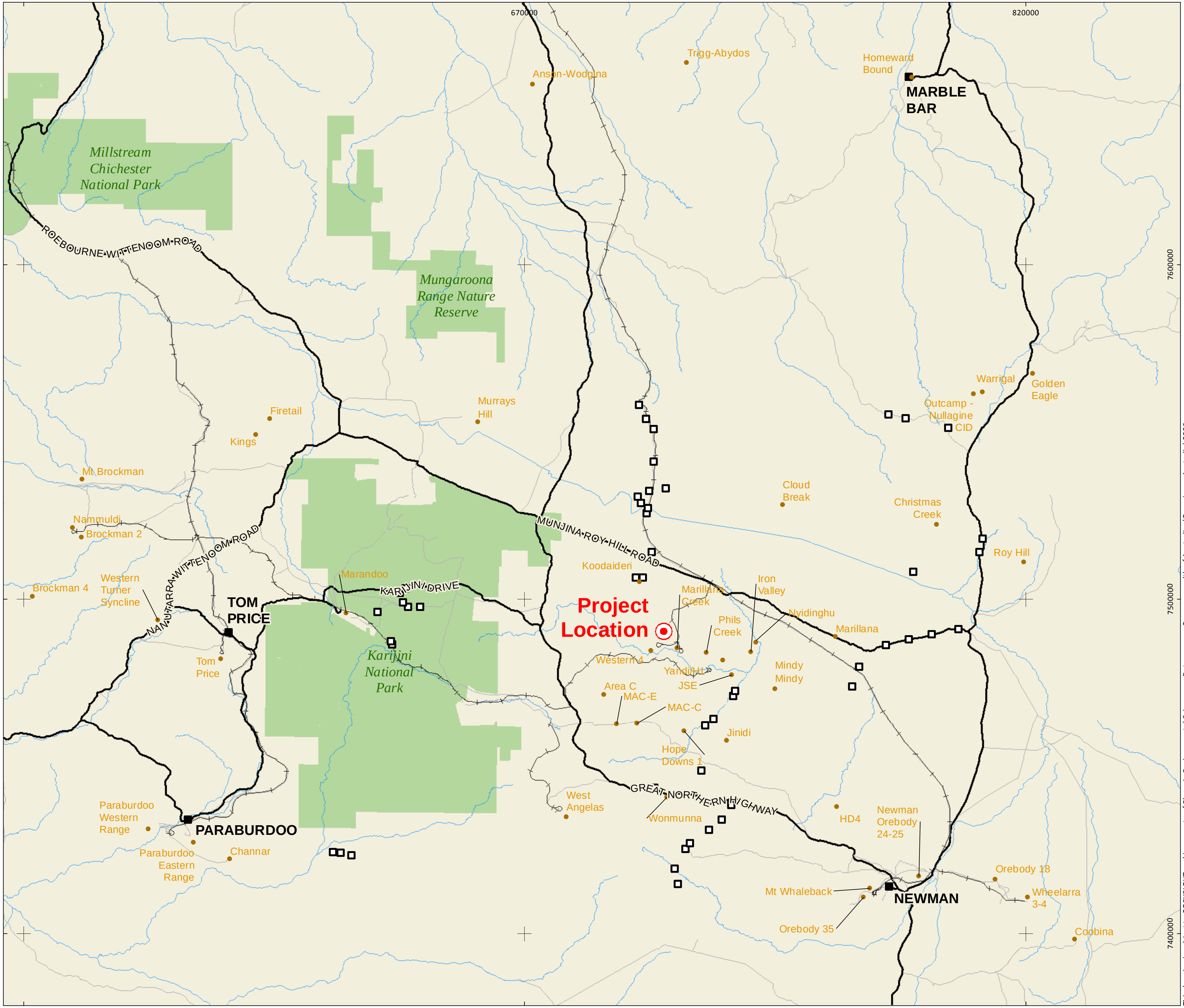
1:1,500,000

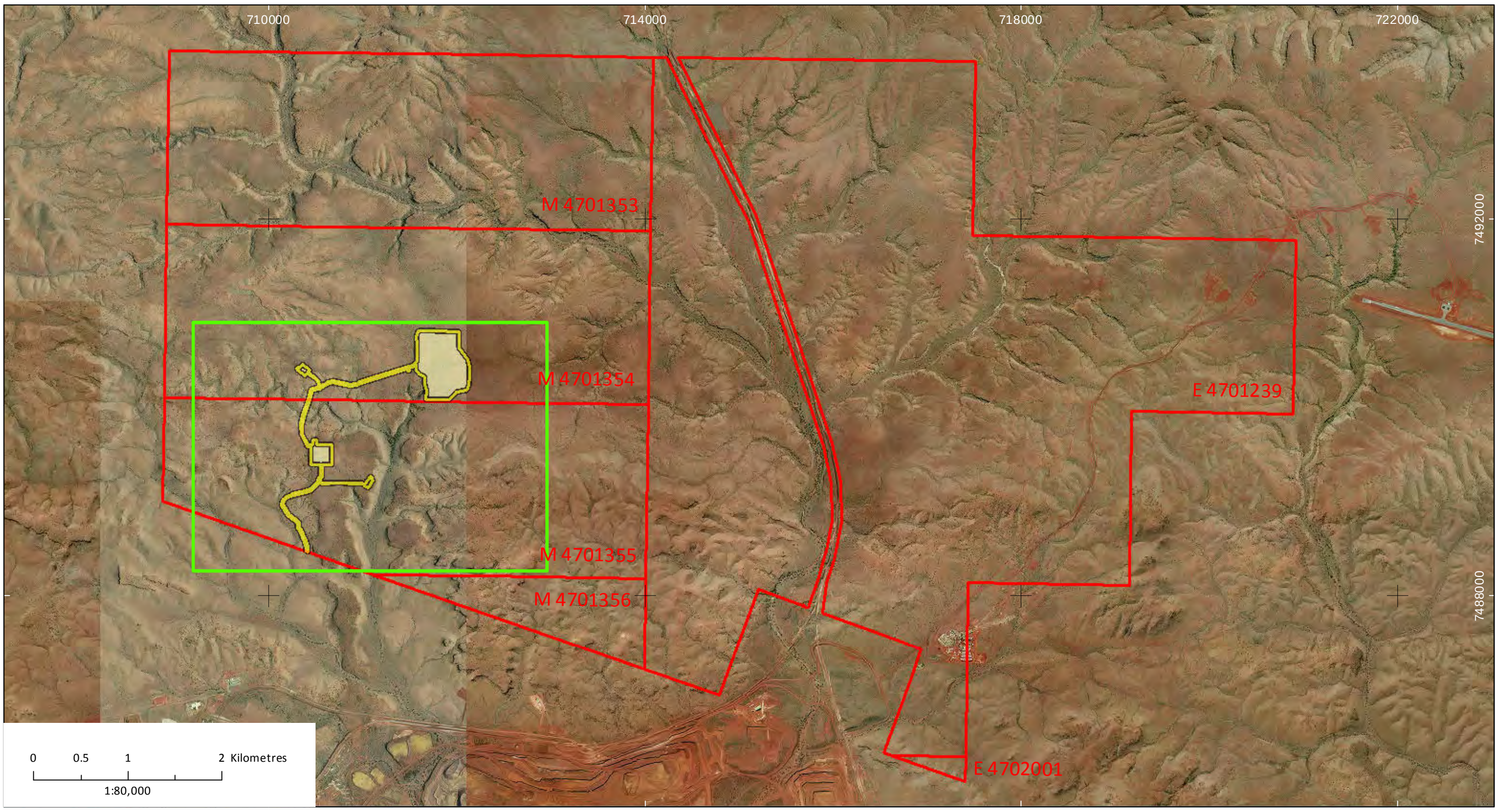
Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

PHOENIX
ENVIRONMENTAL SCIENCES





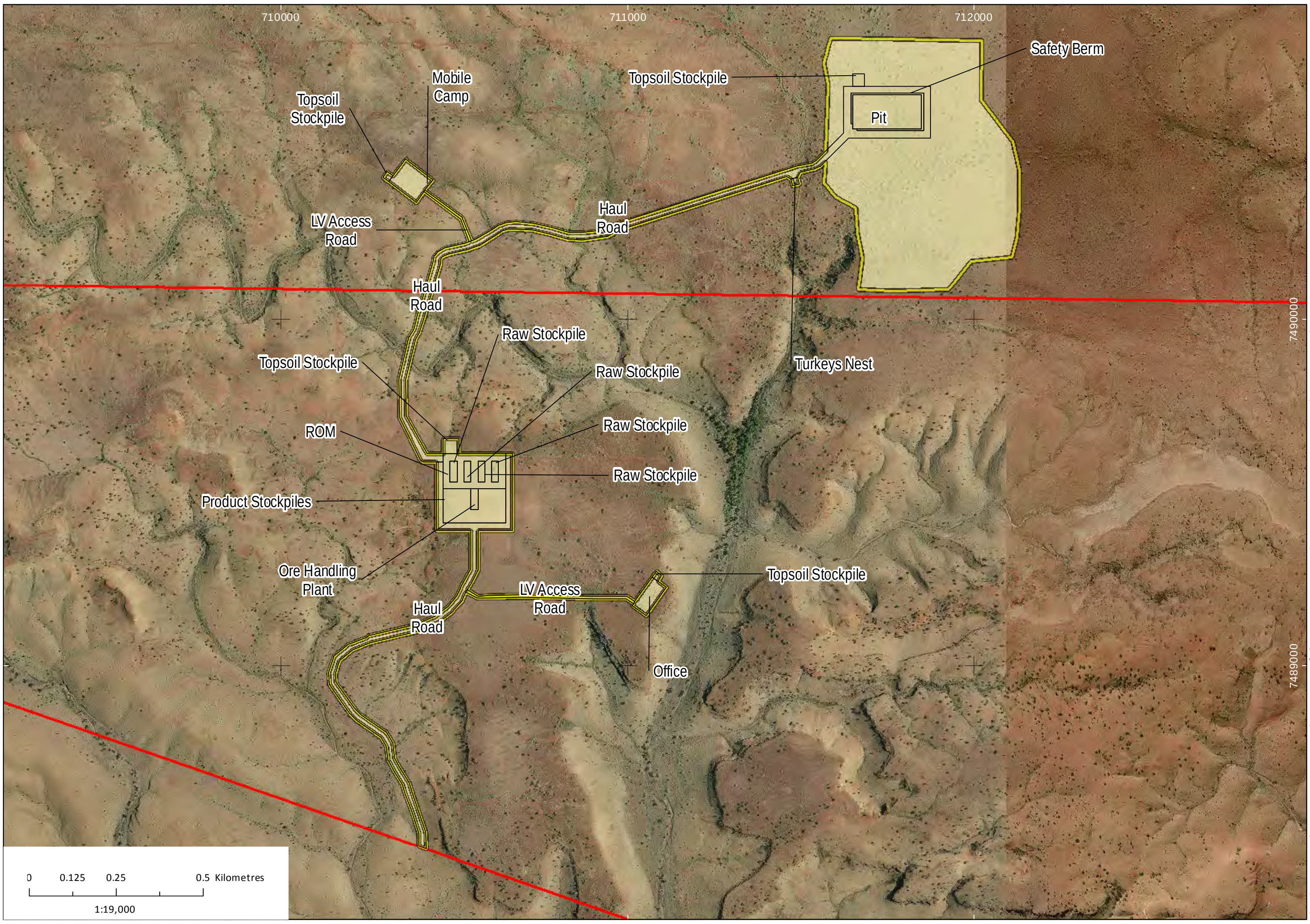


Figure 1–2
Desktop review area and Bulk Sample layout (as at 24/02/2014) for the Bulk Sample

PHOENIX
ENVIRONMENTAL SCIENCES

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

Study area
Tenement
Conceptual mine layout (as at 24/02/2014)

1.3 LEGISLATIVE CONTEXT

The protection of flora and fauna in Western Australia is principally governed by three acts:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Wildlife Conservation Act 1950* (WC Act)
- *Environmental Protection Act 1986* (EP Act).

1.3.1 Commonwealth

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (NES), require approval from the Australian Government Minister for the Environment. The EPBC Act provides for the listing of threatened native flora, fauna and threatened ecological communities (TECs) as matters of NES.

Conservation categories applicable to threatened flora and fauna species under the EPBC Act are as follows:

- Extinct (EX)[2] – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent[2] – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (1997). There are three categories under which ecological communities can be listed as TECs under the EPBC Act: Critically Endangered, Endangered and Vulnerable.

The EPBC Act is also the enabling legislation for protection of migratory species (Mig.) under a number of international agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn)
- Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds (ROKAMBA).

[2] Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

1.3.2 State

1.3.2.1 Threatened and Priority species and communities

In Western Australia, the WC Act provides for the listing of native flora (Threatened Flora) and fauna (Threatened Fauna) species which are under identifiable threat of extinction. Threatened Flora listed under the WC Act receive statutory protection but they are also assigned to one of three categories: Critically Endangered (CR), Endangered (EN) or Vulnerable (VU), which dictates resource allocation priorities for conservation and recovery actions.

Threatened Fauna are assigned to one of four categories under the WC Act: Schedule 1 (fauna that is rare or is likely to become extinct), Schedule 2 (fauna presumed to be extinct), Schedule 3 (Migratory birds protected under an international agreement) and Schedule 4 (other specially protected fauna). Assessments for listing of both flora and fauna are based on the International Union for Conservation of Nature (IUCN) threat categories.

The Department of Parks and Wildlife (DPaW) administers the WC Act and also maintains a non-statutory list of Priority fauna and flora species (updated each year). Priority species are still considered to be of conservation significance – that is they may be rare or threatened – but cannot be considered for listing under the WC Act until there is adequate understanding of their threat levels. Species on the Priority flora and Priority fauna lists are assigned to one of five priority (P) categories, P1 (highest) – P5 (lowest), based on level of knowledge/concern.

The Minister for Environment may also list ecological communities which are at risk of becoming destroyed as 'threatened'. DPaW maintains a list of ministerially-endorsed TECs as well as a non-statutory list of Priority Ecological Communities (PECs) which are also assigned to one of five categories.

Any activities that are deemed to have a significant impact on listed flora or fauna species can trigger referral to the EPA for assessment under the EP Act. The EPA's position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment (EPA 2006).

1.3.2.2 Locally or regionally significant flora and vegetation

Flora species, sub-species, varieties, hybrids and ecotypes may be significant for a variety of other reasons than being listed as Threatened or Priority flora, including where they have keystone roles for threatened species, are representative of the range limit of a species, are locally endemic, are poorly reserved or display anomalous features that indicate a potential new discovery (EPA 2004a).

Native vegetation communities may be considered significant for a range of reasons other than a statutory listing as a TEC, including where they have restricted distributions (i.e. to one or two locations or as isolated communities, or are below threshold levels), exhibit unusually high structural and species diversity, are limited to specific landform types, are determined to be uncommon or restricted within the regional context, have a role as key habitat for threatened or priority species or provide refugial habitats (EPA 2004a). The most important factor in consideration of community significance is the degree of representation at a local and regional scale.

1.3.2.3 Clearing of native vegetation

The clearing of native vegetation in WA is not generally permitted where the biodiversity values, land conservation and water protection roles of native vegetation would be significantly affected. Any clearing of native vegetation in Western Australia requires a permit under Part V Division 2 of the EP Act, except where an exemption applies under the act, or is prescribed by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (the Regulations), and the vegetation is not in an Environmentally Sensitive Area. Permit applications to clear native vegetation require assessment against the '10 Clearing Principles', as outlined in the regulations.

1.3.2.4 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are generally areas where the vegetation has high conservation value. ESAs may include:

- the area covered by vegetation within 50 m of Threatened Flora, to the extent to which the vegetation is continuous with the vegetation in which the Threatened Flora is located
- the area covered by a TEC
- a defined wetland and the area within 50 m of the wetland.

1.3.2.5 Locally or regionally significant vertebrate fauna

Species may be of conservation significance from a local or regional perspective, for example, due to their distributions and migrating patterns. Native species are often considered valuable to local people, particularly to traditional owners. These values are rarely formally recognised through conservation legislation.

Species restricted to a particular biogeographic region, while generally not given additional protection under legislation, may be significant because of their limited distribution. The Chichester subregion of the Pilbara bioregion has a number of bioregional endemic vertebrate species (Table 1-1) (Thackway & Cresswell 1995a).

Table 1-1 Bioregional endemic vertebrate fauna species of the Pilbara region

Mammals	Reptiles
Ningaui timealeyi	*Diplodactylus savagei*
An undescribed Planigale	*Diplodactylus wombeyi*
Dasykaluta rosamondae	*Delma elegans*
Pseudomys chapmani	*Delma pax*
Pseudantechinus roryi	*Ctenotus rubicundus*
	Egernia pilbarensis
	Lerista zietzi
	Lerista flammicauda
	Lerista neander
	Notoscincus butleri
	Varanus pilbarensis
	Acanthophis wellsi
	Demansia rufescens
	Ramphotyphlops pilbarensis
	Ramphotyphlops ganei

1.3.2.6 Short-range endemic invertebrates

Short-range endemic (SRE) fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km^2, that may also be disjunct and highly localised (Harvey 2002; Ponder & Colgan 2002). Short-range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002), relictual short-range endemism and dispersal of habitat specialists. Relictual short-range endemics are believed to have had wider distributions, but with with a drying climate over the last 60 Mio. years, hospitable habitats only persisted in small pockets where moist conditions remain, such as south-facing rockfaces or slopes of mountains or gullies. In contrast, habitat specialist SREs may have settled in particular isolated habitat types by means of dispersal and evolved in isolation into distinct species. Such habitat islands include in particular rocky or granite outcrops. However, SRE invertebrates have also been reported in more widespread habitats such as spinifex plains or woodlands and here mainly in groups with low dispersal capabilities such as mygalomorph spiders and millipedes.

Short-range endemic fauna need to be considered in environmental impact assessments (EIA) as localised, small populations of species are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa (EPA 2009).

There can be uncertainty in categorising a specimen as SRE due to a number of factors including poor regional survey density, lack of taxonomic research and problems of identification, i.e. specimens that may represent SREs cannot be identified to species level based on the life stage at hand. For example, in contrast to mature males, juvenile and female millipedes, mygalomorph spiders and scorpions cannot be identified to species level. Molecular techniques such as ‘barcoding’ (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome taxonomic or identification problems.

Currently, there is no accepted system to determine the likelihood that a species is an SRE. The WA Museum has recently introduced a three tier-rating (confirmed, potential and not SRE) (Western Australian Museum 2013). Phoenix employs a system that differentiates an additional level of short-range endemism, ‘likely’ which better facilitates setting conservation or management priorities (Table 1-2). Any SRE categorisation of a taxon is based on the information available at the time. As new information emerges from additional surveys, the SRE status may change and therefore the SRE status is dynamic.

Although the different categories of ‘SRE-likelihood’ may help to set conservation priorities, SRE taxa of all categories should be assessed on their merit, in order to determine appropriate conservation measures that adhere to the Precautionary Principle within environmental impact assessments. That is, “where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation” (EPA 2002).

Table 1-2 Phoenix SRE categories reflecting survey, taxonomic and identification uncertainties

SRE category	Criteria	Typical troglobitic representative
Confirmed	Confirmed or almost certainly SRE; taxonomy of the group is well known (but not necessarily published); group well represented in collections, in particular from the region in question; high levels of endemism in documented species; inference is often possible from immature specimens	Schizomida*;* troglobitic Pseudoscorpiones, Araneae and Isopoda
Likely	Taxonomically poorly resolved group; unusual morphology for the group (i.e. some form of troglomorphism); often singleton in survey and few, if any, regional records	Symphyla, Palpigradi, Diplura, Chilopoda (Cryptopidae)
Potential	Taxonomically poorly resolved group; often common in certain microhabitats in SRE surveys (i.e. litter dwellers), but no other regional records; congeners often widespread	Species within the genus *Nocticola* (Blattaria) and representatives of the families Meenoplidae (Hemiptera) and Polyxenidae (Diplopoda)
Widespread	Taxonomically well resolved (but often not published) and demonstrated wide distribution (i.e. > 10,000 km^2)	

1.3.2.7 Subterranean fauna

Subterranean fauna live within air- or water-filled underground networks. They are predominantly invertebrates. Organisms specialised for living in air-filled subterranean networks are referred to as troglobites, while those inhabiting water-filled subterranean networks are referred to as stygobites (Howarth 1983; Humphreys 2000).

Subterranean habitats are perpetually dark, are extremely constant in temperature and humidity (air-filled networks) and very low in nutrients and energy that are required to support organisms (Howarth 1993). Evolution under such conditions has resulted in very specialised organisms that are restricted to the void networks in which they have evolved (Harvey 2002; Holsinger 2000; Howarth 1993; Ponder & Colgan 2002). Such species are obligated to living in subterranean networks and cannot survive in epigean (surface) environments. For this reason, species restricted to subterranean void systems often have extremely limited capabilities of dispersal (Harvey 2002; Ponder & Colgan 2002; Volschenk & Prendini 2008) and very small geographic distributions, and may represent extreme SREs (Harvey 2002).

Subterranean SRE fauna need to be considered in EIA because of their highly restricted distributions and therefore possibility that a species conservation status may be impacted as a result of implementation of a proposal (EPA 2013b). The biology, diversity and distributions of most of Western Australia's subterranean fauna are still poorly understood despite extensive survey work undertaken, especially in the Pilbara, over recent years (EPA 2007, 2013c).

Troglofauna are typically divided into three categories of specialisation to subterranean life:

- troglobites, that are restricted to subterranean habitats and usually perish on exposure to the surface environment (Barr 1968; Howarth 1983; Humphreys 2000)

- troglophiles, which facultatively use subterranean habitats but are not reliant on them for survival (Barr 1968; Howarth 1983; Humphreys 2000)
- trogloxenes, which use subterranean systems for specific purposes, such as roosts for reproduction (bats and swiftlets) (Barr 1968; Howarth 1983; Humphreys 2000).

Current EPA guidance only lists troglobites (EPA 2013b). They are often characterised by much specialised adaptations to subterranean life, such as:

- lack or reduction of eyes
- lack or reduction of wings (for species that are normally winged)
- lack or reduction of body pigmentation
- heightened chemosensory and mechanosensory systems
- loss of circadian rhythms
- very low metabolic rate.

These adaptations allow troglobites to exploit the dark, humid, nutrient-poor subterranean void networks (Howarth 1983, 1993; Humphreys 2000; Poulson & Lavoie 2000). Several soil and litter dwelling groups such as silver fish (Thysanura), two-pronge bristle tails (Diplura), and centipedes in the family Cryptopidae are blind and pale and can also be found in subterranean systems, making determination of troglobitic status extremely difficult. In these instances, DNA sequencing is used in order to obtain regional context for such finds (Subterranean Ecology 2010); that is to determine if any records are conspecific with other recorded specimens.

2 METHODS

Desktop review methods entailed:

- a review of existing environmental information relevant to the biological values of the study area including
  - base environmental datasets to define the physical characteristics of the study area
  - searches of relevant biological databases
  - literature reviews of available technical reports from projects adjacent to the study area, or within the area of the desktop review
- assessment and mapping of broad-scale vegetation/fauna habitats in the study area
- assessment of 'likelihood of occurrence' of listed species and communities.

2.1 REVIEW OF EXISTING ENVIRONMENTAL INFORMATION

Base environmental datasets were reviewed to define the physical characteristics of the study area including

- Interim Biogeographic Regionalisation of Australia (IBRA) region(DSEWPaC 2012a; Thackway & Cresswell 1995b)
- land systems – landforms and soils (van Vreeswyk *et al.* 2004)
- surface geology (GSWA 1996)
- hydrology (aerial imagery)

- climate (BOM 2014)
- land use (various sources reviewed for the Pilbara e.g. Kendrick 2001; McKenzie *et al.* 2009; van Vreeswyk *et al.* 2004).

Database searches were undertaken for all target biological groups based on a centre point of 22˚40’47.17”S, 119˚3’42.33”E (designated centre point) as far as possible; however search extent varied as appropriate to each group (Table 2-1).

Table 2-1 Databases searches conducted for the desktop review

Database	Target group/s	Search coordinates and extent
Protected Matters Search Tool (Department of the Environment 2014)	EPBC Act Threatened Flora, TECs and Threatened Fauna	Designated centre point, 22˚40’47.17”S, 119˚3’42.33”E, 20 km radius
DPaW Threatened and Priority Flora database and Western Australian Herbarium database (DPaW 2014d)	WC Act Threatened and Priority Flora	Designated centre point, 22˚40’47.17”S 119˚3’42.33”E, 20 km radius
DPaW Threatened Ecological Communities and Priority Ecological Communities database (DPaW 2014a)	TECs and PECs	Designated centre point, 22˚40’47.17”S 119˚3’42.33”E, 20 km radius
DPaW NatureMap database (DPaW 2014b)	Threatened and Priority Flora and all potentially occurring fauna	Designated centre point, 22˚40’47.17”S 119˚3’42.33”E, 20 km radius
DPaW Threatened Fauna database (DPaW 2014c)	Threatened and Priority Fauna	Designated centre point, 22˚40’47.17”S 119˚3’42.33”E, 20 km radius
Birdlife Australia Birdata database (Birdlife Australia 2014)	All potential avian fauna records, including Threatened and Migratory bird species	Designated centre point, 22˚40’47.17”S 119˚3’42.33”E, 20 km radius
WA Museum Arachnology and Myriapodology database	Terrestrial SRE and troglobitic arachnids and myriapods	NW corner21°46’12”S/118°4’48”E and SE corner 23°34’12”S/120°01’12”23.57°S/120.02°E [1]
WA Museum Mollusca database	Terrestrial SRE molluscs	NW corner 21°46’12”S/118°4’48”E and SE corner 23°34’12”S/120°01’12” [1]
WA Museum Crustacea database	Terrestrial SRE and troglobitic crustaceans	NW corner 21°46’12”S/118°4’48”E and SE corner 23°34’12”S/120°01’12” [1]

[1] rectangular search grid (100 km x 100 km), extending 100 km from the designated centre point based on proposed maximum range of short-range endemism.

The most recent, accessible and relevant technical reports for studies conducted near or in close proximity to the study area were reviewed to obtain additional contextual information for the database search results. The following reports were reviewed (see Figure 1-1 for project locations):

The following flora and vegetation survey reports were accessed for the literature review:

- Flora and vegetation survey of exploration tenement E47/1237 Phil's Creek project area (Mattiske 2008)
- Marillana (E47/1408) vegetation and flora report (Ecologia 2009b)
- Koodaideri camps and airstrip vegetation and flora survey and fauna assessment (Biota 2012a)
- A vegetation and flora survey of the Koodaideri study area (Biota 2012n)
- Koodaideri Southern Infrastructure Corridor vegetation and flora survey (Biota 2012i)
- Koodaideri Northern Extension Area vegetation and flora survey (Biota 2012e)
- Koodaideri Western Rail Corridor vegetation and flora survey (Biota 2012l)
- Koodaideri Iron Ore Project vegetation and flora integration report (Biota 2012c)
- Flora species of interest at Koodaideri (Biota 2013).

The following vertebrate fauna survey reports were accessed for the literature review:

- Biota (2012a) as above
- Koodaideri Iron Ore Project vertebrate fauna integration report (Biota 2012d)
- Koodaideri Northern Extension fauna survey (Biota 2012f)
- Koodaideri Project targeted fauna survey (Biota 2012g)
- Koodaideri Southern Infrastructure Corridor fauna survey (Biota 2012h)
- Koodaideri Western Rail Corridor fauna survey (Biota 2012k)
- Terrestrial fauna of the Koodaideri Lease (Biota 2012m)
- Marillana Iron Ore Project vertebrate fauna assessment (Ecologia 2009c)
- Phil’s Creek Project Area: fauna survey (Western Wildlife 2008)

Short-range endemic invertebrate reports accessed for the literature review were:

- Marandoo Mine phase 2 seasonal fauna survey (Biota 2008)
- Koodaideri Iron Ore Project short-range endemic invertebrate fauna integration report (Biota 2012b)
- Brockman Resources Ltd Marillana Iron Ore Project short-range endemic invertebrate report (Ecologia 2009a)
- Jinidi Iron Ore Mine preliminary statement of findings - terrestrial invertebrate SREs (Biota 2011b)
- Fauna habitats and fauna assemblage of the proposed FMG Stage B rail corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas mine areas (Biota 2005)
- Short range endemic invertebrate fauna survey of Murray's Hill transport corridor (Phoenix 2010)
- Trapdoor spiders (Araneae: Mygalomorphae) from Iron Valley, near Marillana Station (Phoenix 2011d)
- Short-range endemic spiders (Araneae: Mygalomorphae, Araneomorphae) from Christmas Creek (Phoenix 2011c)

- Level 2 SRE fauna survey for the Roy Hill Infrastructure - Bonney Downs Rail Alignment (Phoenix 2011b)
- Roy Hill Iron Ore Project short-range endemic survey (Ecologia 2006)
- Cloudbreak short-range endemic desktop assessment (Ecologia 2010)
- Trapdoor spiders (Araneae: Mygalomorphae) from the FMG Marillana/Nyidinghu Project (Western Australia) (Phoenix 2011e)
- Hope Downs Project life of mine targeted fauna survey (Biota 2011a)
- Level 2 short-range endemic invertebrate survey for the Wonmunna Iron Ore Project (Phoenix 2011a)
- SRE fauna surveys of Yandi and Area C, conducted as part of strategic proposal (BHP Billiton Iron Ore 2012).

The following subterranean fauna reports were reviewed:

- Phil's Creek Project: troglofauna assessment (Bennelongia 2009)
- Koodaideri troglobitic fauna assessment phases I–IV (Biota 2012j)
- Subterranean fauna survey of the Wonmunna Iron Ore Project (Phoenix 2012).

2.2 VEGETATION / HABITAT ASSESSMENTS

Vegetation characterisation of the study area was undertaken using Beard's broad scale 1:1,000,000 vegetation dataset (1975) and van Vreeswyk *et al.* (2004).

Assessments of vertebrate and SRE fauna habitats within the study area were made by referencing land systems of the region (van Vreeswyk *et al.* 2004), aerial photography (incl. Google™ Earth) and topographic maps. Habitats identified in previous reports within the vicinity of the study area were also reviewed for vertebrate fauna habitat delineation (Biota 2012a, d, f, g, h, k, m; Ecologia 2009c; Western Wildlife 2008).

For troglofauna, the surface geologies within the study area were reviewed for their potential to provide suitable habitat for based on current understanding of geologies that are known to support troglofauna.

2.3 LIKELIHOOD OF OCCURRENCE ASSESSMENTS

An assessment of the potential for listed flora and vegetation identified in the database searches to occur in the study area was undertaken. The assessment was based on floristic information relating to habitat preference (soils, landforms, elevation and vegetation associations), locality records from the DPaW database search results and floristic records accumulated from the Koodaideri Iron Ore Project and reviewed during the current desktop assessment.

All listed vertebrate fauna identified in the database searches were assessed for their potential to occur in the study area based on their known biology and habitat preferences, habitats identified in the study area and records of these species from nearby projects (Biota 2012a, d, f, g, h, k, m; Ecologia 2009c; Western Wildlife 2008).

The likelihood for SRE taxa to occur within the study area was assessed based on the results of the database search and habitat identified in the area. The relationship between database results and specific habitat types was determined by known habitat preferences of each taxon and, where provided, the collection habitat listed with each database record.

The flora, vegetation and vertebrate fauna assessments assigned each taxon one of three ratings:

- likely – within known range of species; suitable habitat within the study area and/or records within 5 km of study area
- possible – within known range of species; optimal or potential habitat within the study area, no records within 5 km of study area; habitat where records have been collected (in case of SREs).
- unlikely – no records within 5 km and/or habitat present near study area

The potential for troglofauna to be present in the study area was assessed based on the locations of previous records in the vicinity of the study area and presence of supporting geologies.

2.4 NOMENCLATURE

Nomenclature for flora and vegetation used in this report follows that used by FloraBase (DPaW 2013a) and the Western Australian Herbarium.

Nomenclature used for each vertebrate fauna group is as follows:

- mammals (Menkhorst & Knight 2011)
- birds (Christidis & Boles 2008)
- reptiles (Wilson & Swan 2013)
- amphibians (Tyler & Doughty 2009)

Some taxonomy and nomenclature for species records from previous surveys near the study has been updated with the publications above for consistency.

The nomenclature of described invertebrates and higher taxa follows a number of taxon-specific references, most of which are available online (Table 2-2). However, many SRE invertebrate species are currently unnamed therefore morphospecies designations listed in this report are adopted from the nomenclatural systems developed by the respective taxonomic authorities.

Reference collections generally reside with WA Museum and morphospecies designations generally follow listings developed by the WA Museum (Table 2-2) as expected by the EPA (EPA 2004b).

Table 2-2 Nomenclatural references, morphospecies designations and available reference collections

Taxonomic group	Taxonomic reference for described species and higher taxa	Morphospecies designation and reference collection
Araneae (Mygalomorphae)	Platnick (2014)	"MYG"-morphospecies designation developed by V.W. Framenau (WAM, Phoenix), reference collection at WAM
Araneae (Araneomorphae: Selenopidae)	Platnick (2014)	Morphospecies designations developed by M. Harvey (WAM) and V.W. Framenau (WAM, Phoenix), reference collection at WAM
Pseudoscorpiones	Harvey (2011)	"PSE"-morphospecies designations developed by M. Harvey (WAM), reference collection at WAM
Scorpiones	Rein (2011)	Morphospecies designation developed by E.S. Volschenk (WAM), reference collection at WAM
Chilopoda	Bonato (2011)	"CHI"-morphospecies designations developed at WAM
Diplopoda	Mesibov (2006)	"DIP"-morphospecies designation developed C. Car and M. Harvey (WAM), reference collection at WAM
Isopoda	Schotte *et al.* (2008)	Morphospecies designations developed by S. Judd, reference material at WAM

3 RESULTS

3.1 EXISTING ENVIRONMENT

3.1.1 Interim Biogeographic Regionalisation of Australia (IBRA) Region

The Interim Biogeographic Regionalisation of Australia (IBRA) defines 'bioregions' as large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems (DSEWPaC 2011; Thackway & Cresswell 1995a). They record and categorise the large-scale geophysical patterns that occur across the Australian continent.

Western Australia contains 26 IBRA bioregions and 53 subregions. The survey area falls within the Pilbara bioregion, which covers an area of 178,060 km^2 (Thackway & Cresswell 1995a) and is divided into four subregions (DSEWPaC 2012b): Chichester (PIL 1), Fortescue Plains (PIL 2), Hamersley (PIL 3) and Roebourne (PIL 4) (DSEWPaC 2012b).

The study area falls within the Hamersley subregion and is characterised by (Kendrick 2001):

- mountainous areas of Proterozoic sedimentary ranges and plateaux dissected by gorges
- fine-textured soils in valley floors supporting Mulga (*Acacia aneura*) low woodland over bunch grasses
- skeletal soils of the ranges supporting *Eucalyptus leucophloia* over *Triodia brizoides*
- a semi-desert tropical climate with an average rainfall of 300 mm, generally occurring in summer cyclonic or thunderstorm events.

High species and ecosystem diversity is characteristic of the Hamersley Range. Gorges are common and represent refugia for biota; however, none are present within the study area. Other important attributes of the Hamersley Range include calcrete deposits for troglofauna and mountain tops for a number of restricted flora species and permanent springs, none of which are present within the study area.

3.1.2 Land systems

The Department of Agriculture and Food Western Australia (van Vreeswyk *et al.* 2004) has defined the land systems of the region from landforms, soils, vegetation and aerial photography, providing the largest-scale interpretation of vegetation units for the study area.

The study area traverses three land systems (Figure 3-1):

- Platform land system (75% of the study area) – dissected slopes and raised plains supporting shrubby hard spinifex grasslands
- Robe land system (15% of the study area) – low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands
- Newman land system (10% of the study area) – rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.

Based on a review of aerial photography the study area appears to be characterised primarily by the following landforms (based on van Vreeswyk *et al.* 2004 descriptions):

- stony upper plains occurring mostly as narrow interfluves inter-digitated between dendritic or sub-parallel incised drainage but also as broader plains
- dissected slopes gently to moderately inclined with narrow incised creeklines.

Figure 3–1
Land systems of the study area

Study area

Tenement

Land system

McKay System

Newman System

Platform System

Robe System

Rocklea System

0 0.5 1 2 Kilometres

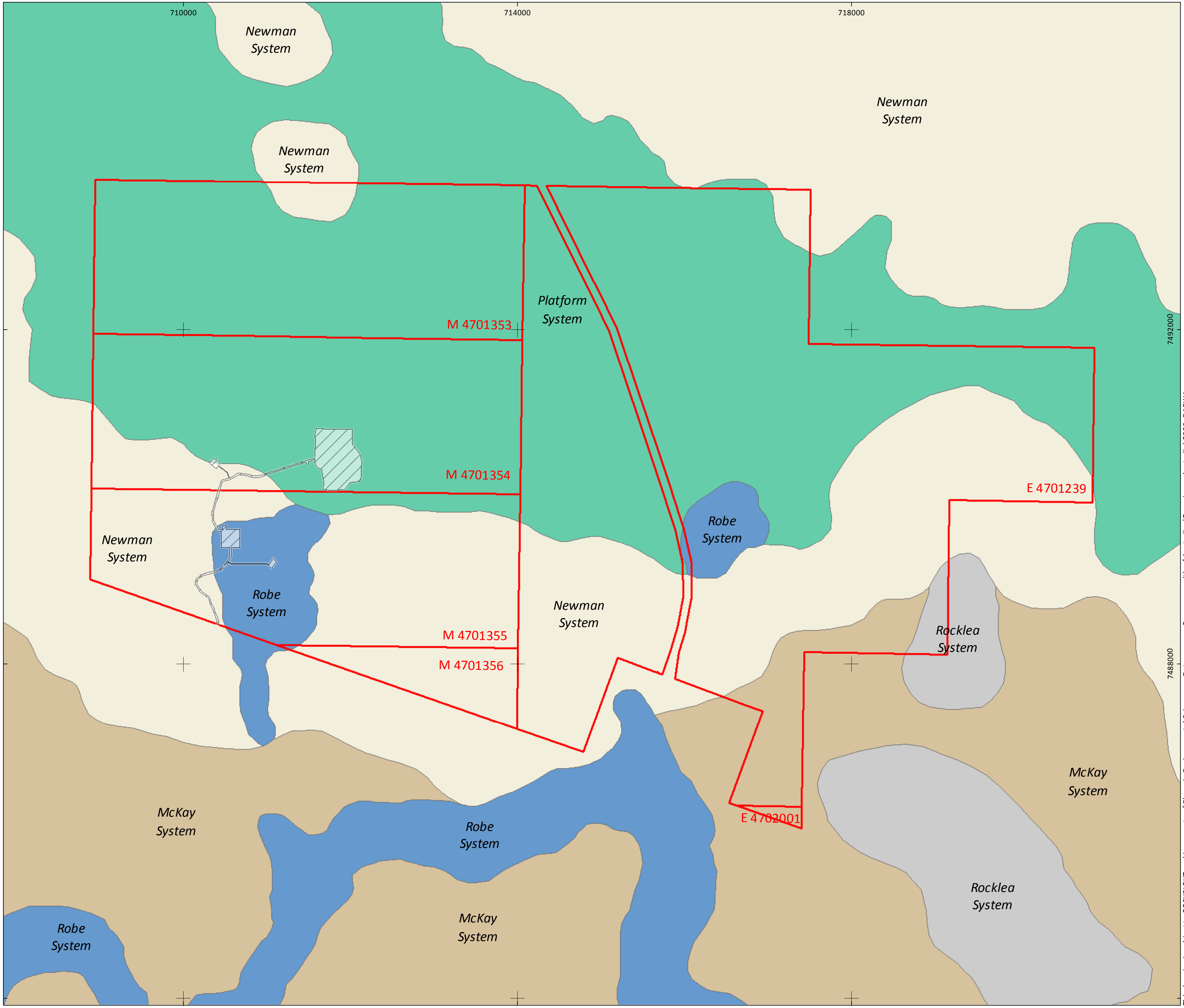
1:60,000

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

PHOENIX
ENVIRONMENTAL SCIENCES



Based on van Vreeswyk *et al*. (2004) the following soil groups may be present in the study area:

- stony soils (203) – dark reddish brown to dark red sand loam to loam, or occasionally clay loam; coarse gravelly, stony or rocky soils, not calcareous (excluding ironstone gravel soils); on hills, ridges, slopes, low rises, plateaux, tor fields and breakaways (major soils of Newman and Robe land systems; minor soils of Platform land system)
- red shallow sandy duplex soils (406) – red shallow sandy duplex soils have thin to medium (10-20 cm) topsoils of loamy sand to sandy loam overlying medium (10-30 cm) subsoils of sandy clay loam to light clay (minor soils of Platform land system)
- red shallow loams (522) – dark reddish brown to dark red, occasionally yellowish red; thin topsoils ranging from sandy loam to clay loam, often overlying weathered rock. Subsoils of sandy clay loam or clay loam; low rises, footslopes and stony plains (major soils of Newman and Platform land systems; minor soils of Robe land system)
- river bed soils (705) – coarse loose sand, clayey sand, silty sand and silty clay (van Vreeswyk *et al*. 2004).

3.1.3 Surface geology

Six surface geology formations were identified within the project tenements based on surface geology information provided by the Geological Survey of Western Australia (GSWA 1996) (Table 3-1, Figure 3-2).

Table 3-1 Surface geology present within the study area

Description	Geological codes	Extent within study area (ha)	Extent within project tenements (ha)
Alluvium unconsolidated silt, sand, and gravel; in drainage channels and on adjacent floodplains	Qa	0%	1.89
Colluvium, partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits	Czc	0%	1056.13
Robe Pisolite: pisolitic limonite deposits developed along river channels	Czp	0%	117.19
Hematite-goethite deposits on banded iron-formation and adjacent scree deposits	Czr1, Czr2	100% (Czr1 only)	683.5
Brockman Iron Formation: banded iron-formation, chert, and pelite	PLHb	0%	100.38
Weeli Wollie Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills	PLHj	0%	942.73

Figure 3–2
Surface geology of the study area

Study area

Tenement

Pit

Surface gelogy

Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits

Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels

Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

Czr1: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

Czr2: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

PLHb: Brockman Iron Formation: banded iron-formation, chert, and pelite

PLHj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills.

Qa: Alluvium: unconsolidated silt, sand, and gravel; in drainage channels and on adjacent floodplains

0 0.5 1 2 Kilometres

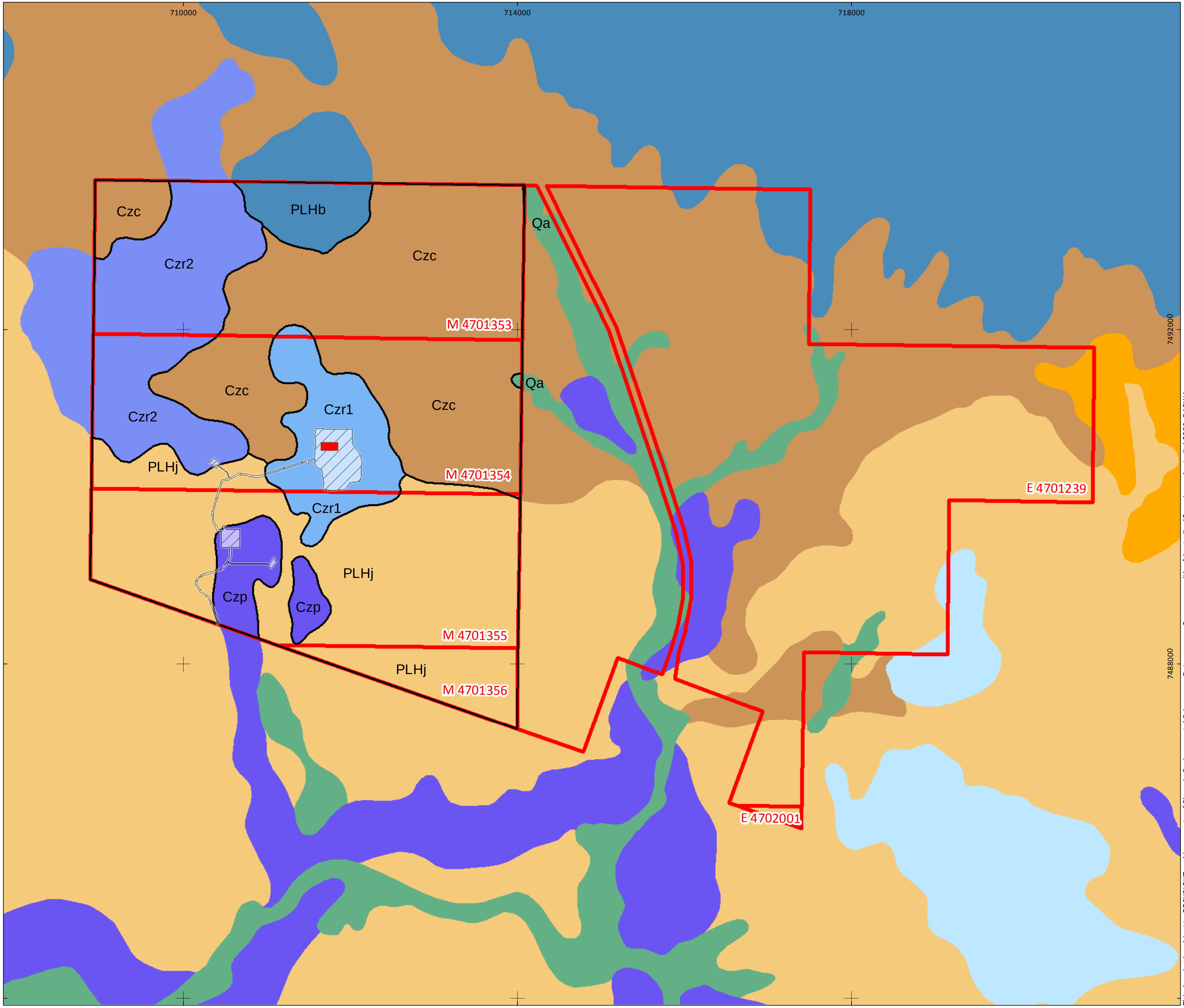
1:60,000

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

PHOENIX ENVIRONMENTAL SCIENCES



3.1.4 Hydrology

Several minor drainage lines transport watershed on the study area in a south to south easterly direction towards a gully which flows into an unnamed minor ephemeral creek. This creek directs water south of the study area, into the Yandicoogina Creek. Surface flows are likely to be haphazard (mainly in the wet season) and of short duration.

3.1.5 Climate

The Pilbara bioregion has a semi-desert to tropical climate with highly variable, mostly summer rainfall (McKenzie *et al.* 2009; van Vreeswyk *et al.* 2004). The average rainfall over the broader Pilbara region is about 290 mm, ranging from a monthly average of approximately 4 mm in September to 76 mm in February. Rainfall patterns are driven by highly variable year-to-year cyclonic activity that accounts for half of the yearly precipitation (McKenzie *et al.* 2009). Average annual (pan) evaporation in the western Pilbara is approximately 3,400 mm per year (Department of Agriculture 2003), which greatly exceeds annual rainfall and consequently contributes to the arid environment.

The nearest Bureau of Meteorology (BOM) weather station is located at Newman Airport (Latitude: 23.36°S Longitude: 119.73°E) approximately 130 km SE of the Extension Project and Bulk Sample. Newman records the highest mean maximum temperature (39.4°C) in January, the lowest mean maximum temperature (23°C) in July and an average annual rainfall of (316.4) mm (Figure 3-3).

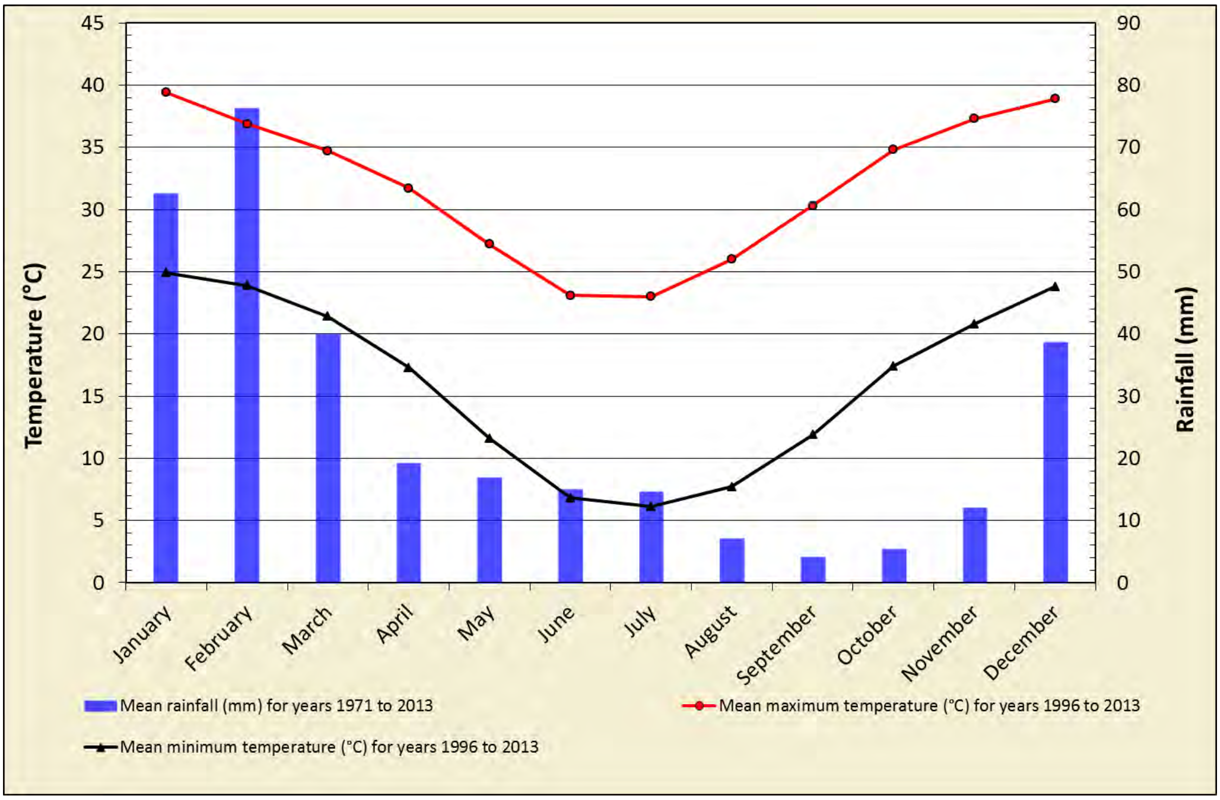


Figure 3-3 Average monthly temperatures (maximum and minimum) and rainfall records from Newman (BOM 2014)

3.1.6 Land use

The study area lies within the broader region of the Pilbara, an area distinct from (but including) the Pilbara IBRA bioregion. The Pilbara region was historically dominated by native grazing and pastoral activities. Current land use in this region is more diverse, comprising pastoral grazing, mineral exploration and mining activities, and dedication of land to Crown Reserves (e.g. Jigalong Aboriginal Reserve, Karijini National Park and Millstream National Park (van Vreeswyk *et al.* 2004). In 2009, land tenure in the broader Pilbara region was approximately 60% pastoral lease, 10% conservation reserve, 5% Aboriginal Reserve and 25% unallocated Crown land (UCL) (McKenzie *et al.* 2009). Within the Hamersley subregion, dominant land uses are grazing, UCL and crown reserves, native pastures, conservation, mining and urban (Kendrick 2001).

Karijini National Park is located approximately 40 km to the north-west of the study area. The Fortescue Marsh is located approximately 15 km north-east of the study area. Although not formally protected, the marsh is a significant wetland. It is the largest ephemeral wetland in the Pilbara region and is recognised as nationally important (EPA 2013a). The study area does not reside within any of the marsh management zones (EPA 2013a) with drainage from the Extension tenements heading away from the Fortescue marsh.

3.2 FLORA AND VEGETATION

3.2.1 Native vegetation extent and status

The vegetation of the study area lies within the Fortescue Botanical District of the Eremaean Province (Beard 1990). This district consists predominantly of tree and shrub steppe communities with *Eucalyptus* trees, *Acacia* shrubs and grasses including *Triodia pungens* and *T. wiseana* (Beard 1975a). Mulga (*Acacia aneura*) occurs in valleys and short-grass plains may be present on alluvial soils (Beard 1990).

Broad scale vegetation mapping (Beard 1975b) of the area (1:1,000,000) indicates there are two vegetation associations represented within the study area (Figure 3-4), as follows:

- Hamersley 18 – Low woodland of Mulga (*Acacia aneura*)
- Hamersley 82 – Snappy Gum (*Eucalyptus leucophloia*) scattered low trees over *Triodia wiseana* hummock grasslands.

The vegetation of the Hamersley subregion is described by Kendrick (2001b) as *Acacia aneura* (mulga) low woodlands, over tussock grasses on valley floors with *Eucalyptus leucophloia* (Snappy Gum) over *Triodia brizoides* on skeletal soils of the ranges. Van Vreeswyk *et al*. (2004) described the following vegetation units as occurring in association with land systems of the study area:

- Platform
    - hummock grasslands of *Triodia wiseana* and other *Triodia* spp. (hard spinifex) with isolated to very scattered *Acacia* spp. shrubs (PHSG)
    - hummock grasslands of *Triodia wiseana*, T. *plurinervata* (hard spinifex) with isolated to very scattered *Acacia* spp. shrubs or *Eucalyptus leucophloia* (snappy gum) (PHSG, HESG)
- Robe
    - hummock grasslands of *Triodia pungens* (soft spinifex) with isolated to scattered *Acacia* and *Senna* spp. shrubs and occasional *Eucalyptus leucophloia* (snappy gum) trees (HSPG)

    - hummock grasslands of *Triodia wiseana, T. longiceps* (hard spinifex) with isolated to very scattered *Acacia* and *Senna* spp. shrubs, (PHSG); occasionally hummock grasslands of *Triodia pungens* (soft spinifex) (PSSG)
    - hummock grasslands of *Triodia pungens* with very scattered to moderately close *Acacia* spp. shrubs (ASSG); also moderately close eucalypt or acacia woodlands/tall shrublands with *T. pungens* understorey (DESG, DAHW)
- Newman
    - hummock grasslands of *Triodia wiseana*, *T. brizoides*, *T. plurinervata* (hard spinifex) with very scattered to scattered shrubs and trees including *Acacia* and *Senna* spp., *Grevillea wickhamii* (Wickham's grevillea), *Eucalyptus leucophloia* (snappy gum) and other eucalypts (HESG, HSPG); occasionally hummock grass is *Triodia biflora* (soft spinifex)
    - smaller floors supporting hummock grassland of *Triodia pungens* with very scattered shrubs (ASSG); larger floors and channels supporting tall shrublands/woodlands of *Acacia* spp. and *Eucalyptus victrix* (coolibah) with tussock grass or hummock grass understoreys (DEGW, DAHW, DESG).

A vegetation type is considered under-represented if there is less than 30% of its original distribution remaining. Several key criteria are applied to vegetation clearing from a biodiversity perspective, as follows (EPA 2000):

- the 'threshold level' below which species loss appears to accelerate exponentially within an ecosystem level is regarded as being at a level of 30% (of the pre-European, i.e. pre 1750 extent of the vegetation type)
- a level of 10% of the original extent of a vegetation community is regarded as being a level representing Endangered
- clearing which would increase the threat level to a vegetation community should be avoided.

Shepherd *et al.* (2001) have assigned the status of vegetation remaining (to pre-European extent) into five classes:

- 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 gives a comparable status.

According to Shepherd *et al*. (2001) the vegetation of the study area is classified as 'Least Concern' in terms of extent of vegetation remaining within the Hamersley subregion (PIL 3) compared to pre-European extents (Table 3-2).

For the Bulk Sample, approximately 17 ha of vegetation will be disturbed. The loss of such a small area of native vegetation will not have a significant impact on the extent or status of the Beard vegetation associations represented in the study area.

Figure 3–4
Beard vegetation of the study area

Study area

Tenement

Beard (1975) vegetation associations

HAMMERSLEY 18 — Low woodland; mulga (*Acacia aneura*)

HAMMERSLEY 82 — Hummock grassland, low tree steppe; snappy gum over *Triodia wineana*

0 0.5 1 2 Kilometres

1:60,000

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

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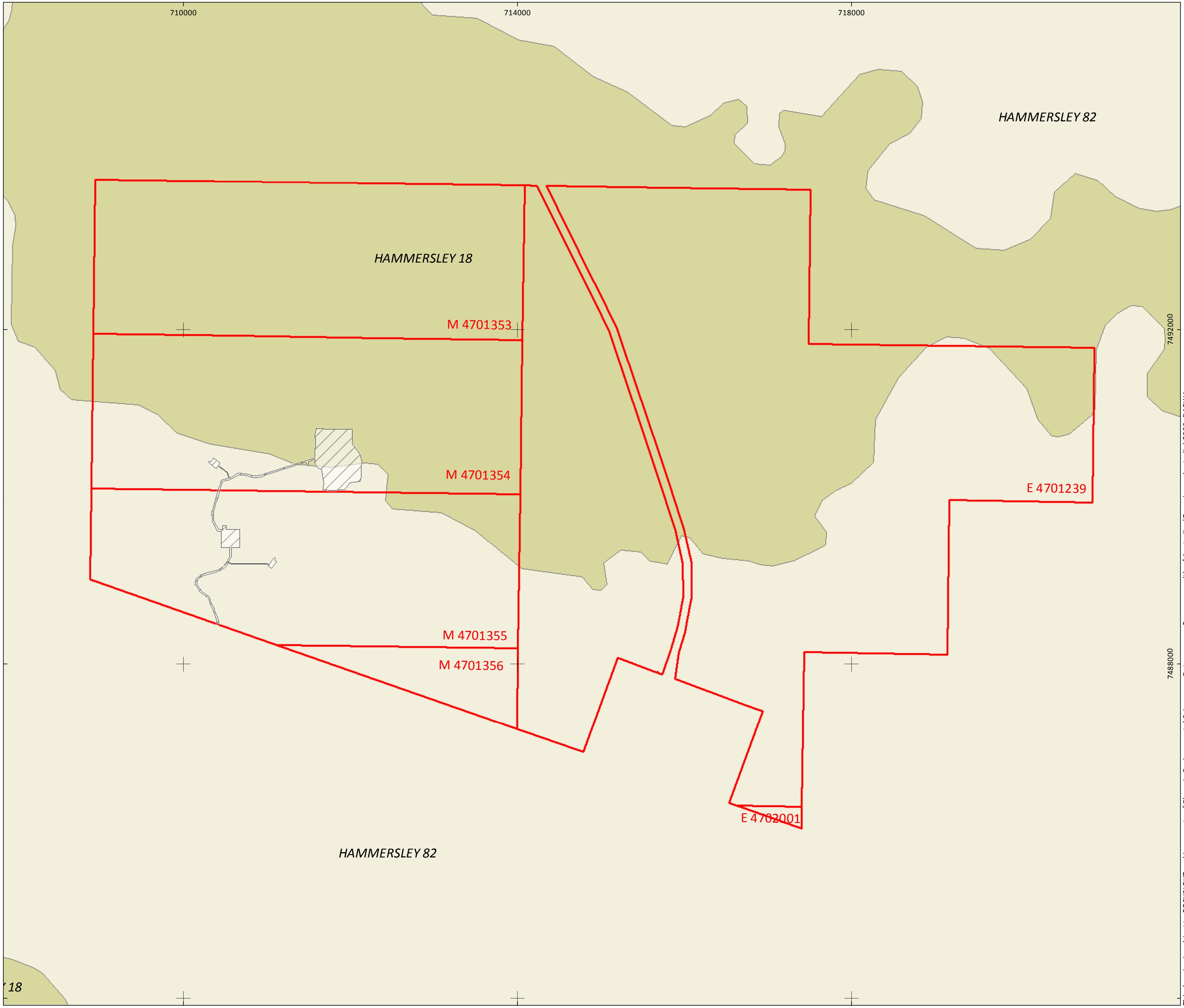

Table 3-2 Vegetation extent, type and status within the study area (Government of Western Australia 2011)

Vegetation association number	Pre-European extent (ha)	Current extent (ha)	Percentage remaining	Percentage pre-European extent in IUCN class I-IV reserves
18	581246.08	577122.68	99.29	19.55
82	2177573.94	2165235.08	99.43	12.03

3.2.2 Listed flora and ecological communities

A total of 161 plant taxa were identified as potentially occurring within a 20 km buffer of the study area (DPaW 2014b). Eighteen of the species are Priority flora and one is listed as Vulnerable under the EPBC Act and Threatened under the WC Act, but none of these were considered likely to occur in the study area (Table 3-3):

- one vulnerable/threatened species (*Lepidium catapycnon*, unlikely to occur)
- three P1 species, of which one may possibly occur
- three P2 species, all possibly occurring
- nine P3 species, of which seven may possibly occur
- three P4 species, of which two may possibly occur.

It is highly unlikely that all of the 13 'possibly occurring' Priority species occur within the Bulk Sample area given its small extent relative to the area of the database searches (20 km radius). The remaining five Priority species are considered 'unlikely' to occur and three additional records could not be determined or require confirmation (Table 3-3): *Vittadinia* ? *pustulata* (P2 – requires confirmation), *Oldenlandia* sp. (possibly a new species) and *Tribulus* sp. (possibly a new species) (Biota 2013, 2012i; Mattiske 2008).

The Protected Matters database search identified *Lepidium catapycnon* (VU), or species habitat, which could potentially occur within the study area. There are five known populations of this taxa occurring within a distance of 20 km from the study area. The closest population is approximately 16.5 km to the south east (Figure 3-5). This species is 'unlikely' to occur in the study area due to limited suitable habitat (Table 3-3).

A series of flora and vegetation surveys have recently been completed for the Koodaideri Iron Ore Project. One of these areas, the proposed Koodaideri Southern Infrastructure Corridor (KSIC), was determined to contain relatively high floristic species richness and is dissected by eight land systems (Biota 2012c). In contrast, the current study area is characterised by three land system units and habitat type within these appears uniform (Figure 3-1). It is therefore expected that floristic biodiversity of the study area would be low to moderate in comparison to the KSIC study area.

There are no state or federally listed TECs occurring within a 20 km radius of the study area (DPaW 2013b) (Department of the Environment 2014). There is one state listed botanical TEC known to occur in the Pilbara bioregion; Themeda grasslands on cracking clays (Hamersley Station). This TEC occurs as a grassland plain dominated by the perennial Themeda (kangaroo grass) and many annual herbs and grasses (DPaW 2013b). It is restricted in distribution and occurs mainly on gilgai plains landforms of the Brockman land system, west of Karijini National Park. This community is highly unlikely to occur in the study area.

According to the DPaW database searches, two PECs and/or their buffers occur within 20 km of the study area (Figure 3-5). This includes the Priority 1 ecological community Fortescue Marsh (Fortescue Land System) and Priority 3 ecological community Fortescue Valley Sand Dunes (DPaW 2013c). At the State level, TECs and PECs are represented within buffer zones and consequently, the true extent of the PECs from the desktop review may be overstated.

The Fortescue Marsh PEC is restricted to the Marsh land system which does not occur within or in close proximity to the study area. This PEC is spatially represented by a 20 km buffer and, while one or more buffers of this PEC intersect the database search area, the PEC does not occur in close proximity to the study area.

The Fortescue Valley Sand Dunes PEC consists of red linear sand dune communities of the Divide land system at the junction of the Hamersley Range and Fortescue Valley, between Weeli Wolli Creek and the low hills to the west. This PEC is not represented on, or in close proximity to, the study area. The occurrence of this PEC is represented spatially by 100 m buffers.

There are no wetlands or conservation areas managed by DPaW in the study area and none that are in close proximity that could be directly or indirectly impacted by the proposed clearing of native vegetation. No ESAs or named watercourses are located within or in close proximity to the study area.

Table 3-3 Likelihood of occurrence of listed flora species identified in the desktop review and potential for impacts

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence and potential for impacts
Acacia subtiliformis		P3	Jun – Aug	Occurs on stony calcrete plain.	Possible. Some calcareous soils groups are present in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Dampiera metallorum		P3	Apr or Jun – Oct	Recorded on skeletal red-brown gravelly soil or banded ironstone on high altitude hills.	Unlikely. Elevation of site is less than 400 m. Impacts unlikely.
Eremophila magnifica subsp. *magnifica*		P4	Aug – Nov	Typically occurs on tall hills, on skeletal soils over ironstone and on rocky screes.	Unlikely. Study area lacks tall hills and is characterised by relatively low elevation. Impacts unlikely.
Eremophila spongiocarpa		P1	May – Jul or Sept	Occurs on sub-saline alluvial plains.	Unlikely. There are no sub-saline alluvial plains in the study area. Impacts unlikely.
Goodenia nuda		P4	Apr – Aug	Typically found growing near creek lines and in wet areas. Recorded from three locations in the KSIC study area, all from Mulga floodplains (Biota 2012i).	Possible. On lower lying areas and in drainage lines of the proposed haul road area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)		P3	Aug – Sep	Red-brown clayey soil and calcrete areas on low, undulating or swampy plains.	Possible. On lower lying areas and in drainage lines of the proposed haul road area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Gymnanthera		P3	Jan – Dec	Occurring on major creek and	Possible. The proposed haul road traverses two ephemeral creeks and

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence and potential for impacts
cunninghamii				drainage lines, in sandy soils.	suitable habitat might be present. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Isotropis parviflora		P2	Feb-Mar, May	Low ironstone hill slopes and plains. Recorded on low stony hills and footslopes of taller hills in the KSIC study area (Biota 2012i).	Possible. Some suitable habitat may exist. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Lepidium catapycnon	T, VU		Oct – Jan?	Skeletal soils of hill slopes and crests of tall to moderate sized hills; recorded in association with *Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered shrubs over *Triodia wiseana, T.* sp. Shovelanna Hill (S. van Leeuwen 3835) open hummock grassland.	Unlikely. While vegetation associations that are affiliated with the occurrence of *Lepidium catapycnon* are represented in the northern portion of the study area, the study area is characterised by plateaux, low hills and low lying areas, landforms that are unsuitable to support this species. Impacts unlikely.
Nicotiana umbratica		P3	Apr– Jun	Shallow soils in rocky outcrops.	Unlikely. Study area does not contain rocky outcrops. Impacts unlikely.
Oldenlandia sp.	Not determined	Not determined	Unavail.	Recently collected from a calcrete plain in the KSIC study area (Biota 2012i).	Possible. Little is known about this species. Could occur if suitable habitat is present. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP		P3	Mar	Collected from cracking clay, basalt; gently undulating plains with large surface rocks, flat crab holed plains	Possible. Suitable habitat to support this species appears limited in the study area. Small disturbance footprint and therefore loss of individual plants, if

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence and potential for impacts
1479)				(Biota 2012d).	any, unlikely to have significant impact on local or regional population extents.
Rhynchosia bungarensis		P4	May – Dec	Occurs in larger creeklines and on associated floodplains, or in wet, sheltered gorge habitats.	Possible. The proposed haul road transverses two ephemeral creeks species Rhynchosia bungarensis was recorded at multiple locations in adjacent creeks and drainage lines in the KSIC study area by (Biota 2012i). Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Rostellularia adscendens var. *latifolia*		P3	April – May	Occurring on ironstone soils near creeks and on rocky hills. Recorded from three locations in the KSIC study area (Biota 2012i); a mulga floodplain, calcrete plain and drainage line (Biota 2012c).	Possible. Suitable habitat is present in the study area. Recorded at multiple locations in creeks and drainage lines, within 15 km of the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Sauropus sp. Koodaideri detritals (J. Naaykens & J. Hurter JH 11213) PN		P1	Aug, Oct – Nov	Collected from rocky slopes, beneath cliff lines of detrital iron formations and in rock gullies within the Koodaideri Mining Lease (KML) area. Recorded growing in association with *Eucalyptus leucophloia* scattered low trees to low open woodland, over variable scattered shrubs to open shrubland of *Senna glutinosa* subsp. *glutinosa, Grevillea wickhamii*, and *Acacia arida*, *over Triodia wiseana* open hummock grassland.	Unlikely. Initial observations suggest that this species occurs in gullies with outcropping rock at elevations between 500 m and 700 m. The landforms of the study area do not reach this elevation. Impacts unlikely.

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence and potential for impacts
Sida sp. Barlee Range (S. van Leeuwen 1642)		P3	Aug	Recorded from 12 locations in the central section of the KML study area (Biota 2012n). This species occurs on red-brown skeletal soils on steep rocky hillslopes, typically amongst large rocks or at the base of free rock faces.	Possible. Suitable habitat exists in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)		P3	Aug	Typically grows on red-brown cracking clay on plains or along creeks.	Possible. Suitable habitat exists in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Tribulus sp.	Not determined	Not determined		Undescribed entity requiring further taxonomic investigation. Recorded in the Koodaideri Western Rail Corridor.	Possible. Limited information is known about this taxa, it could occur if suitable habitat is present in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Vittadinia ? *pustulata*		P2 (if confirmed)	Sep	Previously collected from sand flat adjacent to sand dune in the interior of WA and more recently on mulga plains in the KSIC area (Biota 2012i).	Possible. Suitable habitat is limited in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Vigna sp. central (M.E. Trudgen 1626)		P2	Jan – Oct	Occurs on red-loam on edge of flats and drainage lines, valley floors.	Possible. Some suitable habitat is present in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence and potential for impacts
Euphorbia inappendiculata var. *inappendiculata*[1]		P2	Aug	*Euphorbia inappendiculata*[1] recorded at Phil's Creek on sandy soils of a major water course (Mattiske 2008). *Euphorbia inappendiculata* var. *inappendiculata*[1] has previously been recorded on gently slopes; high in the landscape, on stony rich red clay, very damp, cracking clay, but also from open tussock grasslands and very open low scrub of *Acacia xiphophylla* and *A. synchronicia* over mid-dense hummock grass.	Possible. Suitable habitat to support this taxa is present in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.
Euphorbia inappendiculata var. *queenslandica*[1]		P1	Aug	Known to occur in association with a variety of habitats including broad clay plains, broad drainage lines, broad flat depressions and among broken rocky screes; on dark reddish brown heavy clay with numerous deep gilgai holes (30-40 cm deep) and cracking clays.	Possible. Suitable habitat to support this taxon is present in the study area. Small disturbance footprint and therefore loss of individual plants, if any, unlikely to have significant impact on local or regional population extents.

[1]Taxa assigned Priority 3 status at time of collection but has since been split into two varieties.

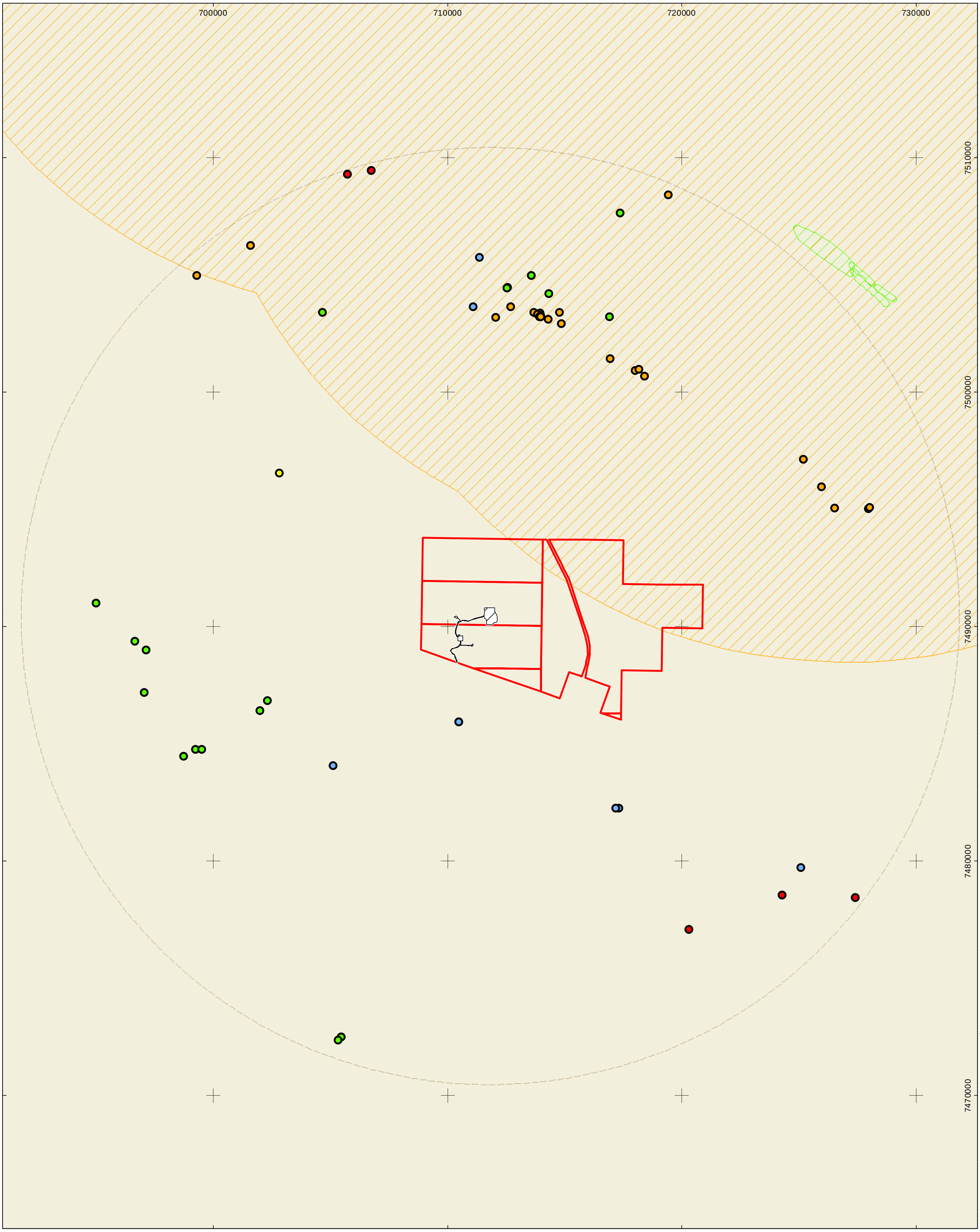

Figure 3–5
List of flora and PECs recorded within 20 km of the study area

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ENVIRONMENTAL SCIENCES

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

0 1.5 3 6 Kilometres
1:210,000

Tenements
Study area
20 km buffer search area
Priority flora (DPaW 2014) - 20 km search buffer
1
2
3
4
T
Priority Ecological Communities (PECs)(DPaW 2014)
Fortescue Marsh (Marsh Land System) — Priority 1
Fortescue Valley Sand Dunes — Priority 3

3.3 VERTEBRATE FAUNA

3.3.1 Habitat assessment

The study area is largely homogenous in terms of fauna habitat, represented mostly by spinifex grassland on plateau of gently rolling hills (Figure 3-6). Three other habitat types are present in small amounts; minor drainage lines, minor creek lines and mixed shrubland (Figure 3-6). The major habitats of the study area provides little vegetation structure and complexity and is unlikely to readily retain water in the landscape.

The access and haul roads also cross two minor creek lines which may provide foraging opportunities for a few listed bird species, but which are unlikely to be impacted by the upgrade of the existing track as proposed.

The habitats of the study area are typical of Pilbara environments and there are no distinguishing features that suggest any isolated or rare habitats or habitats that may be critical for listed vertebrate species such as Northern Quoll, Pilbara Olive Python or Pilbara Leaf-nosed Bat (e.g. mesas, ridgelines or gullies with denning opportunities or suitable cave formations and associated large river systems).

3.3.2 Listed species

A total of 254 vertebrate fauna species were identified in the desktop review as potentially occurring in the study area (Appendix 1). This comprised 39 mammals (30 native and nine introduced), 116 birds, 96 reptiles and three amphibians.

A total of eight species listed as threatened under the EPBC Act and/or the WC Act were identified within the search area of the desktop review (Table 3-4). Eight migratory avifauna and four Priority species were also identified (Table 3-4). Three of the listed species are considered likely to occur in the study area: Fork-tailed Swift (migratory), Australian Bustard (P4) and Western Pebble-mound Mouse (P4). Several of the Pilbara bioregional endemics (section 1.3.2.5) may also occur in the study area.

Figure 3–6 Vertebrate fauna potential habitats

Study area

Habitat

- Minor creek line
- Minor drainage line
- Mixed shrubland
- Spinifex grassland on plateau

0 125 250 500 Metres

1:12,500

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

PHOENIX ENVIRONMENTAL SCIENCES

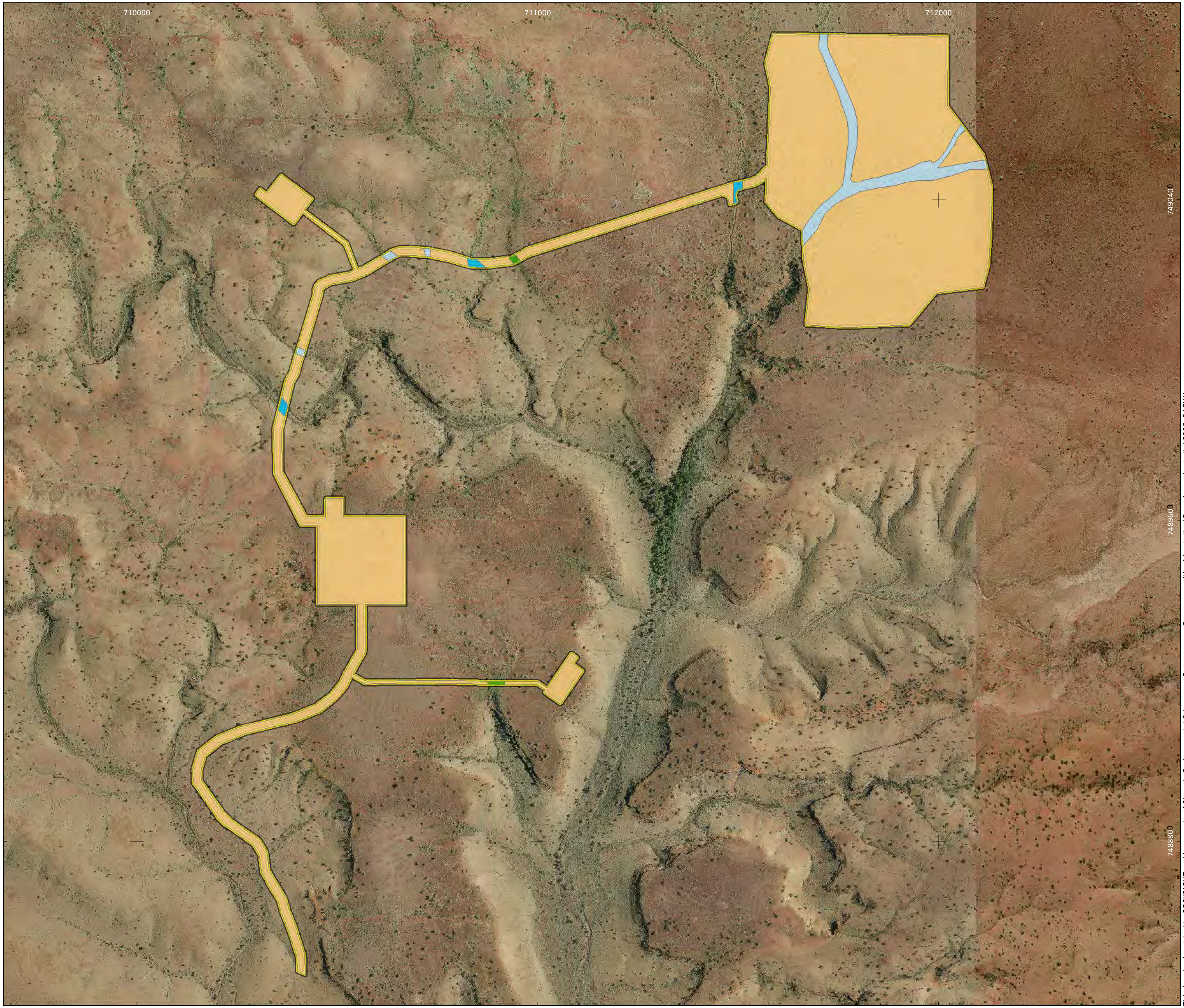


Table 3-4 Likelihood of occurrence of listed vertebrate species identified in the desktop review and potential for impacts

Scientific name	Common name	EPBC Act Category	WC Act Category	DPaW Priority listing	Likelihood of occurrence and potential for impacts
Birds					
Apus pacificus	Fork-tailed Swift	M	S3		Likely. Database searches and habitat assessment indicates species or habitat likely to occur within area. Species very rarely lands so impacts unlikely.
Ardea modesta	Eastern Great Egret	M	S3		Unlikely. No suitable habitat in study area. Impacts unlikely.
Ardea ibis	Cattle Egret	M	S3		Unlikely. No suitable habitat in study area. Impacts unlikely.
Falco hypoleucos	Grey Falcon		S1	VU	Possible. This species has large foraging area so may occasionally occur (Johnstone & Storr 1998) Small disturbance footprint therefore loss of potential habitat will not be significant.
Falco peregrinus	Peregrine Falcon		S4	SP	Possible. This species has large foraging area so may occasionally occur (Johnstone & Storr 1998). Small disturbance footprint therefore loss of potential habitat will not be significant.
Ardeotis australis	Australian Bustard			P4	Likely. Database searches and habitat assessment indicate the species is known within region. Species has large home range and habitat is likely well represented across grassland plateaux, so impacts unlikely.
Charadrius veredus	Oriental Plover	M	S3		Unlikely. May occur but the species is uncommon in this part of the Pilbara region. Impacts unlikely.

Scientific name	Common name	EPBC Act Category	WC Act Category	DPaW Priority listing	Likelihood of occurrence and potential for impacts
Rostratula australis	Australian Painted Snipe	EN/M	S1/S3	EN	Unlikely. No suitable habitat in study area. Impacts unlikely.
Tringa nebularia	Common Greenshank	M	S3		Unlikely. No suitable habitat in study area. Impacts unlikely.
Pezoporus occidentalis	Night Parrot	EN/M	S1	CR	Unlikely. Records are very sparse and little data is available on habitat preferences; however, the species has only been recorded in modern history from the eastern side of the Fortescue Marsh and extensive surveys in the previous decade within close proximity of the study area have failed to record the species. Impacts unlikely.
Merops ornatus	Rainbow Bee-eater	M	S3		Possible. Database searches indicate species and habitat may occur in study area. Impact unlikely to be significant as this species is widely distributed.
Neochmia ruficauda sub. *clarescens*	Star Finch			P4	Unlikely. No suitable habitat (large creeklines) in study area. Impacts unlikely.
Mammals					
Pseudomys chapmani	Western Pebble-mound Mouse			P4	Likely. Database searches and habitat assessment indicate potential. Habitat is likely well represented (grassland plateaus), so impacts unlikely.
Macrotis lagotis	Greater Bilby	VU	S1	VU	Unlikely. No suitable habitat in study area. Impacts unlikely.
Dasyurus hallucatus	Northern Quoll	EN	S1	EN	Unlikely. No suitable denning/shelter habitat present in study area. Impacts unlikely.

Scientific name	Common name	EPBC Act Category	WC Act Category	DPaW Priority listing	Likelihood of occurrence and potential for impacts
Macroderma gigas	Ghost Bat			P4	Possible. Known within region but no roosting habitat likely to be present in study area. If roosts are nearby, foraging is more likely to be along major creek systems and only minor drainage lines exist in study area. Impacts unlikely.
Notoryctes caurinus	Northern Marsupial Mole	EN	S1	EN	Unlikely. No suitable habitat in study area. Impacts unlikely.
Rhinonicteris aurantia	Orange Leaf-nosed Bat	VU	S1	VU	Possible. Known within region but no roosting habitat likely to be present in study area. If roosts are nearby, foraging is more likely to be along major creek systems and only minor drainage lines exist in study area. Impacts unlikely.
Reptiles					
Ramphotyphlops ganei	Gane's Blind Snake			P1	Unlikely. No suitable habitat in study area. Impacts unlikely.
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1	VU	Unlikely. No suitable habitat in study area. Impacts unlikely.

3.4 SHORT-RANGE ENDEMIC FAUNA

3.4.1 Habitat assessment

An initial review of the characteristics of the land systems of the study area did not identify many landforms and features that support characteristic SRE habitat, such as south-facing rockfaces, gullies and isolated mesas. This was confirmed by the habitat assessment as much of the study area is devoid of typical SRE habitat. The Platform land system, which has the greatest coverage of the study area (section 3.1.2) is characterised by stony plains of low relief with spinifex grasslands. The remaining land systems of the study area typically feature low mesas (Robe) and plateaux and ridges (Newman) which potentially support SRE habitats, but these are absent from the disturbance footprint.

Based on aerial imagery, within the tenement there are also two channel systems, one to the north and one to the south. The study area only intersects the southern channel; this channel could provide moisture which is potential SRE habitat. Where the haul road is proposed to be expanded however (Figure 1-2), the existing road avoids major prospective features which could be interpreted as SRE habitat.

3.4.2 SRE taxa

A total of 150 SRE taxa were recovered from the database search of 100 km radius of the study area, but none of these records were located within the study area. The desktop search of the 100 km radius found (Appendix 2):

- nineteen taxa representing confirmed SREs
- one taxon representing a likely SRE
- 130 taxa represent potential SREs.

Considering habitat information provided with these SRE records and existing habitat there is potential for at least 21 taxa from the desktop review to occur in the study area (Table 3-5; Figure 3-7). This list represents a very conservative approach as some taxa listed represent unidentifiable life stages of groups that are known to contain SREs ('sp. indet.') and which may otherwise already be listed, or may in fact represent more widespread species.

Given the small extent of the Bulk Sample area, only very few of the listed species may occur there. In addition, all taxa potentially occurring in the Bulk Sample area have been reported from habitat types that are widespread in the region, such as spinifex grassland and floodplains, and therefore an impact on these is considered minimal.

Table 3-5 SRE taxa likely to occur within the study area based on habitat preference

Taxa	Habitat recorded (as provided by data source)	Likelihood of occurrence and potential for impacts
Araneae (spiders) - Mygalomorphae (trapdoor spiders)		Possible. Lack of optimal habitat but database records from habitat within the study area. Impact unlikely.
Aganippe \`MYG086\`	Spinifex plain	
Aganippe \`MYG233\`	Spinifex plain	
Aganippe sp. indet.	Spinifex plain	
Aname \`MYG098\`	Open floodplain	
Aname \`MYG205\`	Open floodplain	
Aname \`MYG206\`	Open floodplain	
Aname sp. indet.	Grassland, open floodplain, spinifex, undulating plain	
Anidiops sp. indet.	Large *Triodia* hummocks and emergent eucalypts, plain	
Aurecocrypta sp. indet.	Hummock grassland plain	
Conothele sp. indet.	Plain	
Teyl sp. indet.	Plain	
Yilgarnia sp. indet.	Grassland	
Araneae (spiders) - Araneomorphae (modern spiders)		
Karaops sp. indet.	Collected from under rocks	
Pseudoscorpions (pseudoscorpions)		
Paratemnoides sp. indet.	Under rocks	
Olpiidae gen. indet. sp. indet.	Collected from under rocks, plain	
Scorpiones (scorpions)		
Urodacus sp. indet.	Under rocks	
Geopholomorpha (soil centipedes)		
Sepedonophilus sp. indet.	Plain, undulating plain	
Polydesmida (keeled millipedes)		
Antichiropus \`wonmunna\`	Undulating plain	
Antichiropus sp. indet.	Plain	
Eupulmonata (land snails)		
Rhagada richardsonii	Plain; concentrated woodlitter in drifts	
Succinea sp. indet.	Flat country	

Figure 3–7
Short-range endemic taxa from the desktop review that may occur in the study area

- *Aganippe* `MYG086`
- *Aganippe* `MYG233`
- *Aganippe* sp. indet.
- *Aname* `MYG098`
- *Aname* `MYG205`
- *Aname* `MYG206`
- *Aname* sp. indet.
- *Anidiops* sp. indet.
- *Antichiropus* `wonmunna`
- *Antichiropus* sp. indet.
- *Aurecocrypta* sp. indet.
- *Conothele* sp. indet.
- *Karaops* sp. indet.
- Olpiidae gen. indet. sp. indet.
- *Paratemnoides* sp. indet.
- *Rhagada richardsonii*
- *Sepedonophilus* sp. indet.
- *Succinea* sp. indet.
- *Teyl* sp. indet.
- *Urodacus* sp. indet.
- *Yilgarnia* sp. indet.
- Desktop search area
- Railways
- Principal and secondary roads
- Minor road
- Major creeks and rivers
- National Parks and Nature Reserves

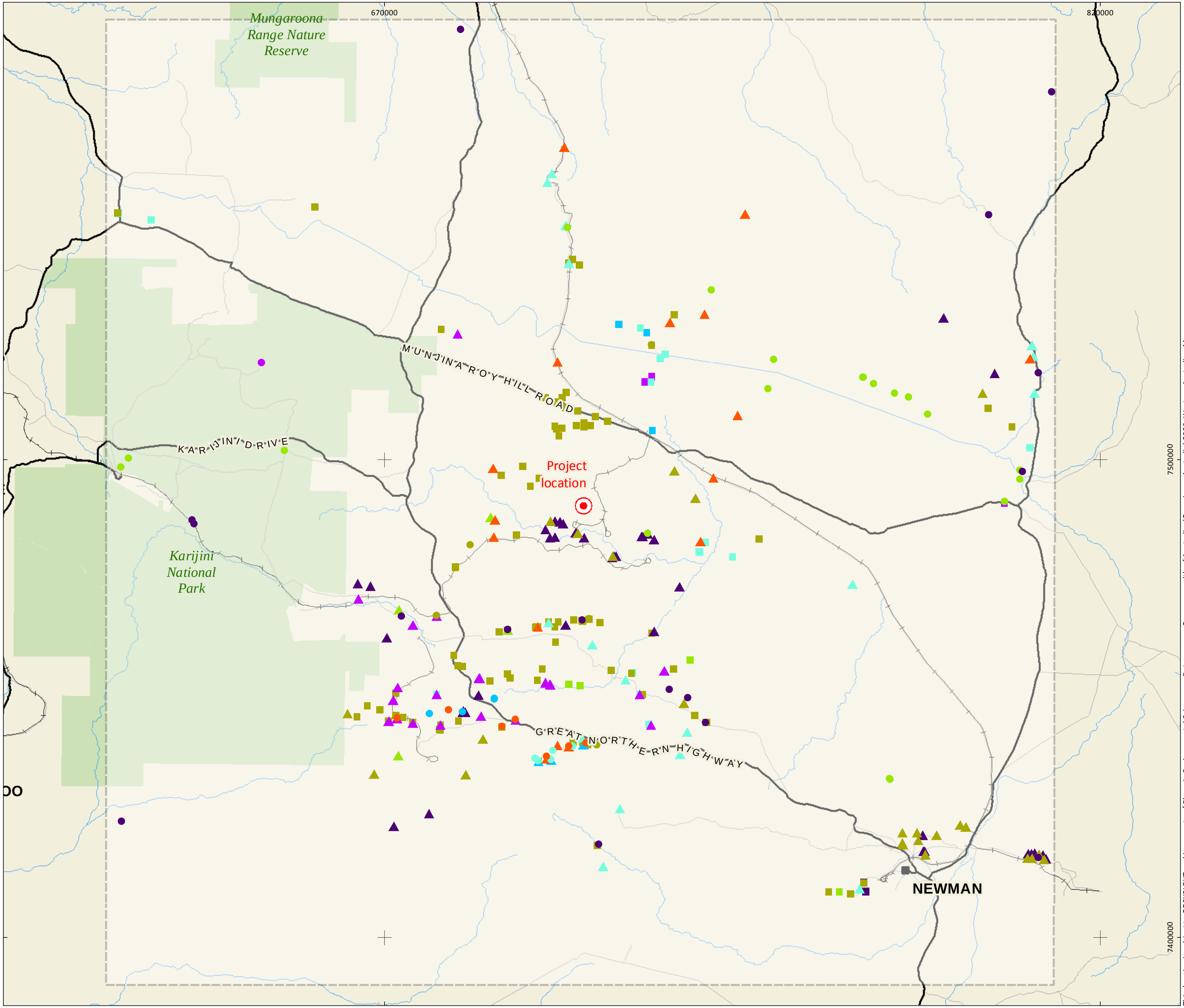
0 10 20 40 Kilometres
1:1,050,000

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

PHOENIX
ENVIRONMENTAL SCIENCES



3.5 TROGLOFAUNA

3.5.1 Habitat assessment

All of the surface geology types present within the study area (section 3.1.3) are known to support troglofauna (EPA 2013b, 2007, 2012). The Bulk Sample is entirely encompassed by one of two Hematite-geothite deposits (Czr1, Czr2) within the study area (Figure 3-2). At their nearest point these two deposits are 260 m apart; Czr1 is entirely encompassed by the project tenements and Czr2 extends beyond the boundary of the tenements.

The close proximity of deposit Czr1 to Czr2 increases the likelihood of a potential subterranean connection; however, it is not known whether this may occur above or below the standing water table. If the geologies are only connected below water table, then they may be effectively isolated from each other and therefore may also support locally endemic troglofauna. If the geologies are broadly connected above the standing water table, then a single troglofauna community is likely to be present.

No other evidence of habitat fragmentation is evident. Assuming that Czr1 represents the smallest potential troglofauna habitat unit for this species, it is possible to estimate potential loss of habitat on this basis. The Bulk Sample represents 0.8% of the surface area of the Czr1 outcropping within which it falls; therefore the potential for impacts is considered to be negligible.

3.5.2 Database searches and literature review

The database searches yielded 218 records of troglobites from ten orders in the classes Arachnida, Chilopoda, Diplopoda, Symphyla, Pauropoda and Malacostraca (Table 3-6; Appendix 3).

WA Museum records revealed a single troglobitic short-tailed whipscorpion (Schizomida), an unidentified *Draculoides* sp. (WAM database T119498), was collected from the Bulk Sample area by Bennelongia in 2009 (Figure 3-8). No technical report was available to provide further information on this record or the survey in which it was collected.

Draculoides sp. is likely to be distributed throughout the Czr1 outcrop that encompasses the proposed pit. Schizomida are small, largely tropical arachnids that live in the top layers of soil or in cavities underneath logs and rocks in rainforests; all species from arid regions in WA are inhabitants of the subterranean fauna (Harvey 1992; Harvey *et al.* 2008; Harvey & Humphreys 1995). Schizomids are carnivorous species and therefore the record suggests the presence of a diverse troglofauna community that also comprises representatives of lower trophic levels commonly found in association with Pilbara schizomids, such as cockroaches, silverfish and diplurans (Bennelongia 2009; Biota 2012j).

All other desktop troglofauna records were outside of the study area (Figure 3-8). The nearest troglofauna records from outside of the study area are:

- *Draculoides* sp. (T130253), approximately 13 km N of the study area
- *Draculoides* sp. (T119493), approximately 12 km SE of the study area
- *Hanseniella* sp. B21 (T131653) (Symphyla) and *Draculoides* sp. B52 (T131652), approximately 15 km SSW of the study area.

Troglobites are not restricted to representatives of the taxa listed in Table 3-6; however, database searches of Hexapoda and Crustacea other than isopods were not provided by the WA Museum. The following troglobitic insect orders sampled from nearby surveys indicate the potential for a wider diversity of troglobites in the study area:

- Bennelongia (2009) (Phil's Creek Project): Thysanura (silverfish) (two species), Blattodea (cockroaches) (two species), Coleoptera (beetles) (one species) and Diptera (flies) (one species)
- Biota (2012j) (Koodaideri): Diplura (diplurans) (one species), Blattodea (cockroaches) (three species), Hemiptera (bugs and allies) (one species).

Table 3-6 Subterranean fauna records identified from within the search area of the desktop review

Order	Number of records
Class Arachnida (spiders and allies)	
Araneae (spiders)	29
Opiliones (harvestmen)	2
Palpigradi (palpigrades)	18
Pseudoscorpiones (pseudoscorpions)	59
Schizomida (short-tailed whipscorpions)	86
Class Chilopoda (centipedes)	
Scolopendromorpha (tropical centipedes)	11
Class Diplopoda (millipedes)	
Spirobolida (spiroboloid millipedes)	1
Class Symphyla (garden centipedes)	
Symphyla (garden centipedes)	7
Class Pauropoda (pauropods)	
Pauropodina (pauropods)	**2**
Class Malacostraca	
Isopoda (slaters)	**3**
Totals	**218**

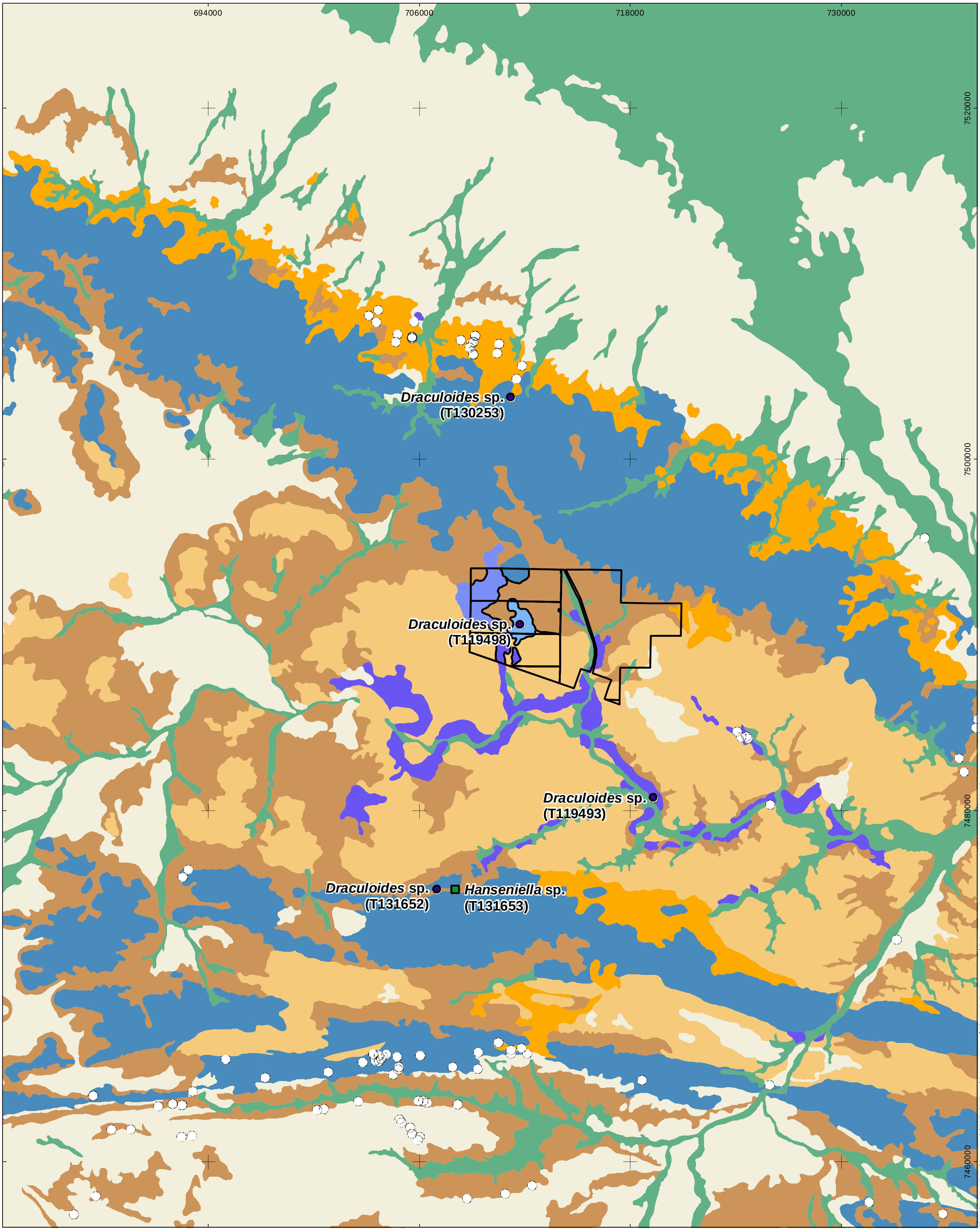


Figure 3–8
Troglofauna records from the search area of the desktop review, and surface geology

PHOENIX
ENVIRONMENTAL SCIENCES

Client: Maiden Iron Pty Ltd
Project: Extension Project and Bulk Sample

Author: G. Bouteloup
Date: 27/03/2014

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

0 2.25 4.5 9 Kilometres
1:280,000

Troglobite records

Troglobite records in closest proximity to study area (with WA Museum registration number)

Draculoides

Hanseniella

Surface gelogy

Non-representative geology
Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels
Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
Czr1: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
Czr2: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
PLHb: Brockman Iron Formation: banded iron-formation, chert, and pelite
PLHj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills.
Qa: Alluvium: unconsolidated silt, sand, and gravel; in drainage channels and on adjacent floodplains

4 DISCUSSION

FLORA AND VEGETATION

Key findings of the desktop review in relation to flora and vegetation of the study area were:

- no threatened ecological communities or priority ecological communities are considered likely to occur
- no Threatened flora species are considered likely to occur
- 13 Priority flora species were assessed as possibly occurring including one P1 species (*Euphorbia inappendiculata* var. *queenslandica*), three P2 species (*Isotropis parviflora*, *Vigna* sp. central (M.E. Trudgen 1626), *Euphorbia inappendiculata* var. *inappendiculata*), seven P3 species (*Acacia subtiliformis*, *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727), *Gymnanthera cunninghamii*, *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479), *Rostellularia adscendens* var. *latifolia*, *Sida sp.* Barlee Range (S. van Leeuwen 1642), *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)) and two P4 flora species (*Goodenia nuda*, *Rhynchosia bungarensis*)
- the vegetation of the study area is classified as 'Least Concern' in terms of extent of vegetation remaining within the Hamersley subregion (PIL 3) compared to pre-European extents
- there are no wetlands or conservation areas managed by DPaW in the study area and none that are in close proximity that could be directly or indirectly impacted by the proposed clearing of native vegetation.
- no Environmentally Sensitive Areas (ESAs) or named watercourses are located within or in close proximity to the study area.

