Rio Tinto

Iron Ore
152-158 St Georges Terrace
Perth 6000
Western Australia
T + 61 (8) 9327 2000

Office of the Environmental Protection Authority

File:

05 FEB 2014

A:	☐ For Information
	☐ For Discussion
Officer:	☐ For Action
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3 February 2014

Sally Bowman
Manager – Mining and Industrial Assessments (North)
Office of the Environmental Protection Authority
The Atrium, 108 St George's Terrace, PERTH WA 6000

Attention: Peter Tapsell

Dear Ms Bowman,

Brockman Syncline 4 Iron Ore Project – Revised Proposal

The enclosed document is a submission by Hamersley Iron Pty Limited (the **Proponent**) under section 38 of the *Environmental Protection Act 1986* (**EP Act**) for the following:

- Environmentally non-significant changes to the approved Brockman Syncline 4 Project (the **B4 Project**).
- The following environmental changes to the B4 Project (this **B4 Proposal**)
  - additional clearing to support waste dump optimisation and ongoing operations at the B4 Project; and
  - surface discharge of surplus dewatering water to Boolgeeda Creek.

A draft Ministerial Statement is included for consideration. The Proponent proposes that this Ministerial Statement supersedes Ministerial Statement 717 (24 March 2006).

Therefore, please find enclosed:

- a completed Proponent Referral Form;
- a CD with the spatial data for the B4 Proposal; and
- an Environmental Review document which provides additional detail on the scope of the B4 Proposal, the studies undertaken and planned, the stakeholder consultation program and the key aspects and proposed management strategies for the B4 Proposal.

If you require any further information in relation to the B4 Proposal please contact Tammy Souster on 6211 6985 in the first instance.

Yours sincerely,

HScott

Hermione Scott

Manager, Government and Environmental Approvals Rio Tinto Iron Ore

GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

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
If yes, what level of assessment? √ Assessment on Proponent Information

PROPONENT DECLARATION (to be completed by the proponent)

I, Tammy Souster declare that I am authorised on behalf of Hamersley Iron Pty Limited submit this form and further declare that the information contained in this form is true and not misleading.

Signature	Tammy Souster
Position Senior Advisor Approvals	Rio Tinto Iron Ore (on behalf of Hamersley Iron Pty. Limited)
Date 3 February 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	Hamersley Iron Pty Limited.
Joint Venture parties (if applicable)	Not applicable
Australian Company Number (if applicable)	ABN: 49 004 558 276
Postal Address	GPO Box A42, Perth, WA 6837
Key proponent contact for the proposal:	Tammy Souster Senior Advisor Environmental Approvals Rio Tinto 152-158 St Georges Terrace, Perth WA 6000 Telephone: (08) 6211 6985 Email: tammy.souster@riotinto.com
Consultant for the proposal (if applicable):	Not applicable

1.2 Proposal

Title	Brockman Syncline 4 Iron Ore Project – Revised Proposal
Description	This Proposal is a revision of the approved Brockman Syncline 4 Iron Ore Project (MS 717), located approximately 60 km west-north-west of Tom Price in the Central Pilbara. The new factor relates to discharge of surplus dewater, as the dewatering rate is increasing from 4.53 GL/a to 6.4 GL/a over the life of the Proposal. The surplus water management will include onsite use and controlled discharge to Boolgeeda Creek.
Extent (area) of proposed ground disturbance.	950 ha in addition to the approved footprint of 2,610 ha
Timeframe in which the activity or development is proposed to occur (including start and finish dates where applicable).	Discharge to commence in Q1 2015.
Details of any staging of the proposal.	Not applicable
Is the proposal a strategic proposal?	No
Is the proponent requesting a declaration that the proposal is a derived proposal?	No.
Please indicate whether, and in what way, the proposal is related to other proposals in the region.	This Proposal is a revision of the approved Brockman Syncline 4 Iron Ore Project (MS 717)
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?	No, the proponent holds Mining Lease 4SA over most of the Proposal area. Infrastructure related to the B4 project is located on a number of Miscellaneous Licenses and General Purpose leases granted under the *Mining Act 1978*.
What is the current land use on the property, and the extent (area in hectares) of the property?	The current land use on ML4SA (total area approximately 58 800 ha) in the vicinity of the Proposal is mineral exploration. Mining and processing of iron ore occurs on ML4SA at the existing WTS S10 and Tom Price mine sites

1.3 Location

Name of the Shire in which the proposal is located.	Shire of Ashburton
For remote localities: • nearest town; and • distance and direction from that town to the proposal site.	The proposal is located approximately 60km from the town of Tom Price
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

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?	NA

1.5 Government Approvals

Is rezoning of any land required before the proposal can be implemented? If yes, please provide details.		No
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.		Yes
Department of Water	Licences to construct wells and take groundwater under the *Rights in Water and Irrigation Act 1914.*	No. Requires amendment to existing License GWL164398

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;

2.2 fauna;

2.3 rivers, creeks, wetlands and estuaries;

2.4 significant areas and/ or land features;

2.5 coastal zone areas;

2.6 marine areas and biota;

2.7 water supply and drainage catchments;

2.8 pollution;

2.9 greenhouse gas emissions;

2.10 contamination; and

2.11 social surroundings.

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?

√ Yes — **If yes**, complete the rest of this section.

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

950 ha

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

√ 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 — Multiple flora and vegetation surveys have been undertaken within the approved B4 Project area and surrounds.
A flora and vegetation survey along Boolgeeda Creek was completed by Biota Environmental Sciences (2013) to support this Proposal. This report is provided as Appendix 5 in the supporting documentation.

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

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

√ Yes No Declared Rare Flora or Threatened Ecological Communities have been recorded within the Proposal boundary, or are expected to.

Six Priority species could potentially be impacted by the Proposal:

- *Ptilotus subspinescens* Priority 3
- *Eremophila magnifica* subsp. *magnifica* Priority 4
- *Peplidium sp.* Fortescue Marsh (S. Van leeuwen 4865) Priority 1
- *Pentalepis trichodesmoides subsp. hispida* Priority 2
- *Indigofera sp.* Bungaroo Creek (S. Van Leeuwen) Priority 3
- *Goodenia nuda* Priority 4

Further information is provided in Section 6 of the Environmental Review document

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

Vegetation condition is from poor to excellent using the Trudgen scale.
Further information on the vegetation condition is contained in the report by Biota Environmental Sciences (2013) Brockman 4 riparian vegetation mapping report located as Appendix 3 in the Environmental Review document.