FAUNA

Key findings of the desktop review in relation to fauna of the study area were:

- the study area is largely homogenous in terms of fauna habitat, represented mostly by spinifex grassland on plateau of gently rolling hills, intersected by very small extents of minor drainage line, minor creek line and mixed shrubland; there are no distinguishing features that suggest any isolated or rare habitats are present that may be critical for listed vertebrate species.
- two Threatened vertebrate species were assessed as potentially occurring, Grey Falcon and Orange Leaf-nosed Bat
- three Priority vertebrate species were assessed as potentially occurring, Australian Bustard, Western Pebble-mound Mouse, Ghost Bat
- three other listed species were assessed as potentially occurring, including Fork-tailed Swift and Rainbow Bee-eater, both migratory and the Peregrine Falcon, Schedule 3 under the WC Act
- none of the potentially occurring listed vertebrate species are likely to be highly dependent on the habitats of the study area.
- the Bulk Sample area avoids major prospective features that provide typical habitat for SRE taxa

- database searches identified 21 terrestrial invertebrate fauna taxa with potentially restricted ranges that have been recorded in the habitat types that are present within the study area; however, based on the small size of the Bulk Sample area, few of these may occur there and all these taxa are from habitat that is well-represented in the region
- the Bulk Sample is entirely encompassed by one of two Hematite-geothite deposits (Czr1) within the study area; this geology type is known to support troglofauna
- a single troglobitic schizomid record, *Draculoides* sp. (WAM database no. T119498) was identified from within the study area in the Czr1 deposit.

Potential impacts to the greater population of any listed flora or terrestrial fauna present in the study area is expected to be low to negligible due to the very small proposed disturbance footprint of the Bulk Sample.

Potential for impacts to the troglobitic schizomid species are considered to be negligible owing to the small size (2 ha) and depth (5-10 m) of the proposed pit. Assuming that Czr1 represents the smallest potential troglofauna habitat unit for this species, the Bulk Sample represents 0.8% of the surface area of the Czr1 outcropping within which it falls.

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Appendix 1 Vertebrate fauna species records from desktop review

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
AMPHBIANS												
Cyclorana maini	Sheep Frog							•				•
Litoria rubella	Little Red Tree Frog							•				•
Uperoleia russelli	Northwest Toadlet							•				•
REPTILES												
Amphibolurus longirostris	Long-nosed Dragon							•				•
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon							•				•
Ctenophorus isolepis isolepis	Central Military Dragon							•				•
Ctenophorus nuchalis	Central Netted Dragon							•				•
Ctenophorus reticulatus	Western Netted Dragon							•				•
Diporiphora amphiboluroides	Mulga Dragon											•
Diporiphora valens	Southern Pilbara Tree Dragon							•				•
Tympanocryptis cephalus	Pebble Mimic Dragon											•
Pogona minor minor	Western Bearded Dragon							•				•
Crenadactylus ocellatus horni	No Common Name							•				•
Diplodactylus conspicillatus	Fat-tailed Gecko							•				•

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Diplodactylus pulcher	No Common Name							•				•
Diplodactylus savagei	Yellow-spotted Pilbara Gecko							•				•
Lucasium stenodactylum	Sand-plain Gecko							•				•
Lucasium wombeyi	Pilbara Ground Gecko							•				•
Oedura marmorata	Marbled Velvet Gecko							•				•
Rhynchoedura ornata	Western Beaked Gecko							•				•
Strophurus elderi	Jewelled Gecko							•				•
Strophurus jeanae	Southern Phasmid Gecko							•				•
Strophurus wellingtonae	Western Spiny-tailed Gecko							•				•
Nephrurus wheeleri cinctus	Northern Banded Knob-tailed Gecko							•				•
Gehyra pilbara	Pilbara Dtella							•				•
Gehyra punctata	Spotted Dtella							•				•
Gehyra purpurascens	Purplish Dtella							•				•
Gehyra variegata	Variegated Tree Dtella							•				•
Heteronotia binoei	Bynoe's Gecko							•				•
Heteronotia spelea	Desert Cave Gecko							•				•

Scientific name	**Common name**	**EPBC Threatened species**	**EPBC Migratory**	**EPBC Marine**	**WC Act**	**DPaW**	**Introduced**	**NatureMap**	**Birdata**	**EPBC Protected Matters Database**	**DPaW Threatened Fauna Database**	**Literature Review**
Delma butleri	Unbanded Delma							•				•
Delma nasuta	No Common Name							•				•
Delma pax	Peace Delma							•				•
Delma tincta	Excitable Delma							•				•
Lialis burtonis	Burton's Legless Lizard							•				•
Pygopus nigriceps	Western Hooded Scaly-foot							•				•
Carlia munda	Rainbow-skink							•				•
Carlia triacantha	Desert Rainbow-skink							•				•
Cryptoblepharus plagiocephalus	Peron's Snake-eyed Skink							•				
Cryptoblepharus ustulatus	Russet Snake-eyed Skink							•				•
Ctenotus ariadnae	Ariadna's Ctenotus							•				•
Ctenotus duricola	Pilbara Ctenotus							•				•
Ctenotus grandis titan	No Common Name							•				•
Ctenotus hanloni	Hanlon's Ctenotus											•
Ctenotus helenae	Clay-soil Ctenotus							•				•
Ctenotus pantherinus ocellifer	No Common Name							•				•

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus							•				•
Ctenotus rubicundus	Ruddy Ctenotus							•				•
Ctenotus rutilans	Rusty Ctenotus							•				•
Ctenotus saxatilis	Rock Ctenotus							•				•
Ctenotus schomburgkii	Barred Widesnout Ctenotus							•				•
Ctenotus serventyi	No Common Name							•				
Ctenotus uber	No Common Name											•
Cyclodomorphus melanops melanops	Spinifex Slender Blue-tongue							•				•
Egernia formosa	Goldfields Crevice Skink							•				•
Eremiascincus richardsonii	Broad-banded Sand Swimmer							•				•
Lerista bipes	North-western Sandslider							•				•
Lerista jacksoni	Jackson's Lerista							•				•
Lerista muelleri	Wood Mulch Slider							•				•
Lerista timida	Timid Slider							•				•
Lerista verhmens	No Common Name							•				•
Lerista zietzi	Pilbara Blue-tailed Slider							•				•

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Menetia greyii	Common Dwarf Skink							●				●
Menetia surda surda	Western Dwarf Skink							●				●
Morethia ruficauda exquisita	Pilbara Lined Fire-tailed Skink							●				●
Proablepharus reginae	Western Soil-crevice Skink							●				●
Tiliqua multifasciata	Central Blue-tongue							●				●
Varanus acanthurus	Ridge-tailed Monitor							●				●
Varanus brevicauda	Short-tailed Pygmy Monitor							●				●
Varanus bushi	Pilbara Mulga Monitor							●				●
Varanus caudolineatus	Stripe-tailed Pygmy Monitor											●
Varanus eremius	Pygmy Desert Monitor							●				●
Varanus giganteus	Perentie											●
Varanus gilleni	No Common Name											●
Varanus gouldii	Sand Monitor											●
Varanus panoptes rubidus	No Common Name							●				●
Varanus pilbarensis	Pilbara Rock Monitor							●				●
Varanus tristis tristis	Black-headed Monitor							●				●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Ramphotyphlops ammodytes	No Common Name							●				●
Ramphotyphlops ganei	Gane's Blind Snake					P1		●			●	●
Ramphotyphlops grypus	Beaked Blind Snake							●				●
Ramphotyphlops hamatus	Paleheaded Blind Snake							●				●
Ramphotyphlops pilbarensis	Pilbara Bline Snake											●
Ramphotyphlops waitii	No Common Name											●
Antaresia perthensis	Pygmy Python							●				●
Antaresia stimsoni	Stimson's Python							●				●
Liasis olivaceus barroni	Pilbara Olive Python	VU			S1	VU		●		●	●	
Acanthophis wellsi	Pilbara Death Adder											●
Brachyurophis approximans	North-western Shovel-nosed Snake							●				●
Demansia psammophis cupreiceps	Yellow-faced Whipsnake							●				●
Demansia rufescens	Rufous Whipsnake							●				●
Furina ornata	Moon Snake							●				●
Parasuta monachus	Monk Snake							●				●
Pseudechis australis	Mulga Snake							●				●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Pseudonaja mengdeni	Western Brown Snake											•
Pseudonaja modesta	Ringed Brown Snake							•				•
Suta fasciata	Rosen's Snake							•				
Suta punctata	Little Spotted Snake											•
Vermicella snelli	Pilbara Bandy-bandy							•				•
BIRDS												
Dromaius novaehollandiae	Emu							•	•			•
Coturnix ypsilophora	Brown Quail											•
Anas superciliosa	Pacific Black Duck							•				
Chenonetta jubata	Australian Wood Duck											•
Phaps chalcoptera	Common Bronzewing							•				•
Ocyphaps lophotes	Crested Pigeon							•	•			•
Geophaps plumifera	Spinifex Pigeon							•				•
Geopelia cuneata	Diamond Dove							•				•
Geopelia striata	Peaceful Dove							•				•
Podargus strigoides	Tawny Frogmouth							•				•

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Eurostopodus argus	Spotted Nightjar			●				●	●			●
Aegotheles cristatus	Australian Owlet-nightjar							●				●
Apus pacificus	Fork-tailed Swift		●	●	S3					●		●
Anhinga novaehollandiae	Australasian Darter							●				
Phalacrocorax varius	Pied Cormorant							●				
Pelecanus conspicillatus	Australian Pelican			●				●				
Ardea modesta	Eastern Great Egret		●	●	S3					●		
Ardea ibis	Cattle Egret		●	●	S3					●		
Egretta novaehollandiae	White-faced Heron							●				●
Nycticorax caledonicus	Nankeen Night-heron			●				●				
Threskiornis spinicollis	Straw-necked Ibis											●
Elanus axillaris	Black-shouldered Kite							●				●
Hamirostra melanosternon	Black-breasted Buzzard											●
Haliastur sphenurus	Whistling Kite			●				●				●
Milvus migrans	Black Kite							●	●			●
Accipiter fasciatus	Brown Goshawk			●				●				●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Accipiter cirrocephalus	Collared Sparrowhawk							●				●
Circus assimilis	Spotted Harrier							●				●
Circus approximans	Swamp Harrier			●				●				●
Aquila audax	Wedge-tailed Eagle							●	●			●
Hieraaetus morphnoides	Little Eagle								●			●
Falco cenchroides	Nankeen Kestrel			●				●				●
Falco berigora	Brown Falcon							●				●
Falco longipennis	Australian Hobby							●				●
Falco peregrinus	Peregrine Falcon				S4	SP		●			●	●
Ardeotis australis	Australian Bustard					P4		●			●	●
Charadrius veredus	Oriental Plover		●	●	S3					●		
Elseyornis melanops	Black-fronted Dotterel							●				
Rostratula australis	Australian Painted Snipe	EN	●	●	S1/S3	EN				●		
Tringa nebularia	Common Greenshank		●	●	S3			●			●	
Turnix varius	Painted Button-quail							●				
Turnix velox	Little Button-quail							●	●			●

Scientific name	**Common name**	**EPBC Threatened species**	**EPBC Migratory**	**EPBC Marine**	**WC Act**	**DPaW**	**Introduced**	**NatureMap**	**Birdata**	**EPBC Protected Matters Database**	**DPaW Threatened Fauna Database**	**Literature Review**
Eolophus roseicapillus	Galah							●	●			●
Cacatua sanguinea	Little Corella							●				●
Nymphicus hollandicus	Cockatiel							●				●
Barnardius zonarius	Australian Ringneck							●				●
Melopsittacus undulatus	Budgerigar							●	●			●
Pezoporus occidentalis	Night Parrot	EN	●		S1	CR				●		
Centropus phasianinus	Phesant Coucal											●
Chalcites basalis	Horsfield's Bronze-cuckoo			●				●				●
Chalcites osculans	Black-eared Cuckoo			●				●				●
Cacomantis pallidus	Pallid Cuckoo			●					●			●
Ninox novaeseelandiae	Southern Boobook											●
Ninox connivens peninsularis	Barking Owl (Pilbara)							●			●	
Tyto javanica	Eastern Barn Owl											●
Dacelo leachii	Blue-winged Kookaburra							●				●
Todiramphus sanctus	Sacred Kingfisher			●				●				●
Todiramphus pyrrhopygius	Red-backed Kingfisher											●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Merops ornatus	Rainbow Bee-eater		●	●	S3			●		●	●	●
Ptilonorhynchus maculatus	Western Bowerbird							●				●
Climacteris melanura	Black-tailed Treecreeper											●
Malurus leucopterus	White-winged Fairy-wren							●	●			●
Malurus lamberti	Variegated Fairy-wren							●				●
Stipiturus ruficeps	Rufous-crowned Emu-wren							●				●
Amytornis striatus whitei	Striated Grasswren (Pilbara)							●				●
Smicrornis brevirostris	Weebill							●				●
Gerygone fusca	Western Gerygone							●				●
Acanthiza robustirostris	Slaty-backed Thornbill							●				●
Acanthiza chrysorrhoa	Yellow-rumped Thornbill							●				●
Acanthiza uropygialis	Chestnut-rumped Thornbill							●				●
Acanthiza apicalis	Inland Thornbill							●				●
Pardalotus rubricatus	Red-browed Pardalote							●				●
Pardalotus striatus	Striated Pardalote							●				●
Certhionyx variegatus	Pied Honeyeater							●				●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Lichenostomus virescens	Singing Honeyeater								●			●
Lichenostomus keartlandi	Grey-headed Honeyeater							●				●
Lichenostomus plumulus	Grey-fronted Honeyeater								●			●
Lichenstomus penicillatus	White-plumed Honeyeater											●
Purnella albifrons	White-fronted Honeyeater											●
Manorina flavigula	Yellow-throated Miner							●	●			●
Acanthagenys rufogularis	Spiny-cheeked Honeyeater							●	●			●
Epthianura tricolor	Crimson Chat							●	●			●
Sugomel niger	Black Honeyeater											●
Lichmera indistincta	Brown Honeyeater							●	●			●
Melithreptus gularis	Black-chinned Honeyeater							●				●
Pomatostomus temporalis	Grey-crowned Babbler							●				●
Pomatostomus superciliosus	White-browed Babbler							●				
Coracina novaehollandiae	Black-faced Cuckoo-shrike			●				●				●
Lalage sueurii	White-winged Triller							●				●
Pachycephala rufiventris	Rufous Whistler							●	●			●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Colluricincla harmonica	Grey Shrike-thrush							●				●
Oreoica gutturalis pallescens	Crested Bellbird							●	●			●
Artamus personatus	Masked Woodswallow							●				●
Artamus cinereus	Black-faced Woodswallow							●	●			●
Artamus minor	Little Woodswallow							●				●
Cracticus torquatus	Grey Butcherbird							●				●
Cracticus nigrogularis	Pied Butcherbird							●	●			●
Cracticus tibicen	Australian Magpie							●				●
Rhipidura leucophrys	Willie Wagtail							●	●			●
Corvus bennetti	Little Crow								●			●
Corvus orru	Torresian Crow							●				●
Grallina cyanoleuca	Magpie-lark			●				●				●
Petroica goodenovii	Red-capped Robin							●				●
Melanodryas cucullata	Hooded Robin							●				●
Mirafra javanica	Horsfield's Bushlark							●				●
Acrocephalus australis	Australian Reed-Warbler							●				

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Cincloramphus mathewsi	Rufous Songlark							●				●
Cincloramphus cruralis	Brown Songlark							●				●
Eremiornis carteri	Spinifexbird							●				●
Petrochelidon ariel	Fairy Martin							●				●
Petrochelidon nigricans	Tree Martin			●				●				●
Dicaeum hirundinaceum	Mistletoebird							●				●
Taeniopygia guttata	Zebra Finch							●	●			●
Neochmia ruficauda sub. clarescens	Star Finch					P4		●				●
Emblema pictum	Painted Finch							●				●
Anthus novaeseelandiae	Australasian Pipit			●				●	●			●
MAMMALS												
Trachyglossus aculeatus	Echidna											●
Dasykaluta rosamondae	Little Red Kaluta							●				●
Dasyurus hallucatus	Northern Quoll	EN			S1	EN		●	●		●	●
Ningaui timealeyi	Pilbara Ningaui							●				●
Planigale sp.	Long-tailed Planigale							●				●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Pseudantechinus woolleyae	Woolley's Pseudantechinus							•				
Sminthopsis macroura	Stripe-faced Dunnart							•				•
Sminthopsis ooldea	Ooldea Dunnart							•				•
Sminthopsis youngsoni	Lesser Hairy-footed Dunnary											•
Macrotis lagotis	Greater Bilby	VU			S1	VU			•			
Notoryctes caurinus	Northern Marsupial Mole	EN			S1	EN			•			
Macropus robustus	Euro							•				•
Macropus rufus	Red Kangaroo							•				•
Petrogale rothschildi	Rothschild's Rock-wallaby							•				
Rhinonicteris aurantia	Orange Leafnosed-bat	VU			S1	VU		•	•		•	•
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat							•				•
Taphozous georgianus	Common Sheathtail-bat							•				•
Taphozous hilli	Hill's Sheathtail-bat							•				•
Chalinolobus gouldii	Gould's Wattled Bat							•				•
Chalinolobus morio	Chocolate Wattled Bat							•				
Nyctophilus daedalus	Northwestern Long-eared Bat							•				•

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Nyctophilus geoffroyi	Lesser Long-eared Bat							●				●
Scotorepens greyii	Little Broad-nosed Bat							●				●
Vespadelus finlaysoni	Finlayson's Cave Bat							●				●
Chaerephon jobensis	Northern Freetail-bat							●				●
Mormopterus beccarii	Beccari's Freetail-bat							●				●
Mus musculus	House Mouse						●	●	●			●
Notomys alexis	Spinifex Hopping Mouse											●
Pseudomys chapmani	Western Pebble-mound Mouse					P4		●			●	●
Pseudomys desertor	Desert Mouse							●				●
Pseudomys hermannsburgensis	Sandy Inland Mouse							●				●
Zyzomys argurus	Common Rock-rat							●				●
Oryctolagus cuniculus	Rabbit						●		●			●
Camelus dromedarius	Camel						●		●			
Bos taurus	Cattle						●					●
Canis lupus	Dog / Dingo						●	●				●
Vulpes vulpes	Red Fox						●		●			

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review
Felis catus	Cat						•	•	•			•
Equus asinus	Donkey						•		•			•
Equus caballus	Horse						•	•	•			•

Appendix 2 Short-range endemic invertebrate species records from desktop review

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
Order Araneae (spiders)							
Infraorder Araneomorphae (modern spiders)							
T112015	Selenopidae	*Karaops* \`BD1\`	114 km NNW. of Newman	Midslope	119.739	-22.3257	Potential
T112016	Selenopidae	*Karaops* \`BD1\`	114 km NNW. of Newman		119.739	-22.3257	Potential
T112017	Selenopidae	*Karaops* \`BD1\`	115 km NNW. of Newman	Midslope	119.748	-22.3179	Potential
T112018	Selenopidae	*Karaops* \`BD1\`	113 km NNW. of Newman	Ridgetop	119.653	-22.3352	Potential
T101159	Selenopidae	*Karaops banyjima*	Area C 87.3 km NW. of Newman	Gully in soil	119.045	-22.8953	Potential
T111456	Selenopidae	*Karaops feedtime*	Bonney Downs 115 km NNW. of Newman		119.733	-22.3167	Potential
T79407	Selenopidae	*Karaops forteyi*	27.5 km N. of Cowra Line Camp Pilbara Survey site RHNW8		119.001	-22.1068	Potential
T79408	Selenopidae	*Karaops forteyi*	24.5 km N. of Cowra Line Camp Pilbara Survey site RHNW10		119.024	-22.1347	Potential
T112019	Selenopidae	*Karaops* sp. indet.	115 km N. of Newman		119.789	-22.3135	Potential
T115975	Selenopidae	*Karaops* sp. indet.	Angelo River	Leaf litter	118.682	-23.2901	Potential
T115976	Selenopidae	*Karaops* sp. indet.	Angelo River	Leaf litter	118.754	-23.2648	Potential
T116567	Selenopidae	*Karaops* sp. indet.	Mudlark 96 km WNW. of Newman	Under rocks	118.852	-23.0403	Potential
T116568	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.82	-23.0731	Potential
T116569	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.82	-23.0731	Potential
T116570	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.82	-23.0731	Potential
T116571	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.82	-23.0731	Potential
T116572	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.825	-23.0731	Potential
T116573	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.825	-23.0731	Potential
T116574	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.825	-23.0731	Potential
T116575	Selenopidae	*Karaops* sp. indet.	Mudlark 98 km WNW. of Newman	Under rocks	118.825	-23.0731	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T117877	Selenopidae	*Karaops* sp. indet.	98.5 km W. of Newman	Under rocks	118.821	-23.0706	Potential
T117878	Selenopidae	*Karaops* sp. indet.	98.5 km W. of Newman	Under rocks	118.821	-23.0706	Potential
T117879	Selenopidae	*Karaops* sp. indet.	98.5 km W. of Newman	Under rocks	118.821	-23.0706	Potential
T117880	Selenopidae	*Karaops* sp. indet.	98.5 km W. of Newman	Under rocks	118.821	-23.0706	Potential
T121790	Selenopidae	*Karaops* sp. indet.	87.5 km NW. of Newman Area C site SUR 19		119.029	-22.9056	Potential
T122804	Selenopidae	*Karaops* sp. indet.	129.2 km NW. of Newman	Rocky gorge	118.603	-22.8317	Potential
T122805	Selenopidae	*Karaops* sp. indet.	129.2 km NW. of Newman	Rocky gorge	118.603	-22.8317	Potential
T122806	Selenopidae	*Karaops* sp. indet.	127.1 km NW. of Newman	Rocky gorge	118.629	-22.8369	Potential
T122807	Selenopidae	*Karaops* sp. indet.	127.1 km NW. of Newman	Rocky gorge	118.629	-22.8369	Potential
T122810	Selenopidae	*Karaops* sp. indet.	119.4 km NW. of Newman	Rocky gorge	118.664	-22.9339	Potential
T123838	Selenopidae	*Karaops* sp. indet.	100 km N. of Newman		119.894	-22.4171	Potential
T130400	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop	119.014	-22.711	Potential
T130401	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop	119.014	-22.711	Potential
T130402	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Veg. grove	119.004	-22.7092	Potential
T130403	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Veg. grove	119.004	-22.7092	Potential
T130404	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Drainage/ Ridge-outcrop	118.984	-22.7259	Potential
T130405	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Drainage/ Ridge-outcrop	119.004	-22.7398	Potential
T130406	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Gully	119.129	-22.7744	Potential
T130407	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Gully	119.129	-22.7744	Potential
T130408	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Gully	119.125	-22.7736	Potential
T130409	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/	119.123	-22.7746	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
				Gully			
T130410	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Gully	119.121	-22.776	Potential
T130411	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Gully/ Minor outcrop	119.047	-22.7305	Potential
T130412	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Gully/ Minor outcrop	119.047	-22.7305	Potential
T130413	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Drainage/ Ridge-outcrop	119.05	-22.7322	Potential
T130414	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop	119.064	-22.7404	Potential
T130415	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Drainage	118.993	-22.7415	Potential
T130416	Selenopidae	*Karaops* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop	119.02	-22.7141	Potential
T131486	Selenopidae	*Karaops* sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Under rocks	120.019	-23.3314	Potential
T131487	Selenopidae	*Karaops* sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Under rocks	119.986	-23.3277	Potential
T131488	Selenopidae	*Karaops* sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Under rocks	119.982	-23.3227	Potential
T131491	Selenopidae	*Karaops* sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Under rocks	120.012	-23.3247	Potential
T131492	Selenopidae	*Karaops* sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Under rocks	119.989	-23.3225	Potential
T131493	Selenopidae	*Karaops* sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Under rocks	119.996	-23.3206	Potential
T76978	Selenopidae	*Karaops* sp. indet.	NW. of Newman Ore Body 24 site 1 (waypoint 119)		119.765	-23.2911	Potential
T76979	Selenopidae	*Karaops* sp. indet.	NW. of Newman Ore Body 24 site 1 (waypoint 119)		119.765	-23.2911	Potential
T76980	Selenopidae	*Karaops* sp. indet.	NE. of Newman Ore Body 25 site 1 (waypoint 128)		119.767	-23.3219	Potential
T76981	Selenopidae	*Karaops* sp. indet.	NE. of Newman Ore Body 25 site 1 (waypoint 128)		119.767	-23.3219	Potential
T76982	Selenopidae	*Karaops* sp. indet.	NE. of Newman Ore Body 25 site 5 (waypoint 133)		119.77	-23.3222	Potential
T77791	Selenopidae	*Karaops* sp. indet.	Yandi 24 km SW. of Marillana YEX75		119.26	-22.83	Potential
T79406	Selenopidae	*Karaops* sp. indet.	0.5 km NW. of Weeli Wolli Spring Pilbara Survey site RHNC11		119.209	-22.9147	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T97629	Selenopidae	*Karaops* sp. indet.	Phils Creek Pilbara Ecologia project 1038		119.193	-22.7316	Potential
T97630	Selenopidae	*Karaops* sp. indet.	Phils Creek Pilbara Ecologia project 1038		119.207	-22.7419	Potential
T97631	Selenopidae	*Karaops* sp. indet.	Phils Creek Pilbara Ecologia project 1038	Under stone	119.183	-22.7361	Potential
T97632	Selenopidae	*Karaops* sp. indet.	Phils Creek Pilbara Ecologia project 1038	Under stone	119.181	-22.7366	Potential
T82064	Oonopidae	*Opopaea aculeatea*	16 km SW. of Rhodes Ridge Pilbara Biological Survey site RHNC06		119.238	-23.1852	Potential
T121116	Oonopidae	*Opopaea aurantiaca*	12 km NE. of Mile Camp site RHNE03		119.726	-22.7073	Potential
T121117	Oonopidae	*Opopaea aurantiaca*	12 km NE. of Mile Camp site RHNE03		119.726	-22.7073	Potential
T78369	Oonopidae	*Opopaea aurantiaca*	21 km WNW. of Bonney Downs Homestead Pilbara Biological Survey site RHNE11		119.754	-22.0947	Potential
T81866	Oonopidae	*Opopaea aurantiaca*	12 km NE. of Mile Camp Pilbara Biological Survey site RHNE03		119.709	-22.7073	Potential
T81867	Oonopidae	*Opopaea aurantiaca*	6 km N. of Cowra Line Camp Pilbara Biological Survey site RHNW06		119.013	-22.3018	Potential
T78350	Oonopidae	*Opopaea durranti*	26 km WNW. of Bonney Downs Homestead Pilbara Biological Survey site RHNE12		119.704	-22.0852	Potential
T121113	Oonopidae	*Opopaea exoculata*	24 km ENE. of Moorimoordinina Native Well site RHNE08		119.976	-22.4519	Potential
T78373	Oonopidae	*Opopaea exoculata*	Roy Hill Station 24 km ENE. of Moormooridinina Native Well site RHNE08		119.976	-22.4519	Potential
T108543	Oonopidae	*Opopaea* sp. indet.	20.5 km NW. of Roy Hill Station homestead		119.871	-22.4548	Potential
T78352	Oonopidae	*Opopaea* sp. indet.	26 km WNW. of Bonney Downs Homestead Pilbara Biological Survey site RHNE12		119.704	-22.0852	Potential
T82018	Oonopidae	*Opopaea* sp. indet.	27.5 km N. of Cowra Line Camp Pilbara Biological Survey site RHNW08		119.001	-22.1068	Potential
T82054	Oonopidae	*Opopaea* sp. indet.	1.5 km W. of Giles Point Pilbara Biological Survey site RHNC04		119.145	-23.2509	Potential
T82061	Oonopidae	*Opopaea* sp. indet.	6 km N. of Cowra Line Camp Pilbara Biological Survey site RHNW06		119.013	-22.3018	Potential
T121123	Oonopidae	*Opopaea subtilis*	5.5 km NE. of Giles Point site RHNC05B		119.202	-23.2136	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T82057	Oonopidae	*Opopaea subtilis*	5.5 km NE. of Giles Point Pilbara Biological Survey site RHNC05B		119.202	-23.2136	Potential
Infraorder Mygalomorphae (trapdoor spiders)							
T122441	Actinopodidae	*Missulena* `insignis grp`	16 km N. of Cowra Line Camp site RHNW07		119.025	-22.2217	Potential
T122093	Actinopodidae	*Missulena* `MYG252-DNA`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.919	-22.5226	Potential
T122094	Actinopodidae	*Missulena* `MYG252-DNA`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.919	-22.5226	Potential
T122095	Actinopodidae	*Missulena* `MYG252-DNA`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.97	-22.5561	Potential
T122096	Actinopodidae	*Missulena* `MYG252-DNA`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.97	-22.5561	Potential
T122099	Actinopodidae	*Missulena* `MYG252-DNA`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.942	-22.4789	Potential
T122101	Actinopodidae	*Missulena* `MYG252-DNA`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.919	-22.5225	Potential
T131217	Actinopodidae	*Missulena* `MYG252-DNA`	Roy Hill Mine 1 ca. 90 km N. Newman	Mulga woodland tributary	119.942	-22.4789	Potential
T96132	Actinopodidae	*Missulena faulderi*	Jinayri ca. 60 km NW. of Newman		119.278	-23.0416	Potential
T96133	Actinopodidae	*Missulena faulderi*	Jinayri ca. 60 km NW. of Newman		119.28	-23.0408	Potential
T97017	Actinopodidae	*Missulena faulderi*	Jinayri ca. 65 km NW. of Newman		119.267	-22.9678	Potential
T112076	Actinopodidae	*Missulena langlandsi*	Wonmunna ca. 73 km heading 291° from Newman	Major creek	119.064	-23.1192	Potential
T115948	Actinopodidae	*Missulena langlandsi*	Wonmunna ca. 73 km heading 291° from Newman	Wide creek	119.063	-23.121	Potential
T91911	Actinopodidae	*Missulena langlandsi*	Hamersley Range Weeli Wolli Creek region Area C site 09-9C		119.038	-22.9258	Potential
T91912	Actinopodidae	*Missulena langlandsi*	Hamersley Range Weeli Wolli Creek region Area C site 15-15B		119.047	-22.9314	Potential
T91913	Actinopodidae	*Missulena langlandsi*	Hamersley Range Weeli Wolli Creek region Area C site 15-15D		119.047	-22.9314	Potential
T91914	Actinopodidae	*Missulena langlandsi*	Hamersley Range Weeli Wolli Creek region Area C site 15-15E		119.047	-22.9316	Potential
T103213	Actinopodidae	*Missulena* sp. indet.	Area C 86.4 km NW. of Newman		119.015	-22.9472	Potential
T103237	Actinopodidae	*Missulena* sp. indet.	Area C 85.7 km NW. of Newman		119.025	-22.9486	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T107190	Actinopodidae	*Missulena* sp. indet.	Chichester Range	Leaf litter	119.419	-22.6688	Potential
T107192	Actinopodidae	*Missulena* sp. indet.	Chichester Range	Leaf litter	119.419	-22.6688	Potential
T112073	Actinopodidae	*Missulena* sp. indet.	110 km NNE. of Newman		119.973	-22.3827	Potential
T112593	Actinopodidae	*Missulena* sp. indet.	Jinidy to Mindy 71.9 km NW. of Newman		119.139	-23.0031	Potential
T112594	Actinopodidae	*Missulena* sp. indet.	Jinidy to Mindy 71.8 km NW. of Newman		119.14	-23.0028	Potential
T115950	Actinopodidae	*Missulena* sp. indet.	Wonmunna ca. 78 km heading 288° from Newman	Mulga woodland plain	119.01	-23.1428	Potential
T116862	Actinopodidae	*Missulena* sp. indet.	Mudlark 121 km W. of Newman		118.584	-23.0817	Potential
T125336	Actinopodidae	*Missulena* sp. indet.	Koodaideri Western Corridor 154.4 km NW. of Newman		118.723	-22.3209	Potential
T125339	Actinopodidae	*Missulena* sp. indet.	Koodaideri Western Corridor 154.8 km NW. of Newman		118.723	-22.3209	Potential
T113641	Barychelidae	*Aurecocrypta* \`MYG246\`	113.5 km NW. of Newman		118.834	-22.7536	Potential
T113668	Barychelidae	*Aurecocrypta* \`MYG246\`	108.4 km NW. of Newman		119.026	-22.6258	Potential
T119722	Barychelidae	*Aurecocrypta* \`MYG246\`	Juna Downs Station 113 km NW. of Newman		118.856	-22.7189	Potential
T119730	Barychelidae	*Aurecocrypta* \`MYG246\`	Juna Downs Station 114 km NW. of Newman		118.917	-22.6544	Potential
T103910	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	West Angelas 98 km SE. of Tom Price		118.615	-23.1419	Potential
T105894	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	Area C 97.6 km NW. of Newman		118.86	-23.0106	Potential
T116787	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	Mudlark 108 km W. of Newman		118.729	-23.0425	Potential
T116800	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	Mudlark 108 km W. of Newman		118.766	-23.0397	Potential
T91895	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	10 km NE. of Newman Ore-body 24 site 06-6B		119.804	-23.3038	Potential
T91896	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	10 km NE. of Newman Ore-body 24 site 07-7C		119.815	-23.3079	Potential
T93462	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	Hope Downs 4 ca. 30 km NW. Newman HD4-16 20	Rocky slopes with boulders occ. Eucalypts	119.171	-23.0914	Potential
T93465	Barychelidae	*Aurecocrypta* \`MYG315-DNA\`	Hope Downs 4 ca. 30 km NW. Newman HD4-3 10	Open eucalypt over mixed shrubs	119.529	-23.1533	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
				and Triodia			
T107962	Barychelidae	*Aurecocrypta* \`MYG316-DNA\`	Koodaideri 105.7 km NW. of Newman		119.14	-22.5761	Potential
T122331	Barychelidae	*Aurecocrypta* \`MYG316-DNA\`	Marillana 96.7 km NW. of Newman		119.202	-22.6346	Potential
T103248	Barychelidae	*Aurecocrypta* \`MYG317-DNA\`	Area C 74.9 km NW. of Newman		119.192	-22.9169	Potential
T119713	Barychelidae	*Aurecocrypta* sp. indet.	Juna Downs Station 112 km NW. of Newman		118.882	-22.7089	Potential
T119724	Barychelidae	*Aurecocrypta* sp. indet.	Juna Downs Station 114 km NW. of Newman		118.873	-22.7033	Potential
T122866	Barychelidae	*Aurecocrypta* sp. indet.	118.6 km NW. of Newman	Mulga woodland	118.687	-22.8806	Potential
T130378	Barychelidae	*Aurecocrypta* sp. indet.	3 km SSW. of West Angelas Aerodrome	Hummock grassland plain	118.69	-23.1563	Potential
T92126	Barychelidae	*Aurecocrypta* sp. indet.	Hamersley Range Weeli Wolli Creek area BHP Billiton Area C site 12-12J		118.91	-22.9167	Potential
T113595	Barychelidae	*Synothele* \`MYG055\`	Southern Flank 72 km NW. of Newman		119.139	-23.0028	Potential
T113602	Barychelidae	*Synothele* \`MYG055\`	Southern Flank 72 km NW. of Newman		119.139	-23.0028	Potential
T101169	Barychelidae	*Synothele* sp. indet.	Area C 61.8 km NW. of Newman	Rocky gully slope	118.869	-22.9989	Potential
T103197	Barychelidae	*Synothele* sp. indet.	Area C 86.4 km NW. of Newman		119.016	-22.9481	Potential
T103912	Barychelidae	*Synothele* sp. indet.	West Angelas 98 km SE. of Tom Price		118.615	-23.1419	Potential
T104798	Barychelidae	*Synothele* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site12-P5	Gully	119.584	-23.3994	Potential
T104799	Barychelidae	*Synothele* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site18-P9	Rocky gully slope	119.585	-23.4178	Potential
T104808	Barychelidae	*Synothele* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site20-P8	Rocky gully slope	119.592	-23.3952	Potential
T105885	Barychelidae	*Synothele* sp. indet.	Area C 103.6 km NW. of Newman		118.808	-22.9847	Potential
T105935	Barychelidae	*Synothele* sp. indet.	Area C 74.1 km NW. of Newman		119.189	-22.9178	Potential
T113564	Barychelidae	*Synothele* sp. indet.	Jinidi 66 km NW. of Newman		119.248	-22.9553	Potential
T116765	Barychelidae	*Synothele* sp. indet.	Mudlark 112 km W. of Newman		118.689	-23.0325	Potential
T116790	Barychelidae	*Synothele* sp. indet.	Mudlark 108 km W. of Newman		118.729	-23.0428	Potential
T116793	Barychelidae	*Synothele* sp. indet.	Mudlark 108 km W. of Newman		118.729	-23.0425	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T116849	Barychelidae	*Synothele* sp. indet.	Mudlark 87 km WNW. of Newman		118.929	-23.0856	Potential
T116852	Barychelidae	*Synothele* sp. indet.	Mudlark 87 km WNW. of Newman		118.929	-23.0858	Potential
T116857	Barychelidae	*Synothele* sp. indet.	Mudlark 98 km W. of Newman		118.831	-23.0456	Potential
T116859	Barychelidae	*Synothele* sp. indet.	Mudlark 98 km W. of Newman		118.831	-23.0458	Potential
T116861	Barychelidae	*Synothele* sp. indet.	Mudlark 121 km W. of Newman		118.584	-23.0814	Potential
T116864	Barychelidae	*Synothele* sp. indet.	Mudlark 121 km W. of Newman		118.584	-23.0814	Potential
T119704	Barychelidae	*Synothele* sp. indet.	Juna Downs Station 116 km NW. of Newman		118.901	-22.66	Potential
T119705	Barychelidae	*Synothele* sp. indet.	Juna Downs Station 116 km NW. of Newman		118.901	-22.6603	Potential
T120975	Barychelidae	*Synothele* sp. indet.	Chichester Range site 11	Base of S.facing slope	119.025	-22.1483	Potential
T122811	Barychelidae	*Synothele* sp. indet.	108.6 km NW. of Newman	Mulga woodland	118.771	-22.9428	Potential
T122815	Barychelidae	*Synothele* sp. indet.	111.5 km NW. of Newman	Mulga woodland	118.72	-22.985	Potential
T98160	Barychelidae	*Synothele* sp. indet.	Roy Hill Station Ecologia Project 1106		119.902	-22.4591	Potential
T94836	Ctenizidae	*Conothele* `MYG002`	Jinayri ca. 60 km NW. of Newman		119.237	-22.99	Potential
T103178	Ctenizidae	*Conothele* `MYG280`	Area C 84 km NW. of Newman		118.988	-23.015	Potential
T103900	Ctenizidae	*Conothele* `MYG280`	West Angelas 97 km SE. of Tom Price		118.589	-23.1644	Potential
T103901	Ctenizidae	*Conothele* `MYG280`	West Angelas 97 km SE. of Tom Price		118.589	-23.1644	Potential
T103911	Ctenizidae	*Conothele* `MYG280`	West Angelas 98 km SE. of Tom Price		118.615	-23.1419	Potential
T103914	Ctenizidae	*Conothele* `MYG280`	West Angelas 106 km SE. of Tom Price		118.707	-23.1472	Potential
T103915	Ctenizidae	*Conothele* `MYG280`	West Angelas 106 km SE. of Tom Price		118.707	-23.1472	Potential
T103916	Ctenizidae	*Conothele* `MYG280`	West Angelas 106 km SE. of Tom Price		118.707	-23.1472	Potential
T103917	Ctenizidae	*Conothele* `MYG280`	West Angelas 106 km SE. of Tom Price		118.707	-23.1472	Potential
T103930	Ctenizidae	*Conothele* `MYG280`	West Angelas 106 km SE. of Tom Price		118.707	-23.1472	Potential
T105867	Ctenizidae	*Conothele* `MYG280`	Area C 92.1 km NW. of Newman		118.918	-23.0106	Potential
T107395	Ctenizidae	*Conothele* `MYG280`	Hope Downs 72.5 km NW. of Newman		119.164	-22.9956	Potential

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T107397	Ctenizidae	*Conothele* `MYG280`	Hope Downs 72.5 km NW. of Newman		119.164	-22.9956	Potential
T113565	Ctenizidae	*Conothele* `MYG280`	Jinidi 66 km NW. of Newman		119.248	-22.955	Potential
T113569	Ctenizidae	*Conothele* `MYG280`	Jinidi 65 km NW. of Newman		119.231	-22.9892	Potential
T113580	Ctenizidae	*Conothele* `MYG280`	South Parmelia 58 km NW. of Newman		119.272	-23.0619	Potential
T113590	Ctenizidae	*Conothele* `MYG280`	South Parmelia 52 km NW. of Newman		119.318	-23.0858	Potential
T113594	Ctenizidae	*Conothele* `MYG280`	Southern Flank 72 km NW. of Newman		119.139	-23.0028	Potential
T113603	Ctenizidae	*Conothele* `MYG280`	Southern Flank 71 km NW. of Newman		119.164	-22.9942	Potential
T116762	Ctenizidae	*Conothele* `MYG280`	Mudlark 112 km W. of Newman		118.689	-23.0325	Potential
T116763	Ctenizidae	*Conothele* `MYG280`	Mudlark 112 km W. of Newman		118.689	-23.0325	Potential
T116778	Ctenizidae	*Conothele* `MYG280`	Mudlark 111 km W. of Newman		118.679	-23.0522	Potential
T116779	Ctenizidae	*Conothele* `MYG280`	Mudlark 111 km W. of Newman		118.678	-23.0522	Potential
T116781	Ctenizidae	*Conothele* `MYG280`	Mudlark 111 km W. of Newman		118.678	-23.0522	Potential
T116786	Ctenizidae	*Conothele* `MYG280`	Mudlark 108 km W. of Newman		118.729	-23.0425	Potential
T116792	Ctenizidae	*Conothele* `MYG280`	Mudlark 108 km W. of Newman		118.73	-23.0431	Potential
T116802	Ctenizidae	*Conothele* `MYG280`	Mudlark 108 km W. of Newman		118.766	-23.0394	Potential
T116803	Ctenizidae	*Conothele* `MYG280`	Mudlark 108 km W. of Newman		118.766	-23.0394	Potential
T116812	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.775	-23.098	Potential
T116818	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.775	-23.0978	Potential
T116822	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.774	-23.0992	Potential
T116823	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.775	-23.0997	Potential
T116826	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.772	-23.1058	Potential
T116829	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.772	-23.1061	Potential
T116836	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.775	-23.1	Potential
T116838	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.811	-23.09	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T116841	Ctenizidae	*Conothele* `MYG280`	Mudlark 102 km W. of Newman		118.811	-23.0903	Potential
T116844	Ctenizidae	*Conothele* `MYG280`	Mudlark 88 km WNW. of Newman		118.947	-23.0364	Potential
T127213	Ctenizidae	*Conothele* `MYG280`	75.4 km NW. of Newman		119.09	-23.0197	Potential
T127216	Ctenizidae	*Conothele* `MYG280`	75.4 km NW. of Newman		119.09	-23.0197	Potential
T127220	Ctenizidae	*Conothele* `MYG280`	75.4 km NW. of Newman		119.09	-23.0197	Potential
T77529	Ctenizidae	*Conothele* `MYG280`	West Angelas 31.6 km SE. of Juna Downs Homestead site WES		118.705	-23.085	Potential
T122364	Ctenizidae	*Conothele* `MYG281-DNA`	Mudlark 92.5 km NW. of Newman		118.885	-23.0478	Potential
T122365	Ctenizidae	*Conothele* `MYG281-DNA`	Mudlark 91.1 km NW. of Newman		118.885	-23.0478	Potential
T122366	Ctenizidae	*Conothele* `MYG281-DNA`	Mudlark 92.6 km NW. of Newman		118.885	-23.0478	Potential
T103234	Ctenizidae	*Conothele* `MYG282-DNA`	Area C 85.7 km NW. of Newman		119.025	-22.9483	Potential
T113655	Ctenizidae	*Conothele* `MYG282-DNA`	119.1 km NW. of Newman		118.871	-22.6335	Potential
T113656	Ctenizidae	*Conothele* `MYG282-DNA`	119.1 km NW. of Newman		118.871	-22.6337	Potential
T113658	Ctenizidae	*Conothele* `MYG282-DNA`	119.1 km NW. of Newman		118.87	-22.6336	Potential
T113659	Ctenizidae	*Conothele* `MYG282-DNA`	119.1 km NW. of Newman		118.869	-22.6338	Potential
T113664	Ctenizidae	*Conothele* `MYG282-DNA`	117.6 km NW. of Newman		118.896	-22.628	Potential
T113667	Ctenizidae	*Conothele* `MYG282-DNA`	110.6 km NW. of Newman		118.88	-22.7415	Potential
T119699	Ctenizidae	*Conothele* `MYG282-DNA`	Juna Downs Station 120 km NW. of Newman		118.876	-22.6108	Potential
T119709	Ctenizidae	*Conothele* `MYG282-DNA`	Juna Downs Station 113 km NW. of Newman		118.893	-22.6864	Potential
T119714	Ctenizidae	*Conothele* `MYG282-DNA`	Juna Downs Station 117 km NW. of Newman		118.903	-22.6281	Potential
T119719	Ctenizidae	*Conothele* `MYG282-DNA`	Juna Downs Station 114 km NW. of Newman		118.85	-22.7258	Potential
T119720	Ctenizidae	*Conothele* `MYG282-DNA`	Juna Downs Station 114 km NW. of Newman		118.85	-22.7258	Potential
T122348	Ctenizidae	*Conothele* `MYG282-DNA`	Area C West 120 km NW. of Newman		118.649	-22.8785	Potential
T122352	Ctenizidae	*Conothele* `MYG282-DNA`	Area C West 115.3 km NW. of Newman		118.706	-22.8975	Potential
T122354	Ctenizidae	*Conothele* `MYG282-DNA`	Area C West 114.6 km NW. of Newman		118.706	-22.8974	Potential

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T122356	Ctenizidae	*Conothele* \`MYG282-DNA\`	Area C West 116.4 km NW. of Newman		118.706	-22.8974	Potential
T122357	Ctenizidae	*Conothele* \`MYG282-DNA\`	Area C West 115.6 km NW. of Newman		118.706	-22.8975	Potential
T122812	Ctenizidae	*Conothele* \`MYG282-DNA\`	108.6 km NW. of Newman	Mulga woodland	118.771	-22.9431	Potential
T122830	Ctenizidae	*Conothele* \`MYG282-DNA\`	127.3 km NW. of Newman	Mulga woodland	118.604	-22.8603	Potential
T122844	Ctenizidae	*Conothele* \`MYG282-DNA\`	115.4 km NW. of Newman	Mulga woodland	118.717	-22.9086	Potential
T122847	Ctenizidae	*Conothele* \`MYG282-DNA\`	104 km NW. of Newman	Mulga woodland	118.801	-22.9658	Potential
T122848	Ctenizidae	*Conothele* \`MYG282-DNA\`	115.4 km NW. of Newman	Mulga woodland	118.717	-22.9086	Potential
T122849	Ctenizidae	*Conothele* \`MYG282-DNA\`	115.4 km NW. of Newman	Mulga woodland	118.717	-22.9086	Potential
T122852	Ctenizidae	*Conothele* \`MYG282-DNA\`	117.2 km NW. of Newman	Mulga woodland	118.707	-22.8908	Potential
T122853	Ctenizidae	*Conothele* \`MYG282-DNA\`	117.2 km NW. of Newman	Mulga woodland	118.706	-22.8906	Potential
T122854	Ctenizidae	*Conothele* \`MYG282-DNA\`	117.2 km NW. of Newman	Mulga woodland	118.706	-22.8906	Potential
T122855	Ctenizidae	*Conothele* \`MYG282-DNA\`	117.2 km NW. of Newman	Mulga woodland	118.706	-22.8906	Potential
T122863	Ctenizidae	*Conothele* \`MYG282-DNA\`	118.6 km NW. of Newman	Mulga woodland	118.687	-22.8808	Potential
T122869	Ctenizidae	*Conothele* \`MYG282-DNA\`	118.6 km NW. of Newman	Mulga woodland	118.688	-22.8803	Potential
T122874	Ctenizidae	*Conothele* \`MYG282-DNA\`	104 km NW. of Newman	Mulga woodland	118.801	-22.9658	Potential
T125343	Ctenizidae	*Conothele* \`MYG282-DNA\`	Koodaideri Western Corridor 146.3 km NW. of Newman		118.801	-22.358	Potential
T126255	Ctenizidae	*Conothele* \`MYG282-DNA\`	118.2 km NW. of Newman		118.919	-22.6053	Potential
T126269	Ctenizidae	*Conothele* \`MYG282-DNA\`	118.3 km NW. of Newman		118.908	-22.6117	Potential
T126290	Ctenizidae	*Conothele* \`MYG282-DNA\`	114.2 km NW. of Newman		118.893	-22.6872	Potential
T126292	Ctenizidae	*Conothele* \`MYG282-DNA\`	114.2 km NW. of Newman		118.893	-22.6872	Potential
T126299	Ctenizidae	*Conothele* \`MYG282-DNA\`	113.8 km NW. of Newman		118.881	-22.7086	Potential
T99598	Ctenizidae	*Conothele* \`MYG282-DNA\`	Bellbird Siding to Juna Downs 80.7 km E. of Tom Price	Leaf litter	118.555	-22.8758	Potential
T103902	Ctenizidae	*Conothele* \`MYG293-DNA\`	West Angelas 90 km SE. of Tom Price		118.469	-23.2217	Potential
T119990	Ctenizidae	*Conothele* \`MYG333-DNA\`	102.1 km NW. of Newman		119.252	-22.5436	Potential

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T119991	Ctenizidae	*Conothele* \`MYG333-DNA\`	102.1 km NW. of Newman		119.251	-22.5436	Potential
T107188	Ctenizidae	*Conothele* sp. indet.	Fortescue Marsh	leaf litter	119.005	-22.4078	Potential
T107274	Ctenizidae	*Conothele* sp. indet.	Fortescue Marsh ca. 50 km NE. of Newman	leaf litter	119.013	-22.0021	Potential
T107403	Ctenizidae	*Conothele* sp. indet.	Iron Valley 5 km NE. of Yandicoogina mine; TDS6		119.301	-22.7439	Potential
T107983	Ctenizidae	*Conothele* sp. indet.	Rhodes Ridge 141.4 km of NNW. of Newman	Claypan	119.382	-22.1244	Potential
T109507	Ctenizidae	*Conothele* sp. indet.	Cloudbreak		119.232	-22.3304	Potential
T109508	Ctenizidae	*Conothele* sp. indet.	Cloudbreak		119.302	-22.3146	Potential
T112072	Ctenizidae	*Conothele* sp. indet.	112 km NNE. of Newman	Plain	119.966	-22.3872	Potential
T112226	Ctenizidae	*Conothele* sp. indet.	Marillana 100 km NW. of Newman site 10		119.373	-22.5048	Potential
T112231	Ctenizidae	*Conothele* sp. indet.	Marillana 100 km NW. of Newman site 10		119.373	-22.5048	Potential
T112232	Ctenizidae	*Conothele* sp. indet.	Marillana 100 km NW. of Newman site 11		119.325	-22.6235	Potential
T112337	Ctenizidae	*Conothele* sp. indet.	Wonmunna ca. 79 km heading 286° from Newman	Gully base	118.993	-23.1593	Potential
T112338	Ctenizidae	*Conothele* sp. indet.	Wonmunna ca. 77 km heading 289° from Newman	Gully base	119.015	-23.1332	Potential
T112339	Ctenizidae	*Conothele* sp. indet.	Wonmunna ca. 75 km heading 289° from Newman	Midslope	119.038	-23.1355	Potential
T113649	Ctenizidae	*Conothele* sp. indet.	110.6 km NW. of Newman		118.88	-22.7414	Potential
T119701	Ctenizidae	*Conothele* sp. indet.	Juna Downs Station 120 km NW. of Newman		118.876	-22.6108	Potential
T119712	Ctenizidae	*Conothele* sp. indet.	Juna Downs Station 112 km NW. of Newman		118.882	-22.7089	Potential
T91916	Ctenizidae	*Conothele* sp. indet.	Hamersley Range Weeli Wolli Creek region Area C site 01-1C		118.971	-22.9097	Potential
T111814	Dipluridae	*Cethegus* sp. indet.	67.4 km NW. of Newman	Under Eucalyptus victrix bark	119.374	-22.8467	Potential
T84013	Idiopidae	*Aganippe* \`Cloudbreak sp. 1\`	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 18)		119.345	-22.3097	Potential
T112227	Idiopidae	*Aganippe* \`MYG085\`	Marillana 100 km NW. of Newman site 2		119.191	-22.5307	Potential
T112228	Idiopidae	*Aganippe* \`MYG085\`	Marillana 100 km NW. of Newman site 11		119.197	-22.5339	Potential
T112229	Idiopidae	*Aganippe* \`MYG085\`	Marillana 100 km NW. of Newman site 11		119.325	-22.6246	Potential

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T112230	Idiopidae	*Aganippe* `MYG085`	Marillana 100 km NW. of Newman site 10		119.373	-22.5045	Potential
T112236	Idiopidae	*Aganippe* `MYG085`	Marillana 100 km NW. of Newman site 11		119.321	-22.6232	Potential
T98151	Idiopidae	*Aganippe* `MYG085`	Roy Hill Station Ecologia Project 1106		119.995	-22.5769	Potential
T98153	Idiopidae	*Aganippe* `MYG085`	Roy Hill Station Ecologia Project 1106		119.97	-22.5566	Potential
T98156	Idiopidae	*Aganippe* `MYG085`	Roy Hill Station Ecologia Project 1106		119.942	-22.5592	Potential
T98158	Idiopidae	*Aganippe* `MYG085`	Roy Hill Station Ecologia Project 1106		119.871	-22.4548	Potential
T114601	Idiopidae	*Aganippe* `MYG086`	IOH Iron Valley Project near Marillana Station site rios2d11	Spinnifex plain	119.196	-22.4346	Potential
T114602	Idiopidae	*Aganippe* `MYG086`	IOH Iron Valley Project near Marillana Station site rios2	Spinnifex plain	119.196	-22.4339	Potential
T114603	Idiopidae	*Aganippe* `MYG086`	IOH Iron Valley Project near Marillana Station site iohs1d6	Spinnifex plain	119.184	-22.4437	Potential
T114604	Idiopidae	*Aganippe* `MYG086`	IOH Iron Valley Project near Marillana Station site iohs1d12	Spinnifex plain	119.183	-22.444	Potential
T114605	Idiopidae	*Aganippe* `MYG086`	IOH Iron Valley Project near Marillana Station site iohs1d5	Spinnifex plain	119.184	-22.4438	Potential
T97001	Idiopidae	*Aganippe* `MYG086`	6 km SW. of Roy Hill Station Pilbara survey site RHNE06		119.919	-22.6611	Potential
T122088	Idiopidae	*Aganippe* `MYG126`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.866	-22.4716	Potential
T131208	Idiopidae	*Aganippe* `MYG126`	Roy Hill Mine 1 ca. 90 km N. Newman	Mulga woodland tributary	119.865	-22.4688	Potential
T131209	Idiopidae	*Aganippe* `MYG126`	Roy Hill Mine 1 ca. 90 km N. Newman	Mulga woodland tributary	119.919	-22.5225	Potential
T131210	Idiopidae	*Aganippe* `MYG126`	Roy Hill Mine 1 ca. 90 km N. Newman	Mulga woodland tributary	119.931	-22.5174	Potential
T110590	Idiopidae	*Aganippe* `MYG233`	Marillana 100 km NW. of Newman site 1		119.2	-22.5355	Potential
T114054	Idiopidae	*Aganippe* `MYG233`	FMG Nyidinghu Project near Marillana Station site s12d	Spinnifex plain	119.185	-22.3506	Potential
T114055	Idiopidae	*Aganippe* `MYG233`	FMG Nyidinghu Project near Marillana Station site s3wt2	Creekbed	119.128	-22.3356	Potential

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T119983	Idiopidae	*Aganippe* `MYG300-DNA`	105.3 km NW. of Newman		119.259	-22.5119	Potential
T122206	Idiopidae	*Aganippe* `MYG300-DNA`	Koodaideri Corridor West 93.3 km NE. of Tom Price		118.612	-22.3284	Potential
T122214	Idiopidae	*Aganippe* `MYG300-DNA`	Koodaideri Corridor West 88.1 km NE. of Tom Price		118.521	-22.2655	Potential
T125337	Idiopidae	*Aganippe* `MYG300-DNA`	Koodaideri Western Corridor 153.8 km NW. of Newman		118.723	-22.3207	Potential
T125338	Idiopidae	*Aganippe* `MYG300-DNA`	Koodaideri Western Corridor 155.1 km NW. of Newman		118.723	-22.3204	Potential
T125346	Idiopidae	*Aganippe* `MYG300-DNA`	Koodaideri Western Corridor 148.9 km NW. of Newman		118.766	-22.3511	Potential
T122349	Idiopidae	*Aganippe* `MYG303-DNA`	Area C West 121.1 km NW. of Newman		118.648	-22.8784	Potential
T122836	Idiopidae	*Aganippe* `MYG303-DNA`	127.6 km NW. of Newman	Mulga woodland	118.596	-22.8811	Potential
T122845	Idiopidae	*Aganippe* `MYG303-DNA`	115.4 km NW. of Newman	Mulga woodland	118.717	-22.9086	Potential
T122851	Idiopidae	*Aganippe* `MYG303-DNA`	117.2 km NW. of Newman	Mulga woodland	118.706	-22.8906	Potential
T119735	Idiopidae	*Aganippe* `MYG305-DNA`	Juna Downs Station 116 km NW. of Newman		118.926	-22.605	Potential
T126265	Idiopidae	*Aganippe* `MYG305-DNA`	118.3 km NW. of Newman		118.907	-22.6111	Potential
T103905	Idiopidae	*Aganippe* `MYG306-DNA`	West Angelas 114 km SE. of Tom Price		118.674	-23.3214	Potential
T116774	Idiopidae	*Aganippe* `MYG306-DNA`	Mudlark 113 km W. of Newman		118.683	-23.0381	Potential
T122813	Idiopidae	*Aganippe* `MYG306-DNA`	108.6 km NW. of Newman	Mulga woodland	118.771	-22.9428	Potential
T113572	Idiopidae	*Aganippe* `MYG384-DNA`	South Parmelia 66 km NW. of Newman		119.182	-23.0347	Potential
T113604	Idiopidae	*Aganippe* `MYG384-DNA`	Southern Flank 71 km NW. of Newman		119.164	-22.9939	Potential
T113605	Idiopidae	*Aganippe* `MYG384-DNA`	Southern Flank 71 km NW. of Newman		119.164	-22.9942	Potential
T113606	Idiopidae	*Aganippe* `MYG384-DNA`	Southern Flank 71 km NW. of Newman		119.163	-22.9942	Potential
T113610	Idiopidae	*Aganippe* `MYG384-DNA`	Southern Flank 71 km NW. of Newman		119.166	-22.9942	Potential
T116865	Idiopidae	*Aganippe* `MYG384-DNA`	Mudlark 94 km W. of Newman		118.858	-23.0811	Potential
T119981	Idiopidae	*Aganippe* `MYG384-DNA`	100.9 km NW. of Newman		119.289	-22.5425	Potential
T119985	Idiopidae	Aganippe `MYG384-DNA`	105.3 km NW. of Newman		119.259	-22.5117	Potential

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T119994	Idiopidae	Aganippe `MYG384-DNA`	81.2 km NW. of Newman		119.378	-22.7003	Potential
T107377	Idiopidae	*Aganippe* sp. indet.	Iron Valley 5 km NE. of Yandicoogina mine; TDS4		119.31	-22.7447	Potential
T107380	Idiopidae	*Aganippe* sp. indet.	Iron Valley 5 km NE. of Yandicoogina mine; TDS11		119.299	-22.7633	Potential
T107381	Idiopidae	*Aganippe* sp. indet.	Iron Valley 5 km NE. of Yandicoogina mine; TDS10		119.301	-22.7639	Potential
T107402	Idiopidae	*Aganippe* sp. indet.	Iron Valley 5 km NE. of Yandicoogina mine; TDS7		119.31	-22.7447	Potential
T107404	Idiopidae	*Aganippe* sp. indet.	Iron Valley 5 km NE. of Yandicoogina mine; TDS8		119.31	-22.7445	Potential
T107405	Idiopidae	*Aganippe* sp. indet.	Iron Valley 5 km NE. of Yandicoogina mine; TDS9		119.3	-22.7633	Potential
T113571	Idiopidae	*Aganippe* sp. indet.	South Parmelia 66 km NW. of Newman		119.182	-23.0347	Potential
T113607	Idiopidae	*Aganippe* sp. indet.	Southern Flank 71 km NW. of Newman		119.167	-22.9942	Potential
T113611	Idiopidae	*Aganippe* sp. indet.	Southern Flank 71 km NW. of Newman		119.166	-22.9939	Potential
T113613	Idiopidae	*Aganippe* sp. indet.	Southern Flank 71 km NW. of Newman		119.166	-22.9944	Potential
T114057	Idiopidae	*Aganippe* sp. indet.	FMG Nyidinghu Project near Marillana Station site s13c	Spinnifex plain	119.214	-22.399	Potential
T114594	Idiopidae	*Aganippe* sp. indet.	FMG Nyidinghu Project near Marillana Station site s13d	Spinnifex plain	119.224	-22.3913	Potential
T114595	Idiopidae	*Aganippe* sp. indet.	FMG Nyidinghu Project near Marillana Station site s12c	Spinnifex plain	119.172	-22.3424	Potential
T114606	Idiopidae	*Aganippe* sp. indet.	IOH Iron Valley Project near Marillana Station site rios2	Spinnifex plain	119.196	-22.4439	Potential
T116804	Idiopidae	*Aganippe* sp. indet.	Mudlark 108 km W. of Newman		118.766	-23.0394	Potential
T118794	Idiopidae	*Aganippe* sp. indet.	Koodaideri 122.1 km NW. of Newman	Spinifex	119.016	-22.4753	Potential
T125314	Idiopidae	*Aganippe* sp. indet.	Koodaideri Western Corridor 215.6 km NW. of Newman	Low closed Mulga woodland over low open herbland	118.107	-22.136	Potential
T125320	Idiopidae	*Aganippe* sp. indet.	Koodaideri Western Corridor 208.2 km NW. of Newman	Mulga/ Triodia complex	118.174	-22.148	Potential
T125326	Idiopidae	*Aganippe* sp. indet.	Koodaideri Western Corridor 215.4 km NW. of	Low closed Mulga	118.108	-22.1354	Potential

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			Newman	woodland over low open herbland			
T62547	Idiopidae	*Aganippe* sp. indet.	Weeli Wolli Creek c. 17 km SW. of Marillana (65 km SW. of Roy Hill Homestead) site FMG08		119.367	-22.7716	Potential
T97352	Idiopidae	*Aganippe* sp. indet.	Hamersley Range 60 km WNW Newman Hope Downs 4	Burrow in read loamy soil	119.2	-23.0909	Potential
T98155	Idiopidae	*Aganippe* sp. indet.	Roy Hill Station Ecologia Project 1106		119.97	-22.5566	Potential
T107183	Idiopidae	*Anidiops* `MYG308-DNA`	Fortescue Marsh	Leaf litter	119.241	-22.3074	Potential
T97639	Idiopidae	*Anidiops* `MYG308-DNA`	Murray Hill Mulga Downs Station Ecologia project 1142		118.518	-22.1247	Potential
T97640	Idiopidae	*Anidiops* `MYG308-DNA`	Murray Hill Mulga Downs Station Ecologia project 1142		118.518	-22.1247	Potential
T101168	Idiopidae	*Anidiops* sp. indet.	Area C 98.2 km NW. of Newman	Open mulga woodland on clayey loam plain	118.853	-23.0078	Potential
T103181	Idiopidae	*Anidiops* sp. indet.	Area C 98 km NW. of Newman		118.854	-23.0083	Potential
T103187	Idiopidae	*Anidiops* sp. indet.	Area C 98 km NW. of Newman		118.854	-23.0083	Potential
T103189	Idiopidae	*Anidiops* sp. indet.	Area C 84 km NW. of Newman		118.988	-23.015	Potential
T103257	Idiopidae	*Anidiops* sp. indet.	Area C 84 km NW. of Newman		118.998	-23.018	Potential
T103258	Idiopidae	*Anidiops* sp. indet.	Area C 84 km NW. of Newman		118.998	-23.018	Potential
T103265	Idiopidae	*Anidiops* sp. indet.	Area C 84 km NW. of Newman		118.999	-23.0186	Potential
T103269	Idiopidae	*Anidiops* sp. indet.	Area C 84 km NW. of Newman		118.989	-23.0142	Potential
T103272	Idiopidae	*Anidiops* sp. indet.	Area C 84 km NW. of Newman		118.999	-23.0186	Potential
T112074	Idiopidae	*Anidiops* sp. indet.	112 km NNE. of Newman	Plain	119.969	-22.3622	Potential
T113567	Idiopidae	*Anidiops* sp. indet.	Jinidi 65 km NW. of Newman		119.231	-22.9892	Potential
T113568	Idiopidae	*Anidiops* sp. indet.	Jinidi 65 km NW. of Newman		119.231	-22.9892	Potential
T113573	Idiopidae	*Anidiops* sp. indet.	South Parmelia 66 km NW. of Newman		119.182	-23.0347	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T116745	Idiopidae	*Anidiops* sp. indet.	Mudlark 107 km W. of Newman		118.719	-23.0942	Potential
T116748	Idiopidae	*Anidiops* sp. indet.	Mudlark 94 km W. of Newman		118.67	-23.0914	Potential
T116749	Idiopidae	*Anidiops* sp. indet.	Mudlark 94 km W. of Newman		118.67	-23.0914	Potential
T116752	Idiopidae	*Anidiops* sp. indet.	Mudlark 111 km WNW. of Newman		118.686	-23.0867	Potential
T116754	Idiopidae	*Anidiops* sp. indet.	Mudlark 111 km WNW. of Newman		118.686	-23.0869	Potential
T116782	Idiopidae	*Anidiops* sp. indet.	Mudlark 111 km W. of Newman		118.678	-23.0519	Potential
T116784	Idiopidae	*Anidiops* sp. indet.	Mudlark 111 km W. of Newman		118.678	-23.0519	Potential
T116799	Idiopidae	*Anidiops* sp. indet.	Mudlark 108 km W. of Newman		118.766	-23.0394	Potential
T116801	Idiopidae	*Anidiops* sp. indet.	Mudlark 108 km W. of Newman		118.766	-23.0394	Potential
T116815	Idiopidae	*Anidiops* sp. indet.	Mudlark 102 km W. of Newman		118.775	-23.098	Potential
T116851	Idiopidae	*Anidiops* sp. indet.	Mudlark 87 km WNW. of Newman		118.929	-23.0856	Potential
T116869	Idiopidae	*Anidiops* sp. indet.	Mudlark 94 km W. of Newman		118.858	-23.0797	Potential
T122816	Idiopidae	*Anidiops* sp. indet.	111.6 km NW. of Newman	Mulga woodland	118.764	-22.8914	Potential
T122818	Idiopidae	*Anidiops* sp. indet.	111.6 km NW. of Newman	Mulga woodland	118.764	-22.8917	Potential
T122828	Idiopidae	*Anidiops* sp. indet.	127.3 km NW. of Newman	Mulga woodland	118.604	-22.8608	Potential
T122829	Idiopidae	*Anidiops* sp. indet.	127.3 km NW. of Newman	Mulga woodland	118.604	-22.8608	Potential
T122841	Idiopidae	*Anidiops* sp. indet.	115.4 km NW. of Newman	Mulga woodland	118.717	-22.9086	Potential
T122842	Idiopidae	*Anidiops* sp. indet.	115.4 km NW. of Newman	Mulga woodland	118.717	-22.9086	Potential
T125344	Idiopidae	*Anidiops* sp. indet.	Koodaideri Western Corridor 146.3 km NW. of Newman	Mulga woodland	118.801	-22.358	Potential
T38490	Idiopidae	*Anidiops* sp. indet.	10.5 km N. of West Angela Hill	Acacia aneura woodland	118.687	-23.0277	Potential
T93463	Idiopidae	*Anidiops* sp. indet.	Hope Downs 4 ca. 30 km NW. Newman HD4-14B 27	Large Triodia hummocks and emergent eucalypts	119.206	-23.0925	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T97295	Nemesiidae	\`Yilgarnia/Kwonkan\` sp. indet.	Area C ca. 120 km NNW. of Newman site 14-14A		118.943	-22.9156	Potential
T104793	Nemesiidae	*Aname* \`MYG098\`	Orebody 35 ca. 8 km W. of Newman Site10-P1	Open floodplain	119.652	-23.4003	Potential
T104813	Nemesiidae	*Aname* \`MYG098\`	Orebody 35 ca. 8 km W. of Newman Site4-P1	Gully	119.597	-23.4022	Potential
T127206	Nemesiidae	*Aname* \`MYG098\`	78.2 km NW. of Newman		119.06	-23.0197	Potential
T127231	Nemesiidae	*Aname* \`MYG098\`	80.4 km NW. of Newman		119.037	-23.0172	Potential
T97015	Nemesiidae	*Aname* \`MYG098\`	Jinayri ca. 65 km NW. of Newman		119.285	-22.9685	Potential
T105948	Nemesiidae	*Aname* \`MYG104\`	Area C 82.7 km NW. of Newman		119.047	-22.9636	Potential
T97313	Nemesiidae	*Aname* \`MYG104\`	Marillana Station site RNHW03		119.023	-22.4665	Potential
T104786	Nemesiidae	*Aname* \`MYG205\`	Orebody 35 ca. 8 km W. of Newman Site14-P2	Open floodplain	119.648	-23.3837	Potential
T104788	Nemesiidae	*Aname* \`MYG205\`	Orebody 35 ca. 8 km W. of Newman Site14-P7	Open floodplain	119.648	-23.3832	Potential
T104795	Nemesiidae	*Aname* \`MYG205\`	Orebody 35 ca. 8 km W. of Newman Site10-P6	Open floodplain	119.652	-23.3999	Potential
T104789	Nemesiidae	*Aname* \`MYG206\`	Orebody 35 ca. 8 km W. of Newman Site14-P10	Open floodplain	119.648	-23.383	Potential
T104790	Nemesiidae	*Aname* \`MYG206\`	Orebody 35 ca. 8 km W. of Newman Site14-P1	Open floodplain	119.648	-23.3837	Potential
T104791	Nemesiidae	*Aname* \`MYG206\`	Orebody 35 ca. 8 km W. of Newman Site10-P4	Open floodplain	119.652	-23.4	Potential
T104796	Nemesiidae	*Aname* \`MYG206\`	Orebody 35 ca. 8 km W. of Newman Site10-P3	Open floodplain	119.652	-23.4002	Potential
T122332	Nemesiidae	*Aname* \`MYG321-DNA\`	Marillana 97.4 km NW. of Newman		119.201	-22.6343	Potential
T113618	Nemesiidae	*Aname* \`MYG323-DNA\`	111.3 km NW. of Newman		118.988	-22.6245	Potential
T113619	Nemesiidae	*Aname* \`MYG323-DNA\`	111.3 km NW. of Newman		118.988	-22.6247	Potential
T113620	Nemesiidae	*Aname* \`MYG323-DNA\`	111.3 km NW. of Newman		118.988	-22.6248	Potential
T113621	Nemesiidae	*Aname* \`MYG323-DNA\`	111.3 km NW. of Newman		118.988	-22.6248	Potential
T113622	Nemesiidae	*Aname* \`MYG323-DNA\`	111.3 km NW. of Newman		118.988	-22.6248	Potential
T113623	Nemesiidae	*Aname* \`MYG323-DNA\`	111.3 km NW. of Newman		118.988	-22.6248	Potential
T113624	Nemesiidae	*Aname* \`MYG323-DNA\`	111.3 km NW. of Newman		118.988	-22.6248	Potential
T113628	Nemesiidae	*Aname* \`MYG323-DNA\`	113.5 km NW. of Newman		118.832	-22.757	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T113630	Nemesiidae	*Aname* `MYG323-DNA`	113.5 km NW. of Newman		118.832	-22.7569	Potential
T113632	Nemesiidae	*Aname* `MYG323-DNA`	113.5 km NW. of Newman		118.832	-22.7569	Potential
T113633	Nemesiidae	*Aname* `MYG323-DNA`	113.5 km NW. of Newman		118.833	-22.7568	Potential
T113639	Nemesiidae	*Aname* `MYG323-DNA`	110.6 km NW. of Newman		118.881	-22.7422	Potential
T113646	Nemesiidae	*Aname* `MYG323-DNA`	113.3 km NW. of Newman		118.801	-22.7992	Potential
T113650	Nemesiidae	*Aname* `MYG323-DNA`	113.5 km NW. of Newman		118.816	-22.7799	Potential
T113661	Nemesiidae	*Aname* `MYG323-DNA`	115.9 km NW. of Newman		118.939	-22.6107	Potential
T113662	Nemesiidae	*Aname* `MYG323-DNA`	115.9 km NW. of Newman		118.939	-22.6105	Potential
T126251	Nemesiidae	*Aname* `MYG323-DNA`	118.2 km NW. of Newman		118.919	-22.6053	Potential
T120023	Nemesiidae	*Aname* `MYG325-DNA`	111.4 km NW. of Newman		119.145	-22.5222	Potential
T122350	Nemesiidae	*Aname* `MYG326-DNA`	Area C West 116.2 km NW. of Newman		118.706	-22.8976	Potential
T118788	Nemesiidae	*Aname* `MYG331`	Koodaideri 124.2 km NW. of Newman		118.981	-22.4764	Potential
T118798	Nemesiidae	*Aname* `MYG331`	Koodaideri 122.1 km NW. of Newman		119.016	-22.4753	Potential
T118803	Nemesiidae	*Aname* `MYG331`	Koodaideri 116.9 km NW. of Newman		119.055	-22.5072	Potential
T118806	Nemesiidae	*Aname* `MYG331`	Koodaideri 115.8 km NW. of Newman		119.059	-22.5167	Potential
T118802	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 116.9 km NW. of Newman		119.055	-22.5072	Potential
T118804	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 115.8 km NW. of Newman		119.059	-22.5167	Potential
T118805	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 115.8 km NW. of Newman		119.059	-22.5167	Potential
T118811	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 114.8 km NW. of Newman		119.084	-22.5111	Potential
T118812	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 112.7 km NW. of Newman		119.108	-22.5194	Potential
T118817	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 112.7 km NW. of Newman		119.108	-22.5194	Potential
T118818	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 112.7 km NW. of Newman		119.108	-22.5194	Potential
T118820	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 118 km NW. of Newman		119.047	-22.5	Potential
T118824	Nemesiidae	*Aname* `MYG331-DNA`	Koodaideri 118 km NW. of Newman		119.047	-22.5	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T118789	Nemesiidae	*Aname* \`MYG331-DNA\`	Koodaideri 121.2 km NW. of Newman	Sandy spinifex	119.015	-22.4869	Potential
T118791	Nemesiidae	*Aname* \`MYG331-DNA\`	Koodaideri 122.1 km NW. of Newman		119.016	-22.4753	Potential
T118793	Nemesiidae	*Aname* \`MYG331-DNA\`	Koodaideri 122.1 km NW. of Newman		119.016	-22.4753	Potential
T118795	Nemesiidae	*Aname* \`MYG331-DNA\`	Koodaideri 122.1 km NW. of Newman		119.016	-22.4753	Potential
T118799	Nemesiidae	*Aname* \`MYG331-DNA\`	Koodaideri 122.1 km NW. of Newman		119.016	-22.4753	Potential
T118800	Nemesiidae	*Aname* \`MYG331-DNA\`	Koodaideri 119.7 km NW. of Newman		119.019	-22.5003	Potential
T113625	Nemesiidae	*Aname* \`MYG336-DNA\`	113.8 km NW. of Newman		118.918	-22.6562	Potential
T126253	Nemesiidae	*Aname* \`MYG336-DNA\`	118.2 km NW. of Newman		118.919	-22.6053	Potential
T126254	Nemesiidae	*Aname* \`MYG336-DNA\`	118.2 km NW. of Newman		118.919	-22.6053	Potential
T113563	Nemesiidae	*Aname* \`MYG377-DNA\`	Jinidi 66 km NW. of Newman		119.249	-22.9553	Potential
T113638	Nemesiidae	*Aname* \`MYG378-DNA\`	110.6 km NW. of Newman		118.881	-22.7421	Potential
T102613	Nemesiidae	*Aname* sp. indet.	Roy Hill		119.931	-22.5174	Potential
T102616	Nemesiidae	*Aname* sp. indet.	Roy Hill		119.881	-22.4828	Potential
T103182	Nemesiidae	*Aname* sp. indet.	Area C 88.7 km NW. of Newman		119.007	-22.9094	Potential
T103201	Nemesiidae	*Aname* sp. indet.	Area C 83.9 km NW. of Newman		119.077	-22.8944	Potential
T103240	Nemesiidae	*Aname* sp. indet.	Area C 85.5 km NW. of Newman		119.064	-22.8975	Potential
T104785	Nemesiidae	*Aname* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site14-HC3	Floodplain among Mulga deeply vegetated	119.648	-23.3837	Potential
T104787	Nemesiidae	*Aname* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site14-P5	Open floodplain	119.648	-23.3834	Potential
T104801	Nemesiidae	*Aname* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site19-P9	Gully	119.621	-23.4048	Potential
T104811	Nemesiidae	*Aname* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site6-P7	Slope with spinifex	119.575	-23.4018	Potential
T105855	Nemesiidae	*Aname* sp. indet.	Area C 96 km NW. of Newman		118.875	-23.0131	Potential
T105856	Nemesiidae	*Aname* sp. indet.	Area C 96 km NW. of Newman		118.875	-23.0131	Potential
T105861	Nemesiidae	*Aname* sp. indet.	Area C 92.4 km NW. of Newman		118.917	-23.0072	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T105883	Nemesiidae	*Aname* sp. indet.	Area C 87.3 km NW. of Newman		118.971	-23.0111	Potential
T105888	Nemesiidae	*Aname* sp. indet.	Area C 103.6 km NW. of Newman		118.808	-22.9847	Potential
T105889	Nemesiidae	*Aname* sp. indet.	Area C 102.5 km NW. of Newman		118.819	-22.9864	Potential
T105904	Nemesiidae	*Aname* sp. indet.	Area C 93.4 km NW. of Newman		118.912	-22.9997	Potential
T105936	Nemesiidae	*Aname* sp. indet.	Area C 87.2 km NW. of Newman		118.982	-22.9892	Potential
T105951	Nemesiidae	*Aname* sp. indet.	Area C 87.3 km NW. of Newman		119.045	-22.8953	Potential
T105962	Nemesiidae	*Aname* sp. indet.	Area C 91.3 km NW. of Newman		118.993	-22.9006	Potential
T105973	Nemesiidae	*Aname* sp. indet.	Area C 85.8 km NW. of Newman		119.062	-22.8964	Potential
T105987	Nemesiidae	*Aname* sp. indet.	Area C 82.7 km NW. of Newman		119.099	-22.8992	Potential
T107133	Nemesiidae	*Aname* sp. indet.	Fortescue Marsh		119.241	-22.3158	Potential
T107273	Nemesiidae	*Aname* sp. indet.	Fortescue Marsh ca. 50 km NE. of Newman	Leaf litter	119.033	-22.2144	Potential
T107394	Nemesiidae	*Aname* sp. indet.	Hope Downs 73.7 km NW. of Newman		119.122	-22.9903	Potential
T107396	Nemesiidae	*Aname* sp. indet.	Hope Downs 72.5 km NW. of Newman		119.164	-22.9956	Potential
T107941	Nemesiidae	*Aname* sp. indet.	Koodaideri 115.9 km NW. of Newman		119.045	-22.5286	Potential
T107943	Nemesiidae	*Aname* sp. indet.	Koodaideri 116.9 km NW. of Newman		119.003	-22.5353	Potential
T107946	Nemesiidae	*Aname* sp. indet.	Koodaideri 114.7 km NW. of Newman		119.061	-22.5306	Potential
T107949	Nemesiidae	*Aname* sp. indet.	Koodaideri 117.3 km of NW. of Newman		119.015	-22.5331	Potential
T107951	Nemesiidae	*Aname* sp. indet.	Koodaideri 116.9 km NW. of Newman		119.003	-22.5353	Potential
T107952	Nemesiidae	*Aname* sp. indet.	Koodaideri 117.3 km of NW. of Newman		119.015	-22.5331	Potential
T107954	Nemesiidae	*Aname* sp. indet.	Koodaideri 116.5 km NW. of Newman		119.009	-22.5478	Potential
T107955	Nemesiidae	*Aname* sp. indet.	Koodaideri 114.7 km NW. of Newman		119.061	-22.5306	Potential
T107956	Nemesiidae	*Aname* sp. indet.	Koodaideri 120.2 km NW. of Newman		119.024	-22.4953	Potential
T107958	Nemesiidae	*Aname* sp. indet.	Koodaideri 122 km NW. of Newman		119.004	-22.4847	Potential
T107961	Nemesiidae	*Aname* sp. indet.	Koodaideri 122 km NW. of Newman		119.004	-22.4847	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T107963	Nemesiidae	*Aname* sp. indet.	Koodaideri 117.3 km NW. of Newman		119.015	-22.5331	Potential
T107964	Nemesiidae	*Aname* sp. indet.	Koodaideri 118.1 km NW. of Newman		119.001	-22.5297	Potential
T107966	Nemesiidae	*Aname* sp. indet.	Koodaideri 122 km NW. of Newman		119.004	-22.4847	Potential
T107967	Nemesiidae	*Aname* sp. indet.	Koodaideri 116.9 km NW. of Newman		119.003	-22.5353	Potential
T107969	Nemesiidae	*Aname* sp. indet.	Koodaideri 115.2 km NW. of Newman		119.061	-22.5233	Potential
T107971	Nemesiidae	*Aname* sp. indet.	Koodaideri 120.2 km NW. of Newman		119.022	-22.495	Potential
T107974	Nemesiidae	*Aname* sp. indet.	Koodaideri 120.2 km NW. of Newman		119.024	-22.495	Potential
T107975	Nemesiidae	*Aname* sp. indet.	Koodaideri 114 km NW. of Newman		119.073	-22.5281	Potential
T107978	Nemesiidae	*Aname* sp. indet.	Koodaideri 114 km NW. of Newman		119.073	-22.5281	Potential
T107979	Nemesiidae	*Aname* sp. indet.	Koodaideri 115.9 km NW. of Newman		119.045	-22.5286	Potential
T107980	Nemesiidae	*Aname* sp. indet.	Koodaideri 120.2 km NW. of Newman		119.022	-22.495	Potential
T112005	Nemesiidae	*Aname* sp. indet.	Wonmunna ca. 72 km heading 290° from Newman	Plain	119.067	-23.1268	Potential
T112081	Nemesiidae	*Aname* sp. indet.	Wonmunna ca. 80 km heading 285° from Newman	Undulatiing plain	118.977	-23.1633	Potential
T112082	Nemesiidae	*Aname* sp. indet.	Wonmunna ca. 71 km heading 290° from Newman	Gully sides	119.077	-23.1315	Potential
T112092	Nemesiidae	*Aname* sp. indet.	Wonmunna ca. 75 km heading 290° from Newman	Wide creek	119.047	-23.1266	Potential
T113570	Nemesiidae	*Aname* sp. indet.	South Parmelia 52 km NW. of Newman		119.318	-23.0858	Potential
T113575	Nemesiidae	*Aname* sp. indet.	South Parmelia 66 km NW. of Newman		119.188	-23.035	Potential
T113578	Nemesiidae	*Aname* sp. indet.	South Parmelia 58 km NW. of Newman		119.295	-23.0733	Potential
T113583	Nemesiidae	*Aname* sp. indet.	South Parmelia 52 km NW. of Newman		119.319	-23.0861	Potential
T113637	Nemesiidae	*Aname* sp. indet.	107.4 km NW. of Newman		118.925	-22.7371	Potential
T113643	Nemesiidae	*Aname* sp. indet.	113.3 km NW. of Newman		118.801	-22.7991	Potential
T113644	Nemesiidae	*Aname* sp. indet.	113.3 km NW. of Newman		118.802	-22.7991	Potential
T113647	Nemesiidae	*Aname* sp. indet.	113.3 km NW. of Newman		118.801	-22.7992	Potential
T113652	Nemesiidae	*Aname* sp. indet.	113.3 km NW. of Newman		118.802	-22.7988	Potential

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T113799	Nemesiidae	*Aname* sp. indet.	Koodaideri 79.4 km ESE. of Wittenoom		119.047	-22.2253	Potential
T114596	Nemesiidae	*Aname* sp. indet.	FMG Nyidinghu Project near Marillana Station site s11wt9	Grass land	119.195	-22.374	Potential
T116741	Nemesiidae	*Aname* sp. indet.	Mudlark 119 km W. of Newman		118.604	-23.0842	Potential
T116742	Nemesiidae	*Aname* sp. indet.	Mudlark 119 km W. of Newman		118.604	-23.0842	Potential
T116743	Nemesiidae	*Aname* sp. indet.	Mudlark 107 km W. of Newman		118.719	-23.0939	Potential
T116750	Nemesiidae	*Aname* sp. indet.	Mudlark 94 km W. of Newman		118.67	-23.0914	Potential
T116758	Nemesiidae	*Aname* sp. indet.	Mudlark 94 km W. of Newman		118.625	-23.0633	Potential
T116759	Nemesiidae	*Aname* sp. indet.	Mudlark 94 km W. of Newman		118.625	-23.0633	Potential
T116760	Nemesiidae	*Aname* sp. indet.	Mudlark 114 km W. of Newman		118.651	-23.07	Potential
T116761	Nemesiidae	*Aname* sp. indet.	Mudlark 114 km W. of Newman		118.651	-23.07	Potential
T116769	Nemesiidae	*Aname* sp. indet.	Mudlark 113 km W. of Newman		118.683	-23.0381	Potential
T116773	Nemesiidae	*Aname* sp. indet.	Mudlark 113 km W. of Newman		118.683	-23.0381	Potential
T116775	Nemesiidae	*Aname* sp. indet.	Mudlark 113 km W. of Newman		118.683	-23.0381	Potential
T116794	Nemesiidae	*Aname* sp. indet.	Mudlark 111 km W. of Newman		118.684	-23.0808	Potential
T116810	Nemesiidae	*Aname* sp. indet.	Mudlark 110 km W. of Newman		118.698	-23.0842	Potential
T116814	Nemesiidae	*Aname* sp. indet.	Mudlark 102 km W. of Newman		118.775	-23.0983	Potential
T116816	Nemesiidae	*Aname* sp. indet.	Mudlark 102 km W. of Newman		118.775	-23.098	Potential
T116827	Nemesiidae	*Aname* sp. indet.	Mudlark 102 km W. of Newman		118.772	-23.1056	Potential
T116835	Nemesiidae	*Aname* sp. indet.	Mudlark 102 km W. of Newman		118.775	-23.1067	Potential
T116837	Nemesiidae	*Aname* sp. indet.	Mudlark 102 km W. of Newman		118.811	-23.0903	Potential
T116847	Nemesiidae	*Aname* sp. indet.	Mudlark 89 km WNW. of Newman		118.901	-23.1	Potential
T118786	Nemesiidae	*Aname* sp. indet.	Koodaideri 124.2 km NW. of Newman		118.981	-22.4764	Potential
T118792	Nemesiidae	*Aname* sp. indet.	Koodaideri 122.1 km NW. of Newman	Spinifex	119.016	-22.4753	Potential
T118796	Nemesiidae	*Aname* sp. indet.	Koodaideri 122.1 km NW. of Newman		119.016	-22.4753	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T118797	Nemesiidae	*Aname* sp. indet.	Koodaideri 122.1 km NW. of Newman		119.016	-22.4753	Potential
T118807	Nemesiidae	*Aname* sp. indet.	Koodaideri 114.8 km NW. of Newman		119.084	-22.5111	Potential
T118808	Nemesiidae	*Aname* sp. indet.	Koodaideri 114.8 km NW. of Newman		119.084	-22.5111	Potential
T118809	Nemesiidae	*Aname* sp. indet.	Koodaideri 114.8 km NW. of Newman		119.084	-22.5111	Potential
T118810	Nemesiidae	*Aname* sp. indet.	Koodaideri 114.8 km NW. of Newman		119.084	-22.5111	Potential
T118813	Nemesiidae	*Aname* sp. indet.	Koodaideri 112.7 km NW. of Newman		119.108	-22.5194	Potential
T118814	Nemesiidae	*Aname* sp. indet.	Koodaideri 112.7 km NW. of Newman		119.108	-22.5194	Potential
T118816	Nemesiidae	*Aname* sp. indet.	Koodaideri 112.7 km NW. of Newman		119.108	-22.5194	Potential
T118819	Nemesiidae	*Aname* sp. indet.	Koodaideri 118 km NW. of Newman		119.047	-22.5	Potential
T118823	Nemesiidae	*Aname* sp. indet.	Koodaideri 118 km NW. of Newman	Sandy spinifex	119.047	-22.5	Potential
T119243	Nemesiidae	*Aname* sp. indet.	20.5 km WNW. of Mt Marsh site RHNW03		119.023	-22.4665	Potential
T119244	Nemesiidae	*Aname* sp. indet.	16 km N. of Cowra Line Camp site RHNW07		119.025	-22.2217	Potential
T119706	Nemesiidae	*Aname* sp. indet.	Juna Downs Station 112 km NW. of Newman		118.952	-22.6444	Potential
T119707	Nemesiidae	*Aname* sp. indet.	Juna Downs Station 112 km NW. of Newman		118.952	-22.6444	Potential
T119708	Nemesiidae	*Aname* sp. indet.	Juna Downs Station 112 km NW. of Newman		118.952	-22.6444	Potential
T119716	Nemesiidae	*Aname* sp. indet.	Juna Downs Station 111 km NW. of Newman		118.97	-22.6292	Potential
T119717	Nemesiidae	*Aname* sp. indet.	Juna Downs Station 111 km NW. of Newman		118.97	-22.6292	Potential
T119734	Nemesiidae	*Aname* sp. indet.	Juna Downs Station 117 km NW. of Newman		118.936	-22.607	Potential
T119937	Nemesiidae	*Aname* sp. indet.	Juna Downs Station 118 km NW. of Newman		118.893	-22.6239	Potential
T122873	Nemesiidae	*Aname* sp. indet.	104 km NW. of Newman	Mulga woodland	118.801	-22.9658	Potential
T125315	Nemesiidae	*Aname* sp. indet.	Koodaideri Western Corridor 217.6 km NW. of Newman	Low closed Mulga woodland over low open herbland	118.107	-22.1354	Potential
T125347	Nemesiidae	*Aname* sp. indet.	Koodaideri Western Corridor 149.2 km NW. of Newman		118.766	-22.3499	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T74771	Nemesiidae	*Aname* sp. indet.	c. 25 km N. of Prairie Downs Homestead site RHNC2		119.1	-23.3208	Potential
T78148	Nemesiidae	*Aname* sp. indet.	Port Hedland-Newman Railway Chichester Rge Fortescue Metals Group site FMG09		119.421	-22.7372	Potential
T89292	Nemesiidae	*Aname* sp. indet.	90.8 km NW. of Newman BHP Billiton Area C		118.993	-22.9001	Potential
T89293	Nemesiidae	*Aname* sp. indet.	90.8 km NW. of Newman BHP Billiton Area C		118.993	-22.9001	Potential
T92123	Nemesiidae	*Aname* sp. indet.	Hamersley Range Weeli Wolli Creek area BHP Billiton Area C site 7-7A		119.013	-22.8999	Potential
T92124	Nemesiidae	*Aname* sp. indet.	Hamersley Range Weeli Wolli Creek area BHP Billiton Area C site 10-10A		118.966	-22.9105	Potential
T92125	Nemesiidae	*Aname* sp. indet.	Hamersley Range Weeli Wolli Creek area BHP Billiton Area C site 12-12E		118.91	-22.9168	Potential
T96147	Nemesiidae	*Aname* sp. indet.	Jinayri ca. 60 km NW. of Newman		119.251	-22.9858	Potential
T97016	Nemesiidae	*Aname* sp. indet.	Jinayri ca. 65 km NW. of Newman		119.204	-22.9189	Potential
T97037	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 05-5F		119.008	-22.938	Potential
T97292	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 01-1B		118.971	-22.9096	Potential
T97293	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 12-12H		118.91	-22.9167	Potential
T97294	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 12-12H		118.894	-22.9202	Potential
T97296	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 12-12L		118.91	-22.9167	Potential
T97297	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 11-11B		118.894	-22.9201	Potential
T97298	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 05-5D		119.008	-22.938	Potential
T97299	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 10-10B		118.967	-22.9102	Potential
T97300	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 05-5C		119.008	-22.938	Potential
T97301	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 01-1A		118.971	-22.9096	Potential
T97302	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 12-12G		118.91	-22.9167	Potential
T97303	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 12-12F		118.91	-22.9167	Potential
T97304	Nemesiidae	*Aname* sp. indet.	Area C ca. 120 km NNW. of Newman site 05-5E		119.008	-22.938	Potential

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T97638	Nemesiidae	*Aname* sp. indet.	Murray Hill Mulga Downs Station Ecologia project 1142		118.508	-22.1207	Potential
T107957	Nemesiidae	*Kwonkan* `MYG325-DNA`	Koodaideri 119.5 km NW. of Newman		119.034	-22.4953	Potential
T107959	Nemesiidae	*Kwonkan* `MYG325-DNA`	Koodaideri 114 km of NW. of Newman		119.073	-22.5281	Potential
T114817	Nemesiidae	*Kwonkan* `MYG325-DNA`	Marillana 105 km NW. of Newman		119.186	-22.5819	Potential
T114821	Nemesiidae	*Kwonkan* `MYG325-DNA`	Marillana 93.6 km NW. of Newman		119.254	-22.6239	Potential
T114823	Nemesiidae	*Kwonkan* `MYG325-DNA`	Marillana 93.6 km NW. of Newman		119.254	-22.6239	Potential
T114825	Nemesiidae	*Kwonkan* `MYG325-DNA`	Marillana 96.9 km NW. of Newman		119.229	-22.6197	Potential
T116549	Nemesiidae	*Kwonkan* `MYG325-DNA`	Marillana 91.6 km NW. of Newman		119.244	-22.665	Potential
T116550	Nemesiidae	*Kwonkan* `MYG325-DNA`	Marillana 91.6 km NW. of Newman		119.244	-22.665	Potential
T118815	Nemesiidae	*Kwonkan* `MYG325-DNA`	Koodaideri 112.7 km NW. of Newman		119.108	-22.5194	Potential
T118821	Nemesiidae	*Kwonkan* `MYG325-DNA`	Koodaideri 118 km NW. of Newman	Sandy spinifex	119.047	-22.5	Potential
T118826	Nemesiidae	*Kwonkan* `MYG325-DNA`	Koodaideri 120.2 km NW. of Newman		119.015	-22.4975	Potential
T120022	Nemesiidae	*Kwonkan* `MYG325-DNA`	111.4 km NW. of Newman		119.145	-22.5222	Potential
T119996	Nemesiidae	*Kwonkan* `MYG337-DNA`	76.3 km NW. of Newman		119.393	-22.7433	Potential
T120000	Nemesiidae	*Kwonkan* `MYG337-DNA`	75.1 km NW. of Newman		119.306	-22.805	Potential
T120001	Nemesiidae	*Kwonkan* `MYG337-DNA`	75.1 km NW. of Newman		119.306	-22.8053	Potential
T120003	Nemesiidae	*Kwonkan* `MYG337-DNA`	75.1 km NW. of Newman		119.306	-22.8053	Potential
T120004	Nemesiidae	*Kwonkan* `MYG337-DNA`	75.1 km NW. of Newman		119.306	-22.8053	Potential
T120011	Nemesiidae	*Kwonkan* `MYG337-DNA`	76 km NW. of Newman		119.31	-22.7936	Potential
T120014	Nemesiidae	*Kwonkan* `MYG337-DNA`	72.7 km NW. of Newman		119.283	-22.85	Potential
T120015	Nemesiidae	*Kwonkan* `MYG337-DNA`	72.7 km NW. of Newman		119.283	-22.85	Potential
T116540	Nemesiidae	*Kwonkan* `MYG338-DNA`	Marillana 86.2 km NW. of Newman		119.303	-22.6789	Potential
T116544	Nemesiidae	*Kwonkan* `MYG338-DNA`	Marillana 89.7 km NW. of Newman		119.29	-22.6622	Potential
T116552	Nemesiidae	*Kwonkan* `MYG338-DNA`	Marillana 92.6 km NW. of Newman		119.265	-22.6508	Potential

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T119999	Nemesiidae	*Kwonkan* `MYG338-DNA`	78.8 km NW. of Newman		119.36	-22.7322	Potential
T103191	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 86.4 km NW. of Newman		119.016	-22.9478	Potential
T105852	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 96 km NW. of Newman		118.875	-23.0131	Potential
T105853	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 96 km NW. of Newman		118.875	-23.0131	Potential
T105854	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 96 km NW. of Newman		118.875	-23.0131	Potential
T105858	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 93.8 km NW. of Newman		118.906	-23	Potential
T105859	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 93.8 km NW. of Newman		118.905	-22.9997	Potential
T105860	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 93.8 km NW. of Newman		118.905	-22.9997	Potential
T105862	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 92.4 km NW. of Newman		118.917	-23.0072	Potential
T105873	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 92.1 km NW. of Newman		118.918	-23.0108	Potential
T105874	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 92.1 km NW. of Newman		118.918	-23.0108	Potential
T105875	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 92.1 km NW. of Newman		118.918	-23.0106	Potential
T105893	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 103.4 km NW. of Newman		118.807	-22.9905	Potential
T105899	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 97.6 km NW. of Newman		118.86	-23.0106	Potential
T105900	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 93 km NW. of Newman		118.908	-23.0178	Potential
T105903	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 93 km NW. of Newman		118.907	-23.0178	Potential
T105906	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 93.4 km NW. of Newman		118.912	-22.9997	Potential
T105907	Nemesiidae	*Kwonkan* `MYG339-DNA`	Area C 93.4 km NW. of Newman		118.913	-23.0003	Potential
T127204	Nemesiidae	*Kwonkan* `MYG339-DNA`	78.2 km NW. of Newman		119.06	-23.0197	Potential
T127232	Nemesiidae	*Kwonkan* `MYG339-DNA`	78.1 km NW. of Newman		119.102	-23.0167	Potential
T127224	Nemesiidae	*Kwonkan* `MYG341-DNA`	80.4 km NW. of Newman		119.037	-23.0147	Potential
T127227	Nemesiidae	*Kwonkan* `MYG341-DNA`	80.4 km NW. of Newman		119.037	-23.015	Potential
T127230	Nemesiidae	*Kwonkan* `MYG341-DNA`	80.4 km NW. of Newman		119.037	-23.015	Potential
T114810	Nemesiidae	*Kwonkan* `MYG379-DNA`	Marillana 100.3 km NW. of Newman		119.201	-22.5903	Potential