2.2 Fauna

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

√ Yes

2.2.2 Describe the nature and extent of the expected impact.

The nature and extent of the expected impact is outlined in Section 6 of the Environmental Review document.

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

√ Yes Multiple fauna surveys have been undertaken within the approved B4 Project area and surrounds.
Details of these studies are provided in Section 6 of the Environmental Review document.

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

√ Yes

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

√ Yes Four priority vertebrate fauna species have been recorded in the B4 survey area (Biota 2005b):

- Western Pebble –mound Mouse *Pseudomys chapmani*
- Australia Bustard *Ardeotis australis*
- Bush Stonecurlew *Burhinus grallarius*
- A skink *Notoscincus butleri*

2.3 Rivers, Creeks, Wetlands and Estuaries

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

√ Yes

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

√ No

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

√ No

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

√ No

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

√ Yes — Dewatering in excess of operational requirements will be discharged to Boolgeeda Creek with a maximum wetting front of 37km.

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

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?

√ No

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?

√ No — **If yes**, please provide details.

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?

√ 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?

√ No — **If no**, go to the next section.

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?

√ No — **If yes**, please describe the extent of the expected impact.

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 The Proposal is located within the Pilbara Groundwater Area proclaimed under the *Rights in Water and Irrigation Act 1914,* in which licences will be required for construction of wells to access groundwater and to abstract groundwater.
Rio Tinto is liaising with DoW regarding amending the existing GWL164398 to increase the abstraction from 4.53GL/a to 6.4 GL/a. The water abstracted will be used for mine operations such as processing and excess disposed to a local watercourse.

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)

√ No

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.)

√ No

2.7.4 Is there sufficient water available for the proposal?

√ Yes

2.7.5 Will the proposal require drainage of the land?

√ No

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

√ Yes

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

Ongoing operational demand for water is approximately 8ML/day.

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

Water supply during operation will be preferentially sourced from mine dewatering.

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?

√ No No different or additional pollutants, to those assessed and approved for the B4 Project (via MS 717), will result from implementation of this Proposal.

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)?

√ No

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?

√ No

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

√ No

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)

√ No

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 Aboriginal heritage surveys of the Proposal area are at various stages of completion. Heritage surveys will be completed prior to any clearing requested as part of this proposal.

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)?

√ No

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

√ No

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
2.	The principle of intergenerational equity.	Yes
3.	The principle of the conservation of biological diversity and ecological integrity.	Yes
4.	Principles relating to improved valuation, pricing and incentive mechanisms.	Yes
5.	The principle of waste minimisation.	Yes

A discussion on the Principles is provided in Section 9 of the Environmental Review document.

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

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 Further information is provided in Section 2 of the Environmental Review document.

Rio Tinto Pty Limited

Brockman Syncline 4 – Revised Proposal

Assessment on Proponent Information

Environmental Review Document

Hamersley Iron Pty Limited

152 – 158 St Georges Terrace, Perth

GPO Box A42, Perth, WA 6837

February 2014

RTIO-HSE-0209902

Disclaimer and Limitation

This report has been prepared by Rio Tinto Iron Ore (Rio Tinto), on behalf of Hamersley Iron Pty Limited (Hamersley Iron), specifically for the Brockman Syncline 4 Iron Ore Project. Neither the report nor its contents may be referred to without the express approval of Rio Tinto, unless the report has been released for referral and assessment of proposals.

Document Status					
Rev	Author	Reviewer/s	Date	Approved for Issue	
				To Whom	Date
A - D	M. Palandri	T. Souster/P. Royce	02/12/13		
E - F	T. Souster	Project Team	08/01/14		
1	T. Souster			OEPA	03/02/2014

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1 PROPOSAL

1.1 PROPONENT DETAILS

The Proponent for this Proposal is Hamersley Iron Pty Limited

ABN: 49 004 558 276

GPO Box A42

Perth WA 6837

The contact person for the Proposal is:

Tammy Souster

Rio Tinto: Senior Advisor Environmental Approvals

T: +61 (08) 6211 6985

tammy.souster@riotinto.com

1.2 THE BROCKMAN SYNCLINE 4 PROJECT

Hamersley Iron Pty Limited (**Hamersley Iron**) (a wholly owned subsidiary of Rio Tinto) is operating the Brockman Syncline 4 Iron Ore Project (**B4 Project**). Refer to Figure 1-1 for the regional setting of the B4 Project.

The B4 Project, as implemented, consists of:

- Three main mining areas (Western, Central and Eastern lenses of mineralisation) with approximately 20% of the orebody occurring below the water table.
- A dry processing plant with a nominal capacity of 42 Mtpa.
- Associated iron ore mine infrastructure (e.g. product stockpiles, waste dumps, topsoil, low-grade stockpiles and haul roads).
- Associated infrastructure (e.g. mine access roads, offices, warehouses, accommodation, bore fields, fuel storage facilities and utilities).
- An extension of the existing Brockman 2 rail spur to the B4 Project.
- Infrastructure corridor for power supply.
- Groundwater abstraction of 12 ML/day (4.38 GL/annum) plus 400kL/day (0.15 GL/annum) for mine camp needs.

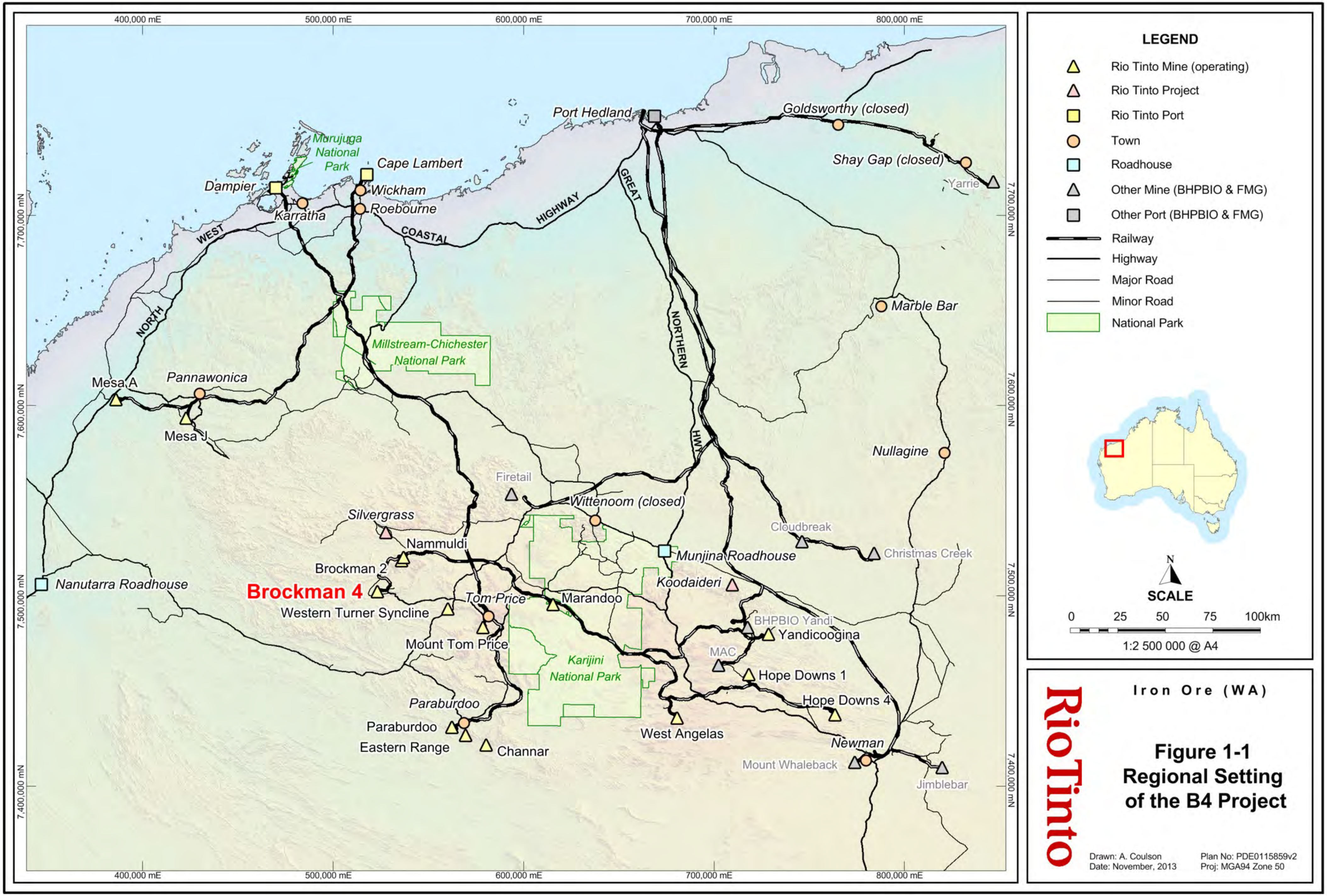


Figure 1-1
Regional Setting of the B4 Project

A summary of the Key Characteristics of the approved B4 Project (from Ministerial Statement 717) is provided below in Table 1-1.

Table 1-1: Summary of Key Characteristics of the B4 Project (MS 717)

Element	Description
General	
Project life	Estimated 30 years
Area of disturbance	Approximately 2,610[1] ha
Potential ore reserves	600 Mt high grade (>60%Fe) 280 Mt low grade (>50% Fe)
Mining rate	42 Mtpa
Waste rock	420 Mt (approx. 150 Mt will be used to backfill pits)
Greenhouse Gas Emissions	5.59 kg CO_{2e} per tonne of production per annum
Mine and mining	
Pits and ore type	Three pits with high phosphorus Brockman ore. The deposit extends approximately 14 km in length, is 1 km wide and averages 150 m deep.
Ore below water table	Approximately 20% of total ore (variable between each pit).
Stripping ratio	Ranges from 0.5:1 to 1.5:1 waste to ore depending on processing and stockpile strategies (average 1.2:1).
Waste rock disposal	Surface dumps until mined-out pit voids become available, then backfilled to above pre-mine water table.
Waste dumps, high grade and low grade stockpiles – location, height	Original site as shown in Figure 2 of Attachment 1 of MS 717 and a stockpile area adjacent to rail loop as shown in Figure 5 of attachment 2 in MS 717. Height of waste dumps to be total height of 50m.
Dewatering	Dewatering is required to access ore from below the water table.
Infrastructure	
Water supply	Supplied from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor. 4.38 GL/annum (dust management) plus additional 0.15 GL/annum for the mine camp.

[1] B4 Phase 2 S45C application, approved (4 November 2008) an increase in clearing from 2,470 ha to 2610 ha. Schedule 1 of MS 717 was not correctly updated to reflect this.

Element	Description
Power supply	25 MW supplied from the Dampier-Tom Price 220 kV transmission system via a 33 kV sub-transmission system. Power lines will approach the mine within the infrastructure corridor, except at the southern end where the route diverges from the infrastructure corridor (Figure 4 of MS 717).
Processing plant	A dry plant with a crushing and screening circuit for a total 42Mtpa.
Product transport	By rail via a 35 km long rail spur from the project area to Brockman 2 mine, then along the existing Brockman 2 rail spur and the main railway to port including rail siding earthworks between Brockman 2 and B4.
Rail Spur	330 ha footprint (see Figures 1a and 1b of MS 717)
Plant, administration, workshops and stockpiles location	Original site as shown in Figure 2 of Attachment 1 of MS 717 and a stockpile area adjacent to rail loop as shown in Figure 5 of Attachment 2 in MS 717.
Mine access roads	Construction of a sealed access road from Brockman 2 that will mostly be provided by bitumen sealing of the approved B4 infrastructure corridor service road (no additional footprint); some deviations from the approved track are required and these will create additional footprint.
Workforce	
Construction operation	Peak of 700 300 (plus approximately 40 during periodic shutdown maintenance periods)
Accommodation	A permanent village and contractor’s camp, plus small rail spur camps Total 570 rooms Total 1350 rooms

1.2.1 Environmental Approvals History

The Minister for the Environment issued Ministerial Statement 717 (**MS 717**) on 24 March 2006 allowing implementation of the B4 Project. Since then several changes have been approved under Part IV of the *Environmental Protection Act 1986* (**EP Act**) as summarised below in Table 1-2. A copy of MS 717 is provided in Appendix 2.