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T114811	Nemesiidae	*Kwonkan* `MYG379-DNA`	Marillana 100.3 km NW. of Newman		119.201	-22.5903	Potential
T114830	Nemesiidae	*Kwonkan* `MYG379-DNA`	Marillana 84.6 km NW. of Newman		119.294	-22.7058	Potential
T114833	Nemesiidae	*Kwonkan* `MYG379-DNA`	Marillana 85.7 km NW. of Newman		119.293	-22.6922	Potential
T116542	Nemesiidae	*Kwonkan* `MYG379-DNA`	Marillana 86.3 km NW. of Newman		119.317	-22.6742	Potential
T116557	Nemesiidae	*Kwonkan* `MYG379-DNA`	Marillana 96.6 km NW. of Newman		119.209	-22.6308	Potential
T116558	Nemesiidae	*Kwonkan* `MYG379-DNA`	Marillana 97.2 km NW. of Newman		119.201	-22.6269	Potential
T116744	Nemesiidae	*Kwonkan* `MYG380-DNA`	Mudlark 107 km W. of Newman		118.719	-23.0939	Potential
T113589	Nemesiidae	*Kwonkan* sp. indet.	South Parmelia 52 km NW. of Newman		119.318	-23.0853	Potential
T113609	Nemesiidae	*Kwonkan* sp. indet.	Southern Flank 71 km NW. of Newman		119.166	-22.9939	Potential
T97036	Nemesiidae	*Kwonkan* sp. indet.	Area C ca. 120 km NNW. of Newman site 11-11D		118.894	-22.9201	Potential
T114056	Nemesiidae	*Swolnpes* `MYG234`	FMG Nyidinghu Project near Marillana Station site s3wt2	Creek bed	119.128	-22.3356	Potential
T44297	Nemesiidae	*Swolnpes* `MYG234`	263 km SSW. of Port Hedland site HDC3)		119.24	-22.6	Potential
T112357	Nemesiidae	*Teyl* `MYG027`	Wonmunna ca. 73 km heading 291° from Newman	Wide creek	119.063	-23.121	Potential
T113601	Nemesiidae	*Teyl* `MYG027`	Southern Flank 72 km NW. of Newman		119.139	-23.0028	Potential
T91918	Nemesiidae	*Teyl* `MYG027`	Hamersley Range Weeli Wolli Creek region Area C site 09-9E		119.038	-22.9252	Potential
T112355	Nemesiidae	*Teyl* sp. indet.	Wonmunna ca. 75 km heading 289° from Newman	Midslope	119.038	-23.1355	Potential
T112356	Nemesiidae	*Teyl* sp. indet.	Wonmunna ca. 72 km heading 290° from Newman	Plain	119.074	-23.1283	Potential
T112358	Nemesiidae	*Teyl* sp. indet.	Wonmunna ca. 79 km heading 286° from Newman	Plain	118.993	-23.1547	Potential
T116756	Nemesiidae	*Teyl* sp. indet.	Mudlark 111 km WNW. of Newman		118.686	-23.0869	Potential
T116806	Nemesiidae	*Teyl* sp. indet.	Mudlark 100 km W. of Newman		118.791	-23.0692	Potential
T116846	Nemesiidae	*Teyl* sp. indet.	Mudlark 89 km WNW. of Newman		118.901	-23.1	Potential
T116853	Nemesiidae	*Teyl* sp. indet.	Mudlark 87 km WNW. of Newman		118.929	-23.0858	Potential
T102620	Nemesiidae	*Yilgarnia* `MYG033`	Roy Hill		120.017	-22.5843	Potential

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T94835	Nemesiidae	*Yilgarnia* \`MYG033\`	Jinayri ca. 60 km NW. of Newman		119.3	-22.9765	Potential
T94840	Nemesiidae	*Yilgarnia* \`MYG033\`	Jinayri ca. 60 km NW. of Newman		119.251	-22.9859	Potential
T94841	Nemesiidae	*Yilgarnia* \`MYG033\`	Jinayri ca. 60 km NW. of Newman		119.25	-22.9856	Potential
T94842	Nemesiidae	*Yilgarnia* \`MYG033\`	Jinayri ca. 60 km NW. of Newman		119.285	-22.9684	Potential
T94843	Nemesiidae	*Yilgarnia* \`MYG033\`	Jinayri ca. 60 km NW. of Newman		119.254	-23.0526	Potential
T94844	Nemesiidae	*Yilgarnia* \`MYG033\`	Jinayri ca. 60 km NW. of Newman		119.255	-23.0279	Potential
T96143	Nemesiidae	*Yilgarnia* \`MYG033\`	Jinayri ca. 60 km NW. of Newman		119.3	-22.974	Potential
T105923	Nemesiidae	*Yilgarnia* \`MYG197\`	Area C 83.9 km NW. of Newman		119.016	-22.9931	Potential
T105955	Nemesiidae	*Yilgarnia* \`MYG197\`	Area C 81.4 km NW. of Newman		119.069	-22.9581	Potential
T130375	Nemesiidae	*Yilgarnia* \`MYG197\`	9 km WSW. of West Angelas Aerodrome	Mixed Acacia woodland on plain	118.624	-23.1723	Potential
T113627	Nemesiidae	*Yilgarnia* \`MYG324-DNA\`	113.5 km NW. of Newman		118.832	-22.757	Potential
T113631	Nemesiidae	*Yilgarnia* \`MYG324-DNA\`	113.5 km NW. of Newman		118.832	-22.757	Potential
T113635	Nemesiidae	*Yilgarnia* \`MYG324-DNA\`	113.5 km NW. of Newman		118.831	-22.7562	Potential
T103176	Nemesiidae	*Yilgarnia* sp. indet.	Area C 83.9 km NW. of Newman		119.077	-22.8944	Potential
T103188	Nemesiidae	*Yilgarnia* sp. indet.	Area C 83.9 km NW. of Newman		119.077	-22.8944	Potential
T103211	Nemesiidae	*Yilgarnia* sp. indet.	Area C 83.9 km NW. of Newman		119.077	-22.8942	Potential
T113640	Nemesiidae	*Yilgarnia* sp. indet.	113.5 km NW. of Newman		118.832	-22.7569	Potential
T114597	Nemesiidae	*Yilgarnia* sp. indet.	FMG Nyidinghu Project near Marillana Station site s11wt9	Grass land	119.195	-22.374	Potential
T114612	Nemesiidae	*Yilgarnia* sp. indet.	Wonmunna ca. 70 km heading 291° from Newman	Gully Sides	119.096	-23.1319	Potential
T122817	Nemesiidae	*Yilgarnia* sp. indet.	111.6 km NW. of Newman	Mulga woodland	118.764	-22.8914	Potential
Order Pseudoscorpiones (pseudoscorpions)							
T76970	Atemnidae	*Paratemnoides* sp. indet.	Kalamina Gorge Karijini National Park	Under Melaleuca bark	118.402	-22.4171	Potential

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T76972	Atemnidae	*Paratemnoides* sp. indet.	Kalamina Gorge Karijini National Park	Under rocks	118.402	-22.4171	Potential
T130398	Chernetidae	*Nesidiochernes* sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Drainage/ Veg. grove	119	-22.7397	Potential
T122167	Chernetidae	*Troglochernes* `PSE072`	South Parmelia 67.4 km NW. of Newman		119.178	-23.0325	Potential
T122169	Chernetidae	*Troglochernes* `PSE072`	South Parmelia 67.4 km NW. of Newman		119.178	-23.0325	Potential
T122172	Chernetidae	*Troglochernes* `PSE072`	South Parmelia 52.1 km NW. of Newman		119.176	-23.0339	Potential
T122173	Chernetidae	*Troglochernes* `PSE072`	South Parmelia 67.4 km NW. of Newman		119.178	-23.0325	Potential
T122174	Chernetidae	*Troglochernes* `PSE072`	South Parmelia 67.4 km NW. of Newman		119.178	-23.0325	Potential
T111843	Garypidae	*Synsphyronus* `PSE006`	Christmas Creek 110 km N. Newman	Tree bark	119.739	-22.3692	Potential
T103480	Garypidae	*Synsphyronus* `PSE014 long hand 2`	Area C 74.1 km NW. of Newman		119.189	-22.9178	Potential
T105083	Garypidae	*Synsphyronus* `PSE014 long hand 2`	Area C 87.3 km NW. of Newman		119.045	-22.8953	Potential
T104956	Garypidae	*Synsphyronus* `sp. nov. long chelal hand`	Orebody 35 ca. 8 km W. of Newman Site 1-P7	Rocky slope	119.632	-23.3945	Potential
T109417	Garypidae	*Synsphyronus* `sp. nov. long chelal hand`	Orebody 35 ca. 8 km W. of Newman Site 12-P10	Gully	119.584	-23.3994	Potential
T109418	Garypidae	*Synsphyronus* `sp. nov. long chelal hand`	Orebody 35 ca. 8 km W. of Newman Site 20-P3	Rocky slope	119.591	-23.395	Potential
T102753	Garypidae	*Synsphyronus* `sp. nov. West Angelas`	West Angelas mine lease 99.6 km NW. of Newman @		118.811	-23.0798	Potential
T102754	Garypidae	*Synsphyronus* `sp. nov. West Angelas`	West Angelas mine lease 99.6 km NW. of Newman @		118.811	-23.0798	Potential
T73304	Garypidae	*Synsphyronus* sp. indet.	Marillana Creek Marillana Station (RTYE9 Yandi YEX80)		119.256	-22.7819	Potential
T112020	Hyidae	*Indohya* `PSE002`	115 km NNW. of Newman	Midslope	119.748	-22.3179	Potential
T112021	Hyidae	*Indohya* `PSE002`	115 km NNW. of Newman	Midslope	119.748	-22.3179	Potential
T112022	Hyidae	*Indohya* `PSE002`	114 km NNW. of Newman	Midslope	119.739	-22.3257	Potential
T109849	Hyidae	*Indohya* `sp. Mt Meharry`	Karijini National Park Mount Meharry		118.589	-22.9798	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T110439	Olpiidae	Olpiidae `gen. nov. 7/4` sp. indet.	67.4 km NW. of Newman	Under Eucalyptus victrix bark	119.374	-22.8467	Potential
T100178	Olpiidae	Olpiidae gen. indet. sp. indet.	East Pilbara ca. 60 km ESE. of Auski Roadhouse	Subterranean	119.246	-22.6116	Potential
T116564	Olpiidae	Olpiidae gen. indet. sp. indet.	Marillana 89.7 km NW. of Newman	Under bark	119.29	-22.6622	Potential
T117781	Olpiidae	Olpiidae gen. indet. sp. indet.	Mudlark 121 km WNW. of Newman	Collected from under rocks	118.585	-23.0781	Potential
T127769	Olpiidae	Olpiidae gen. indet. sp. indet.	West Angelas; c. 32 km ESE. Mt Meharry		118.862	-23.1229	Potential
T130390	Olpiidae	Olpiidae gen. indet. sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Drainage/ Ridge-outcrop	119.05	-22.7322	Potential
T130393	Olpiidae	Olpiidae gen. indet. sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Ridge-outcrop/ Gully	119.123	-22.7746	Potential
T130395	Olpiidae	Olpiidae gen. indet. sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Drainage/ Veg. grove	118.994	-22.7095	Potential
T130396	Olpiidae	Olpiidae gen. indet. sp. indet.	Yandi (Marillana Ck) ca. 98 km NW. of Newman	Drainage/ Veg. grove	118.994	-22.7095	Potential
T131159	Olpiidae	Olpiidae gen. indet. sp. indet.	15 km SE. of West Angelas Aerodrome	Small spinifex rocky ridge	118.828	-23.1904	Potential
T131160	Olpiidae	Olpiidae gen. indet. sp. indet.	9 km SW. of West Angelas Aerodrome	Small spinifex rocky ridge	118.641	-23.1917	Potential
T131260	Olpiidae	Olpiidae gen. indet. sp. indet.	"Homestead" ca. 6km N of Newman	Acacia grove	119.724	-23.3063	Potential
T131280	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 24 ca. 7km N of Newman	Gorge	119.794	-23.291	Potential
T131299	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 25 ca. 5km N of Newman	Gully	119.772	-23.3284	Potential
T131301	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 25 ca. 5km N of Newman	Gorge	119.772	-23.3274	Potential
T131302	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 24 ca. 7km N of Newman	Slope/ Ridge	119.854	-23.274	Potential
T131303	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 25 ca. 5km N of Newman	Slope/ Ridge	119.854	-23.274	Potential
T131304	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 24 ca. 7km N of Newman	Slope/ Ridge	119.842	-23.2715	Potential
T131308	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 24 ca. 7km N of Newman	Slope/ Ridge	119.754	-23.2869	Potential
T131315	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 24 ca. 7km N of Newman	Plain	119.726	-23.3103	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T131408	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Leaf litter	120.016	-23.3322	Potential
T131422	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Leaf litter	120.005	-23.3235	Potential
T131457	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Leaf litter	119.99	-23.3312	Potential
T131458	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 19 ca. 28 km ENE. of Newman	Leaf litter	119.982	-23.3315	Potential
T131862	Olpiidae	Olpiidae gen. indet. sp. indet.	Orebody 24 ca. 7km N of Newman	Gully	119.724	-23.2872	Potential
T131863	Olpiidae	Olpiidae gen. indet. sp. indet.	"Homestead" ca. 6km N of Newman	Acacia grove	119.757	-23.3013	Potential
T94823	Olpiidae	Olpiidae gen. indet. sp. indet.	Jinayri ca. 60 km NW. of Newman		119.273	-23.0504	Potential
T98167	Olpiidae	Olpiidae gen. indet. sp. indet.	Roy Hill Station Ecologia Project 1106		119.871	-22.4548	Potential
T122340	Olpiidae	*Xenolpium* \`PSE033\`	Marillana 173.6 km NW. of Newman		118.222	-22.6313	Potential
T122341	Olpiidae	*Xenolpium* \`PSE033\`	Marillana 173.8 km NW. of Newman		118.222	-22.6313	Potential
T122342	Olpiidae	*Xenolpium* \`PSE033\`	Marillana 173.9 km NW. of Newman		118.222	-22.6333	Potential
T122343	Olpiidae	*Xenolpium* \`PSE033\`	Marillana 174 km NW. of Newman		118.222	-22.6333	Potential
T62934	Olpiidae	*Xenolpium* \`sp. 1\`	Marillana Station 23 km SW. of Marillana Homestead Yandi Extension site YEX85	On Corymbia hamersleyana Corymbia deserticola & Eucaly	119.258	-22.7933	Potential
T62936	Olpiidae	*Xenolpium* \`sp. 1\`	Marillana Station 23 km SW. of Marillana Homestead Yandi Extension site YEX85	On Corymbia hamersleyana	119.258	-22.7933	Potential
T62937	Olpiidae	*Xenolpium* \`sp. 1\`	Marillana Station 23 km SW. of Marillana Homestead Yandi Extension site YEX81		119.254	-22.7877	Potential
T62908	Olpiidae	*Xenolpium* \`sp. 2\`	Marillana Station 26.5 km SW. of Marillana Homestead Yandi Extension site YEX75		119.261	-22.8344	Potential
T122171	Olpiidae	*Xenolpium* sp. indet.	South Parmelia 60.9 km NW. of Newman	Hillslope; silty loam	119.239	-23.0478	Potential
T122180	Olpiidae	*Xenolpium* sp. indet.	Area C West to Yandi 111 km NW. of Newman	Mulga; clay	118.835	-22.7792	Potential
T127764	Olpiidae	*Xenolpium* sp. indet.	West Angelas; c. 32 km ESE. Mt Meharry	Leaf litter	118.862	-23.1229	Potential
Order Scorpiones (scorpions)							

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T79702	Buthidae	*Isometroides* \`sp. 1\`	6 km N. of Cowral Line Camp (site RHNW06)		119.008	-22.3017	Potential
T114205	Buthidae	*Isometroides* sp. indet.	Marillana 100 Km N. Newman (site 1)		119.025	-22.265	Potential
T114207	Buthidae	*Isometroides* sp. indet.	Marillana 100 Km N. Newman (site 6)		119.291	-22.6013	Potential
T114233	Buthidae	*Isometroides* sp. indet.	Marillana 100 Km N. Newman (site 5)		119.231	-22.5625	Potential
T114236	Buthidae	*Isometroides* sp. indet.	Marillana 100 Km N. Newman (site 8)		119.374	-22.6376	Potential
T122061	Buthidae	*Isometroides* sp. indet.	Koodaideri Corridor West 82.2 km NW. of Tom Price		118.415	-22.2324	Potential
T19686	Buthidae	*Isometroides* sp. indet.	Mt Bruce		118.133	-22.6	Potential
T19688	Buthidae	*Isometroides* sp. indet.	Roy Hill		119.95	-22.6166	Potential
T19689	Buthidae	*Isometroides* sp. indet.	Roy Hill		119.95	-22.6166	Potential
T19690	Buthidae	*Isometroides* sp. indet.	Roy Hill		119.95	-22.6166	Potential
T19691	Buthidae	*Isometroides* sp. indet.	Roy Hill		119.95	-22.6166	Potential
T19692	Buthidae	*Isometroides* sp. indet.	Roy Hill		119.95	-22.6166	Potential
T19693	Buthidae	*Isometroides* sp. indet.	Roy Hill		119.95	-22.6166	Potential
T19694	Buthidae	*Isometroides* sp. indet.	Roy Hill		119.95	-22.6166	Potential
T57399	Buthidae	*Isometroides* sp. indet.	Hope Downs @		119.021	-23.03	Potential
T60526	Buthidae	*Isometroides* sp. indet.	Weeli Wolli Creek c. 40 km SW. of Marillana site HDA2		119.179	-22.958	Potential
T81655	Buthidae	*Isometroides* sp. indet.	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 18)		119.345	-22.3097	Potential
T91894	Buthidae	*Isometroides* sp. indet.	10 km NE. of Newman Ore-body 24 site 05-5A		119.794	-23.3116	Potential
T93455	Buthidae	*Isometroides* sp. indet.	Hope Downs 4 ca. 30 km NW. Newman HD4-11 37	Acacia woodland over Ptilotus and Triodia	119.292	-23.1014	Potential
T79714	Buthidae	*Lychas* \`gracilimanus\`	18.5 km NE. of Mile Camp (site RHNE04)		119.775	-22.6906	Potential
T79715	Buthidae	*Lychas* \`gracilimanus\`	26 km WNW. of Bonney Downs Homestead Pilbara Biological Survey site RHNE12		119.703	-22.0853	Potential
T80303	Buthidae	*Lychas* \`marandoo 1\`	Marandoo Mine Expansion 35 km ENE. of Tom Price		118.277	-23.088	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
			(MAR05)				
T80306	Buthidae	*Lychas* `marandoo 1`	Marandoo Mine expansion 35 km ENE. of Tom Price		118.306	-23.1055	Potential
T80307	Buthidae	*Lychas* `marandoo 1`	Marandoo Mine expansion 35 km ENE. of Tom Price		118.17	-22.6522	Potential
T94832	Buthidae	*Lychas* `mjobergi`	Jinayri ca. 60 km NW. of Newman		119.236	-22.9895	Potential
T105012	Buthidae	*Lychas* `waldockae`	Orebody 35 ca. 8 km W. of Newman Site13-P1	Gully	119.639	-23.3946	Potential
T105015	Buthidae	*Lychas* `waldockae`	Orebody 35 ca. 8 km W. of Newman Site11-P10	Rocky slope	119.568	-23.4209	Potential
T105016	Buthidae	*Lychas* `waldockae`	Orebody 35 ca. 8 km W. of Newman Site11-P8	Rocky slope	119.568	-23.4206	Potential
T105031	Buthidae	*Lychas* `waldockae`	Orebody 35 ca. 8 km W. of Newman Site3-P10	Gully	119.605	-23.4047	Potential
T105042	Buthidae	*Lychas* `waldockae`	Orebody 35 ca. 8 km W. of Newman Site11-P4	Rocky slope	119.567	-23.4206	Potential
T93576	Buthidae	*Lychas* `waldockae`	Jinary ca. 60 km NW. of Newman		119.28	-23.0408	Potential
T81638	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 37)		119.427	-22.3025	Potential
T81639	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 30)		119.423	-22.3275	Potential
T81640	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 30)		119.423	-22.3275	Potential
T81641	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 19)		119.359	-22.3119	Potential
T81642	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 06)		119.377	-22.315	Potential
T81643	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 05)		119.378	-22.3086	Potential
T81644	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 11)		119.382	-22.3275	Potential
T81645	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 03)		119.376	-22.2891	Potential
T81646	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group (site 11)		119.382	-22.3275	Potential
T81647	Urodacidae	*Urodacus* `cloudbreak`	`Cloudbreak` Mining Lease Fortescue Metals Group		119.359	-22.3119	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
			(site 19)				
T81648	Urodacidae	*Urodacus* \`cloudbreak\`	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 14)		119.353	-22.3252	Potential
T81649	Urodacidae	*Urodacus* \`cloudbreak\`	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 09)		119.373	-22.3275	Potential
T81650	Urodacidae	*Urodacus* \`cloudbreak\`	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 37)		119.427	-22.3025	Potential
T81651	Urodacidae	*Urodacus* \`cloudbreak\`	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 03)		119.376	-22.2891	Potential
T81652	Urodacidae	*Urodacus* \`cloudbreak\`	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 25)		119.404	-22.335	Potential
T81658	Urodacidae	*Urodacus* \`cloudbreak\`	\`Cloudbreak\` Mining Lease Fortescue Metals Group (site 10)		119.37	-22.3275	Potential
T101152	Urodacidae	*Urodacus* sp. indet.	Area C 85.8 km NW. of Newman		119.062	-22.8964	Potential
T111062	Urodacidae	*Urodacus* sp. indet.	Juna Downs Station area A		118.693	-22.8932	Potential
T118658	Urodacidae	*Urodacus* sp. indet.	15 miles north of Roy Hill	Drainage in valley/flats leaf litter	119.955	-22.6025	Potential
T128289	Urodacidae	*Urodacus* sp. indet.	Orebody 19 ca. 28 km ENE. of Newman		120.003	-23.3304	Potential
T40985	Urodacidae	*Urodacus* sp. indet.	White Springs Ruins 68 miles N. of Wittenoom		118.8	-21.7833	Potential
T79522	Urodacidae	*Urodacus* sp. indet.	17.5 km SE. of Mt Bruce (site TCMBE07)		118.263	-22.7161	Potential
T79530	Urodacidae	*Urodacus* sp. indet.	18.5 km SE. Mt Bruce site TCMBE08		118.268	-22.7225	Potential
T80234	Urodacidae	*Urodacus* sp. indet.	9 km SW. of Giles Point (site RHNC02)		119.102	-23.3195	Potential
T80236	Urodacidae	*Urodacus* sp. indet.	10.5 km NW. of Bonney Downs Homestead (site RHNE10)		119.877	-22.1178	Potential
T80237	Urodacidae	*Urodacus* sp. indet.	47.5 km ESE. of Paraburdoo (site TCMBC11)		118.124	-23.2863	Potential
T80238	Urodacidae	*Urodacus* sp. indet.	25 km NE. of Moorimoordinia Native Well Pilbara Biological Survey site RHNE09		119.984	-22.4154	Potential
T91707	Urodacidae	*Urodacus* sp. indet.	Hope Downs 4 ca. 100 km NW. Newman HD4-8		119.318	-23.0866	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
T91922	Urodacidae	*Urodacus* sp. indet.	Hamersley Range Weeli Wolli Creek region Area C site 12-12I		118.91	-22.9168	Potential
T91923	Urodacidae	*Urodacus* sp. indet.	Hamersley Range Weeli Wolli Creek region Area C site 12-12C		118.91	-22.9168	Potential
T93574	Urodacidae	*Urodacus* sp. indet.	Jinary ca. 60 km NW. of Newman		119.243	-23.0251	Potential
T93575	Urodacidae	*Urodacus* sp. indet.	Jinary ca. 60 km NW. of Newman		119.28	-23.0408	Potential
T9910	Urodacidae	*Urodacus* sp. indet.	8 mile W. of Nullagine	Under rocks	120	-21.8833	Potential
Order Geophilomorpha (soil centipedes)							
T112340	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 73 km heading 291° from Newman	Gorge base	119.061	-23.122	Potential
T112341	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 73 km heading 291° from Newman	Wide creek	119.063	-23.121	Potential
T112342	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 73 km heading 291° from Newman	Wide creek	119.063	-23.121	Potential
T112343	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 73 km heading 291° from Newman	Wide creek	119.063	-23.121	Potential
T112344	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 78 km heading 286° from Newman	Gully base	119.002	-23.1615	Potential
T112345	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 70 km heading 291° from Newman	Gully sides	119.096	-23.1319	Potential
T112346	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 74 km heading 289° from Newman	Wide creek	119.046	-23.1356	Potential
T112347	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 70 km heading 291° from Newman	Midslope	119.09	-23.1288	Potential
T112348	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 81 km heading 286° from Newman	Undulatiing plain	118.97	-23.1597	Potential
T112349	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 80 km heading 285° from Newman	Undulatiing plain	118.977	-23.1633	Potential
T112350	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 78 km heading 288° from Newman	Plain	119.006	-23.1437	Potential
T112351	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 70 km heading 291° from Newman	Midslope	119.09	-23.1288	Potential
T112352	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 73 km heading 291° from Newman	Wide creek	119.063	-23.121	Potential
T112353	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 74 km heading 289° from Newman	Wide creek	119.046	-23.1356	Potential
T112354	Chilenophilidae	*Sepedonophilus* sp. indet.	Wonmunna ca. 70 km heading 291° from Newman	Gully sides	119.096	-23.1319	Potential
Order Eupulmonata (snails)							
S65281	Bithyniidae	*Gabbia* aff. Smithi	Cloudbreak	Marsh	119.789	-22.3134	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
S83528	Bithyniidae	*Gabbia* aff. *smithi*i	Newman	soil around dead vegetation	119.811	-22.2954	Potential
S83530	Bithyniidae	*Gabbia* aff. *smithi*i	Newman	soil around dead vegetation	119.811	-22.2954	Potential
S83535	Bithyniidae	*Gabbia* aff. *smithi*i	Newman	soil around dead vegetation	119.811	-22.2954	Potential
S83536	Bithyniidae	*Gabbia* aff. *smithi*i	Newman	soil around dead vegetation	119.724	-22.4252	Potential
S83542	Bithyniidae	*Gabbia* aff. *smithi*i	Newman	soil around dead vegetation	119.811	-22.2954	Potential
S83546	Bithyniidae	*Gabbia* aff. *smithi*i	Newman	soil around dead vegetation	119.046	-23.1356	Potential
S65328	Camaenidae	cf. Pleuroxia sp. nov.	Karajini National Park		119.582	-23.103	Potential
S59245	Camaenidae	cf. *Quistrachia* sp. indet.	Cloundbreak		118.993	-22.0503	Potential
S59256	Camaenidae	cf. *Quistrachia* sp. indet.	Cloundbreak	Base of cliff	118.992	-21.9586	Potential
S64580	Camaenidae	cf. *Quistrachia* sp. indet.	Cloundbreak	Base of cliff	119.046	-23.1356	Potential
S64582	Camaenidae	cf. *Quistrachia* sp. indet.	Cloundbreak		119.061	-23.122	Potential
S83325	Camaenidae	cf. *Quistrachia* sp. indet.	Cloundbreak		119.063	-23.121	Potential
S83363	Camaenidae	Gen. nov. sp. nov. \`small Mount Robinson\`	Newman	Gully rockpile	119.811	-22.2954	Potential
S83366	Camaenidae	Gen. nov. sp. nov. \`small Mount Robinson\`	Newman	Narrow gorge lined with Mulga	119.811	-22.2954	Potential
S83367	Camaenidae	Gen. nov. sp. nov. \`small Mount Robinson\`	Newman	Gully rockpile	118.992	-21.9586	Potential
S83368	Camaenidae	Gen. nov. sp. nov. \`small Mount Robinson\`	Newman	Tall deep wooded gully; fallen logs and rock outcrops present.	118.285	-23.2884	Potential
S65343	Camaenidae	Gen. nov. sp. nov. \`Z\`	Karajini National Park		119.009	-23.1502	Potential
S83362	Camaenidae	Gen. nov. sp. nov. \`Z\`	Newman	gully	119.863	-22.2972	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
S83364	Camaenidae	Gen. nov. sp. nov. `Z`	Newman		118.674	-22.8697	Potential
S83365	Camaenidae	Gen. nov. sp. nov. `Z`	Newman	Gully	119.995	-22.5769	Potential
S34786	Camaenidae	*Quistrachia* cf. turneri	Cloudbreak	Base of cliff	119.317	-22.265	Potential
S5776	Camaenidae	*Quistrachia* sp. nov. `Marandoo`	Marandoo		119.315	-22.2688	Potential
S60272	Camaenidae	*Quistrachia* sp. nov. `Marandoo`	Marandoo	On aboriginal site shells in very localised area	119.315	-22.2688	Potential
S83466	Camaenidae	*Rhagada* cf. *richardsonii*	Port Hedland	Drainage line	119.317	-22.265	Potential
S28100	Camaenidae	*Rhagada richardsonii*	Roy Hill		118.885	-23.0476	Potential
S59257	Camaenidae	*Rhagada richardsonii*	Roy Hill Station		118.885	-23.0477	Potential
S60381	Camaenidae	*Rhagada richardsonii*	Roy Hill Station	Plain; concentrated woodlitter in drifts	118.885	-23.0476	Potential
S60383	Camaenidae	*Rhagada richardsonii*	Roy Hill Station	Plain; concentrated woodlitter in drifts	118.885	-23.0475	Potential
S60384	Camaenidae	*Rhagada richardsonii*	Roy Hill Station	Plain; concentrated woodlitter in drifts	118.752	-23.0779	Potential
S60391	Camaenidae	*Rhagada richardsonii*	Roy Hill Station	Plain; concentrated woodlitter in drifts	118.82	-23.073	Potential
S59283	Camaenidae	*Rhagada* sp. indet.	Mt Bruce		118.787	-23.077	Potential
S84181	Camaenidae	*Rhagada* sp. indet.	Fortescue Marsh	Under dead triodia on marsh	118.521	-22.8415	Potential

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
				margins; ~100 m from samphire; calcarious ground red clay soil			
S58076	Charopidae	*Discocharopa* sp. indet.	Nullagine	Rock scree slope	119.046	-23.1356	Potential
S58108	Charopidae	*Discocharopa* sp. indet.	Nullagine	Rock scree slope	119.811	-22.2954	Potential
S65428	Planorbidae	*Bayardella* sp. indet.	Koodaideri	Rock pool	119.076	-22.5505	Potential
S83508	Planorbidae	*Leichhardtia* cf. *sisurnius*	Port Hedland	Drainage line	119.15	-22.3108	Potential
S65973	Planorbidae	*Leichhardtia sisurnius*	Wonmunna	Gorge Base	118.303	-22.0679	Potential
S65987	Planorbidae	*Leichhardtia sisurnius*	Wonmunna	wide creek	119.009	-23.1502	Potential
S81068	Planorbidae	*Leichhardtia sisurnius*	Wonmunna	wide creek	119.867	-22.1	Potential
S81088	Planorbidae	*Leichhardtia sisurnius*	Wonmunna	wide creek	119.931	-22.0209	Potential
S59304	Planorbidae	*Leichhardtia* cf. *sisurnius*	Hope Downs	Cliff near pool; Recently burned	119.034	-22.0191	Potential
S42760	Planorbidae	*Leichhardtia* sp. indet.	Chicester Range	Spinifex dominated rocky slopes	118.533	-22.8437	Potential
S59270	Punctidae	*Paralaoma* sp. indet.	Phils Creek	Leaf litter 1-5cm; SW mid-slope	119.315	-22.2688	Potential
S59330	Succineidae	*Succinea* sp. indet.	Juna Downs	Flat country	119.315	-22.2688	Potential
S60365	Succineidae	*Succinea* sp. indet.	Roy Hill Station		118.117	-22.6166	Potential
S61096	Succineidae	*Succinea* sp. indet.	Bonney Creek Station	Under rock in dry creek	118.45	-22.5833	Potential
S64475	Succineidae	*Succinea* sp. indet.	Fortescue Marsh		119.022	-22.1554	Potential
S64646	Succineidae	*Succinea* sp. indet.	Fortescue Marsh East	Heavy stock disturbance	119.95	-22.6166	Potential
S64689	Succineidae	*Succinea* sp. indet.	Fortescue Marsh	Gully base; creek bed	119.92	-22.6593	Potential
S65640	Succineidae	*Succinea* sp. indet.	Newman		119.92	-22.6593	Potential

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S65658	Succineidae	*Succinea* sp. indet.	Newman		119.92	-22.6593	Potential
S65660	Succineidae	*Succinea* sp. indet.	Newman		119.92	-22.6593	Potential
S65661	Succineidae	*Succinea* sp. indet.	Newman		119.95	-22.6	Potential
S65665	Succineidae	*Succinea* sp. indet.	Newman		119.434	-22.4546	Potential
S65666	Succineidae	*Succinea* sp. indet.	Newman		118.133	-22.6	Potential
S65674	Succineidae	*Succinea* sp. indet.	Newman		119.697	-23.1877	Potential
S65685	Succineidae	*Succinea* sp. indet.	Newman		119.696	-23.1874	Potential
S65691	Succineidae	*Succinea* sp. indet.	Newman		119.193	-22.7316	Potential
S81020	Succineidae	*Succinea* sp. indet.	Wonmunna	Gully/Gorge	119.445	-22.3988	Potential
S81040	Succineidae	*Succinea* sp. indet.	Wonmunna	wide creek	119.76	-22.4972	Potential
S81124	Succineidae	*Succinea* sp. indet.	Wonmunna	Gully/Gorge	119.628	-22.4294	Potential
S81884	Succineidae	*Succinea* sp. indet.	Wittenoom	Rocky hillslope low leaf litter & woody debris	119.72	-22.4659	Potential
S83507	Succineidae	*Succinea* sp. indet.	Port Hedland	Drainage line	119.692	-22.459	Potential
S83828	Succineidae	*Succinea* sp. indet.	Paraburdoo	plain	119.627	-22.4295	Potential
S83971	Succineidae	*Succinea* sp. indet.	Coongan Homestead	Emphemeral Pool	119.649	-22.4417	Potential
Order Isopoda (slaters)							
Phoenix	Armadillidae	*Acanthodillo* 'won1'	ca 79.5 km heading 285.5° from Newman		118.9791	-23.1649	Potential
Phoenix	Armadillidae	Armadillidae 'Roy Hill'	113 km NNW of Newman		119.6531	-22.3351	Potential
Phoenix	Armadillidae	*Buddelundia* '10TS'	36km SW Tom Price		118.3173	-23.3242	Potential
Phoenix	Armadillidae	*Buddelundia* '10TS'	36km SW Tom Price		118.3173	-23.3242	Potential
Phoenix	Armadillidae	*Buddelundia* '10TS'	36km SW Tom Price		118.3173	-23.3242	Potential
Phoenix	Armadillidae	*Buddelundia* '26'	114 km NNW of Newman		119.7493	-22.3263	Potential
Phoenix	Armadillidae	*Buddelundia* '26'	118 km N of Newman		119.8633	-22.2972	Potential

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Phoenix	Armadillidae	*Buddelundia* '26'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Armadillidae	*Buddelundia* '26'	115 km N of Newman		119.7886	-22.3135	Potential
Phoenix	Armadillidae	*Buddelundia* '26'	115 km N of Newman		119.7886	-22.3135	Potential
Phoenix	Armadillidae	*Buddelundia* '47TS'	29km WSW Tom Price		118.2932	-23.2201	Potential
Phoenix	Armadillidae	*Buddelundia* '47TS'	57km E Paraburdoo		118.2273	-23.2302	Potential
Phoenix	Armadillidae	*Buddelundia* '47TS'	57km E Paraburdoo		118.2273	-23.2302	Potential
Phoenix	Armadillidae	*Buddelundia* '68'	69km E Paraburdoo		118.2624	-23.2555	Potential
Phoenix	Armadillidae	*Buddelundia* sp. indet.	East of Woodstock Aboriginal Reserve 6km SW of Redmont Airport		118.982	-22.0172	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	114 km NNW of Newman		119.7493	-22.3263	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	114 km NNW of Newman		119.7493	-22.3263	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	114 km NNW of Newman		119.7493	-22.3263	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	104 km N of Newman		119.9758	-22.4511	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	118 km N of Newman		119.8109	-22.2955	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	118 km N of Newman		119.8109	-22.2955	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	115 km NNW of Newman		119.7476	-22.3179	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	115 km NNW of Newman		119.7476	-22.3179	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	115 km N of Newman		119.7886	-22.3135	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	110 km NNE of Newman		119.9727	-22.3828	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	110 km NNE of Newman		119.9727	-22.3828	Potential

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Phoenix	Buddelundinae	Buddelundinae 'PES978'	110 km NNE of Newman		119.9727	-22.3828	Potential
Phoenix	Buddelundinae	Buddelundinae 'PES978'	108 km N of Newman		119.8599	-22.3133	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7493	-22.3263	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7493	-22.3263	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7493	-22.3263	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	104 km NNE of Newman		119.986	-22.4481	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	104 km NNE of Newman		119.986	-22.4481	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	112 km NNE of Newman		119.9664	-22.3872	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	112 km NNE of Newman		119.9664	-22.3872	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	104 km N of Newman		119.9758	-22.4511	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	118 km N of Newman		119.8633	-22.2972	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	118 km N of Newman		119.8109	-22.2955	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	118 km N of Newman		119.8109	-22.2955	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	115 km NNW of Newman		119.7476	-22.3179	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	115 km NNW of Newman		119.7476	-22.3179	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	115 km NNW of Newman		119.7476	-22.3179	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	113 km NNW of Newman		119.6531	-22.3351	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	113 km NNW of Newman		119.6531	-22.3351	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	115 km N of Newman		119.7886	-22.3135	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	110 km NNE of Newman		119.9727	-22.3828	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	110 km NNE of Newman		119.9727	-22.3828	Potential

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Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	108 km N of Newman		119.8599	-22.3133	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7392	-22.3257	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7392	-22.3257	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7392	-22.3257	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7392	-22.3257	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'PES4394'	114 km NNW of Newman		119.7392	-22.3257	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna A'	Wonmunna		119.0064	-23.1437	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna A'	Wonmunna		119.0633	-23.1209	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna A'	Wonmunna		119.0633	-23.1209	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna A'	Wonmunna		119.0633	-23.1209	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna A'	Wonmunna		119.0633	-23.1209	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna B'	Wonmunna		119.0182	-23.1394	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna B'	Wonmunna		119.0611	-23.1221	Potential
Phoenix	Philosciidae	*Laevophiloscia* 'wonmunna B'	Wonmunna		119.0633	-23.1209	Potential
Phoenix	Philosciidae	Philosciidae sp. indet.	50m NNE of Great Northern Hwy and Port Hedland-Wittenoom Rd junction 6km SW of Redmont Airport		118.9823	-22.0178	Potential
Phoenix	Philosciidae	Philosciidae sp. indet.	50m NNE of Great Northern Hwy and Port Hedland-Wittenoom Rd junction 6km SW of Redmont Airport		118.9816	-22.0196	Potential
Phoenix	Philosciidae	Philosciidae sp. indet.	50m NNE of Great Northern Hwy and Port Hedland-Wittenoom Rd junction 6km SW of Redmont Airport		118.9816	-22.0196	Potential
Phoenix	Philosciidae	Philosciidae sp. indet.	Marillana Station 62km E of Great Northern Hwy and Port Hedland Wittenoom Rd junction		119.256	-22.5746	Potential
Order Polydesmida (keeled millipedes)							
T121031	Paradoxosomatidae	*Antichiropus* `cloudbreak`	Newman ca. 130 km NW. of Newman BFS2 Site 08		119.03	-22.2873	confirmed
T121032	Paradoxosomatidae	*Antichiropus* `DIP004`	Roy Hill 1 Mine ca. 90 km NE. of Newman		119.942	-22.4789	confirmed

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T91862	Paradoxosomatidae	*Antichiropus* \`DIP006\`	Area C ca. 120 km NNW. Newman site 12-12N		118.91	-22.9168	confirmed
T105988	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 101 km NW. of Newman		118.827	-23.0056	confirmed
T105989	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 61.8 km NW. of Newman		118.869	-22.9986	confirmed
T105991	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 89.6 km NW. of Newman		118.948	-23.0011	confirmed
T105992	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 86.2 km NW. of Newman		118.982	-23.0014	confirmed
T105993	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 87.2 km NW. of Newman		118.982	-22.9892	confirmed
T105994	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 87.2 km NW. of Newman		118.982	-22.9892	confirmed
T105995	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 85.2 km NW. of Newman		118.994	-23.0036	confirmed
T106003	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 81.8 km NW. of Newman		119.033	-23.005	confirmed
T106004	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 81.8 km NW. of Newman		119.033	-23.005	confirmed
T106134	Paradoxosomatidae	*Antichiropus* \`DIP007\`	Area C 85.2 km NW. of Newman		118.994	-23.0036	confirmed
T76073	Paradoxosomatidae	*Antichiropus* \`DIP012\`	24.5 km N. of Cowra Line Camp Pilbara Biological Survey site RHNW10		119.024	-22.1347	confirmed
T93875	Paradoxosomatidae	*Antichiropus* \`DIP012\`	Chichester Range Pilbara site 24	S facing gully floor and creek line Eucalypts & Acacia	118.993	-22.0504	confirmed
T109072	Paradoxosomatidae	*Antichiropus* \`DIP013\`	Cloudbreak		119.302	-22.3146	confirmed
T109073	Paradoxosomatidae	*Antichiropus* \`DIP013\`	Cloudbreak		119.302	-22.3146	confirmed

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T109074	Paradoxosomatidae	*Antichiropus* `DIP013`	Cloudbreak		119.302	-22.3146	confirmed
T109075	Paradoxosomatidae	*Antichiropus* `DIP013`	Cloudbreak		119.302	-22.3146	confirmed
T112610	Paradoxosomatidae	*Antichiropus* `DIP013`	Cloudbreak		119.302	-22.3146	confirmed
T104715	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site20-P3	Rocky slope	119.591	-23.395	confirmed
T104722	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site13-P1	Gully	119.639	-23.3946	confirmed
T104724	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P5	Rocky slope	119.632	-23.3945	confirmed
T104725	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P6	Rocky slope	119.632	-23.3945	confirmed
T104728	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site17-P2	Ridgebase	119.625	-23.4046	confirmed
T104733	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P3	Rocky slope	119.632	-23.3944	confirmed
T104734	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P3	Rocky slope	119.632	-23.3944	confirmed
T104757	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P4	Rocky slope	119.632	-23.3944	confirmed
T104765	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P10	Rocky slope	119.632	-23.3945	confirmed
T104767	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P9	Rocky slope	119.632	-23.3945	confirmed
T104769	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P9	Rocky slope	119.632	-23.3945	confirmed
T104770	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P9	Rocky slope	119.632	-23.3945	confirmed
T104772	Paradoxosomatidae	*Antichiropus* `DIP014`	Orebody 35 ca. 8 km W. of Newman Site1-P9	Rocky slope	119.632	-23.3945	confirmed

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T104773	Paradoxosomatidae	*Antichiropus* \`DIP014\`	Orebody 35 ca. 8 km W. of Newman Site1-P9	Rocky slope	119.632	-23.3945	confirmed
T104729	Paradoxosomatidae	*Antichiropus* \`DIP015\`	Orebody 35 ca. 8 km W. of Newman Site13-P10	Gully	119.639	-23.3945	confirmed
T104778	Paradoxosomatidae	*Antichiropus* \`DIP015\`	Orebody 35 ca. 8 km W. of Newman Site6-P7	Slope with spinifex	119.575	-23.4018	confirmed
T76079	Paradoxosomatidae	*Antichiropus* \`DIP028\`	9 km NE. of Cowra Line Camp Pilbara Biological Survey site RHNW11		119.061	-22.2941	confirmed
T76054	Paradoxosomatidae	*Antichiropus* \`DIP029\`	24 km WSW. of Mt Marsh Pilbara Biological Survey site RHNW02		118.998	-22.5358	confirmed
T111846	Paradoxosomatidae	*Antichiropus* \`DIP031\`	Christmas Creek 110 km N. Newman; Molecular Species	Leaf litter	119.771	-22.3516	confirmed
T111856	Paradoxosomatidae	*Antichiropus* \`DIP031\`	Christmas Creek 110 km N. Newman	Leaf litter	119.819	-22.3789	confirmed
T113250	Paradoxosomatidae	*Antichiropus* \`DIP031\`	Christmas Creek 110 km N. Newman; Molecular Species	Leaf litter	119.897	-22.4191	confirmed
T113481	Paradoxosomatidae	*Antichiropus* \`DIP031\`	Christmas Creek 110 km N. Newman; Molecular Species	Leaf litter	119.78	-22.3933	confirmed
T124140	Paradoxosomatidae	*Antichiropus* \`DIP031\`	100 km N. of Newman; Molecular Species	Leaf litter	119.777	-22.3967	confirmed
T113251	Paradoxosomatidae	*Antichiropus* \`DIP032\`	Christmas Creek 110 km N. Newman; Molecular Species	Leaf litter	119.897	-22.4191	confirmed
T124598	Paradoxosomatidae	*Antichiropus* \`DIP035\`	15.5 km ENE. of Mt Bruce Pilbara Biological Survey site TCMBE02		118.29	-22.5833	confirmed
T76075	Paradoxosomatidae	*Antichiropus* \`DIP036\`	13 km SSW. of Giles Point Pilbara Biological Survey site RHNC01		119.113	-23.3611	confirmed
T94688	Paradoxosomatidae	*Antichiropus* \`DIP047\`	Auski Road House 55.5 km S. of (Ecologia 997)		118.641	-22.8869	confirmed
T104714	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site1-HC6	Steep south facing ridge deeply vegetated	119.632	-23.3943	confirmed
T104717	Paradoxosomati	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site13-P5	Gully	119.638	-23.3947	confirmed

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
	dae						
T104726	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site17-P2	Ridgebase	119.625	-23.4046	confirmed
T104727	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site17-P2	Ridgebase	119.625	-23.4046	confirmed
T104731	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site7-P2	Slope with Mulga	119.622	-23.4053	confirmed
T104747	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site3-P2	Gully	119.605	-23.4047	confirmed
T104758	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site1-P4	Rocky slope	119.632	-23.3944	confirmed
T104759	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site1-P4	Rocky slope	119.632	-23.3944	confirmed
T104768	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site1-P9	Rocky slope	119.632	-23.3945	confirmed
T104771	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site1-P9	Rocky slope	119.632	-23.3945	confirmed
T104775	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site3-P6	Gully	119.605	-23.405	confirmed
T104783	Paradoxosomatidae	*Antichiropus* \`OB35_1\`	Orebody 35 ca. 8 km W. of Newman Site1-P2	Rocky slope	119.632	-23.3944	confirmed
T104721	Paradoxosomatidae	*Antichiropus* \`OB35_2\`	Orebody 35 ca. 8 km W. of Newman Site13-P1	Gully	119.639	-23.3946	confirmed
T104762	Paradoxosomatidae	*Antichiropus* \`OB35_2\`	Orebody 35 ca. 8 km W. of Newman Site3-P9	Gully	119.605	-23.4048	confirmed
T118099	Paradoxosomatidae	*Antichiropus* \`Wonmunna\`	Wonmunna ca. 78 km heading 286° from Newman	Gully Base	119.002	-23.1615	confirmed
T118100	Paradoxosomatidae	*Antichiropus* \`Wonmunna\`	Wonmunna ca. 79 km heading 286° from Newman	Gully Sides	118.993	-23.1592	confirmed
T118101	Paradoxosomatidae	*Antichiropus* \`Wonmunna\`	Wonmunna ca. 78 km heading 286° from Newman	Gully Base	119.002	-23.1615	confirmed
T118102	Paradoxosomati	*Antichiropus* \`Wonmunna\`	Wonmunna ca. 79 km heading 286° from Newman	Gully Sides	118.993	-23.1592	confirmed

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
	dae						
T118104	Paradoxosomatidae	*Antichiropus* `Wonmunna`	Wonmunna ca. 72 km heading 290° from Newman	Wide creek	119.069	-23.1309	confirmed
T118105	Paradoxosomatidae	*Antichiropus* `Wonmunna`	Wonmunna ca. 80 km heading 285° from Newman	Undulatiing Plain	118.977	-23.1633	confirmed
T107384	Paradoxosomatidae	*Antichiropus* sp. indet.	Hope Downs 73.3 km NW. of Newman		119.152	-23.0069	likely
T107388	Paradoxosomatidae	*Antichiropus* sp. indet.	Hope Downs 81.4 km NW. of Newman		119.084	-22.9419	likely
T109962	Paradoxosomatidae	*Antichiropus* sp. indet.	Hamersley Range SE. of Mt Robinson Pilbara Biological Survey site RHNC07		119.266	-23.1461	likely
T111973	Paradoxosomatidae	*Antichiropus* sp. indet.	115 km N. of Newman		119.789	-22.3135	likely
T111974	Paradoxosomatidae	*Antichiropus* sp. indet.	115 km N. of Newman		119.789	-22.3135	likely
T111975	Paradoxosomatidae	*Antichiropus* sp. indet.	112 km NNE. of Newman	Plain	119.969	-22.3622	likely
T111976	Paradoxosomatidae	*Antichiropus* sp. indet.	112 km NNE. of Newman	Plain	119.969	-22.3622	likely
T111977	Paradoxosomatidae	*Antichiropus* sp. indet.	110 km NNE. of Newman		119.973	-22.3828	likely
T112607	Paradoxosomatidae	*Antichiropus* sp. indet.	Orebody 35 ca. 8 km W. of Newman Site13-P10	Gully	119.639	-23.3945	likely
T112620	Paradoxosomatidae	*Antichiropus* sp. indet.	13 km SSW. of Giles Point Pilbara Biological Survey site RHNC01		119.113	-23.3611	likely
T76055	Paradoxosomatidae	*Antichiropus* sp. indet.	1.5 km W. of Giles Point Pilbara Biological Survey site RHNC04		119.145	-23.2509	likely
T76061	Paradoxosomatidae	*Antichiropus* sp. indet.	4 km SSW. of Mile Camp Pilbara Biological Survey site RHNE01		119.613	-22.8201	likely
T76063	Paradoxosomatidae	*Antichiropus* sp. indet.	24 km ENE. of Moorimoordinia Nativa Well Pilbara Biological Survey site RHNE08		119.976	-22.4518	likely
T76064	Paradoxosomati	*Antichiropus* sp. indet.	34 km NNW. of Cowra Line Camp Pilbara Biological		118.979	-22.0688	likely

WAM reg. no. (or other data source)	Family	Genus and species	Location (as provided by data source)	Habitat (as provided by data source)	Longitude	Latitude	SRE category
	dae		Survey site RHNW09				
T76071	Paradoxosomatidae	*Antichiropus* sp. indet.	16 km N. of Cowra Line Camp Pilbara Biological Survey site RHNW07		119.025	-22.2217	likely
T91863	Paradoxosomatidae	*Antichiropus* sp. indet.	Area C ca. 120 km NNW. Newman site 12-12B		118.91	-22.9168	likely
T91864	Paradoxosomatidae	*Antichiropus* sp. indet.	Area C ca. 120 km NNW. Newman site 08-8B		118.993	-22.9006	likely
T93447	Paradoxosomatidae	*Antichiropus* sp. indet.	Hope Downs 4 ca. 30 km NW. Newman HD4-13 29	Open eucalypt woodland over Triodia	119.28	-23.1038	likely
T93876	Paradoxosomatidae	*Antichiropus* sp. indet.	Chichester Range Pilbara site 22	Acacia open woodland	118.988	-22.0517	likely
T93877	Paradoxosomatidae	*Antichiropus* sp. indet.	Chichester Range Pilbara site 10	Alluvial floodplain almost bare	119.017	-22.1503	likely
Order Polyxenida (pincushion millipedes)							
T116451	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed
T116452	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed
T116453	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed
T116454	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed
T116455	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed
T116456	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed
T116457	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed
T116466	Polyxenidae	*Unixenus karijinensis*	Wittenoom		118.333	-22.2333	confirmed
T116467	Polyxenidae	*Unixenus karijinensis*	Wittenoom		118.333	-22.2333	confirmed
T116468	Polyxenidae	*Unixenus karijinensis*	Wittenoom		118.333	-22.2333	confirmed
T116469	Polyxenidae	*Unixenus karijinensis*	Wittenoom		118.333	-22.2333	confirmed
T71106	Polyxenidae	*Unixenus karijinensis*	Wittenoom Gorge asbestos mine		118.317	-22.3167	confirmed

Appendix 3 Subterranean fauna species records from desktop review

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T131653	yes	Symphyla	*Hanseniella* sp. B21	-22.8154	119.027
WAM	T96825	Uncertain	Acari	sp. indet.	-23.1386	119.589
WAM	T96826	Uncertain	Acari	sp. indet.	-23.1222	119.488
WAM	T96827	Uncertain	Acari	sp. indet.	-23.1478	119.527
WAM	T96828	Uncertain	Acari	sp. indet.	-23.1522	119.739
WAM	T96829	Uncertain	Acari	sp. indet.	-23.1311	119.534
WAM	T96830	Uncertain	Acari	sp. indet.	-23.1619	119.499
WAM	T106133	Uncertain	Acari	*Axonopsella*	-22.7833	119.252
WAM	T96823	Uncertain	Acari	sp. indet.	-23.2039	119.481
WAM	T131322	Uncertain	Acari	Peza ACA001	-23.3258	119.872
WAM	T131323	Uncertain	Acari	Peza ACA001	-23.3284	119.844
WAM	T131324	Uncertain	Acari	Peza ACA001	-23.2988	119.863
WAM	T131325	Uncertain	Acari	*Peza* ACA001	-23.3666	119.841
WAM	T131326	Uncertain	Acari	*Peza* ACA001	-23.2843	119.869
WAM	T127465	Uncertain	Acari	*Recifella* sp. indet	-22.7474	119.301
WAM	T106129	Uncertain	Acari	*Recifella* sp. 1	-22.7692	119.201
WAM	T106130	Uncertain	Acari	*Recifella* sp. 1	-22.7806	119.18
WAM	T106131	Uncertain	Acari	*Recifella* sp. 1	-22.7706	119.197
WAM	T106132	Uncertain	Acari	*Recifella* sp. 1	-22.7692	119.201
WAM	T106135	Uncertain	Acari	*Recifella* sp. 1	-22.7692	119.201
WAM	T106136	Uncertain	Acari	*Recifella* sp. 1	-22.7692	119.201
WAM	T91747	Uncertain	Araneae	sp. indet.	-22.9228	118.851
WAM	T100088	Uncertain	Araneae	*Encoptarthria*?	-22.947	119.021

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T129665	yes	Araneae	nr *Encoptarthria* sp. B01	-23.0008	119.244
WAM	T96822	yes	Araneae	*Opopaea* sp. indet.	-23.2055	119.481
WAM	T96817	yes	Araneae	*Prethopalpus boltoni*	-23.1311	119.534
WAM	T92116	yes	Araneae	*Prethopalpus boltoni*	-23.1308	119.533
WAM	T108273	yes	Araneae	*Prethopalpus julianneae*	-22.9924	118.833
WAM	T108269	yes	Araneae	*Prethopalpus maini*	-23.0098	118.983
WAM	T108270	yes	Araneae	*Prethopalpus maini*	-23.0137	118.989
WAM	T108272	yes	Araneae	*Prethopalpus maini*	-22.9849	118.818
WAM	T108274	yes	Araneae	*Prethopalpus maini*	-22.9849	118.854
WAM	T108276	yes	Araneae	*Prethopalpus maini*	-22.8983	118.989
WAM	T108283	yes	Araneae	*Prethopalpus maini*	-22.9958	118.818
WAM	T108277	yes	Araneae	*Prethopalpus pearsoni*	-22.902	118.989
WAM	T131655	yes	Araneae	*Prethopalpus* sp. B27	-22.8152	118.854
WAM	T127533	yes	Araneae	*Prethopalpus* sp. indet.	-23.1241	118.886
WAM	T108271	yes	Araneae	*Prethopalpus* sp. indet.	-22.9992	118.895
WAM	T108278	yes	Araneae	*Prethopalpus* sp. indet.	-22.9023	118.996
WAM	T108279	yes	Araneae	*Prethopalpus* sp. indet.	-22.9796	118.842
WAM	T108280	yes	Araneae	*Prethopalpus* sp. indet.	-22.9306	118.945
WAM	T108281	yes	Araneae	*Prethopalpus* sp. indet.	-22.966	119.073
WAM	T108282	yes	Araneae	*Prethopalpus* sp. indet.	-22.9382	119.004
WAM	T125179	yes	Araneae	*Prethopalpus* sp. indet.	-22.9988	118.912
WAM	T125180	yes	Araneae	*Prethopalpus* sp. indet.	-22.9921	118.813
WAM	T125181	yes	Araneae	*Prethopalpus* sp. indet.	-22.9884	118.827
WAM	T130737	yes	Araneae	*Prethopalpus* sp.	-23.3255	119.76

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T130739	yes	Araneae	*Prethopalpus* sp.	-23.2991	119.735
WAM	T108275	Uncertain	Araneae	sp. indet.	-22.8993	118.99
WAM	T96821	Uncertain	Araneae	sp. indet.	-23.1147	119.529
WAM	T127457	yes	Symphyla	*Symphyella* sp. indet.	-22.7439	119.305
WAM	T131656	Uncertain	Geophilida	*Ribautia* sp. B02	-22.8153	118.877
WAM	T00087	Uncertain	Opilionida	‘isolatus?’	-22.9267	118.973
WAM	T129669	Uncertain	Opilionida	sp. B03	-22.0136	119.267
WAM	T93967	yes	Palpigradi	sp. indet.	-23.0755	118.665
WAM	T93968	yes	Palpigradi	sp. indet.	-22.9408	118.838
WAM	T93969	yes	Palpigradi	sp. indet.	-22.9407	118.849
WAM	T93970	yes	Palpigradi	sp. indet.	-22.9241	119.008
WAM	T93971	yes	Palpigradi	sp. indet.	-22.9295	118.952
WAM	T93972	yes	Palpigradi	sp. indet.	-22.9239	119.011
WAM	T96813	yes	Palpigradi	sp. indet.	-23.1478	119.527
WAM	T96824	yes	Palpigradi	sp. indet.	-23.1222	119.488
WAM	T95581	yes	Palpigradi	sp. indet.	-23.037	118.727
WAM	T95582	yes	Palpigradi	sp. indet.	-22.9011	119.009
WAM	T97276	yes	Palpigradi	sp. indet.	-22.9064	119.027
WAM	T97277	yes	Palpigradi	sp. indet.	-22.8989	119.041
WAM	T97278	yes	Palpigradi	sp. indet.	-22.8964	119.065
WAM	T129666	yes	Palpigradi	sp. indet.	-22.9782	119.3
WAM	T92118	yes	Palpigradi	sp. indet.	-23.1219	119.488
WAM	T92119	yes	Palpigradi	sp. indet.	-23.1539	119.573
WAM	T92120	yes	Palpigradi	sp. indet.	-23.1506	119.523

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T92121	yes	Palpigradi	sp. indet.	-23.1308	119.533
WAM	T127458	yes	Pauropodina	sp. indet.	-22.7347	119.184
WAM	T92109	yes	Pauropodina	*Decapauropus tenuis*	-23.1228	119.493
WAM	T127459	Uncertain	Polydesmida	**karrie**	-22.7346	119.185
WAM	T116537	Uncertain	Polydesmida	sp. indet.	-22.7001	119.333
WAM	T98371	Uncertain	Polyxenida	sp. indet.	-23.1072	119.513
WAM	T98372	Uncertain	Polyxenida	sp. indet.	-23.1222	119.488
WAM	T98373	Uncertain	Polyxenida	sp. indet.	-23.1942	119.488
WAM	T98374	Uncertain	Polyxenida	sp. indet.	-23.1331	119.542
WAM	T98375	Uncertain	Polyxenida	sp. indet.	-23.1072	119.513
WAM	T98376	Uncertain	Polyxenida	sp. indet.	-23.1222	119.488
WAM	T98377	Uncertain	Polyxenida	sp. indet.	-23.1867	119.476
WAM	T98378	Uncertain	Polyxenida	sp. indet.	-23.1867	119.476
WAM	T98379	Uncertain	Polyxenida	sp. indet.	-23.1072	119.513
WAM	T98380	Uncertain	Polyxenida	sp. indet.	-23.1942	119.488
WAM	T100179	Uncertain	Polyxenida	sp. indet.	-22.8897	118.676
WAM	T100180	Uncertain	Polyxenida	sp. indet.	-22.1208	118.51
WAM	T100181	Uncertain	Polyxenida	sp. indet.	-22.5591	119.214
WAM	T100182	Uncertain	Polyxenida	sp. indet.	-22.6118	119.214
WAM	T100183	Uncertain	Polyxenida	sp. indet.	-22.8733	118.675
WAM	T100184	Uncertain	Polyxenida	sp. indet.	-22.591	119.221
WAM	T92111	Uncertain	Polyxenida	sp. indet.	-23.1319	119.587
WAM	T122112	Uncertain	Polyxenida	sp. indet.	-22.5353	119.035
WAM	T122113	Uncertain	Polyxenida	sp. indet.	-22.5353	119.035

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T122114	Uncertain	Polyxenida	sp. indet.	-22.5289	119.035
WAM	T122115	Uncertain	Polyxenida	sp. indet.	-22.5289	119.035
WAM	T122116	Uncertain	Polyxenida	sp. indet.	-22.5331	118.985
WAM	T102935	Uncertain	Polyxenida	sp. indet.	-22.8222	119.289
WAM	T122135	Uncertain	Polyxenida	sp. indet.	-22.5303	119.034
WAM	T122136	Uncertain	Polyxenida	sp. indet.	-22.5303	119.034
WAM	T122137	Uncertain	Polyxenida	sp. indet.	-22.5236	118.978
WAM	T127513	Uncertain	Polyxenida	sp. indet.	-23.1456	118.627
WAM	T122138	Uncertain	Polyxenida	sp. indet.	-22.5317	118.994
WAM	T127514	Uncertain	Polyxenida	sp. indet.	-23.1255	118.856
WAM	T127515	Uncertain	Polyxenida	sp. indet.	-23.1479	118.681
WAM	T127516	Uncertain	Polyxenida	sp. indet.	-23.1492	118.663
WAM	T127517	Uncertain	Polyxenida	sp. indet.	-23.1476	118.678
WAM	T127518	Uncertain	Polyxenida	sp. indet.	-23.1915	118.832
WAM	T127519	Uncertain	Polyxenida	sp. indet.	-23.1424	118.728
WAM	T127520	Uncertain	Polyxenida	sp. indet.	-23.1674	118.617
WAM	T127521	Uncertain	Polyxenida	sp. indet.	-23.1469	118.646
WAM	T127522	Uncertain	Polyxenida	sp. indet.	-23.1958	118.844
WAM	T127523	Uncertain	Polyxenida	sp. indet.	-23.1416	118.73
WAM	T127524	Uncertain	Polyxenida	sp. indet.	-23.1794	118.725
WAM	T127525	Uncertain	Polyxenida	sp. indet.	-23.1415	118.728
WAM	T127526	Uncertain	Polyxenida	sp. indet.	-23.1727	118.729
WAM	T127527	Uncertain	Polyxenida	sp. indet.	-23.1736	118.664
WAM	T127528	Uncertain	Polyxenida	sp. indet.	-23.1493	118.666

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T129320	Uncertain	Polyxenida	sp. indet.	-22.5433	119.036
WAM	T129349	Uncertain	Polyxenida	sp. indet.	-22.5433	119.036
WAM	T96108	Uncertain	Polyxenida	sp. indet.	-23.1867	119.476
WAM	T96109	Uncertain	Polyxenida	sp. indet.	-22.1072	119.513
WAM	T96110	Uncertain	Polyxenida	sp. indet.	-22.1072	119.513
WAM	T126328	Uncertain	Polyxenida	sp. indet.	-22.5433	119.036
WAM	T126336	Uncertain	Polyxenida	sp. indet.	-22.5331	118.985
WAM	T126337	Uncertain	Polyxenida	sp. indet.	-22.5206	118.975
WAM	T126340	Uncertain	Polyxenida	sp. indet.	-22.5319	118.999
WAM	T126343	Uncertain	Polyxenida	sp. indet.	-22.5267	119.026
WAM	T122110	Uncertain	Polyxenida	sp. indet.	-22.5314	118.999
WAM	T122111	Uncertain	Polyxenida	sp. indet.	-22.5353	119.035
WAM	T98370	Uncertain	Polyxenida	sp. indet.	-23.1942	119.488
WAM	T96106	Uncertain	Polyxenida	sp. indet.	-23.1867	119.476
WAM	T96107	Uncertain	Polyxenida	sp. indet.	-23.1244	119.553
WAM	T92113	Uncertain	Polyxenida	sp. indet.	-23.1328	119.506
WAM	T127460	Uncertain	Polyxenida	sp. indet.	-22.7184	119.316
WAM	T100089	Uncertain	Polyxenida	sp. indet.	-22.9267	118.999
WAM	T100090	Uncertain	Polyxenida	sp. indet.	-22.9397	118.85
WAM	T115425	Uncertain	Polyxenida	*Unixenus* sp. indet. (juvenile)	-22.8419	119.283
WAM	T130738	Uncertain	Polyxenida	*Unixenus* sp.	-23.3337	119.769
WAM	T119436	yes	Pseudoscorpiones	*Lagynochthonius* PSE039	-22.9435	118.883
WAM	T119437	yes	Pseudoscorpiones	*Lagynochthonius* PSE039	-22.9339	118.998
WAM	T119438	yes	Pseudoscorpiones	*Lagynochthonius* PSE039	-22.9427	119.009

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T119439	yes	Pseudoscorpiones	*Lagynochthonius* PSE039	-22.9753	118.83
WAM	T119440	yes	Pseudoscorpiones	*Lagynochthonius* PSE040	-23.3021	119.8
WAM	T119441	yes	Pseudoscorpiones	*Lagynochthonius* PSE041	-23.0627	118.635
WAM	T119429	yes	Pseudoscorpiones	*Lagynochthonius* PSE043	-22.7283	119.314
WAM	T119431	yes	Pseudoscorpiones	*Lagynochthonius* PSE045	-22.9042	118.986
WAM	T119432	yes	Pseudoscorpiones	*Lagynochthonius* PSE045	-22.9011	118.983
WAM	T119433	yes	Pseudoscorpiones	*Lagynochthonius* PSE046	-22.9011	118.986
WAM	T119434	yes	Pseudoscorpiones	*Lagynochthonius* PSE046	-22.9028	118.987
WAM	T119435	yes	Pseudoscorpiones	*Lagynochthonius* PSE046	-22.905	118.977
WAM	T122123	yes	Pseudoscorpiones	*Lagynochthonius* PSE062	-22.5178	118.98
WAM	T126339	yes	Pseudoscorpiones	*Lagynochthonius* PSE062	-22.5242	118.979
WAM	T129664	yes	Pseudoscorpiones	*Lagynochthonius* sp. B02	-23.0221	119.224
WAM	T91728	yes	Pseudoscorpiones	*Lagynochthonius* sp. Packsaddle	-22.9041	118.901
WAM	T91729	yes	Pseudoscorpiones	*Lagynochthonius* sp. Packsaddle	-22.9208	118.883
WAM	T91730	yes	Pseudoscorpiones	*Lagynochthonius* sp. Packsaddle	-22.9238	118.828
WAM	T99763	yes	Pseudoscorpiones	*Lagynochthonius* yandi	-22.7692	119.201
WAM	T97280	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet.	-22.8975	119.059
WAM	T97281	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet.	-22.8992	119.059
WAM	T119446	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet.	-22.9258	119.03
WAM	T119448	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet.	-22.8376	119.272
WAM	T119453	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet.	-23.0072	118.982
WAM	T119473	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet.	-22.9444	118.877
WAM	T97279	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet.	-22.9069	118.997
WAM	T119456	yes	Pseudoscorpiones	*Tyrannochthonius* PSE050	-22.9006	118.983

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T119457	yes	Pseudoscorpiones	*Tyrannochthonius* PSE050	-22.9003	118.983
WAM	T119458	yes	Pseudoscorpiones	*Tyrannochthonius* PSE050	-22.9018	118.996
WAM	T119464	yes	Pseudoscorpiones	*Tyrannochthonius* PSE053	-23.4127	119.596
WAM	T119465	yes	Pseudoscorpiones	*Tyrannochthonius* PSE054	-22.0816	119.83
WAM	T119466	yes	Pseudoscorpiones	*Tyrannochthonius* PSE055	-22.925	119.013
WAM	T119474	yes	Pseudoscorpiones	*Tyrannochthonius* PSE059	-23.3027	119.797
WAM	T119475	yes	Pseudoscorpiones	*Tyrannochthonius* PSE059	-23.3842	119.645
WAM	T96816	yes	Pseudoscorpiones	*Tyrannochthonius* sp. indet. (juvenile)	-23.1311	119.534
WAM	T128113	yes	Pseudoscorpiones	*Indohya* sp. indet.	-22.0098	119.981
WAM	T118292	Uncertain	Pseudoscorpiones	*Indohya* PSE002?	-22.123	118.579
WAM	T118293	Uncertain	Pseudoscorpiones	*Indohya* PSE002?	-22.123	118.579
WAM	T118294	Uncertain	Pseudoscorpiones	*Indohya* PSE002?	-22.123	118.579
WAM	T111706	yes	Pseudoscorpiones	*Indohya* PSE005	-22.9248	118.975
WAM	T111707	yes	Pseudoscorpiones	*Indohya* PSE005	-22.9353	118.999
WAM	T111708	yes	Pseudoscorpiones	*Indohya* PSE005	-22.9444	119.008
WAM	T111709	yes	Pseudoscorpiones	*Indohya* PSE005	-22.9849	118.818
WAM	T111710	yes	Pseudoscorpiones	*Indohya* PSE005	-22.9015	118.988
WAM	T111711	yes	Pseudoscorpiones	*Indohya* PSE005	-22.9038	118.984
WAM	T111712	yes	Pseudoscorpiones	*Indohya* PSE005	-22.9028	118.987
WAM	T97275	yes	Pseudoscorpiones	*Indohya* PSE005	-22.8992	119.068
WAM	T111718	yes	Pseudoscorpiones	*Lechytia* PSE019	-23.3855	119.647
WAM	T111719	yes	Pseudoscorpiones	*Lechytia* PSE019	-23.4066	119.637
WAM	T111720	yes	Pseudoscorpiones	*Lechytia* PSE019	-23.4009	119.651
WAM	T118284	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1629	118.989

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T118285	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1629	118.989
WAM	T118286	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1618	119
WAM	T118287	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1625	118.991
WAM	T118288	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1625	118.991
WAM	T118289	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1645	118.979
WAM	T118290	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1645	118.979
WAM	T118291	yes	Pseudoscorpiones	*Lechytia* wonmunna	-23.1649	118.979
WAM	T96818	Uncertain	Pseudoscorpiones	*Austrohorus* sp. indet.	-23.1331	119.542
WAM	T92108	Uncertain	Pseudoscorpiones	*Indolpium* sp. indet.	-23.1539	119.573
WAM	T92117	Uncertain	Pseudoscorpiones	*Indolpium* sp. indet.	-23.1261	119.489
WAM	T91754	yes	Pseudoscorpiones	Genus? sp. indet.	-22.0949	118.992
WAM	T130251	yes	Schizomida	*Draculoides* sp. indet.	-22.5523	119.057
WAM	T130252	yes	Schizomida	*Draculoides* sp. indet.	-22.5453	119.06
WAM	T130253	yes	Schizomida	*Draculoides* sp. indet.	-22.5617	119.054
WAM	T93782	yes	Schizomida	*Draculoides* sp. indet.	-22.9278	118.877
WAM	T93784	yes	Schizomida	*Draculoides* sp. indet.	-22.9286	118.864
WAM	T93787	yes	Schizomida	*Draculoides* sp. indet.	-22.91	118.958
WAM	T93790	yes	Schizomida	*Draculoides* sp. indet.	-22.9072	119.041
WAM	T127461	yes	Schizomida	*Draculoides* sp. indet.	-22.7319	119.182
WAM	T127462	yes	Schizomida	*Draculoides* sp. indet.	-22.7355	119.188
WAM	T93786	yes	Schizomida	*Draculoides* SCH012	-22.9278	118.877
WAM	T119486	yes	Schizomida	*Draculoides* SCH012	-22.9134	118.923
WAM	T119484	yes	Schizomida	*Draculoides* SCH013	-22.9006	118.99
WAM	T119485	yes	Schizomida	*Draculoides* SCH013	-22.9011	118.986

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T119488	yes	Schizomida	*Draculoides* SCH018	-22.9742	119.036
WAM	T119494	yes	Schizomida	*Draculoides* SCH019	-22.0579	119.912
WAM	T119496	yes	Schizomida	*Draculoides* SCH020	-22.7238	119.315
WAM	T119497	yes	Schizomida	*Draculoides* SCH020	-22.751	119.308
WAM	T119500	yes	Schizomida	*Draculoides* SCH021	-22.7345	119.187
WAM	T119501	yes	Schizomida	*Draculoides* SCH022	-23.0125	118.994
WAM	T119502	yes	Schizomida	*Draculoides* SCH022	-23.0046	118.983
WAM	T119503	yes	Schizomida	*Draculoides* SCH022	-23.0099	118.989
WAM	T119505	yes	Schizomida	*Draculoides* SCH023	-23.0004	118.913
WAM	T119477	yes	Schizomida	*Draculoides* SCH024	-22.9136	119.203
WAM	T119478	yes	Schizomida	*Draculoides* SCH025	-22.912	119.132
WAM	T119491	yes	Schizomida	*Draculoides* SCH029	-22.7194	119.374
WAM	T119492	yes	Schizomida	*Draculoides* SCH029	-22.709	119.336
WAM	T122120	yes	Schizomida	*Draculoides* SCH030 complex	-22.5314	118.999
WAM	T122124	yes	Schizomida	*Draculoides* SCH030 complex	-22.54	119.033
WAM	T126477	yes	Schizomida	*Draculoides* SCH030 complex	-22.54	119.033
WAM	T122131	yes	Schizomida	*Draculoides* SCH030 complex	-22.5344	119.047
WAM	T126323	yes	Schizomida	*Draculoides* SCH030 complex	-22.54	119.033
WAM	T126335	yes	Schizomida	*Draculoides* SCH030 complex	-22.5336	119.033
WAM	T119493	yes	Schizomida	*Draculoides* SCH030	-22.7668	119.136
WAM	T119489	yes	Schizomida	*Draculoides* SCH034	-22.973	119.259
WAM	T98369	yes	Schizomida	*Draculoides* sp. (female)	-23.1272	119.506
WAM	T100188	yes	Schizomida	*Draculoides* sp. (female)	-22.6311	119.284
WAM	T100084	yes	Schizomida	*Draculoides* sp. (female)	-22.9669	119.072

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T100086	yes	Schizomida	*Draculoides* sp. (female)	-22.9381	119.004
WAM	T100083	yes	Schizomida	*Draculoides* sp. (male)	-22.9411	119.005
WAM	T100085	yes	Schizomida	*Draculoides* sp. (male)	-22.9714	119.057
WAM	T93783	yes	Schizomida	*Draculoides* sp. 01	-22.9272	118.872
WAM	T93785	yes	Schizomida	*Draculoides* sp. 03	-22.9289	118.956
WAM	T93788	yes	Schizomida	*Draculoides* sp. 03	-22.9081	118.997
WAM	T93789	yes	Schizomida	*Draculoides* sp. 03	-22.9108	118.994
WAM	T131650	yes	Schizomida	*Draculoides* sp. B50	-22.8067	118.879
WAM	T131651	yes	Schizomida	*Draculoides* sp. B51	-22.8108	118.876
WAM	T131652	yes	Schizomida	*Draculoides* sp. B52	-22.8154	119.017
WAM	T126324	yes	Schizomida	*Draculoides* sp. indet. (female & juvenile)	-22.54	119.033
WAM	T126326	yes	Schizomida	*Draculoides* sp. indet. (female & juvenile)	-22.5303	119.034
WAM	T126342	yes	Schizomida	*Draculoides* sp. indet. (female & juvenile)	-22.5319	118.999
WAM	T122122	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.5206	118.975
WAM	T122125	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.54	119.033
WAM	T122127	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.5303	119.034
WAM	T122128	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.5314	118.999
WAM	T122133	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.5325	119.026
WAM	T122479	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.5314	118.999
WAM	T122481	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.5314	118.999
WAM	T126331	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.5336	119.033
WAM	T119498	yes	Schizomida	*Draculoides* sp. indet. (female)	-22.6785	119.061
WAM	T122117	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.54	119.033
WAM	T122118	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5314	118.999

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T122119	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5314	118.999
WAM	T122121	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5364	119.031
WAM	T122126	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.54	119.033
WAM	T126478	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.54	119.033
WAM	T122129	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5314	118.999
WAM	T122130	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5314	118.999
WAM	T122132	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5303	118.991
WAM	T122134	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5206	118.975
WAM	T98366	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-23.2055	119.481
WAM	T98367	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-23.1186	119.475
WAM	T98368	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-23.1203	119.475
WAM	T122480	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5314	118.999
WAM	T126325	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5303	119.034
WAM	T126327	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5392	119.046
WAM	T126329	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5344	119.047
WAM	T126330	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5342	119.032
WAM	T126332	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5336	119.033
WAM	T126334	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5336	119.033
WAM	T126338	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5206	118.975
WAM	T126341	yes	Schizomida	Draculoides sp. indet. (juvenile)	-22.5319	118.999
WAM	T126344	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5342	118.99
WAM	T126345	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5236	119
WAM	T126346	yes	Schizomida	*Draculoides* sp. indet. (juvenile)	-22.5336	119.033
WAM	T93781	yes	Schizomida	*Draculoides* sp. SPB2	-22.8936	119.052

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
WAM	T96814	yes	Schizomida	Genus indet. sp. indet. (juvenile)	-23.1331	119.542
WAM	T98381	yes	Scolopendrida	Cryptopidae sp. indet.	-23.1308	119.533
WAM	T98382	yes	Scolopendrida	Cryptopidae sp. indet.	-23.1203	119.475
WAM	T100185	yes	Scolopendrida	Cryptopidae sp. indet.	-22.8833	119.687
WAM	T100186	yes	Scolopendrida	Cryptopidae sp. indet.	-22.902	118.673
WAM	T100187	yes	Scolopendrida	Cryptopidae sp. indet.	-22.902	118.673
WAM	T126333	yes	Scolopendrida	Cryptopidae sp. indet.	-22.5336	119.033
WAM	T92115	yes	Scolopendrida	Cryptopidae sp. indet.	-23.1261	119.489
WAM	T129668	yes	Scolopendrida	*Cryptops* sp. B07	-22.0153	119.256
WAM	T127529	Uncertain	Scolopendrida	*Cormocephalus* CHI003	-23.1234	118.859
WAM	T120946	Uncertain	Scolopendrida	*Cormocephalus* CHI003	-22.901	118.993
WAM	T120962	Uncertain	Scolopendrida	*Cormocephalus* CHI003	-22.9226	118.872
WAM	T131657	Uncertain	Scolopendrida	Genus unknown sp. B02	-22.8144	119.019
WAM	T131829	Uncertain	Spirobolida	*Speleostrophus*? DIP051	-23.2973	119.729
WAM	T116538	Uncertain	Spirostreptida	sp. indet.	-22.6818	119.342
WAM	T127463	Uncertain	Spirostreptida	sp. indet.	-22.7373	119.188
WAM	T127464	Uncertain	Spirostreptida	sp. indet.	-22.732	119.183
WAM	T96815	yes	Symphyla	Symphyla sp. indet.	-23.1233	119.46
WAM	T96819	yes	Symphyla	Symphyla sp. indet.	-23.1619	119.499
WAM	T92107	yes	Symphyla	Symphyla sp. indet.	-23.1286	119.51
WAM	T92112	yes	Symphyla	Symphyla sp. indet.	-23.1328	119.506
WAM	T92114	yes	Symphyla	Symphyla sp. indet.	-23.1286	119.51
PES	4718	yes	Isopoda	*Troglarmadillo* sp. indet.	-23.143677	119.012047
PES	5420	yes	Isopoda	*Troglarmadillo* 'won1'	-23.147497	118.996971

Source	WAM Registration number	Troglobite certainty	Order	Species	Latitude	Longitude
PES	5509	yes	Isopoda	Cf. *Acanthodillo* 'won1'	-23.164892	118.979118

PHOENIX
ENVIRONMENTAL SCIENCES

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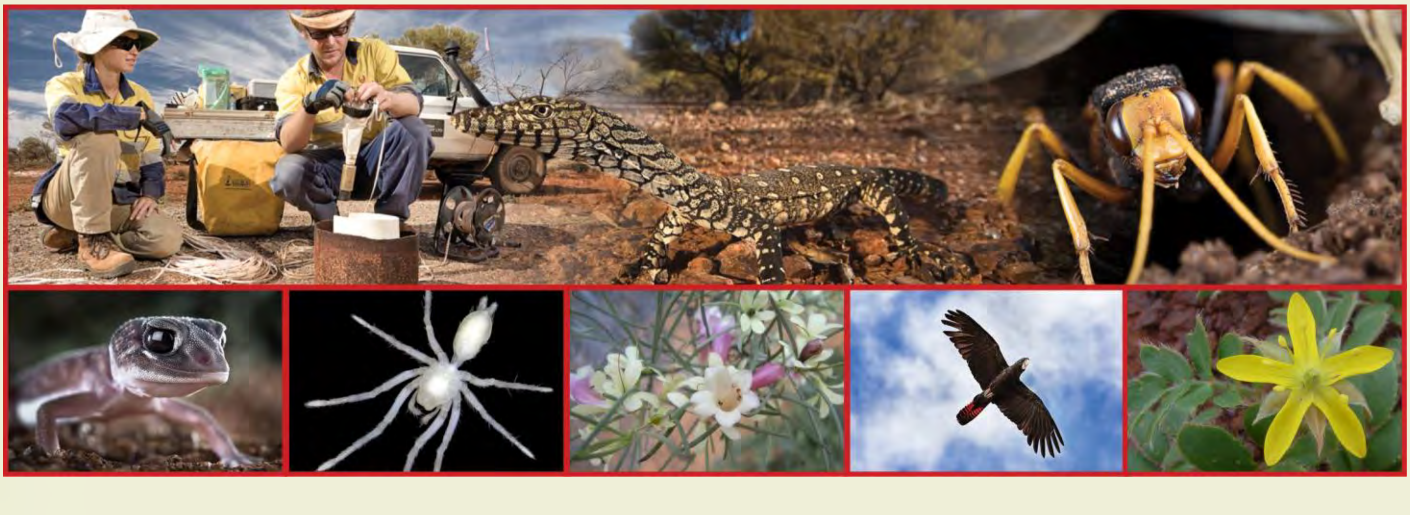
November 2014

Final Report



Flora and vegetation survey for the Extension Project

Prepared for Australian Aboriginal Mining Corporation Pty Ltd

Final Report

Author: G. Wells

Reviewer: K. Crews

Date: 25 November 2014

Submitted to: Phil Scott (Preston Consulting on behalf of Australian Aboriginal Mining Corporation)

Chain of authorship and review			
Name	Task	Version	Date
G. Wells	Draft for review	0.1	22 May 2014
K. Crews	Internal review	0.2	29 May 2014
G. Wells	Internal review	0.3	2 June 2014
K. Crews	Draft for client comments	0.4	5 June 2014
G. Wells	Final draft for review	0.5	26 June 2014
K. Crews	Final draft to client	0.6	3 July 2014
V. Framenau	Final to client	1.0	29 August 2014
G. Wells	OEPA comments incorporated	2.0	25 November 2014

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Contents

List of Figures

List of Tables

List of Appendices

EXECUTIVE SUMMARY

In March 2014, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Australian Aboriginal Mining Corporation Pty Ltd (AAMC) to undertake a Level 1 flora and vegetation survey for the Extension Project (the Project) located in the Hamersley Ranges in the Central Pilbara region of Western Australia, approximately 130 km northwest of Newman. The study area encompasses two distinct components, the Mine Study Area (MSA) and the Road Study Area (RSA), collectively referred to as the Combined Study Area and covering 916 ha in total.

The objective of the survey was to define the botanical values of the Combined Study Area and follows on from a desktop review compiled previously for the Project by Phoenix. The scope of works entailed a single phase flora and vegetation field survey; targeted searches for conservation significant species and weeds; definition, mapping and description of vegetation types present in a context of local and regional significance; description of the condition of vegetation and preparation of a comprehensive technical report detailing the outcomes of the desktop review and the field survey.

The field survey was undertaken from 28 March to 2 April 2014 following above average summer rainfall. Field assessment involved a combination of recording data within 25 permanent vegetation quadrats (50 m x 50 m), three relevés and traversing the Combined Study Area to record additional flora taxa present at the time of the survey. The location of quadrats was selected based on colour aerial photography targeting different landforms and by ground-truthing in the field. Quadrats, relevés, special features and any listed (priority and exotic) flora were recorded using a hand-held Global Positioning System.

A total of 193 plant taxa representing 104 genera and 40 plant families were recorded. The flora of the Combined Study Area comprised 188 native species and five exotic species, and included 48 annuals and 145 perennials. The most prominent families included the Fabaceae, Poaceae, Malvaceae and Amaranthaceae. The dominant families recorded were also prominent in previous flora surveys conducted in the Pilbara in the vicinity of the Combined Study Area.

No Threatened Flora listed by Department of Parks and Wildlife (DPaW) or species of national conservation significance listed under the *Environment Protection and Biodiversity Conservation Act 1999* were recorded in the Combined Study Area during the current survey. Two Priority flora species were recorded in the MSA, *Sauropus* sp. Koodaideri detritals (J. Naaykens & J. Hurter JH 11213) P1 and *Sida* sp. Barlee Range (S. van Leeuwen 1642) P3. *Sauropu*s sp. Koodaideri detritals was recorded at one location within a small gorge. The species is listed on DPaW's database within 20 km radius of the Combined Study Area (from Koodaideri study area). *Sida* sp. Barlee Range was recorded at two locations in the MSA, both at the base of a cliff face. *Sida* sp. Barlee Range is also listed on DPaW's database within 20 km radius of the Combined Study Area and there are numerous records for the species in the broader Pilbara bioregion.

Five species within the Combined Study Area represent an extension to the recorded range, *Eucalyptus* ? *aridimontana*, *Flueggea virosa*, *Sauropus* sp. Koodaideri detritals, *Sida* sp. Articulation below and *Tribulopis angustifolia*. Identification of range extensions are a common occurrence in flora surveys in the Pilbara bioregion especially with recently discovered species.

A total of five exotic species (weeds) were recorded in the Combined Study Area during the flora survey; **Alternanthera pungens, Bidens bipinnata**, *Lactuca saligna**, **Malvastrum americanum* and **Cenchrus ciliaris*. None are listed as a Declared Plant species under the *Agricultural and Related Resources Protection Act 1976*. All of the weeds have previously been recorded in the Pilbara bioregion and with the exception of *Alternanthera pungens* were also recorded in other flora surveys conducted in close proximity to the Combined Study Area.

The vegetation in the Combined Study Area was comprised primarily of native species with negligible weed infestations. Of a total 13 vegetation types (associations), nine were recorded in MSA, six in RSA and two in both the MSA and RSA during the field survey. The associations are characterised by three broad floristic sub-formations: *Triodia wiseana* dominant hummock grassland; isolated low trees over isolated mid to tall *Acacia* shrubs over isolated low shrubs to mixed low shrubland over *Triodia* hummock grassland; and isolated trees to woodland over tall mixed shrubland over isolated low shrubs over mixed grassland. All associations resembled previously defined vegetation types that are common, widespread and represented in nature reserves.

The condition of the vegetation within the Combined Study Area ranged from very good to excellent. Disturbance in the majority of areas rated very good comprised previous mining exploration activities, pastoral tracks, evidence of feral animal grazing and the presence of weeds. Cleared areas, including some exploration and access tracks were rated as degraded.

A total of four of the vegetation associations recorded in the Combined Study Area may be considered to have low to moderate local conservation significance. Two of the vegetation types (Veg 6 and Veg 7) had limited representations within the MSA. Veg 6 also was a habitat for two species of priority flora, one with possible range extension. Vegetation type 11 was recorded in the MSA in similar habitat and possesses similar species composition to vegetation identified as low to moderately locally significant from a previous assessment in the vicinity of the Combined Study Area. The second largest association recorded within the MSA (Veg 1) may also have low conservation significance as it represents habitat for a priority flora.

No Threatened Ecological Communities (TECs) as listed under the EPBC Act or by DPaW are known to occur within or in close proximity to the Combined Study Area and none was identified during the field survey. None of the defined associations resembled Protected Ecological Communities (PECs) recorded for the Pilbara bioregion. There are no Environmentally Sensitive Areas, wetlands, permanent water courses or conservation reserves within or in close proximity to the MSA. One PEC, the Fortescue Marsh Community, occurs in close proximity to RSA.

The field survey was conducted following above average rainfall. As such weather posed no limitation; however, some annual and ephemeral species prevalent in other seasons may not have been present during the single season field survey. Further, due to time and access constraints the field survey conducted did not cover the entire Combined Study Area and as such the presence of populations of further priority and/or threatened flora cannot be ruled out. The desktop assessment determined that numerous other priority species and two threatened species, *Lepidium catapycnon* and *Thryptomene wittweri*, may potentially occur in the Combined Study Area.

The risk of potential impacts to conservation significant flora could be reduced by conducting targeted foot-searches in areas to be impacted by mining operations and infrastructure, in particular:

- in areas not previously surveyed
- in suitable habitat for the potential conservation significant species
- with consideration to appropriate timing for the potential conservation significant species.

In conclusion:

- a flora and vegetation survey has been completed over the areas known as Mine Study Area and Road Study Area for the Extension Project in the Hamersley Ranges
- the survey was carried out in good conditions – following substantial rainfall
- no Declared Rare Flora were located in the survey

- two species of Priority Flora were located in the survey, both in restricted areas in the MSA
- no TECs or PECs were located in the Combined Study Area
- common with other surveys in the Pilbara, some range extensions were noted for several species
- the vegetation was generally in very good to excellent condition
- further targeted searches in proposed impact areas could further reduce risk of impacts to conservation significant flora.

1 INTRODUCTION

In March 2014 Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Australian Aboriginal Mining Corporation Pty Ltd (AAMC) to undertake a Level 1 flora and vegetation survey for the Extension Project (the Project) following on from a desktop review compiled for the Project (Phoenix 2014). This report compiles the results of the desktop survey and the flora survey.

1.1 BACKGROUND

The Project is located in the Hamersley Ranges in the Central Pilbara region of Western Australia, approximately 130 km northwest of Newman (Figure 1-1). It includes four mining leases (M47/1353, M47/1354, M47/1355, and M47/1356) containing the Extension deposit, a superficial channel iron deposit (CID).

The surveyed area encompassed two distinct components:

- Mine Study Area (MSA), the area shown in Figure 1-2 that will be the location of mining (three proposed pits), processing and ancillary infrastructure (778 ha)
- Road Study Area (RSA), the area shown in Figure 1-2 that will be developed for road haulage of ore and site access (~15 km by 100 m; 138 ha).

Together the MSA and RSA are referred to as the Combined Study Area and cover 916 ha in total. The RSA extends to the limit of new road development that would be required to enable ore haulage.

Figure 1–1
Location of the Extension Project

Project location

Operating mines

Railways

Principal and secondary roads

Minor road

Major creeks and rivers

National Parks and Nature Reserves

0 10 20 40 Kilometres

1:1,500,000

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

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

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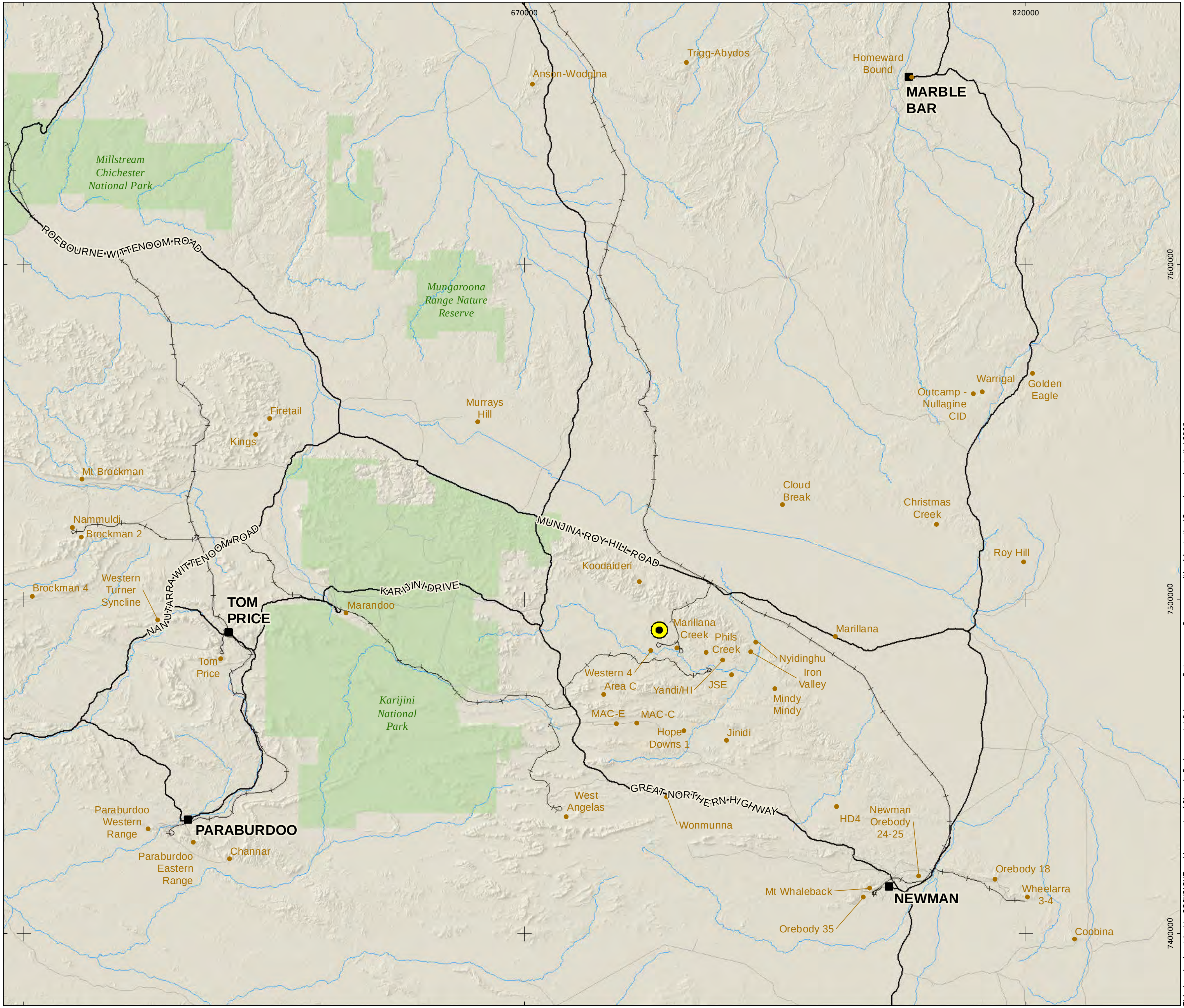

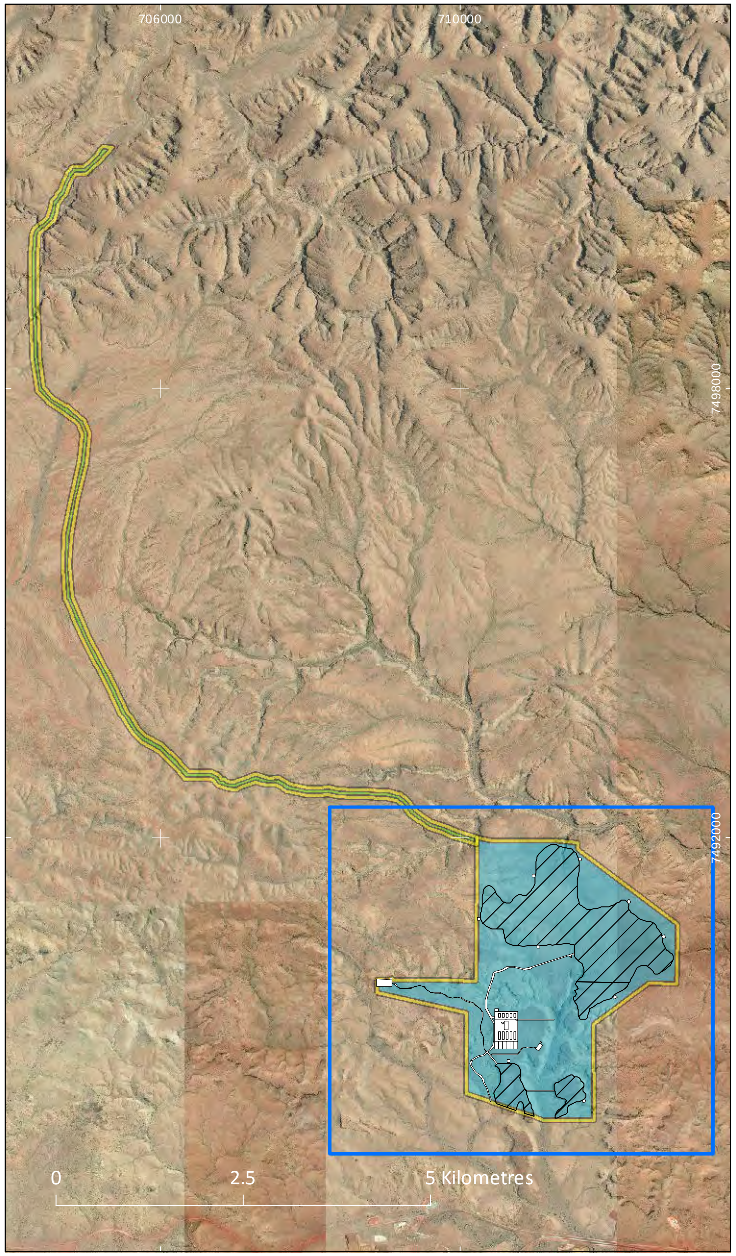

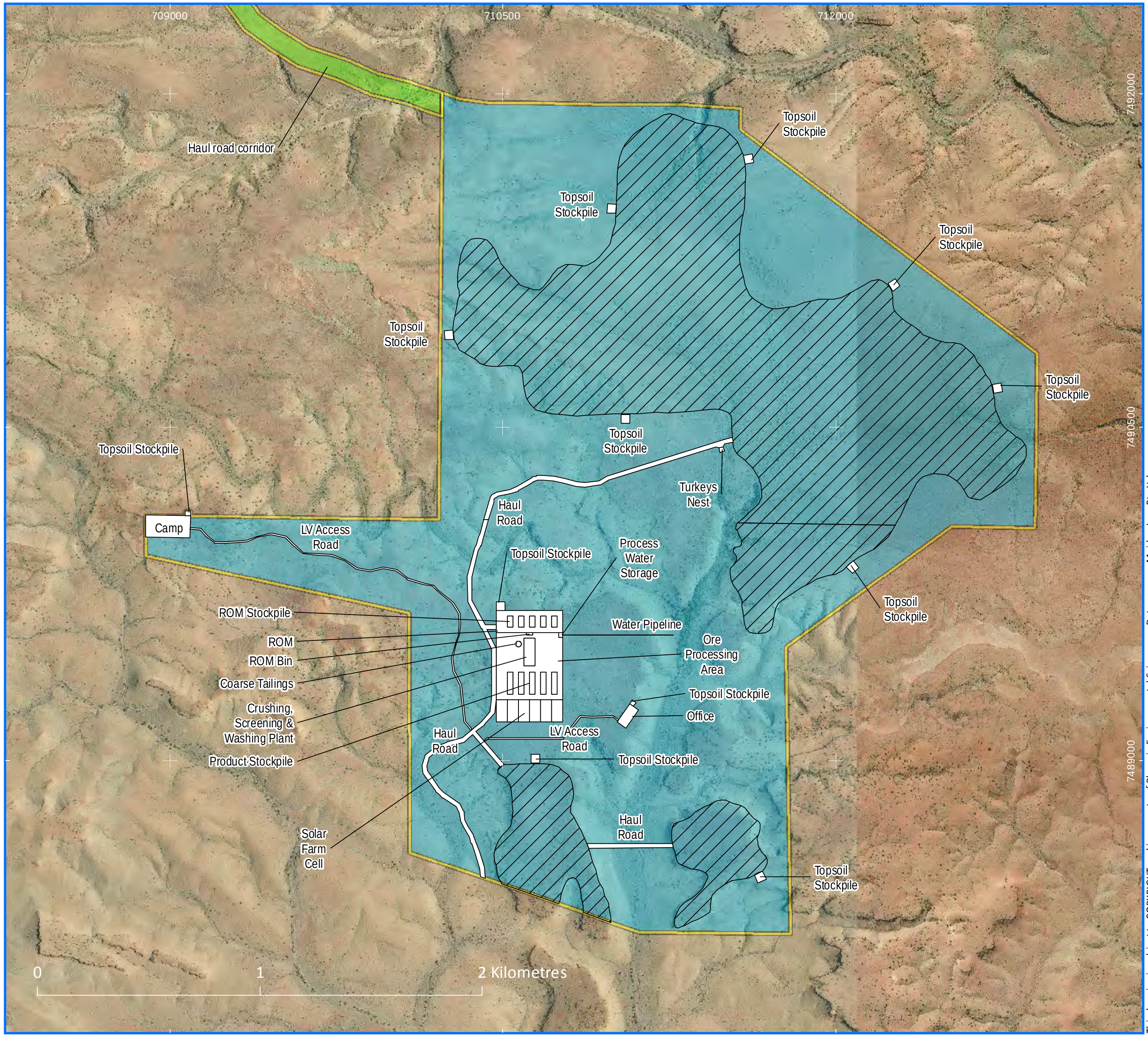

Figure 1–2
Extension Project conceptual mine layout (as at 19 February 2014) and Study Area for the Level 2 flora and vegetation survey

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Project: Extension Project

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Road Study Area

Mine Study Area

Conceptual mine layout (as at 19/02/2014)

Conceptual pits (as at 19/02/2014)

1.2 SCOPE OF WORKS AND SURVEY OBJECTIVE

The objective of the survey was to define the botanical values of the Combined Study Area which will be used to inform an environmental impact assessment for the Project.