Table 1-2: Summary of B4 Project Approvals History

Change	Date	Changes to B4 Project	Approval
1	19/09/07	Minor changes including: - re-design of approved rail spur; - relocation of approved 220kV powerline and construction of 33kV powerline reticulation system; - increase in throughput from 20Mtpa to 22Mtpa; - increase in water use from 6.2ML/day to 8ML/day (2.92 GL/a) plus 300kL/day (0.11GL/a) for mine camp purposes; - bitumen sealing of the White Quartz Road; and - removal of the conveyor and a new airstrip.	S45C
2	22/09/08	Rerouting of the powerline corridor and change in power capacity.	S45C
3	17/12/08	Minor changes including: - an increase in throughput from 22Mtpa to 42Mtpa; - an increase in water use from 8ML/day to 12ML/day (4.38GL/a), plus an increase from 300kL/day to 400kL/day (0.15GL/a) for mine camp needs; and - an increase in the clearing limit.	S45C

The Brockman Syncline 4 - Nammuldi Water Pipeline Corridor Proposal was granted *Not Assessed – Public Advice Given* in May 2011 after the Office of the Environmental Protection Authority (**OEPA**) determined that the scope of works was not significant as to warrant formal assessment or the setting of conditions. This proposal included a pipeline between Nammuldi and B4 to supplement water supply at B4 and reduce surplus discharge associated with the Nammuldi-Silvergrass project. This proposal has not been implemented.

1.3 PROPOSAL TENURE

State Agreement and Mining Act

The mining operations within the B4 Project area are located on Mineral Lease 4SA (ML4SA) which was granted in 1965 under the *Iron Ore (Hamersley Range) Agreement Act 1963* (Figure 1-2). State Agreements are contracts between the State and major project developers that establish a framework of rights and obligations for both parties to facilitate the development of resources and/or downstream processing projects in Western Australia. The State Agreement provides rights of renewal of ML4SA for further periods of 21 years; the current expiry date of ML4S is 24 March 2028.

The infrastructure associated with the B4 mining operations is located on a number of Miscellaneous Licences and General Purpose Leases that were granted under the *Mining Act 1978* (Figure 1-2). These include Miscellaneous Licences No. L47/141; L47/152; L47/153; L47/184; and L47/185 and General Purpose Leases No. G47/1225; No. G47/1227; and No. G47/1232. This tenure supports the

B2 – B4 railway and road, the B4 powerline, the B4 airstrip, the Boolgeeda exploration camp and the B4 accommodation village.

In regards to tenure that has been granted under the *Land Administration Act 1997*, the majority of the Proposal area is situated on Rocklea Station which is held by Rio Tinto. There is a northern portion of the Proposal area that is within Hamersley Station which is also held by Rio Tinto. Some of the western part of the Proposal area extends into Cheela Plains Station and Mt Stuart Station which are held by a third party.

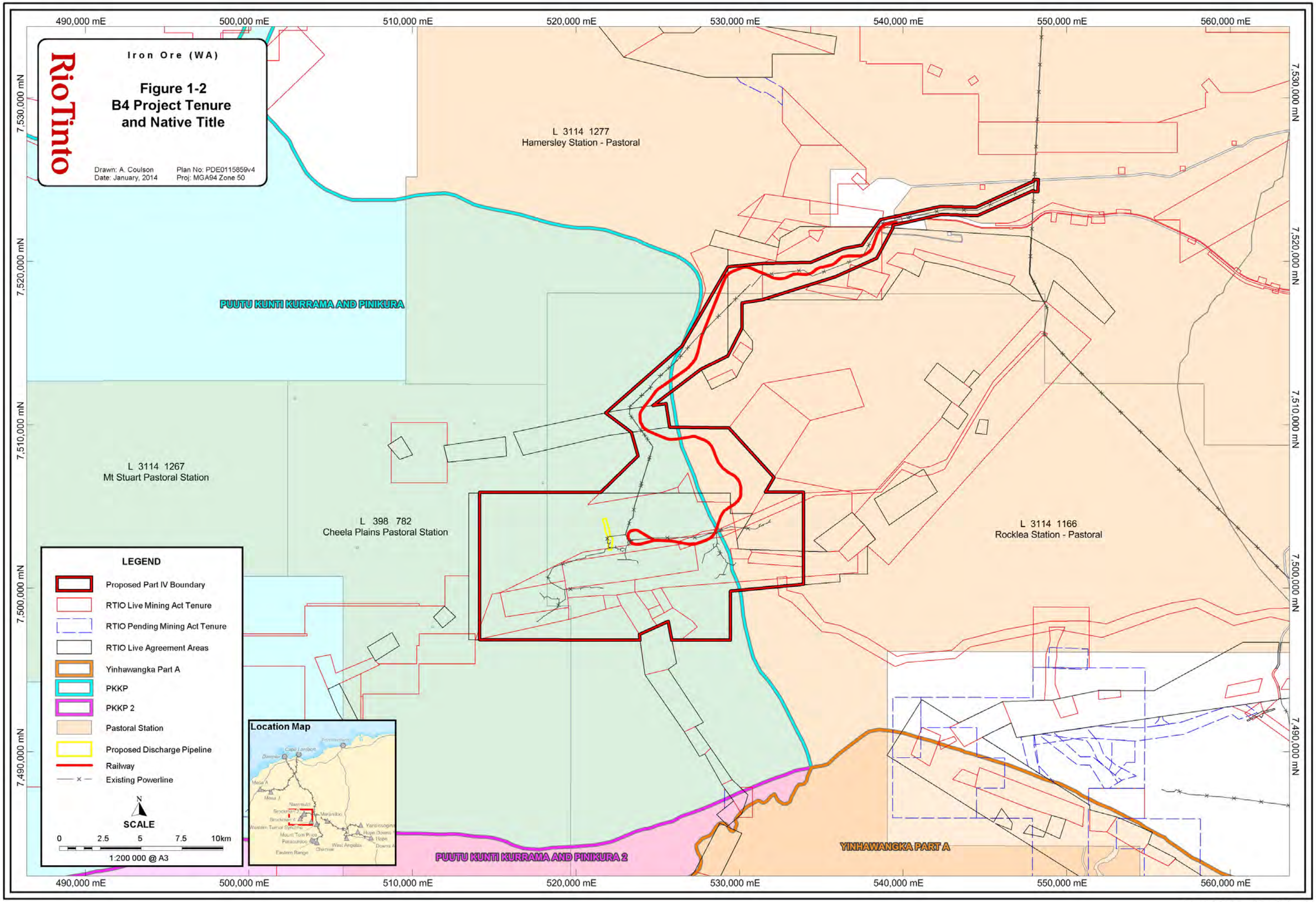
All pastoral leases in Western Australia issued under the now repealed *Land Act 1993* expire on 30 June 2015. When these pastoral leases are reissued to lessees' some portions will be retained by the State and added to the conservation estate and other areas will be set aside for conservation management under conservation agreements with the Department of Parks and Wildlife (**DPaW**). The parts of Rocklea Station, Hamersley Station, Cheela Station or Mt Stuart Station that are within the Proposal area will be not be subject to these changes.