The scope of works undertaken to achieve this objective was as follows:

- conduct a single phase flora and vegetation survey of the Combined Study Area
- identify the vascular plant species present
- conduct targeted searches for and describe populations of plants of conservation significance, particularly those recorded in or in close proximity to the Combined Study Area and identified from the database and literature reviews
- conduct targeted searches for and describe populations of exotic plant species (weeds), particularly declared plants
- define and map vegetation types present
- review the local and regional significance of the vegetation types recorded
- record the condition of vegetation
- prepare a comprehensive flora and vegetation technical report and supporting raw and digital data incorporating the results of the previous desktop assessment and results from the field survey.

This flora and vegetation survey adhered to the principles and practices of the Environmental Protection Authority's (EPA's) Guidance Statement No. 51: *Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia* (EPA 2004), which outlines preferred methods for the surveying and assessment of vegetation and flora in the context of EIA.

The survey was also designed in accordance with EPA Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection* (EPA 2002).

2 LEGISLATIVE CONTEXT

The protection of flora in Western Australia is principally governed by three acts:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Wildlife Conservation Act 1950* (WC Act)
- *Environmental Protection Act 1986* (EP Act).

2.1 COMMONWEALTH

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (NES), require approval from the Australian Government Minister for the Environment. The EPBC Act provides for the listing of threatened native flora, fauna and threatened ecological communities (TECs) as matters of NES. Conservation categories applicable to threatened flora species under the EPBC Act are as follows:

- Extinct (EX)[1] – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent1 – taxa whose survival depends upon ongoing conservation measures; without these measures the taxon would receive a higher classification.

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English & Blyth 1997). There are three categories under which ecological communities can be listed as TECs under the EPBC Act: Critically Endangered, Endangered and Vulnerable.

2.2 STATE

2.2.1 Threatened and Priority species and communities

In Western Australia, the WC Act provides for the listing of native flora (Threatened Flora) species which are under identifiable threat of extinction. Threatened Flora listed under the WC Act receive statutory protection, but they are also assigned to one of three categories which dictate resource allocation priorities for conservation and recovery actions:

- Critically Endangered (CR)
- Endangered (EN)
- Vulnerable (VU).

[1] Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

The Department of Parks and Wildlife (DPaW) administers the WC Act and also maintains a non-statutory list of Priority flora species (updated each year). Priority species are still considered to be of conservation significance – that is they may be rare or threatened – but cannot be considered for listing under the WC Act until there is adequate understanding of their threat levels. Species on the Priority flora list are assigned to one of five priority (P) categories, P1 (highest) – P5 (lowest), based on level of knowledge/concern.

The Minister for Environment may also list ecological communities which are at risk of becoming destroyed as 'threatened'. DPaW maintains a list of ministerially-endorsed TECs as well as a non-statutory list of Priority Ecological Communities (PECs) which are also assigned to one of five categories.

Any activities that are deemed to have a significant impact on listed flora species can trigger referral to the EPA for assessment under the EP Act. The EPA's position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment (EPA 2006).

2.2.2 Locally and regionally significant flora and vegetation

Flora may also be locally or regionally significant in addition to statutory listings by the State and Federal Government. The EPA (2004) states that flora species, sub-species, varieties, hybrids and ecotypes may be significant other than as Threatened or Priority flora, for a variety of reasons, including:

- a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species
- relic status
- anomalous features that indicate a potential new discovery
- being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- the presence of restricted subspecies, varieties, or naturally occurring hybrids
- local endemism/a restricted distribution
- being poorly reserved.

Vegetation may be locally or regionally significant in addition to statutory listings by State or Federal Governments. Vegetation communities may be considered locally or regionally significant if they contain Priority or Threatened Flora, landform type supporting conservation significant fauna, are restricted to one or two locations, occur as small isolated communities and/or exhibit unusually high structural and unusual or novel species diversity or being representative of the range of a unit (EPA 2004). One important factor in consideration of community significance is the degree of representation at a local and regional scale. It may be considered that representation of less than one percent of the total survey area defines limited representation within the local context.

2.2.3 Clearing of native vegetation in Western Australia

The clearing of native vegetation is not generally permitted where the biodiversity values, land conservation and water protection roles of native vegetation would be significantly affected.

Any clearing of native vegetation in Western Australia requires a permit under Part V Division 2 of the EP Act, except where an exemption applies under Schedule 6 of the act, or is prescribed by regulation in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004, and it is not in an Environmentally Sensitive Area.

The clearing of native vegetation is assessed against the “10 Clearing Principles” as outlined in Schedule 5 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004. Adherence to these Principles ensures that all potential impacts resulting from removal of native vegetation are assessed systematically and in an integrated manner.

2.2.4 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are areas where the vegetation has high conservation value. According to the Environmental Protection (Clearing of Native Vegetation) Regulations 2004, under Regulation 6, ESAs may include:

- the area covered by vegetation within 50 m of Threatened Flora, to the extent to which the vegetation is continuous with the vegetation in which the Threatened Flora is located
- the area covered by a TEC
- a defined wetland and the area within 50 m of the wetland.

2.3 INVASIVE SPECIES (WEEDS)

According to the Australian Weeds Strategy (AWC 2007), weeds pose threats to biodiversity and natural values by successfully out-competing native species for available nutrients, water, space and sunlight; reducing the natural diversity by smothering native plants or preventing them from growing back after clearing, fire or other disturbance; replacing the native plants that animals use for shelter, food and nesting; and altering fire regimes, often making fires hotter and more destructive.

Specific terms are used in WA to describe weeds, including declared plant, environmental weed, exotic, invasive plant, naturalised plant and weed (Table 2-1).

Table 2-1 Terms used to describe weeds (DEC 2012)

Term	Definition
Declared plant	A weed that has been "Declared" under the *Agriculture and Related Resources Protection Act 1976*. The Declared Plants Database lists declared plants within a particular region (shire/city) of WA and contains information on the status of a plant, its declaration, a brief description and control methods.
Environmental weed	An introduced plant that establishes in natural ecosystems and adversely modifies natural processes, resulting in decline of invaded communities (refer to the Environmental Weed Strategy, DEC 1999).
Exotic	A plant occurring in a place to which it is not native.
Invasive plant	One that is introduced and successfully reproduces resulting in the establishment of a population that spreads and threatens ecosystems, habitats or species with economic or environmental harm. Often called weeds when established they can result in harmful impacts to biodiversity, property and life. Not all introduced species are invasive if there are controls on their spread or competitiveness.
Naturalised plant	A plant that is not native to an area but has become established and can reproduce there. Not all naturalised species become weeds or have detrimental environmental or economic effects, but many do.
Weed	A plant that requires some form of action to reduce its harmful effects on the economy, the environment, human health and amenity, and can include plants from other countries or other regions in Australia or WA.

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) defines ‘bioregions’ as large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems (Department of the Environment 2014c; Thackway & Cresswell 1995). They record and categorise the large-scale geophysical patterns that occur across the Australian continent.

Western Australia contains 26 IBRA bioregions and 53 subregions. The Combined Study Area falls within the Pilbara bioregion, which covers an area of 178,060 km^2 (Thackway & Cresswell 1995) and is divided into four subregions (Department of the Environment 2014c): Chichester (PIL 1), Fortescue Plains (PIL 2), Hamersley (PIL 3) and Roebourne (PIL 4). The Combined Study Area falls within the Hamersley subregion (Figure 3-1) which is characterised by (Kendrick 2001b):

- mountainous areas of Proterozoic sedimentary ranges and plateaux dissected by gorges
- fine-textured soils in valley floors supporting Mulga (*Acacia aneura*) low woodland over bunch grasses
- skeletal soils of the ranges supporting *Eucalyptus leucophloia* over *Triodia brizoides*
- a semi-desert tropical climate with an average rainfall of 300 mm, generally occurring in summer cyclonic or thunderstorm events.

High species and ecosystem diversity is characteristic of the Hamersley Range where gorges provide refugia for biota and mountain tops and permanent springs support restricted flora species. These features are not present in the Combined Study Area.

Figure 3-3
Location of the Extension Project in relation to IBRA bioregions and subregions and conservation estates

- Project location
- Key WA Towns
- Major creeks and rivers
- Nationally important wetlands
- National Parks and Nature Reserves

IBRA bioregions

- Little Sandy Desert
- Great Sandy Desert
- Carnarvon
- Dampierland
- Gascoyne
- Pilbara

0 20 40 80 Kilometres
1:2,872,789

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

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

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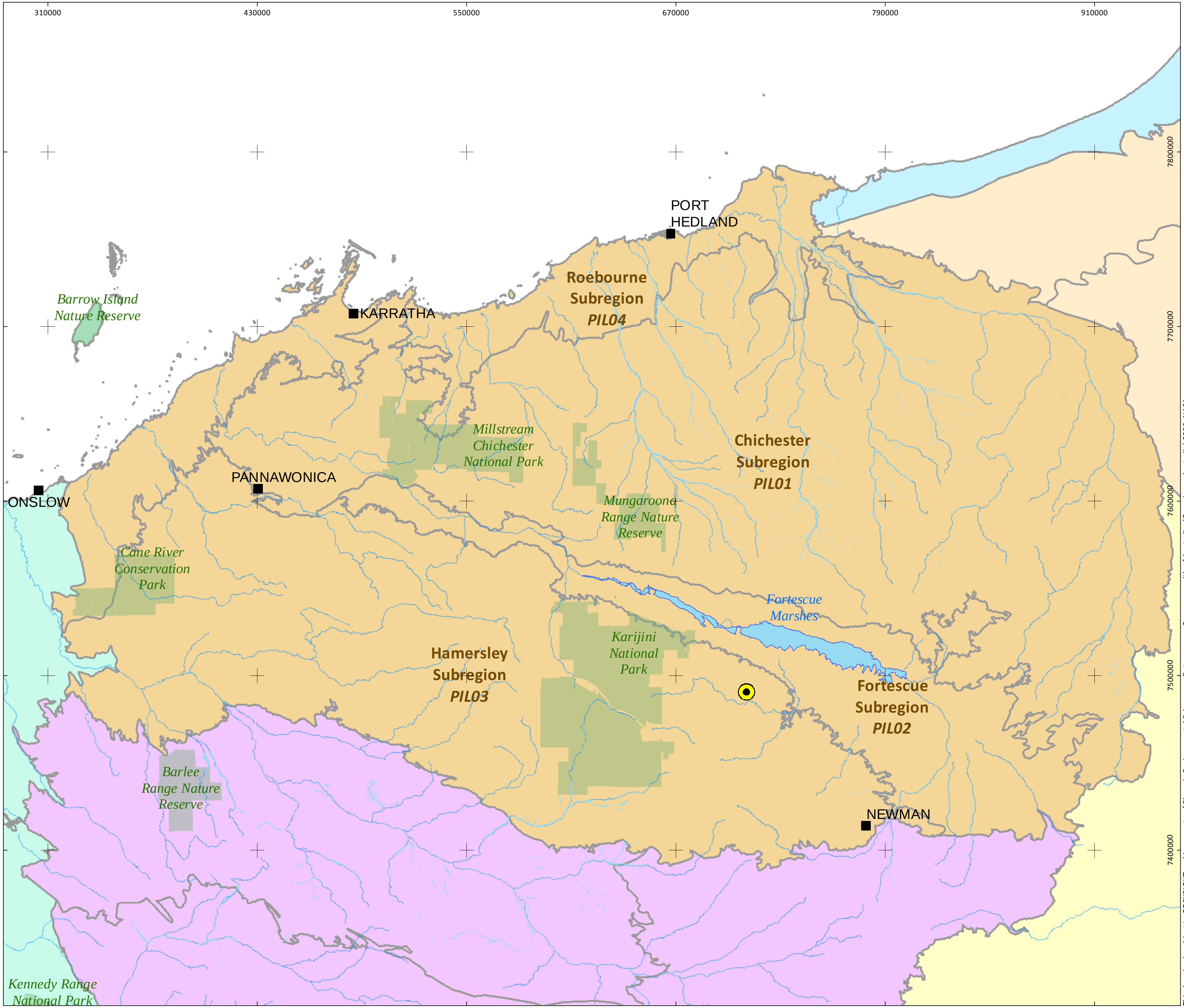

3.2 LAND SYSTEMS

The Department of Agriculture and Food Western Australia (van Vreeswyk *et al.* 2004) has defined the land systems of the Pilbara region from landforms, soils, vegetation and aerial photography, providing the largest-scale interpretation of vegetation units for the Combined Study Area.

The Combined Study Area traverses four land systems (Figure 3-2):

- Platform land system (PLA) – dissected slopes and raised plains supporting shrubby hard spinifex grasslands, occurring in the MSA only
- Robe land system (ROB) – low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands, occurring in the MSA only
- Newman land system (NEW) – rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands, occurring in both the MSA and RSA
- Boolgeeda land system (BGD) – stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands, occurring in the RSA only.

The dominant land system in the Combined Study Area is Platform, followed by Robe and Newman (Table 3-1). Boolgeeda is the least represented land system of the Combined Study Area.

Table 3-1 Land systems present in the Combined Study Area

Land system	Combined Study Area ha (% of study area)	Pilbara total ha (% of Pilbara)
Platform (PLA)	445.7 (48.6%)	157,000 (0.9%)
Robe (ROB)	174.3 (19.0%)	86,500 (0.5%)
Newman (NEW)	246.1 (26.9%)	1,458,000 (8.0%)
Boolgeeda (BGD)	50.6 (5.5%)	774,800 (4.3%)
Combined Study Area total	**916.7**	**2,476,300**

Figure 3-4
Land systems
of the Extension Project

	Road Study Area
	Mine Study Area

Land systems

	Boolgeeda System
	Calcrete System
	McKay System
	Newman System
	Oakover System
	Platform System
	Robe System
	Rocklea System
	Wannamunna System

0 0.75 1.5 3 Kilometres
1:80,000

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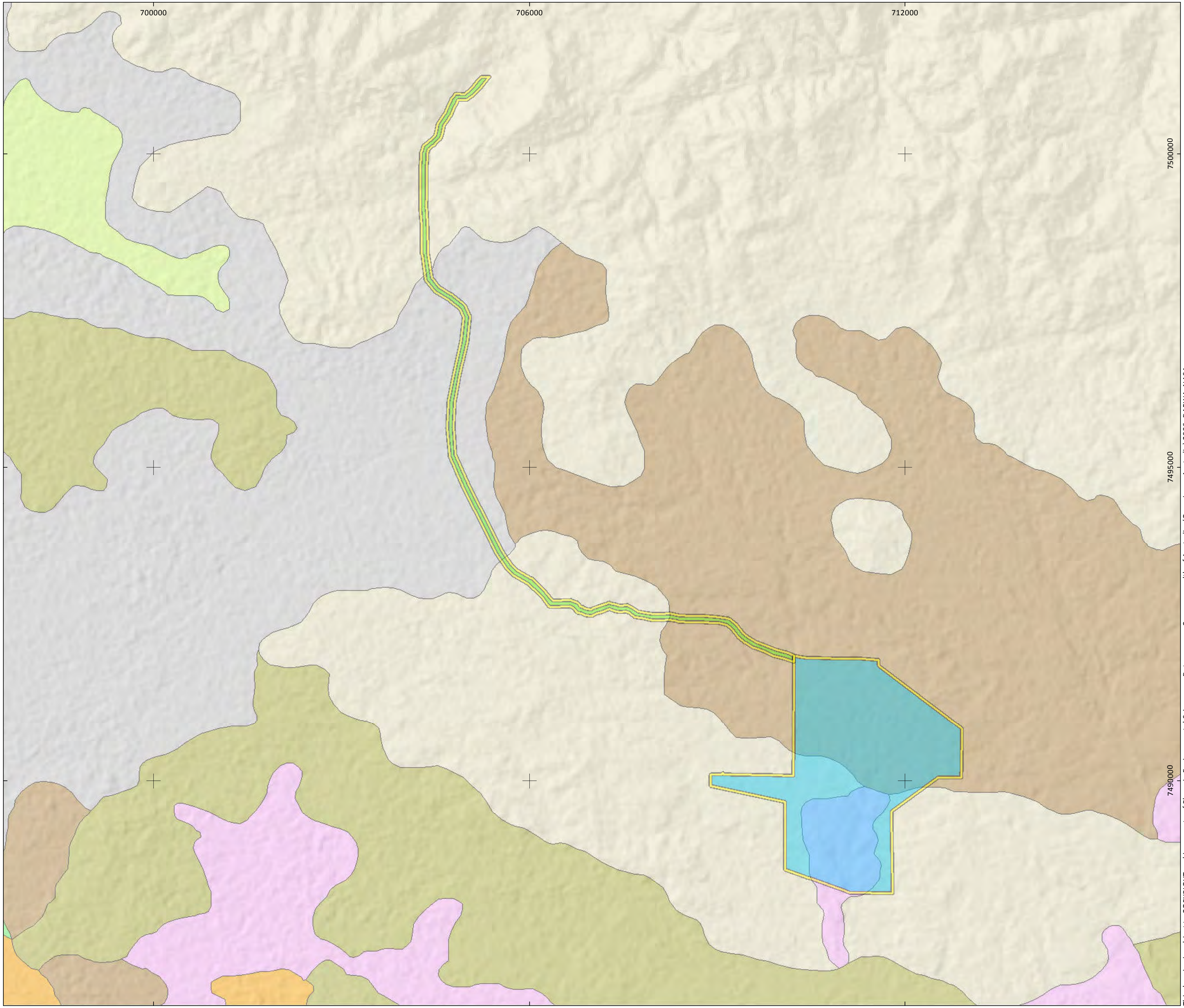


3.3 CLIMATE AND WEATHER

The Pilbara has a semi-desert to tropical climate with highly variable, mostly summer rainfall (Leighton 2004; McKenzie *et al.* 2009). The average rainfall is about 290 mm, ranging from a monthly average of approximately 4 mm in September to 76 mm in February. Rainfall patterns are driven by highly variable year-to-year cyclonic activity that accounts for half of the yearly precipitation (McKenzie *et al.* 2009). Average annual (pan) evaporation in the Pilbara is approximately 3,400 mm per year (Department of Agriculture 2003), which greatly exceeds annual rainfall.

The nearest Bureau of Meteorology (BOM) weather station that records rainfall is located Marillana (Latitude: 22.63°S Longitude: 119.41°E) approximately 35 km east of the study area. Newman Airport (Latitude: 23.36°S Longitude: 119.73°E) approximately 130 km SE of the study area is the closest weather station that records temperature. Marillana has an average annual rainfall of 26.8 mm (Figure 3-3). Newman has a mean maximum temperature of 39.1°C in January and 23.0°C in July (Figure 3-4).

In the months preceding the field survey, rainfall at Marillana was considerably higher than the average for January 2014, but lower than the average in February and March 2014 (Figure 3-3). Temperatures at Newman Airport in March 2014 exceeded the average for the months (Figure 3-4).

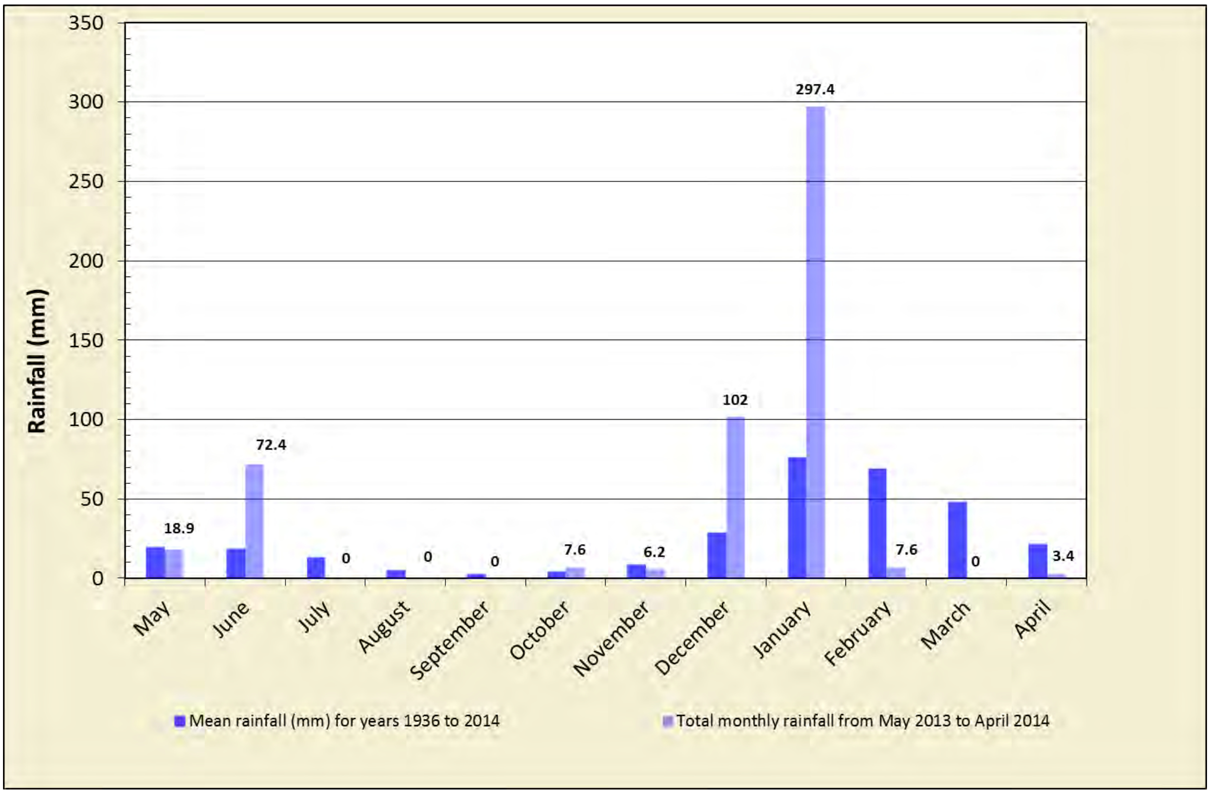


Figure 3-3 Rainfall data (monthly mean and year preceding survey) for Marillana (BOM 2014)

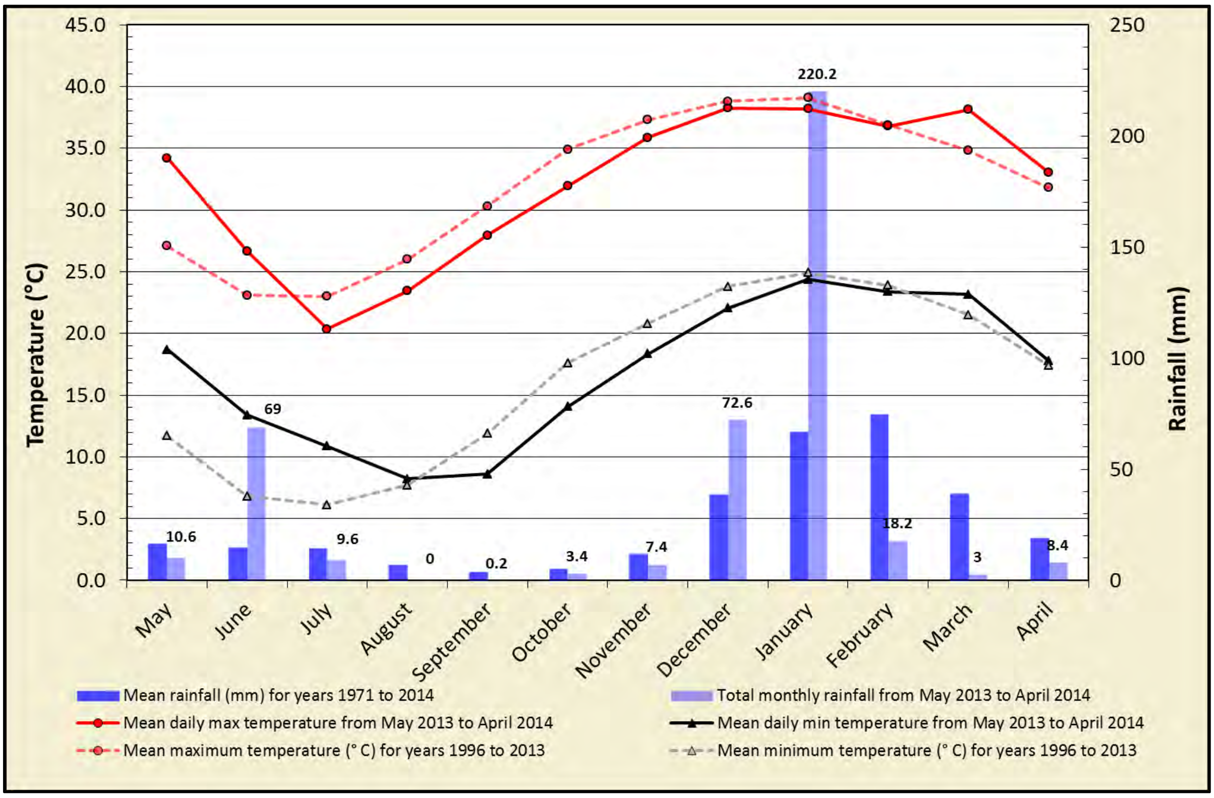


Figure 3-4 Temperature and rainfall records (long term averages and year preceding survey) for Newman (BOM 2014)

3.4 NATIVE VEGETATION EXTENT AND STATUS

The vegetation of the Combined Study Area lies within the Fortescue Botanical District of the Eremaean Province (Beard 1990). This district consists predominantly of tree and shrub steppe communities with *Eucalyptus* trees, *Acacia* shrubs and grasses including *Triodia pungens* and *T. wiseana* (Beard 1975a). Mulga (*Acacia aneura*) occurs in valleys and short-grass plains may be present on alluvial soils (Beard 1990).

Broad scale vegetation mapping (Beard 1975b) of the area (1:1,000,000) indicates there are two vegetation associations represented within the Combined Study Area (Figure 3-5):

- Hamersley 18 – Low woodland of Mulga (*Acacia aneura*)
- Hamersley 82 – Snappy Gum (*Eucalyptus leucophloia*) scattered low trees over *Triodia wiseana* hummock grasslands.

The vegetation of the Hamersley subregion is described as *Acacia aneura* (mulga) low woodlands, over tussock grasses on valley floors with *Eucalyptus leucophloia* (Snappy Gum) over *Triodia brizoides* on skeletal soils of the ranges (Kendrick 2001). The following vegetation units occur in association with land systems of the Combined Study Area (van Vreeswyk *et al.* 2004):

- Boolgeeda
  - o hummock grasslands of *Triodia wisean*a (hard spinifex) and other *Triodia* spp. with very scattered acacia shrubs (HSPG, PHSG)
  - o hummock grasslands of *T. lanigera*, *T. wiseana* (hard spinifex) (PHSG) or scattered tall shrublands of *Acacia aneura* (mulga), *A. ancistrocarpa* (shiny leaf wattle), *A.*

  atkinsiana and other acacias, occasional eucalypt trees and prominent hard spinifex ground layer (HESG, PMSS)
  - hummock grasslands *T. wiseana*, *T. lanigera* (hard spinifex) or *T. pungens* (soft spinifex) (PHSG, PSSG); also scattered to moderately close tall shrublands of *A. aneura* and other acacias with hard and soft spinifex ground layer (PHSG, PMSS)
  - moderately close woodlands or tall shrublands of *A. aneura* with sparse low shrubs and tussock or hummock grasses (GMUW, GMGW, DAHW)
  - scattered to close tall shrublands or woodlands of *A. aneura*, *A. atkinsiana*, *Corymbia hamersleyana* (Hamersley bloodwood) with sparse low shrubs and hummock and tussock grasses, (DAHW, DEGW, DESG); occasionally hummock grasslands of *T. pungens* (ASSG)
- Platform
  - hummock grasslands of *Triodia wiseana* and other *Triodia* spp. (hard spinifex) with isolated to very scattered *Acacia* spp. shrubs (PHSG)
  - hummock grasslands of *Triodia wiseana*, *T. plurinervata* (hard spinifex) with isolated to very scattered *Acacia* spp. shrubs or *Eucalyptus leucophloia* (snappy gum) (PHSG, HESG)
- Robe
  - hummock grasslands of *Triodia pungens* (soft spinifex) with isolated to scattered *Acacia* and *Senna* spp. shrubs and occasional *Eucalyptus leucophloia* (snappy gum) trees (HSPG)
  - hummock grasslands of *Triodia wiseana*, *T. longiceps* (hard spinifex) with isolated to very scattered *Acacia* and *Senna* spp. shrubs, (PHSG); occasionally hummock grasslands of *Triodia pungens* (soft spinifex) (PSSG)
  - hummock grasslands of *Triodia pungens* with very scattered to moderately close *Acacia* spp. shrubs (ASSG); also moderately close eucalypt or acacia woodlands/tall shrublands with *T. pungens* understorey (DESG, DAHW)
- Newman
  - hummock grasslands of *Triodia wiseana*, *T. brizoides*, *T. plurinervata* (hard spinifex) with very scattered to scattered shrubs and trees including *Acacia* and *Senna* spp., *Grevillea wickhamii* (Wickham's grevillea), *Eucalyptus leucophloia* (snappy gum) and other eucalypts (HESG, HSPG); occasionally hummock grass is *Triodia biflora* (soft spinifex)
  - smaller floors supporting hummock grassland of *Triodia pungens* with very scattered shrubs (ASSG); larger floors and channels supporting tall shrublands/woodlands of *Acacia* spp. and *Eucalyptus victrix* (coolibah) with tussock grass or hummock grass understoreys (DEGW, DAHW, DESG).

All of the vegetation units that occur within the Combined Study Area are described as extensive, common or widespread in the Pilbara region and with the exception of ASSG have been recorded in nature reserves including Karijini National Park and/or Millstream National Park and on Unallocated Crown Land (UCL). ASSG is poorly represented in nature reserves but was recorded at the Cane River Nature Reserve and also on UCL.

A vegetation type is considered under-represented if there is less than 30% of its original distribution remaining. Several key criteria are applied to vegetation clearing from a biodiversity perspective, as follows (EPA 2000):

- the 'threshold level' below which species loss appears to accelerate exponentially within an ecosystem level is regarded as being at a level of 30% (of the pre-European, i.e. pre 1750 extent of the vegetation type)
- a level of 10% of the original extent of a vegetation community is regarded as being a level representing Endangered
- clearing which would increase the threat level to a vegetation community should be avoided.

Shepherd *et al.* (2001) have assigned the status of vegetation remaining (to pre-European extent) into five classes:

- 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 gives a comparable status.

Figure 3-5
Beard vegetation of the Combined Study Area

Road Study Area

Mine Study Area

Beard (1965) vegetation associations

HAMMERSLEY 18 — Low woodland; mulga (*Acacia aneura*)

HAMMERSLEY 82 — Hummock grassland, low tree steppe; snappy gum over *Triodia wineana*

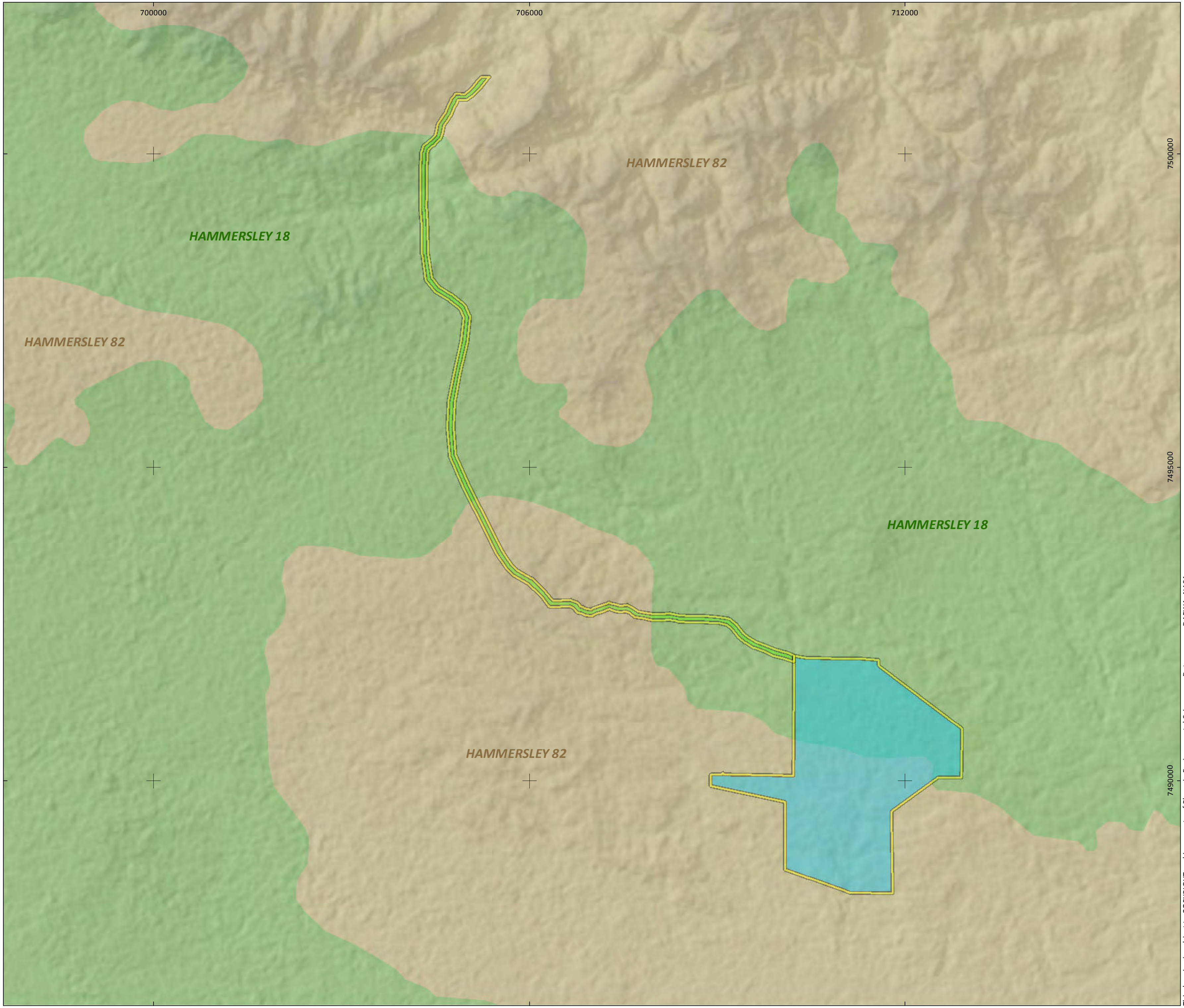
0 0.75 1.5 3 Kilometres
1:80,000

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

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

PHOENIX ENVIRONMENTAL SCIENCES



According to Shepherd *et al.* (2001) the vegetation of the Combined Study Area is classified as 'Least Concern' in terms of extent of vegetation remaining within the Hamersley subregion (PIL 3) compared to pre-European extents (Table 3-2).

Table 3-2 Vegetation extent, type and status within the Combined Study Area (Government of Western Australia 2011)

Vegetation association number	Pre-European extent (ha)	Current extent (ha)	Percentage remaining	Percentage pre-European extent in IUCN class I-IV reserves
18	581246.08	577122.68	99.29	19.55
82	2177573.94	2165235.08	99.43	12.03

3.5 LISTED WEEDS

In the Pilbara the most common weed species include **Acetosa vesicaria*,**Aerva javanica*, **Argemone ochroleuca* subsp. *ochroleuca*, **Bidens bipinnata*, **Cenchrus ciliaris*, **Cenchrus setiger*, **Chloris* spp., **Malvastrum americanum,* **Senna occidentalis*, **Setaria verticillata*, **Sigesbeckia orientalis*, **Solanum nigrum* and **Sonchus oleraceus* (Table 3-3). Weeds have been a part of the Pilbara flora before the establishment of settlements. For example, eight cosmopolitan weedy 'tramp' species: **Vachellia farnesiana*, **Phyla nodiflora*, *Helichrysum luteoalbum*, *Albizia lebbeck*, **Bidens pilosa*, **Echinochloa colona*, *Salsola kali* and **Persicaria lapathifolia* have been described by Groves *et al.* (2003).**Vachellia farnesiana* and **Phyla nodiflora* were first collected in late 1800s and *Helichrysum luteoalbum* in the 1870s.

Weed species amount to just over 6% of all taxa of the Pilbara (Keighery 2010, in George *et al.* 2010). A number of weed species have been considered major threats to the Pilbara including: **Calotropis procera*, **Cenchrus ciliaris*, **Leucaena leucocephala*, **Opuntia* spp., **Phyla* spp., **Prosopis* spp., **Salvinia molesta*, **Senna occidentalis*, **Malvastrum americanum*, **Acetosa vesicaria*, **Aerva javanica*, **Cenchrus setiger*, **Phoenix dactylifera* (Grice & Martin 2006; McKenzie *et al.* 2009; van Vreeswyk *et al.* 2004). Two species **Bidens bipinnata* and **Bidens pilosa* were also found to be increasingly widespread weeds of many habitats (Keighery 2010, in George *et al.* 2010). Weed life forms are mainly annual or perennial herbs with a few trees, shrubs and vines from families such as Poaceae, Fabaceae, and Asteraceae.

A large proportion of weeds have been introduced to the Pilbara through pastoralism leading to land degradation and over grazing (DSEWPaC 2009). For example, **Cenchrus ciliaris* was introduced into Australia's northwest in the mid to late 1800s as a pasture species that included nine major cultivars. The species is highly persistent and is quick to respond to small amounts of rainfall and can form monospecific stands, out-competing native grasses and significantly raising the fire regime of an area to the point of removing competing shrubs and trees (CSIRO 2007).

Table 3-3 Common weeds from an Environmental Weed List of the Pilbara bioregion (DEC 2012)

Scientific name	Common name
**Acetosa vesicaria*	Ruby Dock
**Aerva javanica*	Kapok Bush
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy
**Bidens bipinnata*	Bipinnate Begger's Tick
**Bidens pilosa*	Cobbler's Pegs
**Cenchrus ciliaris*	Buffel Grass
**Cenchrus setiger*	Birdwood Grass
**Chloris* spp.	Feathertop Rhodes Grass
**Citrullus colocynthis*	Colocynth
**Citrullus lanatus*	Pie Melon
**Conyza bonariensis*	Fleabane, Flaxleaf Fleabane
**Crotalaria juncea*	Sunnhemp
**Cynodon dactylon*	Couch
**Datura leichhardtii*	Native Thornapple, Leichhardt's Thornapple
**Digitaria ciliaris*	Summer Grass
**Leucaena leucocephala* subsp. *leucocephala*	Leucaena
**Malvastrum americanum*	Spiked Malvastrum
**Malvastrum coromandelianum*	Prickly Malvastrum
**Parkinsonia aculeata*	Parkinsonia
**Persicaria lapathifolia*	Persicaria
**Prosopis* spp.	Mesquite
**Salvinia molesta*	Salvinia
**Senna occidentalis*	Coffee Senna
**Setaria verticillata*	Whorled Pigeon Grass
**Sigesbeckia orientalis*	Indian Weed
**Solanum nigrum*	Black Berry Nightshade
**Sonchus oleraceus*	Common Sowthistle
**Vachellia farnesiana*	Mimosa Bush

3.6 LAND USE

The Pilbara region was historically dominated by native grazing and pastoral activities. Current land use in this region is more diverse, comprising pastoral grazing, mineral exploration and mining activities, and dedication of land to Crown Reserves (e.g. Jigalong Aboriginal Reserve, Karijini National Park and Millstream National Park (van Vreeswyk *et al.* 2004). In 2009, land tenure in the broader Pilbara region was approximately 60% pastoral lease, 10% conservation reserve, 5% Aboriginal Reserve and 25% UCL (McKenzie *et al.* 2009). Within the Hamersley subregion, dominant land uses are grazing, UCL and crown reserves, native pastures, conservation, mining and urban (Kendrick 2001).

Karijini National Park is located approximately 40 km west of the MSA and approximately 30 km west of the northern end of the RSA. The Fortescue Marsh is located approximately 15 km north-east of the Combined Study Area. Although not formally protected, the marsh is a significant wetland. It is the largest ephemeral wetland in the Pilbara region and is recognised as nationally important (EPA 2013). The Combined Study Area does not reside within any of the marsh management zones (EPA 2013).

4 METHODS

4.1 DESKTOP REVIEW

A separate fauna and flora desktop review was conducted for the Project prior to the commencement of the flora and vegetation survey (Phoenix 2014). Database searches (from a designated centre point, 22°40'47.17"S, 119°3'42.33"E, 20 km radius) and a literature review conducted as part of the desktop review are applicable to the current Combined Study Area and are used in this report.

The desktop review (Phoenix 2014) was expanded for the purposes of this report as the Combined Study Area differed to the study area of the desktop review. Tasks undertaken included:

- review of land systems (van Vreeswyk *et al.* 2004) encompassed in the Combined Study Area
- literature review of the technical reports from projects conducted near or in close proximity to the Combined Study Area to identify:
    - any vegetation types considered to be of conservation significance, local or regional
    - identification of weed species recorded
    - identification of range extensions for species reported
    - identification of the composition of the flora recorded (i.e. number of taxa, families and genera represented
    - identification of the prominent plant families recorded and the proportion of the total number of flora collected that they represented
- review of the likelihood of occurrence in the Combined Study Area of priority species recorded in the searches of the DPaW databases
- literature review of the classification of weed species in Western Australia
- literature review of the occurrence of weed species in the Pilbara bioregion.

4.2 FIELD SURVEY

A single phase flora and vegetation field survey was undertaken from 28 March to 2 April, 2014. Field assessment methodology involved a combination of sampling within permanent vegetation quadrats (50 m x 50 m dimension) located in representative vegetation, relevés, targeted searches, as well as traversing the Combined Study Area to record additional flora taxa present at the time of the survey. The location of all quadrats, relevés, and any Threatened or Priority listed flora was recorded using a hand-held Global Positioning System (GPS).

The survey was undertaken to provide a description of the dominant vegetation types present, vegetation condition and flora species present at the time of the survey. Additionally, the survey was also conducted to determine whether any of the significant species identified on the DPaW Threatened and Priority Flora list or Threatened Flora species listed under the EPBC Act for the general area occur or are likely to occur in the Combined Study Area.

Prior to the commencement of the field survey, all known data (including aerial photography) were loaded on a GPS unit and field computer. This allowed points of interest and vegetation boundaries to be directly inserted into an electronic format, ensuring all locations were accurately mapped at the time of the survey.

4.2.1 Quadrat and relevé selection

A total of 25 quadrats located within representative vegetation types were selected and all plant species and floristic data recorded, including height for each species within each quadrat. Quadrat sampling sites typically measured 50 m x 50 m; however, quadrat dimensions were modified to reflect the vegetation type to be sampled (e.g. creek lines, rocky gullies) at some sites because of topographical constraints. Quadrat locations were selected to ensure that an adequate representation of the major vegetation types and flora present within the Combined Study Area was sampled. This was achieved using colour aerial photography, targeting different landforms and by ground- truthing on foot.

A total of three relevés were selected during the field survey. Relevés are often used in flora and vegetation surveys to ascertain vegetation types and boundaries by recording the dominant plant species present including height and percentage and then comparing resulting floristic data to data recorded in established quadrats. Relevés are also utilised to map discreet pockets of vegetation which are either limited in spatial distribution, absent or poorly represented in the remaining survey area or alternatively, cannot be sampled using quadrats due to topographical constraints.

The following information was recorded for each quadrat (Appendix 1):

1. location – the coordinates of the quadrat were recorded in GDA 94 projection utilising a hand-held Garmin GPS
2. description of vegetation – a broad description utilising the structural formation and height classes based on NVIS (2003) (Appendix 2)
3. habitat – a brief description of landform and habitat
4. soil – a broad description of surface soil type and rocks
5. disturbance history – a brief description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance and animal grazing
6. vegetation condition – the condition of the vegetation was recorded utilising the condition scale of Trudgen (1991)
7. height and foliage cover – a visual estimate of the canopy cover of each species present was recorded as was the total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover
8. photograph – a colour photograph of the vegetation within each quadrat
9. species list – the name of every species present in the quadrat. Where species were located that were unknown to the botanist conducting the survey, a specimen was collected and pressed for later identification.

4.2.2 Targeted searches

A targeted search was undertaken concurrently with the flora and vegetation survey to determine whether any of the conservation significant species identified from the database and literature review occurred in the Combined Study Area. The search focused on habitats considered likely to contain or support conservation significant flora. Unusual vegetation types such as rock piles, creek lines, gullies, ridges, rocky outcrops and low lying area were also targeted as these areas typically support a higher level of diversity.

For each population of conservation significant flora recorded, the following information was documented:

- location (as points for individual plants or as polygons for populations)
- description of the floristic community in which the species was located and population size estimate
- location map showing distribution within the Combined Study Area
- voucher collection for lodgement at the Western Australian Herbarium.

4.2.3 Vegetation mapping

Quadrat and relevé data were analysed and sites grouped according to similar species composition, structure, and dominance at the stratum level. To define vegetation associations, a statistical ordination test was conducted using UPGMA Cluster Analysis (with the software package PATN™) based on species composition and cover values at individual sites (quadrats). Vegetation associations were defined from the clusters of quadrats on a dendrogram that confirmed field observations.

The vegetation associations were mapped by plotting boundaries visible on colour aerial photography, contour lines and changes in the vegetation recorded on GPS during the field survey.

4.2.4 Taxonomy and nomenclature

Plant identification was undertaken by Dr Grant Wells. Species well known to the field botanist were identified during the field survey. Any taxa that could not be identified in the field were collected and assigned a unique number to facilitate tracking. All plant species collected during the field program were dried and frozen in accordance with the requirements of the Western Australian Herbarium.

Collected plant species were identified, using local and regional flora keys and comparisons with named species held at the Western Australian Herbarium. When necessary, plant taxonomists widely considered authorities on particular plant groups were consulted.

The conservation status of all recorded flora was compared against the current lists available on FloraBase (DPaW 2014a) and the EPBC Act Threatened species database provided by the Department of the Environment (2014b).

Nomenclature used in this report follows that used by FloraBase (DPaW 2014a) and the Western Australian Herbarium.

4.2.5 Vegetation condition

The vegetation condition of the site was assessed using the vegetation condition rating scale developed by Trudgen (1991) that recognises the intactness of vegetation, which is defined by the following:

- completeness of structural levels
- extent of weed invasion
- historical disturbance from tracks and other clearing or dumping
- the potential for natural or assisted regeneration.

The scale consists of six rating levels (Table 4-1).

Table 4-1 Vegetation condition rating scale (Trudgen 1991)

Condition code	Vegetation condition	Description
E	Excellent	Pristine or nearly so, no obvious signs of damage caused by the activities of European man
VG	Very good	Some relative slight signs of damage caused by the activities of European man, e.g. some signs of damage to tree trunks caused by repeated fire and the presence of some relatively non-aggressive weeds such as *Ursinia anthemoides* or *Briza* species, or occasional vehicle tracks
G	Good	More obvious signs of damage caused by the activities of European man, including some obvious impacts on the vegetation structure such as that caused by low levels of grazing or by selected logging. Weeds as above, possibly plus some aggressive ones such as *Ehrharta* species
P	Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some aggressive ones such as *Ehrharta* species
VP	Very poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including very aggressive species.
D	Completely degraded	Areas that are completely or almost completely without native species in the structure of their vegetation, e.g. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs

5 RESULTS

5.1 DESKTOP REVIEW

The combined results of the database searches and literature review identified 87 plant taxa of conservation significance occurring within a 20 km buffer of the Combined Study Area (Table 5-1). None of the records for these species occurred within the Combined Study Area (Figure 5-1).

Suitable habitat for the majority of these species may be present in the Combined Study Area including two threatened species *Lepidium catapycno*n and *Thryptomene wittweri* (Table 5-1):

- two vulnerable/threatened species, both may occur
- 29 P1 species, of which 24 may possibly occur
- 17 P2 species, of which 15 may possibly occur
- 31 P3 species, of which 23 may possibly occur
- five P4 species, of which four may possibly occur.

Three additional records could not be determined or require confirmation (Table 5-1): *Vittadinia* ? *pustulata* (P2 – requires confirmation), *Oldenlandia* sp. (possibly a new species) and *Tribulus* sp. (possibly a new species) (Biota 2012d, 2013; Mattiske 2008).

The EPBC Protected Matters database search identified *Lepidium catapycno*n (VU), or species habitat, which could potentially occur within the Combined Study Area. There are five known populations of this taxon occurring within a distance of 20 km from the Combined Study Area. The closest population is approximately 16.5 km to the south east (Figure 5-1).

There are no state or federally listed TECs occurring within a 20 km radius of the Combined Study Area (Department of the Environment 2014d; DPaW 2013d). There is one state listed botanical TEC known to occur in the Pilbara bioregion; *Themeda* grasslands on cracking clays (Hamersley Station). This TEC occurs as a grassland plain dominated by the perennial *Themeda* (kangaroo grass) and many annual herbs and grasses (DPaW 2013b). It is restricted in distribution and occurs mainly on gilgai plains landforms of the Brockman land system, west of Karijini National Park. This community is highly unlikely to occur in the Combined Study Area.

According to the DPaW database searches, two PECs and/or their buffers occur within 20 km of the Combined Study Area (Figure 5-1). This includes the Priority 1 ecological community Fortescue Marsh (Fortescue Land System) and Priority 3 ecological community Fortescue Valley Sand Dunes (DPaW 2013c). At the State level, TECs and PECs are represented within buffer zones and consequently, the true extent of the PECs from the desktop review may be overstated.

The Fortescue Marsh PEC is restricted to the Marsh land system. This PEC is spatially represented by a 20 km buffer. The RSA projects approximately 1.2 km into the buffer area of this PEC.

The Fortescue Valley Sand Dunes PEC consists of red linear sand dune communities of the Divide land system at the junction of the Hamersley Range and Fortescue Valley, between Weeli Wolli Creek and the low hills to the west. This PEC is not represented on, or in close proximity to, the Combined Study Area. The occurrence of this PEC is represented spatially by 100 m buffers.

There are no wetlands or conservation areas managed by DPaW in the Combined Study Area and none that are in close proximity that could be directly or indirectly impacted by the proposed clearing of native vegetation. No ESAs or named watercourses are located within or in close proximity to the Combined Study Area.

Review of previous flora and vegetation surveys conducted in close proximity to the Combined Study Area identified numerous vegetation types that were considered to have local conservation significance. The majority of these communities contained an upper stratum dominated by mulga (previously *Acacia aneura* varieties). For example Biota (2012a) and Biota (2012c) each identified one community, Biota (2012d) three and Biota (2012e) nine mulga communities of local conservation value. Each were considered to resemble either the 'Valley floor mulga' or 'Grove/intergrove mulga' communities identified by Kendrick (2001) to be 'at risk' ecological communities due to multiple threats in the form of grazing by feral animals, weed invasion and death from large-scale fires. In addition the Biota (2012f), Biota (2012d) and Biota (2012c) surveys identified communities that resembled vegetation associated with major ephemeral water courses also considered by Kendrick (2001) to be 'at risk' due to grazing of feral animals and weed infestation.

The Ecologia (2009) survey identified sand dunes in two vegetation types to be potentially of regional conservation significance as they represented regionally rare ecological communities.

Biota (2012c) considered one community that inhabited steep rocky slopes and hill crests to be of "elevated conservation significance" as a population of the threatened species *Lepidium catapycnon* was recorded in this vegetation type. This community was described as, "*Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered shrubs over *Triodia wiseana, T.* sp. Shovelanna Hill (S. van Leeuwen 3835) open hummock grassland.

Biota (2012f) considered vegetation recorded growing around a natural spring feature in a deep narrow gorge to be of moderate to high local conservation significance. This community was described as a gully mosaic and comprised "a variety of vegetation types, some of which include phreatophytic species; units ranged from *Eucalyptus camaldulensis* forest to closed canopy *Ficus virens* communities."

Table 5-1 Likelihood of occurrence of listed flora species identified in the desktop review and potential for impacts

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Acacia aphanoclada		P1	Aug - Oct	Skeletal stony soils. Rocky hills, ridges & rises.	Possible. Some suitable habitat may exist in Combined Study Area.
Acacia bromilowiana		P4	Jul - Aug	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.	Possible. Some suitable habitat may exist in the Combined Study Area.
Acacia cyperophylla var. omearana		P1	Mar - Apr	Stony & gritty alluvium. Along drainage lines.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Acacia daweana		P3	Jul - Sep	Stony red loamy soils. Low rocky rises, along drainage lines.	Possible. Some suitable habitat may exist in the Combined study Area.
Acacia effusa		P3	May - Aug	Stony red loam. Scree slopes of low ranges.	Unlikely. Combined Study Area lacks tall hills and is characterised by relatively low elevation.
Acacia fecunda		P3	May - Aug	Quartzite gibbers over grey-red skeletal soil. Along shallow creeks and drainage lines, hills, road verges.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Acacia sp. Nullagine (B.R. Maslin 4955)		P1	NA	Rocky clay. Low-lying areas between rocky hills.	Possible. Some suitable habitat may exist in the Combined Study Area.
Acacia subtiliformis		P3	Jun – Aug	Occurs on stony calcrete plain.	Possible. Some calcareous soils groups are present in the Mine Study Area.
Adiantum capillus-veneris		P2	NA	Moist, sheltered sites in gorges and on cliff walls.	Possible. Some suitable habitat may exist in the Combined Study Area.
Amaranthus centralis		P3	Jan - Dec	Red sand in ephemeral watercourses, sandy to	Possible. On lower lying areas and in drainage lines of the

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
				clayey loam on river banks and edges of permanent pools in eucalypt lined channels, or *Acacia* shrubland.	Combined Study Area.
Ampelopteris prolifera		P3	NA	Near water or in wet ground.	Possible. Some suitable habitat may exist in the Combined Study Area.
Aristida calycina var. *calycina*		P2	NA	Red earths, sands, alluvial soils.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Aristida jerichoensis var. *subspinulifera*		P1	NA	Hardpan plains.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Aristida lazaridis		P2	Apr	Sand or loam.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Atriplex spinulosa		P1	NA	Hummock grasslands	Possible. Some suitable habitat may exist in the Combined Study Area.
Barbula ehrenbergii		P1	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Bothriochloa decipiens var. *cloncurrensis*		P1	Jan - Nov	Plain next to the Robe River	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)		P1	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Brunonia sp. Long hairs (D.E. Symon 2440)		P1	NA	Along creeklines.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Calotis latiuscula		P3	Jun - Oct	Rocky hillsides, floodplains, rocky creeks or	Possible. Some suitable habitat may exist in the Combined

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
				river beds.	Study Area.
Calotis squamigera		P1	Jul	Pebbly loam.	Possible. Some suitable habitat may exist in the Combined Study Area.
Cladium procerum		P2	Nov	Perennial pools.	Unlikely. No perennial pools are known in the Combined Study Area.
Cochlospermum macnamarae		P1	Apr - June	Upper slopes of a low hill in shallow, stony soil closely underlain by granitic bedrock	Unlikely. Currently known only from a small area in the central part of the Pilbara bioregion about 160 km south of Port Hedland
Dampiera anonyma		P3	Jun - Sep	Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite. Hill summits, upper slopes (above 1000 m).	Unlikely. Elevation of site is less than 400 m in the Combined Study Area.
Dampiera metallorum		P3	Apr or Jun – Oct	Recorded on skeletal red-brown gravelly soil or banded ironstone on high altitude hills.	Unlikely. Elevation of site is less than 400 m in the Combined Study Area.
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)		P1	Sep	Red-brown skeletal soils, ironstone. Steep slopes, summits.	Possible. Some suitable habitat may exist in the Combined Study Area.
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)		P2	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined study Area.
Eremophila magnifica subsp. *magnifica*		P4	Aug – Nov	Typically occurs on tall hills, on skeletal soils over ironstone and on rocky screes.	Unlikely. The Combined Study Area lacks tall hills and is characterised by relatively low elevation.
Eremophila magnifica subsp. *velutina*		P3	Aug - Sep	Skeletal soils over ironstone. Summits.	Possible. Some suitable habitat may exist in the Combined study Area.

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Eremophila sp. Hamersley Range (K. Walker KW 136) PN		P1	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Eremophila sp. Snowy Mountain (S. van Leeuwen 3737)		P1	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Eremophila sp. West Angelas (S. van Leeuwen 4068)		P1	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Eremophila spongiocarpa		P1	May – Jul or Sept	Occurs on sub-saline alluvial plains.	Unlikely. There are no sub-saline alluvial plains in the Combined Study Area.
Eremophila youngii subsp. *lepidota*		P4	Jan - Sep	Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Eucalyptus lucens		P1	NA	Ironstone. Rocky slopes and mountain tops, high in the landscape.	Unlikely. The Combined Study Area lacks tall hills and is characterised by relatively low elevation.
Eucalyptus rowleyi		P3	NA	Red sandy loams on plains and very minor and broad flood-out plains	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Euphorbia australis var. *glabra*		P2	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Euphorbia inappendiculata var. *inappendiculata*[1]		P2	Aug	*Euphorbia inappendiculata*[1] recorded at Phil's Creek on sandy soils of a major water course (Mattiske 2008). *Euphorbia inappendiculata* var. *inappendiculata*[1] has previously been recorded	Possible. Suitable habitat to support this taxon is present in the Mine Study Area.

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
				on gently slopes; high in the landscape, on stony rich red clay, very damp, cracking clay, but also from open tussock grasslands and very open low scrub of *Acacia xiphophylla* and *A. synchronicia* over mid-dense hummock grass.	
Euphorbia inappendiculata var. *queenslandica*[1]		P1	Aug	Known to occur in association with a variety of habitats including broad clay plains, broad drainage lines, broad flat depressions and among broken rocky screes; on dark reddish brown heavy clay with numerous deep gilgai holes (30-40 cm deep) and cracking clays.	Possible. Suitable habitat to support this taxon is present in the Combined Study Area.
Euphorbia stevenii		P3	NA	Clay, sandy soils.	Possible. Some suitable habitat may exist in the Combined Study Area.
Fimbristylis sieberiana		P3	May - Jun	Mud, skeletal soil pockets. Pool edges, sandstone cliffs.	Unlikely. Lack of suitable habitat in the Combined Study Area.
Geijera salicifolia		P3	Sep	Skeletal soils, stony soils. Massive rock scree gorges.	Possible. Some suitable habitat may exist in the Combined Study Area.
Glycine falcata		P3	May-Jul	Black clayey sand. Along drainage depressions in crabhole plains on river floodplains.	Unlikely. Black clayey sand does not occur in the Combined Study Area.
Goodenia lyrata		P3	Aug	Red sandy loam. Near claypan.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Goodenia nuda		P4	Apr – Aug	Typically found growing near creek lines and in wet areas. Recorded from three locations in the KSIC Study Area, all from Mulga floodplains (Biota 2012d).	Possible. On lower lying areas and in drainage lines of the Combined Study Area.

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)		P3	Aug – Sep	Red-brown clayey soil and calcrete areas on low, undulating or swampy plains.	Possible. On lower lying areas and in drainage lines of the Combined Study Area.
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) PN		P1	NA	Patches of Mulga on lower slopes of tall hills	Unlikely. Mulga vegetation is not located in the Combined Study Area.
Gymnanthera cunninghamii		P3	Jan – Dec	Occurring on major creek and drainage lines, in sandy soils.	Possible. Suitable habitat might be present in the Combined Study Area.
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) PN		P2	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Hibiscus sp. Mt Brockman (E. Thoma ET 1354) PN		P1	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Indigofera ixocarpa		P2	May	Skeletal red soils over massive ironstone.	Possible. Some suitable habitat may exist in the Combined Study Area.
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)		P3	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Indigofera sp. Gilesii (M.E. Trudgen 15869) PN		P3	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Iotasperma sessilifolium		P3	NA	Cracking clay, black loam. Edges of waterholes, plains.	Unlikely. Suitable soils do not occur in the Combined Study Area.
Ipomoea racemigera		P2	Mar - Aug	Sandy soils along watercourses.	Possible. Suitable habitat exists in the Combined Study Area.

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Isotropis parviflora		P2	Feb-Mar, May	Low ironstone hill slopes and plains. Recorded on low stony hills and footslopes of taller hills in the KSIC Study Area (Biota 2012d).	Possible. Suitable habitat exists in the Combined Study Area.
Lepidium catapycnon	T, VU		Oct – Jan?	Skeletal soils of hill slopes and crests of tall to moderate sized hills; recorded in association with *Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered shrubs over *Triodia wiseana, T.* sp. Shovelanna Hill (S. van Leeuwen 3835) open hummock grassland.	Possible. Suitable habitat is present in the Combined Study Area.
Nicotiana umbratica		P3	Apr– Jun	Shallow soils in rocky outcrops.	Unlikely. The Combined Study Area does not contain rocky outcrops.
Oldenlandia sp.	Not determined	Not determined	Unavail.	Recently collected from a calcrete plain in the KSIC Study Area (Biota 2012d).	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)		P3	Mar	Collected from cracking clay, basalt; gently undulating plains with large surface rocks, flat crab holed plains (Biota 2012d).	Unlikely. Suitable habitat to support this species appears limited in the Combined Study Area.
Oxalis sp. Pilbara (M.E. Trudgen 12725)		P2	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Pentalepis trichodesmoides subsp. *hispida*		P2	Aug - Sep	*Triodia* hummock grassland, often in the understorey of a shrubland of *Acacia* spp., *Gossypium* spp., *Senna* spp., *Brachychiton* spp. and *Eucalyptus* spp., on summits and slopes of low hills, on basaltic soils, at altitudes to 1150 m.	Possible. Some suitable habitat may exist in the Combined Study Area.

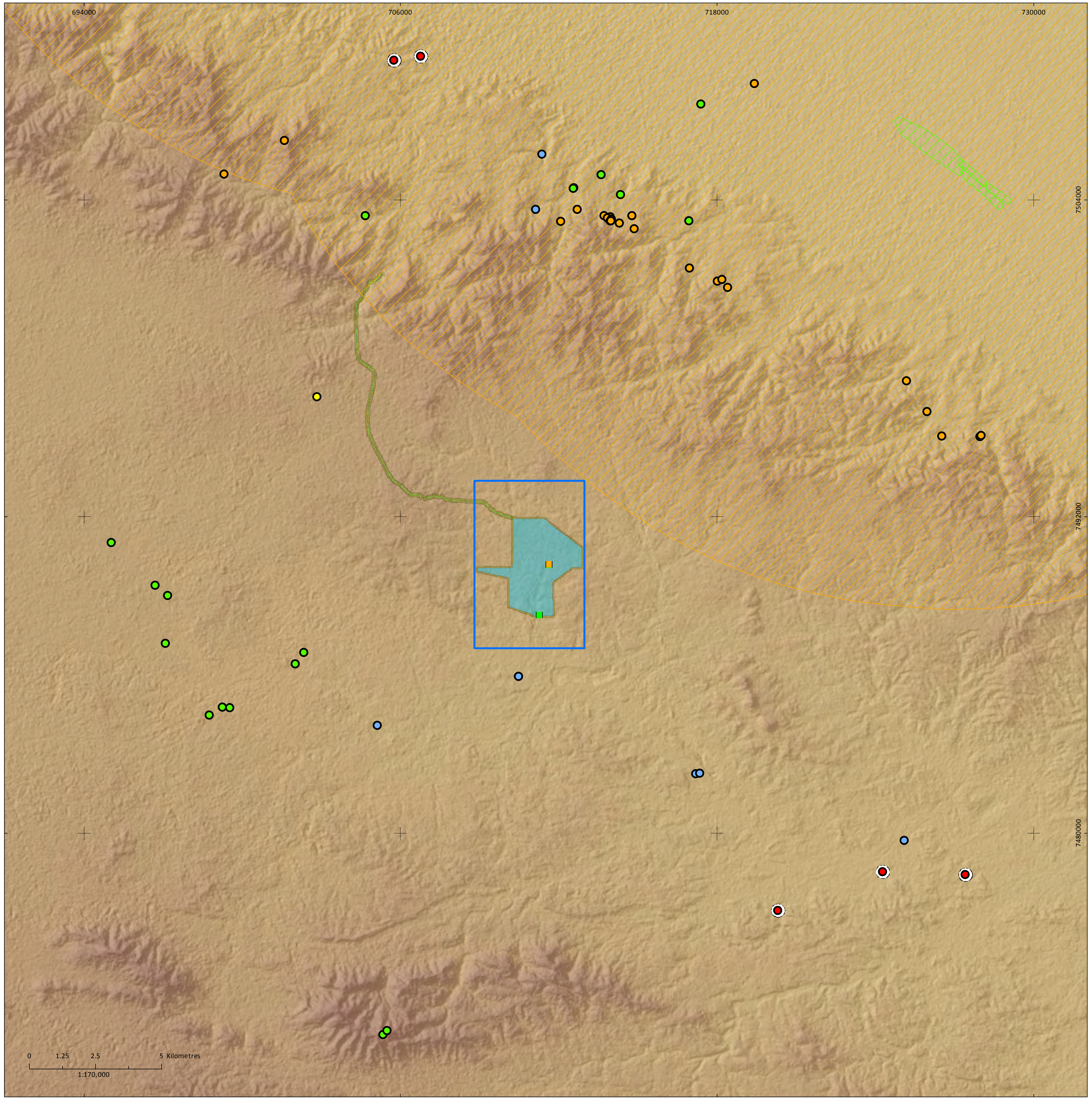
Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Pilbara trudgenii		P2	Sep - Oct	In skeletal, red, stony soil on steep, scree slopes and in crevices on steep gully walls and cliff faces of massive banded ironstone amongst sparse subshrubs, tussock grasses and sedges *P. trudgenii* is an obligate lithophyte with little plasticity in its habitat preference of massive banded ironstone landforms.	Possible. Some suitable habitat may exist in the Combined Study Area.
Pleurocarpaea gracilis		P3	May - Oct	Summits, slopes and sheltered gullies of rounded hills in skeletal, red, gritty soil over massive banded ironstone of the Brockman Iron Formation; amongst woodland with *Eucalyptus*, *Acacia*, *Hakea*, *Triodia*, *Dampiera* and *Waltheria* species.	Possible. Some suitable habitat may exist in the Combined Study Area.
Rhagodia sp. Hamersley (M. Trudgen 17794)		P3	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Rhodanthe ascendens		P1	Aug	Clay. Roadside verge	Possible. Some suitable habitat may exist in the Combined Study Area.
Rhynchosia bungarensis		P4	May – Dec	Occurs in larger creeklines and on associated floodplains, or in wet, sheltered gorge habitats.	Possible. Some suitable habitat may exist in the Combined Study Area.
Rostellularia adscendens var. *latifolia*		P3	April – May	Occurring on ironstone soils near creeks and on rocky hills. Recorded from three locations in the KSIC Study Area (Biota 2012d); a mulga floodplain, calcrete plain and drainage line (Biota 2012b).	Possible. Suitable habitat is present in the Combined Study Area. Recorded at multiple locations in creeks and drainage lines, within 15 km of the Combined Study Area.
Sauropus sp. Koodaideri detritals (J. Naaykens & J.		P1	Aug, Oct –	Collected from rocky slopes, beneath cliff lines of detrital iron formations and in rock gullies	Possible. Suitable habitat is present in the Combined Study

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Hurter JH 11213) PN			Nov	within the Koodaideri Mining Lease (KML) area. Recorded growing in association with *Eucalyptus leucophloia* scattered low trees to low open woodland, over variable scattered shrubs to open shrubland of *Senna glutinosa* subsp. *glutinosa, Grevillea wickhamii*, and *Acacia arida*, *over Triodia wiseana* open hummock grassland.	Area. Recorded at multiple locations in rocky gullies, within 20 km of the Study Area.
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)		P2	Jul - Aug	Skeletal, brown gritty soil over basalt. Summits of hills, steep hills.	Unlikely. Suitable soils do not occur in the Combined Study Area.
Sida sp. Barlee Range (S. van Leeuwen 1642)		P3	Aug	Recorded from 12 locations in the central section of the KML Study Area (Biota 2012f). This species occurs on red-brown skeletal soils on steep rocky hillslopes, typically amongst large rocks or at the base of free rock faces.	Possible. Suitable habitat exists in the Combined Study Area.
Sida sp. Hamersley Range (K. Newbey 10692)		P1	NA	NA	Possible. Little is known about this species. Could occur if suitable habitat is present in the Combined Study Area.
Solanum kentrocaule		P3	Jul - Oct	Found only in the Hamersley Range between 700 metres to 1,250 metres altitude. It inhabits hillsides and mountaintops, or occasionally creek-beds, in skeletal red-brown soil over ironstone or on basalt scree. Associated tree species include *Eucalyptus leucophloia* and *E. kingsmillii*.	Unlikely. Elevation of site is less than 400 m in the Combined Study Area.

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Spartothamnella puberula		P2	Sep - Nov	Rocky loam, sandy or skeletal soils, clay. Sandplains, hills.	Possible. Suitable habitat exists in the Combined Study Area.
Tetratheca fordiana		P1		Shale pocket amongst ironstone.	Possible. Some suitable habitat may exist in the Combined Study Area.
Teucrium pilbaranum		P1	May - Sep	Clay. Crab hole plain in a river floodplain, margin of calcrete table.	Possible. Some calcareous soils groups are present in the Mine Study Area.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)		P3	Aug	Typically grows on red-brown cracking clay on plains or along creeks.	Possible. Suitable habitat exists in the Combined Study Area.
Thryptomene wittweri		T	Apr - Aug	Skeletal red stony soils. Breakaways, stony creek beds.	Possible. Some suitable habitat is present in the Combined Study Area.
Tribulus minutus		P1	NA	NA	Possible. Limited information is known about this taxon, it could occur if suitable habitat is present in the Combined Study Area.
Tribulus sp.	Not determine d	Not determine d		Undescribed entity requiring further taxonomic investigation. Recorded in the Koodaideri Western Rail Corridor.	Possible. Limited information is known about this taxon, it could occur if suitable habitat is present in the Combined Study Area.
Triodia sp. Karijini (S. van Leeuwen 4111) PN		P1	NA	NA	Possible. Limited information is known about this taxon, it could occur if suitable habitat is present in the Combined Study Area.
Triodia sp. Mt Ella (M.E. Trudgen 12739)		P3	NA	Light orange-brown, pebbly loam. Amongst rocks & outcrops, gully slopes.	Possible. Some suitable habitat is present in the Combined Study Area

Scientific name	EPBC Act category, WC Act category	DPaW Priority listing	Flowering period	Habitat preference	Likelihood of occurrence
Triodia sp. Robe River (M.E. Trudgen *et al.* MET 12367)		P3	NA	Very shallow red-brown clayey loam. Banded iron formation. *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland over *Acacia ptychophylla* low open shrubland over *Triodia wiseana* (*Triodia* sp. Robe River) hummock grassland	Possible. Suitable habitat may be present in the Combined Study Area.
Triodia triticoides		P1	Jan - Jul	Rocky sandstone & limestone hillslopes.	Unlikely. Suitable substrate does not occur in the Combined Study Area.
Vigna sp. central (M.E. Trudgen 1626)		P2	Jan – Oct	Occurs on red-loam on edge of flats and drainage lines, valley floors.	Possible. Some suitable habitat is present in the Combined Study Area.
Vittadinia ? *pustulata*		P2 (if confirmed)	Sep	Previously collected from sand flat adjacent to sand dune in the interior of WA and more recently on mulga plains in the KSIC area (Biota 2012d).	Possible. Suitable habitat is limited in the Combined Study Area.
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)		P1	NA	NA	Possible. Limited information is known about this taxon, it could occur if suitable habitat is present in the Combined Study Area.

[1]Taxa assigned Priority 3 status at time of collection but has since been split into two varieties.



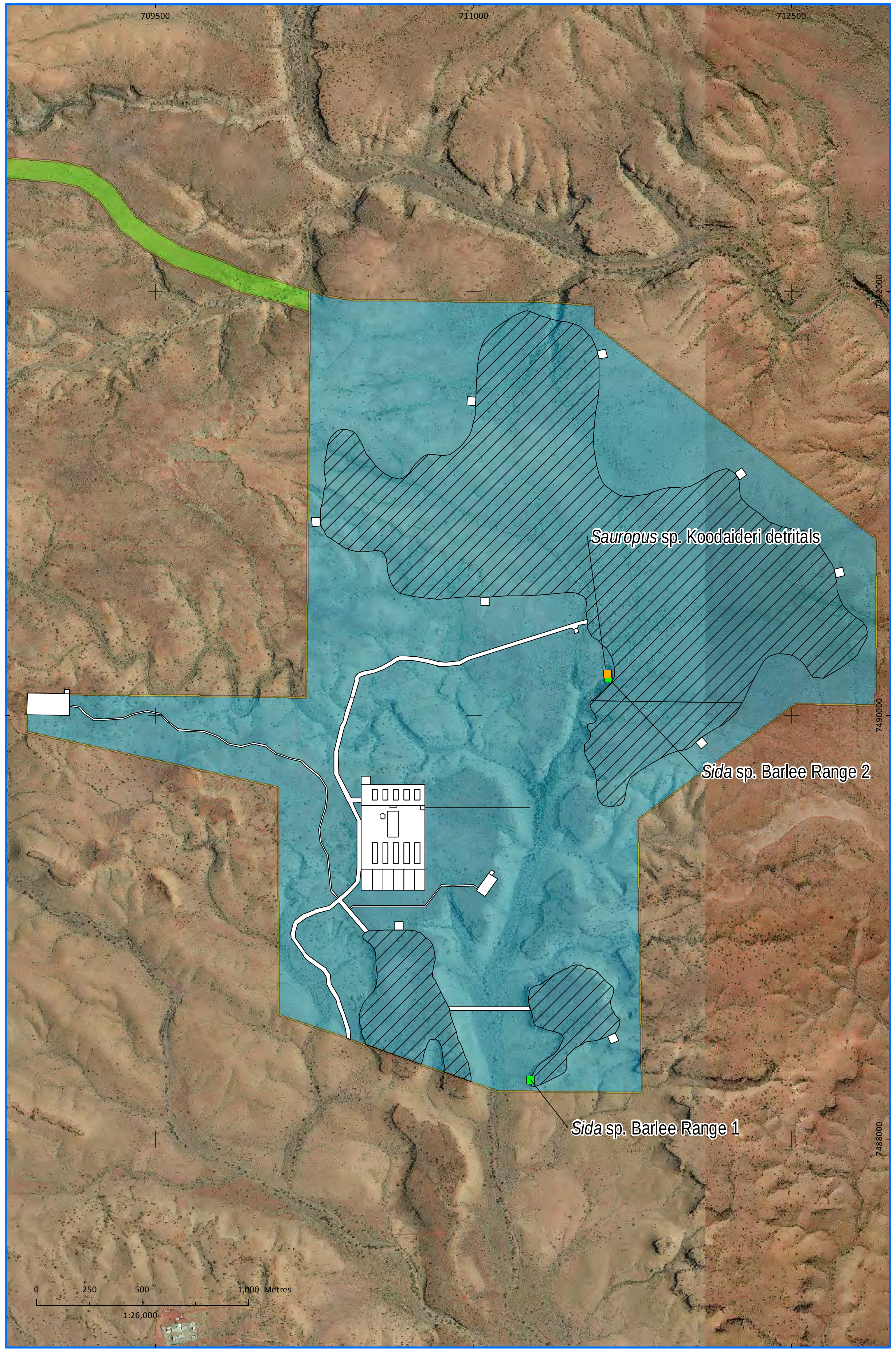


Figure 5-1
Listed flora and PECs recorded within 20 km of the Study Area and Priority flora records from the survey

Road Study Area
Mine Study Area
Conceptual pits (as at 19/02/2014)
Conceptual mine layout (as at 19/02/2014)

Priority Ecological Communities (PECs)(DPaW 2014)

Fortescue Marsh (Marsh Land System) — Priority 1
Fortescue Valley Sand Dunes — Priority 3

Priority flora survey records (Phoenix 2014)

Priority 1
Priority 3

Priority flora desktop records (DPaW 2014)

Priority 1
Priority 2
Priority 3
Priority 4
Threatened

PHOENIX ENVIRONMENTAL SCIENCES

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

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

Western Australia
PERTH

5.2 FLORA

A total of 193 plant taxa (including subspecies and varieties) representing 104 genera and 40 families were recorded in the Combined Study Area during the field survey. This total is comprised of 188 native species and five introduced (exotic) species including 48 annual (or annual/perennial species) and 145 perennial species (Appendix 3).

The number of taxa recorded is comparable to that of previous flora surveys conducted in close proximity to the Combined Study Area (Table 5-2).

Table 5-2 Comparison of floristic data from the current survey with previous flora surveys conducted within close proximity of the Combined Study Area

Survey	Area	No. quadrats	Vegetation types	Species, subspecies and varieties	Families	Genera	Weeds
Biota (2012f)	11,991 ha	62	25	384	43	130	11
Biota (2012a)	1,040 ha	16	14	212	38	90	3
Biota (2012c)	4,991 ha	39	18	285	39	102	9
Biota (2012e)	38,628 ha	191	45	469	49	149	13
Biota (2012d)	12,022 ha	98	49	577	58	190	14
Biota (2010)	1,460 ha	NA	23	278	105	42	13
Mattiske (2008)	NA	NA	10	185	33	64	1
Current survey	917 ha	25	13	193	40	104	5

The most prominent families recorded in the Combined Study Area included the Fabaceae, Poaceae, Malvaceae and Amaranthaceae (Table 5-3). The dominant families recorded were also prominent in previous flora surveys and comprised a similar proportion of the total flora collected.

The identity of a single taxon could not be definitively identified to species level, *Eucalyptus* ? *aridimontana*, as reproductive structures present (fruit) were in a poor condition. Characters defined for the species suggest this identity but a better specimen is required for confirmation.

5.2.1 Conservation significant flora

No Threatened Flora listed under the WC Act or the EPBC Act (Department of the Environment 2014b) were recorded from the Combined Study Area during the field survey. Two Priority flora species were recorded during the field survey (Figure 5-1):

- *Sauropus* sp. Koodaideri detritals (J. Naaykens & J. Hurter JH 11213) **P1**
- *Sida* sp. Barlee Range (S. van Leeuwen 1642) **P3**.

Both of the Priority species were previously recorded within 20 km radius of the Combined Study Area and are listed in the DPaW databases. Both were recorded in restricted areas of the MSA. The details of the records from the field survey, including geographic coordinates (GDA94) and plant numbers or percentage foliar cover are provided in Appendix 4.

Table 5-3 Dominant families recorded for the Combined Study Area and the proportion of the total number of species recorded compared with flora surveys in close proximity

	Biota (2012f)	Biota (2012a)	Biota (2012d)	Biota (2012c)	Biota (2012e)	Mattiske (2008)	Current survey
Amaranthaceae	21	13	25	10	23	7	10
Convolvulaceae	11	5	15	8	16	2	7
Cyperaceae	5	2	15	3	6	1	7
Euphorbiaceae	10	6	16	10	17	5	5
Fabaceae	89	51	118	63	108	41	36
Goodeniaceae	11	6	22	10	14	8	7
Malvaceae	53	28	68	46	65	19	25
Myrtaceae	12	5	16	5	8	12	8
Phyllanthaceae	8	4	7	5	6	1	6
Poaceae	59	32	96	48	71	21	29
Scrophulariaceae	9	4	6	4	5	6	4
Solonaceae	8	4	11	6	9	2	5
% species recorded	77.1	75.5	71.9	76.5	74.2	67.6	76.9

5.2.1.1 *Sauropus* sp. Koodaideri detritals (J. Naaykens & J. Hurter JH 11213) (P1)

Sauropus sp. Koodaideri detritals (Figure 5-2) was previously recorded at a single location in a gully with outcropping rock in the Koodaideri study area (Biota 2012f). The Koodaideri study area occurs approximately 20 km to the north of the Combined Study Area. The species was first collected in 2007 and is yet to be formally described (Biota 2012f).

A single plant was recorded in the MSA in a small gorge in Veg 6 and may represent a range extension for the species. The plant was sterile when recorded.

Figure 5-2 *Sauropus* sp. Koodaideri detritals (P1) ex situ

5.2.1.2 *Sida* sp. Barlee Range (S. van Leeuwen 1642) (P3)

Sida sp. Barlee Range is a spreading shrub growing to 0.5 m with yellow flowers (Figure 5-3). There are 37 records for the species (ALA 2014), all of which occur in Western Australia. The speices is predominantly listed for the Pilbara bioregion but also occurs in the Gascoyne. The species has been recorded in skeletal red soil pockets on steep slopes (DPaW 2013a).

The species was recorded at two locations in the MSA:

- a single plant was found at the base of the cliff face of a mesa in Veg 4
- seven plants were recorded at the base of a cliff face in a narrow gorge in vegetation type Veg 6.

All of the plants observed were flowering at the time they were recorded.

Figure 5-3 ***Sida* sp. Barlee Range (P3) in situ**

5.2.2 Introduced flora

A total of five introduced species (weeds) were recorded in the Combined Study Area during the flora survey; **Alternanthera pungens*, *Bidens bipinnata**, *Lactuca saligna**, **Malvastrum americanum* and **Cenchrus ciliaris* (Appendix 3). None are listed as a Declared Plant species pursuant to section 37 of the *Agricultural and Related Resources Protection Act 1976* (DAFWA 2014).

All of the weeds recorded have previously been recorded in the Pilbara bioregion (DPaW 2013a) and with the exception of *Alternanthera pungens* were also recorded in at least one of the flora surveys conducted in close proximity to the Combined Study Area (Table 5-4).

Table 5-4 **Weed species recorded during the current survey and previous records for the species**

Weed species	Previous survey records
Alternanthera pungens	None
Bidens bipinnata	Biota (Biota 2012d, e, f)
Cenchrus ciliaris	Mattiske (2008), Biota (2012a, c, d, e)
Lactuca saligna	Biota (2012f)
Malvastrum americanum	Biota (Biota 2012c, e, f)

Alternanthera pungens was recorded in two quadrats (Q24 and Q26) both of which occur within the RSA. *Bidens bipinnata* was recorded in low numbers in three quadrats, one in the RSA (Q26) and two in the MSA (Q3, Q4). *Cenchrus ciliaris* was recorded in two quadrats, one in the RSA (Q26), where it was present in low numbers, and one in the MSA (Q3), where it comprised a dominant component of the grass stratum. *Lactuca saligna* was present in low numbers in a single quadrat in the MSA (Q3). *Malvastrum americanum* was recorded in two quadrats in the MSA (Q3, Q12) in low numbers. Notably, all of the weed species were recorded in riparian vegetation.

5.2.3 Range extensions

Examination of distribution records (DPaW 2013a, 2014c) for the species recorded in the Combined Study Area indicated that the records represent a range extension for five taxa (Table 5-5).

Table 5-5 Range extensions of flora species recorded during the flora and vegetation survey

Species	Approximate distance of range extension	Comment
Eucalyptus ? *aridimontana*	30 km (MSA)	South-western range extension
Flueggea virosa	100 km (RSA)	South-western range extension
Sauropus sp. Koodaideri detritals	20 km (MSA)	Southern range extension
Sida sp. Articulation below	<10 km (RSA)	South-western range extension
Tribulopis angustifolia	20 km (RSA)	Southern range extension

Identification of range extensions are a common occurrence in flora surveys in the Pilbara bioregion, for example, Biota (2012d) identified 21 and Biota (2012b) in excess of 100 changes to taxon ranges. The range extension for *Flueggea virosa*, based on DPaW databases, was substantially higher than that of others; however, this species was also recorded by Biota (Biota 2012a, b). Notably, *Sida* sp. Articulation below was also recorded by Biota (2012a).

5.3 VEGETATION

The vegetation of the Combined Study Area was characterised by three broad floristic sub-formations (NVIS 2003; Appendix 5).:

1. *Triodia wiseana* dominant hummock grassland (Veg 7)
2. isolated low trees over isolated mid to tall *Acacia* shrubs over isolated low shrubs to mixed low shrubland over *Triodia* hummock grassland (Veg 1, 2, 4, 5, 8, 10 and 13)
3. isolated trees to woodland over tall mixed shrubland over isolated low shrubs over mixed grassland (Veg 3, 6, 9, 11 and 12).

Classification into these broad vegetation classes was based solely on the descriptions of the vegetation strata (Table 5-6). For these broader classifications the *Triodia wiseana* dominant hummock grassland was classed as a separate category due to the virtual lack of a tree or shrub stratum. The second category noted the presence of isolated trees over isolated shrubs in grassland dominated by *Triodia* species with isolated tussocks of other grasses occasionally present. The third category noted the presence of denser shrub layers of greater diversity over grasslands of greater diversity.

5.3.1 Vegetation types

Utilising the UPGMA dendrogram (Figure 5-4) and field observations, the vegetation of the Combined Study Area (Figure 5-5; Table 5-6) were then further classified to the level of association (NVIS 2003; Appendix 5). A total of 13 vegetation associations were determined, six were recorded in the RSA (Veg 2, 3, 5, 8, 12 and 13) and nine (Veg 1, 3, 4, 6, 7, 8, 9, 10 and 11) in the MSA. Two associations (Veg 3 and 8) were recorded in both, RSA and MSA (Table 5-7).

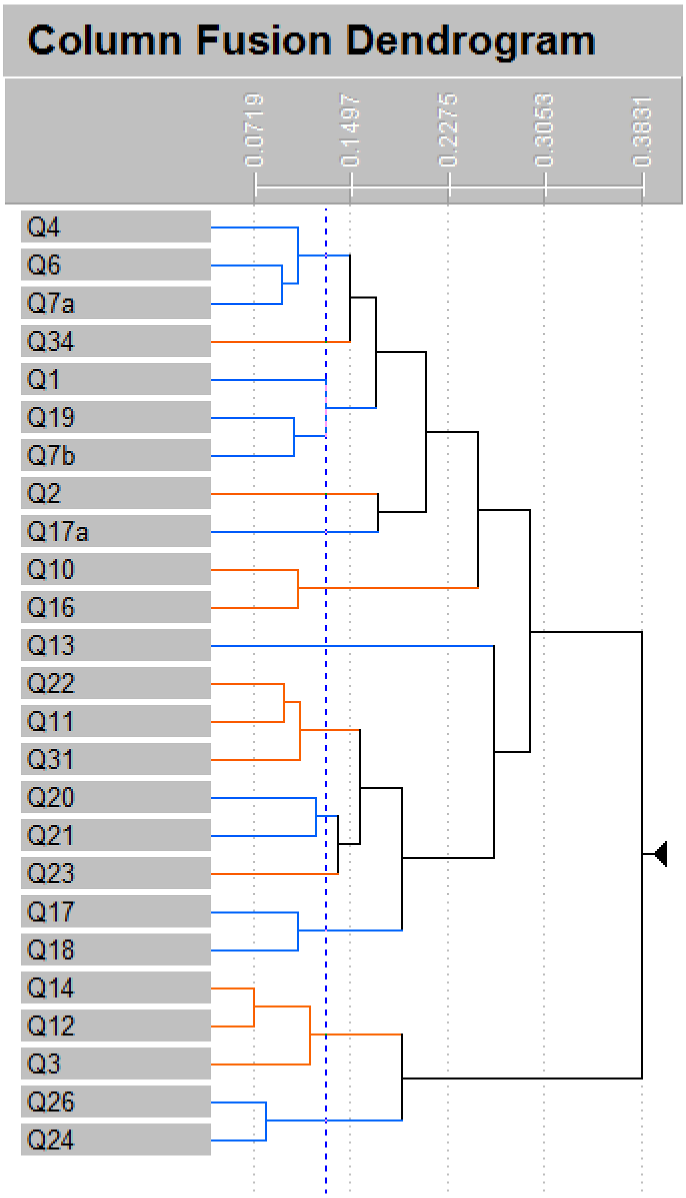


Figure 5-4 Dendrogram from UPGMA cluster analysis showing grouping of quadrats

The more detailed statistical analysis utilising cover values for all of the species present in the quadrat resulted in the three broad vegetation sub-formations being interspersed on the dendogram as:

- in the majority of quadrats most of the species recorded were present at the lowest cover value (0.1%) and therefore not considered for the broader sub-formation classification
- although two communities are grouped in the broader class because they have a prominent upper and lower shrub layer these may be comprised of different species and they therefore group with associations with isolated shrubs which share a more similar suite of species
- correspondingly, though communities may be comprised of a similar suite of species (and therefore are clustered together on the dendrogram) they are placed into different broader classes as the stratum are isolated in one community, i.e. isolated shrubs as opposed to a more prominent shrubland at the other.

Notably, although the sub-formations are interspersed on the dendogram the prominence of the stratum layers does separate those associations with a more defined shrub layer from those with only isolated shrubs.

The defined vegetation associations resembled vegetation types of van Vreeswyk *et al.* (2004) that are common, widespread and represented in nature reserves.

Vegetation 1 (Veg 1) of the MSA and Veg 8 (found in RSA and MSA) were recorded on the plateaux and slopes of mesas, and on the crests and slopes of low rolling hills. These vegetation associations closely resembled the hill eucalypt spinifex grassland (HESG) vegetation type of van Vreeswyk *et al.* (2004) recorded on hillslopes, footslopes and low rises. Vegetation 2 (Veg 2) of the RSA was recorded on the plateau of a mesa and was representative of the hill spinifex grassland (HSPG) vegetation type of van Vreeswyk *et al.* (2004) recorded on hill slopes, footslopes, plateaux, ridges and low rises.

Vegetation associations Veg 3, Veg 6, Veg 8 and Veg 12 (found in RSA and MSA) were riparian vegetation found in drainage lines, creeks, broad valleys and gorges. These associations resembled the drainage eucalypt and acacia grassy woodland/shrubland (DEGW) vegetation type of van Vreeswyk *et al.* (2004) recorded in drainage tracts, drainage floors, floodplains, alluvial plains and levees.

Vegetation associations Veg 4 and Veg 7 of the MSA were recorded on the footslope and plateau of a mesa and resembled the plain hard spinifex grassland (PHSG) of van Vreeswyk *et al.* (2004) recorded on plains and footslopes of low rises.

Vegetation association 5 of the RSA was recorded on a flat plain and was similar to the drainage acacia hummock grass shrubland/woodland (DAHW) of van Vreeswyk *et al.* (2004) recorded in narrow drainage floors and groves on wash plains.

Vegetation associations Veg 9 of the MSA and Veg 13 of the RSA recorded along a small creek, a drainage line and a flat plain resembled the drainage spinifex grassland with eucalypt overstorey (DESG) vegetation type of van Vreeswyk *et al.* (2004) recorded in drainage tracts and narrow valley floors.

Vegetation association 10 of the MSA was recorded on flat plains and resembled the plain soft spinifex grassland (PSSG) of van Vreeswyk *et al.* (2004) recorded on stony plains, loamy plans and gritty surfaced plains.

Vegetation associations Veg 1 of the MSA, Veg 8 found in RSA and MSA and Veg 10 of the MSA were the most widespread and combined accounted for 75% of the Combined Study Area (Table 5-7). Associations Veg 6 and Veg 7 were the most restricted, each accounting for less than 1%.

Differences in the vegetation communities present in the MSA and RSE have arisen from differences in both the land systems and landforms present in the two areas. The MSA occurs on three land systems two of which are present in the RSA, each area also contains an additional land system. The presence of the different land systems has resulted in some of the differences in vegetation between the two areas. Notably in the lower section of the RSA that connects to the MSA vegetation is similar. The change in vegetation in the mid-section of RSA corresponds with a change into the Boolgeeda land system which is not present in the MSA.

The northern most section of the RSA does pass back into the Newman land system which is present in both areas. However, the majority of this section passed through a large gorge as well as substantially larger mesas and ridges (with different vegetation types present) than on the lower mesas and valleys in the MSA.

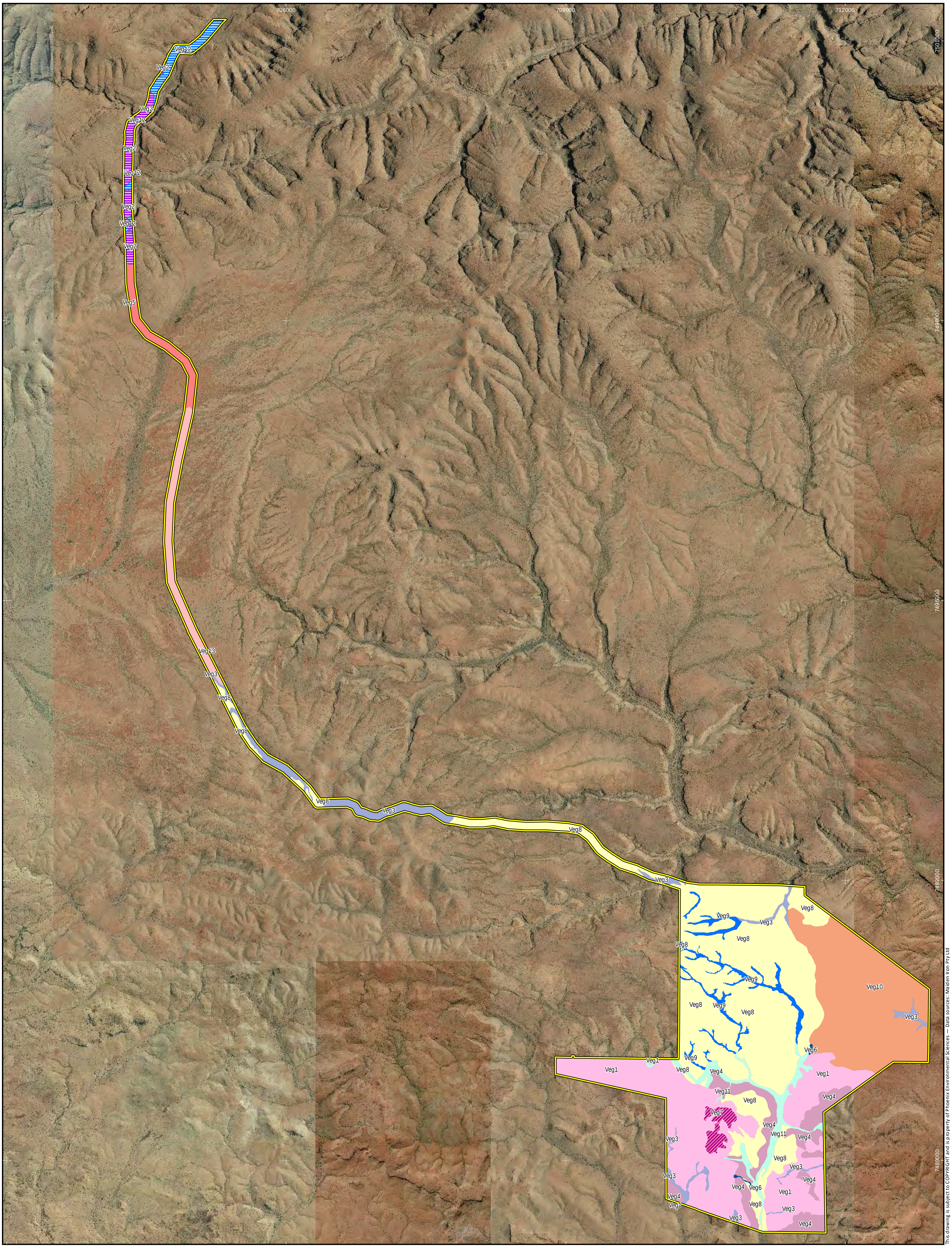


Figure 5-5
Vegetation associations in the Combined Study Area

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

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

0 0.5 1 Kilometres
1:35,471

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Combined Study Area

Vegetation type

- Vegetation 1
- Vegetation 2
- Vegetation 3
- Vegetation 4
- Vegetation 5
- Vegetation 6
- Vegetation 7
- Vegetation 8
- Vegetation 9
- Vegetation 10
- Vegetation 11
- Vegetation 12
- Vegetation 13

Description of the vegetation types

Vegetation 1: Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over isolated mid *Acacia* spp. shrubs over isolated low shrubs to open shrubland of *Acacia adoxa* var. *adoxa*, *A. hilliana*, *Corchorus lasiocarpus* and *Ptilotus astrolasius* over a low *Triodia wiseana* and *T. epactia* hummock grassland with isolated *Aristida holathera* and *Eriachne pulchella* tussocks and isolated *Tribulus hirsutus* herbs.

Vegetation 2: Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over isolated mid *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over isolated low *Corchorus lasiocarpus* shrubs in a low *Triodia epactia* hummock grassland over isolated *Ptilotus fusiformis* and *Oldenlandia crouchiana* herbs.

Vegetation 3: Isolated low *Corymbia hamersleyana* trees over a tall *Acacia monticola*, *A. tenuissima*, *A. tumida* and *Petalostylis labicheoides* shrubland over isolated low shrubs to low shrubland of *Androcalva luteiflora*, *Jasminum didymum*, *Senna glutinosa* and *Ptilotus astrolasius* over a low *Triodia epactia* and *Themeda triandra* grassland with isolated *Cymbopogon ambiguus* and *Eriachne mucronata* tussocks.

Vegetation 4: Isolated low *Corymbia hamersleyana* trees over isolated mid *Acacia inaequilatera* shrubs over isolated low *Indigofera rugosa* and *Senna artemisioides* subsp. *oligophylla* shrubs over low *Triodia epactia* hummock grassland.

Vegetation 5: Isolated low *Corymbia deserticola* trees over isolated tall *Acacia tumida* shrubs over isolated mid *Grevillea wickhamii* subsp. *hispidula* shrubs over isolated low *Goodenia stobbsiana* shrubs in low *Triodia wiseana* hummock grassland.

Vegetation 6: Isolated low trees to low woodland of *Corymbia aspera*, *Eucalyptus aridimontana* and *E. leucophloia* over a tall *Acacia tumida* shrubland over isolated low *Adriana tomentosa* shrubs and *Duperreya commixta* vines over isolated low grasses to low grassland of *Eriachne mucronata*, *Themeda triandra* and *Triodia epactia*.

Vegetation 7: Isolated low *Goodenia stobbsiana* shrubs over a low *Triodia wiseana* hummock grassland over isolated *Fimbristylis simulans* herbs.

Vegetation 8: Isolated low *Corymbia hamersleyana* and *Eucalyptus leucophloia* trees over isolated mid to tall *Acacia tumida*, *A. maitlandii* and *A. pruinocarpa* shrubs over isolated low shrubs to low shrubland of *Acacia arida*, *A. adoxa* var. *adoxa*, *Corchorus lasiocarpus*, *Gompholobium oreophilum*, *Goodenia stobbsiana* and *Senna glutinosa* subsp. *glutinosa* over a low *Triodia epactia* and *T. wiseana* hummock grassland and isolated *Goodenia triodiophila* herbs.

Vegetation 9: Isolated low trees to low open woodland of *Corymbia hamersleyana* occasionally with low *Eucalyptus leucophloia* trees and *E. gamophylla* mallee over a mid to tall *Acacia tumida*, *Grevillea wickhamii* subsp. *hispidula*, *Petalostylis labicheoides* and *Santalum lanceolatum* shrubland over isolated low shrubs to low open shrubland of *Acacia adoxa* var. *adoxa*, *Bonamia erecta*, *Gompholobium oreophilum*, *Indigofera monophylla*, *Keraudrenia velutina* and *Sida arenicola* over a *Triodia wiseana*, *T. epactia* and *Themeda triandra* grassland with isolated *Aristida holathera* and *Amphipogon sericeus* tussocks.

Vegetation 10: Isolated low *Corymbia deserticola* trees over isolated mid to tall *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over isolated low *Acacia ancistrocarpa* and *Indigofera monophylla* shrubs over a low *Triodia wiseana* hummock grassland with isolated low *Amphipogon sericeus* tussocks and *Goodenia triodiophila* and *Ptilotus calostachyus* herbs.

Vegetation 11: Isolated mid trees to mid-woodland of *Eucalyptus camaldulensis* occasionally with low *Corymbia hamersleyana*, *Atalaya hemiglauca* and *Eucalyptus leucophloia* trees over isolated tall shrubs to tall shrubland of *Acacia maitlandii*, *A. pyrifolia* and *A. tumida* over isolated low mixed shrubs to low open shrubland over isolated low mixed grasses and sedges to low mixed grass-sedgeland with *Triodia epactia*, *Themeda triandra*, *Enneapogon lindleyanus* and *Cyperus vaginatus* prominent over isolated mixed herbs with occasional patches of a tall *Myoporum montanum* shrubland over a tall *Typha domingensis* sedgeland in wet depressions.

Vegetation 12: Isolated mid *Corymbia aspera*, *Brachychiton acuminatus* and *Eucalyptus camaldulensis* trees over isolated low *Atalaya hemiglauca* and *Corymbia hamersleyana* trees over isolated tall *Acacia* spp. shrubs over isolated low to low open mixed shrubland with *Cleome viscosa*, *Senna venusta*, *Tephrosia rosea* and *Trachymene oleracea* prominent over a low open *Cymbopogon ambiguus*, *Eriachne mucronata*, *Eulalia aurea* and *Themeda triandra* tussock grassland with isolated *Yakirra australiensis* bunch grasses and isolated *Amaranthus cuspidifolius*, *A. undulatus*, *Euphorbia coghlanii* and *Gomphrena cunninghamii* herbs and *Cucumis maderaspatensis* vines.

Vegetation 13: Isolated low *Eucalyptus leucophloia* and *Corymbia deserticola* trees over isolated low *Eucalyptus gamophylla* mallee over mid open *Acacia elachantha* and *Bonamia erecta* shrubland over low *Acacia ancistrocarpa* shrubland over a low *Triodia wiseana* hummock grassland over isolated *Goodenia microptera* and *Ptilotus calostachyus* herbs.

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Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

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Table 5-6 Vegetation associations recorded in the Combined Study Area

Vegetation association	Vegetation description	Site photo	Site
Veg 1	Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over isolated mid Acacia spp. shrubs over isolated low shrubs to open shrubland of *Acacia adoxa* var. *adoxa*, *A. hilliana*, *Corchorus lasiocarpus* and *Ptilotus astrolasius* over a low *Triodia wiseana* and *T. epactia* hummock grassland with isolated *Aristida holathera* and *Eriachne pulchella* tussocks and isolated *Tribulus hirsutus* herbs.		Q4, Q6, Q7a
Veg 2	Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over isolated mid *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over isolated low *Corchorus lasiocarpus* shrubs in a low *Triodia epactia* hummock grassland over isolated *Ptilotus fusiformis* and *Oldenlandia crouchiana* herbs.		Q34

Vegetation association	Vegetation description	Site photo	Site
Veg 3	Isolated low *Corymbia hamersleyana* trees over a tall *Acacia monticola*, *A. tenuissima*, *A. tumida* and *Petalostylis labicheoides* shrubland over isolated low shrubs to low shrubland of *Androcalva luteiflora*, *Jasminum didymum*, *Senna glutinosa* and *Ptilotus astrolasius* over a low *Triodia epactia* and *Themeda triandra* grassland with isolated *Cymbopogon ambiguus* and *Eriachne mucronata* tussocks.		Q1, Q7b, Q19, R9, R28
Veg 4	Isolated low *Corymbia hamersleyana* trees over isolated mid *Acacia inaequilatera* shrubs over isolated low *Indigofera rugosa* and *Senna artemisioides* subsp. *oligophylla* shrubs over low *Triodia epactia* hummock grassland.		Q2
Veg 5	Isolated low *Corymbia deserticola* trees over isolated tall *Acacia tumida* shrubs over isolated mid *Grevillea wickhamii* subsp. *hispidula* shrubs over isolated low *Goodenia stobbsiana* shrubs in low *Triodia wiseana* hummock grassland.		Q17a

Vegetation association	Vegetation description	Site photo	Site
Veg 6	Isolated low trees to low woodland of *Corymbia aspera*, *Eucalyptus aridimontana* and *E. leucophloia* over a tall *Acacia tumida* shrubland over isolated low *Adriana tomentosa* shrubs and *Duperreya commixta* vines over isolated low grasses to low grassland of *Eriachne mucronata*, *Themeda triandra* and *Triodia epactia*.		Q10, Q16
Veg 7	Isolated low *Goodenia stobbsiana* shrubs over a low *Triodia wiseana* hummock grassland over isolated *Fimbristylis simulans* herbs.		Q13

Vegetation association	Vegetation description	Site photo	Site
Veg 8	Isolated low *Corymbia hamersleyana* and *Eucalyptus leucophloia* trees over isolated mid to tall *Acacia tumida*, *A. maitlandii* and *A. pruinocarpa* shrubs over isolated low shrubs to low shrubland of *Acacia arida*, *A. adoxa* var. *adoxa*, *Corchorus lasiocarpus*, *Gompholobium oreophilum*, *Goodenia stobbsiana* and *Senna glutinosa* subsp. *glutinosa* over a low *Triodia epactia* and *T. wiseana* hummock grassland and isolated *Goodenia triodiophila* herbs.		Q11, Q22, Q31
Veg 9	Isolated low trees to low open woodland of *Corymbia hamersleyana* occasionally with low *Eucalyptus leucophloia* trees and *E. gamophylla* mallee over a mid to tall *Acacia tumida*, *Grevillea wickhamii* subsp. *hispidula*, *Petalostylis labicheoides* and *Santalum lanceolatum* shrubland over isolated low shrubs to low open shrubland of *Acacia adoxa* var. *adoxa*, *Bonamia erecta*, *Gompholobium oreophilum*, *Indigofera monophylla*, *Keraudrenia velutina* and *Sida arenicola* over a *Triodia wiseana*, *T. epactia* and *Themeda triandra* grassland with isolated *Aristida holathera* and *Amphipogon sericeus* tussocks.		Q20, Q21

Vegetation association	Vegetation description	Site photo	Site
Veg 10	Isolated low *Corymbia deserticola* trees over isolated mid to tall *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over isolated low *Acacia ancistrocarpa* and *Indigofera monophylla* shrubs over a low *Triodia wiseana* hummock grassland with isolated low *Amphipogon sericeus* tussocks and *Goodenia triodiophila* and *Ptilotus calostachyus* herbs.		Q17, Q18
Veg 11	Isolated mid trees to mid-woodland of *Eucalyptus camaldulensis* occasionally with low *Corymbia hamersleyana*, *Atalaya hemiglauca* and *Eucalyptus leucophloia* trees over isolated tall shrubs to tall shrubland of *Acacia maitlandii*, *A. pyrifolia* and *A. tumida* over isolated low mixed shrubs to low open shrubland over isolated low mixed grasses and sedges to low mixed grass-sedgeland with *Triodia epactia*, *Themeda triandra*, *Enneapogon lindleyanus* and *Cyperus vaginatus* prominent over isolated mixed herbs with occasional patches of a tall *Myoporum montanum* shrubland over a tall *Typha domingensis* sedgeland in wet depressions.		Q3, Q12, Q14

Vegetation association	Vegetation description	Site photo	Site
Veg 12	Isolated mid *Corymbia aspera*, *Brachychiton acuminatus* and *Eucalyptus camaldulensis* trees over isolated low *Atalaya hemiglauca* and *Corymbia hamersleyana* trees over isolated tall *Acacia* spp. shrubs over isolated low to low open mixed shrubland with *Cleome viscosa*, *Senna venusta*, *Tephrosia rosea* and *Trachymene oleracea* prominent over a low open *Cymbopogon ambiguus*, *Eriachne mucronata*, *Eulalia aurea* and *Themeda triandra* tussock grassland with isolated *Yakirra australiensis* bunch grasses and isolated *Amaranthus cuspidifolius*, *A. undulatus*, *Euphorbia coghlanii* and *Gomphrena cunninghamii* herbs and *Cucumis maderaspatensis* vines.		Q24, Q26, R25
Veg 13	Isolated low *Eucalyptus leucophloia* and *Corymbia deserticola* trees over isolated low *Eucalyptus gamophylla* mallee over mid open *Acacia elachantha* and *Bonamia erecta* shrubland over low *Acacia ancistrocarpa* shrubland over a low *Triodia wiseana* hummock grassland over isolated *Goodenia microptera* and *Ptilotus calostachyus* herbs.		Q23

Table 5-7 Total area of vegetation associations and percentage representation in the Combined Study Area

Vegetation association	MSA ha (%)	RSA ha (%)	Total area ha (%)
Veg 1	196.00 (21.4)		196.00 (21.4)
Veg 2		16.88 (1.8)	16.88 (1.8)
Veg 3	13.2 (1.4)	26.4 (2.9)	39.60 (4.3)
Veg 4	52.31 (5.7)		52.31 (5.7)
Veg 5		18.27 (2.0)	18.27 (2.0)
Veg 6	0.73 (0.1)		0.73 (0.1)
Veg 7	9.01 (1.0)		9.01 (1.0)
Veg 8	293.22 (32.0)	42.23 (4.6)	335.45 (36.6)
Veg 9	22.04 (2.4)		22.04 (2.4)
Veg 10	156.90 (17.1)		156.90 (17.1)
Veg 11	24.90 (2.7)		24.90 (2.7)
Veg 12		13.99 (1.5)	13.99 (1.5)
Veg 13		30.49 (3.3)	30.49 (3.3)

5.3.2 Vegetation condition

Cleared areas within the Combined Study Areas including exploration and access tracks were rated as Completely Degraded. The condition of the vegetation within the Combined Study Area ranged from Very Good to Excellent (Figure 5-6). The MSA was rated mostly as Very Good and the RSA was rated mostly as Excellent (Figure 5-6). Disturbance in the majority of areas rated Very Good was from previous mining exploration activities and pastoral tracks. In some riparian vegetation evidence of feral animal grazing (e.g. cattle tracks, dung) and the presence of weeds in low or high numbers resulted in the Very Good rating rather than Excellent.

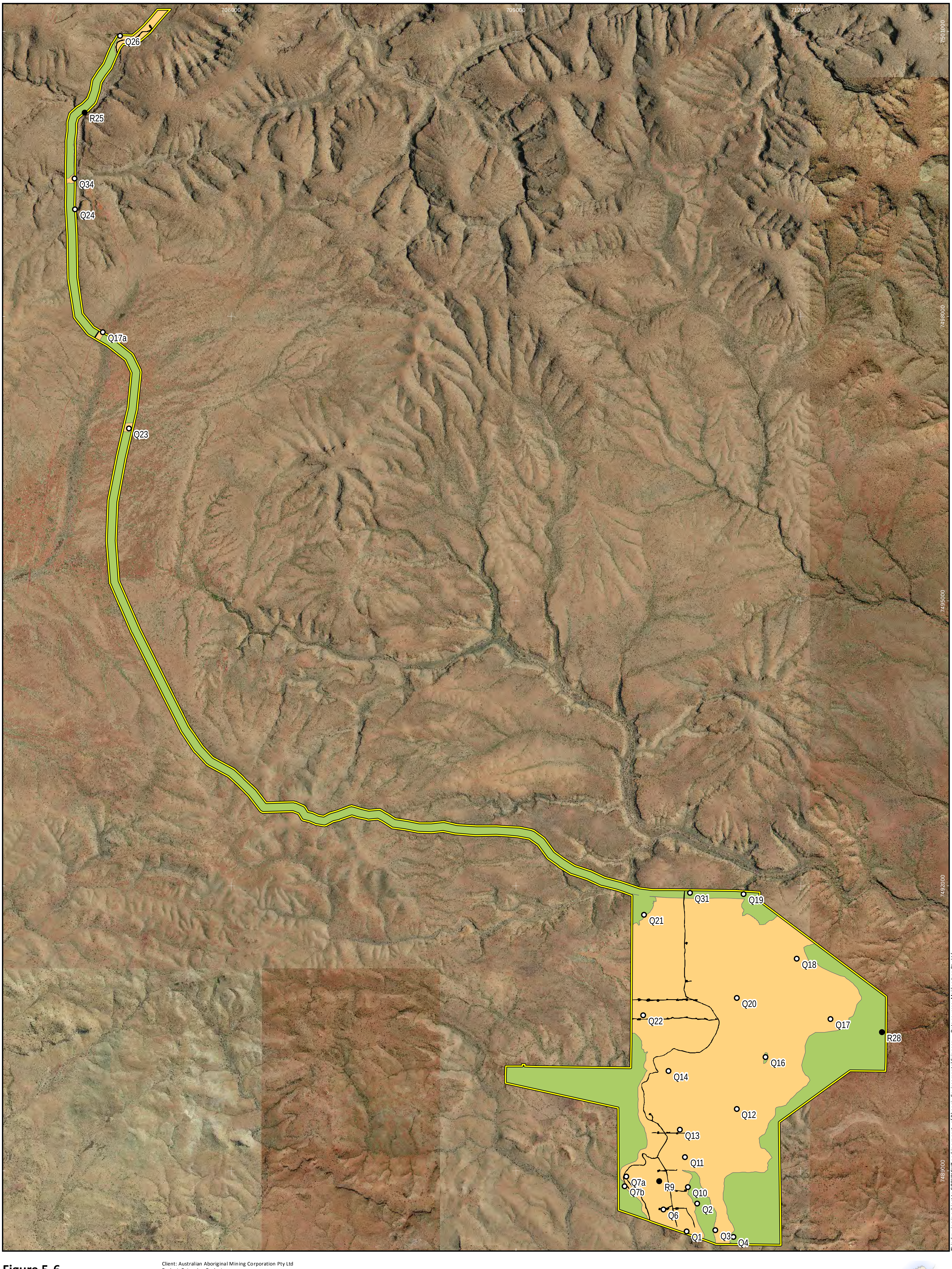

Figure 5-6
Vegetation condition in the Study Area

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/06/2014

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

0 0.5 1 Kilometres
1:35,000

PHOENIX ENVIRONMENTAL SCIENCES

Combined Study Area
Quadrat
Releve

Vegetation condition
Excellent
Very Good
Degraded tracks

5.3.3 Threatened ecological communities

The vegetation associations recorded in the Combined Study Area were not considered representative of any federal or state listed TEC as defined by the EPBC Act (Department of the Environment 2014a) or by DPaW (2013b).

None of the associations resemble PECs or ESAs recorded for the Pilbara bioregion.

5.3.4 Local and regional significance of vegetation

5.3.4.1 Local context

A total of four of the vegetation associations recorded in the Combined Study Area may be considered to have local conservation significance (Table 5-8) for one or more of the following reasons:

- the association represents habitat for priority flora
- the association represents potential range extensions for flora
- the association has limited representation in the Combined Study Area (<1%)
- the association resembles vegetation types considered to have local significance in previous flora assessments.

Table 5-8 Vegetation associations of local conservation significance

Vegetation association	Reasons for conservation significance	Level of conservation significance
Veg 1	Habitat for priority flora	Low
Veg 6	Limited representation Habitat for priority flora Possible range extension for taxa including priority flora	Low to moderate
Veg 7	Limited representation	Low
Veg 11	Resembled conservation significant vegetation from previous assessment	Low to moderate

Veg 7 is considered to have a low level of local significance as, although it has limited representation in the Combined Study Area, this association resembled the widespread PHSG vegetation type of van Vreeswyk *et al.* (2004) and as such is likely to be represented outside of the Combined Study Area.

Similarly, Veg 1 is considered to have low local conservation significance as the association resembled a widespread vegetation type (HESG) of van Vreeswyk *et al.* (2004) and only a small population of a priority species, *Sida* Sp. Barlee Range, was recorded. In addition, the priority species recorded in this association is known from numerous locations spread over a broad distribution.

Veg 11 was recorded in similar habitat and possesses similar species composition to the 'gully mosaic' vegetation regarded by Biota (2012a) as low to moderately locally significant.

Veg 6 was considered to be of moderate local conservation significance as it had limited representation, was habitat for two priority flora (*Sauropus* sp. Koodaideri detritals and *Sida* Sp. Barlee Range) and had a possible range extension for *Sauropus* sp. Koodaideri detrital and *Eucalyptus* ? *aridimontana*.

5.3.4.2 Regional context

Broad scale vegetation mapping of the area (1:1,000,000) undertaken by Beard (1975a) indicates that there are two vegetation communities present within the Combined Study Area. These both have greater than 98% of their pre- European extent remaining and are therefore are not regionally significant (see section 3.3).

All of the vegetation associations recorded during the current survey resemble widespread vegetation types of van Vreeswyk *et al.* (2004) none of which were considered regionally significant.

6 DISCUSSION

6.1 FLORA

A total of 193 plant taxa representing 104 genera and 40 families comprised of 188 native species and five introduced species were recorded in the Combined Study Area during the field survey. This included 48 annual (or annual/perennial) species and 145 perennial species. Both the number of flora collected and the composition of the flora compare favourably to other flora surveys conducted in close proximity to the Combined Study Area.

No populations of Threatened Flora were recorded in the MSA or the RSA by database searches or during the field survey. Three populations of priority flora, *Sida* sp. Barlee Range P3 (2 populations) and *Sauropus* sp. Koodaideri detritals (1 population), were recorded within the MSA (Figure 5-1).

The desktop assessment determined that numerous other Priority species and two Threatened species, *Lepidium catapycnon* and *Thryptomene wittweri*, may potentially occur in the Combined Study Area. The field survey did not cover the entire Combined Study Area and as such the presence of populations of further Priority and/or Threatened flora cannot be ruled out. To minimise potential impacts to conservation significant flora further foot-searches of areas to be impacted by mining operations and infrastructure may be warranted.

Populations of several introduced/weed species were recorded in the Combined Study Area during the current survey and it is likely that further populations are present, particularly in creek systems and drainage lines. None of the species are a Declared Plant under the *Agriculture and Related Resources Protection Act 1976*. All species have previously been recorded in the Pilbara bioregion and/or in flora assessments conducted in close proximity to Combined Study Area and have wide distributions in Western Australia.

6.2 VEGETATION

The majority of vegetation in the Combined Study Area was comprised primarily of native species with negligible weed infestations. Most vegetation was also considered to be in either Very Good or Excellent condition.

No TEC of national or regional significance occurs in the Combined Study Area. The majority of vegetation associations defined for the Combined Study Area resembled common widespread communities and were therefore not considered regionally significant.

The RSA intercepts the buffer zone applied to the Priority 1 ecological community Fortescue Marsh (Fortescue Land System) but does not intercept the PEC itself.

Several vegetation associations recorded in the MSA were considered to be of low to moderate local conservation significance. Veg 1 provides habitat to Priority flora, *Sida* sp. Barlee Range. Veg 6 has limited representation within the MSA, provides habitat for Priority flora *Sida* sp. Barlee Range and *Sauropus* sp. Koodaideri detritals, and represents a possible range extension for some taxa including the latter. Veg 7 has limited representation within the MSA but resembles a widespread vegetation type and is not considered to be of regional significance. Veg 11 resembled conservation significant vegetation identified from a previous assessment in the vicinity of the Combined Study Area (Biota 2012a).

6.3 Survey limitations

Complete flora and vegetation surveys may require multiple surveys at different times of year and over a period of a number of years, to enable observation of all species present. Some flora species, such as annuals, are only available for collection at certain times of the year when they are flowering. Furthermore, climatic and stochastic events such as fire may affect the presence of certain plant species or the timing of flowering. Species with low abundance in an area are more difficult to locate.

Flora composition changes over time, with flora species having specific growing periods, especially annuals and ephemerals. Therefore the results of future botanical surveys in the Combined Study Area may differ from the results of this survey.

The limitations of the current flora and vegetation survey have been considered in accordance with the potential survey limitations listed in Guidance Statement 51 (EPA 2004) (Table 6-1).

Table 6-1 Limitations and constraints associated with the field survey

Variable	Impact on survey outcomes
Availability of contextual information	**Not a constraint.** Existing information of the vegetation and land systems of the area has been mapped (Beard 1975a; van Vreeswyk *et al.* 2004). Access to online floristic records and information including previous studies undertaken in close proximity to the Combined Study Area provided adequate information on the vegetation of the area
Access problems	**Partial constraint.** Due to time constraints and lack of vehicle access some sections of the proposed haul road and the area proposed for the mine camp could not be accessed. Mapping of the vegetation in these areas was limited to review of aerial photography and extrapolation of vegetation recorded in apparently similar habitats.
Experience levels	**Not a constraint**. The botanist who executed this survey, Dr Grant Wells, is a practitioner suitably qualified in his respective field, having completed numerous flora and vegetation surveys in the Pilbara bioregion in the last 10 years.
Timing, weather, season	**Partial Constraint.** The survey was conducted following above average rainfall and as such weather posed no limitation. However, some annual and ephemeral species prevalent in other seasons may not have been present during the single season field survey. Some areas had been recently burnt. Vegetation composition will change over time in these areas.
Disturbances	**Not a constraint**. Disturbance from mineral exploration in the Combined Study Area was limited to small areas.

Variable	Impact on survey outcomes
Survey intensity	**Slight constraint.** The field program was conducted over a five day period consisting of 12 hour field days, by one field survey team. A total of 25 quadrats were sampled and numerous relevé' observations completed over the Combined Study Area. Comparison of the number of quadrats completed per unit area with that of other previous assessments (Table 5-2) identified that the current survey effort exceeded previous surveys.
Completeness	**Partial constraint.** As the survey was conducted over one season rather than several times over the course of a year some annual, ephemeral condition specific species may be present that were not recorded in the survey. In addition, as the survey was undertaken in a single field trip there was no opportunity to verify boundaries or increase the replication of study quadrats. According to NatureMap (DPaW 2014b), 161 plant taxa are known to occur within a 20 km buffer of the Combined Study Area. A total of 196 taxa, were recorded from the Combined Study Area (919 ha). The number of taxa recorded compares favourably with numbers recorded in previous assessments (Table 5-2). The surveys were restricted to flowering plants; fungi and nonvascular plants (e.g. alga, mosses and liverworts) were not systematically searched for.
Determination	The taxonomy and conservation status of the Western Australian flora are dynamic. This report was prepared in reliance on taxonomy and conservation classifications current at the time, but it should be noted this may change.

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Appendix 1 Vegetation Quadrat and Relevé data – all sites

Described by: Grant Wells	Site: Q1	Date: 28/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710802 mE	7488362 mN	

DESCRIPTION:	Isolated low *Corymbia hamersleyana* and *Eucalyptus leucophloia* trees over amid to tall *Acacia monticola* shrubland over a low *Triodia wiseana* and *Triodia epactia* hummock grassland	
TOPOGRAPHY:	drainage line in valley floor	
SOIL TYPE/ROCK TYPE:		
% TOTAL VEGETATION COVER:	70	
% TREE SHRUB >2 M COVER:	10	
% SHRUB < 2 M COVER:	20	
% GRASS COVER:	40	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:		
FIRE HISTORY:	2 to 5 years	
SPECIES PRESENT:	% cover	Height (m)
Acacia arida	0.1	0.7
Acacia maitlandii	0.1	1.4
Acacia monticola	30	2
Acacia tenuissima	0.1	1.2
Capparis spinosa	0.1	0.8
Corchorus lasiocarpus	0.1	0.5
Corchorus sidoides	0.1	0.5
Corymbia hamersleyana	0.5	5
Cymbopogon ambiguus	0.1	0.3
Dodonaea coriacea	0.1	1
Eriachne mucronata	0.1	0.3
Eucalyptus leucophloia	0.5	5
Hakea chordophylla	0.1	1
Jasminum didymum	0.1	1
Ptilotus astrolasius	0.1	0.4

Santalum lanceolatum	0.1	1
Senna glutinosa	0.1	1
Senna glutinosa subsp. *pruinosa*	0.1	1
Solanum centrale	0.1	0.75
Themeda triandra	10	0.5
Triodia epactia	10	0.5
Triodia wiseana	20	0.5

Described by: Grant Wells	Site: Q2	Date: 28/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710912.02 mE	7488657 mN	

DESCRIPTION:	Isolated low *Corymbia hamersleyana* trees over isolated mid *Acacia inaequilatera* shrubs over isolated low *Indigofera rugosa* and *Senna artemisioides* subsp. *oligophylla* shrubs over low *Triodia epactia* tussock grassland	
TOPOGRAPHY:	mid-lower slope of low mesa	
SOIL TYPE/ROCK TYPE:	dominated by ferrous rocks / iron stone	
% TOTAL VEGETATION COVER:	40	
% TREE SHRUB >2 M COVER:	0.1	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	40	
% HERB COVER:	0	
CONDITION:	excellent / pristine	
DISTURBANCE DETAILS:	none	
FIRE HISTORY:	2-5 years	
SPECIES	% cover	Height (m)
Acacia bivenosa	0.1	1.4
Acacia inaequilatera	0.1	3.5
Acacia tenuissima	0.1	1.4
Bonamia media	0.1	0.1
Corymbia hamersleyana	0.1	5
Cymbopogon ambiguus	0.1	0.4
Eremophila longifolia	0.1	1.5
Hakea chordophylla	0.1	1.3
Indigofera rugosa	0.1	0.7
Ptilotus astrolasius	0.1	0.3
Rhynchosia minima	0.1	0.2
Senna artemisioides subsp. *oligophylla*	0.1	0.8
Senna glutinosa	0.1	0.4
Senna glutinosa subsp. *pruinosa*	0.1	0.7
Tephrosia supina	0.1	0.15

Triodia brizoides	0.1	0.4
Triodia epactia	40	0.2

Described by: Grant Wells	Site: Q3	Date: 29/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	711103 mE	7488373 mN	

DESCRIPTION:	Isolated mid *Eucalyptus camaldulensis* trees over a mid open mixed shrubland over sparse mixed shrubland over a mixed low grassland over isolated herb	
TOPOGRAPHY:	dry creek bed	
SOIL TYPE/ROCK TYPE:	ferrous alluvium	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	2	
% SHRUB <2 M COVER:	10	
% GRASS COVER:	40	
% HERB COVER:	1	
CONDITION:	very good	
DISTURBANCE DETAILS:	cattle and weeds	
FIRE HISTORY:	5 to 10 years	
SPECIES	% cover	Height (m)
Acacia arida	0.1	1.5
Acacia bivenosa	1	1.5
Acacia maitlandii	0.1	0.6
Acacia pyrifolia	1	2
Acacia tumida	1	3
Alternanthera nana	0.1	0.3
Amaranthus cuspidifolius	0.1	0.6
Ammannia multiflora	0.1	0.4
Androcalva luteiflora	0.1	2
Aristida holathera	0.1	0.3
Aristida inaequiglumis	0.1	0.6
Atalaya hemiglauca	0.1	2
*Bidens bipinnata**	0.1	0.5
Boerhavia coccinea	0.1	0.2
*Cenchrus ciliaris**	15	0.7
Cleome viscosa	0.1	0.1

Corchorus lasiocarpus	0.1	0.5
Corchorus tridens	0.1	0.3
Crotalaria medicaginea	0.1	0.3
Cymbopogon ambiguus	0.1	0.8
Cyperus ixiocarpus	0.1	0.7
Cyperus squarrosus	0.1	0.2
Cyperus vaginatus	0.1	0.8
Diplatia grandibractea	0.1	0.5
Duperreya commixta	0.1	1
Enneapogon lindleyanus	0.1	0.3
Eragrostis cumingii	0.1	0.2
Eragrostis exigua	0.1	0.5
Eriachne mucronata	0.1	0.3
Eriachne pulchella subsp. *dominii*	0.1	0.05
Eucalyptus camaldulensis	0.1	15
Eulalia aurea	1	0.6
Euphorbia australis	0.1	0.1
Euphorbia coghlanii	0.1	0.4
Evolvulus alsinoides var. *villosicalyx*	0.1	0.1
Gomphrena cunninghamii	0.1	0.2
Goodenia triodiophila	0.1	0.4
Gossypium robinsonii	1	2.5
Grevillea wickhamii subsp. *hispidula*	1	2
Heliotropium cunninghamii	0.1	0.3
Hibiscus brachychlaenus	0.1	0.3
Hibiscus burtonii	0.1	0.4
Hybanthus aurantiacus	0.1	0.5
Indigofera rugosa	0.1	1
*Lactuca saligna**	0.1	0.4
*Malvastrum americanum**	0.1	0.3
Melaleuca lasiandra	2	2.5
Mollugo molluginea	0.1	0.2
Paspalidium constrictum	0.1	0.3
Phyllanthus maderaspatensis	0.1	0.4

Pluchea dentex	0.1	0.4
Ptilotus astrolasius	0.1	0.3
Rhynchosia minima	0.1	1
Salsola australis	0.1	0.4
Santalum lanceolatum	0.1	1.5
Setaria dielsii	0.1	0.9
Stemodia grossa	0.1	0.8
Tephrosia supina	0.1	0.2
Themeda triandra	5	0.6
Triodia epactia	20	0.6
Waltheria indica	1	0.6

Described by: Grant Wells	Site: Q4	Date: 29/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	711292.95 mE	7488304 mN	

DESCRIPTION:	Isolated low *Eucalyptus leucophloia* trees over isolated mid *Acacia pruinocarpa* and *Gossypium robinsonii* shrubs over isolated low *Ptilotus astrolasius* shrubs over a low *Triodia wiseana* tussock grassland over isolated herbs	
TOPOGRAPHY:	mesa plateau	
SOIL TYPE/ROCK TYPE:	ferrous, skeletal, shallow	
% TOTAL VEGETATION COVER:	40	
% TREE SHRUB >2 M COVER:	0.1	
% SHRUB <2 M COVER:	1	
% GRASS COVER:	40	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:	drill pad	
FIRE HISTORY:	5	
SPECIES PRESENT:	% cover	Height (m)
Acacia adoxa var. *adoxa*	0.1	0.4
Acacia hilliana	0.1	0.6
Acacia maitlandii	0.1	0.4
Acacia tenuissima	0.1	1.4
Acacia tumida	0.1	2.5
Eriachne mucronata	0.1	0.4
Androcalva luteiflora	0.1	1.4
Aristida holathera	0.1	0.2
Aristida contorta	0.1	0.2
Corchorus lasiocarpus	0.1	0.6
Cymbopogon ambiguus	0.1	0.6
Enneapogon lindleyanus	0.1	0.2
Eriachne pulchella	0.1	0.02
Eucalyptus leucophloia	0.1	7

Goodenia triodiophila	0.1	0.1
Gossypium australe	0.1	0.5
Gossypium robinsonii	0.1	2
Hibiscus coatesii	0.1	0.3
Jasminum didymum	0.1	1
Ptilotus astrolasius	0.1	0.6
Ptilotus calostachyus	0.1	0.6
Senna glutinosa	0.1	1.1
Senna glutinosa subsp. *pruinosa*	0.1	0.8
Solanum lasiophyllum	0.1	0.4
Triodia wiseana	40	0.3

Described by: Grant Wells	Site: Q6	Date: 28/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710555.01 mE	7488592 mN	

DESCRIPTION:	Isolated *Eucalyptus leucophloia* trees over isolated low *Acacia arida*, *Corchorus lasiocarpus* and *Senna notabilis* shrubs over sparse low *Eriachne lanata*, *Triodia epactia* and *Triodia wiseana* grasses over isolated clumps of herbs	
TOPOGRAPHY:	crest and upper slope of low hill	
SOIL TYPE/ROCK TYPE:	outcropping ironstone dense ironstone pebbles over re clay	
% TOTAL VEGETATION COVER:	10	
% TREE SHRUB >2 M COVER:	1	
% SHRUB <2 M COVER:	3	
% GRASS COVER:	10	
% HERB COVER:	>1	
CONDITION:	very good	
DISTURBANCE DETAILS:	tracks drill pads	
FIRE HISTORY:	>1 year	
SPECIES PRESENT:	% cover	Height (m)
Acacia arida	1	1.2
Acacia pruinocarpa	0.1	0.7
Aristida contorta	0.1	0.25
Aristida holathera	0.1	0.3
Cleome viscosa	0.1	0.6
Corchorus lasiocarpus	1	0.6
Duperreya commixta	0.1	0.3
Eriachne lanata	5	0.4
Eriachne mucronata	0.1	0.4
Eriachne pulchella subsp. *dominii*	0.1	0.05
Eucalyptus leucophloia	1	7
Goodenia microptera	0.1	0.2
Goodenia triodiophila	0.1	0.2
Hibiscus coatesii	0.1	0.3

Indigofera monophylla	0.1	0.4
Jasminum didymum	0.1	0.25
Paraneurachne muelleri	0.1	0.2
Ptilotus astrolasius	0.1	0.5
Senna glutinosa	0.1	0.4
Senna notabilis	0.5	0.3
Solanum ashbyae	0.1	0.4
Solanum lasiophyllum	0.1	0.5
Tribulus hirsutus	0.1	0.05
Triodia epactia	3	0.4
Triodia wiseana	2	0.3

Described by: Grant Wells	Site: Q7a	Date: 1/04/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710163.7 mE	7488939 mN	

DESCRIPTION:	Isolated *Eucalyptus leucophloi*a and *Corymbia hamersleyana* low trees over isolated mid to tall *Acacia inaequilatera* shrubs over a low open *Acacia hilliana*, *Acacia monticol*a and *Ptilotus astrolasius* shrubland over a low *Triodia epactia* hummock grassland.	
TOPOGRAPHY:	lower slope of mesa	
SOIL TYPE/ROCK TYPE:	ironstone of skeletal red loam	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	2	
% SHRUB <2 M COVER:	10	
% GRASS COVER:	35	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration tracks disturbance	
FIRE HISTORY:	Patchy. From less than 1, 3 to 5 years	
SPECIES	% cover	Height (m)
Acacia adoxa var. *adoxa*	1	0.4
Acacia hilliana	6	0.5
Acacia inaequilatera	1	4
Acacia monticola	1	1.2
Adriana tomentosa	0.1	0.3
Aristida holathera	0.1	0.2
Cleome viscosa	0.1	0.6
Clerodendrum floribunda subsp. *angustifolia*	0.1	1.3
Corchorus lasiocarpus	0.1	0.2
Corymbia hamersleyana	0.5	6
Cymbopogon ambiguus	0.1	0.3
Eriachne aristidea	0.1	0.15
Eriachne pulchella subsp. *dominii*	0.1	0.05
Eucalyptus leucophloia	0.5	7

Fimbristylis dichotoma	0.1	0.3
Fimbristylis simulans	0.1	0.1
Hakea lorea	0.1	2.5
Paraneurachne muelleri	0.1	0.4
Ptilotus astrolasius	2	0.3
Ptilotus auriculifolius	0.1	0.4
Ptilotus calostachyus	0.1	0.9
Senna artemisioides subsp. *oligophylla*	0.1	0.6
Senna notabilis	1	0.4
Tribulus hirsutus	0.1	0.05
Triodia epactia	35	0.3
Triodia wiseana	0.1	0.3
Yakirra australiensis	0.1	0.1

Described by: Grant Wells	Site: Q7b	Date: 1/04/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710147 mE	7488839 mN	

DESCRIPTION:	Isolated low *Corymbia hamersleyana* trees over a tall *Acacia tumida* and *Petalostylis labicheoides* shrubland over isolated low *Senna artemisioides* subsp. *Oligophylla*, *Androcalva luteiflora*, *Ptilotus astrolasius* and *Bonamia erecta* shrubs over a low *Triodia epactia* hummock grassland.	
TOPOGRAPHY:	small defined creek channel riparian vegetation	
SOIL TYPE/ROCK TYPE:	ironstone over red loam and colluvium	
% TOTAL VEGETATION COVER:	60	
% TREE SHRUB >2 M COVER:	20	
% SHRUB <2 M COVER:	5	
% GRASS COVER:	40	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:	none	
FIRE HISTORY:	5 years	
SPECIES	% cover	Height (m)
Acacia adoxa var. *adoxa*	0.1	0.6
Acacia monticola	0.1	1.6
Acacia tenuissima	0.1	0.5
Acacia tumida	15	2.8
Androcalva luteiflora	0.1	1.2
Bonamia erecta	2	0.5
Corymbia hamersleyana	0.1	4
Cymbopogon ambiguus	0.1	0.4
Enneapogon polyphyllus	0.1	0.2
Eriachne mucronata	1	0.4
Eriachne pulchella subsp. *dominii*	0.1	0.05
Gossypium australis	0.1	0.6
Gossypium robinsonii	0.1	2.3
Grevillea wickhamii subsp. *hispidula*	0.1	3

Hibiscus sturtii	0.1	0.3
Hybanthus aurantiacus	0.1	0.6
Jasminum didymum	0.1	1.5
Keraudrenia velutina subsp. *elliptica*	0.1	0.6
Mollugo molluginea	0.1	0.3
Paraneurachne muelleri	0.1	0.4
Petalostylis labicheoides	5	3.2
Ptilotus astrolasius	0.1	0.5
Rhynchosia minima	0.1	0.3
Senna artemisioides subsp. *oligophylla*	1	1
Senna glutinosa subsp. *glutinosa*	0.1	1.3
Senna pleurocarpa	0.1	0.5
Tephrosia sp. Fortescue	1	1.2
Themeda triandra	5	0.5
Triodia epactia	35	0.5

Described by: Grant Wells	Site: Q10	Date: 30/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710813.04 mE	7488827.02 mN	

DESCRIPTION:	Isolated mid *Eucalyptus leucophloia* trees over tall *Acacia tumida* heath over open *Eriachne mucronata*, *Themeda triandra* and *Triodia epactia* grassland	
TOPOGRAPHY:	top of hillslope of mesa	
SOIL TYPE/ROCK TYPE:	ferrous sparse soil, shallow skeletal. Some scree, many boulders	
% TOTAL VEGETATION COVER:	70	
% TREE SHRUB >2 M COVER:	65	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	5	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:		
FIRE HISTORY:	5 to 10 years	
SPECIES	% cover	Height (m)
Acacia pruinocarpa	0.1	1
Acacia tumida	65	4
Adriana tomentosa	0.1	0.6
Duperreya commixta	0.1	2
Eriachne mucronata	2	0.4
Eucalyptus leucophloia	1	11
Gossypium robinsonii	0.1	1
Jasminum didymum	0.1	1
Santalum lanceolatum	0.1	1.2
Themeda triandra	2	0.4
Triodia epactia	1	0.7


30 MAR 2014

Described by: Grant Wells	Site: Q11	Date: 01/04/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710785.26 mE	7489144.54 mN	

DESCRIPTION:	Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over isolated tall *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over low open *Acacia pruinocarpa* and *Acacia arida* shrubland over a low *Triodia wiseana* hummock grassland.	
TOPOGRAPHY:	mesa top	
SOIL TYPE/ROCK TYPE:	red loam	
% TOTAL VEGETATION COVER:	40	
% TREE SHRUB >2 M COVER:	2	
% SHRUB <2 M COVER:	7	
% GRASS COVER:	35	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	some exploration tracks and drill pads	
FIRE HISTORY:	3 to 5 years	
SPECIES	% cover	Height (m)
Acacia arida	5	1.1
Acacia pruinocarpa	1	1.4
Acacia tumida	0.1	1.5
Aristida contorta	0.1	0.2
Aristida inaequiglumis	0.1	0.3
Corchorus lasiocarpus	0.1	0.7
Corymbia hamersleyana	0.1	8
Enneapogon polyphyllus	0.1	0.15
Eremophila latrobei subsp. *filifolia*	0.1	1
Eriachne pulchella subsp. *dominii*	0.1	0.05
Eucalyptus leucophloia	0.1	8
Goodenia microptera	0.1	0.1
Goodenia stobbsiana	0.1	0.3
Goodenia triodiophila	0.1	0.3
Grevillea wickhamii subsp. *hispidula*	1	4.5

Ptilotus calostachyus	0.1	0.7
Scaevola browniana	0.1	0.35
Senna glutinosa subsp. *glutinosa*	0.1	2.5
Solanum centrale	0.1	0.4
Solanum phlomoides	0.1	0.5
Triodia epactia	5	0.5
Triodia wiseana	30	0.4

Described by: Grant Wells	Site: Q12	Date: 01/04/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	711329 mE	7489651.19 mN	

DESCRIPTION:	A mid *Eucalyptus camaldulensis* woodland over a tall *Myoporum montanum* shrubland over tall *Typha domingensis* sedges over mid *Cyperus vaginatus* sedges and mixed low grasses.	
TOPOGRAPHY:	large creek system in gorge	
SOIL TYPE/ROCK TYPE:	colluvium mud	
% TOTAL VEGETATION COVER:	95	
% TREE SHRUB >2 M COVER:	40	
% SHRUB <2 M COVER:	10	
% GRASS COVER:	90	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	weeds present	
FIRE HISTORY:	10 years	
SPECIES	% cover	Height (m)
Acacia ampliceps	2	3
Acacia bivenosa	3	3
Acacia maitlandii	0.1	1.1
Acacia pyrifolia	0.1	1
Acacia tumida	1	3.5
Atalaya hemiglauca	0.1	3
Cymbopogon ambiguus	0.1	0.5
Cyperus vaginatus	25	1
Dodonaea lanceolata	0.1	6
Eremophila longifolia	0.1	0.5
Eriachne mucronata	0.1	0.3
Eucalyptus camaldulensis	25	20
Eulalia aurea	60	0.5
Euphorbia coghlanii	0.1	0.3
Gossypium robinsonii	0.1	3
*Malvastrum americanum**	0.1	0.3

Myoporum montanum	20	6
Paspalidium rarum	0.1	0.3
Phyllanthus maderaspatensis	0.1	0.4
Senna glutinosa subsp. *glutinosa*	0.1	1
Themeda triandra	0.1	0.6
Triodia epactia	0.1	0.3
Typha domingensis	10	3

Described by: Grant Wells	Site: Q13	Date: 28/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710731.04 mE	7489430.9 mN	

DESCRIPTION:	Isolated low *Goodenia stobbsiana* shrubs over a low *Triodia wiseana* tussock grass land over isolated *Fimbristylis simulans* herbs.	
TOPOGRAPHY:	flat top of mesa	
SOIL TYPE/ROCK TYPE:	ferrous rocks, skeletal soil	
% TOTAL VEGETATION COVER:	30	
% TREE SHRUB >2 M COVER:	0	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	30	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration gridline	
FIRE HISTORY:	2 years	
SPECIES	% cover	Height (m)
Amphipogon sericeus	0.1	0.2
Fimbristylis simulans	0.1	0.1
Goodenia stobbsiana	0.1	0.25
Goodenia triodiophila	0.1	0.1
Hakea chordophylla	0.1	0.5
Ptilotus calostachyus	0.1	0.5
Solanum centrale	0.1	0.15
Triodia wiseana	30	0.3


28 MAR 2014

Described by: Grant Wells	Site: Q14	Date: 28/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710609.07 mE	7490050.93 mN	

DESCRIPTION:	Isolated mid *Eucalyptus camaldulensis* and *Eucalyptus leucophloia* trees over tall *Acacia tumida, Grevillea wickhamii* subsp. *hispidula* shrubland over mid mixed shrubland over a low closed *Themeda triandra* tussock grassland over isolated herbs.	
TOPOGRAPHY:	creek bed, in a gorge	
SOIL TYPE/ROCK TYPE:	alluvium, ferrous sandy soil	
% TOTAL VEGETATION COVER:	90	
% TREE SHRUB >2 M COVER:	1	
% SHRUB <2 M COVER:	50	
% GRASS COVER:	45	
% HERB COVER:	1	
CONDITION:	very good	
DISTURBANCE DETAILS:	some weeds	
FIRE HISTORY:	10 years	
SPECIES	% cover	Height (m)
Acacia maitlandii	0.1	1.2
Acacia pyrifolia	0.1	2.5
Acacia tumida	20	4.5
Alternanthera nana	0.1	0.4
Alternanthera nodiflora	0.1	0.3
Amaranthus cuspidifolius	0.1	0.4
Androcalva luteiflora	0.1	1.5
*Bidens bipinnata**	0.1	0.2
Cheilanthes sieberi subsp. *sieberi*	0.1	0.1
Clerodendrum floribundum var. *angustifolium*	0.1	0.5
Corymbia hamersleyana	0.1	3
Cymbopogon ambiguus	0.1	0.6
Duperreya commixta	0.1	1.5
Enneapogon lindleyanus	0.1	0.4
Eragrostis cumingii	0.1	0.2

Eragrostis exigua	0.1	0.2
Eremophila jucunda	0.1	0.5
Eriachne mucronata	0.1	0.4
Eucalyptus camaldulensis	1	12
Eucalyptus leucophloia	0.1	3
Eulalia aurea	0.1	0.5
Evolvulus alsinoides var. *villosicalyx*	0.1	0.1
Ficus platypoda	Outside of quadrat	
Gomphrena cunninghamii	0.1	0.1
Gossypium robinsonii	1	2
Grevillea pyramidalis	0.1	1.5
Grevillea wickhamii subsp. *hispidula*	20	4.5
Hybanthus aurantiacus	0.1	0.5
Ipomoea muelleri	0.1	0.1
Jasminum didymum	0.1	0.3
Petalostylis labicheoides	5	3.5
Pluchea dentex	0.1	0.2
Polycarpaea longiflora	0.1	0.3
Senna glutinosa subsp. *glutinosa*	0.1	1
Sida echinocarpa	0.1	0.2
Themeda triandra	10	0.6
Triodia epactia	5	0.5
Triodia epactia	30	0.5
Waltheria indica	0.1	1


28 MAR 2014
31N E:166021.4
N: 0.0

Described by: Grant Wells	Site: Q16	Date: 29/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	711631.99 mE	7490199.05 mN	

DESCRIPTION:	A mid *Corymbia asper*a and *Eucalyptus* ? *aridimontana* open woodland over a tall *Acacia tumida* shrubland over isolated low *Adriana tomentosa* shrubs over *Themeda triandra* and *Triodia epactia* grassland.	
TOPOGRAPHY:	bottom and sides of gully/gorge	
SOIL TYPE/ROCK TYPE:	boulders and rocks, ferrous and a little quartz	
% TOTAL VEGETATION COVER:	70	
% TREE SHRUB >2 M COVER:	30	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	40	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:	none	
FIRE HISTORY:	10 years	
SPECIES	% cover	Height (m)
Acacia pruinocarpa	0.1	0.5
Acacia tumida	20	5
Adriana tomentosa	0.1	0.7
Capparis spinosa	0.1	0.3
Corymbia aspera	5	15
Cymbopogon ambiguus	0.1	0.6
Duperreya commixta	0.1	4
Eriachne mucronata	2	0.4
Eucalyptus aridimontana	5	10
Eucalyptus leucophloia	1	8
Grevillea wickhamii subsp. *hispidula*	0.1	2
Petalostylis labicheoides	1	3.5
Sauropus sp. Koodaideri detritals **P1**	0.1	1.5
Senna glutinosa subsp. *glutinosa*	0.1	1.3
Sida cardiophylla	0.1	0.3
Sida sp. Barlee Range (S. van Leeuwen	Outside of quadrat	

1642) **P3**		
Themeda triandra	15	0.4
Triodia epactia	20	0.6

Described by: Grant Wells	Site: Q17	Date: 30/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	712316.22 mE	7490596.17 mN	

DESCRIPTION:	Isolated low *Corymbia deserticola* trees over isolated tall *Acacia tumida* shrubs over isolated mid *Grevillea wickhamii* subsp. *hispidula* shrubs over isolated low *Goodenia stobbsiana* shrubs in low *Triodia wiseana* grassland.	
TOPOGRAPHY:	plain	
SOIL TYPE/ROCK TYPE:	ferrous aeolian loamy soil	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	0.1	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	50	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration tracks and drill pads	
FIRE HISTORY:	<5 years	
SPECIES	% cover	Height (m)
Acacia ancistrocarpa	0.1	0.6
Acacia tumida	0.1	2.5
Amphipogon sericeus	0.1	0.2
Aristida holathera	0.1	0.2
Corymbia deserticola	0.1	5
Goodenia stobbsiana	0.1	0.5
Goodenia triodiophila	0.1	0.25
Grevillea wickhamii subsp. *hispidula*	0.1	4
Hakea lorea	0.1	1.3
Heliotropium pachyphyllum	0.1	0.2
Indigofera monophylla	0.1	0.3
Ptilotus astrolasius	0.1	0.3
Ptilotus calostachyus	0.1	0.9
Sida arenicola	0.1	1.1
Triodia wiseana	50	0.4


30 MAR 2014

Described by: Grant Wells	Site: Q17a	Date: 31/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	704651.45 mE	7497834.41 mN	

DESCRIPTION:	Isolated low *Corymbia hamersleyana* and *Corymbia deserticola* trees over a low *Eucalyptus gamophylla* open mallee woodland over a tall *Acacia elachantha* and *Acacia adsurgens* open shrubland over open low *Acacia tenuissima*, *Bonamia erecta* and *Sida cardiophylla* shrubland over a *Chrysopogon fallax*, *Themeda triandra* and *Triodia epactia* low grassland over isolated herbs.	
TOPOGRAPHY:	plain	
SOIL TYPE/ROCK TYPE:	alluvial and aeolian sandy loam	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	15	
% SHRUB <2 M COVER:	5	
% GRASS COVER:	35	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration tracks and exotic animal disturbance (horses)	
FIRE HISTORY:	4-5 years	
SPECIES	% cover	Height (m)
Abutilon otocarpum	0.1	0.5
Acacia adoxa var. *adoxa*	0.1	0.7
Acacia adsurgens	1	1.8
Acacia elachantha	10	2.5
Acacia pteraneura	0.1	3
Acacia tenuissima	0.1	1
Aristida contorta	0.1	0.2
Atalaya hemiglauca	0.1	2.5
Chrysopogon fallax	1	1
Corymbia deserticola	1	4
Corymbia hamersleyana	0.1	4.5
Duperreya commixta	0.1	1.5
Eremophila longifolia	0.1	1.8

Eucalyptus gamophylla	5	2.5
Eulalia aurea	2	0.6
Euphorbia coghlanii	0.1	0.1
Gompholobium oreophilum	0.1	0.5
Goodenia microptera	0.1	0.1
Goodenia stellata	0.1	0.05
Hibiscus burtonii	0.1	0.8
Hibiscus sturtii var. *campylochlamys*	0.1	0.6
Hybanthus aurantiacus	0.1	0.5
Indigofera georgei	0.1	0.3
Jasminum didymum	0.1	1
Keraudrenia velutina subsp. *elliptica*	2	0.6
Paraneurachne muelleri	0.1	0.2
Polycarpaea corymbosa	0.1	0.2
Psydrax suaveolens	0.1	0.8
Rhyncharrhena linearis	0.1	1
Scaevola parvifolia	0.1	0.3
Senna notabilis	0.1	0.1
Senna pleurocarpa	0.1	0.5
Sida cardiophylla	1	0.6
Sida fibulifera	0.1	0.1
Sporobolus australasicus	0.1	0.1
Themeda triandra	10	0.6
Triodia epactia	20	0.6


31 MAR 2014

Described by: Grant Wells	Site: Q18	Date: 30/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	711962.02 mE	7491234.02 mN	

DESCRIPTION:	Isolated *Corymbia deserticola* low trees over isolated tall *Hakea lorea* and *Grevillea wickhamii* subsp. *hispidula* shrubs over isolated low *Acacia ancistrocarpa* and *Bonamia erecta* shrubs over low *Triodia wiseana* hummock grassland.	
TOPOGRAPHY:	plain	
SOIL TYPE/ROCK TYPE:	ferrous, gravelly loam	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	0.1	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	50	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration tracks drill pads and sumps	
FIRE HISTORY:	5 years	
SPECIES	% cover	Height (m)
Acacia ancistrocarpa	0.1	0.9
Acacia tenuissima	0.1	0.9
Amphipogon sericeus	0.1	0.2
Bonamia erecta	0.1	0.5
Codonocarpus cotinifolius	0.1	0.7
Corymbia deserticola	0.1	4
Goodenia triodiophila	0.1	0.3
Grevillea wickhamii subsp. *hispidula*	0.1	3
Hakea lorea	0.1	4
Indigofera monophylla	0.1	0.3
Panicum effusum	0.1	0.4
Paraneurachne muelleri	0.1	0.4
Ptilotus calostachyus	0.1	0.4
Triodia wiseana	50	0.4


30 MAR 2014
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N:7491216.0

Described by: Grant Wells	Site: Q19	Date: 1/04/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	711401.01 mE	7491912.6 mN	

DESCRIPTION:	A low open *Corymbia aspera* and *Corymbia hamersleyana* woodland over tall *Acacia tumida* shrubland over a low *Androcalva luteiflora* shrubland over *Themeda triandra* grassland.	
TOPOGRAPHY:	creek bed in gorge	
SOIL TYPE/ROCK TYPE:	alluvium	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	15	
% SHRUB <2 M COVER:	5	
% GRASS COVER:	30	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:		
FIRE HISTORY:	3 to 5 years	
SPECIES	% cover	Height (m)
Abutilon cryptopetalum	0.1	1
Abutilon otocarpum	0.1	0.3
Acacia pruinocarpa	0.1	2
Acacia tumida	10	4
Adriana tomentosa	0.1	0.4
Androcalva luteiflora	4	1.5
Atalaya hemiglauca	0.1	0.5
Cleome viscosa	0.1	0.4
Corchorus lasiocarpus	0.1	0.2
Corymbia aspera	2	10
Corymbia hamersleyana	3	7
Cucumis maderaspatensis	0.1	0.1
Cymbopogon ambiguus	0.1	0.4
Duperreya commixta	0.1	0.3
Enneapogon lindleyanus	0.1	0.3
Eremophila jucunda	0.1	0.4

Eriachne mucronata	0.1	0.3
Eucalyptus leucophloia	1	8
Euphorbia coghlanii	0.1	0.2
Gompholobium oreophilum	0.1	1
Gossypium robinsonii	0.1	1
Grevillea pyramidalis	0.1	0.4
Grevillea wickhamii subsp. *hispidula*	0.1	1.8
Hibiscus sturtii	0.1	0.4
Jasminum didymum	0.1	1
Paraneurachne muelleri	0.1	0.2
Petalostylis labicheoides	0.1	1.6
Ptilotus astrolasius	0.1	0.5
Senna glutinosa subsp. *glutinosa*	0.1	1
Senna notabilis	0.1	0.3
Sida sp. Articulation below	0.1	1
Themeda triandra	30	0.6
Trichodesma zeylanicum	0.1	1
Triodia epactia	0.1	0.4
Triumfetta leptacantha	0.1	0.4
Yakirra australiensis	0.1	0.3


1 APR 2014

Described by: Grant Wells	Site: Q20	Date: 29/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	711332.02 mE	7490819.97 mN	

DESCRIPTION:	Open low *Corymbia hamersleyana* woodland over a tall *Acacia tumida*, *Petalostylis labicheoides*, *Grevillea wickhamii* subsp. *hispidula* closed shrubland over a low *Triodia epactia*, *Triodia wiseana* and *Themeda triandra* tussock grassland over isolated herbs.	
TOPOGRAPHY:	riparian small creek	
SOIL TYPE/ROCK TYPE:	ferrous alluvium	
% TOTAL VEGETATION COVER:	90	
% TREE SHRUB >2 M COVER:	50	
% SHRUB <2 M COVER:	35	
% GRASS COVER:	30	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration drill track	
FIRE HISTORY:	5 years	
SPECIES	% cover	Height (m)
Acacia adoxa var. *adoxa*	0.1	0.2
Acacia ancistrocarpa	0.1	1
Acacia hilliana	0.1	0.4
Acacia tenuissima	0.1	1
Acacia tumida	40	2.5
Amphipogon sericeus	0.1	0.3
Androcalva luteiflora	5	1.5
Aristida holathera	0.1	0.6
Bonamia erecta	0.1	0.7
Corymbia hamersleyana	10	10
Dicrastylis cordifolia	0.1	0.6
Dodonaea lanceolata	1	1.5
Duperreya commixta	0.1	1.5
Eriachne mucronata	0.1	0.4
Eucalyptus gamophylla	0.1	2

Eucalyptus leucophloia	0.1	2
Gompholobium oreophilum	1	0.5
Grevillea wickhamii subsp. *hispidula*	5	4
Hakea chordophylla	0.1	0.9
Indigofera monophylla	0.1	0.2
Keraudrenia velutina subsp. *elliptica*	0.1	0.5
Paraneurachne muelleri	0.1	0.3
Petalostylis labicheoides	20	4
Ptilotus calostachyus	0.1	0.8
Santalum lanceolatum	0.1	1.5
Scaevola parvifolia	0.1	0.4
Sida arenicola	0.1	0.7
Sida cardiophylla	0.1	0.6
Themeda triandra	10	2.7
Triodia epactia	5	0.5
Triodia wiseana	10	0.5

Described by: Grant Wells	Site: Q21	Date: 30/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710354.02 mE	7491696.01 mN	

DESCRIPTION:	Isolated low *Corymbia hamersleyana* and *Hakea lorea* trees over a mid *Acacia tumida* shrubland over a low open *Acacia arida, Gompholobium oreophilum* and *Maytenus* sp. Mt. Windell low shrubland over a *Triodia wiseana* hummock grassland.	
TOPOGRAPHY:	drainage line	
SOIL TYPE/ROCK TYPE:	fine - coarse gravel, sandy loam, ferrous	
% TOTAL VEGETATION COVER:	60	
% TREE SHRUB >2 M COVER:	0.1	
% SHRUB <2 M COVER:	40	
% GRASS COVER:	40	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:		
FIRE HISTORY:	2-3 years	
SPECIES	% cover	Height (m)
Acacia adoxa var. *adoxa*	1	0.3
Acacia arida	2	0.3
Acacia tumida	30	2
Amphipogon sericeus	0.1	0.3
Aristida holathera	0.1	0.15
Bonamia erecta	0.1	0.5
Clerodendrum floribundum var. *angustifolia*	0.1	1.3
Corymbia hamersleyana	0.1	4.2
Gompholobium oreophilum	2	0.5
Grevillea wickhamii subsp. *hispidula*	0.1	2.5
Hakea lorea	0.1	2.5
Indigofera monophylla	0.1	0.3
Keraudrenia velutina subsp. *elliptica*	0.1	0.5
Maytenus sp. Mt. Windell	1	0.7
Santalum lanceolatum	0.1	1.1

Sida arenicola	0.1	0.8
Triodia wiseana	40	0.4

Described by: Grant Wells	Site: Q22	Date: 29/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710343.02 mE	7490637.01 mN	

DESCRIPTION:	Isolated low *Eucalyptus leucophloia* trees over isolated mid *Petalostylis labicheoides* shrubs over isolated low *Acacia adoxa* var. *adoxa* shrubs over a low *Triodia wiseana* and *Triodia epactia* hummock grassland over isolated herbs.	
TOPOGRAPHY:	drainage line, lower slopes of low hills	
SOIL TYPE/ROCK TYPE:	ferrous alluvium	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	1	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	50	
% HERB COVER:	0.1	
CONDITION:	very good, disturbance from track	
DISTURBANCE DETAILS:	exploration drill tracks	
FIRE HISTORY:	2-5 years	
SPECIES	% cover	Height (m)
Acacia adoxa var. *adoxa*	0.1	0.5
Acacia arida	0.1	1
Acacia bivenosa	0.1	1.1
Acacia maitlandii	0.1	1.1
Acacia tumida	0.1	2
Amphipogon sericeus	0.1	0.3
Cassytha racemosa	0.1	0.2
Dampiera candicans	0.1	0.6
Eriachne mucronata	0.1	0.4
Eucalyptus leucophloia	0.1	7
Gompholobium oreophilum	0.1	0.5
Goodenia stobbsiana	0.1	0.2
Goodenia triodiophila	0.1	0.3
Grevillea wickhamii subsp. *hispidula*	0.1	3
Hakea chordophylla	0.1	1.8

Mollugo molluginea	0.1	0.2
Paraneurachne muelleri	0.1	0.2
Petalostylis labicheoides	0.5	3
Ptilotus calostachyus	0.1	0.6
Senna artemisioides subsp. *oligophylla*	0.1	0.6
Senna ferraria	0.1	1
Senna glutinosa subsp. *glutinosa*	0.1	0.6
Senna hamersleyensis	0.1	0.8
Tephrosia supina	0.1	0.3
Triodia epactia	30	0.5
Triodia wiseana	20	0.3

Described by: Grant Wells	Site: Q23	Date: 31/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	704923 mE	7496818 mN	

DESCRIPTION:	Isolated low *Eucalyptus leucophloia* and *Corymbia deserticola* trees over isolated low *Eucalyptus gamophylla* mallee over mid open *Acacia elachantha* shrubland over low *Acacia ancistrocarpa* shrubland over a low *Triodia wiseana* hummock grassland over isolated herbs.	
TOPOGRAPHY:	plain	
SOIL TYPE/ROCK TYPE:	ferrous sandy loam with coarse gravel on the surface	
% TOTAL VEGETATION COVER:	50	
% TREE SHRUB >2 M COVER:	2	
% SHRUB <2 M COVER:	10	
% GRASS COVER:	45	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration track	
FIRE HISTORY:	3-5 years	
SPECIES	% cover	Height (m)
Acacia adsurgens	0.1	1.2
Acacia ancistrocarpa	5	1.2
Acacia elachantha	0.1	2.5
Acacia tenuissima	0.1	1
Aristida contorta	0.1	0.2
Bonamia erecta	2	0.6
Cassytha racemosa	0.1	0.2
Corchorus sidoides subsp. *sidoides*	0.1	0.3
Corymbia deserticola	0.1	8
Cymbopogon ambiguus	0.1	0.6
Dicrastylis cordifolia	0.1	0.5
Duperreya commixta	0.1	1
Eragrostis setifolia	0.1	0.3
Eremophila longifolia	0.1	1.2
Eucalyptus gamophylla	0.1	3.5

Eucalyptus leucophloia	0.1	8
Gompholobium oreophilum	0.1	0.7
Goodenia microptera	0.1	0.3
Hakea lorea	0.1	2.5
Indigofera monophylla	0.1	0.4
Paraneurachne muelleri	0.1	0.3
Ptilotus calostachyus	0.1	0.6
Santalum lanceolatum	0.1	0.9
Scaevola parvifolia	0.1	0.2
Senna artemisioides subsp. *oligophylla*	0.1	0.5
Senna glutinosa subsp. *glutinosa*	0.1	0.7
Sida arenicola	0.1	0.5
Sida cardiophylla	0.1	0.5
Triodia epactia	0.1	0.6
Triodia wiseana	45	0.3

Described by: Grant Wells	Site: Q24	Date: 31/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	704367.4 mE	7499134.55 mN	

DESCRIPTION:	Isolated *Eucalyptus camaldulensis* and *Corymbia aspera* trees over isolated low *Flueggea virosa* and *Cleome viscosa* shrubs over a low *Themeda triandra* and *Eriachne mucronata* grassland.	
TOPOGRAPHY:	gorge floor	
SOIL TYPE/ROCK TYPE:	ironstone red colluvium	
% TOTAL VEGETATION COVER:	60	
% TREE SHRUB >2 M COVER:	0.1	
% SHRUB <2 M COVER:	0.1	
% GRASS COVER:	60	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:		
FIRE HISTORY:	<1	
SPECIES	% cover	Height (m)
*Alternanthera pungens**	0.1	0.4
Amaranthus cuspidifolius	0.1	0.7
Amaranthus undulatus	0.1	0.4
Cleome viscosa	1	0.7
Corymbia aspera	0.1	7
Crotalaria novae-hollandiae subsp. *novae-hollandiae*	0.1	0.5
Cucumis maderaspatensis	0.1	4
Cymbopogon ambiguus	0.1	0.6
Cynanchum floribundum	0.1	2
Eriachne mucronata	20	0.3
Eucalyptus camaldulensis	0.1	8
Eulalia aurea	0.1	0.4
Euphorbia coghlanii	0.1	0.2
Flueggea virosa	0.1	1.5
Gomphrena cunninghamii	0.1	0.15

Grevillea pyramidalis	0.1	1
Polycarpaea holtzei	0.1	0.1
Senna venusta	0.1	0.4
Tephrosia sp. Fortescue	0.1	0.5
Themeda triandra	40	0.5
Trachymene oleracea	0.1	0.3
Trichodesma zeylanicum	0.1	0.4
Yakirra australiensis	0.1	0.3

Described by: Grant Wells	Site: Q26	Date: 31/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	704831 mE	7500950 mN	

DESCRIPTION:	Isolated mid *Eucalyptus camaldulensis*, *Corymbia aspera* and *Brachychiton acuminatus* trees over isolated low *Corymbia hamersleyana* and *Atalaya hemiglauca* trees over isolated tall *Acacia tumida* shrubs over isolated low *Cleome viscosa*, *Senna venusta* and *Trichodesma zeylanicum* shrubs over open low *Themeda triandra* and *Eulalia aurea* tussock grassland over isolated herbs.	
TOPOGRAPHY:	Creek bed in a gorge	
SOIL TYPE/ROCK TYPE:	mixed alluvial boulders-cobles/pebbles, BIF, calcrete, chert, quartz	
% TOTAL VEGETATION COVER:	20	
% TREE SHRUB >2 M COVER:	1	
% SHRUB <2 M COVER:	2	
% GRASS COVER:	20	
% HERB COVER:	0.1	
CONDITION:	very good	
DISTURBANCE DETAILS:	exploration track	
FIRE HISTORY:	1-2 years	
SPECIES	% cover	Height (m)
Acacia pyrifolia	0.1	0.2
Acacia tumida	0.1	4
Adriana tomentosa	0.1	1.5
*Alternanthera pungens**	0.1	0.1
Amaranthus undulatus	0.1	1
Amaranthus cuspidifolius	0.1	0.8
Androcalva luteiflora	0.1	5.5
Atalaya hemiglauca	0.1	2.5
*Bidens bipinnata**	0.1	0.4
Boerhavia coccinea	0.1	0.3
Brachychiton acuminatus	0.1	10
Bulbostylis turbinata	0.1	0.1
*Cenchrus ciliaris**	0.1	1

Cleome viscosa	2	0.7
Corymbia aspera	0.1	10
Corymbia hamersleyana	0.1	7
Crotalaria medicaginea	0.1	0.4
Cucumis maderaspatensis	0.1	0.05
Cymbopogon ambiguus	0.1	0.4
Duperreya commixta	0.1	0.4
Dysphania kalpari	0.1	0.05
Enneapogon lindleyanus	0.1	0.4
Eragrostis exigua	0.1	0.2
Eriachne mucronata	1	0.3
Eucalyptus camaldulensis	0.1	15
Eulalia aurea	5	0.6
Euphorbia boophthona	0.1	0.1
Euphorbia coghlanii	0.1	0.2
Euphorbia tannensis	0.1	0.2
Evolvulus alsinoides var. *villosicalyx*	0.1	0.3
Gomphrena cunninghamii	0.1	0.3
Gossypium robinsonii	0.1	0.5
Ipomoea calobra	0.1	0.1
Nicotiana occidentalis	0.1	0.3
Notoleptopus decaisnei	0.1	0.3
Paspalidium rarum	0.1	0.3
Phyllanthus erwinii	0.1	0.2
Phyllanthus maderaspatensis	0.1	0.5
Polycarpaea longiflora	0.1	0.2
Polymeria ambigua	0.1	0.2
Rhynchosia minima	0.1	0.1
Senna glutinosa subsp. *glutinosa*	0.1	0.7
Senna venusta	0.1	0.5
Setaria dielsii	0.1	0.6
Stemodia grossa	0.1	0.1
Tephrosia sp. Fortescue	0.1	0.4
Themeda triandra	10	0.5

Trachymene oleracea	0.1	0.2
Trianthema pilosa	0.1	0.05
Tribulopis angustifolia	0.1	0.1
Tribulus hirsutus	0.1	0.05
Yakirra australiensis	0.1	0.15

Described by: Grant Wells	Site: Q31	Date: 01/04/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	710835.17 mE	7491924.42 mN	

DESCRIPTION:	Isolated low *Eucalyptus leucophloia* and *Corymbia hamersleyana* trees over a low *Acacia arida* shrubland over a *Triodia wiseana* and *Triodia epactia* grassland.	
TOPOGRAPHY:	top of mesa	
SOIL TYPE/ROCK TYPE:	ferric pebbles red loam	
% TOTAL VEGETATION COVER:	60	
% TREE SHRUB >2 M COVER:	2	
% SHRUB <2 M COVER:	25	
% GRASS COVER:	40	
% HERB COVER:	0.1	
CONDITION:	excellent	
DISTURBANCE DETAILS:		
FIRE HISTORY:	5 to 10 years	
SPECIES	% cover	Height (m)
Acacia adoxa var. *adoxa*	0.1	0.4
Acacia ancistrocarpa	0.1	1
Acacia arida	20	1.2
Acacia maitlandii	0.1	1.8
Acacia pruinocarpa	0.1	0.4
Acacia tumida	1	3
Amphipogon sericeus	0.1	0.3
Aristida holathera	0.1	0.3
Corchorus lasiocarpus	0.1	0.6
Corymbia hamersleyana	0.1	5.3
Eucalyptus leucophloia	1	8
Gompholobium oreophilum	0.1	0.5
Goodenia stobbsiana	0.1	0.3
Goodenia triodiophila	0.1	0.3
Grevillea wickhamii subsp. *hispidula*	0.1	4
Hakea lorea	0.1	3.5
Jasminum didymum	0.1	1.5

Ptilotus calostachyus	0.1	0.6
Scaevola browniana	0.1	0.35
Sida arenicola	0.1	0.6
Tephrosia supina	0.1	0.4
Triodia epactia	5	0.4
Triodia wiseana	35	0.6

Described by: Grant Wells	Site: Q34	Date: 31/03/2014	Type: Quadrat	50 m x 50 m
Location: Extension Project	MGA Zone: 50	704349.29 mE	7499449.69 mN	

DESCRIPTION:	Isolated low *Eucalyptus leucophloia* and *Corymbia opaca* trees over isolated mid *Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* shrubs over isolated *Corchorus incanus* low shrubs in a low *Triodia epactia* grassland over isolated *Ptilotus fusiformis* and *Oldenlandia crouchiana* herbs	
TOPOGRAPHY:	Mesa crest	
SOIL TYPE/ROCK TYPE:	Skeletal red loam over ironstone	
% TOTAL VEGETATION COVER:	25	
% TREE SHRUB >2 M COVER:	4	
% SHRUB <2 M COVER:	1	
% GRASS COVER:	20	
% HERB COVER:	0.1	
CONDITION:	Very good	
DISTURBANCE DETAILS:	Drill pad, exploration tracks	
FIRE HISTORY:	2-5	
SPECIES	% cover	Height (m)
Aristida contorta	0.1	0.1
Cleome viscosa	0.1	0.3
Corchorus incanus	0.1	0.5
Corymbia opaca	1	4.5
Dampiera candicans	0.1	0.4
Eriachne pulchella	0.1	0.05
Eucalyptus leucophloia	3	6.5
Gossypium robinsonii	0.1	1.8
Grevillea wickhamii subsp. *hispidula*	0.1	2
Hakea lorea	0.1	2.8
Hibiscus sturtii var. *campylochlamys*	0.1	0.3
Oldenlandia crouchiana	0.1	0.1
Schizachyrium fragile	0.1	0.25
Ptilotus fusiformis	0.1	0.4
Senna glutinosa subsp. *glutinosa*	0.1	0.5

Tribulus hirsutus	0.1	0.05
Trichodesma zeylanicum	0.1	0.1
Triodia epactia	20	0.3

Described by: Grant Wells	Site: R9	Date: 1/04/2014	Type: Relevé
Location: Extension Project	MGA Zone: 50	710513.98 mE	7488887.98 mN

DESCRIPTION:	Isolated *Eucalyptus leucophloia* low trees over *Triodia* sp., *Themeda triandra* and *Eriachne mucronata* grasses.
DOMINANT SPECIES:	
Eucalyptus leucophloia	
Triodia sp.	
Eriachne mucronata	
Themeda triandra	
Grevillea wickhamii subsp. *hispidula*	

Described by: Grant Wells	Site: R25	Date: 31/03/2014	Type: Relevé
Location: Extension Project	MGA Zone: 50	704432.91 mE	7500151.91 mN
DESCRIPTION:		Isolated mid *Eucalyptus camaldulensis*, *Corymbia aspera* and *Brachychiton acuminatus* trees over isolated low *Corymbia hamersleyana* and *Atalaya hemiglauca* trees over isolated tall *Acacia tumida* shrubs over isolated low *Cleome viscosa*, *Senna venusta* and *Trichodesma zeylanicum* shrubs over open low *Themeda triandra* and *Eulalia aurea* tussock grassland over isolated herbs.	
SPECIES: Same as Q26 +			
Crotalaria novae-hollandiae subsp. *novae-hollandiae*			
Ammannia multiflora			
Cyperus vaginatus			
Flueggea virosa subsp. *melanthesoides*			
Bulbostylis barbata			

Described by: Grant Wells	Site: R28	Date: 30/03/2014	Type: Relevé
Location: Extension Project	MGA Zone: 50	712858.06 mE	7490458.81 mN
DESCRIPTION:		*Eucalyptus leucophloia*, *Corymbia hamersleyana* over *Acacia tumida*, *Petalostylis labicheoides*, *Grevillea wickhamii* subsp. *hispidula* over *Triodia epactia* and *Themeda triandra*.	
TOPOGRAPHY:		Creek line	

Appendix 2 Vegetation structural classes (NVIS 2003)

Height Classes

Height	Growth form					
Height class	Height range (m)	Tree, vine (M & U), palm (single-stemmed)	Shrub, heath shrub, chenopod shrub, ferns, Samphire shrub, cycad, tree-fern, Grass-tree, palm (multi-stemmed)	Tree mallee, Mallee Shrub	Tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)	Bryophyte, lichen, seagrass, aquatic
8	>30	tall	NA	NA	NA	NA
7	10-30	mid	NA	tall	NA	NA
6	<10	low	NA	mid	NA	NA
5	<3	NA	NA	low	NA	NA
4	>2	NA	tall	NA	tall	NA
3	1-2	NA	mid	NA	tall	NA
2	0.5-1	NA	low	NA	mid	tall
1	<0.5	NA	low	NA	low	low

Structural Formation Classes

Growth form	Height ranges (m)	Structural formation classes					
Foliage cover % (cover #)		70-100% (5)	30-70% (4)	10-30% (3)	<10% (2)	0-5% (1)	≈0% (N)
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs
mallee	<3, <10,	closed	mallee	open	sparse	isolated	isolated

shrub	10-30	mallee shrubland	shrubland	mallee shrubland	mallee shrubland	mallee shrubs	clumps of mallee shrubs
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns
bryophyte	<0.5	closed bryophytela nd	bryophyte land	open bryophytel and	sparse bryophytel and	isolated bryophytes	isolated clumps of bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of

							lichens
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines
aquatic	0-0.5,<1	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics
seagrass	0-0.5,<1	closed seagrass bed	seagrass bed	open seagrass bed	sparse seagrass bed	isolated seagrasses	isolated clumps of seagrasses

Appendix 3 Combined Study Area flora species inventory

Family	Species
AIZOACEAE	*Trianthema pilosa*
AMARANTHACEAE	*Alternanthera nana*
	Alternanthera nodiflora
	*Alternanthera pungens**
	Amaranthus cuspidifolius
	Amaranthus undulatus
	Gomphrena cunninghamii
	Ptilotus astrolasius
	Ptilotus auriculifolius
	Ptilotus calostachyus
	Ptilotus fusiformis
APOCYNACEAE	*Cynanchum floribundum*
	Rhyncharrhena linearis
ARALIACEAE	*Trachymene oleracea*
ASTERACEAE	*Bidens bipinnata**
	*Lactuca saligna**
	Pluchea dentex
BORAGINACEAE	*Heliotropium cunninghamii*
	Heliotropium pachyphyllum
	Trichodesma zeylanicum
CAPPARACEAE	*Capparis spinosa*
CARYOPHYLLACEAE	*Polycarpaea corymbosa*
	Polycarpaea holtzei
	Polycarpaea longiflora
CELASTRACEAE	*Maytenus* sp. Mt Windell (S. van Leeuwen 846)
CHENOPODIACEAE	*Dysphania kalpari*
	Salsola australis
CLEOMACEAE	*Cleome viscosa*
CONVOLVULACEAE	*Bonamia erecta*

	Bonamia media
	Duperreya commixta
	Evolvulus alsinoides var. *villosicalyx Ooststr.*
	Ipomoea calobra
	Ipomoea muelleri
	Polymeria ambigua
CUCURBITACEAE	*Cucumis maderaspatanus*
CYPERACEAE	*Bulbostylis barbata*
	Bulbostylis turbinata
	Cyperus ixiocarpus
	Cyperus squarrosus
	Cyperus vaginatus
	Fimbristylis dichotoma
	Fimbristylis simulans
EUPHORBIACEAE	*Adriana tomentosa* var. *hookeri* (F. Muell.) C.L. Gross & M.A.Whalen
	Euphorbia australis
	Euphorbia boophthona
	Euphorbia coghlanii
	Euphorbia tannensis
FABACEAE	*Acacia adoxa Pedley* var. *adoxa*
	Acacia adsurgens
	Acacia ampliceps
	Acacia ancistrocarpa
	Acacia arida
	Acacia bivenosa
	Acacia dictyophleba
	Acacia elachantha
	Acacia hilliana
	Acacia inaequilatera
	Acacia maitlandii
	Acacia monticola

	Acacia pruinocarpa
	Acacia pteraneura
	Acacia pyrifolia
	Acacia tenuissima
	Acacia tumida
	Crotalaria medicaginea var. *neglecta* (Wight & Arn.) Baker
	Crotalaria novae-hollandiae DC. subsp. *novae-hollandiae*
	Gompholobium oreophilum
	Indigofera georgei
	Indigofera monophylla
	Indigofera rugosa
	Petalostylis labicheoides
	Rhynchosia minima
	Senna artemisioides subsp. *oligophylla* (F. Muell.) Randell
	Senna ferraria
	Senna glutinosa
	Senna glutinosa (DC.) Randell subsp. *glutinosa*
	Senna glutinosa subsp. *pruinosa* (F. Muell.) Randell
	Senna hamersleyensis
	Senna notabilis
	Senna pleurocarpa
	Senna venusta
	Tephrosia sp. Fortescue (A.A. Mitchell 606)
	Tephrosia supina
GOODENIACEAE	*Dampiera candicans*
	Goodenia microptera
	Goodenia stellata
	Goodenia stobbsiana
	Goodenia triodiophila
	Scaevola browniana
	Scaevola parvifolia

GYROSTEMONACEAE	*Codonocarpus cotinifolius*
LAMIACEAE	*Clerodendrum floribundum* R. Br. var. *angustifolium*
	Dicrastylis cordifolia
LAURACEAE	*Cassytha racemosa*
LORANTHACEAE	*Diplatia grandibractea*
LYTHRACEAE	*Ammannia multiflora*
MALVACEAE	*Abutilon cryptopetalum*
	Abutilon otocarpum
	Androcalva luteiflora
	Brachychiton acuminatus
	Corchorus lasiocarpus
	Corchorus sidoides
	Corchorus sidoides F. Muell. subsp. *sidoides*
	Corchorus tridens
	Gossypium australe
	Gossypium robinsonii
	Hibiscus brachychlaenus
	Hibiscus burtonii
	Hibiscus coatesii
	Hibiscus sturtii
	Hibiscus sturtii var. *campylochlamys* Benth.
	Keraudrenia velutina subsp. *elliptica* C. F. Wilkins ms
	*Malvastrum americanum**
	Sida arenicola
	Sida cardiophylla
	Sida echinocarpa
	Sida fibulifera
	Sida sp. Articulation below (A.A. Mitchell PRP 1605)
	Sida sp. Barlee Range (S. van Leeuwen 1642) **P3**
	Triumfetta leptacantha
	Waltheria indica

MOLLUGINACEAE	*Mollugo molluginea*
MORACEAE	*Ficus platypoda*
MYRTACEAE	*Corymbia aspera*
	Corymbia deserticola
	Corymbia hamersleyana
	Eucalyptus ? aridimontana
	Eucalyptus camaldulensis
	Eucalyptus gamophylla
	Eucalyptus leucophloia
	Melaleuca lasiandra
NYCTAGINACEAE	*Boerhavia coccinea*
OLEACEAE	*Jasminum didymum*
PHYLLANTHACEAE	*Flueggea virosa*
	Notoleptopus decaisnei
	Phyllanthus erwinii
	Phyllanthus maderaspatensis
	Sauropus sp. Koodaideri detritals (J. Naaykens & J. Hurter JH 11213) **P1**
	Stemodia grossa
POACEAE	*Amphipogon sericeus*
	Aristida contorta
	Aristida holathera
	Aristida inaequiglumis
	*Cenchrus ciliaris**
	Chrysopogon fallax
	Cymbopogon ambiguus
	Enneapogon lindleyanus
	Enneapogon polyphyllus
	Eragrostis cumingii
	Eragrostis exigua
	Eragrostis setifolia
	Eriachne aristidea

	Eriachne lanata
	Eriachne mucronata
	Eriachne pulchella subsp*. dominii* (Hartley) *Lazarides*
	Eulalia aurea
	Panicum effusum
	Paraneurachne muelleri
	Paspalidium constrictum
	Paspalidium rarum
	Schizachyrium fragile
	Setaria dielsii
	Sporobolus australasicus
	Themeda triandra
	Triodia brizoides
	Triodia epactia
	Triodia wiseana
	Yakirra australiensis
PROTEACEAE	*Grevillea pyramidalis*
	Grevillea wickhamii subsp*. hispidula* Makinson
	Hakea chordophylla
	Hakea lorea
PTERIDACEAE	*Cheilanthes sieberi Kunze* subsp*. sieberi*
RUBIACEAE	*Oldenlandia crouchiana*
	Psydrax suaveolens
SANTALACEAE	*Santalum lanceolatum*
SAPINDACEAE	*Atalaya hemiglauca*
	Dodonaea coriacea
	Dodonaea lanceolata
SCROPHULARIACEAE	*Eremophila jucunda*
	Eremophila latrobei subsp*. filifolia* Chinnock
	Eremophila longifolia
	Myoporum montanum

SOLANACEAE	*Nicotiana occidentalis*
	Solanum ashbyae
	Solanum centrale
	Solanum lasiophyllum
	Solanum phlomoides
TYPHACEAE	*Typha domingensis*
VIOLACEAE	*Hybanthus aurantiacus*
ZYGOPHYLLACEAE	*Tribulopis angustifolia*
	Tribulus hirsutus

Appendix 4 Priority flora locations at quadrat and relevés, including, opportunistic collections

Species	Conservation status	No. plants or % foliar cover	Easting	Northing	Notes
Sauropus sp. Koodaideri detritals (J. Naaykens & J. Hurter JH 11213)	P1	1 plant	711632	7490199	Plant sterile
Sida sp. Barlee Range (S. van Leeuwen 1642)	P3	1 plant	711268.8	7488281	Plant flowering
Sida sp. Barlee Range (S. van Leeuwen 1642)	P3	7 plants	711635.8	7490177	All plants flowering

Appendix 5 Vegetation hierarchy (NVIS 2003)

Hierarchical level	Description	National Vegetation Information System structural/floristic components required
I	Class	Dominant growth form of the ecologically dominant stratum.
II	Structural formation	Dominant growth form, cover and height of the ecologically dominant stratum
III	Broad floristic formation	Dominant growth form, cover and height of the ecologically dominant stratum
IV	Sub- formation	Dominant growth form, cover, height and broad floristic code usually dominant genus and family of the three traditional strata (i.e. upper, mid and ground)
V	Association	Dominant growth form, height, cover and species (three species) of the three traditional strata (i.e. upper, mid and ground).
VI	Sub- association	Dominant growth form, height, cover and species (five species) of all layers/strata.

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ENVIRONMENTAL SCIENCES

Troglofauna survey for the Extension Project

Prepared for

Australian Aboriginal Mining Corporation Pty Ltd

October 2014

Final Report

Troglofauna survey for the Extension Project

Prepared for Australian Aboriginal Mining Corporation Pty Ltd

Final Report

Author: E.S. Volschenk

Reviewer: V.W. Framenau, K. Crews

Date: 16 October 2014

Submitted to: Phil Scott (Preston Consulting on behalf of Australian Aboriginal Mining Corporation)

Chain of authorship and review			
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E.S. Volschenk	Draft for technical review	1.1	10 July 2014
V.W. Framenau	Technical review	1.2	11 July 2014
K. Crews	Draft for client comments	1.3	16 July 2014
K. Crews	Final draft to client	1.4	22 July 2014
E.S. Volschenk	Final for editorial review	1.5	20 August 2014
V.W. Framenau	Interim for client comments	1.6	29 August 2014
V.W. Framenau	Final submitted to client	1.7	16 October 2014

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Contents

List of Figures

List of Tables

List of Appendices

EXECUTIVE SUMMARY

Australian Aboriginal Mining Corporation Pty Ltd (AAMC) is seeking to develop the Extension Project (the Project), an iron ore mine located approximately 130 km north-west of Newman, Western Australia.

In March 2014, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by AAMC to undertake a troglofauna survey for the Project. The survey followed a desktop review undertaken in March 2014 which identified the presence of troglofauna, a single record of an unidentified (juvenile) schizomid, within the Mine Study Area (MSA). The MSA encompasses three iron ore deposits (North deposit, West deposit and East deposit) and associated mine infrastructure totalling an area of 778 ha.

The objective of the survey was to define the troglofauna values of the MSA. The scope of works entailed a troglofauna survey, data analyses, species identification, mapping and preparation of a technical report.

The survey adhered to EPA Environmental Assessment Guideline 12 (*Environmental assessment Guideline for the assessment of subterranean fauna in environmental impact assessment in Western Australia*) and EPA Guidance Statement No. 54a (*Sampling methods and survey considerations for subterranean fauna in Western Australia (Technical appendix to Guidance Statement No. 54).*

The field survey was undertaken from 27 March to 5 April 2014 and solely utilised the bore scraping sampling technique. Thirty-one geological survey bores were surveyed, spanning all three deposits. Five survey bores in the East deposit were much degraded and none deeper than 3 m. They yielded no troglofauna and must therefore be excluded from the survey analysis, leaving 26 valid survey sites: 16 in the North deposit and 10 in the West deposit.

Ten species of troglofauna were identified and, where necessary, their identity was verified using DNA barcoding methods:

- two species were only recorded from the West deposit:
    - Atelurinae 'marillana' , a type of silverfish, a likely SRE
    - *Draculoides* 'SCH30', a schizomid, a potential SRE
- six species were only recorded from the North deposit:
    - *Enchytraeus* 'marillana', a segmented worm, a potential SRE
    - Isotomidae 'marillana', a collembolan , a potential SRE
    - *Prethopalpus* 'marillana', a goblin spider, a likely SRE
    - Palpigradi sp. indet., a palpigrade, a likely SRE
    - Stenoniscidae 'marillana', a slater, a likely SRE
    - *Trinemura* 'marillana', a silverfish, a likely SRE
- two species were recoded from both North and West deposits:
    - *Cyphoderus* 'marillana', a springtail, a potential SRE
    - *Nocticola* 'pilbara1', a cockroach, a widespread species.

Only three of these species were recorded from more than three sample bores facilitating an interpretation of their distribution pattern: *Enchytraeus* 'marillana' (eight bores), *Cyphoderus* 'marillana' (six bores) and *Nocticola* 'pilbara1' (four bores). All of the remaining species were only recorded from one or two bores. Both *Cyphoderus* 'marillana' and *Nocticola* 'pilbara1' have been recorded elsewhere in the Hamersley Range of the Pilbara.

The presence of two species in both North and West deposits, and for *Nocticola* ‘pilbara1’ high genetic similarity between those deposits, suggests habitat connectivity through the underlying Weeli Wolli formation, as banded iron formations are likely to support troglofauna. The species collected from the greatest number of sites was *Enchytraeus* 'marillana', but since this species was only recorded from the North deposit, connectivity between the North and West deposits may not being utilised by some species.

The absence of troglofauna records from the East deposit may be due to the shallow nature and dry condition of the bores and therefore the bore results cannot be considered representative of the East deposit. The Weeli Wolli formation that connects the North and West deposits also connects these deposits to the East deposit and therefore may serve as connecting habitat more broadly.

Surface geology data indicate that the North deposit encompasses the southern limits of a much larger hematite-goethite formation which extends north-east of the MSA. Similarly, the West deposit encompasses part of the northern limits of larger Robe Pisolite formation which extends south of the MSA. It is therefore likely, independent of connectivity between the deposits, that the fauna recorded within the North and West deposits also occur within the broader north-eastern and southern extents respectively which are not impacted by the mining proposal.

The troglofauna composition of the MSA reflects results of more comprehensive surveys in the vicinity of the MSA, although a comparison is difficult due to a much smaller survey area and survey effort. Wider contemporary or historically recent connectivity of the troglofauna of the Project’s MSA with that of neighbouring projects is suggested by the presence of the *Draculoides* ‘SCH030’-complex. This complex is known from both the BHP BIO’ s Yandi (Marillana Creek) Mine just south of the Project’s MSA and RTIO’s Koodaideri Project approximately 15 km to the north of the MSA.

Examination of the drill cores from the MSA indicate that despite being attributed different names in the surface geology data, they are structurally very similar in terms of mesocavernous void availability for troglofauna and may therefore represent the same habitat type.

Species richness analyses indicated that the survey is likely to have recorded between 50% and 58% of the predicted species richness based on incidence-based estimators. While not achieving the minimum level recommended by the EPA for a Level 2 survey, the field survey did achieve better results than expected, given the relatively low levels of sampling undertaken.

1 INTRODUCTION

In March 2014, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Australian Aboriginal Mining Corporation Pty Ltd (AAMC) to undertake a troglofauna survey for the Extension Project (the Project) following on from a desktop review compiled for the Project (Phoenix 2014a). This report presents methods and findings of the troglofauna survey.

1.1 BACKGROUND

The Project is located in the Hamersley Ranges in the Central Pilbara region of Western Australia, approximately 130 km northwest of Newman. It includes four mining leases (M47/1353, M47/1354, M47/1355, and M47/1356) containing the Extension deposit (Figure 1-1). The resource comprises iron ore in the form of three superficial channel iron deposits (CID).

Two study areas have been designated (Figure 1-2):

- Mine Study Area (MSA; 778 ha), encompasses three proposed mining pits and supporting infrastructure
- Road Mine Study Area (RSA; 138 ha), encompasses approximately 15 km haul road (100 m survey corridor) to the north-west.

Only the MSA, containing the proposed pits, is relevant to this survey.

The desktop review conducted for the Project (Phoenix 2014a) identified the presence of troglofauna within the MSA as a single record of an unidentified (juvenile) schizomid.

Figure 1–1
Location of the Extension Project

Project location

Operating mines

Railways

Principal and secondary roads

Minor road

Major creeks and rivers

National Parks and Nature Reserves

0 10 20 40 Kilometres

1:1,500,000

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

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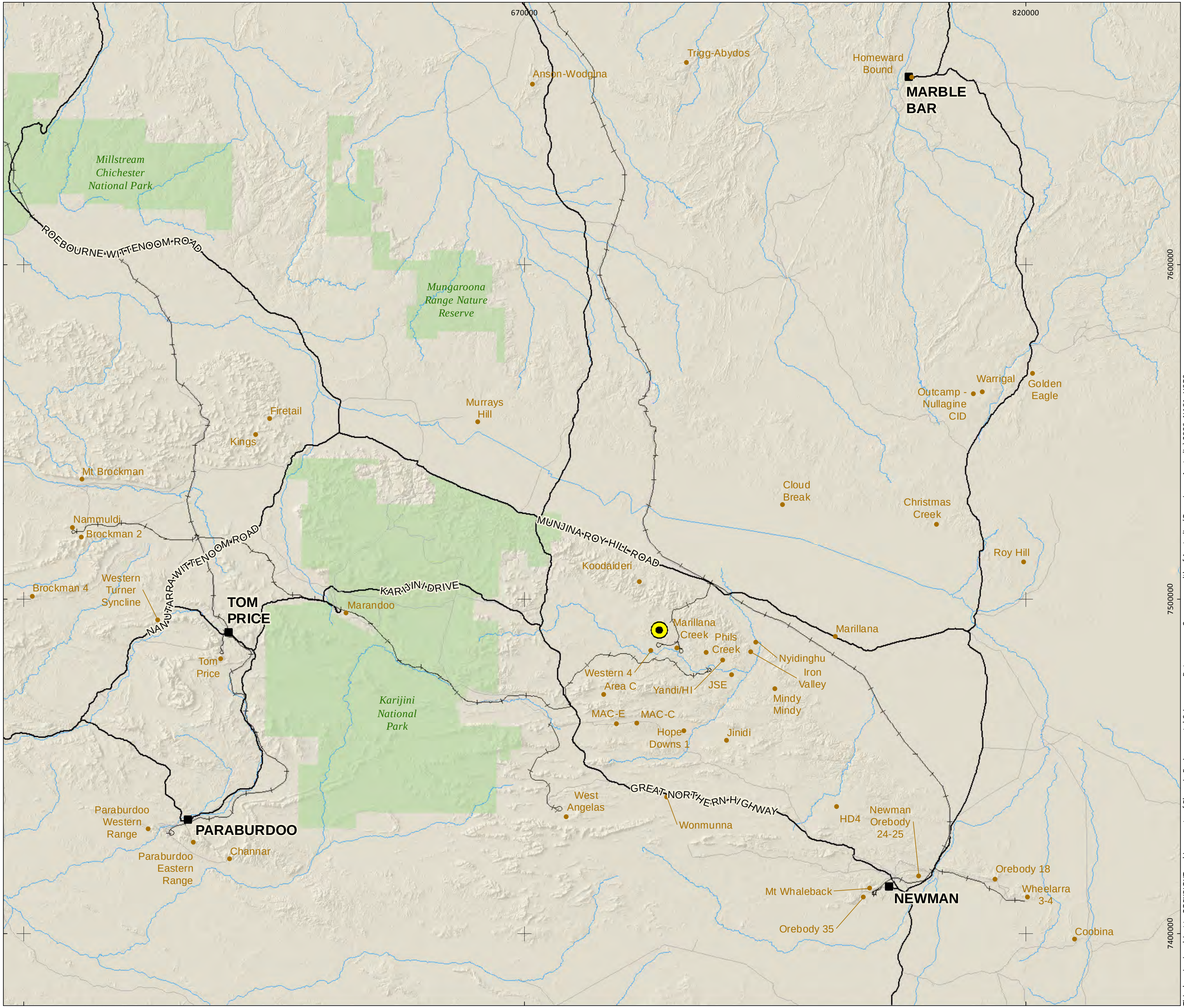

This drawing is subject to COPYRIGHT and is property of Phoenix Environmental Sciences — Data sources: Commonwealth of Australia (Geoscience Australia) 2006, NASA, USGS

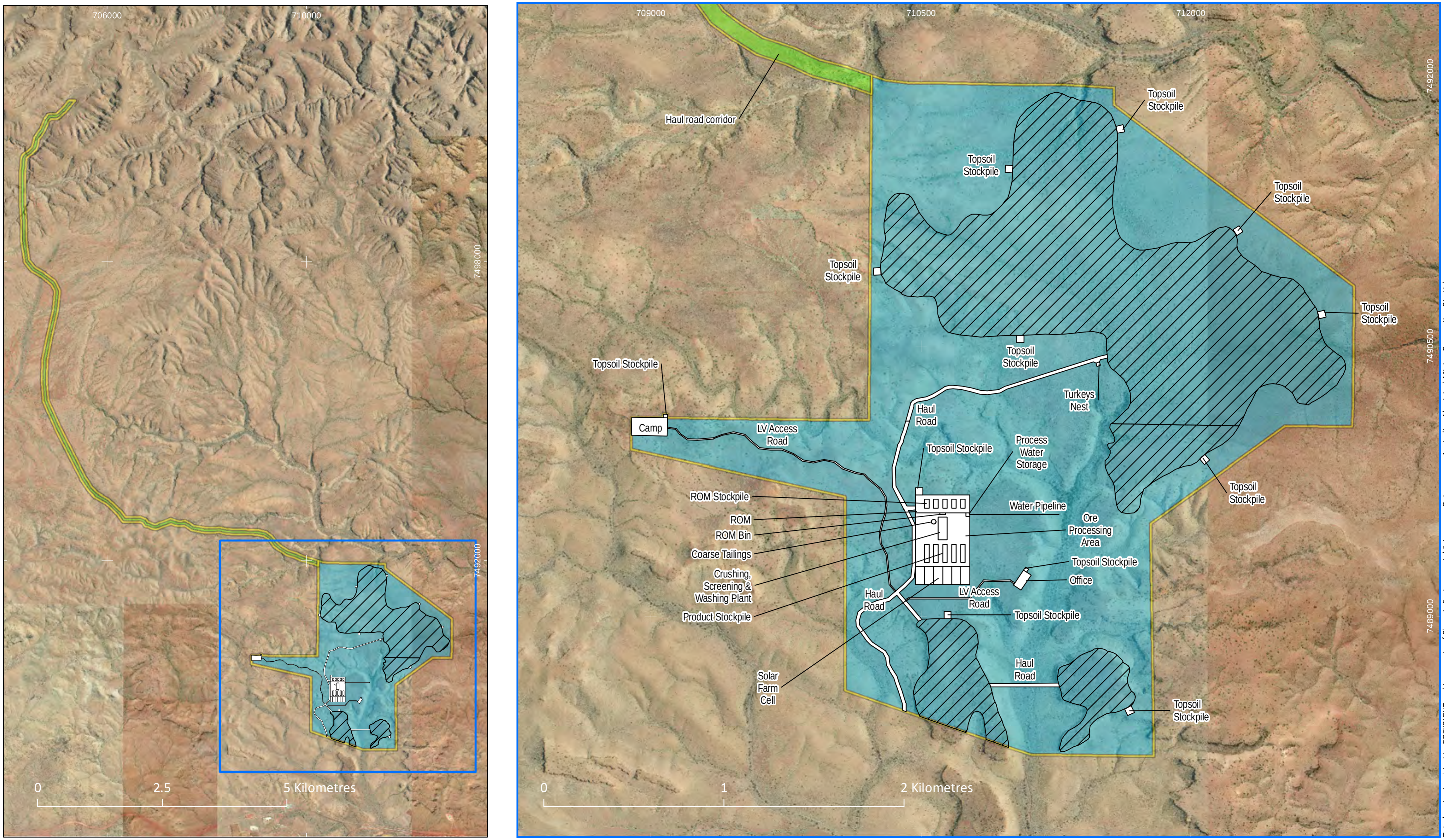

Figure 1–2

Extension Project conceptual mine layout (as at 19 February 2014) and Mine Study Area for the troglofauna survey

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Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 15/07/2014

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

Road Study Area
Mine Study Area
Conceptual mine layout (as at 19/02/2014)
Conceptual pits (as at 19/02/2014)

1.2 SCOPE OF WORK AND SURVEY OBJECTIVES

The objective of the survey was to define the fauna values of the MSA with regard to troglofauna to determine whether the Project will have significant impacts on troglofauna species, and/or their respective habitats.