Native Title

The Proposal area lies within two native title claims (refer to Figure 1-2).

The native title claim over the western area was lodged in 2001 by the Puutu Kunti Kurrama and Pinikura (**PKKP**) people; in March 2011 a claim wide participation agreement was signed with Rio Tinto which provides consent of the PKKP people to Rio Tinto's operations including to the Proposal.

The Eastern Guruma group has determined native title over the eastern part of the B4 Project area. This part of the B4 Project area is subject to an Indigenous Land Use Agreement between the Eastern Guruma group and Hamersley Iron, and provides consent of the Eastern Guruma people to Rio Tinto's operations including the Proposal.



Geospatial Information and Mapping

1.4 LAND USE AND SOCIAL ENVIRONMENT IN PROXIMITY TO THE PROPOSAL

The Proposal is located in the Shire of Ashburton (Pilbara Region) and is approximately 60km and 80km from the towns of Tom Price and Paraburdoo respectively (refer to Figure 1-1).

Pastoral Activities

Pastoralism has been active in the area for over 100 years, with grazing by sheep until 1970 and by cattle thereafter. Rio Tinto holds and directly manages five stations in the Pilbara region: Karratha, Hamersley, Rocklea; Yarraloola and Juna Downs. Rio Tinto also holds a sixth station in the Pilbara (Yalleen) which is sub-leased to a third party.

The Proposal is mostly located within Rocklea Station which borders Hamersley Station. The Hamersley Station homestead is the closest residential premise (other than the Brockman 2 camp, the B4 village and the Nammuldi village) and is located approximately 55 km from the Proposal. Cheela Plains Station homestead is approximately 110 km south-east of the Proposal area. Cheela Plains Station is a family owned and managed cattle station which was formerly part of Wyloo Station until 2001. The Mt Stuart Station is a family owned and managed cattle station located west of Cheela Plains Station. The now abandoned Duck Creek Homestead is located on Mt Stuart Station.

Mining

The Rio Tinto Brockman 2 and Nammuldi Silvergrass mines are located approximately 22km and 25km north east of the Proposal area, respectively. The Western Turner Syncline B1 and Section 10 mine is located 40km east/south east from the Proposal area (refer to Figure 1-1). First ore was railed from the B4 project in 2010.

Tourism

National Parks are the major tourism focus in the central Pilbara region. The Proposal is located approximately 90 km from the nearest boundary of the Karijini National Park and 100 km from the nearest boundary of the Millstream Chichester National Park.

The Proposal area contains no significant features that warrant attention from the tourism sector. There are few public roads in the vicinity to facilitate access for tourists; therefore tourism is very limited in, or adjacent to, the Proposal area.

2 STAKEHOLDER CONSULTATION

Identified key stakeholders for this Proposal include:

- Government agencies:
  - Office of the Environmental Protection Authority (**OEPA**);
  - Department of Parks and Wildlife (**DPaW**) – Pilbara region, Perth Environmental Management Branch (EMB);
  - Department of Environment and Regulation (**DER**);
  - Department of Mines and Petroleum (**DMP**);
  - Department of Water (**DoW**) – Pilbara regional office, Perth office; and
  - Department of Aboriginal Affairs (**DAA**).
- Traditional Owners:
  - Puutu Kunti Kurrama and Pinikura People (**PKKP**); and
  - Eastern Guruma Group.
- Cheela Plains Pastoral Station.
- Mt Stuart Station

Stakeholder consultation undertaken to date, and Rio Tinto's response to issues raised, is detailed in Table 2-1. Rio Tinto will continue to consult with relevant stakeholders during the environmental approval process and during implementation of the Proposal.

Table 2-1: Stakeholder Consultation Relevant to this Proposal

Date	Topics/Issues Raised	Proponent Response
Office of the Environmental Protection Authority (OEPA)		
02/07/2013	Rio Tinto provided a detailed overview of the Proposal and discussed the preferred approvals pathway. OEPA advised that surface discharge, as a new factor in addition to MS 717, should be assessed via an API A.	Rio Tinto accepted the OEPA's position that the Proposal warranted formal assessment via an API A.
26/09/2013	Rio Tinto discussed additions to the scope of the Proposal which included additional clearing at B4 and some administrative changes to Schedule 1 of MS 717. The OEPA requested detailed information regarding the significance of the proposed clearing. OEPA advised that the administrative changes to Schedule 1 of MS 717 could proceed via a s45c application.	Rio Tinto provided detailed information regarding the additional clearing required.
12/11/2013	Based on the information provided by Rio Tinto regarding the significance of the proposed clearing, the OEPA requested that the clearing be included in the API for assessment with the proposed surface water discharge.	Rio Tinto revised the draft API and s45C documents accordingly.
25/11/2013	The OEPA advised Rio Tinto that all proposed works should be included in the API as a Revised Proposal to MS 717.	Rio Tinto revised the draft API document accordingly.
Department of Parks and Wildlife (DPaW)		
29/07/2013	Rio Tinto-DPaW Quarterly meeting: Rio Tinto presented on the proposed surface discharge to Boolgeeda Creek at the Rio Tinto – DPaW Quarterly meeting. No issues or concerns were raised by DPaW.	Rio Tinto will continue to consult with DPaW throughout the environmental approvals process.
Department of Environment Regulation (DER)		
Ongoing	Rio Tinto will apply for approval to discharge surplus dewatering water to the environment under Part V of the *Environmental Protection Act 1986*. This includes providing a detailed overview of the Proposal, relevant environmental studies, potential environmental impacts and proposed management.	