The scope of works undertaken to achieve these objectives was as follows:

- conduct a troglofauna survey within the MSA
- undertake data analysis, sample processing and species identifications for samples collected during the field survey
- prepare maps showing significant species records and habitats within the MSA
- prepare a comprehensive troglofauna technical report with supporting raw and digital data
- provide recommendations for targeted species surveys if required.

The survey adhered to the following guidelines:

- EPA Guidance statement No. 54a: *Sampling methods and survey considerations for subterranean fauna in Western Australia (Technical appendix to Guidance Statement No. 54)* (EPA 2007)
- EPA Environmental Assessment Guideline 12: *Environmental assessment Guideline for the assessment of Subterranean fauna in environmental impact assessment in Western Australia* (EPA 2013).

2 LEGISLATIVE CONTEXT

The protection of fauna in Western Australia is principally governed by three acts:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Wildlife Conservation Act 1950* (WC Act)
- *Environmental Protection Act 1986* (EP Act).

2.1 COMMONWEALTH

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (NES), require approval from the Australian Government Minister for the Environment. The EPBC Act provides for the listing of threatened native fauna as matters of NES.

Conservation categories applicable to threatened fauna species under the EPBC Act are as follows:

- Extinct (EX)[1] – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent[1] – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.

Few subterranean taxa from WA are listed as matters of NES. One example is the Cape Range Remipede (*Kumonga exlayi*) (Vulnerable) (Department of the Environment 2014).

2.2 STATE

In Western Australia, the WC Act provides for the listing of native fauna (Threatened Fauna) species which are under identifiable threat of extinction. Threatened Fauna are assigned to one of four categories under the WC Act:

- Schedule 1 (S1) – fauna that is rare or is likely to become extinct
- Schedule 2 (S2) – fauna presumed to be extinct
- Schedule 3 (S3) – Migratory birds protected under an international agreement
- Schedule 4 (S4) – other specially protected fauna.

Assessments for listing of fauna are based on the International Union for Conservation of Nature (IUCN) threat categories.

The Department of Parks and Wildlife (DPaW) administers the WC Act and also maintains a non-statutory list of Priority fauna species which is updated annually with the current version issued 18 September 2013 (DPaW 2013). Priority species are still considered to be of conservation significance – that is they may be rare or threatened – but cannot be considered for listing under the WC Act until there is adequate understanding of their threat levels. Species on the Priority fauna lists are assigned to one of five priority (P) categories, P1 (highest) – P5 (lowest), based on level of knowledge/concern.

Any activities that are deemed to have a significant impact on listed fauna species can trigger referral to the EPA for assessment under the EP Act. Troglofauna species from the Pilbara that are currently listed (Western Australian Government 2013) include four short-tailed whipscorpions (Schizomida):

- *Paradraculoides anachoretus* (Mesa A Paradraculoides) – VU
- *Paradraculoides bythius* (Mesa B Paradraculoides) – VU
- *Paradraculoides gnophicola* (Mesa G Paradraculoides) – VU
- *Paradraculoides kryptus* (Mesa K Paradraculoides) – VU.

Under the EP Act, any proposal that may potentially have a significant impact on subterranean fauna may be subject to formal assessment. The EPA's objective for subterranean fauna is to maintain representation, diversity, viability and ecological function at the species, population and assemblage level (EPA 2013). In EIA, proponents must demonstrate that they will meet this objective.

3 EXISTING ENVIRONMENT

Subterranean fauna are organisms (almost exclusively invertebrates) that live beneath the surface of the ground. Surface-dwelling species are generally referred to as epigean (Howarth 1983; Humphreys 2000) and subterranean species are named to reflect their eco-physiological specialisation to subterranean habitat. Subterranean organisms can exist within a variety of subterranean void networks, including solution cavities within calcrete and karst; fractured rock and course sediments such as cobble or gravel strata (Howarth 1983; Humphreys 2008).

The energy and nutrient resources for subterranean habitats are almost exclusively sourced from allochthonous materials. Tree roots and water form the most important transport routes that move energy and nutrients into subterranean networks (Howarth 1983; Humphreys 2000; Poulson & Lavoie 2000).

3.1 GEOLOGY

To describe the geology of the MSA the following data sources where consulted:

- surface geology data provided by the Geological survey of Western Australia (GSWA 1996)
- geochemical and drill core data provided by the client.

3.1.1 Surface geology data

The MSA is comprised of five geology types (GSWA 1996) (Figure 3-1):

- Hematite-goethite (Czr) – hematite-goethite deposits on banded iron formation and adjacent scree deposits
- Robe Pisolite (Czp) – pisolitic limonite deposits developed along river channels
- Colluvium (Czc) – partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
- Weeli Wolli Formation (PLHj) – banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills
- Alluvium (Qa) – unconsolidated silt, sand and gravel in drainage channels and on adjacent floodplains.

All surface geology types present within the MSA are known to support troglofauna (EPA 2007, 2012, 2013).

Table 3-1 Surface geology represented within the Mine Study Area

Geology type	Name	Total area (ha)	Area within MSA (ha)	Percentage within MSA
Hematite-goethite	Czr1	687.5	28.3	4%
Hematite-goethite	Czr2	237.6	233.1	98%
Robe Pisolite	Czp1	561.1	84.6	15%
Robe Pisolite	Czp2	32.67	32.6	100%
Weeli Wolli Formation	NA	7261.9	230.8	3%
Colluvium	NA	12087.0	168.8	1%

Figure 3-1
Surface geology of the Mine Study Area

Mine Study Area

Conceptual mine pits (as of 19/02/2014)

Surface gelogy

- Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
- Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels
- Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
- PLHj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills.

0 200 400 800 Metres
1:20,500

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup and E. Volschenk
Date: 15/07/2014

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

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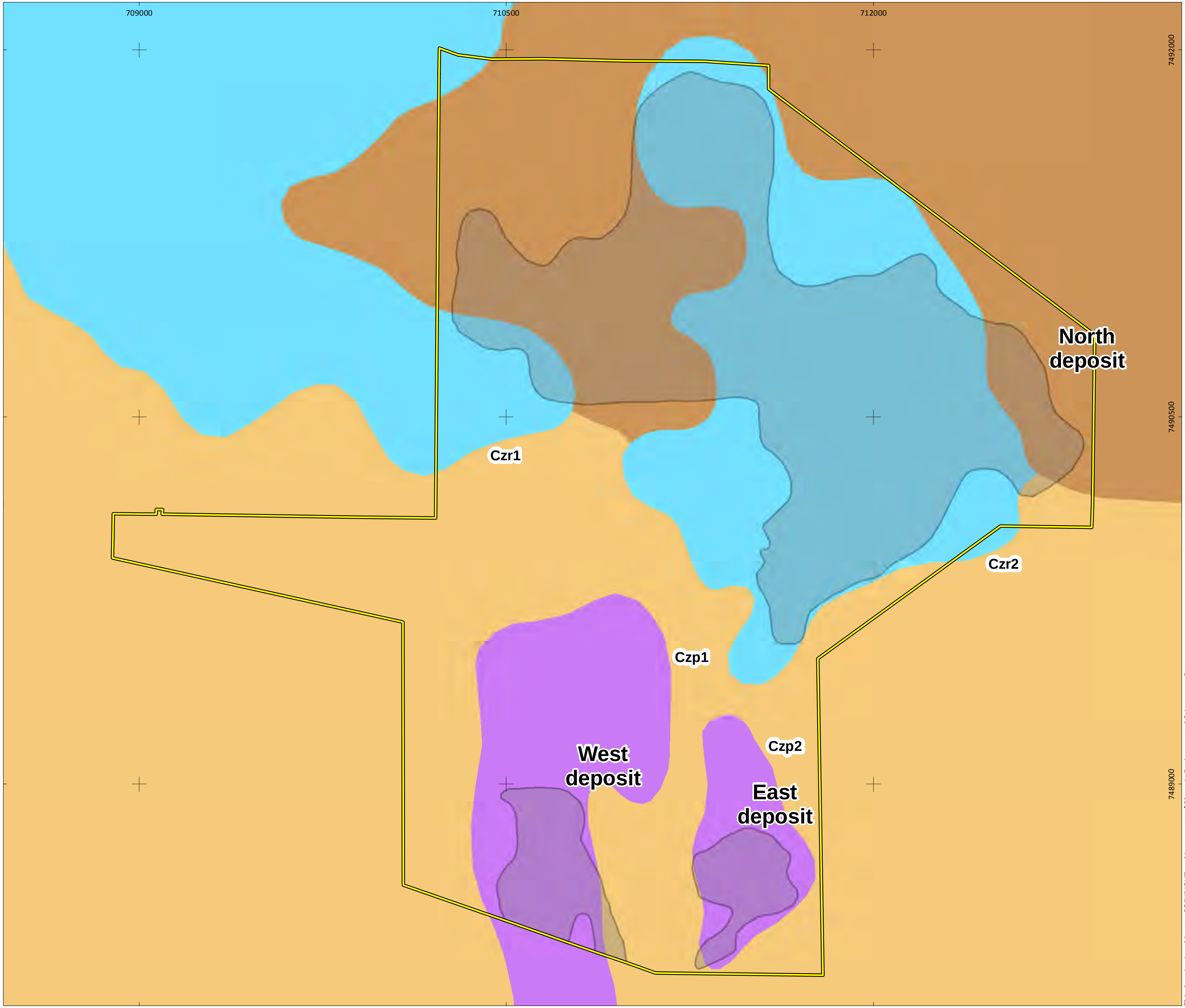

3.1.2 Drill core data

Examination of drill cores indicated that the extent and nature of the mesocavernous void network (vugginess) appears to be comparable within the west (Figure 3-2) and north (Figure 3-3) deposits.

Figure 3-2 Drill cores from bore DC072 in the West deposit of the Mine Study Area

Figure 3-3 **Drill cores from bore DC042 in the North deposit of the Mine Study Area**

3.2 CLIMATE AND WEATHER

The Pilbara has a semi-desert to tropical climate with highly variable, mostly summer rainfall (Leighton 2004; McKenzie *et al.* 2009). The average rainfall is about 290 mm, ranging from a monthly average of approximately 4 mm in September to 76 mm in February. Rainfall patterns are driven by highly variable year-to-year cyclonic activity that accounts for half of the yearly precipitation (McKenzie *et al.* 2009). Average annual (pan) evaporation in the Pilbara is approximately 3,400 mm per year (Department of Agriculture 2003), which greatly exceeds annual rainfall.

The nearest Bureau of Meteorology (BOM) weather station that records rainfall is located Marillana (Latitude: 22.63°S Longitude: 119.41°E) approximately 35 km east of the study area. Newman Airport (Latitude: 23.36°S Longitude: 119.73°E) approximately 130 km SE of the study area is the closest weather station that records temperature. Marillana has an average annual rainfall of 26.8 mm (Figure 3-4). Newman has a mean maximum temperature of 39.1°C in January and 23.0°C in July (Figure 3-5).

In the months preceding the field survey, rainfall at Marillana was considerably higher than the average for January 2014, but lower than the average in February and March 2014 (Figure 3-4). Temperatures at Newman Airport in March 2014 exceeded the average for the months (Figure 3-5).

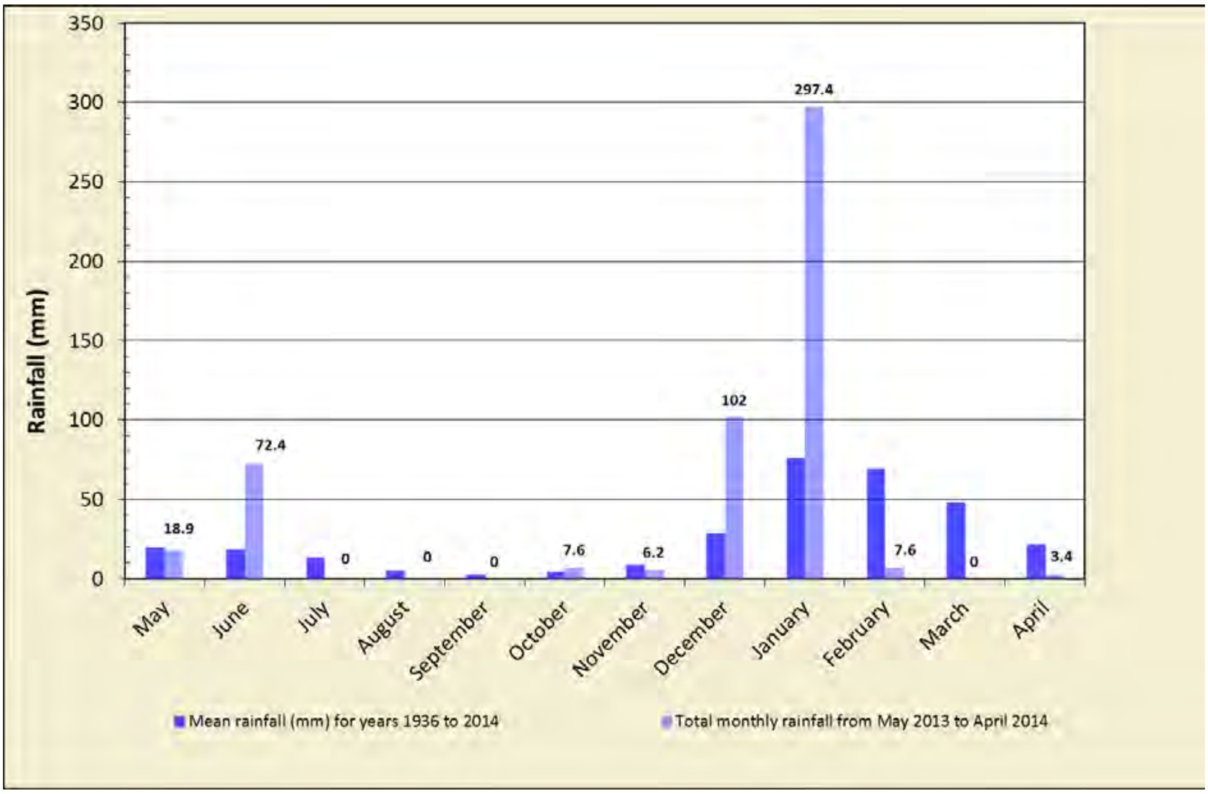

Figure 3-4 Rainfall data (monthly mean and year preceding survey) for Marillana (BOM 2014)

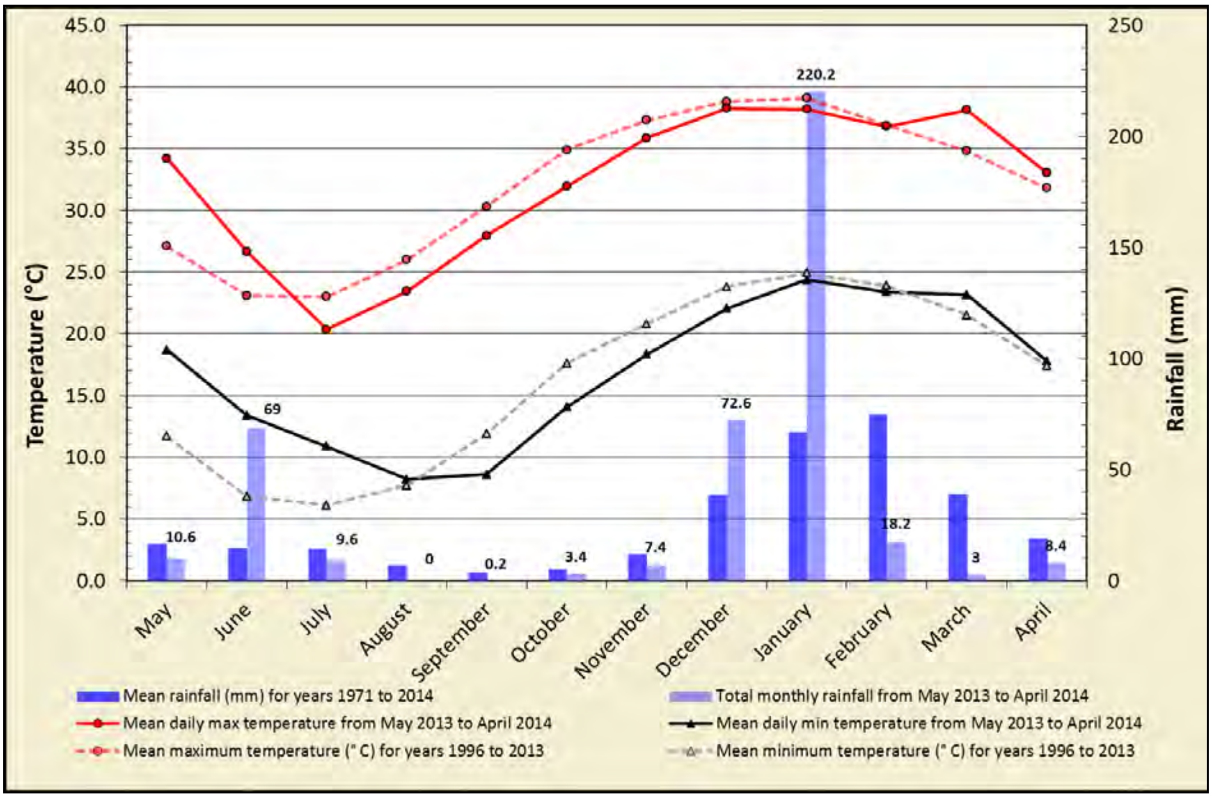

Figure 3-5 **Temperature and rainfall records (long term averages and year preceding survey) for Newman (BOM 2014)**

3.3 Biological Context

Subterranean fauna live within air- or water-filled underground networks. They are predominantly invertebrates. Organisms specialised for living in air-filled subterranean networks are referred to as troglofauna, while those inhabiting water-filled subterranean networks are referred to as stygofauna (Howarth 1983; Humphreys 2000).

Subterranean habitats are perpetually dark, are extremely constant in temperature and humidity (air-filled networks) and very low in nutrients and energy that are required to support organisms (Howarth 1993). Evolution under such conditions has resulted in highly specialised organisms that appear to be restricted to the void networks in which they are presumed to have evolved (Harvey 2002; Holsinger 2000; Howarth 1993; Ponder & Colgan 2002). Such species are obligated to living in subterranean networks and are usually incapable of living in epigean (surface) environments.

For this reason, organisms specialised to live in subterranean networks are likely to represent short-range endemics (SREs) with extremely limited capabilities of dispersal (Harvey 2002; Ponder & Colgan 2002; Volschenk & Prendini 2008). Short-range endemics are species with naturally small distributions; nominally defined by Harvey as less than 10,000 km^2. Species restricted to subterranean void systems may have considerably smaller distributions and therefore represent extreme SREs (Harvey 2002). It is these subterranean species that are considered to be of conservation significance because they are at greatest risk of extinction from development projects.

In Western Australia, and particularly in the Pilbara region, there has been a recent renaissance in the study of subterranean biodiversity (Humphreys 2008) driven by the growth of the mineral resources industry and mining environmental impact assessment (EPA 2003, 2007). Despite the extensive survey work undertaken in the Pilbara, relatively little knowledge on SRE diversity and biology has emerged from the primary literature. The biology, diversity and distributions of most of Western Australia's subterranean fauna are still poorly understood.

3.3.1 Troglofauna

Troglofauna represent fauna living within the air-filled subterranean networks. They are typically divided into three categories of specialisation to subterranean life:

- troglobites, that are restricted to subterranean habitats and usually perish on exposure to the surface environment (Barr 1968; Howarth 1983; Humphreys 2000)
- troglophiles, which facultatively use subterranean habitats but are not reliant on them for survival (Barr 1968; Howarth 1983; Humphreys 2000)
- trogloxenes, which use subterranean systems for specific purposes, such as roosts for reproduction (Bats and Swiftlets).

Current EPA guidance only applies to troglobites (EPA 2013).

3.3.2 Identifying troglofauna

The characterisation of subterranean fauna into troglobites or stygobites (obligate subterranean stygofauna) is largely based on an understanding of species habitat requirements. The recognition and identification of these species are usually limited to the presence of the following characteristics:

- lack or reduction of eyes
- lack or reduction of wings (for species that are normally winged)
- lack or reduction of body pigmentation
- heightened chemosensory and mechano-sensory systems
- loss of circadian rhythms
- very low metabolic rate.

Troglomorphies are used to infer a species that have become specialised to subterranean existence over many generations of confinement to subterranean habitats. These adaptations allow troglobites and stygobites to exploit the dark, humid, nutrient-poor subterranean void networks (Howarth 1983, 1993; Humphreys 2000; Poulson & Lavoie 2000). They also tend to result in very similar looking animals with convergent morphologies and in such cases; species delineation is often extremely difficult. In these instances, comparison of DNA sequences can be used to discriminate between different species.

3.3.3 Categories of short-range endemism

Short-range endemic fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km^2, that may also be disjunct and highly localised (Harvey 2002; Ponder & Colgan 2002). Species restricted to subterranean void systems may have considerably smaller distributions and therefore represent extreme SREs (Eberhard *et al.* 2009; Harvey 2002).

All subterranean short-range endemic species are thought be relictual (Harvey 2002). Relictual SREs are thought to have had wider distributions during more mesic geological periods. Australia's aridification over the last 60 million years resulted in a contraction of the ranges of these species into relatively small habitat pockets where moist conditions persist (relictual Gondwanan habitats). Evolutionary processes over long periods of isolation result in each population developing into a distinctive species. Relictual SREs often inhabit areas with high rainfall or humidity, a feature of most subterranean habitats. In Australia, troglobites and stygobites are, largely thought to be relictual SREs that became 'trapped' in mesic subterranean habitats following the aridification of the continent.

Currently, there is no accepted system to determine the likelihood that a species is an SRE. The WA Museum has recently introduced a three-tier ranking system (confirmed, potential and not SRE) (Western Australian Museum 2013). In contrast, Phoenix employs a system that differentiates an additional level of short-range endemism, 'likely' which, in comparison to the WA Museum, facilitates setting conservation or management priorities (Table 3-2). Any SRE categorisation of a taxon is based on the information available at the time. As new information emerges from additional surveys, the SRE status may change and therefore the SRE status is dynamic.

Life stages of species that cannot be identified at the species level, e.g. females and juveniles, can be assessed based on the knowledge of the higher taxon they belong to, i.e. family or genus. For example, all juvenile or female schizomids are classified as 'confirmed SRE' as all of the known Western Australian subterranean species in this order are currently considered SREs (Harvey *et al.* 2008).

Table 3-2 Phoenix SRE categories reflecting survey, taxonomic and identification uncertainties

SRE category	Criteria	Typical subterranean representative
Confirmed	Confirmed or almost certainly SRE; taxonomy of the group is well known (but not necessarily published); group well represented in collections, in particular from the region in question; high levels of endemism in documented species; inference is often possible from immature specimens	Troglofauna: Schizomida*;* troglobitic Pseudoscorpiones, Araneae and Isopoda
Likely	Taxonomically poorly resolved group; unusual morphology for the group (i.e. some form of troglomorphism); often singleton in survey and few, if any, regional records	Troglofauna: Symphyla, Palpigradi, Diplura, Chilopoda (Cryptopidae)
Potential	Taxonomically poorly resolved group; often common in certain microhabitats in SRE surveys (i.e. litter dwellers), but no other regional records; congeners often widespread	Troglofauna: Species within the genus *Nocticola* (Blattaria) and representatives of the families Meenoplidae and Cixiidae (Hemiptera) and representatives of the order Polyxenida (Diplopoda)
Widespread	Taxonomically well resolved (but often not published) and demonstrated wide distribution (i.e. > 10,000 km^2)	

3.3.4 Threatening processes

Impacts to subterranean fauna can be classed as either:

- **primary impacts** – impacts that physically destroy the subterranean void networks
- **secondary impacts** – impacts that change the subterranean habitat without physically destroying the void networks.

The principal threatening process from mining activities that impacts troglofauna is direct removal of habitat. Troglofauna require air-filled void networks and most of this habitat exists in the overburden, which is typically destroyed during pit construction/excavation. The EPA (2013) also recognises habitat compaction as a potential direct impact.

Secondary impacts are those that affect the physicochemical properties of subterranean habitats. The nature of these changes can be difficult to measure and there is limited empirical evidence to support or refute these putative impacts. There are four secondary impacts that may be relevant to the Project:

- Depletion of an aquifer leading to altered relative humidity – troglofauna are dependent on high relative humidity (Barr 1968; Humphreys 1991; Humphreys 2000). Dewatering may impact troglofauna habitat in unsaturated strata above the water table by lowering relative humidity.
- Alteration to nutrient balance – surface vegetation is the primary source of nutrients entering subterranean systems. Large-scale clearing of vegetation may result in the localised nutrient starvation of underlying subterranean habitat. Smothering of these nutrient sources on which subterranean systems depend, in the form of waste and overburden stockpiles and tailings ponds, may reduce inflow of nutrients to subterranean systems and lead to nutrient deficient habitats.
- Contamination – contamination of subterranean habitats from spills, such as diesel fuel, may degrade the quality of subterranean habitats. Such impacts would generally be highly localised and minor in scale.
- Siltation – siltation, as identified in EAG12 (EPA 2013) We interpret siltation to refer to the anthropogenic increase in silt (turbidity) of an aquifer. Activities that may lead to siltation impact include:
  - mining activities directly above the aquifer
  - through injection (i.e. reinjection) of silted water into the aquifer

  Changes in turbidity are likely to interfere with the feeding mechanisms of stygofauna within the aquifer; impacts are less clear for troglofauna.

4 METHODS

4.1 DESKTOP REVIEW

A separate fauna and flora desktop review was conducted for the Project prior to the commencement of the troglofauna survey (Phoenix 2014a). Fauna database searches and a literature review conducted as part of that desktop review are applicable to the current MSA and are used in this report.

4.2 FIELD SURVEY

The survey was designed to address two objectives:

- document the troglofauna species present
- determine if the three resource deposits support one or multiple troglofauna communities.

Bores were selected from a list provided by the client. All bores sampled were greater than six months old. Bores were spread across the full extent of the MSA to maximise coverage. In the field, all bores found to contain oil were rejected for sampling. The locations of all of the bores surveyed are listed in Appendix 1.

4.2.1 Survey effort

A single survey trip was conducted from 27 March to 5 April 2014. A total of 31 bores were surveyed across the three survey areas (Table 4-1 and Figure 4-1)

Table 4-1 Distribution of survey effort between the three survey areas

Survey area	Geology represented	Number of bores surveyed
North deposit	Czr1, Czr2	16
West deposit	Czp1	10
East deposit	Czp2	5

The survey intensity conforms with the first phase of a Level 2 "Comprehensive survey" (EPA 2013: 7) since the objectives were to "provide detailed information to allow an understanding of the subterranean faunal values of an area and to place it into appropriate context". An important component of a Level 2 survey is the requirement for repeated sampling, which was not undertaken.

4.2.2 Sampling method

Troglofauna were sampled using a modified bore scraping method. Guidance Statement 45a (EPA 2007) does not provide specific guidance on this survey method; however, this method has been shown to significantly outperform troglofauna trapping (Halse & Pearson 2014) and its exclusive use is supported by the EPA.

Samples were collected using a 150 µm plankton net, with a 'tickler device' positioned ca. 40 cm above the net. The assembly of net and 'tickler' is referred to as a 'scraper'. The tickler device was comprised of numerous strands of heavy gauge nylon fishing line threaded through a fishing burley cage. The effect of the 'tickler' was to gently agitate the sides of the bore and dislodge any fauna clinging to the sides of the bore. Dislodged troglofauna are likely to drop into the net on either lowering or retrieval of the scraper.

Scrape samples were obtained using the following procedure:

- Each bore was scraped four times along four sides: north, south, east and west. For the first scrape, the scraper was lowered and retrieved along one side of the bore, but subsequent scrapes were lowered along the side previously scraped and retrieved along the side intended for sampling.
- Between each scrape, the sample contents were emptied into a jug of clean water.
- After four scrapes were collected, the combined net samples were elutriated to consolidate fauna and remove sediment. Samples were then cold-fixed. Cold fixing involved the following methodology:
    - Each sample was fixed with cold (approximately 0°C) 95+% ethanol and was maintained at a constant temperature within a cooler bag or cooler box filled with ice.
    - The sample was stored in the same ice bag as the ethanol for the remainder of the day.
    - At the end of the day, samples were transferred and stored in a refrigerator (*ca* 2°C) for at least 48 hours prior to transport to the laboratory for processing.

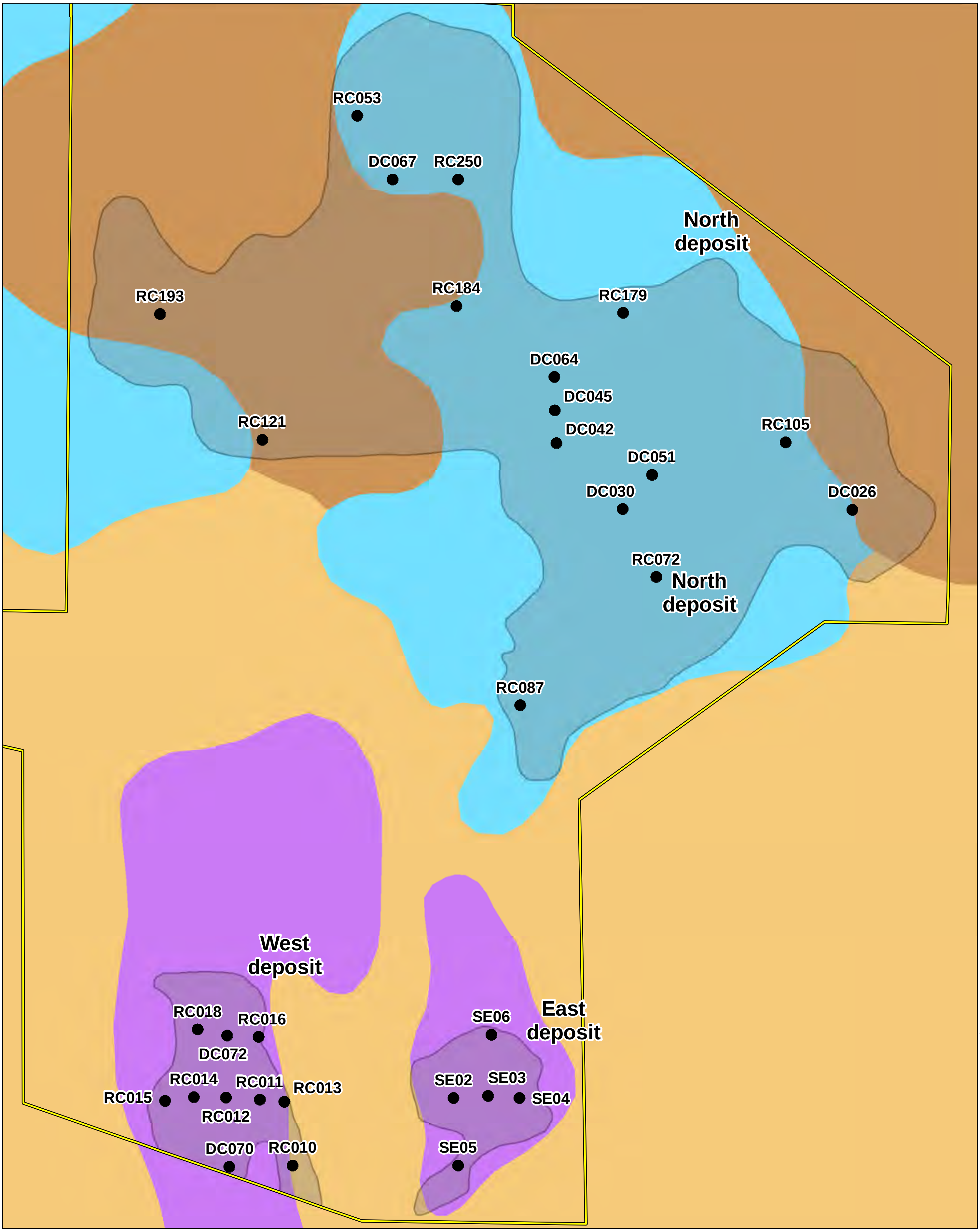

Figure 4-1
Location of troglofauna survey bores

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: E. Volschenk & G. Bouteloup
Date: 15/07/2014

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

0 125 250 500 Metres
1:15,000

- Troglofauna survey bores
- Mine Study Area
- Conceptual mine pits (as of 19/02/2014)

- Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
- Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels
- Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
- PLHj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills.

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4.3 TAXONOMY

4.3.1 Morphological species identification

The majority of troglobitic invertebrate species are currently unnamed and therefore requiring morphospecies designation as listed in this report. In designating morphospecies, Phoenix applies a phylogenetic species approach, whereby morphospecies are defined by the presence of consistent morphological characteristics (Cracraft 1983). Specialist taxonomists were consulted for groups that were targeted in the survey (Table 4-2).

Table 4-2 Taxonomic specialists

Personnel	Taxonomic group/s
Dr Erich S. Volschenk[1]	Arachnida (non-spiders), Hexapoda, Myriapoda, Annelida
Dr Volker W. Framenau[1]	Arachnida, Myriapoda
Ms Anna Leung[1]	Pseudoscorpiones, Amphipoda
Dr Mark Harvey[2]	Arachnida, Myriapoda
Dr Simon Judd[1]	Isopoda

[1] Phoenix Environmental Sciences; [2] Western Australian Museum

4.3.2 Genomic species identification

A taxonomic framework based on morphology is lacking for many subterranean invertebrates. In addition, some life stages of many invertebrates, for examples juveniles or females, lack morphological characters for species identifications. In this case, genomic species identification provides a valuable tool to assess species-level boundaries.

The gene COI contains variation that is widely accepted at being able to distinguish different species from one another (Hebert *et al.* 2003a; Hebert *et al.* 2003b). Hebert *et al.* (2003a) found that members of the same species rarely differed by more than 2% sequence divergence. Hebert *et al.* (2003b) compared COI sequences from over 13,000 species pairs and found that:

- on average, species differed from each other by about 11%
- species pairs diverged from each other by more than 8% sequence divergence in approximately 80% of pairwise comparisons.

A grey area therefore lies between 2% and 8% sequence divergence. Genetic divergences between 2% and 8% may indicate:

- allopatric populations in the process of speciation
- sympatric populations with narrow genetic exchange, or
- specimens from widely separated populations of the same species.

Identification based on morphological and genomic information is the ideal approach when assessing species boundaries, since these data sets are largely complimentary (Prendini 2005). Strengths of the genomic approach permits assessment of species boundaries where morphological information is either limited or absent:

- **Discrimination between cryptic species –** obligate subterranean organisms, troglofauna in air filled voids and stygofauna in water filled voids (Humphreys 2000), frequently exhibit highly convergent, morphologies (Finston *et al.* 2004; Finston & Johnson 2004; Finston *et al.* 2007). Such species are extremely difficult to identify on the basis of morphology alone. Similarly, recently isolated species populations may appear identical (Finston *et al.* 2004; Finston & Johnson 2004; Finston *et al.* 2007). The implementation of DNA barcoding has emerged as powerful technique to overcome these identification problems (Finston *et al.* 2004; Phoenix 2011; Subterranean Ecology 2010).
- **Discrimination between different life stages of different species –** barcoding methods may also be helpful in resolving species level identification where specimens represent taxonomically uninformative life stages or sexes. Most arthropods can only be identified from adult individuals and often, from only one sex. The application of DNA barcoding can confirm species level identity between any life stages of any sex (Hebert *et al.* 2003a; Hebert *et al.* 2003b).

In instances where COI sequences could not be obtained, the ribosomal genes 12S were targeted and used in a similar way. The mitochondrial gene 12s has been used as a surrogate for COI in insect systematics (Caterino *et al.* 2000; Simon *et al.* 2006). Fewer broad scale comparative studies have been undertaken for 12S than for COI; however, 12s has proven useful for establishing phylogenetic relationships in many insect groups (Caterino *et al.* 2000). The 12s gene evolves 1.5-3 times more slowly than COI, (Hebert *et al.* 2003a; Mueller 2006) more slowly than COI; therefore species delineation thresholds are also lower than COI: with most species having less than 0.7% sequence divergence, and the grey zone of species delineation between 0.7% and 1.3% sequence divergence.

Where available, specimens from Phoenix' DNA database were included in the analysis. Additional sequences for comparison were also sourced from GenBank (Benson *et al.* 2012) using the megablast search function in Geneious. For each sequence, the most similar 10 matches were retrieved. In cases where the retrieved sequences represented a species more than twice, then the two longest sequences were retained and the shorter conspecific sequences discarded. Where megablast results yielded families differing from the morphological assessment, then additional sequences were obtained from GenBank, representing the morphological taxonomic assessment. If all of the resulting blast sequences represented organisms from a different taxonomic class, sequences were discarded as likely contamination. Outgroups were selected from GenBank from more basal (plesiomorphic) representative of the class under study.

Sequences were aligned using ClustalW (Larkin *et al.* 2007) implemented in Geneious using Clastal cost matrix. The optimal model for sequence evolution and base substitution for each data set was determined using jModeltest2 (Darriba *et al.* 2012; Guindon & Gascuel 2003). Phylogenetic analyses were performed using MrBayes (Ronquist *et al.* 2012) as implemented in Geneious. Analyses were performed using the following parameters:

- 6 gamma categories
- chain length 10,000,000
- subsampling frequency 10,000
- heated chains 4
- burn-in length 500,000
- heated chain temperature 0.2
- priors set to exponential 1 unconstrained branch lengths.

4.4 ASSESSMENT OF SPECIES RICHNESS

The efficiency of the survey effort was evaluated by comparing the observed species richness of both troglofauna against the predicted species richness of seven widely used species richness estimators. Species richness estimations were calculated with EstimateS (v9.1.0) using the default settings, with the following exceptions:

- species accumulation curves were smoothed using 10,000 repetitions rather than the default setting of 50 to provide greater accuracy to extrapolations
- the coverage estimator value was set to two rather than 10, so as to more reliably treat rare taxa, since troglobites are often sampled in very low numbers.

Extrapolations were performed on the abundance data; however, both incidence and abundance extrapolations were used:

- incidence extrapolations treat the presence or absence of species from samples
- abundance extrapolations attempt to account for the number of specimens, rather than just their presence.

4.5 PROJECT PERSONNEL

The survey personnel involved in the Project are presented (Table 4-3).

Table 4-3 Project personnel

Name	Role/s
Dr Erich S. Volschenk	Field work, report writing, genomic analyses, GIS
Mr Nicolas Dight	Field work, laboratory work
Ms Anna Leung	Laboratory work
Dr Volker Framenau	Taxonomy, report review
Mr Guillaume Bouteloup	GIS
Mrs Karen Crews	Report review

5 RESULTS

5.1 OVERVIEW OF SAMPLING RESULTS

Forty-seven individuals were collected from a total sample effort of 29 samples (Appendix 2). Ten putative troglobite (obligate troglofauna) species were recorded (Figure 5-1 and Table 5-1). Troglofauna were recorded from 24 out of a total of 31 bores (Figure 5-1; Figure 5-3; Figure 5-4):

- 10 bores out of 16 bores sampled in the North deposit
- 6 bores out of 10 bores samples in the West deposit
- no bore out of 5 bores sampled in the East deposit.

Three species were sampled from three or more bores and the remaining seven species were represented by only one or two specimens (Figure 5-1). Two species were collected in more than one deposit, the springtail *Cyphoderus* 'marillana' and the cockroach *Nocticola* 'pilbara1', both found in the North and West deposits (Table 3-1; Figure 5-4). No troglofauna were sampled from the East deposit; however, the survey bores were suboptimal: < 3 m deep and uncapped.

No subterranean fauna species listed under the EPBC Act or the WC Act were recorded in the survey.

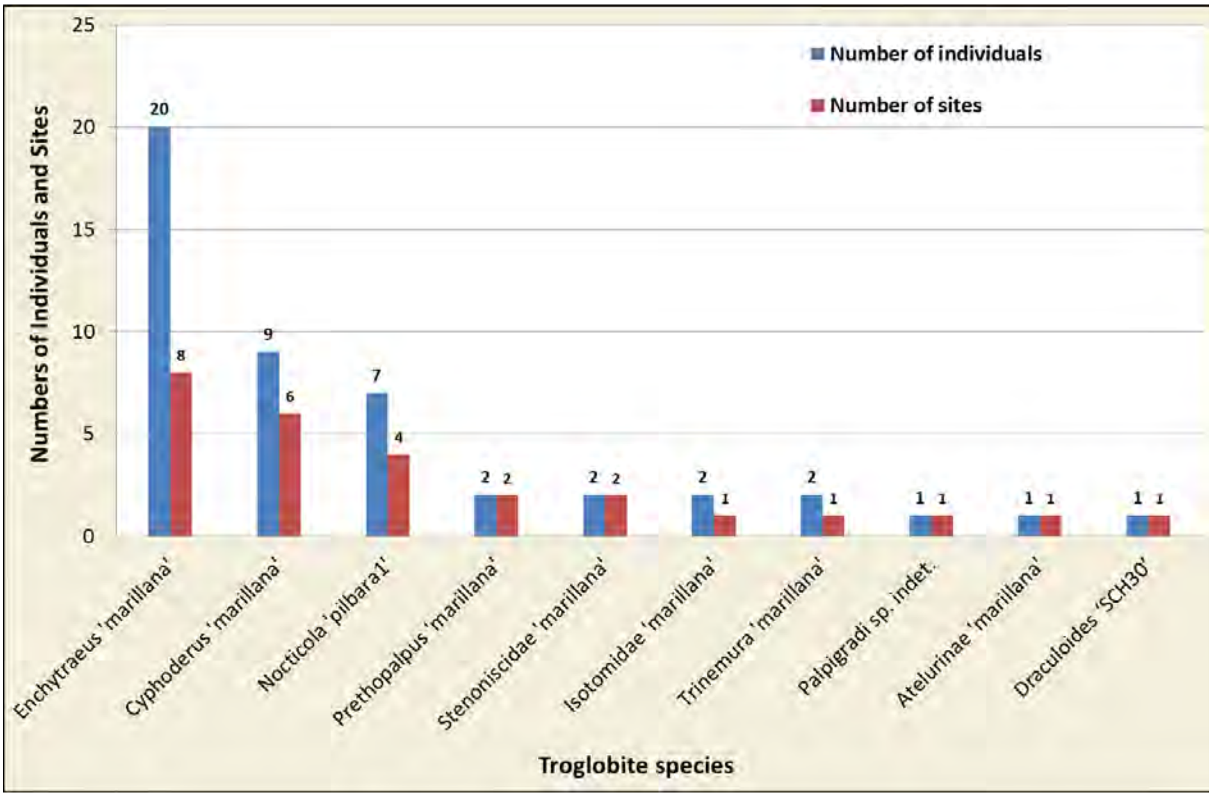

Figure 5-1 Numbers of individual (abundance) and site records for troglobitic species

Table 5-1 Troglofauna recorded during the field survey

Class	Order	Family	Species	Number of sites / survey bores	Abundance	SRE status	Troglomorphism
Clitellata (clitellate worms)	Haplotaxida	Enchytraeidae	*Enchytraeus* 'marillana'	8	20	Potential	Troglobite
Arachnida (spiders and allies)	Araneae	Oonopidae	*Prethopalpus* 'marillana'	2	2	Likely	Troglobite
	Palpigradi	Palpigradi[1]	Palpigradi[1] ‘marillana’	1	1	Likely	Troglobite
	Schizomida	Hubbardiidae	*Draculoides* 'SCH30'	1	1	Potential	Troglobite
Malacostraca (crabs and allies)	Isopoda	Stenoniscidae	Stenoniscidae[1] 'marillana'	2	2	Likely	Troglobite
Collembola (springtails)	Entomobryomorpha	Entomobryidae	*Cyphoderus* ‘marillana’	6	9	Potential	Troglobite
		Isotomidae	Isotomidae[1] 'marillana'	1	2	Potential	Troglobite
Insecta (insects)	Blattaria	Nocticolidae	*Nocticola* 'pilbara1'	4	7	Widespread	Troglobite
	Thysanura	Nicoletiidae	Atelurinae[1] 'marillana'	1	1	Potential	Troglobite
		Nicoletiidae	*Trinemura* 'marillana'	1	2	Likely	Troglobite

[1] represents unresolved classifications, the name of the lowest clear taxon rank was used.

Table 5-2 Comparisons of species records from deposits and outside study area

Higher taxon	Morphospecies name	Number of bores			Figure	Known occurrence outside Mine Study Area
		North deposit	West deposit	East deposit		
Clitellata (worms)	*Enchytraeus* 'marillana'	6	-	-	Figure 5-3	No
Arachnida (spiders and allies)	*Prethopalpus* 'marillana'	2	-	-		No
	Palpigradi ‘marillana’	1	-	-		No
	Draculoides 'SCH30'	-	1	-		Yes (WAM database)
Malacostraca (crabs and allies)	Stenoniscidae 'marillana'	2	-	-		No
Collembola (springtails)	*Cyphoderus* 'marillana'	4	2	-	Figure 5-4	Yes (Phoenix 2014b)
	Isotomidae 'marillana'	1	-	-		No
Insecta (insects)	*Nocticola* 'pilbara1'	2	2	-		Yes (Phoenix unpublished data)
	Atelurinae 'marillana'	-	1	-		No
	Trinemura 'marillana'	1	-	-		No

Figure 5-2
Troglofauna survey bores and bores yielding troglofauna

Mine Study Area

Conceptual mine pits (as of 19/02/2014)

Bores with troglofauna

Bores without troglofauna

Surface gelogy

Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits

Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels

Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

PLHj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills.

0 200 400 800 Metres

1:20,000

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 15/07/2014

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

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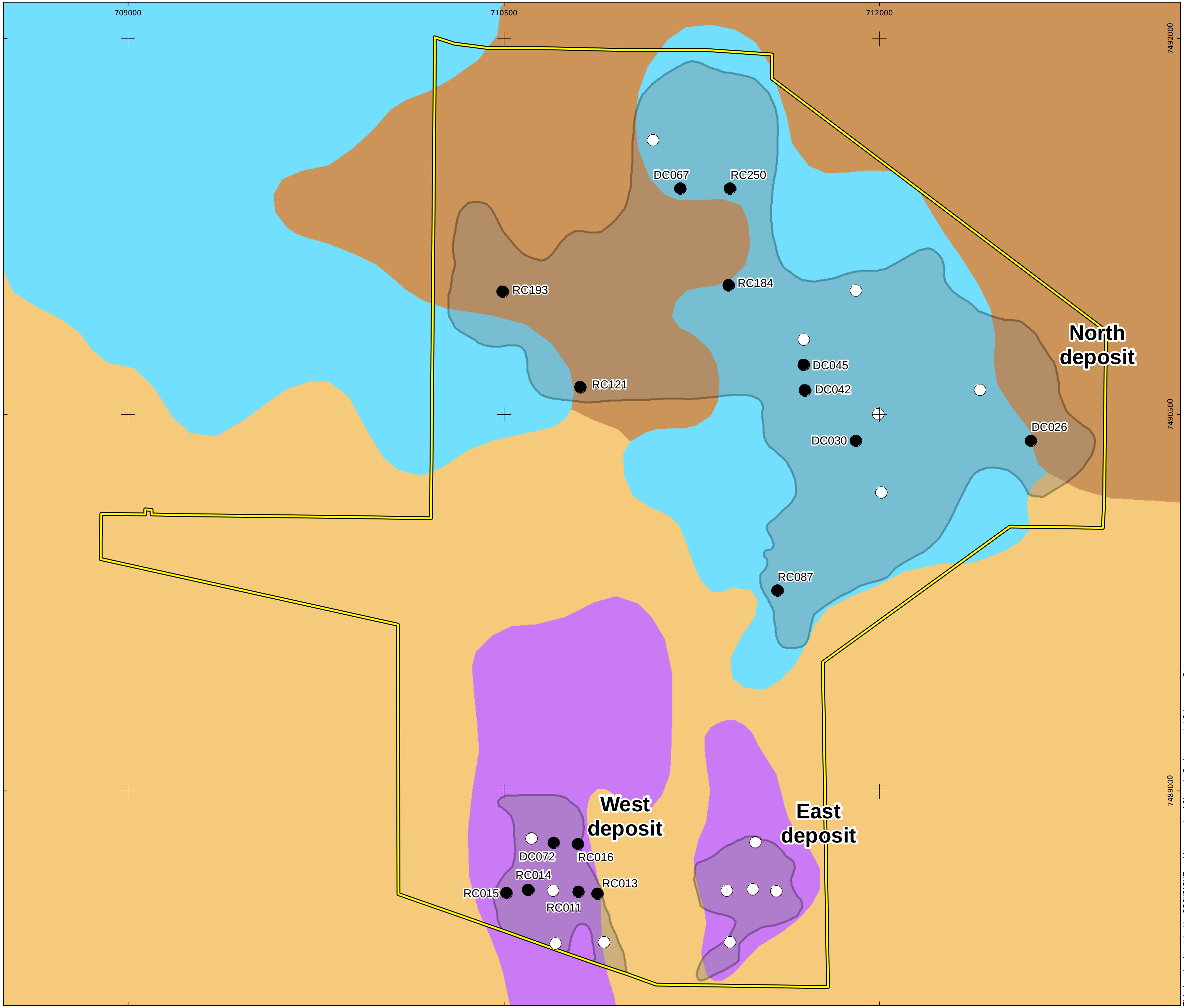

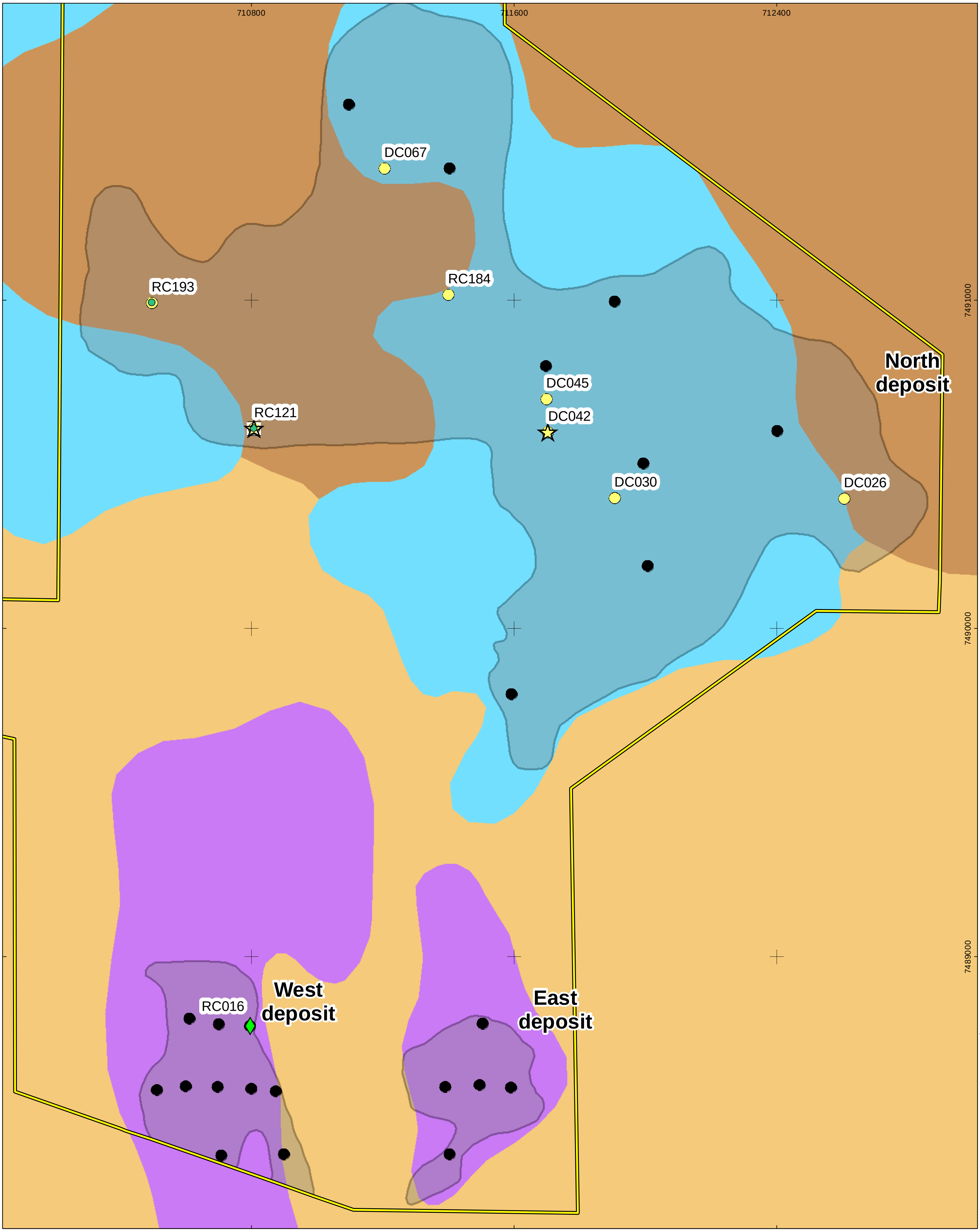

Figure 5–3
Troglofauna species records from the Mine Study Area (Clitellata, Arachnida, Malacostraca)

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Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: E. Volschenk & G. Bouteloup
Date: 29/08/2014

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

0 125 250 500 Metres
1:15,000

Conceptual mine pits (as of 19/02/2014)
Mine Study Area
Troglofauna survey bores
Draculoides 'SCH30'
Prethopalpus 'marillana'
Stenoniscidae 'marillana'
Enchytraeus 'marillana'
Palpigradi 'marillana'

Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels
Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
PLHj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills.

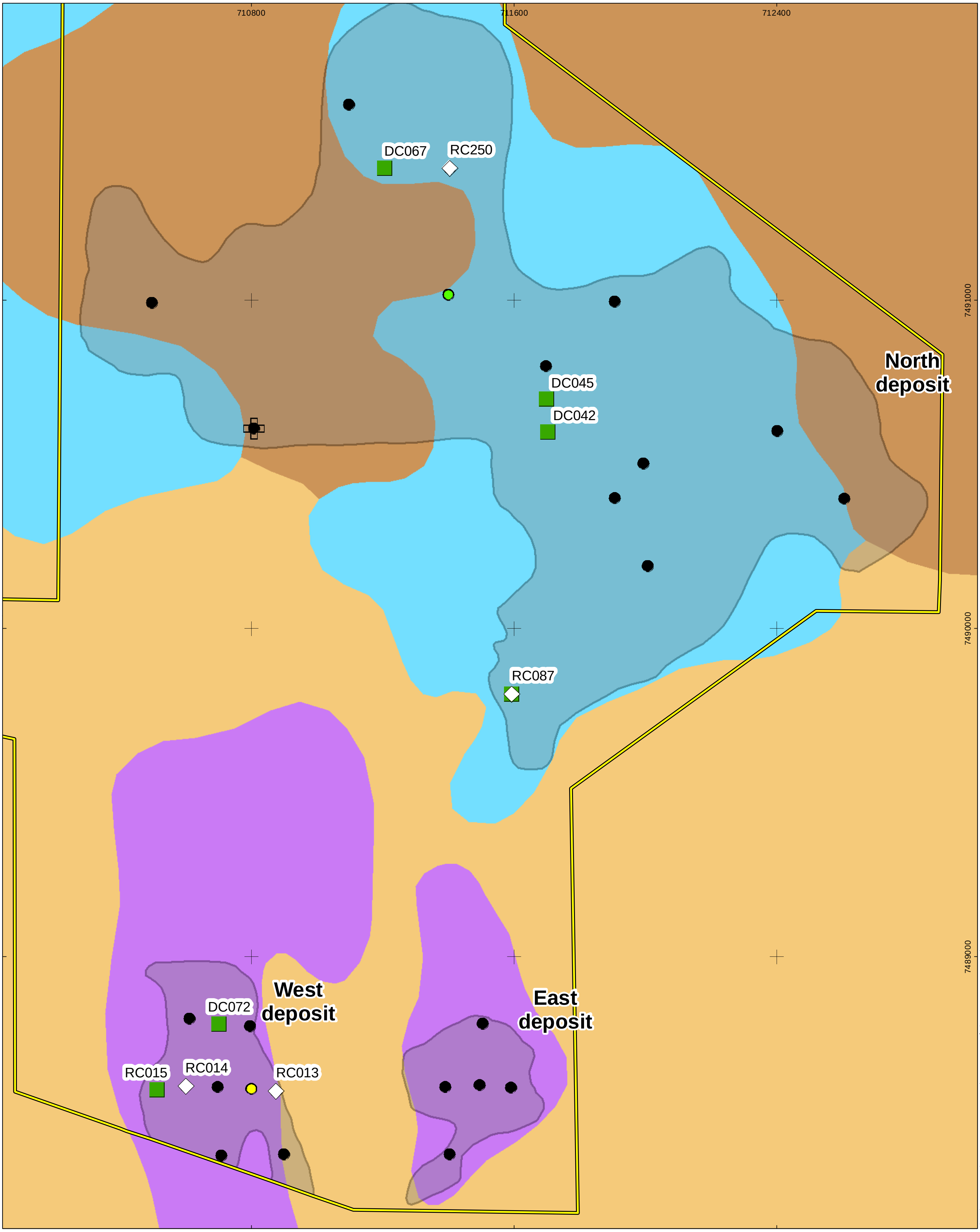

Figure 5–4
Troglofauna species records from the Mine Study Area (Collembola, Insecta)

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Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: E. Volschenk & G. Bouteloup
Date: 29/08/2014

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

0 125 250 500 Metres
1:15,000

Mine Study Area
Conceptual mine pits (as of 19/02/2014)
Troglofauna survey bores
Isotomidae 'marillana'
Trinemura 'marillana'
Atelurinae 'marillana'
Nocticola 'marillana'
Entomobryidae 'marillana'

Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels
Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
PLHj: Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills.

5.2 Assessment of species richness

The troglofauna richness estimation indicates that between 11 and 20 species were predicted to occur within the surveyed bores at the time of sampling (Table 5-3, Figure 5-5). With 10 troglofauna species recorded from this survey, the percentage of species sampled relative to extrapolated species richness ranges from approximately 50% to 90%; however, only considering the incidence-based estimators, this value ranges from approximately 50% to 58% (Figure 5-5).

Table 5-3 Estimation of troglofauna richness using seven commonly used richness estimators

	Observed species richness	ACE mean	ICE[1] mean	Chao 1 mean	Chao 2[1] mean	Jack 1 mean	Jack 2[1] mean	Bootstrap mean
Scrape samples	10	13	20	11	17	18	18	12

[1] Incidence-based species richness estimators

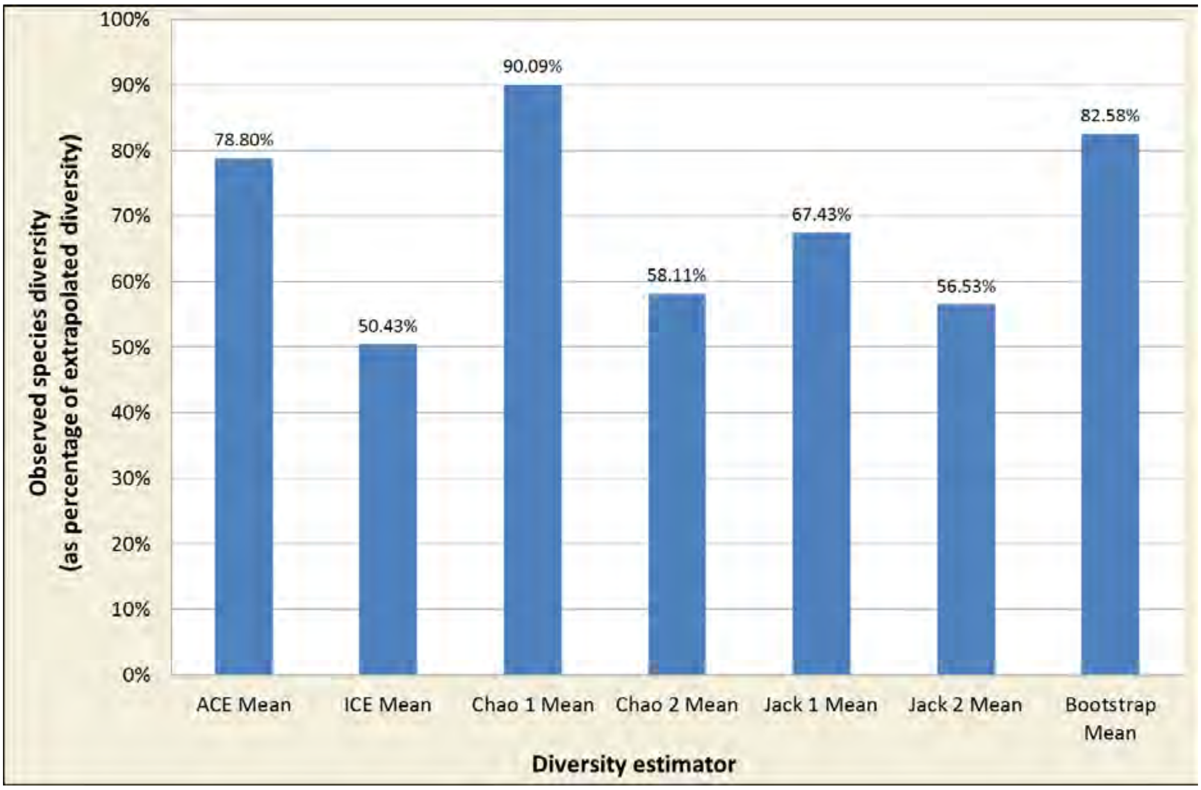

Figure 5-5 Observed troglofauna species richness as a percentage of extrapolated species richness

5.3 TROGLOFAUNA

5.3.1 Clitellata, Haplotaxida, Enchytraeidae

Clitellata are annelid worms (Annelida) that possess a clitellum, an organ that they use to produce cocoons into which their eggs are laid and in which part of their development occurs (Michaelsen 1928; Pinder 2010).

Enchytraeidae is a large and complex family of worms. They are characterised by the placement of the clitellum between segments XII–XIII and have all chaetae single pointed (Figure 5-6A)(Pinder 2010). Their diversity and taxonomy are poorly known in Western Australia.

Most subterranean oligochaetes are considered stygofauna; however, the preferred habitats of many enchytraeids are poorly known as they are frequently sampled from air-filled voids, thus qualifying as troglobites or troglophiles.

5.3.1.1 *Enchytraeus* 'marillana'

All of the *Enchytraeus* specimens collected were sub adult, making species level identifications using morphology (dependant on adults) impossible. Genomic assessment of the five representative specimens revealed a single species of Enchytraeidae with less than 4.1% sequence divergence between specimens. This species differed from all others included in the analysis by more than 11% sequence divergence. This species is therefore unique among the species examined.

Distribution

Twenty specimens were sampled from eight survey bores in the North deposit: DC030, DC042, DC045, RC184, DC067, RC121, DC026, and RC193 (Figure 5-4).

SRE status

This species is considered a likely SRE based on unpublished genomic assessments of oligochaetes undertaken by Phoenix throughout the Pilbara region of Western Australia.

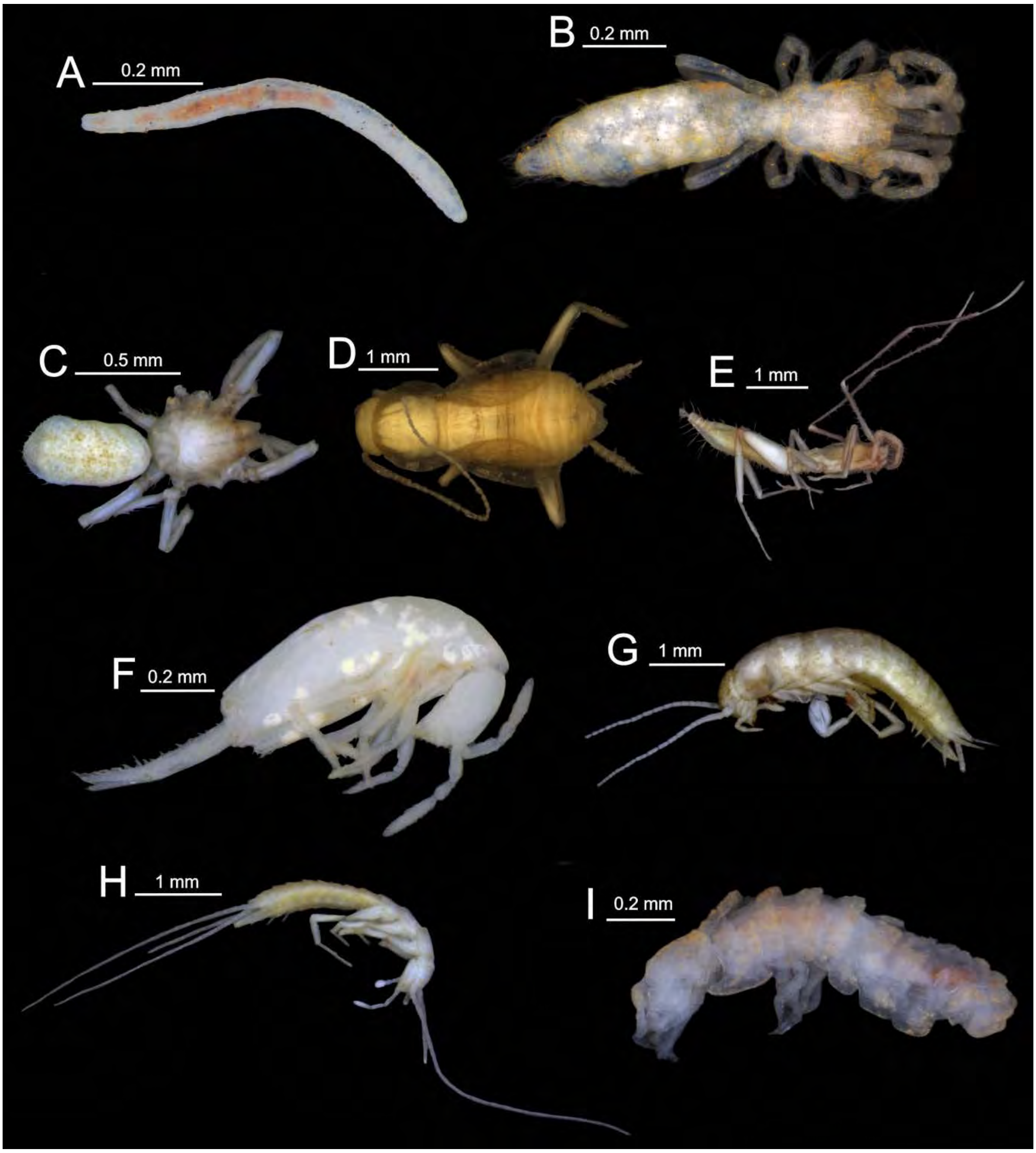

Figure 5-6 **Representatives images of taxa recorded during this survey: A, Enchytraeidae sp.; B, Palpigradi sp.; C, Olpiidae sp.; D, *Nocticola* 'pilbara1'; E, *Draculoides* sp.; F, *Cyphoderus* 'marillana'; G, Atelurinae sp.; H, *Trinemura* sp.; I, Stenoniscidae sp.**

5.3.2 Arachnida, Araneomorphae, Oonopidae

The name goblin spiders for the family Oonopidae (Figure 5-6C) refers to the somewhat peculiar appearance of these small spiders that measure up to 9 mm in body length. They are often hard-bodied with strong sclerotised abdominal plates and orange-brown in colour (Framenau *et al.* 2014; Platnick 2013). At a global scale, Goblin Spiders are known for some unusual morphological features, such as bizarre spines on the head, horny extensions on the chelicerae, strange-looking mouthparts, sternal pouches, and hand-like extensions on the posterior coxae.

Goblin Spiders have a worldwide distribution but are most common in the tropics and subtropics. The Australian fauna currently includes 142 named species in 13 genera, some of which have been treated in extensive recent revisions, e.g. *Cavisternum* , *Prethopalpus*, *Opopaea* and *Ischnothyreus* (Baehr *et al.* 2012; Baehr *et al.* 2010; Baehr *et al.* 2013; Edward & Harvey 2014); others represent the legacy of historical taxonomic work and still require revision (e.g. *Gamasomorpha*, *Oonops* and *Orchestina* (e. g. Eichenberger *et al.* 2012).

The goblin spiders include a considerable subterranean element; for example in the genera *Opopaea* and *Prethopalpus* (Baehr *et al.* 2012; Harvey & Edward 2007). Many of these species are only known from single bore holes.

5.3.2.1 *Prethopalpus* 'marillana'

Males of *Prethopalpus* are characterised by the swollen pedipalp patella which is one to two times the size of the femur. They resemble species in *Opopaea* but most males can be easily distinguished by the separate cymbium and bulb; females and males lack a pair of small dorsolateral, triangular extensions on the pedicel as well as the paired curved scutal ridges on the scutopedicel region (Baehr *et al.* 2012). *Prethopalpus* is restricted to the Australasian tropics. Most species are recorded from single locations in Australia, demonstrating high local endemicity. Of 20 known Australian species, 14 are troglobitic and only known from subterranean ecosystems in the northern half of Western Australia. Three of these have been reported from Area C, ca. 26 km SSW of the Mining MSA (Baehr *et al.* 2012). However, *Prethopalpus* ‘marillana’ has different morphological features to those three species and is here considered a species not previously recorded.

Distribution

This species was recorded from the North deposit from two bores: RC121 and DC042 (Figure 5-3).

SRE status

Troglobitic species of *Prethopalpus* exhibit very high incidence of short-range endemism (Baehr *et al.* 2012). We therefore consider this species a likely SRE.

5.3.3 Arachnida, Schizomida, Hubbardiidae

Schizomida, the short-tailed whipscorpions (Figure 5-6E), is an order of Arachnida that superficially resemble palpigrades (Figure 5-6B); however, they are not closely related and share closer affinity with the Uropygi (Wheeler & Hayashi 1998) which are not known from Australia. The Australian species are relatively well studied and numerous subterranean species are known from Western Australia, both described and undescribed (Harvey 1992; Harvey *et al.* 2008). All Australian species belong to the family Hubbardiidae (Harvey *et al.* 2008).

In the Pilbara, Hubbardiidae is represented by the genera *Draculoides* and *Paradraculoides*, both of which are only known from troglobitic species (Harvey *et al.* 2008). *Draculoides* can be identified from *Paradraculoides* by the presence of two macrosetae on tergite II, instead of three, and by the males' possession of a laterally compressed flagellum, as opposed to a dorso-ventrally compressed flagellum in *Draculoides*. However, recent collections of specimens with mixed morphologies cast doubt on the validity of the genus *Paradraculoides*. Pilbara schizomids show high levels of endemicity and are all considered either likely or potential SREs.

5.3.3.1 *Draculoides* 'SCH30'

The presence of paired setae on tergite II indicated that this species is likely to be a representative of the genus *Draculoides* (Harvey *et al.* 2008). Species level determination is very difficult in *Draculoides* and *Paradraculoides* and is complicated by the presence of numerous undescribed species and at least one species-complex in the Pilbara: *Draculoides* 'SCH30'.

Barcoding analysis

In addition to the specimen sampled in this survey, three samples were obtained from WA Museum records:

The desktop review undertaken for this project identified one specimen of *Draculoides* previously collected from within the MSA from WA Museum records (Phoenix 2014a). This specimen (WAM T119498), as well as three additional representatives from nearby populations, was subsampled for tissues for the purpose of DNA sequencing:

- T119498, *Draculoides* sp.; identified in Phoenix (2014a) from within the MSA collected by Bennelongia (2012) as reference specimen for IOH's Iron Valley project
- T119500, *Draculoides* s 'SCH21'; collected at Phil's Creek, approximately 14 km SE of MSA
- T119493, *Draculoides* 'SCH30'; collected at Yandi, approximately 12 km SE of the MSA
- T131652, *Draculoides* sp. B52; approximately 15 km SSW of the MSA (unknown project).

Samples T119498 and T119500 failed to produce DNA sequences.

Barcoding analysis indicated that the specimen collected at MSA differed from all but one species by more than 8% divergence. One specimen (T119493) from BHP Billiton Iron Ore's Yandi project differed by 5.3% sequence divergence, which is within a grey zone of species delineation (Hebert *et al.* 2003a; Hebert *et al.* 2003b). Specimen T119493 was identified as *Draculoides* 'SCH30' by the WA Museum; other specimen in the *Draculoides* 'SCH30'-complex known from Rio Tinto's Koodaideri Project (Biota 2012) differed by more than 6.7% sequence divergence. Specimen T119493 and the specimen sampled in the present study cannot be placed unambiguously in the same species but are here referred to the species complex *Draculoides* 'SCH30'.

Distribution

A single specimen of *Draculoides* 'SCH30' was recorded from bore RC016 in the West deposit (Figure 5-4).

SRE status

Draculoides 'SCH30' appears to be a widespread species-complex with numerous 'grey-zone' genetic species. Because of the unresolved (one species or more) status of this species complex, we consider this species to represent a potential SRE.

5.3.4 Arachnida, Palpigradi

Palpigrades (Figure 5-6B), commonly known as micro-whipscorpions, are an order of the Arachnida and are therefore related to spiders and scorpions; however, their position within the Arachnida is enigmatic with no clear relationship to the other arachnid orders (Giribet *et al.* 2014; Shultz 1990; Wheeler & Hayashi 1998). They are very small (usually only a few millimetres long), pale and possess a distinctively long articulated tail. The tail is very fragile and typically broken off during the sampling process.

Palpigrades inhabit moist soils and leaf litter (Barranco & Harvey 2008). The order is distributed worldwide including Australia; however, despite the presence of several species in Western Australia, only one native Western Australian palpigrade has been described: *Eukoenenia guzikae* (Barranco & Harvey 2008).

Species delineation of Pilbara species using COI data has revealed high levels sequence divergence and local endemism within Pilbara palpigrades (Phoenix 2011, 2012, 2014b).

5.3.4.1 Palpigradi 'marillana'

Barcoding analysis

Genomic DNA failed to amplify from the specimen, therefore barcoding analyses could not be undertaken for this specimen.

Distribution

A single specimen of Palpigradi was sampled from bore RC121 in the North deposit (Figure 5-4).

SRE status

In the absence of a clear morphological or molecular identification for this species, Palpigradi are considered likely SREs because representatives of the order from the Pilbara have shown very high levels of sequence divergence over quite short distances and therefore appear to be characterised by high local endemicity (Phoenix 2011, 2012, 2014b).

5.3.5 Malacostraca, Isopoda

Isopods are crustaceans which are recognised by their armour-like exoskeleton and possession of seven pairs of legs in the thoracic region. Isopods inhabit both terrestrial and aquatic environments. The Oniscidea, a suborder of the Isopoda, contain the supralittoral, terrestrial and secondarily aquatic slaters (or woodlice). Almost 200 species of slaters have been recorded from Australia (Green *et al.* 2010). Terrestrial (epigean and hypogean) isopods often have highly localised distribution and are very diverse; therefore they are recognised as a target group for SRE surveys (Harvey 2002). This is attributed to their photonegative tendencies (sensitivity to light) and susceptibility to desiccation in dry environments which are factors in limiting their dispersal abilities (Edney 1954). Slaters are an ideal biological model for faunistic and biogeographical studies, due to their reduced dispersal ability and narrow habitat preferences (Taiti & Argano 2009).

Overall the WA fauna is comparatively poorly known with many undescribed species (Judd & Horwitz 2003), although the isopod fauna of south-west WA is fairly well known based on a taxonomic study by Judd (2004).

Troglobitic isopods are regularly collected in the Pilbara region of Western Australia and have often been shown to have restricted distributions. Therefore, they considered likely SREs unless a wider distribution can be demonstrated.

5.3.5.1 Stenoniscidae 'marillana'

This isopod was identified to the family Stenoniscidae on the basis of its long and slender body, and pronounced tubercles on the abdominal tergites (Figure 5-6I). The family is currently represented by two described genera, both of which are represented by littoral species:

- *Stenoniscus*: from the Mediterranean, France, Portugal, Canaries Islands and Bermuda
- *Metastenoniscus*: from India, SE Asia and the Caribbean (Schmalfuss 2003; Schmidt & Leistikow 2004).

The specimen recorded from this survey is likely to represent a new genus and is the first record for the family in the Pilbara. Specimens likely to belong to this genus are known from subterranean habitats in the Yilgarn (S. Taiti unpublished data).

Owing to the lack of published keys and rarity of this genus in the Pilbara, this species was sequenced in order to determine if any similar haplotypes have been previously sequenced and lodged on Genbank (Benson *et al.* 2012). No close matches were found on Genbank with the most similar taxon (*Haloniscus searlei* (family Scyphacidae), GenBank accession EU364616) being 19.6% divergent.

Distribution

Single specimens were recorded from two bores in the North deposit: RC121 and RC193 (Figure 5-3).

SRE status

This species is considered a likely SRE because it belongs to a group previously unrecorded from the Pilbara.

5.3.6 Collembola, Entomobryomorpha, Cyphoderidae

Collembola are small terrestrial arthropods closely related to insects. Like insects, they possess three pairs of legs and a single pair of antennae; however, they differ from insects by the absence of wings, possession of internal mouthparts, and by a furca: an abdominal organ that they use to ‘jump’ with and which gives the group their common name springtails (Greenslade 1991). The Entomobryomorpha is the largest and most diverse order of springtails and members of this order are generally recognised by their slender abdomen, long antennae, short legs and well developed furca (Christiansen & Bullion 1978; Christiansen 1961; Greenslade 1991).

Collembolans in the family Cyphoderidae are blind, pale and possess distinctive scale-like setae on the dens (Greenslade 1991). Representatives of this family inhabit subterranean habitats including caves (Jantarit *et al.* 2014), and nests of ants and termites (Greenslade 1991). Little is known about the representatives of this family in Australia and approximately 30 species have been described (Greenslade 1991).

5.3.6.1 *Cyphoderus* 'marillana'

The genus *Cyphoderus* (Figure 5-6F) can be identified by the shape of the head and a specific arrangement of seta types on the dorsum of the furca dens, acuminate setae between large scale-setae (Bellinger *et al.* 1996–2014).

The taxonomy of Pilbara *Cyphoderus* is poorly known and species level assessments are made using DNA barcode analyses.

Barcoding analysis

Tissue samples were amplified from three samples:

- PES16196, from RC087, North deposit
- PES16199, from DC072, West deposit
- PES16318, from RC015, West deposit.

Genomic assessment revealed a single species. Three of the specimens from this study were assessed and found to have less than 0.5% sequence divergence between each other, indicating that these belong to the same species. This species differed by less than 3.1% divergence from specimens recently collected from a locality approximately 49 km south of the MSA (Phoenix 2014b), indicating that these specimens are likely to belong to the same species. This species differed from all of the remaining Collembola in the study by more than 14.4% sequence divergence.

Distribution

Nine specimens of this species were detected from six different bores in both North deposit and West deposit (Figure 5-3):

- North deposit: RC087, DC042, DC045 and DC067
- West deposit: DC072 and RC015.

SRE status

This species is considered a potential SRE, because it was sampled from near Weeli Wolli Creek, approximately 49 km south of the MSA. Records of this species still categorise it as an SRE (i.e. less than 10,000 km^2); however, 49 km is an unusually large range for a troglobite.

5.3.6.2 Isotomidae 'marillana'

Isotomidae is a diverse family of collembolans that include soil dwelling forms that are both blind and pale. Native species in the family are poorly known; however they can be very significant elements in established pastures. Subterranean forms are often very small and possess very similarly developed abdominal segments. The furca is often quite small and lacks scale setae.

The specimens differed from *Cyphoderus* by the shape of the head and by the absence of scale-setae on the dens of the jumping organ. The identity of this species was assessed using barcode analyses.

A single damaged specimen was sequenced, PES16329 from the North deposit.

Distribution

Two specimens of this species were sampled from bore RC121 within the North deposit (Figure 5-4), COI barcoding did not reveal any species specific matches.

RE status

This species is considered a potential SRE owing to its troglomorphic appearance; it is blind and lacks pigmentation. Isotomidae distributions are poorly documented in the Pilbara.

5.3.7 Insecta, Blattaria

Blattaria are commonly referred to as cockroaches. This order of insects is extremely widespread and its pest species *Periplaneta americana* (American cockroach), *Periplaneta australasiae* (Australian cockroach) and *Blattella germanica* (German cockroach) are infamous. While about 30 species are associates with human habitation, there are more than 4,000 species of cockroach globally (Rentz 2014; Roth 1991).

Troglobitic forms of several cockroach families are known; however the most common family of cockroaches in the Pilbara is Nocticolidae. In Australia, this family is represented by the single genus *Nocticola* which are sometimes referred to as 'delicate cockroaches' because of their long slender legs and tiny size (Figure 5-6D) (Rentz 2014). *Nocticola* are primitive cockroaches and are characterised by wingless females, and males that possess soft membranous wings. Epigean *Nocticola* species are known from the tropics of Queensland (*Nocticola australiensis*) and some species have also been recorded living with termites (Roth 1991). In Australia, *Nocticola* are most often troglobitic and these species have reduced eyes or lack them, and the males often have much reduced wings.

Identification of the Australian *Nocticola* species is complicated by the description of only a hand full of species and only one species, *Nocticola flabella*, is described from Western Australia, from Cape Range (Rentz 2014). Species level identification of *Nocticola* is dependent on characteristics of the adult males; however, adult males can be scarce in populations and are often not present in samples. There are no published keys to enable unambiguous identification of Pilbara *Nocticola* species. For this reason, species level identification often relies on DNA barcoding.

Genetic studies on the Pilbara *Nocticola* species (Phoenix unpublished data) indicate the presence of two undescribed *Nocticola* species with widespread distributions, as well as some species that are likely SREs.

Species delineation of Pilbara *Nocticola* is currently only reliable using genomic methods since many of the genetic variants are only known from female or juvenile specimens which are not known to possess diagnostic features to enable morphological identification.

5.3.7.1 *Nocticola* 'pilbara1'

Barcoding analysis

Genomic DNA sequences were amplified from four specimens:

- PES16195, from RC087, North deposit
- PES16331, from RC250, North deposit
- PES16339, from RC013, West deposit
- PES16344, from RC014, West deposit.

The sequence fragments were unequal, with a short fragment (measured in numbers of bases) amplified for PES16331 (329) and PES16339 (395) and longer fragments amplified for PES16195 (987) and PES16344 (989). While the long fragment encompasses the same sequence region as the short fragment, most of the sequences samples sourced elsewhere in the Pilbara do not overlap the short fragment. For this reason, assessment of the four species against each other, and limited regional context, was made using the short fragment; however broader scale regional context was further assessed using a 619 base portion of the long fragment.

Assessment of all four species against each indicated that they represent the same species, with 1.7% or less sequence divergence between them. This result was confirmed with the longer fragment as well, with PES16195 differing from PES16344 by 1.5% sequence divergence. This species differed from 14 different haplotypes of *Nocticola* 'pilbara1' by between 2.6% and 3.6% sequence divergence.

Distribution

Seven specimens were sampled from four bores from both North and West deposits (Figure 5-3):

- North deposit: RC087 and RC250
- West deposit: RC013 and RC014.

SRE status

This species is known to be widespread in the Hamersley Range.

5.3.8 Insects, Thysanura

Thysanurans are the silverfish, an order of insects, sometimes also referred to as Zygentoma (Smith & Watson 1991). They are characterised by external mouth parts, absence of wings and possess short abdominal appendages (styles); however, their most noteworthy feature are the three circi that protrude from the last abdominal segment (Smith & Watson 1991). The most commonly encountered thysanuran is *Ctenolepisma longicaudata* (silverfish), a pest species in the family Lepismatidae (Smith & Watson 1991).

The family Nicoletiidae comprises all of the known SRE thysanurans and can be identified by the absence of eyes and pale and scale-less bodies (Naumann 2000). Although all species in this family are pale and blind, not all are troglobitic, and litter dwelling species are common from mesic environments.

Species in the family Nicoletiidae (comprising the subfamilies Nicoletiinae, Figure 5-6G and Atelurinae, Figure 5-6H) are often encountered in subterranean surveys and are likely SREs (Phoenix 2011). Nicoletiinae possess elongated bodies while Ateluriinae have relatively short bodies.

5.3.8.1 Atelurinae 'marillana'

Atelurinae are poorly known in Western Australia. Genetic data indicate that this subfamily is moderately diverse in the Pilbara, despite none of its Pilbara representatives being formally described and many show strong local endemism.

Barcoding analysis

Genomic assessment indicated that this species differed from others in the analysis by more than 19.15% sequence divergence using the 12S gene.

Distribution

A single specimen of this species was recorded from bore RC011 in the West deposit (Figure 5-4).

SRE status

This species is considered e a likely SRE because most Pilbara Atelurinae assessed by Phoenix (unpublished data) to date have been found to be SREs.

5.3.8.2 *Trinemura* 'marillana'

Trinemura is the only described genus in the subfamily Nicoletiinae in Western Australia (Smith & Watson 1991). Genetic data indicate that this genus is moderately diverse, and often locally endemic in the Pilbara (Phoenix 2011).

Barcoding analysis

Owing to the lack of published keys and presence of numerous undescribed species, species assessment was made using DNA barcoding. Genomic assessment indicated that this species differed from others in the analysis by more than 12.79% sequence divergence using the 12S and more than 20% sequence divergence using COI mitochondrial genes.

Distribution

Two specimens of this species were recorded from a single bore in the North deposit: RC184 (Figure 5-4).

SRE status

This species is considered a likely SRE because most Pilbara Atelurinae assessed by Phoenix (unpublished data) to date have been found to be SREs.

5.4 SURVEY LIMITATIONS

This survey aimed to provide information to develop an understanding of the subterranean faunal values and to place them into appropriate context. The objectives of this survey were consistent with those of a Level 2 comprehensive survey (EPA 2013); however, the following limitations are noted in relation to the requirements of a Level 2 survey:

- no repeated surveys in different seasons were undertaken
- observed species richness represented between approximately 50% and 58% of extrapolated species richness, which is less than the recommended 95% recommended in Guidance statement 54a (EPA 2007).

The East deposit has undergone rehabilitation which limited vehicle access to access and hindered bore recovery. Only five bores were recovered for sampling in the area and these were less than 3 m deep. The absence of troglofauna records from these bores may be an artefact of their shallow depth.

Owing to the single sampling event, seasonal variation cannot be discussed or inferred.

6 DISCUSSION

The objectives of this baseline survey were to describe the troglofauna present within the MSA.

6.1 SPECIES RICHNESS

This survey recorded 10 putative troglobitic species; however, extrapolations of species richness indicate that between 11 and 19 species were present at the time of the survey within the surveyed boreholes. The use of both incidence (presence-absence data) and abundance (numbers of specimens) based species richness estimators partly explains the large range of extrapolated richness (Table 5-3). The high level of singleton records suggests that the data set is largely an incidence data set, therefore incidence-based extrapolations may be more representative for this study. On this basis, extrapolated species richness is in the order of approximately 50% and 58%.

A comparison of species richness and composition between different surveys near the MSA is difficult as there are differences in the survey effort and categorisation of taxa as troglobites or troglophiles between studies. A four-phase troglofauna survey at Rio Tinto's Koodaideri Project based on 450 samples from 78 bores recovered 193 specimens representing eight species of troglofauna (one pseudoscorpion, four schizomids, two cockroaches and one centipede) in addition to a number of species rated as troglophilic (Biota 2012). The troglofauna of IOH's Iron Valley Project included 16 species of very similar taxa (one pseudoscorpion, one schizomid, two cockroaches, one centipede), in addition to three isopods, one pin-cushion millipede, one symphylan, two diplurans, two Hemiptera, one beetle and one fly (Diptera) based on 112 specimens from 170 samples (three phases) in 115 bores (Bennelongia 2012). The single troglofauna record from the MSA identified through the desktop review was recovered during this study. The Wonmunna Project approximately 50 km south of the MSA resulted in 35 troglobitic or troglophilic species from 511 samples of 198 bores (Phoenix 2014b). This comparatively rich troglofauna included similar taxa as above (four pseudoscorpions, one cockroach, one centipede), although no schizomids where found. Comparatively high species richness at Wonmunna was recovered for spiders (Araneae; three species), micro-whipscorpions (Palpigradi; four species), glasshouse centipedes (Symphyla; three species) and diplurans (four species).

Additional local survey reports are not in the public domain, but some data were available through the WAM database review (Phoenix 2014a). For example, of the 17 species of troglofauna collected at Phil's Creek (Bennelongia 2009), only two specimens of *Draculoides* 'SCH021' were submitted to the WA Museum Arachnology/Myriapodology department. In general, the troglofaunas of projects that often predate subterranean assessments (e.g. BHP BIO's Area C, Packsaddle or Orebody 25) are difficult to characterise.

Overall, the species composition of the local troglofauna based on the desktop review (Phoenix 2014a) corresponds to the fauna of the MSA at the higher taxonomic level. However, species richness was much lower which probably mainly reflects the much smaller size of the survey area of the MSA in comparison to the projects mentioned above and a reduced sampling effort.

6.2 HABITAT ASSESSMENT

Interpretation of distribution patterns of subterranean fauna requires the presence of species records from multiple localities. Of the three species recorded from three or more bores, two spanned both North and West deposits: *Cyphoderus* 'marillana' and *Nocticola* 'pilbara1' (Figure 5-4). This pattern suggests the presence of connectivity between North and West deposits. The third species, *Enchytraeus* 'marillana', was recorded from the greatest number of bores; however, all of these records were from the North deposit, which based on the data at hand suggests that the connectivity between North and West deposits is not utilised by this species. Similarly, *Prethopalpus* 'marillana' and Stenoniscidae 'marillana' were only collected from the North deposit; both from two different bore holes each.

Geology is often used as surrogate for habitat availability in subterranean surveys and it is not a single geology that provides underground pores and voids; types of geology that may support troglofauna in Western Australia include karst, channel iron deposits (CID), banded iron formations (BIF), alluvium/colluvium in valley-filled areas and fractured sandstone (EPA 2013). Therefore, troglofauna habitat of particular species may exceed a particular geology if the neighbouring geology also supports subterranean life. For example, as in the Mine Study Area, Marillana CIDs within ancient palaeochannels may abut with BIFs forming the palaeochannels (Ramanaidou *et al.* 2003) and both are known to support subterranean fauna.

Surface geology data shows that the troglofauna supporting CIDs of the North (hematite-goethite, Czr) and West (Robe Pisolite, Czp) deposits are isolated by Weeli-Wolli formation (PLHj), as BIF also likely to support troglofauna (EPA 2013). However, no bores in the Weeli-Wolli formation were available for sampling to demonstrate presence of troglofauna. Proposed connectivity of some form, either present or geologically recent, would explain the presence of two troglobitic species occurring in both deposits. Of these, *Nocticola* 'pilbara1' from the North and West deposits are genetically much more similar to each other than they are to specimens found elsewhere in the Hamersley Range. This similarity suggests either existing or very recent connectivity between the two deposits through the underlying Weeli Wolli formation and therefore availability of the widespread Czr geologies to troglofauna found in the West deposit and *vice versa*.

The North deposit represents the southern extent of a much larger, and broadly connected, geology (Figure 6-1). It is therefore likely that the fauna recorded within the extent of Czr1 and Czr2 also exist within the larger western portion of Czr1.

Similarly, the West deposit represents the northern extent of a formation, Czp1, and it is likely that fauna present within the West deposit will also occur throughout the extent of Czp1 (Figure 6-1).

The absence of troglofauna records from the East deposit may be due to the dry condition and shallow nature of the bores. The bore results therefore cannot be considered representative of the East deposit in that failure to detect troglofauna does not demonstrate their absence in this instance. However, the Weeli Wolli formation that connects the North and West deposits also connects these deposits to the East deposit. Therefore, if troglofauna are present in the East deposit the Weeli Wolli formation may serve as connecting habitat more broadly.

Wider contemporary or historically recent connectivity of the troglofauna of the Project's MSA with that of neighbouring projects is suggested by the presence of a representative of the short-tailed whipscorpion of the *Draculoides* 'SCH030'-complex. This complex is known from both the BHP BIO's Yandi (Marillana Creek) just south of the Project's MSA (WAM T119493) and RTIO's Koodaideri Project (Biota 2012) (e.g. WAM T122120, T122124), ca. 15 km north of the MSA (see also Phoenix 2014a). Accurate species delineation within this complex is currently difficult as all specimens differ by less than 7% COI sequence divergence, which falls within the 'grey zone' of species delineation (Hebert *et al.* 2003a; Hebert *et al.* 2003b).

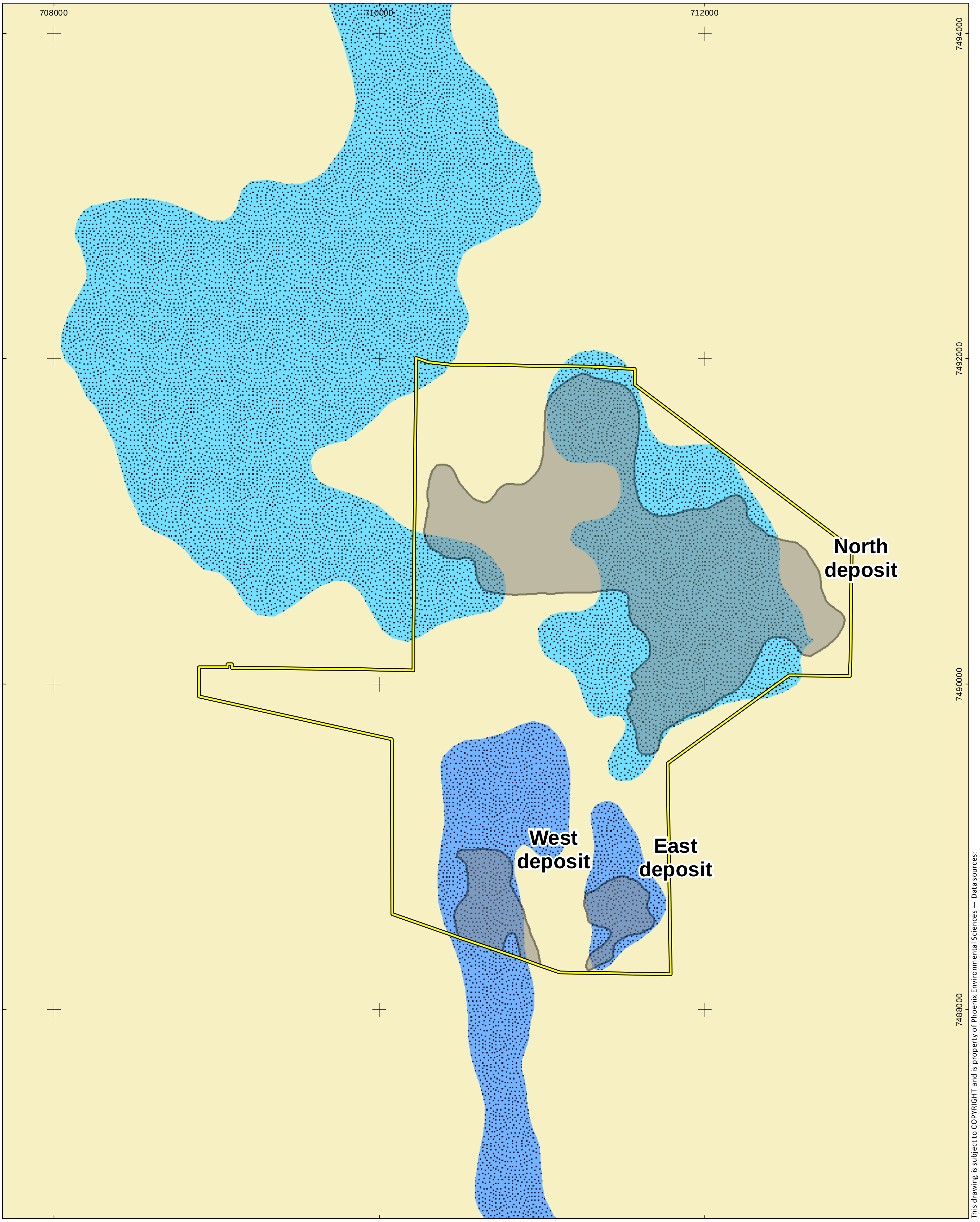

Figure 6-2
Likely extent of troglofauna habitat based on surface geology

Client: Australian Aboriginal Corporation Pty Ltd
Project: Extension Project

Author: E. Volschenk & G. Bouteloup
Date: 15/07/2014

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

0 0.225 0.45 0.9 Kilometres
1:30,000

Mine Study Area
Conseptual mine pits (as of 19/02/2014)
Potential troglofauna habitat
<all other values>
Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels
Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits

PHOENIX
ENVIRONMENTAL SCIENCES

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Appendix 1 List and locations of all bores surveyed

Deposit	Bore code	Latitude	Longitude	UTM [Zone 50] Easting	UTM [Zone 50] Northing
North	DC026	-22.680239	119.069415	712606	7490396
	DC030	-22.680311	119.062606	711906	7490398
	DC042	-22.678526	119.060607	711703	7490598
	DC045	-22.677621	119.060548	711699	7490699
	DC051	-22.679353	119.063454	711995	7490503
	DC064	-22.676703	119.060521	711697	7490800
	DC067	-22.671324	119.055653	711205	7491403
	RC053	-22.669588	119.054567	711096	7491597
	RC072	-22.682166	119.063622	712007	7490191
	RC087	-22.685749	119.059645	711593	7489800
	RC105	-22.67841	119.067401	712402	7490602
	RC121	-22.678536	119.051891	710807	7490610
	RC179	-22.674911	119.062533	711907	7490996
	RC184	-22.674785	119.057594	711399	7491017
	RC193	-22.675115	119.048813	710496	7490993
	RC250	-22.671301	119.057589	711404	7491403
West	DC070	-22.698556	119.051216	710707	7488393
	DC072	-22.694948	119.051091	710700	7488793
	RC010	-22.698496	119.053083	710899	7488397
	RC011	-22.696705	119.052087	710800	7488597
	RC012	-22.69666	119.051085	710697	7488604
	RC013	-22.696755	119.052817	710875	7488591
	RC014	-22.69666	119.050135	710599	7488605
	RC015	-22.696778	119.049286	710512	7488593
	RC016	-22.694975	119.052018	710795	7488789
	RC018	-22.694794	119.050213	710610	7488812
East	SE02	-22.696579	119.057826	711390	7488603
	SE03	-22.696508	119.058852	711495	7488609
	SE04	-22.696563	119.059776	711590	7488602
	SE05	-22.698436	119.057998	711405	7488397

Deposit	Bore code	Latitude	Longitude	UTM [Zone 50] Easting	UTM [Zone 50] Northing
	SE06	-22.694826	119.058923	711505	7488796

Appendix 2 Field survey results

Phoenix database	Order	Family	Genus and species	Deposit	Bore hole	Number collected	Specimens sequenced
Arachnida (spiders and relatives)							
16188	Araneae	Oonopidae	*Prethopalpus* 'marillana'	North	DC042	1	Yes
16326	Araneae	Oonopidae	*Prethopalpus* 'marillana'	North	RC121	1	No
16327	Palpigradi	unknown	Palpigradi ‘marillana’	North	RC121	1	Unsuccessful
16330	Schizomida	Hubbardiidae	*Draculoides* 'SCH30'	West	RC016	1	Yes
16189	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	DC042	4	Yes
Haplotaxida (oligochaete worms)							
16194	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	DC045	1	Yes
16197	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	RC184	1	No
16200	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	DC067	2	No
16322	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	DC030	7	Yes
16328	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	RC121	3	Yes
16335	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	DC026	1	Yes
16343	Enchytraeidae	Haplotaxida	*Enchytraeus* 'marillana'	North	RC193	1	No
Crustacea (crabs and allies)							
16325	Isopoda	Stenoniscidae	Stenoniscidae 'marillana'	North	RC121	1	Yes
16342	Isopoda	Stenoniscidae	Stenoniscidae 'marillana'	North	RC193	1	No

Phoenix database	Order	Family	Genus and species	Deposit	Bore hole	Number collected	Specimens sequenced
Collembola (springtails)							
16190	Entomobryomorpha	Entomobryidae	*Cyphoderus* 'marillana'	North	DC042	2	No
16193	Entomobryomorpha	Entomobryidae	*Cyphoderus* 'marillana'	North	DC045	1	No
16196	Entomobryomorpha	Entomobryidae	*Cyphoderus* 'marillana'	North	RC087	1	Yes
16199	Entomobryomorpha	Entomobryidae	*Cyphoderus* 'marillana'	West	DC072	1	Yes
16201	Entomobryomorpha	Entomobryidae	*Cyphoderus* 'marillana'	North	DC067	2	No
16318	Entomobryomorpha	Entomobryidae	*Cyphoderus* 'marillana'	West	RC015	2	Yes
16329	Entomobryomorpha	Isotomidae	Isotomidae 'marillana'	North	RC121	2	Yes
Insecta (insects)							
16195	Blattaria	Nocticolidae	*Nocticola* 'pilbara1'	North	RC087	3	Yes
16331	Blattaria	Nocticolidae	*Nocticola* 'pilbara1'	North	RC250	1	Yes
16339	Blattaria	Nocticolidae	*Nocticola* 'pilbara1'	West	RC013	2	Yes
16344	Blattaria	Nocticolidae	*Nocticola* 'pilbara1'	West	RC014	1	Yes
16466	Thysanura	Nicoletiidae	Atelurinae 'marillana'	West	RC011	1	Yes
16198	Thysanura	Nicoletiidae	*Trinemura* 'marillana'	North	RC184	2	Yes
Total:						**47**	

PHOENIX
ENVIRONMENTAL SCIENCES

Terrestrial fauna survey for the Extension Project

Prepared for
Australian Aboriginal Mining Corporation Pty Ltd

August 2014

Final Report

Terrestrial fauna survey for the Extension Project

Prepared for Australian Aboriginal Mining Corporation Pty Ltd

Final Report

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Date: 29 August 2014

Submitted to: Phil Scott (Preston Consulting on behalf of Australian Aboriginal Mining Corporation)

Chain of authorship and review			
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V. Framenau	Technical review	1.1	14 May 2014
K. Crews	Draft for client comments	1.2	16 May 2014
J. Clark, R. Ellis & N. Dight	Final draft for review	2.0	14 June 2014
K. Crews	Final draft submitted to client	2.1	22 July 2014
V. Framenau	Final submitted to client	2.2	29 August 2014

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CONTENTS

List of Figures

List of Tables

List of Appendices

EXECUTIVE SUMMARY

Australian Aboriginal Mining Corporation Pty Ltd (AAMC) is seeking to develop the Extension Project (the Project), which is located approximately 130 km north-west of Newman, Western Australia. The 916 ha study area (Combined Study Area) encompasses three iron ore deposits and associated mine infrastructure (collectively the Mine Study Area - MSA) and a haul road to the north-west of the Project (the Road Study Area - RSA). AAMC is proposing to develop the Project in a staged manner, commencing with a small scale bulk sample of approximately 130,000 t of haematite ore to confirm product characteristics and marketability. Assuming satisfactory results from that stage, the second stage would see the development of a small scale mining operation on the Extension deposit.

In March 2014, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by AAMC to undertake a Level 1 terrestrial vertebrate fauna and a Level 2 short-range endemic (SRE) invertebrate survey for the Project following a desktop review undertaken in the same month.

The objective of the survey was to define the terrestrial fauna values of the Combined Study Area to inform an environmental impact assessment for the Project. The scope of works entailed habitat assessment, a combined Level 1 vertebrate and Level 2 SRE field survey, data analyses, species identification, mapping and preparation of a technical report.

The field survey was undertaken from 27 March to 5 April 2014 and comprised habitat mapping, targeted searches/foraging for evidence of conservation significant vertebrate fauna and SRE taxa, infra-red remote sensor camera trapping, bat echolocation call recording (SongMeter SM2), and leaf litter and soil sieving for SREs. Twenty two sites were surveyed across the Combined Study Area.

Six broad habitat types were defined in the Combined Study Area. Hummock and tussock grassland covered approximately 58% of the Combined Study Area. Open and closed shrubland stretched over 27% of the Combined Study Area. All other habitats, mesas and rocky hill slopes, minor creek and drainage lines, gorges and gullies each covered less than 10% each of the Combined Study Area.

Three vertebrate species of conservation significance were recorded during the survey. Echolocation calls of the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*; Vulnerable – EPBC Act, Schedule 1 – WC Act) were recorded at a single site within a deep gorge at the northern end of the RSA. The species is likely to be foraging in low numbers and frequency within the gorge. No suitable roosting habitat was identified in the Combined Study Area. Foraging individuals are likely to be moving from a previously recorded roost located approximately 7 km north-west of the Combined Study Area.

A pair of Australian Bustard (*Ardeotis australis;* Priority 4 – DPaW) was observed in the MSA. The species is likely to frequently occur within the Combined Study Area in hummock and tussock grassland and shrubland habitats.

Seven active and three inactive mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani;* Priority 4) were recorded in the MSA. The species is likely to be common and widespread in suitable hummock grassland and shrubland habitats where suitable sized pebble substrate is present for mounds and burrow construction.

Potential habitat was identified in the Combined Study Area for a further 12 of the 20 species of conservation significance from the desktop review:

- Gane's Blind Snake (*Ramphotyphlops ganei*; Priority 1) – may possibly occur
- Pilbara Olive Python (*Liasis olivaceus barroni*; Vulnerable – EPBC Act, Schedule 1 – WC Act) – likely to occur
- Fork-tailed Swift (*Apus pacificus*; Migratory) – likely to occur

- Eastern Great Egret (*Ardea modesta*; Migratory) – may possibly occur
- Cattle Egret (*Ardea ibis*; Migratory) – may possibly occur
- Grey Falcon (*Falco hypoleucos*; Schedule 1 – WC Act) – may possibly occur
- Peregrine Falcon (*Falco peregrinus*; Schedule 4 – WC Act) – may possibly occur
- Night Parrot (*Pezoporus occidentalis*; Endangered – EPBC Act, Schedule 1 – WC Act) – may possibly occur
- Rainbow Bee-eater (*Merops ornatus*; Migratory) – likely to occur
- Star Finch (*Neochmia ruficauda* sub. *Clarescens*; Priority 4) – may possibly occur
- Northern Quoll (*Dasyurus hallucatus*; Endangered – EPBC Act, Schedule 1 – WC Act) – may possibly occur
- Ghost Bat (*Macroderma gigas*; Priority 4) – may possibly occur.

Two potential SRE taxa were collected in the Combined Study Area during the field survey, a wall crab spider (*Karaops* 'marillana' – family Selenopidae) and a land snail (Camaenidae gen. nov. sp. nov.), both from the northern section of the RSA. The wall crab spider was identified based on molecular methods (COI barcoding) and no species-specific match was found in the COI databases of the WA Museum, Phoenix or GenBank. The camaenid land snail was recorded as dead shell and targeted surveys to obtain live specimens would need to precede molecular evaluation.

All fauna habitats within the Combined Study Area have the potential to support fauna of conservation significance. Based on the presence or likelihood of occurrence of conservation significant vertebrate species and SREs, the gorge and gully habitats in the northern section of the RSA appear to provide the highest fauna values within the Combined Study Area with the Pilbara Leaf-nosed Bat, *Karaops* 'marillana' and the camaenid land snail all recorded here. These habitats are well represented outside of the RSA, particularly to the north and west as part of a broader gorge system. The broader scale habitats such as hummock and tussock grassland are widely represented regionally and the conservation significant species recorded here, such as the Western Pebble-mound Mouse, are widespread.

While it was apparent from the field survey that the gorge and gully habitat within the RSA extends beyond the study area, desktop habitat mapping could be undertaken to confirm the extent of this habitat within the RSA relative to regional extent. This assessment would provide further background data for an impact assessment and enable detailed management actions to control impacts to be determined.

1 INTRODUCTION

In March 2014 Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Australian Aboriginal Mining Corporation Pty Ltd (AAMC) to undertake a terrestrial fauna survey for the Extension Project (the Project) following on from a desktop review compiled for the Project (Phoenix 2014). This terrestrial fauna survey targeted vertebrate fauna and short-range endemic invertebrates (SREs). This report presents the results of that fauna survey.

1.1 BACKGROUND

The Project is located in the Hamersley Ranges in the Central Pilbara region of Western Australia, approximately 130 km north-west of Newman (Figure 1-1). It includes four mining leases (M47/1353, M47/1354, M47/1355, and M47/1356) containing the Extension deposit, a superficial channel iron deposit (CID).

The Combined Study Area encompasses two distinct components:

1. Mine Study Area (MSA) – the area shown in Figure 1-2 that will be the location of mining (three proposed pits), processing and ancillary infrastructure (778 ha)
2. Road Study Area (RSA) – the area shown in Figure 1-2 that will be developed for road haulage of ore and site access (~15 km by 100 m; 138 ha).

Together the MSA and RSA are referred to as the Combined Study Area and cover 916 ha in total. The RSA extends to the limit of new road development that would be required to enable ore haulage.

Figure 1–1 Location of the Extension Project

Project location

Operating mines

Railways

Principal and secondary roads

Minor road

Major creeks and rivers

National Parks and Nature Reserves

0 10 20 40 Kilometres

1:1,500,000

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

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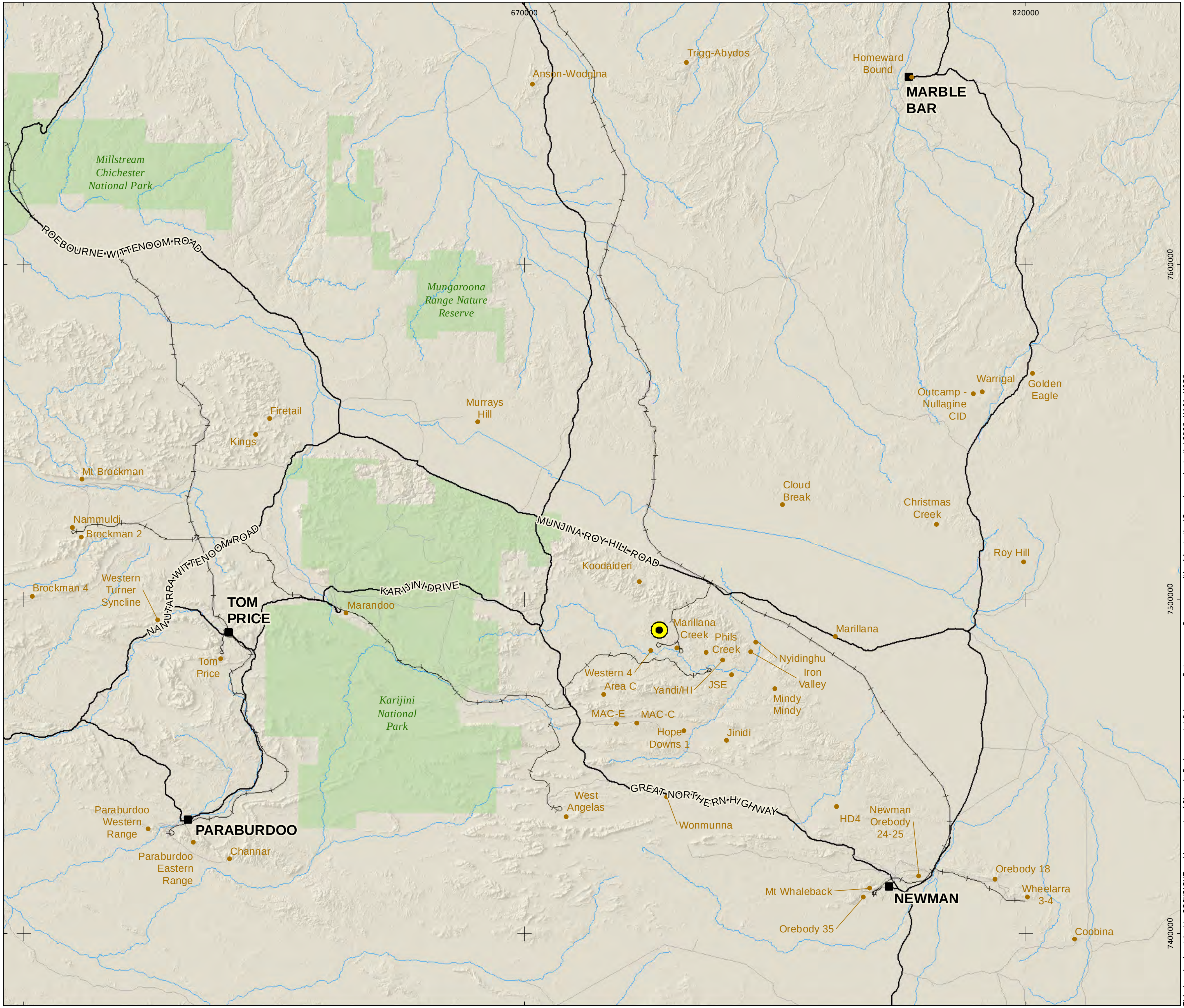

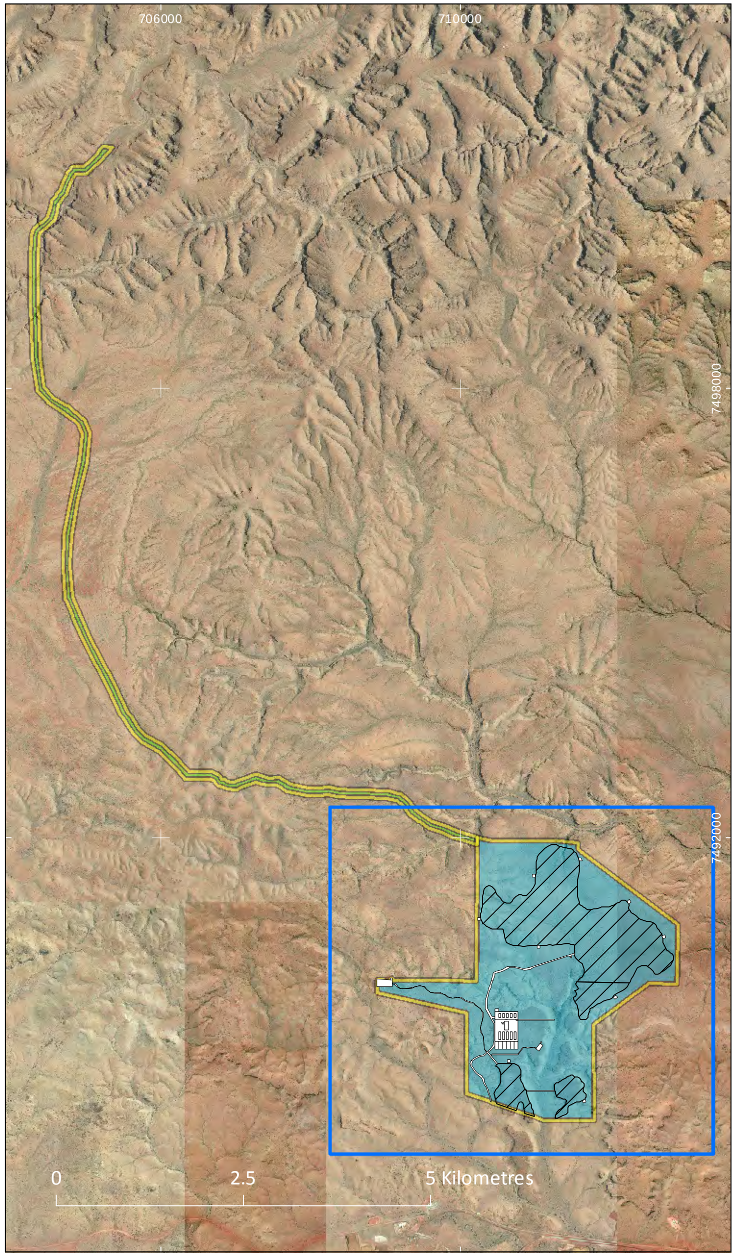

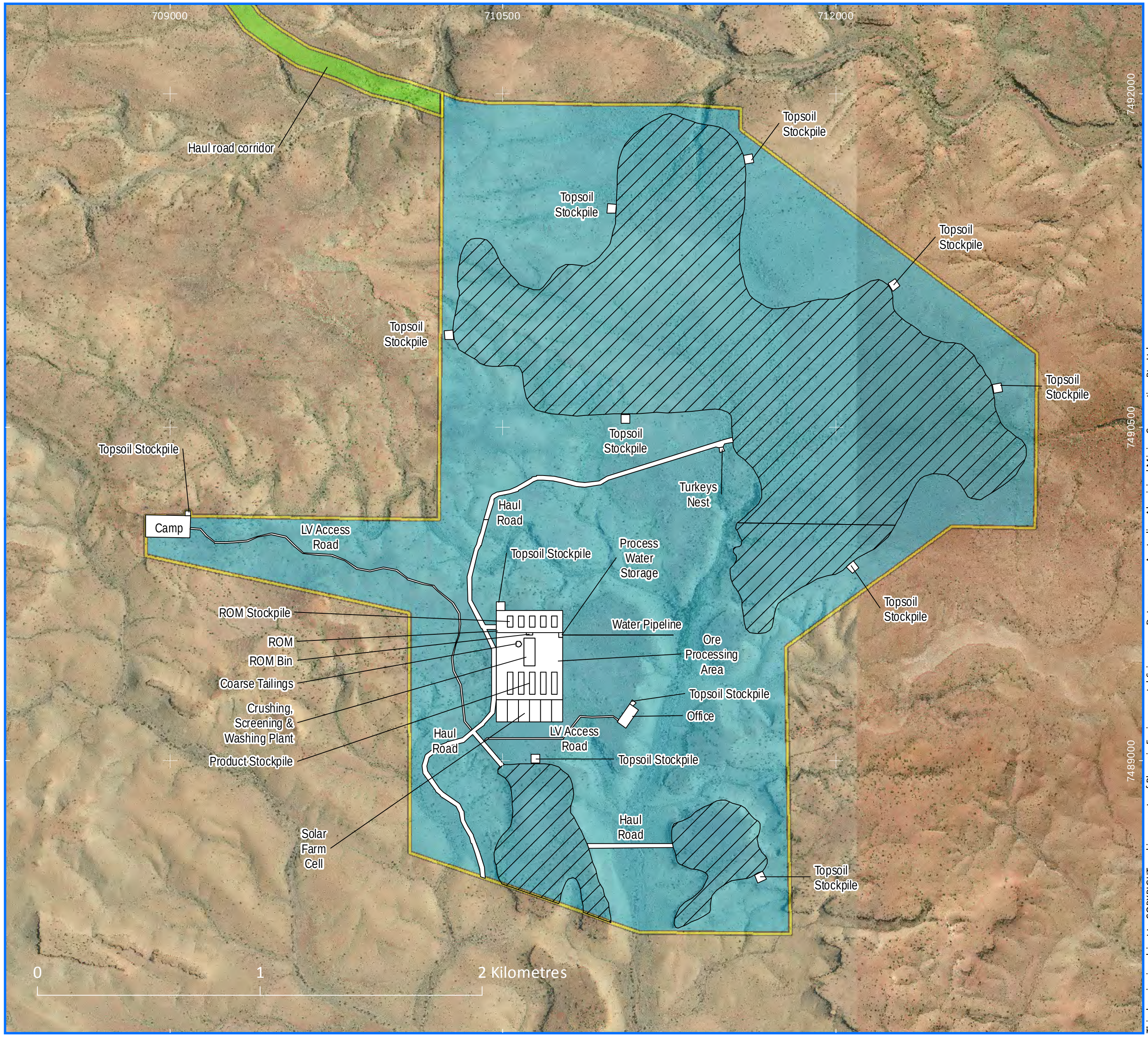

Figure 1–2

Extension Project conceptual mine layout(as at 19 February 2014) and Combined Study Area for the terrestrial fauna survey

PHOENIX ENVIRONMENTAL SCIENCES

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

Road Study Area

Mine Study Area

Conceptual mine layout (as at 19/02/2014)

Conceptual pits (as at 19/02/2014)

1.2 Scope of work and survey objectives

The objective of the survey was to define the terrestrial fauna values of the Combined Study Area to determine whether the Project will have significant impacts on terrestrial vertebrate fauna, SRE invertebrate species, and/or their respective habitats.

The scope of works undertaken to achieve these objectives was as follows:

- conduct a Level 1 field survey for vertebrate fauna and a Level 2 survey for SRE invertebrates of the Combined Study Area
- undertake a detailed terrestrial vertebrate fauna habitat assessment, including fauna habitat mapping of the Combined Study Area
- undertake data analyses, sample processing and species identifications for samples collected during the field survey
- prepare maps showing significant species records and habitats (including potential SRE habitats) in the Combined Study Area
- provide recommendations for targeted species surveys if required
- prepare a comprehensive terrestrial vertebrate and SRE invertebrate fauna technical report and supporting digital data.

The survey adhered to the following guidelines:

- Environmental Protection Authority (EPA) Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection* (EPA 2002)
- EPA Guidance Statement No. 56: *Terrestrial fauna surveys for environmental impact assessment in Western Australia* (EPA 2004).
- *Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA & DEC 2010).
- EPBC Act policy statement 3.25: *Referral guidelines for the endangered Northern Quoll, Dasyurus hallucatus.* (DSEWPC 2011)
- EPA Guidance Statement No. 20: *Sampling of short-range endemic invertebrate fauna for environmental impact assessment (EIA) in Western Australia* (EPA 2009a).

2 LEGISLATIVE CONTEXT

The protection of fauna in Western Australia is principally governed by three acts:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Wildlife Conservation Act 1950* (WC Act)
- *Environmental Protection Act 1986* (EP Act).

2.1 COMMONWEALTH

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (NES), require approval from the Australian Government Minister for the Environment. The EPBC Act provides for the listing of threatened native fauna as matters of NES.

Conservation categories applicable to threatened fauna species under the EPBC Act are as follows:

- Extinct (EX)[1] – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent[1] – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.

Few invertebrate taxa from WA are listed as matters of NES and those that are mostly include species that have experienced significant range contractions and population declines due to habitat loss, for example the Margaret River Marron (*Cherax tenuimanus*) (Critically Endangered) and the Shield-backed Trapdoor Spider (*Idiosoma nigrum*) (Vulnerable) (Department of the Environment 2014c).

The EPBC Act is also the enabling legislation for protection of migratory species (Mig.) under a number of international agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn)
- Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds (ROKAMBA).

[1] Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

2.2 STATE

In Western Australia, the WC Act provides for the listing of native fauna (Threatened Fauna) species which are under identifiable threat of extinction. Threatened Fauna are assigned to one of four categories under the WC Act:

- Schedule 1 (S1) – fauna that is rare or is likely to become extinct
- Schedule 2 (S2) – fauna presumed to be extinct
- Schedule 3 (S3) – Migratory birds protected under an international agreement
- Schedule 4 (S4) – other specially protected fauna

Assessments for listing of fauna are based on the International Union for Conservation of Nature (IUCN) threat categories.

The Department of Parks and Wildlife (DPaW) administers the WC Act and also maintains a non-statutory list of Priority fauna species which is updated annually. Priority species are still considered to be of conservation significance – that is they may be rare or threatened – but cannot be considered for listing under the WC Act until there is adequate understanding of their threat levels. Species on the Priority fauna lists are assigned to one of five priority (P) categories, P1 (highest) – P5 (lowest), based on level of knowledge/concern.

Any activities that are deemed to have a significant impact on listed fauna species can trigger referral to the EPA for assessment under the EP Act.

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) defines 'bioregions' as large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems (Department of the Environment 2014d; Thackway & Cresswell 1995). They record and categorise the large-scale geophysical patterns that occur across the Australian continent.

Western Australia contains 26 IBRA bioregions and 53 subregions. The Combined Study Area falls within the Pilbara bioregion, which covers an area of 178,060 km^2 (Thackway & Cresswell 1995) and is divided into four subregions (Department of the Environment 2014d): Chichester (PIL 1), Fortescue Plains (PIL 2), Hamersley (PIL 3) and Roebourne (PIL 4).

The Combined Study Area falls within the Hamersley subregion (Figure 3-1) and is characterised by (Kendrick 2001b):

- mountainous areas of Proterozoic sedimentary ranges and plateaux dissected by gorges
- fine-textured soils in valley floors supporting Mulga (*Acacia aneura*) low woodland over bunch grasses
- skeletal soils of the ranges supporting *Eucalyptus leucophloia* over *Triodia brizoides*
- a semi-desert tropical climate with an average rainfall of 300 mm, generally occurring in summer cyclonic or thunderstorm events.

High species and ecosystem diversity is characteristic of the Hamersley Range. Gorges are common and represent refugia for biota. Other important attributes of the Hamersley Range include calcrete deposits for troglofauna and mountain tops and permanent springs to support a number of restricted flora species. None of these features are well-represented in the Combined Study Area.

Figure 3–1
Location of the Extension Project in relation to IBRA bioregions and subregions and conservation estates

- Project location
- Key WA Towns
- Major creeks and rivers
- Nationally important wetlands
- National Parks and Nature Reserves

IBRA bioregions

- Little Sandy Desert
- Great Sandy Desert
- Carnarvon
- Dampierland
- Gascoyne
- Pilbara

0 20 40 80 Kilometres
1:2,872,789

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

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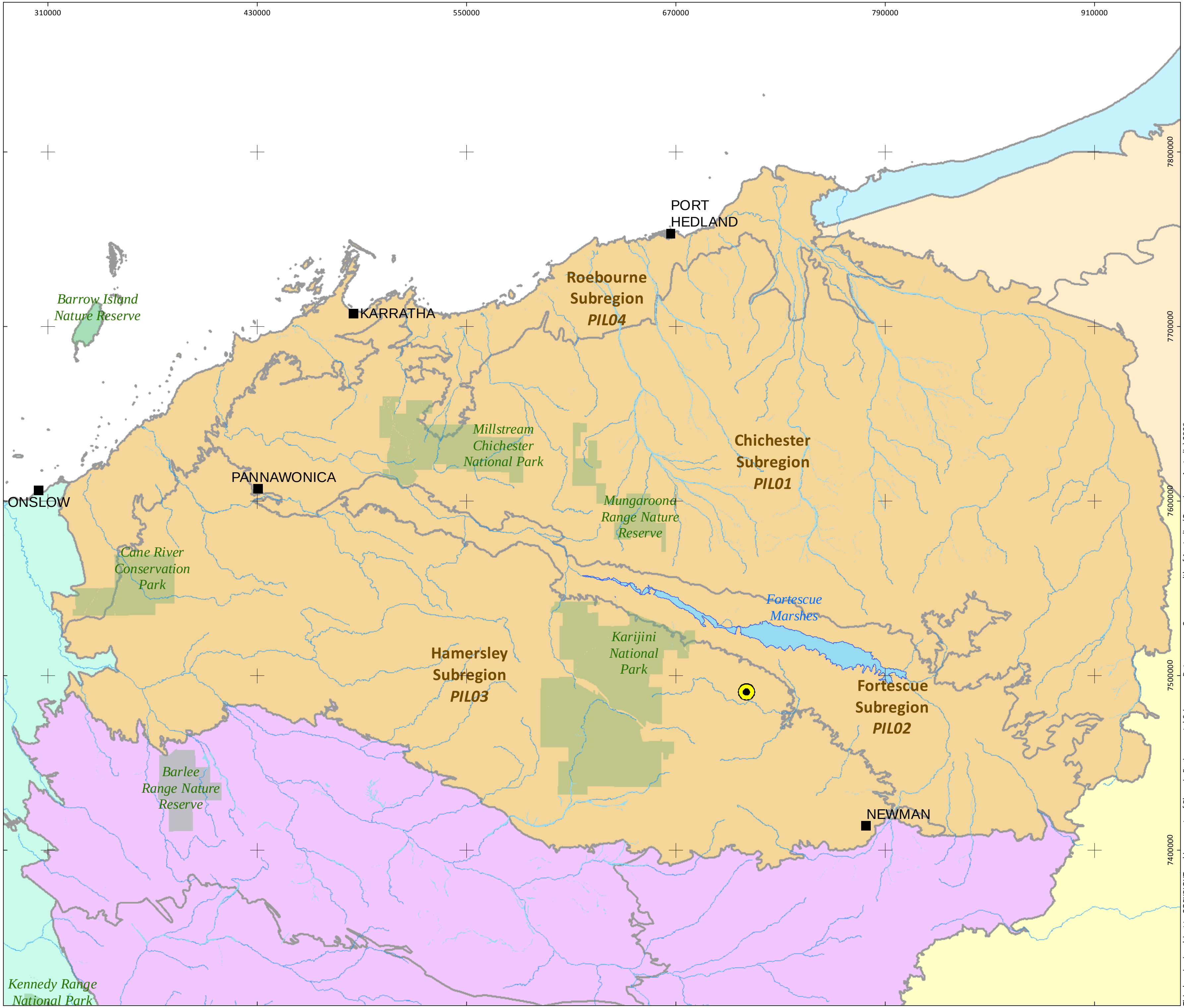

3.2 LAND SYSTEMS

The Department of Agriculture and Food Western Australia (van Vreeswyk *et al.* 2004) has defined the land systems of the Pilbara region from landforms, soils, vegetation and aerial photography, providing the largest-scale interpretation of vegetation units for the Combined Study Area.

The Combined Study Area traverses four land systems (Figure 3-2):

- **Platform land system (PLA)** – dissected slopes and raised plains supporting shrubby hard spinifex grasslands
- **Robe land system (ROB)** – low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands
- **Newman land system (NEW)** – rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands
- **Boolgeeda land system (BGD)** – stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.

The dominant land system in the Combined Study Area is Platform, followed by Robe and Newman (Table 3-1). Boolgeeda is the least represented land system of the Combined Study Area.

Table 3-1 Extent of each land system present in the Combined Study Area

Land system	Combined Study Area ha (% of study area)	Pilbara total ha (% of Pilbara)
Platform (PLA)	445.7 (48.6%)	157,000 (0.9%)
Robe (ROB)	174.3 (19.0%)	86,500 (0.5%)
Newman (NEW)	246.1 (26.9%)	1,458,000 (8.0%)
Boolgeeda (BGD)	50.6 (5.5%)	774,800 (4.3%)
Combined Study Area total	**916.7**	**2,476,300**

Important vertebrate fauna habitat contained within the dominant land systems represented in the Combined Study Area include:

- low mesas and gullies of the Robe land system providing suitable habitat for ground dwelling mammal species such as Northern Quoll, potential roost caves for bats such as Ghost Bat and Pilbara Leaf-nosed Bat and potential nesting sites for birds of prey such as the Peregrine Falcon
- foraging habitat for conservation significant birds of prey and ground-dependant foraging birds such as the Grey Falcon and Australian Bustard within spinifex grasslands of the Boolgeeda and Platform land systems
- minor creek and drainage lines with riparian vegetation in the Robe and Platform land systems providing foraging and dispersal habitat for Northern Quoll and Bush-stone Curlew.

Typical SRE habitats occurring in land systems represented in the Combined Study Area include:

- south-facing bases of plateaus and ridgelines in the Robe and Newman land systems providing greater shelter from the sun throughout the day and creating cool moist microhabitats and protection from predation.
- riparian vegetation along drainage lines in the Robe and Platform land systems providing refuge habitats with abundant shade, moisture and dense leaf litter.

Figure 3-2
Land systems of the Extension Project

Road Study Area

Mine Study Area

Land systems

- Boolgeeda System
- Calcrete System
- McKay System
- Newman System
- Oakover System
- Platform System
- Robe System
- Rocklea System
- Wannamunna System

0 0.75 1.5 3 Kilometres

1:80,000

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

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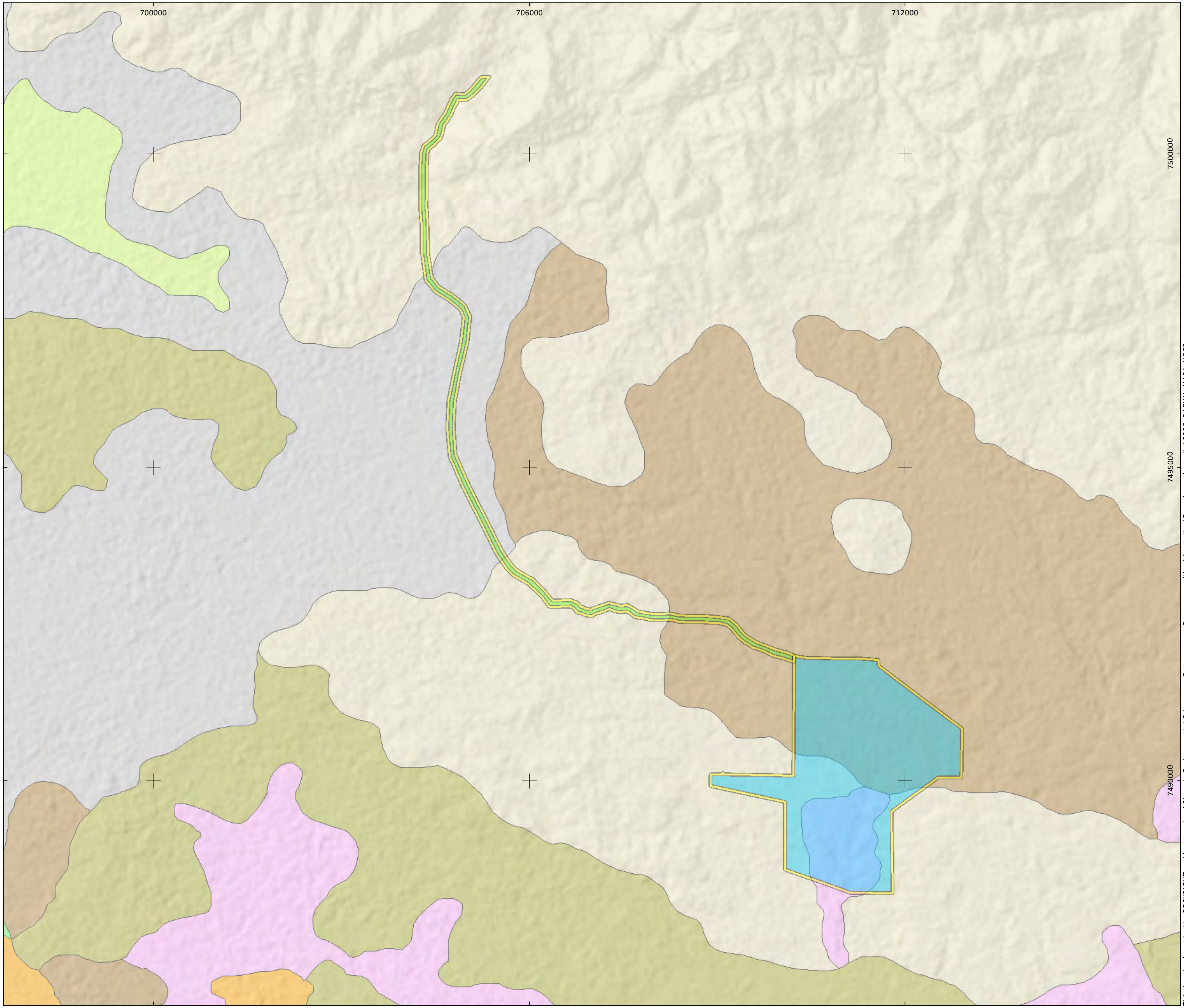


3.3 Climate and weather

The Pilbara has a semi-desert to tropical climate with highly variable, mostly summer rainfall (Leighton 2004; McKenzie *et al.* 2009). The average rainfall is about 290 mm, ranging from a monthly average of approximately 4 mm in September to 76 mm in February. Rainfall patterns are driven by highly variable year-to-year cyclonic activity that accounts for half of the yearly precipitation (McKenzie *et al.* 2009). Average annual (pan) evaporation in the Pilbara is approximately 3,400 mm per year (Department of Agriculture 2003), which greatly exceeds annual rainfall.

The nearest Bureau of Meteorology (BOM) weather station that records rainfall is located Marillana (Latitude: 22.63°S Longitude: 119.41°E) approximately 35 km east of the study area. Newman Airport (Latitude: 23.36°S Longitude: 119.73°E) approximately 130 km SE of the study area is the closest weather station that records temperature. Marillana has an average annual rainfall of 26.8 mm (Figure 3-3). Newman has a mean maximum temperature of 39.1°C in January and 23.0°C in July (Figure 3-4).

In the months preceding the field survey, rainfall at Marillana was considerably higher than the average for January 2014, but lower than the average in February and March 2014 (Figure 3-3). Temperatures at Newman Airport in March 2014 exceeded the average for the months (Figure 3-4).

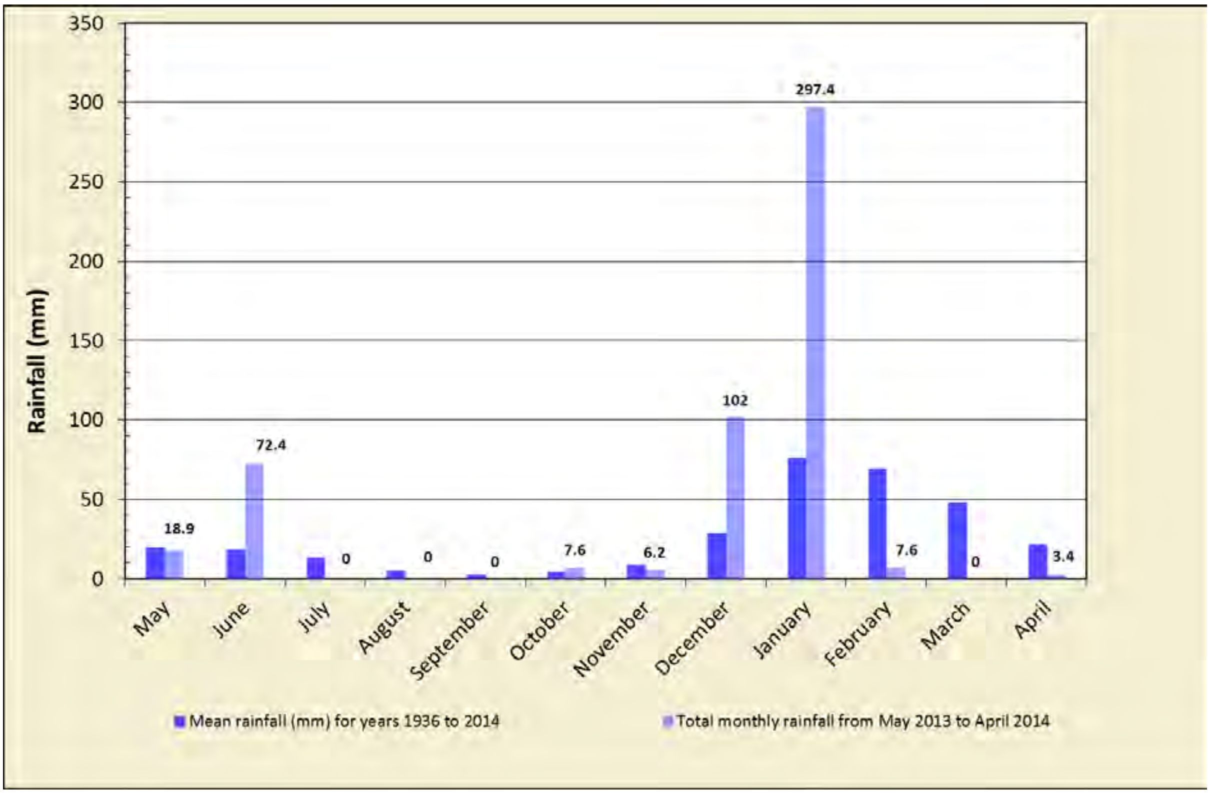


Figure 3-3 Rainfall data (monthly mean and year preceding survey) for Marillana (BOM 2014)

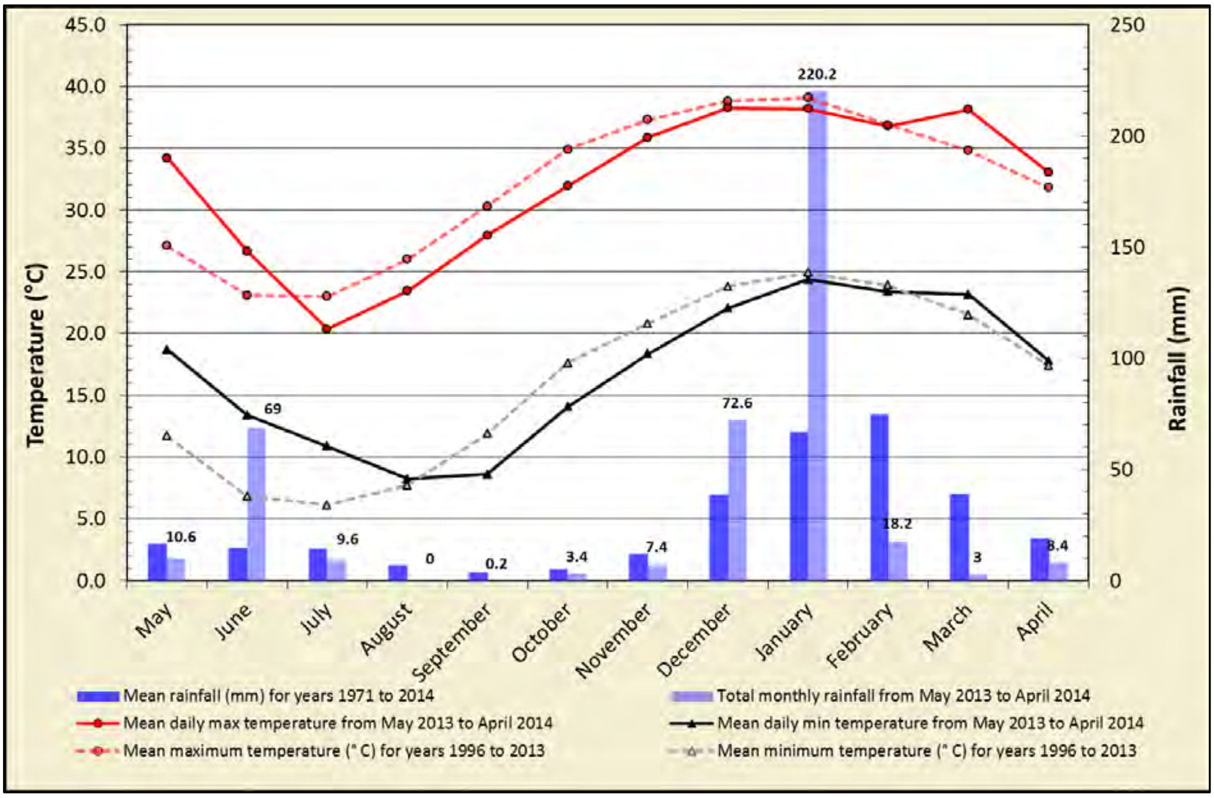


Figure 3-4 Temperature and rainfall records (long term averages and year preceding survey) for Newman (BOM 2014)

3.4 LAND USE

The Pilbara region was historically dominated by native grazing and pastoral activities. Current land use in this region is more diverse, comprising pastoral grazing, mineral exploration and mining activities, and dedication of land to Crown Reserves (e.g. Jigalong Aboriginal Reserve, Karijini National Park and Millstream National Park (van Vreeswyk *et al.* 2004). In 2009, land tenure in the broader Pilbara region was approximately 60% pastoral lease, 10% conservation reserve, 5% Aboriginal Reserve and 25% unallocated Crown land (UCL) (McKenzie *et al.* 2009). Within the Hamersley subregion, dominant land uses are grazing, UCL and crown reserves, native pastures, conservation, mining and urban (Kendrick 2001b).

3.5 THREATENING PROCESSES

There are several threatening processes to the vertebrate and invertebrate fauna of the Pilbara region (Kendrick 2001a, b; Kendrick & McKenzie 2001; Kendrick & Stanley 2001):

- **Wildfire and alteration of fire regimes**: Over 72% of the Pilbara region was burnt between 1993 and 2006 (van Leeuwen *et al.* 1995). For example, the extent of mulga woodland in the Central Hamersley Range is decreasing as a consequence of too-frequent fires. These woodlands support assemblages of species, including vertebrates and SREs, which do not persist in the spinifex scrublands that are replacing the mulga.
- **Habitat alteration through grazing**: Livestock grazing started depleting the native grass cover along the main river channels in the early 1900s, resulting in increasingly occluded drainage systems with substantial bed loads. Simultaneously, the introduced Buffel Grass (*Cenchrus*

ciliaris) rapidly colonised alluvial surfaces via these river systems. Subsequently, it has displaced indigenous shrubs and grasses from a variety of Pilbara environments (McKenzie *et al.* 2009).

- **Spread of introduced fauna including unmanaged livestock and feral bees:** Twelve introduced mammals compete with and/or prey on indigenous species in the Pilbara, including house mice, black rats, feral dogs and cats, red fox, European rabbit, brumbies, feral pigs and camels (see also McKenzie & Burbidge 2002).
- **Spread of weeds**: A total of 103 weed species are currently established in the Pilbara comprising 6.3% of the region's flora. Fourteen of these species alter the region at a landscape scale by altering fire patterns, modifying soil characteristics or competing directly with native species (Keighery 2010).
- **Habitat destruction through mining and associated infrastructure:** Several large-scale mining and infrastructure developments are present in the Pilbara. The cumulative effects of these projects are not well understood and include habitat fragmentation and edge effects (EPA 2009b). Large scale projects such as these and associated infrastructure developments such as railways also potentially impact surface and sub-surface hydrology which in turn may affect surface vegetation and therefore dependent fauna species and assemblages.
- **Climate change**: Current predictions suggest that the Pilbara region may become warmer with more hot days and fewer cold nights and may experience less annual rainfall. Droughts may be more severe and storm events become more common (McKenzie *et al.* 2009). These changes may enhance the effects of other threatening processes, in particular the likelihood of fire and the introduction of more species from the tropics.

3.6 CONSERVATION RESERVES

There are no conservation reserves within the Combined Study Area. Karijini National Park lies approximately 40 km west of the MSA and approximately 30 km west of the northern end of the RSA and covers approximately 620,000 ha of the Hamersley Range (Figure 1-1). It is characterised by steep gorges providing deep permanent pools influencing its considerable diversity (Department of the Environment 2014b).

The Fortescue Marsh is located approximately 15 km north-east of the Combined Study Area. Although not formally protected, the marsh is a significant wetland. It is the largest ephemeral wetland in the Pilbara region and is recognised as nationally important (EPA 2013). The Combined Study Area does not reside within any of the marsh management zones (EPA 2013).

3.7 BIOLOGICAL CONTEXT

The Pilbara accommodates a rich species assemblage comprising of a diverse array of vertebrate and invertebrate fauna (van Vreeswyk *et al.* 2004). Fauna within the region have adapted to survive in the harsh Pilbara climatic regime. Several Pilbara fauna species are listed as threatened or priority species in need of protection or research.

A comprehensive biological survey of the Pilbara was conducted by the Department of Environment and Conservation (DEC) from 2002–2007 (McKenzie *et al.* 2009). This survey provided a benchmark for environmental assessment studies in the Pilbara, as it comprehensively surveyed the biota and summarised fauna and floristic data for the region for many groups of plants and animals. Survey data have provided substantial background information on the small mammal, bat and bird fauna of the region (Baynes & McDowell 2010; Burbidge *et al.* 2010; Gibson & McKenzie 2009; McKenzie &

Bullen 2009) and for selected invertebrates, including target SRE taxa such as spiders (Durrant *et al.* 2010) and scorpions (Volschenk *et al.* 2010).

3.7.1 Vertebrate fauna

Within the Pilbara bioregion there are currently 44 declared threatened (CR, EN, VU; definitions provided in section 2) fauna (15 mammals, 14 birds, 11 reptiles and four fish) and 34 Priority (P1–P4) species (10 mammals, seven birds, 16 reptiles and one fish) (DPaW 2013; Western Australian Government 2013). The Pilbara bioregion is relatively high in endemism with 22 described bioregional endemic vertebrate species and several undescribed species only recorded from the bioregion (Catullo *et al.* 2011; Doughty *et al.* 2011; Doughty *et al.* 2012; Doughty & Oliver 2011; Doughty *et al.* 2010; McKenzie *et al.* 2003; McKenzie *et al.* 2009).

3.7.2 Short-range endemic invertebrates

Short-range endemic (SRE) fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km^2, that may also be disjunct and highly localised (Harvey 2002; Ponder & Colgan 2002). Short-range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002), relictual short-range endemism and dispersal of habitat specialists. Relictual short-range endemics are believed to have had wider distributions, but with a drying climate over the last 60 million years, hospitable habitats only persisted in small pockets where moist conditions remain, such as south-facing rock faces or slopes of mountains or gullies. In contrast, habitat specialist SREs may have settled in particular isolated habitat types by means of dispersal and evolved in isolation into distinct species. Such habitat islands include in particular rocky or granite outcrops. However, SRE invertebrates have also been reported in more widespread habitats such as spinifex plains or woodlands and here mainly in groups with low dispersal capabilities such as mygalomorph spiders and millipedes.

Short-range endemic fauna need to be considered in environmental impact assessments (EIA) as localised, small populations of species are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa (EPA 2009a).

There can be uncertainty in categorising a specimen as SRE due to a number of factors including poor regional survey density, lack of taxonomic research and problems of identification, i.e. specimens that may represent SREs cannot be identified to species level based on the life stage at hand. For example, in contrast to mature males, juvenile and female millipedes, mygalomorph spiders and scorpions cannot be identified to species level. Molecular techniques such as 'barcoding' (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome taxonomic or identification problems.

Currently, there is no accepted system to determine the likelihood that a species is an SRE. The WA Museum has recently introduced a three tier-rating (confirmed, potential and not SRE) (Western Australian Museum 2013). Phoenix employs a system that differentiates an additional level of short-range endemism, 'likely' which better facilitates setting conservation or management priorities (Table 3-2). Any SRE categorisation of a taxon is based on the information available at the time. As new information emerges from additional surveys, the SRE status may change and therefore the SRE status is dynamic.

Table 3-2 Phoenix SRE categories reflecting survey, taxonomic and identification uncertainties

SRE category	Criteria	Typical representative
Confirmed	Confirmed or almost certainly SRE; taxonomy of the group is well known (but not necessarily published); group well represented in collections, in particular from the region in question; high levels of endemism in documented species; inference is often possible from immature specimens	*Antichiropus* millipedes; some mygalomorph spiders (e.g. genus *Swolnpes*)
Likely	Taxonomically poorly resolved group; unusual morphology for the group (i.e. some form of troglomorphism); often singleton in survey and few, if any, regional records	Harvestman (i.e. in the genus *Dampetrus*), some millipedes (i.e. Siphonotidae) and isopods (family Philosciidae)
Potential	Taxonomically poorly resolved group; often common in certain microhabitats in SRE surveys (i.e. litter dwellers), but no other regional records; congeners often widespread	Most trapdoor spiders (Mygalomorphae) and flat-rock spiders (Selenopidae), many isopods (i.e. genus *Buddelundia*)
Widespread	Taxonomically well resolved (but often not published) and demonstrated wide distribution (i.e. > 10,000 km^2)	

4 METHODS

4.1 DESKTOP REVIEW

A separate fauna and flora desktop review was conducted for the Project prior to the commencement of the terrestrial fauna surveys (Phoenix 2014). Fauna database searches and a literature review conducted as part of the desktop review are applicable to the current Combined Study Area and are used in this report.

The habitat assessment completed as part of the desktop review (Phoenix 2014) only covered parts of the current Combined Study Area. Additional desktop habitat mapping was conducted for the remaining, unmapped areas as part of this survey by referencing land systems of the region (van Vreeswyk *et al.* 2004), aerial photography (incl. Google™ Earth) and topographic maps. Habitats identified in previous reports within the vicinity of the Combined Study Area were also reviewed for vertebrate fauna habitat delineation (Biota 2012a, b, c, e, f, g, h; Ecologia 2009; Western Wildlife 2008).

4.2 FIELD SURVEY

A combined Level 1 vertebrate fauna and Level 2 SRE invertebrate fauna survey was undertaken from 27 March to 5 April, 2014 to assess habitat quality and the likelihood of occurrence of conservation significant species in the Combined Study Area.

4.2.1 Habitat assessment and site selection

Site selection for the field survey was based on the habitats identified during the desktop review, including Phoenix (2014), which were then refined after ground-truthing during the field survey. At the broadest scale, site selection considered aspect, topography and land systems. At the finer scale, consideration was given to proximity to water bodies (ephemeral drainage lines and creeks), vegetation structure and condition, including recent fire history and soil type.

Sites were primarily chosen to:

- represent the best examples of habitats with the potential to support conservation significant vertebrate or SRE invertebrate fauna species
- represent the best examples of the broader habitat associations of the Combined Study Area
- best inform the assessment process, e.g. possible impact/non-impact areas based on the extent of mesas (target resource) and proposed impact areas.

4.2.2 Vertebrate fauna

A total of 22 sites were surveyed for vertebrate fauna covering all pit areas and main infrastructure areas as well as some non-impact sites (Appendix 1; Table 4-1; Figure 4-1). Each survey site was assessed for habitat significance and actively searched, with particular attention given to targeting species of conservation significance. Opportunistic observations were recorded at each site and while moving within the Combined Study Area. Twenty infra-red remote sensor camera traps and three SM2BAT SongMeter recording devices were also deployed within the Combined Study Area (Table 4-1; Figure 4-1). Habitat descriptions were recorded at each of the combined survey sites (Appendix 1).

No systematic avifauna surveys were undertaken during the survey; however, observed species were recorded. No spotlighting for nocturnal species was undertaken during the field survey due to logistic constraints; however, additional time was allocated to target diurnal retreat sites of nocturnal species, particularly reptiles.

Table 4-1 Survey effort for vertebrate fauna

Location	Opportunistic sites (#)	Camera trap (# deployed)	SongMeter (overnight recording)
Mine – northern pit	8	6	1
Mine – south-eastern pit	1	-	-
Mine – south-western pit	2	3	-
Mine – infrastructure area	1	-	-
Mine – non-impact	4	7	1
Haul road	6	4	2
Total	**22**	**20**	**4**

Survey work was undertaken over seven consecutive days and comprised:

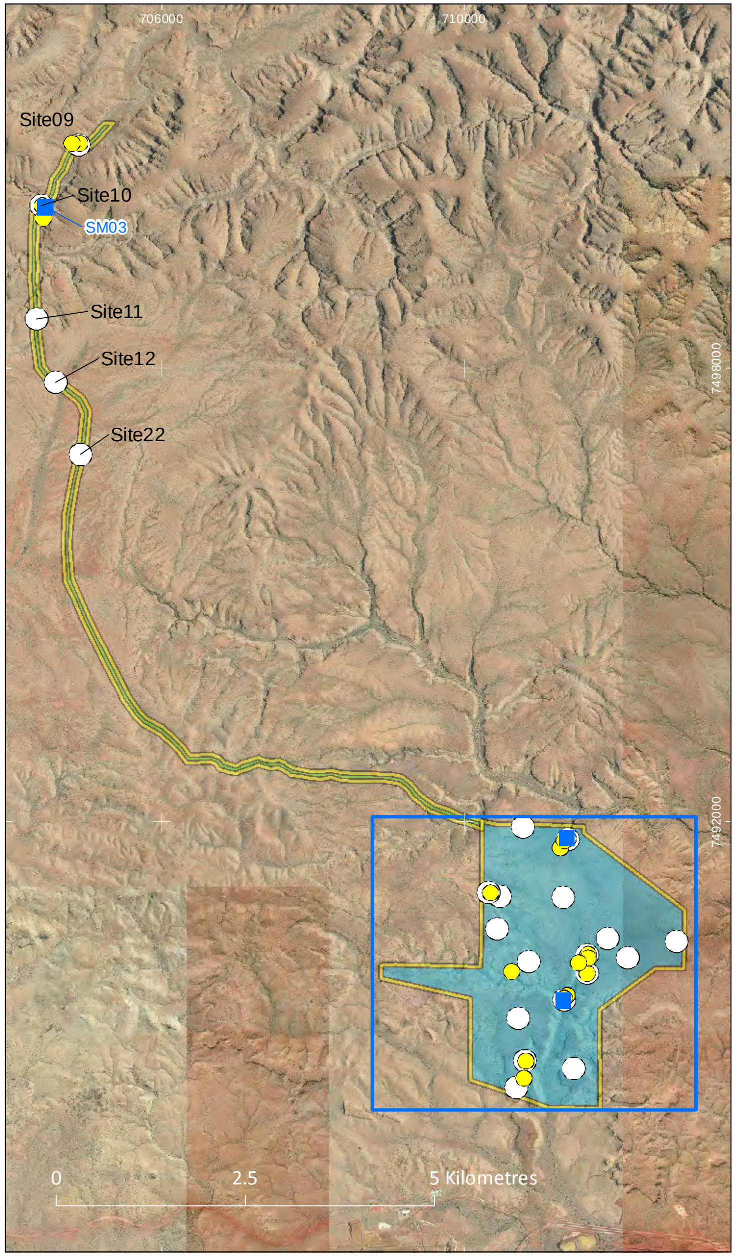
- active searches (see 4.2.2.1)
- targeted searches for species of conservation significance (see 4.2.2.2)
- opportunistic records (see 4.2.2.3)
- infrared motion sensor camera trapping (see 4.2.2.4)
- bat echolocation call recordings (see 4.2.2.5).

The survey components are described in more detail in the sections 4.2.2.1 to 4.2.2.5.

4.2.2.1 Active searches

Active surveys comprised searches of any observable microhabitats likely to support mammals, reptiles and amphibians. Searches aimed to record any vertebrate fauna species from direct sightings and secondary evidence of species occurrence. Active surveys comprised searches of any observable microhabitats likely to support target taxa.

Active search techniques included raking leaf and bark litter, overturning logs and rocks, searching beneath the bark of trees, investigating dead trees and fallen logs, burrows, rock piles and identifying any secondary evidence including tracks, diggings, scats, fur or sloughs (shed skins), predation or feeding sites, and fauna constructed structures such as pebble mounds. Active searches were undertaken at all opportunistic sites for a minimum of one person hour per site and totalled 26 hours over the survey period.



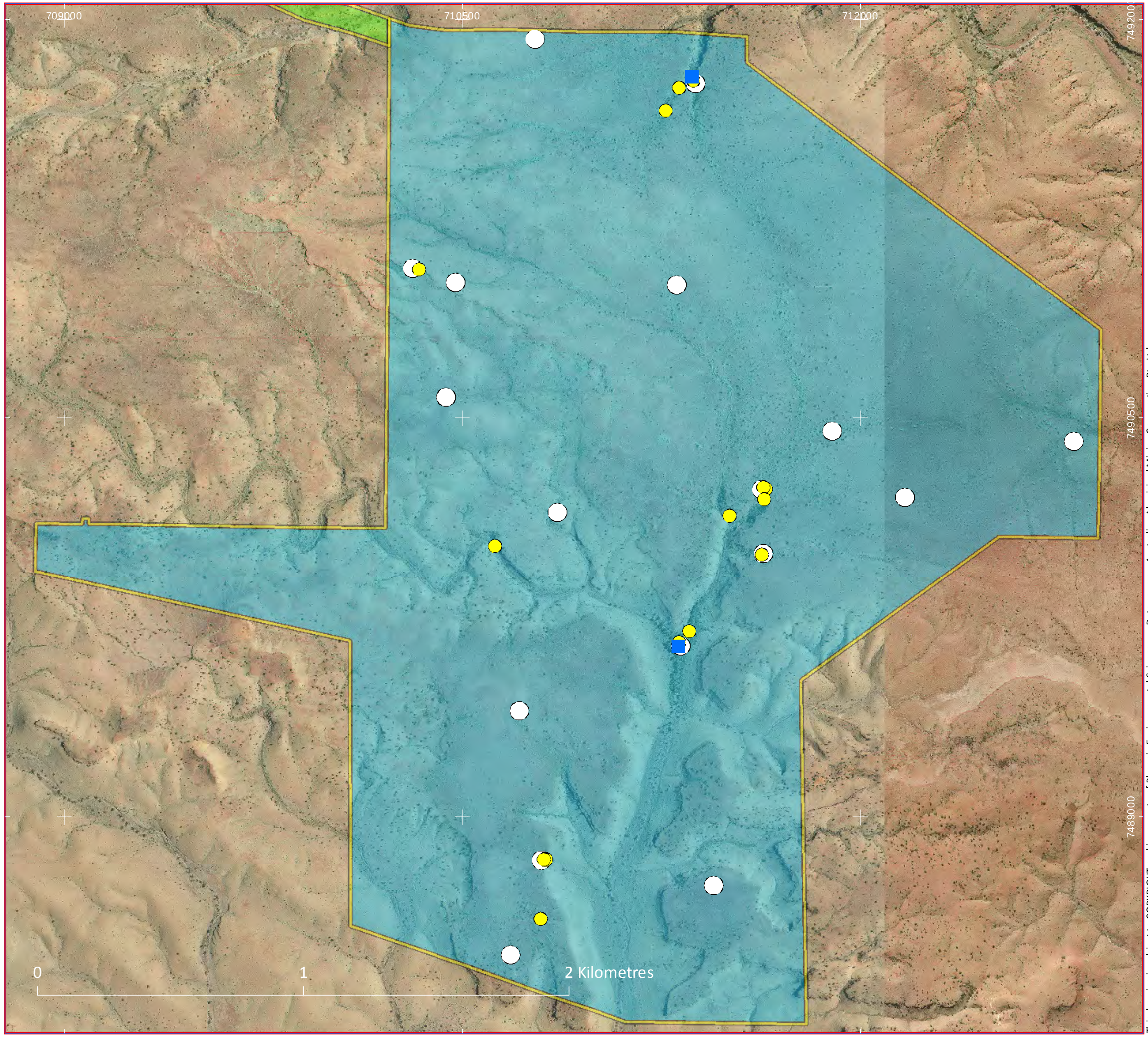


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Figure 4–1

Survey sites,camera trap and SongMeter locations for the Extension Project terrestrial fauna survey

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Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

Song meter
Camera trap
Survey site
Road Study Area
Mine Study Area

4.2.2.2 Targeted searches for species of conservation significance

Targeted searches were undertaken for evidence of specific conservation significant species presence. These searches were mainly undertaken within gullies/gorges, caves and creeklines. The targeted species included (but were not limited to):

- Northern Quoll (*Dasyurus hallucatus*; EN-EPBC Act, S1-WC Act)
- Pilbara Olive Python (*Liasis olivaceus barroni*; VU-EPBC Act, S1-WC Act)
- Orange Leaf-nosed Bat (Pilbara form; *Rhinonicteris aurantia*; herein referred to as Pilbara Leaf-nosed Bat; VU-EPBC Act; S1-WC Act)
- various species of lesser conservation significance.

Targeted searches primarily involved searching for secondary evidence of species presence such as tracks, scats, feeding sites or fauna constructed structures. Targeted search methods followed those identified in threatened fauna survey guidelines (DSEWPaC 2010, 2011c, d).

For Northern Quoll, searches for scats and latrine sites were conducted in areas of suitable habitat, particularly areas containing boulder piles or rocky sites considered suitable for denning or shelter sites, in accordance with the referral and survey guidelines for the species (DSEWPaC 2011c; DSEWPC 2011). In addition remote sensor camera traps were deployed in areas of suitable habitat (see section 4.2.2.4).

Searches for Pilbara Olive Python were conducted in suitable habitats where water was present or was considered likely to persist for longer periods after rainfall.

Pilbara Leaf-nosed Bat and Ghost Bat (*Macroderma* gigas; P4-DEC) were targeted by searching areas considered likely to provide suitable caves or overhangs that may be used to roost or feed. Any caves located were examined for evidence of feeding or roosting individuals. Bat echolocation call recording devices were deployed in areas of suspected movement by these species (see section 4.2.2.5).

Low hill slopes within the Combined Study Area were searched for secondary evidence of Western Pebble-mound Mouse (*Pseudomys chapmani*; P4 DEC), particularly the distinctive pebble mound constructed by the species. Field staff walked transects across areas of potential habitat in search for active, abandoned or relic mounds.

4.2.2.3 Opportunistic records

All opportunistic observations of vertebrate species were recorded during the survey. Opportunistic or non-systematic sampling involved recording all sightings of vertebrate fauna species within the Combined Study Area.

4.2.2.4 Infrared motion sensor camera trapping

A total of 20 infrared motion-sensor camera traps (Reconyx Hyperfire™ HC600 and Bushnell Trophy Cam™) were deployed for between three and seven consecutive nights during the field survey (Figure 4-1; Appendix 2).

Traps were deployed in areas that showed signs of animal movement or disturbance, provided a resource such as food or water (such as pools of collected rainwater), or provided potential habitat for conservation significant species. Most cameras were deployed in habitat considered suitable to support Northern Quoll.

Camera traps were set to take between three and ten photos or collect between ten every time movement was detected, 24 hours a day for the duration of deployment. The cameras contained no-glow infrared sensors and flashes to minimise disturbance to nocturnal species. Some camera traps were baited using a universal bait mix to lure fauna into the detection zone.

4.2.2.5 Bat echolocation call recordings

Two SongMeter 2 recording devices were used to record bat echolocation calls at three opportunistic sites within the Combined Study Area (Figure 4-1; Appendix 2). In total, four nights of recording were conducted, recording between eight and 12 continuous hours per night.

Recording devices were deployed horizontally at height or aimed at a 45° angle from the ground, and were set to record overnight. Areas of habitat likely to support bat species or areas of expected movement such as gorges, gullies and drainage were targeted. SongMeter deployments particularly targeted Ghost Bat and Pilbara Leaf-nosed Bat.

The recorded data was analyzed by Mr. Bob Bullen, Bat Call WA.

4.2.3 Short-range endemic invertebrates

A total of 22 SRE invertebrate fauna sites were surveyed (Figure 4-1; Appendix 1). The collecting methods consisted of two proven, industry-recognised sampling techniques to target SRE taxa: hand foraging, and the sieving of combined leaf litter and soil samples (Table 4-2). Habitat descriptions were recorded at each of the combined survey sites (Appendix 1).

4.2.3.1 Foraging

Foraging was undertaken at each site and incorporated the systematic inspection of logs, larger plant debris, the underside of bark of larger trees and the underside of rocks. Methodical searches were conducted amongst the leaf litter of shade-bearing tall shrubs and trees and spinifex bases were inspected thoroughly. Rocks and rock crevices were inspected, particularly for pseudoscorpions.

A standardised approach was undertaken, whereby each site was sampled for a minimum of 0.5 person hours. Specimens of the target taxa were immediately fixed in absolute ethanol (EtOH) to preserve tissue for future molecular analyses.

Table 4-2 Summary of survey effort for the short-range endemic invertebrates

Site	Collecting techniques[a]	Foraging time (mins)	Litter sifts (no.)
Site01	FO, LS	30	3
Site02	FO, LS	30	3
Site03	FO, LS	30	3
Site04	FO, LS	30	3
Site05	FO, LS	30	3
Site06	FO, LS	30	3
Site07	FO, LS	30	3
Site08	FO, LS	30	3
Site09	FO, LS	30	3
Site10	FO, LS	30	3
Site11	FO, LS	30	3
Site12	FO, LS	30	3
Site13	FO, LS	30	3
Site14	FO, LS	30	3
Site15	FO, LS	30	3
Site16	FO, LS	30	3
Site17	FO, LS	30	3
Site18	FO, LS	30	3
Site19	FO, LS	30	3
Site20	FO, LS	30	3
Site21	FO, LS	30	3
Site22	FO, LS	30	3

[a] FO – foraging; LS – litter and soil sieve.

4.2.3.2 Litter/soil sieving

A minimum of three combined leaf litter and soil samples were taken at each site (Table 4-2). The collection of leaf litter samples were standardised volumetrically by the diameter and height (310 mm x 50 mm = 1.55 L) of the sieves which were completely filled with compressed litter and the upper layers of underlying soil.

Samples were sieved through three stages of decreasing mesh size over a round tray and invertebrates were picked from the sieves and tray with forceps.

These samples particularly targeted small spiders (Araneomorphae), pseudoscorpions, buthid scorpions, millipedes, centipedes (in particular Geophilomorpha and Cryptopidae), smaller species of molluscs (e.g. Pupillidae) and slaters.

In situ collecting and sieving is preferred over transporting litter samples to the laboratory. Small invertebrates are best detected when moving and transport to the laboratory can kill a large proportion of the catch. In addition, if litter sieves in the field contain groups of interest, more extensive searches can be conducted, providing greater flexibility in the sampling protocol.

4.3 TAXONOMY AND NOMENCLATURE

4.3.1 Morphological species identification

The nomenclature follows a number of taxon-specific references (Table 4-3). However, many invertebrate species are currently unnamed requiring morphospecies designation as listed in this report. These are adopted from the nomenclatural systems developed by the respective taxonomic authorities (Table 4-3). Reference collections for these morphospecies generally reside with WA Museum as expected by EPA (2004).

Table 4-3 Nomenclatural references, morphospecies designations and reference collections

Taxonomic group	Taxonomic reference for described species and higher taxa	Morphospecies designation and reference collection (invertebrates only)
Mammals	Menkhorst and Knight (2011)	
Birds	Simpson and Day (2010); Christidis and Boles (2008)	
Reptiles	Wilson and Swan (2013)	
Amphibians	Tyler and Doughty (2009)	
Araneae	Platnick (2014); Framenau (2014b)	“MYG”-numbering system for Mygalomorphae developed by V.W. Framenau (WAM, Phoenix) and continued by WAM, reference collection at WAM
Pseudoscorpiones	Harvey (2011)	“PSE”-morphospecies designations developed by M. Harvey (WAM), reference collection at WAM
Scorpiones	Rein (2011); Fet *et al.* (2000), Glauert (1925), Koch, (1977), Kovařík (1997), Kovařík (2002), Volschenk and Prendini (2008), Volschenk *et al.* (2000) Volschenk *et al.* (2012)	Morphospecies designation developed by E.S. Volschenk (Phoenix, WAM), reference collection at WAM

Taxonomic group	Taxonomic reference for described species and higher taxa	Morphospecies designation and reference collection (invertebrates only)
Eupulmonata[a]	Smith (1992); C. Whisson (Collection Manager: Non-Marine Aquatics, WA Museum, Department of Aquatic Zoology, pers. comm.)	Morphospecies designations developed by C. Whisson and S. Slack-Smith (WAM); reference collection at WAM
Geophilomorpha	Colloff *et al.* (2005)	
Isopoda	Schotte *et al.* (2008)	Morphospecies designations developed by S. Judd, reference material at Phoenix and WAM

[a] For practical purposes, Eupulmonata (land snails) is here considered an order (Department of the Environment 2014a); however, it is acknowledged that Bouchet *et al.* (2005) consider it a rank-free clade.

Recent changes in the taxonomy and nomenclature of vertebrates have also been incorporated; for example:

- The Pygmy Spiny-tailed Skink (*Egernia depressa*) species complex was recently revised and *E. depressa* was replaced in the Pilbara region with the Western Pygmy Spiny-tailed Skink (*E cygnitos)* and the Eastern Pilbara Pygmy Spiny-tailed Skink (*E. epsisolus*) (Doughty *et al.* 2011).
- The arid zone *Diporiphora* species were revised and three new Pilbara species were described (*D. addunctus, D. paraconvergens* and *D. vescus*) with *D. weneckii* no longer considered to occur in Western Australia (Doughty *et al.* 2012)
- The Western Australian arid zone *Uperoleia* were revised resulting in the description of a new Pilbara species, the Pilbara Toadlet *U. saxatilis* (Catullo *et al.* 2011).

Phoenix has considerable in-house expertise in the identification of fauna, including that of all SRE target groups. Senior staff members involved in the identification of SREs are also Research Associates with a longstanding taxonomic research history at the WA Museum (Table 4-4).

Table 4-4 Taxonomic specialists that identified the vertebrate fauna and SRE invertebrates from the Extension Project

Fauna	Personnel	Taxonomic group/s
Vertebrates	Mr Ryan Ellis[1, 2]	Amphibia, Reptilia, Mammalia
	Mr Bob Bullen[4]	Mammalia - Chiroptera (bats)
Short-range endemic invertebrates	Dr Volker W. Framenau[1, 2]	Araneae, Diplopoda
	Dr Erich S. Volschenk[1, 2]	Scorpiones, Pseudoscorpiones
	Ms Anna Leung[1]	Pseudoscorpiones
	Mr Nicholas Dight[1]	Eupulmonata
	Dr Simon Judd[1]	Isopoda
	Mr Corey Whisson[3]	Eupulmonata
	Dr Mark Harvey[3]	Pseudoscorpiones

[1] Phoenix Environmental Sciences; [2]Research Associate WA Museum; [3]WA Museum; [4]freelance taxonomic consultant/ sub-contractor.

4.3.2 Genomic species identification

A taxonomic framework based on morphology is lacking for many subterranean invertebrates. In addition, some life stages of many invertebrates, for examples juveniles or females, lack morphological characters for species identifications. In this case, genomic species identification provides a valuable tool to assess species-level boundaries.

The gene COI contains variation that is widely accepted at being able to distinguish different species from one another (Hebert *et al.* 2003a; Hebert *et al.* 2003b). Hebert *et al.* (2003a) found that members of the same species rarely differed by more than 2% sequence divergence. Hebert *et al.* (2003b) compared COI sequences from over 13,000 species pairs and found that:

- on average, species differed from each other by about 11.1%
- species pairs diverged from each other by more than 8% sequence divergence in approximately 80% of pairwise comparisons.

A grey area therefore lies between 2% and 8% sequence divergence. Genetic divergences between 2% and 8% may indicate:

- allopatric populations in the process of speciation
- sympatric populations with narrow genetic exchange, or
- specimens from widely separated populations of the same species.

A juvenile wall crab spider, *Karaops* sp. indet. (family Selenopidae), collected in the Combined Study Area, was subjected to COI barcoding analysis. Sequences from Phoenix' DNA database were included in the analysis. Additional sequences for comparison were also sourced from GenBank (Benson *et al.* 2012) using the megablast search function in Geneious (Biomatters 2013). The sequence data was submitted to the WA Museum for comparison with their COI database (Dolman 2014).

4.4 STATISTICAL ANALYSES

A minimum of 20 individuals collected is recommended for species richness estimates and estimates are only calculated for those groups of which a minimum of 20 records are available (Gotelli & Colwell 2001). Due to the low number of specimens collected during the survey species richness estimates were not calculated for any group.

4.5 PROJECT PERSONNEL

The personnel involved in the survey are presented (Table 4-5).

Table 4-5 Project team

	Name	Qualifications	Role/s
Vertebrate fauna	Mr Jarrad Clark	B.Sc. (Env. Mgmt)	Project manager
	Mr Ryan Ellis	Dip. (Cons. Land Mgmt)	Field survey, taxonomy, report writing
	Mr Bob Bullen	B. Eng. (Aero. Eng.)	Bat echolocation analysis
Short-range endemic invertebrate fauna	Dr Volker W. Framenau	M.Sc. (Cons. Biol.), Ph.D. (Zool.)	Project manager, report review
	Dr Erich Volschenk	B.Sc. (Env. Biol.) (Hons) Ph.D. (Zool.)	Taxonomy, report review, genomic analyses
	Dr Simon Judd	Ph. D. (Env. Mgmt)	Taxonomy
	Mr Nicholas Dight	B.Sc. (Biol.)	Field survey, taxonomy, report writing
	Ms Anna Leung	B.Sc. (Env. Sci.) (Hons)	Taxonomy
GIS	Mr Guillaume Bouteloup	Ad. Dip. (Cons. Land Mgmt.)	GIS
Report QA	Mrs Karen Crews	B.Sc. (Env. Biol.) (Hons)	Report review

5 RESULTS

5.1 DESKTOP REVIEW

A summary of results of the desktop review for vertebrate fauna (Phoenix 2014) are presented in Appendix 3. Refer to the source report for detailed results of the earlier desktop review.

5.2 FIELD SURVEY

5.2.1 Habitats of the Combined Study Area and sites sampled

The Combined Study Area is largely homogenous in terms of fauna habitat, represented mostly by hummock and tussock grassland on plateau of gently rolling hills (Table 5-1; Figure 5-1). Other less-represented habitats in the Combined Study Area include; mesa and rocky slope, minor drainage lines, gullies, and mixed shrubland (Table 5-1). The major habitat of the Combined Study Area, hummock and tussock grasslands and mixed shrubland habitats provide limited vegetation structure and complexity and do not readily retain water in the landscape.

The Combined Study Area contains six fauna habitats (Table 5-1; Figure 5-1)**:**

- Hummock and tussock grassland – 58.3% of the Combined Study Area is comprised of hummock and tussock grassy plains (Table 5-1), generally associated with stony substrates around mesas and rock hill slopes though to clay loam substrates on grassy plains.
- Open and closed shrubland – a mix of open and closed shrubland habitats containing small to large shrub species represent 26.9% of the Combined Study Area (Table 5-1). Shrubland habitats provide sheltering and nesting opportunities for a wide range of vertebrate fauna species as well as foraging habitat.
- Mesa and rocky hill slope – this habitat represents 9.4% of the Combined Study Area (Table 5-1) and comprises mesa edges and bordering rocky hill slopes.
- Gully – a small portion (2.7%) of the Combined Study Area is covered by minor and major gully systems (Table 5-1). Gully systems are located along mesas and are generally associated with creek or drainage lines. Vegetation within the gully systems is more protected than other habitats and often supports mixed species including tall eucalypts, mixed shrubs and grasses, particularly *Triodia.* A number of gullies contain steep rocky sides with fallen rock piles.
- Minor creek and drainage line – creek and drainage lines cover 1.8%, only a small area of the Combined Study Area (Table 5-1). Most are bordered by sparse vegetation with spinifex or mixed shrubs and are likely to flow only after heavy or continuous rains. Some creek lines across the Combined Study Area, particularly between the southern mesas and within major gullies are more vegetated and structurally complex.
- Gorge – this habitat type represents 0.9% of the Combined Study Area (Table 5-1) and is located only in the northern most portion of the RSA. It comprises deep steep-walled rocky gorges with mixed vegetation. Pooling water was observed during the survey; however, its permanency is unknown.

Table 5-1 Fauna habitats of the Combined Study Area and extent of occurrence

Habitat	Total area (ha)	Percentage
Hummock and tussock grassland	534.1	58.3 %
Open and closed shrubland	246.6	26.9 %
Mesa and rocky hill slope	86.1	9.4 %
Gully	25.2	2.7 %
Minor creek and drainage line	16.7	1.8 %
Gorge	8.0	0.9 %
Total area	**916.7**	100 %

Figure 5–1
Terrestrial fauna habitat types within the Combined Study Area

PHOENIX ENVIRONMENTAL SCIENCES

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

0 0.5 1 Kilometres
1:35,000

Mine & Road Study Areas

Terrestrial fauna habitats

- Minor creek and drainage line
- Gorge
- Gully
- Hummock and tussock grassland
- Mesa and rocky hill slope
- Open and closed shrubland

The 22 survey sites sampled during the field survey represented the full range of fauna habitats within the Combined Study Area (Table 5-2; Figure 5-1). Seventeen survey sites were located in proposed impact areas (Table 5-2; Figure 5-1). Site descriptions of the survey sites detail geography, vegetation, soil, rockiness, litter, disturbance and include site photographs (Appendix 1).

A total of 736 motion triggers were recorded from camera traps resulting in 5,428 images collected.

Table 5-2 Survey sites of the terrestrial fauna survey for the Extension Project

Site	Habitat type	Impact area	Latitude (GDA94)	Longitude (GDA94)
Site01	Gully	Yes	-22.6946	119.0521
Site02	Hill Slope – hummock grassland	Yes	-22.6752	119.0488
Site03	Gorge	Yes	-22.6681	119.0572
Site04	Gully	No	-22.6818	119.0599
Site05	Gully	Yes	-22.6840	119.0600
Site06	Drainage line	Yes	-22.6800	119.0626
Site07	Mesa	Yes	-22.6953	119.0584
Site08	Plateau – hummock grassland	Yes	-22.6895	119.0512
Site09	Gorge	Yes	-22.5859	118.9931
Site10	Gorge	Yes	-22.5931	118.9881
Site11	Plateau – hummock grassland	Yes	-22.6068	118.9879
Site12	Plain – open shrubland	Yes	-22.6143	118.9905
Site13	Breakaway – hummock grassland	No	-22.6745	119.0471
Site14	Plain – hummock grassland	Yes	-22.6667	119.0514
Site15	Gully	No	-22.6828	119.0524
Site16	Drainage line	Yes	-22.6749	119.0567
Site17	Gully	Yes	-22.6799	119.0718
Site18	Plain – hummock grassland	Yes	-22.6821	119.0652
Site19	Drainage line	No	-22.6789	119.0483
Site20	Gully	No	-22.6872	119.0569
Site21	Mesa	Yes	-22.6979	119.0509
Site22	Plain – open shrubland	Yes	-22.6229	118.9937

5.2.2 Vertebrate fauna

The survey recorded a total of 78 vertebrate species, including three amphibians, 29 reptiles, 32 birds and 14 mammals (ten native and four introduced) (Table 5-3; Appendix 3). One species endemic to the Pilbara and not previously identified in the desktop review (Phoenix 2014), the Pilbara Flame-tailed Slider (*Lerista flammicauda*), was recorded during the field survey (Appendix 3).

Table 5-3 Vertebrate taxa recorded during the survey and the total number of species potentially occurring in the Combined Study Area

Taxa	No. of species recorded during this survey in the Combined Study Area	Total no. of species potentially occurring in Combined Study Area (Phoenix 2014)
Amphibians	3	3
Reptiles	29	96
Birds	32	116
Native mammals	10	30
Introduced mammals	4	9
Total fauna species	**78**	**254**

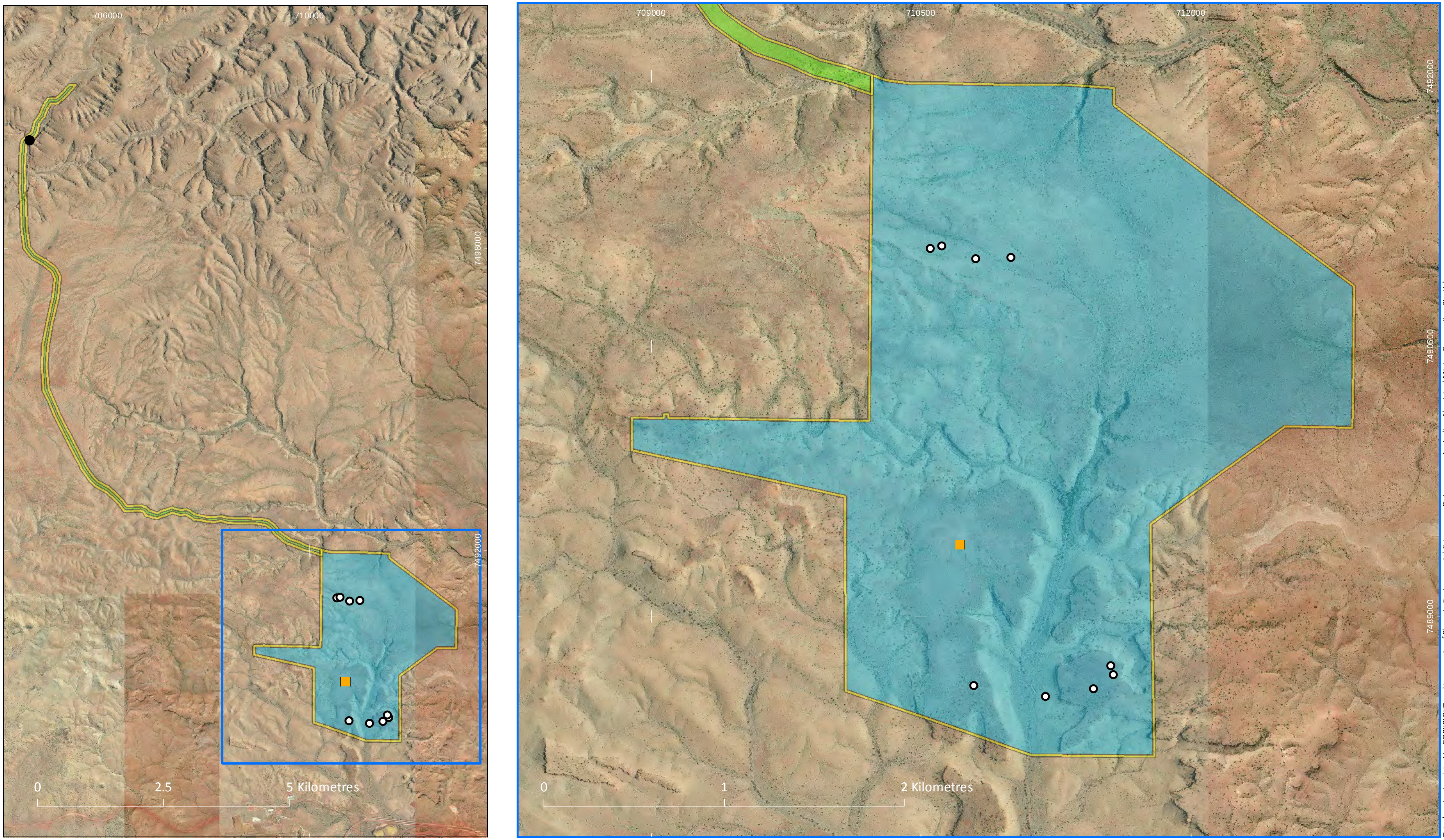

Figure 5–2
Conservation significant vertebrate fauna records from the terrestrial fauna survey for the Extension Project

PHOENIX ENVIRONMENTAL SCIENCES

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 4/07/2014

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

Conservation significant vertebrate species recorded

- Australian Bustard (P4)
- Pilbara Leaf-nosed Bat
- Western Pebble-mound Mouse (P4)

- Road Study Area
- Mine Study Area

5.2.2.1 Conservation significant species

Three species of conservation significance were recorded during the field survey from direct sightings, secondary evidence and/or echolocation recordings (Figure 5-2). The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*; VU, S1) was recorded from echolocation call recordings during the field survey (Figure 5-2). The Australian Bustard (*Ardeotis australis*; P4) was recorded from direct observations and the Western Pebble-mound Mouse (*Pseudomys chapmani*; P4) was recorded from secondary evidence (pebble mounds) and remote camera trap captures.

Potential habitat was identified in the Combined Study Area for a further 12 of the 20 species of conservation significance from the desktop review (Phoenix 2014). Records and the potential occurrence and distribution of these species within the Combined Study Area are discussed below. The remaining eight species are considered unlikely to occur due to lack of suitable habitat to support these species and are not discussed further. Migratory waterbird species may infrequently be recorded after heavy rainfall when water is abundant within the Combined Study Area; no suitable permanent habitat for these birds was identified during the survey.

Gane's Blind Snake (*Ramphotyphlops ganei*)

<u>Status:</u> Priority 1 (DPaW)

<u>Distribution and ecology:</u> Gane’s Blind Snake is a moderately robust blind snake endemic to the Pilbara region. Little is known of the ecology and habitat preference of this species, but limited records indicate that it is often associated with moist ridges and gullies. The species diet is considered to be comparable to other blind snakes consisting of primarily the eggs, larvae and pupae of ants. (Storr *et al.* 2002; Wilson & Swan 2013). The species is known from few records at scattered localities between Newman and Pannawonica (Wilson & Swan 2013).

<u>Records and likely distribution in the Combined Study Area:</u> The species was not recorded during the survey. The closest record of Gane’s Blind Snake is located approximately 7 km west of the RSA (DPaW 2014). Based on the limited knowledge of the species’ preferred habitat it is difficult to accurately determine its likelihood of occurrence; however, the presence of habitat comparable to habitats the species has previously been recorded in indicates it may occur within the Combined Study Area.

Pilbara Olive Python (*Liasis olivaceus barroni*)

<u>Status:</u> Vulnerable (EPBC Act); Schedule 1 (WC Act); Vulnerable (DPaW)

<u>Distribution and ecology:</u> The Pilbara Olive Python is a large and robust python growing to a length of 2.5–3 m on average, although 4.5–6.5 m long individuals have been recorded. The species is generally a uniform olive colour with no patterning but specimens can show some variation in colouration (Barker & Barker 1994; Smith 1981).

The Pilbara Olive Python is thought to be endemic to the Pilbara, with scattered records from across the region, including some offshore islands (Barker & Barker 1994; Pearson 2007; Smith 1981). It is commonly found in rocky areas (gullies, gorges, ridgelines, boulder piles and mesas) in association with watercourses and pools. It has also been recorded in riparian vegetation along major rivers, such as the Robe River (Barker & Barker 1994; Pearson 2003, 2007).

The Pilbara Olive Python is an opportunistic predator with a varied diet including mammals, birds and potentially frogs and reptiles. Olive Pythons will often wait in an ambush position on rock ledges, at cave entrances or at water sources for prey to come within striking distance (Barker & Barker 1994; Pearson 2007).

Records and likely distribution in the Combined Study Area: No Pilbara Olive Python were recorded during the survey. The nearest record of the species is approximately 8 km north-east of the northern most point of the RSA (DPaW 2014). Rocky gorge habitat within the RSA where pooling water was present is likely to support the species (Figure 5-1). It is unknown if water present at the sites recorded is permanent spring fed or from rainfall events preceding the survey. The vegetation assemblage of some sites (site09, site10 and site20) indicates water may be permanent or persist for longer periods.

Fork-tailed Swift (Apus pacificus)

Status: Migratory (EPBC), Schedule 3 (WC Act)

Distribution and ecology: The Fork-tailed Swift is a widespread migratory species that overwinters in Australia. It can be found across most of Western Australia and is uncommon to moderately common in the north-west. They are mostly found over inland plains, and also in foothills, coastal areas and over settlements. They occur in a wide range of dry or open habitats, including riparian woodlands, tea-tree swamps, low scrub, heathland, saltmarsh, grassland and spinifex sandplains, open farmland and inland and coastal sand-dunes. Fork-tailed Swifts are often found in areas that experience updraughts around cliffs, and normally forage several hundred metres above ground level (DSEWPaC 2011a).

Records and likely distribution in the Combined Study Area: The species was not recorded during the survey and the nearest record of the Fork-tailed Swift is located approximately 20 km north of the Combined Study Area (DPaW 2014); however, the species can occur within a wide range of habitats, including those found in the Combined Study Area and therefore it is considered likely to occasionally occur. The species is likely to forage within the Combined Study Area, although unlikely to land or nest there.

Eastern Great Egret (Ardea modesta)

Status: Migratory (EPBC Act); Schedule 3 (WC Act)

Distribution and ecology: The Eastern Great Egret can be found along inland rivers, lakes and shallow freshwater or saltwater wetlands and inundated samphire flats. This species is highly mobile and can be found throughout most of the western fringes of the State in coastal areas and towards the semi-arid interior (Johnstone & Storr 1998).

Records and likely distribution in the Combined Study Area: The Eastern Great Egret was not recorded during the survey and the nearest record is located over 50 km from the Combined Study Area (DPaW 2014). Suitable creek and drainage lines within the study area are not permanently flowing or abundant within the study area. The species may temporarily occur within the study area, particularly after rains when water is present within minor creek and drainage lines.

Cattle Egret (*Ardea ibis*)

Status: Migratory (EPBC Act); Schedule 3 (WC Act)

Distribution and ecology: The Cattle Egret is a widespread, polytypic, medium-sized member of the Ardeidae. In Australia, they are more common in eastern states than on the west coast. The species is uncommon in south-western WA and breeds in small numbers near Kununurra. The origin of the species in Australia is not certain. It may have been introduced but a natural colonisation from individuals reaching the northern coast through Indonesian islands is more probable (McKilligan 2005).

In Australia, Cattle Egrets have benefited from human settlements (irrigation, grazing). They can feed on a wide range of prey (vertebrates and invertebrates), that they find in swamps and open grasslands, inland as well as along the coast. The species is partially migratory with movement between New Zealand and Australia.

Records and likely distribution in the Combined Study Area: No Cattle Egret was recorded during the survey. The nearest record of the Cattle Egret is located approximately 30 km north of the Combined Study Area (DPaW 2014). Suitable creek and drainage lines within the study area are not permanently flowing or abundant within the study area. The species may temporarily occur within the study area, particularly after rains when water is present within minor creek and drainage lines.

Grey Falcon (*Falco hypoleucos*)

Status: Schedule 1 (WC Act); Vulnerable (DPaW)

Distribution and ecology: The Grey Falcon is a widespread but rare species inhabiting much of the semi-arid interior of Australia. Its distribution is centred on inland drainage systems. It has a large foraging range extending from timbered plains, such as *Acacia* shrublands, into open grasslands. Prey includes mainly birds (Sutton 2010) but also invertebrates and mammals. The species often utilizes old nests of other species, particularly other raptors, in the tallest trees along watercourses and sometimes in telecommunication towers (Sutton 2010).

There are no confirmed threats to the Grey Falcon but it is thought that clearing of the semi-arid zone for marginal farming has reduced habitat availability and overgrazing of arid zone rangelands may affect prey abundance (Garnett *et al.* 2011).

Records and likely distribution in the Combined Study Area: The Grey Falcon was not recorded during the survey and the nearest record for the species is located over 50 km north east from the Combined Study Area (DPaW 2014). Due to the large foraging range the species may occasionally forage on the open shrubland and grassland habitats of the Combined Study Area. If present, nesting may take place in tall established eucalypts along drainage lines.

Peregrine Falcon (*Falco peregrinus*)

Status: Schedule 4 (WC Act)

Distribution and ecology: The Peregrine Falcon is a widespread bird of prey found across Australia, with a large foraging range. In Western Australia, it can be rare or scarce to moderately common. The Peregrine Falcon's preferred habitat includes cliffs and wooded watercourses. Nesting occurs mainly on cliff ledges, granite outcrops, quarries and in trees with old raven or Wedge-tailed Eagle nests (Johnstone & Storr 1998).

Birds constitute a very large proportion of their diet, if not the exclusive part (Johnstone & Storr 1998; Ratcliffe 1980). Historically, the widespread use of DDT caused worldwide global decline of the Peregrine Falcon. The main current threat to the species in Australia is habitat loss, particularly woodland trees for nesting (DSEWPaC 2011b).

Records and likely distribution in the Combined Study Area: The Peregrine Falcon was not recorded during the survey; however, it has previously been recorded in very close proximity to the RSA with a record of less than 500 m from the RSA boundary (DPaW 2014). Due to the large foraging range the species may forage within and in the vicinity of the Combined Study Area. The species may nest on cliff edges of suitably sized gullies and gorges.

Australian Bustard (*Ardeotis australis*)

Status: Priority 4 (DPaW)

Distribution and ecology: The Australian Bustard is the heaviest flying bird in Australia (Ziembicki 2010). They are nomadic, distributed across much of the northern arid areas of the state and may be found singly, in pairs or large groups. Abundance will vary seasonally according to rainfall and food availability (Johnstone & Storr 1998). The species has a broad preference for open habitats, ranging from open grassland plains to low shrub lands and grassy open woodlands. They tend to avoid densely vegetated areas and favour flat terrain over hilly areas. They may also be associated with watercourses, particularly in more arid regions (Ziembicki 2010).

Bustards have a broad omnivorous diet that includes seeds, fruits, leaves, flowers, green shoots, various invertebrates and small vertebrates. Bustards are highly opportunistic, and will gorge on favoured food items when available (Ziembicki 2009). Breeding takes place from March to September (mainly March to April and July to August). One to three (commonly one) eggs are laid on bare, preferably stony ground, by a bush or tussock (Johnstone & Storr 1998).

Records and likely distribution in the Combined Study Area: A pair of Australian Bustard was recorded once during the survey in the MSA (Figure 5-2) and is likely to frequently occur in the grassland habitat of the Combined Study Area. The species is widely distributed and has been recorded regularly in close proximity to the Combined Study Area (DPaW 2014).

Night Parrot (*Pezoporus occidentalis*)

Status: Endangered (EPBC), Schedule 1 (WC Act), Critically Endangered (DPaW)

Distribution and ecology: The Night Parrot is the rarest bird in Australia; with very sparse records available for the species. The species was thought to be extinct until a single road killed specimen was collected in Queensland in October 1990 (Boles *et al.* 1994). Since then, another dead individual was found in Queensland (McDougall *et al.* 2009) and three individuals were sighted in the Pilbara region in 2005 (Davis & Metcalf 2008) .

Little is known about the biology of the species. Most sightings occur at night near water, and it is assumed that birds come to drink prior to feeding at night. The nest is thought to be located in tunnelled dense vegetation and can contain three to six eggs (Garnett & Crowley 2000). Chenopod grasslands, spinifex plains and hummock grasslands in the proximity of salt lakes are thought to be its typical habitat although historical records from WA indicate the species can potentially occur across a wide range of common habitat (Davis & Metcalf 2008).

Records and likely distribution in the Combined Study Area: The Night Parrot was not recorded during the survey. The nearest record for the species is located approximately 30 km north-east of the Combined Study Area (DPaW 2014) and grassland habitats are present particularly in the RSA. Therefore, while there are sparse records and limited knowledge of the Night Parrot's preferred habitat and ecology make determination of likelihood of occurrence difficult, the species cannot be entirely excluded and it may possibly occur.

Rainbow Bee-eater (*Merops ornatus*)

Status: Migratory (EPBC), Schedule 3 (WC Act)

Distribution and ecology: The Rainbow Bee-eater is a migratory bird that moves between Australia and Asia commonly seen singly or in pairs. It can be found across Australia, with complex seasonal movements depending on location and rainfall, preferring the more watered areas of the country. In Western Australia, the Rainbow Bee-eater can be found in lightly wooded, preferably sandy country, near water.

Occurring as a resident, breeding visitor, postnuptial nomad, passage migrant or winter visitor, and being highly mobile, they can be scarce to locally common. They are often associated with creeklines supporting sandy banks in which burrows can be created (Johnstone & Storr 1998). Its diet consists primarily of bees (especially hive bees) and flies, but is known to predate on other invertebrates.

The species nests in sandy banks and breeding occurs from August to November; however, breeding can occur at other times of year if environmental conditions are suitable. Four to six eggs are laid in an open chamber at the end of a burrow (Johnstone & Storr 1998).

Records and likely distribution in the Combined Study Area: The Rainbow Bee-eater was not recorded during the survey. The nearest record of the species is located approximately 3 km east of the Combined Study Area. The species is considered likely to occur within the Combined Study Area where it can forage and nest along creek and drainage lines with sandy substrates.

Star Finch (*Neochmia ruficauda subclarescens*)

Status: Priority 4 (DPaW)

Distribution and ecology: The Star Finch is a small granivorous bird present in north-western WA in low densities with a patchy distribution. They are usually found in small flocks in grasslands and eucalypt woodlands typically near permanent water. The species can occur in arid habitat after the wet season, if the conditions are good for breeding.

Habitat alteration (essentially due to grazing), clearance and drainage are responsible for the decline of the species throughout most of its range (Garnett & Crowley 2000).

Records and likely distribution in the Combined Study Area: The Star Finch was not recorded during the survey; however, the species may occur along creeklines and associated riparian habitat when water is present. The nearest record of the species is located approximately 8 km north-east of the RSA (DPaW 2014).

Western Pebble Mound Mouse (*Pseudomys chapmani*)

Status: Priority 4 (DPaW)

Distribution and ecology: The Western Pebble-mound Mouse is widespread in the ranges of the central and southern Pilbara and extends into the Little Sandy Desert Ranges (Van Dyck & Strahan 2008). Originally classified as a Priority 1 species, recent survey records have found the species is widespread and its conservation status has since been downgraded to Priority 4.

These mice construct large mounds from small pebbles. Colonies of up to 25 mice may live inside a mound. Pebble size averages 3.5 grams and the mounds may cover 0.5–9.0 m^2. The mounds are located on the gentle slopes of rocky ranges covered in rocky mulch, hard spinifex and sparse trees and shrubs (*Eucalyptus*, *Senna*, *Acacia* and *Ptilotus*). They are also often found near *Acacia*-dominated drainage lines (Van Dyck & Strahan 2008).

Threats to the Western Pebble-mound Mouse are not well known but predation by the feral cat and red fox may be responsible for the species' range contraction and mining activities may locally be responsible for small-scale population reduction (Morris 2000).