Date	Topics/Issues Raised	Proponent Response
Department of Water (DoW) – Perth Office		
Ongoing	Rio Tinto is liaising with the DoW to amend the existing *Rights in Water and Irrigation Act 1914* Groundwater Licence (GWL164398), to increase the abstraction limit from 4.53 GL/a to 6.4 GL/a. The Groundwater Operating Strategy under GWL164398 will also be updated. This involves providing an overview of the Proposal, relevant hydrogeological studies and proposed management measures, with a focus on groundwater management issues.	
Department of State Development		
Ongoing	Rio Tinto provides ongoing updates on relevant projects at monthly meetings with the DSD. No specific concerns have been raised to date with the Proposal.	Rio Tinto will continue consultation with DSD.
Department of Aboriginal Affairs		
Ongoing	Rio Tinto provides ongoing updates on relevant Proposals and heritage matters at regular liaison meetings.	Rio Tinto will continue liaising with the DAA and will discuss Proposal specific matters as required. Rio Tinto will consult with DAA regarding any planned submissions for approval under s18 of the *Aboriginal Heritage Act 1972* to disturb any heritage sites that cannot be avoided.
Cheela Plains Station Owners		
28/11/2013	Meeting with Evan and Robin Pensini of Cheela Plains Station in town of Paraburdoo. Rio Tinto provided the background approvals history for the B4 Project and outlined details of the Proposal. Key issues of concern that were raised and discussed included: • Discharge of open waters into Boolgeeda Creek that will extend into Cheela Plains station is likely to attract feral animals (mainly donkeys, camels and cattle). • The public availability of the SCARD Management Plan. • Agreement to meet again toward the end of January 2014 once the API document is drafted.	Rio Tinto advised it would address the issue for feral animals in the API document. Rio Tinto, if requested, will provide information from the Rio Tinto SCARD Management Plan. A follow-up meeting has been tentatively scheduled to coincide with Cheela Plains station owners being in Perth between 26 January and 11 February 2014.

<table>
<tr><th>Date</th><th>Topics/Issues Raised</th><th>Proponent Response</th></tr>
<tr><td colspan="3">Mt Stuart Station and Badgingarra Owners</td></tr>
<tr><td>13/01/2014</td><td>Conversation with Martin (Mt Stuart Station) and Deborah (Badgingarra) Avery.
Rio Tinto provided the background approvals history for the B4 Project and outlined details of the Proposal.
Key issues of concern that were raised and discussed included:
• Will the quality of the discharge water into Boolgeeda Creek be suitable for feral herbivores/cattle?
• It was considered that water would not pool along Boolgeeda Creek for more than a day or so.
• Provision of Proposal details.</td><td>Rio Tinto noted these comments and addresses water quality in the API document.
A copy of the API, as submitted to the OEPA, will be provided to both Mt Stuart station and Badgingarra properties.</td></tr>
<tr><td colspan="3">Puutu Kunti Kurrama and Pinikura (PKKP) – Traditional Owner</td></tr>
<tr><td>Ongoing</td><td>Issues relevant to the B4 Project are discussed with PKKP at six monthly Local Implementation Committee (LIC) meetings, as agreed to in the claim-wide Participation Agreement. This proposal was raised at the LIC meeting in Dampier on the 26 November 2013.</td><td>Rio Tinto will continue with regular consultation with PKKP through the LIC meetings.</td></tr>
<tr><td colspan="3">Eastern Guruma – Traditional Owner</td></tr>
<tr><td>Ongoing</td><td>Any issues relevant to the Eastern Guruma People are raised at quarterly Monitoring and Liaison Meetings. It is a condition of the Agreements that notification of any activities is provided to Eastern Guruma prior to works taking place and effort is made to address any areas of concern raised by the group</td><td>Rio Tinto will continue with regular consultation with Eastern Guruma through the Monitoring and Liaison meetings.</td></tr>
</table>

3 PROPOSAL DESCRIPTION

3.1 THIS PROPOSAL

This Environmental Review document (**ER**) provides a detailed description of this Proposal and assesses the potential environmental impacts that may result should the Proposal be implemented.

This ER has been referred to the OEPA in order to enable assessment under the provisions of Part IV of the *Environmental Protection Act 1986* (**EP Act**) and has been prepared in accordance with the information requirements for a API Category A as set out in the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012* (**2012 Administrative Procedures**). The s38 Referral Form is provided in Appendix 1.

This Proposal will be a Revised Proposal to the existing MS 717 and it allows for assessment of the following:

- Non-significant changes to Schedule 1 of MS 717, such as:
  - provision of a Project Boundary (refer to Section 4.1); and
  - minor changes to the Key Characteristics (refer to Section 4.2).
- Waste dump optimisation and additional clearing to support ongoing operations at the B4 Project (refer to Section 4.3).
- Surface discharge of surplus dewatering water to Boolgeeda Creek (refer to Section 5).

3.2 ENVIRONMENTAL APPROVAL PROCESS

The OEPA has determined that this Proposal is a revised proposal to the existing B4 Project (Ministerial Statement 717). Upon approval of this Proposal, a new Ministerial Statement will be issued which will supercede MS 717 and any associated s45c attachments, providing one overall contemporary Ministerial Statement for the B4 Project.

3.2.1 Proposed Environmental Conditions

Rio Tinto has developed proposed environmental conditions (refer to Appendix 3) to address the key environmental aspects of the B4 Project. These environmental conditions are proposed to apply to the whole B4 Project (i.e. the approved B4 Project and this Proposal) and to replace the existing MS 717 that currently applies to the approved B4 Project.