Records and likely distribution in the Combined Study Area: The Western Pebble-mound Mouse was recorded a total of ten times during the survey from secondary evidence and camera trap captures (Figure 5-2). A total of seven active mounds were located in addition to two currently inactive and one historic mound. Camera traps deployed on pebble mounds confirmed the presence of Western Pebble-Mound Mice at four mounds (see Figure 5-3 for example).

Figure 5-3 Western Pebble-mound Mouse (*Pseudomys chapmani*) recorded during the survey by remote camera trap

Northern Quoll (*Dasyurus hallucatus*)

Status: Endangered (EPBC Act); Schedule 1 (WC Act); Endangered (DPaW)

Distribution and ecology: The Northern Quoll is the smallest of the four Australian quoll species and is a solitary carnivorous marsupial found in the northern parts of Australia. This primarily nocturnal species makes its dens in rock crevices, tree holes or occasionally termite mounds. It occurs in a wide range of habitats and with an omnivorous diet consisting of invertebrates, small vertebrates and fruits of a number of plant species (Oakwood *et al.* 2008).

Historically, the Northern Quoll’s distribution occurred from the Pilbara to south-east Queensland. There has been a substantial decline across most of its distribution across northern Australia since the invasion of the cane toad (Van Dyck & Strahan 2008).

The Northern Quoll does not have highly specific habitat requirements, being found in a variety of habitats; however, rocky areas provide particular support for high prey densities and diversity, and protection from predators, fire and livestock grazing (Hill & Ward 2010).

Records and likely distribution in the Combined Study Area: No Northern Quoll were recorded during the survey through direct observations, secondary evidence or remote camera traps. No optimal denning or shelter habitat was recorded in the Combined Study Area; however, the species may occasionally occur within the Combined Study Area, particularly during foraging and dispersal movements. Suitable denning and shelter habitat was identified outside the Combined Study Area to the north where suitable habitat for the species generally is more abundant. The nearest record of the species is located approximately 10 km north of the Combined Study Area (DPaW 2014).

Ghost Bat (*Macroderma gigas*)

Status: Priority 4 (DPaW)

Distribution and ecology: The Ghost Bat is a large microchiropteran (~150 g). It is Australia’s only carnivorous bat that preys on a range of vertebrate fauna species. Ghost bats were previously thought to maintain a foraging area of approximately 60 ha (approximately two radial km from a roost) (Tidemann *et al.* 1985); however, there is evidence that some individuals will fly much further than this (B. Bullen, chiropterologist, Bat Call, pers. comm. 14 June 2010).

The species has now been recorded from the broader Pilbara bioregion where it is widespread. It is found across northern Australia, east into the rain forests of north Queensland. (Van Dyck & Strahan

2008). Typically the species prefers to roost in caves beneath bluffs of low, rounded hills composed of Marra Mamba geology and granite rock piles in the Pilbara. It has been recorded roosting in large colonies within sandstone caves, within boulder piles and in adits (abandoned mines) (Churchill 2008).

Records and likely distribution in the Combined Study Area: The Ghost Bat was not recorded during the survey. It has previously been recorded approximately 8 km north-west of the northern most point of the RSA (DPaW 2014). Although no evidence of the species was recorded, it may occasionally forage within the Combined Study Area along prominent drainage lines. No suitable roost sites were located during the survey.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

Status: Vulnerable (EPBC Act); Schedule 1 (WC Act); Vulnerable (DEC)

Distribution and ecology: The Pilbara Leaf-nosed Bat is small insectivorous cave-dwelling bat (Van Dyck & Strahan 2008). Two forms of the nominal species *Rhinonicteris aurantia* are recognised; a northern and a Pilbara endemic form. It is easily differentiated from other bats by its scalloped leaf-shaped nose, short hair and small ears (Churchill 2008). The fur is usually bright orange but some colonies occasionally have different colour that can change over time (darker or lighter) (Churchill 2008). The wings are uniformly dark.

At night, individuals disperse outside of the cave to forage in the open, typically over open water (DSEWPaC 2012). In the Pilbara this habitat is almost exclusively present in large creek beds or in gorges. Pilbara Leaf-nosed Bat also forages over *Triodia* grasslands, usually flying close to the ground up to 3 m high (DSEWPaC 2012). There is no data available on the diet of the Pilbara Leaf-nosed Bat; however, it is likely to be comparable to the northern form of the species, which consists of invertebrates, mostly moths and beetles (DSEWPaC 2012; Vestjens & Hall 1977).

The distribution of the species ranges across WA, the Northern Territory and Queensland. In WA, two populations are recognised, one in the Kimberley (that extends across coastal Northern Territory) and one in the Pilbara (Pilbara Leaf-nosed Bat) (Armstrong 2001; Van Dyck & Strahan 2008). Pilbara Leaf-nosed Bats roost in warm and humid caves. Adequate temperature (28-32°C) and relative humidity (96-100%) are critical at the roost site (Churchill 2008).

Records and likely distribution in the Combined Study Area: The Pilbara Leaf-nosed Bat was recorded from one site from echolocation call recording and analysis (Figure 5-2). A Pilbara Leaf-nosed Bat roost has previously been identified approximately 7 km to the north-west of the Combined Study Area (Biota 2012d, e, h). Low numbers of calls were recorded in the survey suggesting the species is foraging in low densities, but unlikely to be roosting, in the Combined Study Area (B. Bullen, Batcall WA, 2014, pers. comm., 9 April).

5.2.3 Short-range endemic invertebrates

A total of 29 individual specimens in the SRE target groups (see section 3.7.1) were collected from the Combined Study Area, representing at least 12 individually-recognised taxa from six orders, nine families and at least 11 genera (Table 5-4).

Two taxa (10% of total catch of SRE target groups) are considered to include potential SREs (Table 5-4):

- the flat rock spiders *Karaops* 'marillana' (family Selenopidae) (section 5.2.3.1)
- the land snail Camaenidae gen. nov. sp. nov. (section 5.2.3.6).

Both SRE species were collected in the northern parts of the RSA in gorge habitat (Table 5-4; Figure 5-4).

Karaops 'marillana' was identified using molecular methods (COI barcoding). No species-specific match was found in the COI databases of the WA Museum (Dolman 2014) and Phoenix. The camaenid land snail could not be associated with a particular morphotype. It was collected as dead shell and recent studies have shown that shell morphology is not considered to provide reliable taxonomic features within a group with many cryptic species (Stankowski 2011).

Table 5-4 Invertebrates of the short-range endemic invertebrate target groups recorded during the survey for the Extension Project

Higher taxon	Species (Family)	SRE status	Impact sites	Non-impact sites	No. of specimens [impact/non-impact]	Habitat/s
Araneae (spiders)	*Karaops* 'marillana' (Selenopidae)	Potential	Site10	-	1/0	Gorge
Pseudoscorpiones (pseudoscorpions)	*Austrohorus* 'M1' (Olpiidae)	Widespread	Site17	Site15	2/1	Gully
	Austrohorus 'M2' (Olpiidae)	Widespread	Site07	-	2/0	Mesa
	Beierolpium sp. indet. (Olpiidae)	Widespread	-	Site19	0/1	Drainage line
	Indolpium sp. indet. (Olpiidae)	Widespread	Site01, 02, 05, 06, 07, 08, 17	-	10/0	Drainage line, Gully, Hill slope, Mesa, Plateau
	Olpiidae sp. indet.	Widespread	Site03, 05, 06	-	3/0	Drainage line, Gorge, Gully
Scorpiones (scorpions)	*Lychas bituberculatus* (Buthidae)	Widespread	Site05	-	1/0	Gully
Diplopoda (millipedes)	*Austrostrophus* sp. indet. (Trigoniulidae)	Widespread	Site07	-	1/0	Mesa
Isopoda (slaters)	*Buddelundia* '15' (Armadillidae)	Widespread	Site06	-	1/0	Drainage line
Eupulmonata (land snails)	*Bothriembryon* sp. indet. (Bothriembryontidae)	Widespread	Site09	-	1/0	Hill slope
	Gen. nov. sp. nov. (Camaenidae)	Potential	Site10	-	1/0	Gorge
	Pupoides beltianus (Pupillidae)	Widespread	-	Site20	0/3	Gully
	Eremopeas interioris (Tate, 1894)	Widespread	Site06	-	1/0	Drainage line
Sum			**19**	**3**	**24/5**	

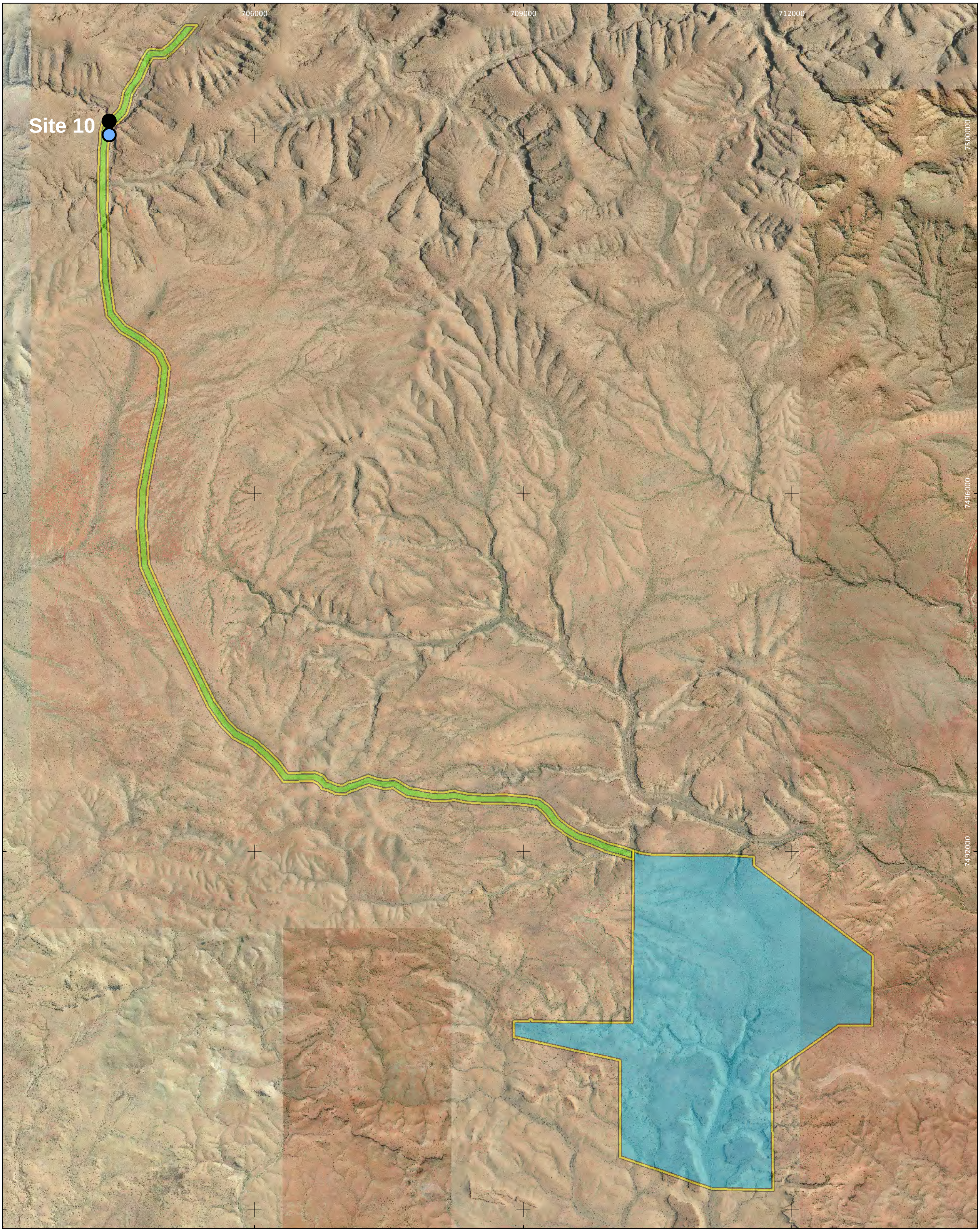

Figure 5–4

Short-range endemic invertebrates collected during the terrestrial fauna survey for the Extension Project

PHOENIX ENVIRONMENTAL SCIENCES

Client: Australian Aboriginal Mining Corporation Pty Ltd
Project: Extension Project

Author: G. Bouteloup
Date: 20/08/2014

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

0 0.425 0.85 1.7 Kilometres

1:55,000

Road Study Area

Mine Study Area

SRE species recorded

Karaops 'marillana'

Camaenidae new genus sp. nov.

5.2.3.1 Araneae – Araneomorphae (modern spiders)

The Araneae (spiders) are characterised by a number of unique characters, including abdominal appendages modified as spinnerets, silk glands and associated spigots, cheliceral venom glands and male pedipalp tarsi modified as secondary genitalia from sperm transfer (Coddington & Levi 1991). Spiders are one of the largest and most diverse orders of arachnids with more than 40,000 described species worldwide (Platnick 2014), and approximately 3,400 species named from Australia (Framenau 2014a).

Araneomorphae (modern spiders) are rarely targeted in SRE surveys. Araneomorphae often disperse very well, for example by wind-drift on gossamer threads ('ballooning') (e.g. Bell *et al.* 2005), and many species are widely distributed across the Australian landscape (Harvey 2002).

No SRE araneomorph spiders were recorded from the Combined Study Area in the desktop review.

Family Selenopidae (wall crab spiders)

Wall crab spiders are small to medium-sized dorso-ventrally flattened spiders. They are superficially similar to huntsmen spiders (family Sparassidae) and flat ground spiders (families Gnaphosidae and Trochanteriidae), but differ by their characteristic eye pattern. Wall crab spiders have a light brown mottled colouration and often strongly banded legs. They are extremely fast runners and therefore very difficult to catch.

Their flat morphology is a perfect adaptation to a life in narrow crevices and they can typically be found under exfoliating slabs of granite outcrops and under bark of trees. The preference for isolated outcrops or mountain ridges predisposes Selenopidae to short-range endemism (Crews & Harvey 2011). Selenopidae occur in tropical and subtropical regions world-wide. In Australia, a single genus, *Karaops*, is known with 37 described species (Crews 2013; Crews & Harvey 2011).

Genus *Karaops*

The genus *Karaops* differs from other genera in the family Selenopidae by the spination of the two first pairs of legs and by the absence of scopulae (brushes of dense setae) from their tarsi (Crews 2013; Crews & Harvey 2011). *Karaops* is currently known from Australia only. Sixteen species are described from the Pilbara region and its vicinity of which one, *K. martamarta* is fairly widespread. This supports a high diversity of the genus in the region and suggests restricted ranges for many of the species. Unidentifiable members of the genus are therefore categorised as potential SREs.

***Karaops* 'marillana'**

A single, juvenile specimen of *Karaops* 'marillana' was collected from a single site (Figure 5-4) in the impact area from within gorge habitat (Table 5-4). Species identification was conducted using molecular methods (COI barcoding) (Hebert *et al.* 2003a; Hebert *et al.* 2003b). The COI sequence of *Karaops* 'marillana' differed by 7.23% from the closest match in the COI database of the WA Museum, a juvenile specimen from near Marble Bar (Dolman 2014) and by at least 7.9% from the closest match in the Phoenix database, a juvenile from Turner Syncline (Phoenix unpublished data). Whilst these divergences are within the 'grey zone' of species discrimination for COI (Hebert *et al.* 2003a; Hebert *et al.* 2003b), within the context of Pilbara *Karaops* and their divergence patterns (Phoenix unpublished data), *Karaops* 'marillana' is here considered a distinct species.

5.2.3.2 Scorpiones (scorpions)

Scorpions are characterised by the presence of chelate pedipalps, pectines and an elongate metasoma furnished with a sting. Scorpions are important components of arid ecosystems because their levels of diversity and abundance contribute significantly to the biomass of animal assemblages and they are important predators and prey for other species (Volschenk *et al.* 2010).

The comprehensive DEC Pilbara Biological Survey (PBS) recovered two families of scorpions, Buthidae and Urodacidae. The buthids were represented by two genera, *Lychas* (10 species) and *Isometroides* (2 species). The family Urodacidae was represented by 10 species in the single genus *Urodacus* (Volschenk *et al.* 2010). However, the regional scorpion fauna is clearly more diverse both at the species and the genus level, than was recorded in the PBS survey. For example, the urodacid genus *Aops* was recently described from Barrow Island (Volschenk & Prendini 2008) and has since also been found on the mainland in the Pilbara.

No SRE scorpion was recorded from the Combined Study Area in the desktop review. A single scorpion specimen was collected at site05 representing *Lychas bituberculatus* (Table 5-4). *Lychas bituberculatus* is a widespread species. Due to the low number of individuals collected, it was not statistically meaningful to calculate species accumulation curves for scorpions.

5.2.3.3 Pseudoscorpiones (pseudoscorpions)

The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families (M. Harvey 2012, pers. comm.). They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats (Harvey 1992).

No SRE pseudoscorpions were recorded from the Combined Study Area in the desktop review. A total of 19 pseudoscorpion specimens from at least four species were collected from the Combined Study Area (Table 5-4). All specimens belong to the family Olpiidae and none of these are considered to include SRE species.

5.2.3.4 Diplopoda (millipedes)

The Australian millipedes are poorly studied and biogeographic patterns remain largely unresolved (Black 1997; Shelley & Golovatch 2011). At least eight orders of millipedes are native to Australia; all species in the order Julida are introduced (Mesibov 2006). Millipedes belong to one of the main target groups of SRE surveys. SREs are particularly expected within the orders Sphaerotheriida (rolling millipedes), Polydesmida, and Chordeumatida (not known from WA) (EPA 2009a; Harvey 2002). A recent review of Australian *Atelomastix* (order Spirostreptida) found all of 29 species treated were SREs (Edward & Harvey 2010).

A single unidentifiable juvenile millipede specimen in the genus *Austrostrophus* was collected during the survey (Table 5-4). *Austrostrophus* sp. indet. most closely resembles *A. stictopygus*, a widespread Pilbara species (Harvey *et al.* 2011) and is not considered to be an SRE.

5.2.3.5 Isopoda (Slaters)

Almost 200 described species of Oniscidea, a suborder of the Isopoda containing the supralittoral, terrestrial and secondarily aquatic slaters (or woodlice), have been recorded from Australia (Department of the Environment 2011). The WA fauna is comparatively poorly known with many undescribed species (Judd & Horwitz 2003). Slaters are an ideal biological model for faunistic and biogeographical studies, due to their reduced dispersal ability and narrow habitat preferences (e.g. Taiti & Argano 2009). Consequently, they belong to one of the target groups of SRE surveys (EPA 2009a; Harvey 2002).

No SRE isopods were recorded from the Combined Study Area in the desktop review. A single specimen of slater, most likely *Buddelundia* '15' (family Armadillidae) was collected in the Combined Study Area (Table 5-4). The specimen was collected dry and the identification is tentative. It is a fairly widespread Pilbara species and therefore not an SRE.

5.2.3.6 Eupulmonata (land snails)

Molluscs are one of the most diverse groups of invertebrates and the Australian fauna is characterised by a high degree of endemism (Beesley *et al.* 1998). Land snails (Eupulmonata) belong to the target groups for SRE surveys due to their limited dispersal capabilities, in combination with often strict dependencies on particular soils (EPA 2009a; Harvey 2002). These characteristics have also resulted in a significant global decline of non-marine molluscs (Lydeard *et al.* 2004).

No SRE snails were recovered from the Combined Study Area by the desktop review. A total of six snail shells from four species were collected from the Combined Study Area (Table 5-4). Both *Eremopeas interioris* and *Pupoides beltianus* are widespread arid zone species, including in the Pilbara (Smith 1992). Although many SRE species in the genus Bothriembryon have been identified from molecular data (Whisson & Kirkendale 2014), the genus appears to have fairly uniform shell morphology in the Pilbara and therefore representatives of the genus are here not considered SREs. The genus is commonly collected in the vicinity of the Combined Study Area. In contrast, members of the Camaenidae are considered to include many SRE species in northern WA.

Family Camaenidae

The Camaenidae is one of the most diverse land snail families in Australia both in species richness and morphology. Shell diameter ranges between 5 to 70 mm and shell shapes vary from discoidal and lenticular to globose, trochoidal, conical and elongate (Stanisic *et al.* 2010). The family is found Australia-wide with the exception of Tasmania and south-west WA (Stanisic *et al.* 2010).

In northern WA, the Camaenidae are the dominant group of land snails, with greatest diversity in the Kimberley region, where 19 of the 25 camaenid genera include SREs (Harvey *et al.* 2011; Solem 1997). In the Ningbing Ranges east of Kununurra, for example, the median geographical range of the 26 species occupying the area is less than one square-kilometre (Cameron 1992). Many of these ranges are shrinking, due to grazing and fire (Solem 1997) which resulted in the listing of 31 camaenid species under the WC Act (Western Australian Government 2013).

Based on the latest taxonomic revision, the Pilbara camaenid fauna comprised 27 species from six genera, distributed in latitude between Port Hedland and Cape Range, with no evidence of sympatry between congeneric species (Solem 1997). However, recent targeted sampling of camaenid land snails in the region has shown that many forms are parapatric, allowing direct genetic tests of reproductive isolation. This has revealed that some species have broader distributions than formerly thought, while other described species are actually complexes of multiple species, some with very narrow distributions. The molecular analyses have also shown the unreliability of shell characteristics on their own for assessing species taxonomy in many of these snails (Stankowski 2011). However, molecular 'barcoding' of COI sequence data may also not provide satisfactory results to distinguish species in some camaenid genera (Köhler & Johnson 2012).

Camaenidae gen. nov. sp. nov.

A single specimen most closely resembling an undescribed species from a new genus in the subfamily Sinumeloninae was collected in the Combined Study Area from within gorge habitat (Table 5-4; Figure 5-4). This group has been encountered previously in the Mt Robinson area and molecular work is required to determine species limitations (C. Whisson, Technical Officer, Non-Marine Molluscs, WA Museum, pers. comm.). It is not possible to determine whether this specimen is the same as other unidentified Camaenidae specimens from the desktop review and therefore it is considered a potential SRE.

5.3 SURVEY LIMITATIONS

Guidance Statement 56 (EPA 2004) identified potential limitations that may be encountered during terrestrial fauna surveys. With respect to this guidance statement, no major limitations were identified for the survey. Some areas, particularly along the haul road were inaccessible by vehicle; however, no significant variation in habitat was observed in surrounding areas and through thorough assessment of aerial imagery.

6 DISCUSSION

In assessing development proposals, the EPA's broad objective for vertebrate fauna is to maintain the abundance, diversity, geographic distribution, and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge (EPA 2008). Accordingly, the aim of this assessment was to determine the conservation significant vertebrate fauna species and habitats present or likely to be present to enable an impact assessment to be completed and management actions to be identified.

The EPA's objective for SRE species in EIA is to ensure that proposals do not potentially threaten the viability of, or lead to the extinction of any SRE species (EPA 2009a). This objective focuses on the impacts of the Project on the persistence of species rather than, as in vertebrates, impacts on populations of conservation significant (i.e. EPBC Act and WC Act listed) species which are often widespread. Therefore, the aim of this assessment for SREs was to:

- determine whether any SRE taxa may be restricted solely to the proposed project area and therefore be at risk of extinction from the Project
- determine whether adequate habitat exists outside the proposed project area for SRE species recorded within the proposed project area.

6.1 VERTEBRATE FAUNA

Three vertebrate species of conservation significance were recorded during the field survey (Figure 5-2; Table 6-1). A further three are considered likely to occur in the Combined Study Area and nine additional species may possibly occur (Table 6-1).

The Pilbara Leaf-nosed Bat appears to forage in low numbers and frequency within the gorges of the RSA. It is considered likely that foraging individuals are likely to be moving from a previously recorded roost located approximately 7 km north-west of the Combined Study Area. Foraging records from this roost have also been recorded on the 'Koodaideri Southern Infrastructure Corridor' to the west of the Combined Study Area (Biota 2012f). The gorges within the RSA are at the southern extent of a gorge system extend to the north and west; it is likely the roost population is foraging throughout that broader gorge system.

While there is no optimal denning or shelter habitat for Northern Quoll in the Combined Study Area, there is the potential that the gorges and gullies present may provide foraging habitat and dispersal corridors for the species; suitable denning habitat was identified to the north of the Combined Study Area and there may be patches of suitable habitat throughout the broader gorge system. With similar habitat requirements, the Pilbara Olive Python may also frequent the rocky gorge habitat in the north of the RSA, in particular where pooling water persists.

Table 6-1 Summary of conservation significant vertebrate species, likelihood of occurrence

Species	EPBC Act Category	WC Act Category	DPaW listing	Likelihood of occurrence		Suitable habitats for the species						Summary of records and occurrence
				RSA	MSA	Mixed shrubland	Hummock and tussock grassland	Mesa and rocky hill slope	Creek and drainage line	Gully	Gorge	
Reptiles												
Gane's Blind Snake (*Ramphotyphlops ganei*)			P1	Possible	Possible			●	●	●	●	Limited knowledge of habitat and occurrence. Nearest record 7 km west of the Project.
Pilbara Olive Python (*Liasis olivaceus barroni*)	VU	S1	VU	Likely	Likely			●	●	●	●	Likely to occur in rocky habitats where water permanent or persists for long periods after rainfall. Nearest record located 8 km north-west of northern most point of the RSA.
Birds												
Fork-tailed Swift *(Apus pacificus*)	M	S3		Likely	Likely	●	●	●	●	●	●	Species likely to forage in flight; however, unlikely to land or nest in the vicinity of the Project. Nearest record located 20 km north of the Project.
Eastern Great Egret (*Ardea modesta*)	M	S3		Possible	Possible				●			Species may occur within the Combined Study Area, particularly after rains when water is present within minor creek and drainage lines. Nearest record over 50 km from the Project.
Cattle Egret (*Ardea ibis*)	M	S3		Possible	Possible				●			Species may occur within the Combined Study Area, particularly after rains when water is present within minor creek and drainage lines. Nearest record 30 km north of the Project.
Grey Falcon (*Falco hypoleucos*)		S1	VU	Possible	Possible	●	●		●			Species may occasionally forage on the open shrubland and grassland habitats of the Combined Study Area. If present, nesting may take place in tall established eucalypts along drainage lines.

Species	EPBC Act Category	WC Act Category	DPaW listing	Likelihood of occurrence		Suitable habitats for the species						Summary of records and occurrence
				RSA	MSA	Mixed shrubland	Hummock and tussock grassland	Mesa and rocky hill slope	Creek and drainage line	Gully	Gorge	
Peregrine Falcon (*Falco peregrinus*)		S4	SP	Possible	Possible	●	●	●	●	●	●	Species may forage within and in the vicinity of the Combined Study Area. The species may nest on cliff edges of suitably sized gullies and gorges, which are preferred for nesting, are present. The species has previously been recorded along the proposed haul road to the north of the Project.
Australian Bustard (*Ardeotis australis*)			P4	Likely	Recorded	●	●		●			One pair recorded once within the MSA during the field survey. Species likely to frequently occur in shrubland and grassland habitats.
Night Parrot (*Pezoporus occidentalis*)	EN/ M	S1	CR	Possible	Possible	●	●					Limited knowledge of habitat preferences and records. However, nearest record 30 km north-east of the Project and potential grassland habitat present, therefore species presence cannot be excluded based on current knowledge.
Rainbow Bee-eater (*Merops ornatus*)	M	S3		Likely	Likely	●			●			May occur within the Combined Study Area where it is likely to forage and nest along creek and drainage lines with sandy substrates. Nearest record approximately 3 km east of the Project.
Star Finch (*Neochmia ruficauda sub. clarescens*)			P4	Possible	Possible				●	●	●	May occur along creeklines and associated riparian habitat when water is present. The nearest record of the species is located approximately 8 km north-east of the Project
Mammals												
Western Pebble-mound Mouse (Pseudomys chapmani)			P4	Likely	Recorded	●	●	●				Recorded 10 times through secondary and direct evidence during the field survey. Likely to be common and widespread within the Combined Study Area

Species	EPBC Act Category	WC Act Category	DPaW listing	Likelihood of occurrence		Suitable habitats for the species						Summary of records and occurrence
				RSA	MSA	Mixed shrubland	Hummock and tussock grassland	Mesa and rocky hill slope	Creek and drainage line	Gully	Gorge	
Northern Quoll (*Dasyurus hallucatus*)	EN	S1	EN	Possible	Possible			●	●	●	●	No optimal denning habitat recorded; however, species may occasionally occur within Combined Study Area as a transient, dispersing or foraging from suitable habitat outside of the Combined Study Area. Nearest record located approximately 10 km north of the Project.
Ghost Bat (*Macroderma gigas*)			P4	Possible	Possible	●	●	●	●	●	●	May occasionally forage within the Combined Study Area along prominent drainage lines. Roosting unlikely due to lack of suitable roost sites.
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	VU	S1	VU	Recorded	Possible			●	●	●	●	Recorded from bat echolocation call analysis in gorge habitat within the RSA during the field survey. Records considered being evidence of foraging only, roost site within Combined Study Area unlikely.

EN – Endangered (EPBC Act); VU – Vulnerable (EPBC Act); S1 – Schedule 1 (WC Act); S4 – Schedule 4 (WC Act) P1 – Priority 1 (DEC); P2 – Priority 2 (DEC); P3 – Priority 3 (DEC); P4 – Priority 4 (DEC); M – Migratory species (EPBC Act).

6.2 SHORT-RANGE ENDEMIC INVERTEBRATES

Two SRE taxa were collected during the field survey and both were represented by a single individual from the northern part of the RSA in the Combined Study Area only (Figure 5-4). No additional taxa were recorded within the study or impact areas from the desktop review (Phoenix 2014). However, representatives of the two higher SRE taxa recorded from the Combined Study Area during the field survey were also well represented in the vicinity of the Project as detailed in the desktop review, indicating that the species they represent may occur outside the Combined Study Area (Phoenix 2014).

The desktop review resulted in a number of *Karaops* species from within a 100 km radius of the Combined Study Area, including the SREs *K. banyima*, *K. feedtime*, *K. forteyi* and *Karaops* 'BD1', as well as many unidentified records of the genus (Phoenix 2014). Molecular identification of *Karaops* 'marillana' did not provide a match within the WA Museum COI database, but it showed that the species in not *K. feedtim*e (WAM T111456) or a number of *Karaops* sp. indet. (WAM T123838, WAM T122804–7, T122810) from the desktop review (Dolman 2014). The specimens did not provide a match within the Phoenix molecular database or from GenBank (http://www.ncbi.nlm.nih.gov/genbank; accessed 3 July 2014). However, many *Karaops* specimens from the desktop review have no associated COI data available and *Karaops* 'marillana' may represent one of these species.

Similarly, some SRE camaenid land snails have been recorded in the vicinity of the Combined Study Area, including a species, Camaenidae gen. nov. sp. nov. 'small Mount Robinson' (Phoenix 2014), with similar shell morphology to Camaenidae gen. nov. sp. nov. collected during the survey. This provides the possibility that the species recorded from the field survey occurs outside the Combined Study Area. However, an accurate species-level assessment of the land snail is only possible through collecting live specimens and follow-up molecular analyses.

In lieu of taxonomic certainty or lack of reference specimens from outside the impact area, the EPA Guidance Statement 20 (EPA 2009a) allows for a risk-based approached based on the perceived habitat preferences of SREs only recorded from the project area after investing a reasonable survey effort to demonstrate species distributions. Both SRE taxa were recorded from typical gorge habitat (Table 6-2) that are characteristic of and widespread in most of the land systems present within and outside the Combined Study Area; Robe, Newman and Boolgeeda.

Table 6-2 Summary of potential impacts to short-range endemic invertebrates

Species	SRE category	Recorded in desktop review outside Combined Study Area	Combined Study Area[b]	Collected habitats		Taxon summary
				Drainage line	Gorge	
Karaops 'marillana'	Potential	✓[a]	HR		✓	Higher taxon known from outside Combined Study Area.
Camaenidae gen. nov. sp. nov.	Potential	✓[a]	HR		✓	Higher taxon known from outside Combined Study Area.

[a] Higher level identification, conspecifity cannot be determined based on morphology; [b] CP – conceptual pit; HR – haul road.

6.3 FAUNA HABITATS

Six fauna habitats are present within the Combined Study Area. A summary of their potential to support conservation significant species is as follows:

- Hummock and tussock grassland (58.3% of the Combined Study Area) – provides potential habitat for Australian Bustard, and foraging habitat for conservation significant birds of prey including the Grey Falcon and Peregrine Falcon.
- Open and closed shrubland (26.9%) – provides suitable habitat for Bush Stone-curlew, and to a lesser extent foraging habitat for Pilbara Leaf-nosed Bat, Ghost Bat, Grey Falcon and Peregrine Falcon. Open shrubland associated with rolling stony hills provides suitable habitat for the Western Pebble-mound Mouse.
- Mesa and rocky hill slope (9.4%) – provides suitable rock cover for transient Northern Quoll and Pilbara Olive Python for short periods. South facing slopes with adequate vegetation and rock cover may provide suitable habitat for SRE species.
- Gully (2.7%) – a number of gullies contain steep rocky sides with fallen rock piles which may support transient Northern Quoll for short periods. Gullies may also support Pilbara Olive Python in areas where water remains for long periods after rainfall events. Gully habitat can provide suitable habitat for SRE invertebrates in the form of shade from steep sides and moist leaf litter beds from associated vegetation and drainages.
- Minor creek and drainage line (1.8%) – when well vegetated, this habitat type provides sheltering and nesting opportunities for a wide range of vertebrate fauna species as well as food resources. Creeklines associated with rocky habitats including gullies and gorges with frequent or permanent water are likely to support the Pilbara Olive Python. Creek lines may also provide foraging/dispersal habitat for Northern Quoll where they are linked to denning habitats for the species outside the study area. The moisture, shade and leaf litter beds, when well vegetated provide suitable habitat for SRE invertebrates.
- Gorge (0.9%) – may support Pilbara Leaf-nosed Bat and a number of saxicolous (rock-dwelling) reptile and mammal species including Northern Quoll and Pilbara Olive Python. Relictual Gondwanan SRE species are frequently found in shaded areas of deep gorges.

Based on the presence or likelihood of occurrence of conservation significant vertebrate species and SREs, the gorge and gully habitats in the northern section of the RSA appear to provide the highest fauna values within the Combined Study Area. The Pilbara Leaf-nosed Bat, *Karaops* 'marillana' and the camaenid land snail were recorded in the northern section of this corridor (Figure 5-2; Figure 5-4). These habitats are well represented outside of the RSA, particularly to the north and west as part of a broader gorge system.

Broader scale habitats such as hummock and tussock grassland comprise the largest area within the Combined Study Area; however, this habitat is widely represented regionally and the conservation significant species recorded here, such as the Western Pebble-mound Mouse, are widespread. Similar assessments are valid for open/closed shrublands and mesas and rocky hill slopes, of which the latter recorded the widely distributed Australian Bustard.

6.4 RECOMMENDATIONS

While it was apparent from the field survey that the gorge and gully habitat within the RSA extends beyond the study area, desktop habitat mapping could be undertaken to confirm the extent of this habitat within the RSA relative to regional extent. This assessment would provide further background data for an impact assessment and enable detailed management actions to control impacts to be determined.

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Appendix 1 Terrestrial fauna survey site descriptions

Site number	Site01
Site location	mine study area – south-western pit
Impact/non-impact area	impact area
Easting	710804
Northing	7488833
Zone	50K
Habitat	gully
Habitat type	open woodland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	51-75%
Dominant grass	none
Grass cover	0%
Slope	steep
Soil texture	clay loam
Soil colour	brown;
Surface	boulders; stones; loose soil
Rock cover	50-75%
Leaf litter distribution	>75%
Litter distribution	under trees
Dead wood	moderate
Disturbance details	none evident
Fire history	>5 years
Fire intensity	medium

Description:
Minor shallow gully on edge of mesa. Rocky slope dominated by thicket of *Acacia* sp to 3 m over scattered *Triodia*. Sparsely scattered eucalypts to 8 m along mesa edge and rocky slope.

Site number	**Site02**
Site location	mine study area – northern pit
Impact/non-impact area	impact area
Easting	710492
Northing	7490988
Zone	50K
Habitat	hill slope
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	26-50%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; stones
Rock cover	50-75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks; erosion channels
Fire history	1-5 Years
Fire intensity	medium

Description:
Spinifex grassland with scattered sparse eucalypts to 5 m and mixed shrubs to 1.5 m over sparse young spinifex to .5 m. Stony substrate with gentle slope to sparsely vegetated drainage line.

Site number	**Site03**
Site location	mine study area – northern pit
Impact/non-impact area	impact area
Easting	711370
Northing	7491763
Zone	50K
Habitat	gorge
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	26-50%
Dominant shrub	*Acacia*
Shrub cover	51-75%
Dominant grass	other grasses
Grass cover	51-75%
Slope	steep
Soil texture	clay loam
Soil colour	red / brown
Surface	boulders; stones
Rock cover	>75%
Leaf litter distribution	50-75%
Litter distribution	under trees
Dead wood	moderate
Disturbance details	none evident
Fire history	1-5 Years
Fire intensity	Medium

Description:
Minor gully with minor drainage line (dry) into larger gorge. Scattered eucalypts to 8 m over mixed shrubs to 2 m over mixed grasses to .5 m.

Site number	Site04
Site location	mine study area – northern pit
Impact/non-impact area	non-impact area
Easting	711627
Northing	7490238
Zone	50K
Habitat	gully
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	none
Shrub cover	0%
Dominant grass	other grasses
Grass cover	51-75%
Slope	steep
Soil texture	clay loam
Soil colour	red / brown
Surface	coarse gravel; boulders; stones
Rock cover	>75%
Leaf litter distribution	25-50%
Litter distribution	under trees
Dead wood	moderate
Disturbance details	none evident
Fire history	1-5 years
Fire intensity	medium

Description:
Minor gully with scattered eucalypts to 8 m over mixed grasses to .5 m. Steep rocky sides with scattered fallen rock and boulder piles.

Site number	**Site05**
Site location	mine study area – northern pit
Impact/non-impact area	impact area
Easting	711633
Northing	7489996
Zone	50K
Habitat	gully
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	26-50%
Dominant shrub	*Acacia*
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	51-75%
Slope	moderate
Soil texture	clay loam
Soil colour	red / brown
Surface	coarse gravel; boulders; stones
Rock cover	>75%
Leaf litter distribution	25-50%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	none evident
Fire history	1-5 years
Fire intensity	low

Description:
Minor shallow gully with scattered eucalypts to 10 m over mixed shrubs to 3 m over mixed grasses (primarily *Triodia*) to .5 m. Small pool of water present along gully drainage line from recent rains.

Site number	Site06
Site location	mine study area – northern pit
Impact/non-impact area	impact area
Easting	711909
Northing	7490435
Zone	50K
Habitat	drainage line
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	51-75%
Dominant shrub	other
Shrub cover	26-50%
Dominant grass	*Triodia*
Grass cover	51-75%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; stones
Rock cover	50-75%
Leaf litter distribution	25-50%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks
Fire history	>5 years
Fire intensity	medium

Description:
Minor drainage line (dry) with bordering riparian vegetation. Scattered eucalypts to 15 m over mixed shrubs to 3 m over *Triodia* to .8 m. Thicket of eucalypt saplings along drainage line. Exposed rock and gravel substrate.

Site number	**Site07**
Site location	mine study area – south-eastern pit
Impact/non-impact area	impact area
Easting	711446
Northing	7488740
Zone	50K
Habitat	mesa
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	26-50%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; stones
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks
Fire history	>5 years
Fire intensity	low

Description:
Mesa top with scattered sparse eucalypts to 6 m over sparse scattered sparse shrubs to 2 m over *Triodia* to .5 m. Stony and gravelly surface, large open areas with sparse vegetation.

Site number	Site08
Site location	mine study area – infrastructure area
Impact/non-impact area	impact area
Easting	710716
Northing	7489396
Zone	50K
Habitat	plateau
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	76-100%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	surface crust; fine gravel; coarse gravel; loose soil
Rock cover	50-75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks; vehicle tracks
Fire history	none evident
Fire intensity	

Description:
Spinifex grassland with scattered sparse eucalypts to 10 m over scattered patches of mixed shrubs to 2 m over scattered young spinifex to .6 m. No old growth spinifex present. Large areas of exposed clay loam substrate and gravel surface.

Site number	**Site09**
Site location	haul road study area
Impact/non-impact area	impact area
Easting	704904
Northing	7500950
Zone	50K
Habitat	hill slope
Habitat type	grassland
Dominant tree	*Ficus*
Tree cover	0-25%
Dominant shrub	other
Shrub cover	0-25%
Dominant grass	other grasses
Grass cover	26-50%
Slope	moderate
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; stones; loose soil
Rock cover	>75%
Leaf litter distribution	25-50%
Litter distribution	under trees
Dead wood	moderate
Disturbance details	vehicle tracks
Fire history	1-5 years
Fire intensity	medium

Description:
South facing foot slope in gorge with scattered *Ficus* and eucalypts to 6-8 m over mixed shrubs to 1 m over mixed grasses to .5 m. Fallen rock and loose scree substrate.

Site number	**Site10**
Site location	haul road study area
Impact/non-impact area	impact area
Easting	704378
Northing	7500156
Zone	50K
Habitat	gorge
Habitat type	riparian Zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	other
Shrub cover	26-50%
Dominant grass	other grasses
Grass cover	26-50%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; boulders; loose soil
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	moderate
Disturbance details	none evident
Fire history	1-5 years
Fire intensity	medium

Description:
Minor gorge with riparian vegetation. Scattered sparse eucalypts over mixed shrubs and grasses to .5 m. High water flow area with river stone substrate. Scattered pools of water present along gorge system.

Site number	**Site11**
Site location	haul road study area
Impact/non-impact area	impact area
Easting	704336
Northing	7498644
Zone	50K
Habitat	plateau
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	other
Shrub cover	26-50%
Dominant grass	*Triodia*
Grass cover	26-50%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	coarse gravel; stones
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks
Fire history	1-5 years
Fire intensity	high

Description:
Spinifex grassland to .5 m with scattered eucalypts to 5 m over mixed small shrubs to .5 m. Area recently burnt, carting on trees and spinifex/shrubs all recent growth. Open areas of exposed stony gravel surface.

Site number	**Site12**
Site location	haul road study area
Impact/non-impact area	impact area
Easting	704592
Northing	7497807
Zone	50K
Habitat	plain
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25
Dominant shrub	none
Shrub cover	0%
Dominant grass	other grasses
Grass cover	51-75%
Slope	gentle
Soil texture	sandy loam
Soil colour	red / brown
Surface	fine gravel; loose soil
Rock cover	0-25%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	moderate
Disturbance details	drill pads and tracks; grazing - med; vehicle tracks; livestock tracks
Fire history	1-5 years
Fire intensity	medium

Description:
Grassland with scattered eucalypts to 8 m over mixed grasses to .5 m. Scattered dead burnt shrubs to 2 m, little regrowth present. Areas of sparse vegetation with exposed loose soil and fine gravel substrate. Area recently burnt, most vegetation regrowth including eucalypts.

Site number	Site13
Site location	mine study area – northern pit
Impact/non-impact area	non-impact area
Easting	710318
Northing	7491069
Zone	50K
Habitat	breakaway
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	51-75%
Slope	moderate
Soil texture	sandy loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; boulders; stones
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	none evident
Fire history	>5 years
Fire intensity	medium

Description:
Breakaway with scattered sparse eucalypts to 6 m over scattered patches of acacia to 2 m over *Triodia* to .5 m. Caves present throughout breakaway though mostly shallow.

Site number	**Site14**
Site location	haul road study area
Impact/non-impact area	impact area
Easting	710775
Northing	7491925
Zone	50K
Habitat	plain
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	other
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	76-100%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; stones
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	none
Disturbance details	drill pads and tracks
Fire history	1-5 years
Fire intensity	low

Description:
Spinifex grassland on undulating plain with stony clay loam substrate. Scattered sparse eucalypts to 8 m over mixed small to medium shrubs to 3 m. Spinifex all recent growth with scattered areas of exposed stony gravel surface.

Site number	**Site15**
Site location	mine study area – non-impact
Impact/non-impact area	non-impact area
Easting	710852
Northing	7490137
Zone	50K
Habitat	Gully
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	51-75%
Dominant grass	*Triodia*
Grass cover	26-50%
Slope	moderate
Soil texture	sandy loam
Soil colour	red / brown; grey
Surface	coarse gravel; boulders; stones; surface plates
Rock cover	>75%
Leaf litter distribution	25-50%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	none evident
Fire history	1-5 years
Fire intensity	low

Description:
Minor gully with scattered eucalypts to 10 m over acacia to 3 m in gully. Gully side slopes dominated by scattered acacia to 3 m over spinifex to .5 m.

Site number	Site16
Site location	mine study area – northern pit
Impact/non-impact area	impact area
Easting	711307
Northing	7491001
Zone	50K
Habitat	drainage line
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	26-50%
Dominant grass	*Triodia*
Grass cover	51-75%
Slope	gentle
Soil texture	sandy loam
Soil colour	red / brown
Surface	fine gravel; stones; loose soil
Rock cover	50-75%
Leaf litter distribution	25-50%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks; vehicle tracks
Fire history	1-5 years
Fire intensity	low

Description:
Minor drainage line with scattered eucalypts to 10 m over mixed shrubs to 3 m over scattered patches of spinifex and mixed shrubs to .5 m. Scattered patches of sparse vegetation with exposed gravelly surface substrate.

Site number	**Site17**
Site location	mine study area – northern pit
Impact/non-impact area	impact area
Easting	712847
Northing	7490426
Zone	50K
Habitat	gully
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	26-50%
Dominant shrub	*Acacia*
Shrub cover	26-50%
Dominant grass	*Triodia*
Grass cover	51-75%
Slope	moderate
Soil texture	clay loam
Soil colour	red / brown
Surface	coarse gravel; boulders; stones
Rock cover	>75%
Leaf litter distribution	25-50%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	none evident
Fire history	1-5 years
Fire intensity	medium

Description:
Minor gully and hill slope with scattered sparse eucalypts to 10 m over mixed shrubs to 3 m over scattered spinifex patches to .5 m. *Acacia* to 3 m dominating drainage line in gully. Rocky substrate with areas of sparse vegetation and exposed base rock.

Site number	Site18
Site location	mine study area - northern pit
Impact/non-impact area	impact area
Easting	712167
Northing	7490199
Zone	50K
Habitat	plain
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	other
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	76-100%
Slope	gentle
Soil texture	sandy clay
Soil colour	red / brown
Surface	fine gravel; coarse gravel
Rock cover	25-50%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks; vehicle tracks
Fire history	>5 years
Fire intensity	low

Description:
Spinifex grassland with scattered sparse eucalypts to 8 m and mixed shrubs to 2.5 m. Spinifex regrowth with patches of sparse vegetation with exposed gravel surface.

Site number	**Site19**
Site location	mine study area – non-impact
Impact/non-impact area	non-impact area
Easting	710434
Northing	7490578
Zone	50K
Habitat	drainage line
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	0-25%
Dominant grass	*Triodia*
Grass cover	51-75%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; stones
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	drill pads and tracks; grazing - low; livestock tracks
Fire history	1-5 years
Fire intensity	low

Description:
Minor drainage line with scattered eucalypts to 10 m over mixed shrubs to 2 m over scattered patches of spinifex. Drainage line bordered by low rolling stony hills with scattered eucalypts to 8 m over spinifex to .5 m. Scattered open areas with sparse vegetation and exposed gravelly surface.

Site number	**Site20**
Site location	mine study area – non-impact
Impact/non-impact area	non-impact area
Easting	711309
Northing	7489644
Zone	50K
Habitat	gully
Habitat type	riparian zone
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	26-50%
Dominant shrub	other
Shrub cover	51-75%
Dominant grass	other grasses
Grass cover	76-100%
Slope	Moderate
Soil texture	sandy loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; stones; loose soil
Rock cover	25-50%
Leaf litter distribution	>75%
Litter distribution	under trees
Dead wood	dense
Disturbance details	none evident
Fire history	none evident
Fire intensity	

Description:
Drainage line in deep wide gully with dense riparian vegetation. Eucalypts to 16 m over mixed riparian shrubs to 3 m over mixed grasses and reeds to 1 m. Scattered fallen logs an debris from previous water flow. Scattered pools of water with rushes/reeds growing. Leaf litter dry in most places.

Site number	Site21
Site location	mine study area – south-western pit
Impact/non-impact area	impact area
Easting	710677
Northing	7488472
Zone	50K
Habitat	mesa
Habitat type	grassland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	26-50%
Dominant grass	*Triodia*
Grass cover	76-100%
Slope	gentle
Soil texture	clay loam
Soil colour	red / brown
Surface	fine gravel; coarse gravel; stones
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	moderate
Disturbance details	drill pads and tracks; vehicle tracks
Fire history	1-5 years
Fire intensity	low

Description:
Spinifex grassland on mesa top with scattered eucalypts to 10 m over mixed shrubs to 2.5 m over spinifex to 1 m. Scattered patches of old growth spinifex and areas of sparse vegetation over bare gravelly substrate.

Site number	Site22
Site location	haul road study area
Impact/non-impact area	impact area
Easting	704913
Northing	7496852
Zone	50K
Habitat	plain
Habitat type	shrubland
Dominant tree	*Eucalyptus/Corymbia*
Tree cover	0-25%
Dominant shrub	*Acacia*
Shrub cover	51-75%
Dominant grass	*Triodia*
Grass cover	76-100%
Slope	gentle
Soil texture	sandy loam
Soil colour	red / brown
Surface	coarse gravel; loose soil
Rock cover	>75%
Leaf litter distribution	0-25%
Litter distribution	under trees
Dead wood	sparse
Disturbance details	grazing - med; livestock tracks
Fire history	>5 years
Fire intensity	low

Description:
Open shrubland and with scattered eucalypts to 8 m over scattered patches of dense mixed shrubs to 2 m over spinifex to .5 m. Scattered patches of dense shrub and/or mature spinifex cover with patches of sparse vegetation and exposed gravelly substrate.

Appendix 2 Camera trap and SongMeter locations

Trap type	Number	Easting	Northing	Zone	Longitude	Latitude
Camera trap	CT01a	710817	7488838	50K	-22.694526	119.0522
Camera trap	CT01b	710808	7488838	50K	-22.694527	119.0521
Camera trap	CT03a	711266	7491656	50K	-22.669028	119.0562
Camera trap	CT03b	711370	7491771	50K	-22.667985	119.0572
Camera trap	CT03c	711316	7491742	50K	-22.668243	119.0567
Camera trap	CT04a	711642	7490232	50K	-22.68184	119.0601
Camera trap	CT04b	711635	7490240	50K	-22.681773	119.06
Camera trap	CT05a	711638	7490193	50K	-22.682198	119.06
Camera trap	CT05b	711627	7489986	50K	-22.684067	119.06
Camera trap	CT09a	704913	7500963	50K	-22.585788	118.9932
Camera trap	CT09b	704812	7500962	50K	-22.585803	118.9922
Camera trap	CT10	704409	7500139	50K	-22.593285	118.9884
Camera trap	CT13	710339	7491060	50K	-22.674529	119.0473
Camera trap	CT15	710621	7490017	50K	-22.683909	119.0502
Camera trap	CT20a	711354	7489697	50K	-22.686705	119.0573
Camera trap	CT20b	711316	7489655	50K	-22.687083	119.057
Camera trap	CTOpp01	704422	7499976	50K	-22.59476	118.9886
Camera trap	CTOpp02	710794	7488613	50K	-22.696561	119.052
Camera trap	CTOpp03	711506	7490130	50K	-22.682773	119.0588
SongMeter	SM01	711363	7491785	50K	-22.667854	119.0571
SongMeter	SM02	711313	7489641	50K	-22.687221	119.0569
SongMeter	SM03	704448	7500123	50K	-22.593427	118.9888

Appendix 3 Vertebrate species list from the desktop review (Phoenix 2014) and recorded during the field survey

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
AMPHBIANS													
Cyclorana maini	Sheep Frog							●				●	●
Litoria rubella	Little Red Tree Frog							●				●	●
Uperoleia russelli	Northwest Toadlet							●				●	
REPTILES													
Amphibolurus longirostris	Long-nosed Dragon							●				●	●
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon							●				●	●
Ctenophorus isolepis isolepis	Central Military Dragon							●				●	●
Ctenophorus nuchalis	Central Netted Dragon							●				●	
Ctenophorus reticulatus	Western Netted Dragon							●				●	●
Diporiphora amphiboluroides	Mulga Dragon											●	
Diporiphora valens	Southern Pilbara Tree Dragon							●				●	
Tympanocryptis cephalus	Pebble Mimic Dragon											●	
Pogona minor minor	Western Bearded Dragon							●				●	●
Crenadactylus ocellatus horni	No Common Name							●				●	
Diplodactylus conspicillatus	Fat-tailed Gecko							●				●	
Diplodactylus pulcher	No Common Name							●				●	
Diplodactylus savagei	Yellow-spotted Pilbara Gecko							●				●	
Lucasium stenodactylum	Sand-plain Gecko							●				●	
Lucasium wombeyi	Pilbara Ground Gecko							●				●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Oedura marmorata	Marbled Velvet Gecko							●				●	●
Rhynchoedura ornata	Western Beaked Gecko							●				●	
Strophurus elderi	Jewelled Gecko							●				●	
Strophurus jeanae	Southern Phasmid Gecko							●				●	
Strophurus wellingtonae	Western Spiny-tailed Gecko							●				●	
Nephrurus wheeleri cinctus	Northern Banded Knob-tailed Gecko							●				●	
Gehyra pilbara	Pilbara Dtella							●				●	●
Gehyra punctata	Spotted Dtella							●				●	●
Gehyra purpurascens	Purplish Dtella							●				●	
Gehyra variegata	Variegated Tree Dtella							●				●	●
Heteronotia binoei	Bynoe's Gecko							●				●	●
Heteronotia spelea	Desert Cave Gecko							●				●	●
Delma butleri	Unbanded Delma							●				●	
Delma nasuta	No Common Name							●				●	
Delma pax	Peace Delma							●				●	
Delma tincta	Excitable Delma							●				●	
Lialis burtonis	Burton's Legless Lizard							●				●	●
Pygopus nigriceps	Western Hooded Scaly-foot							●				●	
Carlia munda	Rainbow-skink							●				●	●
Carlia triacantha	Desert Rainbow-skink							●				●	
Cryptoblepharus plagiocephalus	Peron's Snake-eyed Skink							●					●
Cryptoblepharus ustulatus	Russet Snake-eyed Skink							●				●	●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Ctenotus ariadnae	Ariadna's Ctenotus							●				●	
Ctenotus duricola	Pilbara Ctenotus							●				●	●
Ctenotus grandis titan	No Common Name							●				●	●
Ctenotus hanloni	Hanlon's Ctenotus											●	
Ctenotus helenae	Clay-soil Ctenotus							●				●	●
Ctenotus pantherinus ocellifer	No Common Name							●				●	●
Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus							●				●	
Ctenotus rubicundus	Ruddy Ctenotus							●				●	
Ctenotus rutilans	Rusty Ctenotus							●				●	●
Ctenotus saxatilis	Rock Ctenotus							●				●	●
Ctenotus schomburgkii	Barred Widesnout Ctenotus							●				●	
Ctenotus serventyi	No Common Name							●					
Ctenotus uber	No Common Name											●	
Cyclodomorphus melanops melanops	Spinifex Slender Blue-tongue							●				●	
Egernia formosa	Goldfields Crevice Skink							●				●	
Eremiascincus richardsonii	Broad-banded Sand Swimmer							●				●	
Lerista bipes	North-western Sandslider							●				●	●
Lerista flammicauda	Fire-tailed Lerista												●
Lerista jacksoni	Jackson's Lerista							●				●	
Lerista muelleri	Wood Mulch Slider							●				●	
Lerista timida	Timid Slider							●				●	
Lerista verhmens	No Common Name							●				●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Lerista zietzi	Pilbara Blue-tailed Slider							●				●	
Menetia greyii	Common Dwarf Skink							●				●	●
Menetia surda surda	Western Dwarf Skink							●				●	
Morethia ruficauda exquisita	Pilbara Lined Fire-tailed Skink							●				●	●
Proablepharus reginae	Western Soil-crevice Skink							●				●	
Tiliqua multifasciata	Central Blue-tongue							●				●	
Varanus acanthurus	Ridge-tailed Monitor							●				●	
Varanus brevicauda	Short-tailed Pygmy Monitor							●				●	
Varanus bushi	Pilbara Mulga Monitor							●				●	
Varanus caudolineatus	Stripe-tailed Pygmy Monitor											●	
Varanus eremius	Pygmy Desert Monitor							●				●	
Varanus giganteus	Perentie											●	
Varanus gilleni	No Common Name											●	
Varanus gouldii	Sand Monitor											●	●
Varanus panoptes rubidus	No Common Name							●				●	
Varanus pilbarensis	Pilbara Rock Monitor							●				●	●
Varanus tristis tristis	Black-headed Monitor							●				●	
Ramphotyphlops ammodytes	No Common Name							●				●	
Ramphotyphlops ganei	Gane's Blind Snake					P1		●			●	●	
Ramphotyphlops grypus	Beaked Blind Snake							●				●	
Ramphotyphlops hamatus	Paleheaded Blind Snake							●				●	
Ramphotyphlops pilbarensis	Pilbara Blind Snake											●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Ramphotyphlops waitii	No Common Name											●	
Antaresia perthensis	Pygmy Python							●				●	
Antaresia stimsoni	Stimson's Python							●				●	●
Liasis olivaceus barroni	Pilbara Olive Python	VU			S1	VU		●		●	●		
Acanthophis wellsi	Pilbara Death Adder											●	
Brachyurophis approximans	North-western Shovel-nosed Snake							●				●	
Demansia psammophis cupreiceps	Yellow-faced Whipsnake							●				●	
Demansia rufescens	Rufous Whipsnake							●				●	
Furina ornata	Moon Snake							●				●	
Parasuta monachus	Monk Snake							●				●	
Pseudechis australis	Mulga Snake							●				●	
Pseudonaja mengdeni	Western Brown Snake											●	
Pseudonaja modesta	Ringed Brown Snake							●				●	
Suta fasciata	Rosen's Snake							●					
Suta punctata	Little Spotted Snake											●	
Vermicella snelli	Pilbara Bandy-bandy							●				●	
BIRDS													
Dromaius novaehollandiae	Emu							●	●			●	●
Coturnix ypsilophora	Brown Quail											●	
Anas superciliosa	Pacific Black Duck							●					
Chenonetta jubata	Australian Wood Duck											●	
Phaps chalcoptera	Common Bronzewing							●				●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Ocyphaps lophotes	Crested Pigeon							●	●			●	●
Geophaps plumifera	Spinifex Pigeon							●				●	●
Geopelia cuneata	Diamond Dove							●				●	●
Geopelia striata	Peaceful Dove							●				●	●
Podargus strigoides	Tawny Frogmouth							●				●	●
Eurostopodus argus	Spotted Nightjar			●				●	●			●	
Aegotheles cristatus	Australian Owlet-nightjar							●				●	
Apus pacificus	Fork-tailed Swift		●	●	S3					●		●	
Anhinga novaehollandiae	Australasian Darter							●					
Phalacrocorax varius	Pied Cormorant							●					
Pelecanus conspicillatus	Australian Pelican			●				●					
Ardea modesta	Eastern Great Egret		●	●	S3					●			
Ardea ibis	Cattle Egret		●	●	S3					●			
Egretta novaehollandiae	White-faced Heron							●				●	
Nycticorax caledonicus	Nankeen Night-heron			●				●					
Threskiornis spinicollis	Straw-necked Ibis											●	
Elanus axillaris	Black-shouldered Kite							●				●	
Hamirostra melanosternon	Black-breasted Buzzard											●	
Haliastur sphenurus	Whistling Kite			●				●				●	
Milvus migrans	Black Kite							●	●			●	
Accipiter fasciatus	Brown Goshawk			●				●				●	
Accipiter cirrocephalus	Collared Sparrowhawk							●				●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Circus assimilis	Spotted Harrier							●				●	
Circus approximans	Swamp Harrier			●				●				●	
Aquila audax	Wedge-tailed Eagle							●	●			●	
Hieraaetus morphnoides	Little Eagle								●			●	
Falco cenchroides	Nankeen Kestrel			●				●				●	●
Falco berigora	Brown Falcon							●				●	●
Falco longipennis	Australian Hobby							●				●	
Falco peregrinus	Peregrine Falcon				S4	SP		●			●	●	
Ardeotis australis	Australian Bustard					P4		●			●	●	●
Charadrius veredus	Oriental Plover		●	●	S3					●			
Elseyornis melanops	Black-fronted Dotterel							●					
Rostratula australis	Australian Painted Snipe	EN	●	●	S1/S3	EN				●			
Tringa nebularia	Common Greenshank		●	●	S3			●			●		
Turnix varius	Painted Button-quail							●					
Turnix velox	Little Button-quail							●	●			●	
Eolophus roseicapillus	Galah							●	●			●	
Cacatua sanguinea	Little Corella							●				●	●
Nymphicus hollandicus	Cockatiel							●				●	●
Barnardius zonarius	Australian Ringneck							●				●	●
Melopsittacus undulatus	Budgerigar							●	●			●	●
Pezoporus occidentalis	Night Parrot	EN	●		S1	CR				●			
Centropus phasianinus	Pheasant Coucal											●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Chalcites basalis	Horsfield's Bronze-cuckoo			●				●				●	
Chalcites osculans	Black-eared Cuckoo			●				●				●	
Cacomantis pallidus	Pallid Cuckoo			●					●			●	
Ninox novaeseelandiae	Southern Boobook											●	
Ninox connivens peninsularis	Barking Owl (Pilbara)							●			●		
Tyto javanica	Eastern Barn Owl											●	
Dacelo leachii	Blue-winged Kookaburra							●				●	
Todiramphus sanctus	Sacred Kingfisher			●				●				●	●
Todiramphus pyrrhopygius	Red-backed Kingfisher											●	
Merops ornatus	Rainbow Bee-eater		●	●	S3			●		●	●	●	
Ptilonorhynchus maculatus	Western Bowerbird							●				●	
Climacteris melanura	Black-tailed Treecreeper											●	
Malurus leucopterus	White-winged Fairy-wren							●	●			●	●
Malurus lamberti	Variegated Fairy-wren							●				●	●
Stipiturus ruficeps	Rufous-crowned Emu-wren							●				●	
Amytornis striatus whitei	Striated Grasswren (Pilbara)							●				●	
Smicrornis brevirostris	Weebill							●				●	●
Gerygone fusca	Western Gerygone							●				●	
Acanthiza robustirostris	Slaty-backed Thornbill							●				●	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill							●				●	
Acanthiza uropygialis	Chestnut-rumped Thornbill							●				●	
Acanthiza apicalis	Inland Thornbill							●				●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Pardalotus rubricatus	Red-browed Pardalote							●				●	
Pardalotus striatus	Striated Pardalote							●				●	
Certhionyx variegatus	Pied Honeyeater							●				●	
Lichenostomus virescens	Singing Honeyeater								●			●	●
Lichenostomus keartlandi	Grey-headed Honeyeater							●				●	
Lichenostomus plumulus	Grey-fronted Honeyeater								●			●	
Lichenostomus penicillatus	White-plumed Honeyeater											●	●
Purnella albifrons	White-fronted Honeyeater											●	
Manorina flavigula	Yellow-throated Miner							●	●			●	●
Acanthagenys rufogularis	Spiny-cheeked Honeyeater							●	●			●	●
Epthianura tricolor	Crimson Chat							●	●			●	
Sugomel niger	Black Honeyeater											●	
Lichmera indistincta	Brown Honeyeater							●	●			●	●
Melithreptus gularis	Black-chinned Honeyeater							●				●	
Pomatostomus temporalis	Grey-crowned Babbler							●				●	●
Pomatostomus superciliosus	White-browed Babbler							●					
Coracina novaehollandiae	Black-faced Cuckoo-shrike			●				●				●	●
Lalage sueurii	White-winged Triller							●				●	●
Pachycephala rufiventris	Rufous Whistler							●	●			●	
Colluricincla harmonica	Grey Shrike-thrush							●				●	
Oreoica gutturalis pallescens	Crested Bellbird							●	●			●	
Artamus personatus	Masked Woodswallow							●				●	

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Artamus cinereus	Black-faced Woodswallow							●	●			●	
Artamus minor	Little Woodswallow							●				●	
Cracticus torquatus	Grey Butcherbird							●				●	
Cracticus nigrogularis	Pied Butcherbird							●	●			●	
Cracticus tibicen	Australian Magpie							●				●	
Rhipidura leucophrys	Willie Wagtail							●	●			●	●
Corvus bennetti	Little Crow								●			●	
Corvus orru	Torresian Crow							●				●	●
Grallina cyanoleuca	Magpie-lark			●				●				●	●
Petroica goodenovii	Red-capped Robin							●				●	
Melanodryas cucullata	Hooded Robin							●				●	
Mirafra javanica	Horsfield's Bushlark							●				●	
Acrocephalus australis	Australian Reed-Warbler							●					
Cincloramphus mathewsi	Rufous Songlark							●				●	
Cincloramphus cruralis	Brown Songlark							●				●	
Eremiornis carteri	Spinifexbird							●				●	●
Petrochelidon ariel	Fairy Martin							●				●	●
Petrochelidon nigricans	Tree Martin			●				●				●	
Dicaeum hirundinaceum	Mistletoebird							●				●	
Taeniopygia guttata	Zebra Finch							●	●			●	●
Neochmia ruficauda sub. clarescens	Star Finch					P4		●				●	
Emblema pictum	Painted Finch							●				●	●

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Anthus novaeseelandiae	Australasian Pipit			●				●	●			●	
MAMMALS													
Tachyglossus aculeatus	Echidna											●	●
Dasykaluta rosamondae	Little Red Kaluta							●				●	
Dasyurus hallucatus	Northern Quoll	EN			S1	EN		●	●		●	●	
Ningaui timealeyi	Pilbara Ningaui							●				●	
Planigale sp.	Long-tailed Planigale							●				●	
Pseudantechinus woolleyae	Woolley's Pseudantechinus							●					
Sminthopsis macroura	Stripe-faced Dunnart							●				●	
Sminthopsis ooldea	Ooldea Dunnart							●				●	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart											●	
Macrotis lagotis	Greater Bilby	VU			S1	VU			●				
Notoryctes caurinus	Northern Marsupial Mole	EN			S1	EN			●				
Macropus robustus	Euro							●				●	●
Macropus rufus	Red Kangaroo							●				●	
Petrogale rothschildi	Rothschild's Rock-wallaby							●					●
Rhinonicteris aurantia	Orange Leaf-nosed Bat	VU			S1	VU		●	●		●	●	●
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat							●				●	
Taphozous georgianus	Common Sheath-tail Bat							●				●	●
Taphozous hilli	Hill's Sheath-tail Bat							●				●	
Chalinolobus gouldii	Gould's Wattled Bat							●				●	●
Chalinolobus morio	Chocolate Wattled Bat							●					

Scientific name	Common name	EPBC Threatened species	EPBC Migratory	EPBC Marine	WC Act	DPaW	Introduced	NatureMap	Birdata	EPBC Protected Matters Database	DPaW Threatened Fauna Database	Literature Review (Phoenix 2014)	This survey
Nyctophilus daedalus	Northwestern Long-eared Bat							●				●	
Nyctophilus geoffroyi	Lesser Long-eared Bat							●				●	●
Scotorepens greyii	Little Broad-nosed Bat							●				●	●
Vespadelus finlaysoni	Finlayson's Cave Bat							●				●	●
Chaerephon jobensis	Northern Freetail-bat							●				●	
Mormopterus beccarii	Beccari's Freetail-bat							●				●	
Mus musculus	House Mouse						●	●	●			●	
Notomys alexis	Spinifex Hopping Mouse											●	
Pseudomys chapmani	Western Pebble-mound Mouse					P4		●			●	●	●
Pseudomys desertor	Desert Mouse							●				●	
Pseudomys hermannsburgensis	Sandy Inland Mouse							●				●	
Zyzomys argurus	Common Rock-rat							●				●	
Oryctolagus cuniculus	Rabbit						●		●			●	
Camelus dromedarius	Camel						●		●				
Bos taurus	Cattle						●					●	●
Canis lupus	Dog / Dingo						●	●				●	●
Vulpes vulpes	Red Fox						●		●				
Felis catus	Cat						●	●	●			●	●
Equus asinus	Donkey						●		●			●	
Equus caballus	Horse						●	●	●			●	●

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MEMO

TO:	Phil Scott	COMPANY:	Preston Consulting
FROM:	Adam Pratt	PROJECT TITLE:	Maiden Iron Extension Geochemical Assessment
DATE:	7 February 2014	PROJECT & DOCUMENT NO:	MAI-001-1-8 001
SUBJECT:	Extension Desktop Geochemical Assessment		

1 INTRODUCTION

Soilwater Consultants (SWC) were engaged by Preston Consulting to undertake a desktop geochemical assessment for the proposed Extension Iron Ore Project (Extension) to be developed by Maiden Iron Ore Pty Ltd (Maiden Iron). This deposit covers an approximate area of 690 ha and represents principally the surficial portion of a Channel Iron Deposit (CID), which now forms a subdued mesa formation within the Hamersley Range (Figure 1). The nature of this orebody results in a low waste:ore stripping ratio, with ore-to-surface conditions occurring in some parts of the deposit.

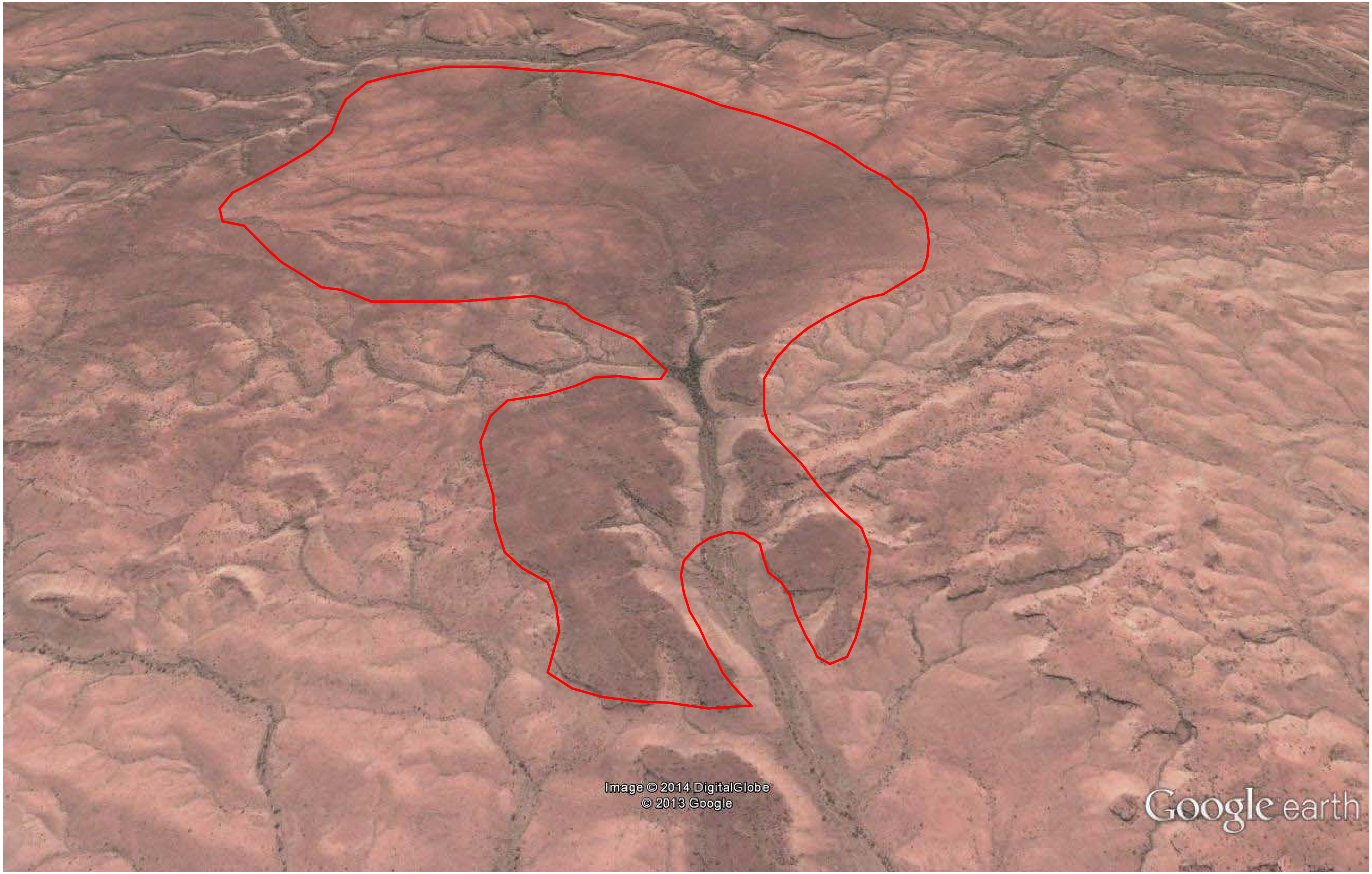
Mining of Extension will involve traditional open-cut methods, resulting in the formation of shallow open pits that will be reshaped and rehabilitated. Only the upper, supergene-enriched portion of the mesa profile will be mined, leaving a residual low-grade iron ore on the mesa surface (i.e. there will be no change to the mesa formation). Given the surficial nature of the deposit, no groundwater will be intersected (i.e. dry mining conditions); hence the profile exists in a well-drained, highly leached condition. As part of the environmental approvals to mine, this desktop geochemical assessment was undertaken to assess whether sulfides or other problematic materials may be present in the surficial deposit and thus to determine the potential for Acid and Metalliferous Drainage (AMD) to occur following disturbance.

The scope of work undertaken by SWC included:

- Review of the geological drilling database.
- Assess the potential for sulfides to be present based on the assay and geological data.
- Establish the potential for AMD to occur following disturbance.
- Preparation of this memo-style report.

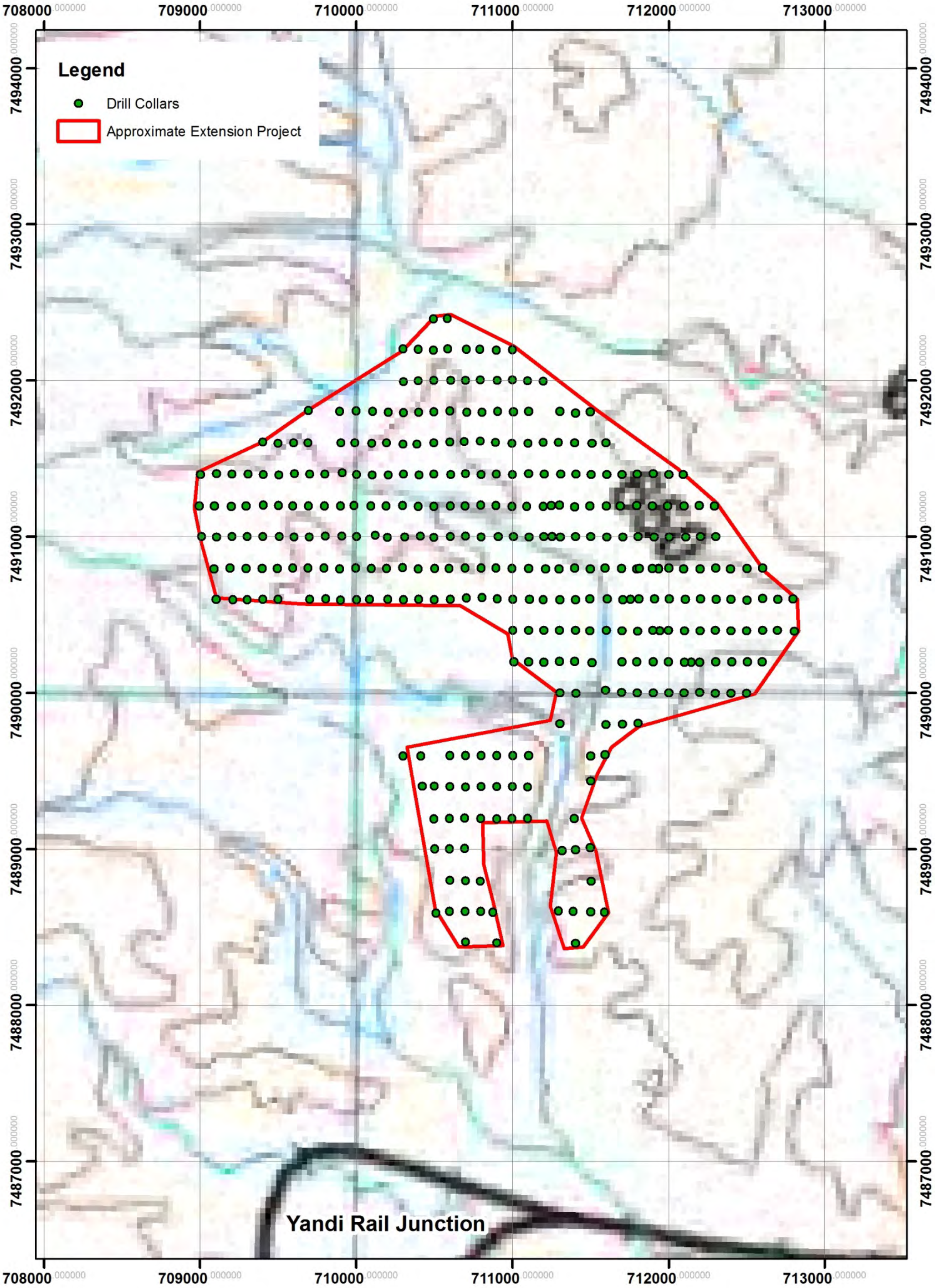
2 REVIEW OF GEOLOGICAL DRILLING DATABASE

At Extension, a total of 345 exploration and geological holes have been drilled (Figure 2), representing a drilling density of approximately 0.5 drillholes/ha. This is considered sufficient to accurately assess the geochemical properties of the orebody and to capture the heterogeneity in materials and material properties throughout the orebody.



Preston Consulting	Figure 1: Approximate outline of the Extension Project	soilwater GROUP
Maiden Iron Extension Geochemical Assessment		

PN: MAI-001-1-8 Prepared by: ASP Date: 06/02/14 Reviewed by: MT Date: 06//02/14 Revision: 1



Preston Consulting	Figure 2: Drillhole location map	soilwater GROUP
Maiden Iron Extension Geochemical Assessment		

A summary of the holes drilled to date at Extension is provided in Table 1. On average the drillholes extend to around 12 m, highlighting the surficial nature of the deposit. Samples have typically been collected at 1 m vertical intervals for geological logging and multi-element analysis, resulting in the collection and testing of 4,193 samples. Multi-element assay was undertaken using an XRF and included the analysis of the following elements: Fe, Si, Al, Ti, Mn, Ca, P, S, Mg, Na and K.

Table 1: Details of the geological holes drilled to date at Extension

No. drillholes	Minimum depth (m)	Maximum depth (m)	Average depth (m)	Median depth (m)
345	4	28	12	13

2.1 POTENTIAL FOR ACID AND METALLIFEROUS DRAINAGE

Of particular interest to the potential formation of AMD is the Total S assay data. The results of this analysis are summarised in Table 2, whilst Total S depth profiles, from 40 representative drillholes across the deposit, are provided in Figure 3. These results highlight that negligible sulfides are likely to be present in the surficial mineralised profile, as the maximum Total S content is only 0.22% (below the typical cut-off level of 0.3%; AMIRA, 1998[1]), with an average Total S content of only 0.024%; if all Total S present was in the form of sulfides then this would only equate to a Maximum Potential Acidity (MPA) of < 1 kg H_2SO_4/t.. These results are expected given the well-drained and oxidised status of the surficial CID materials, and thus any sulfides that may have been present in this material would have long-since oxidised and all reaction products would have been leached out of the surficial profile. The conditions in the surficial profile are not suitable for the formation or hosting of sulfides and thus the potential for Acid Rock Drainage (ARD) to form is considered low.

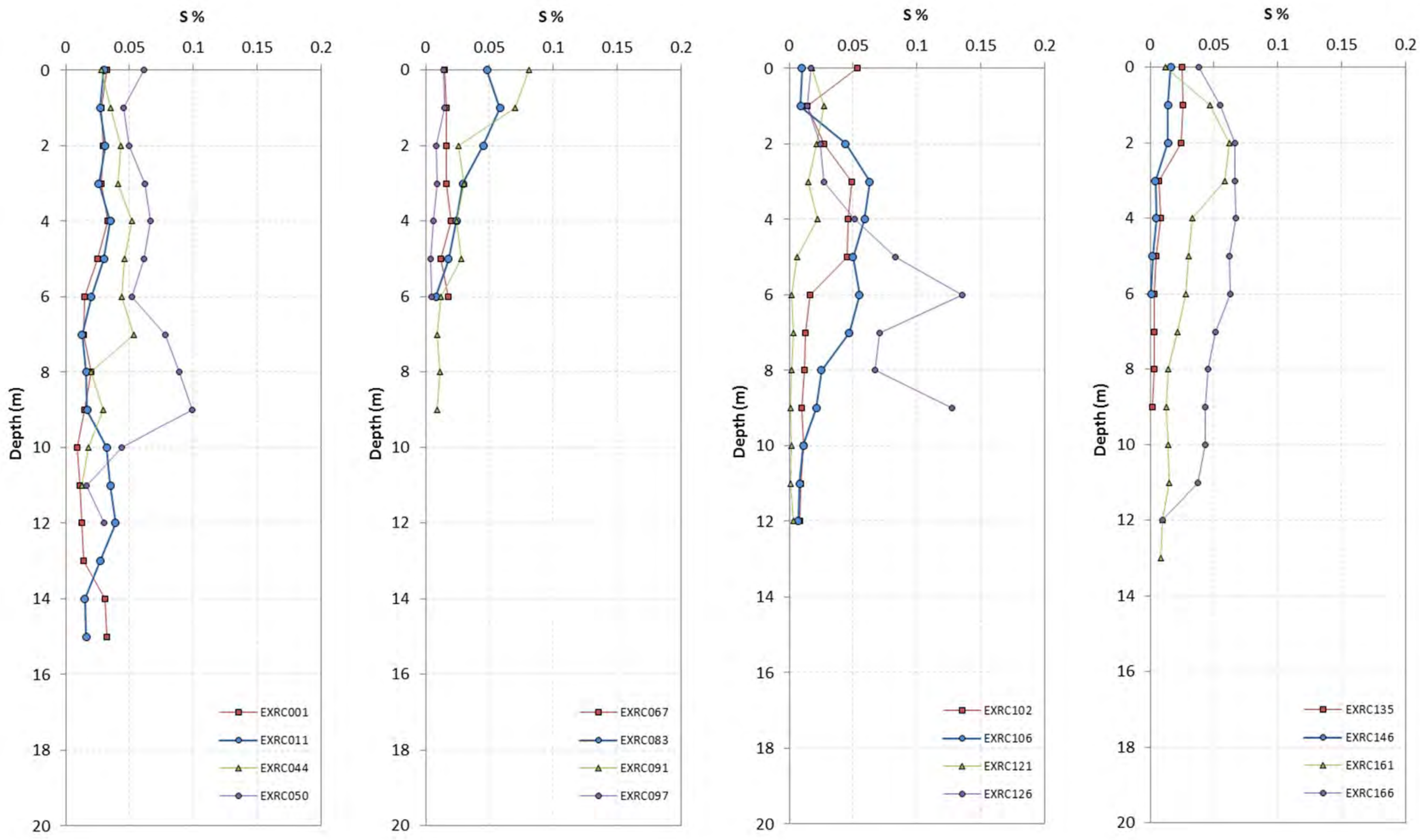
Table 2: Summary of Total S assay data

Minimum Total (S%)	Maximum Total (S%)	Average Total (S%)	Median Total (S%)
0.001	0.216	0.024	0.019

Although the multi-element assay data did not include elements of environmental concern (i.e. As, Cr, Hg, Pb, Ni, Zi etc), the iron-rich and highly weathered nature of the materials will limit both the release or availability of these elements and their actual mobilisation if they are released. Elevated levels of these metals and metalloids are likely to be isomorphically substituted with Fe in the crystal mineral structure, and thus not available to leaching solutions, whilst the highly weathered nature of the materials likely results in them being inherently acidic, and thus any anionic-oxyanionic metals (i.e. As, Cr, Se etc) will be strongly absorbed onto the positively charged mineral surfaces. In addition, no change in redoximorphic condition will occur during mining; hence all materials will remain oxidised throughout the process.

Based on the above discussion, the potential for metalliferous drainage to occur during mining, rehabilitation and closure is considered small, and of minor environmental risk.

[1] AMIRA (1998). *ARD Test Handbook. Project P387A Prediction and Kinetic Control of Acid Mine Drainage*. AMIRA International, Melbourne, Australia.



Preston Consulting	Figure 3: Total S depth profiles for representative drillholes across the Extension Deposit
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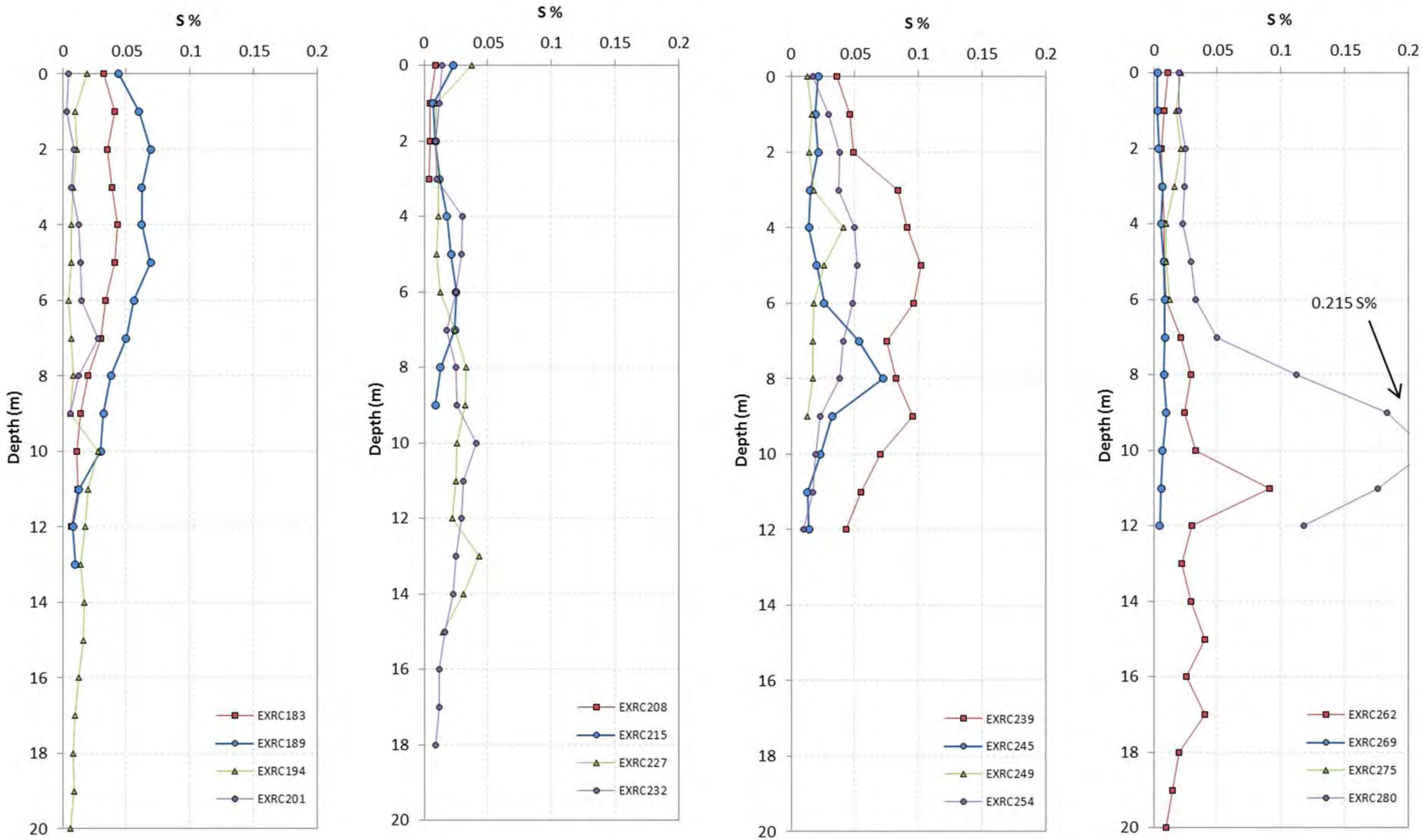

Preston Consulting	*Figure 3 Continued…*
Maiden Iron Extension Geochemical Assessment	

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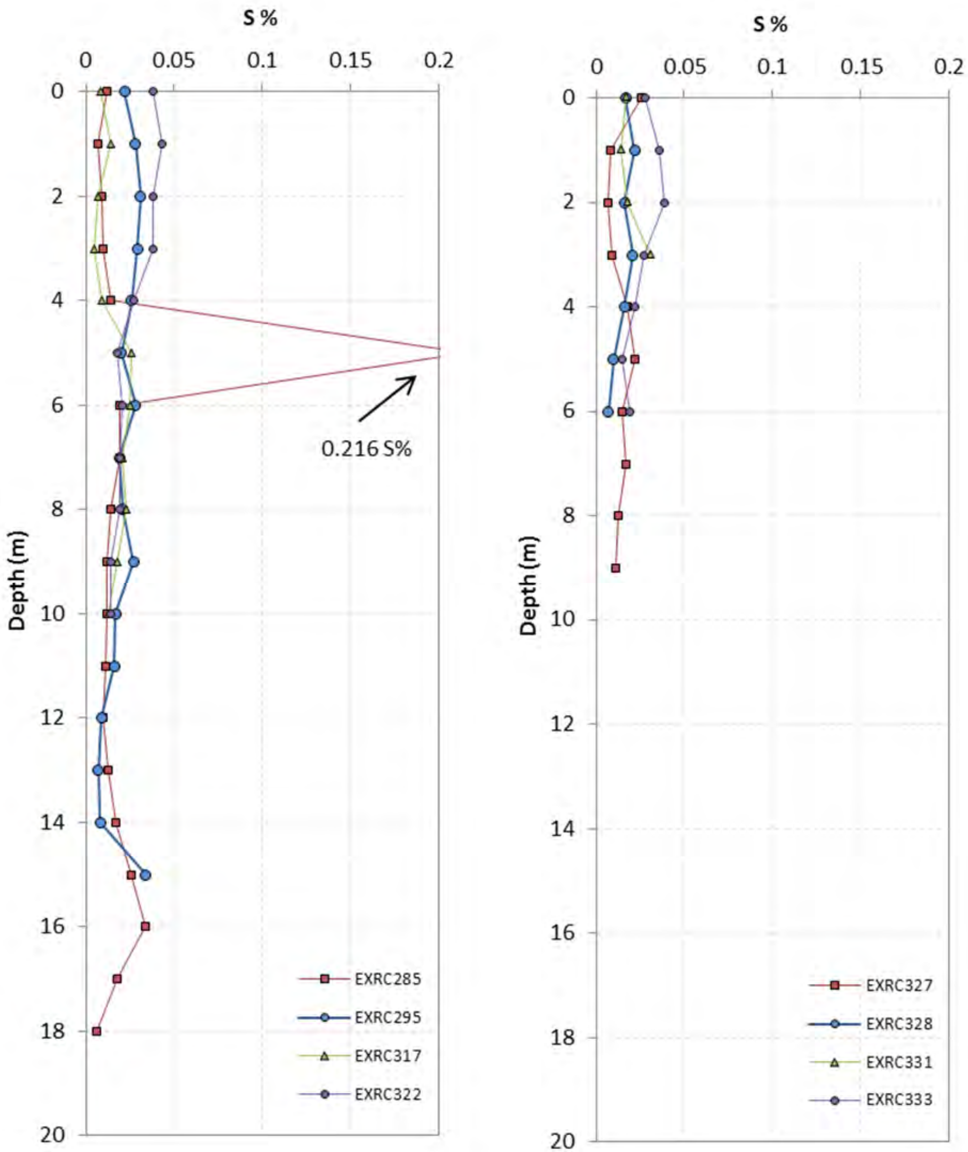

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2.2 OCCURRENCE OF OTHER PROBLEMATIC MATERIALS

The presence of other problematic materials, such as saline, sodic or dispersive materials can represent a significant environmental risk, if not managed appropriately. By using the Al/Si ratio from the assay data, it is possible to identify the dominant clay mineralogy throughout the profile. Clay mineralogy controls the 'reactivity' of the material (i.e. shrink – swell and dispersion), and provides insight into the degree of weathering, which in-turn is a function of the inherent permeability and overall clay content of the material. An example of the weathering sequence of clays, the characteristic Al/Si ratio and the inferred properties is shown in Figure 4. Depth profiles showing the Al/Si ratio for a selected number of drillholes across Extension is provided in Figure 5.

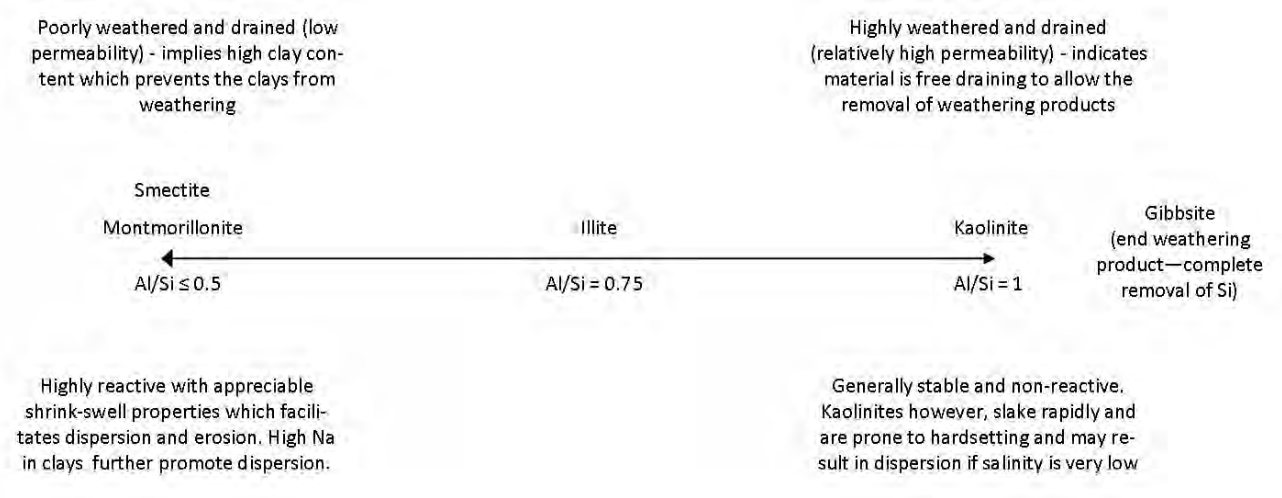
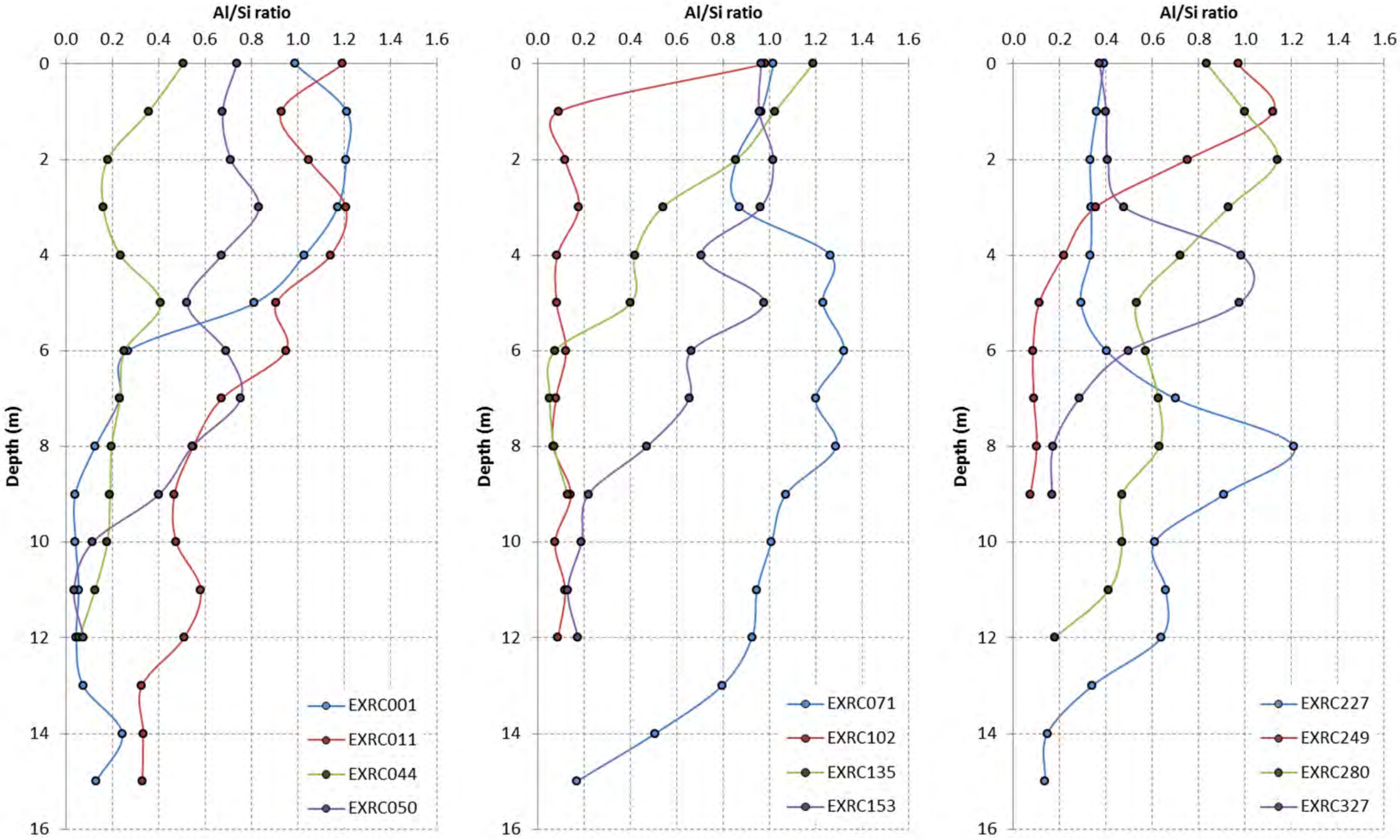


Figure 4: Clay weathering sequence and associated behaviour and function

The Al/Si ratio depth profiles clearly show that the upper portion of the profile is highly weathered, associated primarily with the supergene enriched CID deposits, and well-drained conditions facilitating the formation of predominantly kaolinites. It is likely, given this upper portion represents the orebody, that there is only minor clays and that this iron-rich horizon consists of a friable (or will become friable during excavation), gravel and stable soil/waste rock material. These materials are optimal for use in rehabilitation due to their stability, self-armouring properties and high permeability; however, they are likely to have negligible water holding and plant available water capacity and thus they are unlikely to support a high density, large transpiring vegetation; consequently, small low-transpiring vegetation should be favoured if these materials are to be utilised in rehabilitation.

With depth, there is a gradual decrease in Al/Si ratio implying less permeable conditions (higher clay contents), resulting in the retention of base cations and the transition to an Illite dominanted clay mineral fraction to a smectitic clay in the basement materials. As shown in Figure 4, the less-weathered clays are more reactive and prone to instability, dispersion and erosion; which are further exacerbated by their low permeability. The presence of these clay minerals, and associated clayey, low permeability conditions may require specific management during mining and rehabilitation, as although they have high water holding and plant available water contents, their presence at the surface of any rehabilitated post-mine landform will likely result in instability and erosion, and therefore should be avoided.



Preston Consulting	Figure 5: Al/Si ratio depth profiles	soilwater GROUP
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3 CONCLUSIONS

Based on this desktop geochemical assessment, it is considered that mining of the Extension Deposit, will be of low-environmental risk, and can be undertaken successfully without deleterious impacts on the surrounding environment. The presence of potentially problematic materials in the basement can be effectively managed so as to ensure that a safe, stable, non-polluting and sustainable post-landform is created for closure.

Should you have any queries regarding this report, please do not hesitate to contact us.

Yours sincerely,

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