These environmental conditions have been proposed so as to not duplicate other regulatory controls that are, or will be, applied under other existing legislation (refer to Section 8). A condition has not been proposed if the environmental factor is already adequately addressed by other environmental control instruments (i.e. the existing B4 Project Environmental Management Plan {**EMP**}).

3.3 KEY CHARACTERISTICS OF THIS PROPOSAL

This Proposal will be implemented as part of the existing B4 Project and will be managed in accordance with existing legislative conditions and Rio Tinto management systems and procedures.

Table 3-1 summarises this Proposal and Table 3-2 details the Key Characteristics of this Proposal.

Table 3-1: Proposal Summary

	Brockman Syncline 4
Short description	This Proposal is a revision of the approved Brockman Syncline 4 Iron Ore Project, located approximately 60 km west-north-west of Tom Price in the Central Pilbara. The dewatering rate is increasing to 6.4GL per year over the life of the Proposal. The surplus water management will include onsite use and controlled discharge to Boolgeeda Creek.

Table 3-2: Location and Extent of Physical and Operational Elements of the Proposal

Element	Location	Extent
Additional area of disturbance	Within the B4 Project Boundary	950 ha
Management of surplus water	Figure 4-1 for location of discharge outlet and estimated wetting front in Boolgeeda Creek	• Onsite use • Surface discharge to Boolgeeda Creek (maximum of 6.4GL/annum)

4 NON-SIGNIFICANT CHANGES TO SCHEDULE 1 OF MS 717

This Section provides details regarding the non-significant changes sought to Schedule 1 of MS 717.

4.1 PROVISION OF A B4 PROJECT BOUNDARY

Rio Tinto requires flexibility to maximise the use of the approved ore bodies at B4. The current B4 conceptual footprint (as defined in Figure 2 - Schedule 1 of MS 717) is restrictive as it places a specified area on the development of the mine. As long as disturbance is undertaken within the B4 Project Boundary and within the approved clearing limit, Rio Tinto considers that specifying the location of individual aspects of the mine via a detailed project footprint is unwarranted. This approach is consistent with the OEPA's position taken towards most comparable proposals.

The proposed B4 Project Boundary includes all elements approved under MS 717 as well as relevant changes sought in this Proposal. Refer to Figure 4-1 for the spatial extent of the proposed B4 Project Boundary.

4.2 CHANGES TO KEY CHARACTERISTICS

Rio Tinto requires the following minor changes to the Key Characteristics of MS 717:

- *Removal of GHG emissions limit* - Rio Tinto considers that Greenhouse Gas Emissions (**GHG**) is not environmentally significant for the B4 Project. In Bulletin 1214 the EPA considered that GHG was not considered a relevant environmental factor that required evaluation. In addition, this factor is adequately managed under Commonwealth legislation. Therefore, this Proposal seeks the removal of this limit from the Key Characteristics.

- *Removal of stripping ratio* - Rio Tinto requires the flexibility to mine its resources within an approved area and to meet changes in technology and economic situations. As such, the specification of a stripping ratio should be removed from the Key Characteristics as this aspect can be managed under more relevant environmental restrictions (i.e. the overall clearing limit).

- *Removal of waste dump height restriction* – Rio Tinto considers that the operational height of a waste dump is constrained by a combination of the available clearing limit, the maximum waste rock capacity, and batter slopes required for long term stability of the waste dump. Similarly, Rio Tinto considers that the final height of a waste dump will be determined by the final landform design as part of the mine closure planning. In addition, as there are no sensitive receptors in the surrounding area there is no impact to visual amenity. Therefore Rio Tinto requires the removal of the specific height limits to waste dumps at B4.

- *Removal of water supply limit* - Rio Tinto considers that the water supply limits stated in the Key Characteristics should be removed as it is more appropriate to manage this aspect under the *Rights in Water and Irrigation Act 1914* (**RIWI Act**).

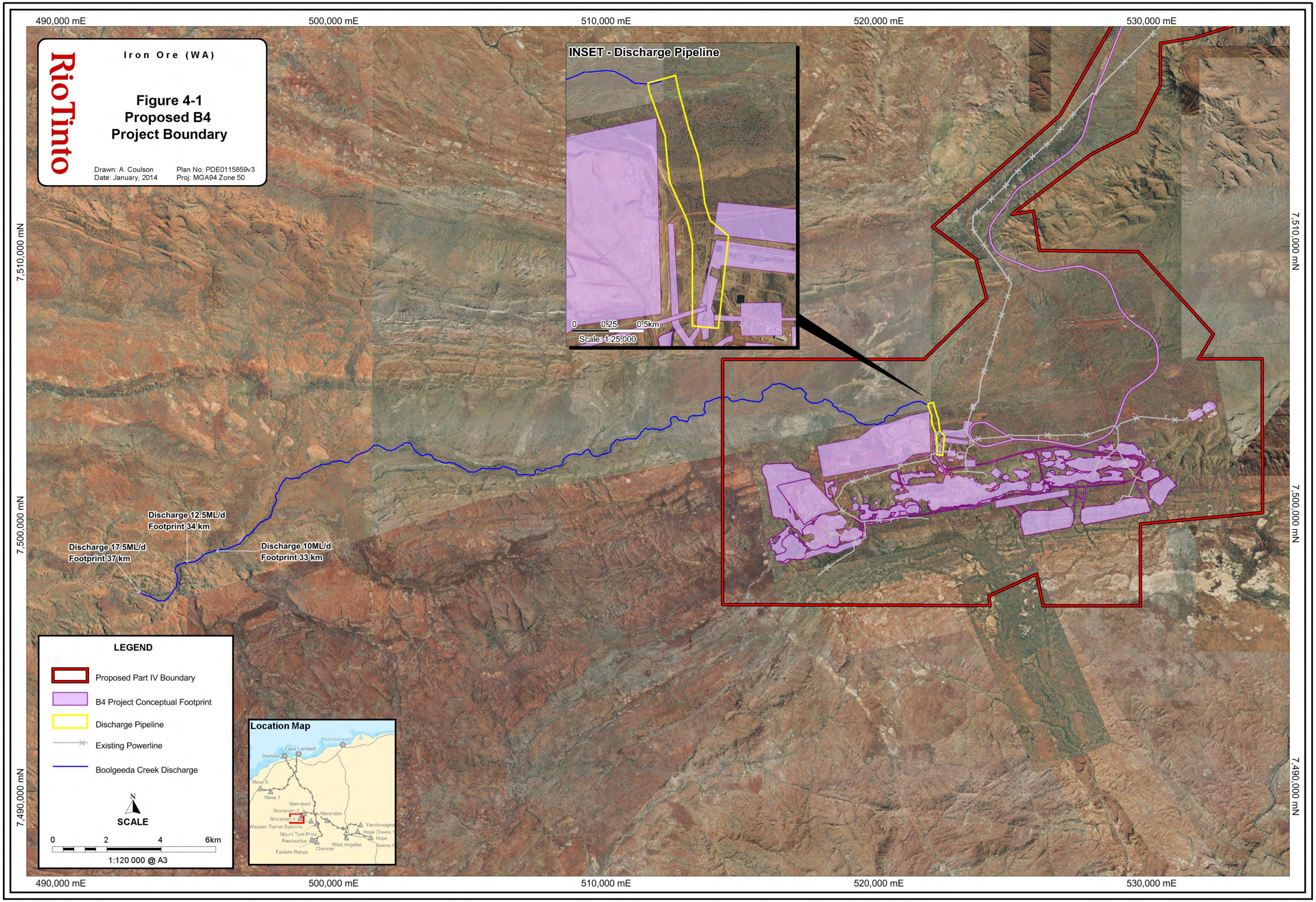
- *Removal of specific locations of plant, administration, workshops and stockpiles location* – Rio Tinto considers that location of infrastructure does not need specification and that development of the B4 Project will be managed in accordance with the Project Boundary and clearing limit.

- *Removal of restriction to accommodation and workforce numbers* - Rio Tinto requires the flexibility to staff the mine site to meet requirements associated with changes in technology, safety, environment and other activities associated with mining and as such, requests that the specification of workforce numbers and accommodation be removed from the Key Characteristics as there is no environment impact associated with this element.

These proposed changes to the Key Characteristics of MS 717 are presented in Table 4-1.

Table 4-1: Proposed Changes to the Approved B4 Project Key Characteristics (MS 717)

Element	Approved Description	Proposed Change
Area of disturbance	Approximately 2,610 ha.	Clearing of up to 3,560 ha within the Project Boundary.
Waste rock	420 Mt (approx. 150 Mt will be used to backfill pits).	620 Mt (approximately 150 Mt will be used to backfill pits)
Greenhouse Gas Emissions	5.59 kg CO_{2e} per tonne of production per annum.	*Remove*
Stripping ratio	Ranges from 0.5:1 to 1.5:1 waste to ore depending on processing and stockpile strategies (average 1.2:1).	*Remove*
Waste dumps, high and low grade stockpiles – location and height	Original site as shown in Figure 2 of Attachment 1 of MS717 and a stockpile area adjacent to rail loop as shown in Figure 5 of attachment 2 in Statement 717. Height of waste dumps to be total height of 50m.	*Remove specified location – within Proposed B4 Project Boundary.* *Remove waste dump height.*
Dewatering	Supplied from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor. 4.38 GL/annum (dust management) plus additional 0.15 GL/annum for the mine camp.	Dewatering from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor. *Remove specific limits required for operations and mine camp.*
Plant, administration, workshops and stockpiles location	Original site as shown in Figure 2 of Attachment 1 of MS717 and a stockpile area adjacent to rail loop as shown in Figure 5 of Attachment 2 in MS 717.	*Remove*
Construction operation workforce	Peak of 700 300 (plus approximately 40 during periodic shutdown maintenance periods)	*Remove*
Accommodation	- Construction village capacity 1570 rooms - Operational village capacity 570 rooms	*Remove*



Geospatial Information and Mapping

4.3 WASTE DUMP OPTIMISATION

In line with the B4 Project and Closure commitments, the Life of Mine (**LOM**) Schedule has incorporated in-pit dumping to ensure that areas mined Below Water Table (**BWT**) are backfilled to at least 2m above the pre-mining water table. However, timely access to pit voids to allow the commencement of backfilling activities will not be possible until approximately 2018. In addition, areas with potential future low grade cutbacks cannot be backfilled as it would result in a loss of this low grade ore resource to backfill material and compromise the potential value from future processing.

It is against this background that Rio Tinto seeks the following waste dump optimisation:

- remove the waste dump height limit to allow flexibility in handling of waste rock and low grade ore whilst maintaining the backfill schedule; and
- an increase in waste dump capacity.

4.3.1 Waste Dump Height Limit

The height of a waste dump is constrained by a combination of its approved footprint limit, maximum waste rock capacity, and the batter slopes required for long term stability. The final height is determined by the final landform design requirements, although changes in operational height may be required during the life of the mine in order to maximise flexibility in handling of waste rock and low grade material.

Any increases in waste dump height will be managed in accordance with the Rio Tinto Landform Design Guidelines (RTIO-HSE-0015708) and the Rio Tinto D3 Standard– Management of pit slopes, stockpiles, spoil and waste dumps. Additional lift heights will be 20 metres, with operational angles of approximately 37 degrees (angle of repose). Final rehabilitation angles of 18 degrees will be required, based on the material types and quantities expected in the dumps. The Brockman 4 Closure Plan is currently being updated (scheduled to be submitted to Government in Quarter 1 2015 in accordance with Ministerial Statement 717 Condition 10.2) and will provide further detail on each of the waste dumps (including material type and volume) and their associated rehabilitation criteria.

4.3.2 Waste Dump Capacity

Rio Tinto considers that the above mentioned flexibility regarding the height of waste dumps will provide a temporal buffer to the opening of relevant pit voids for backfilling and reduce the overall B4 Project footprint that would otherwise be required. However, additional waste dumps will still be required to cater for waste rock handling from the eastern pits (Pit 18, 11, 12 and 17).

New waste dumps will be built with the same configuration as the existing waste dumps at B4 and will require capacity to manage an expected increase in waste rock generated from 420 Mt to approximately 620 Mt. The amount of additional clearing that is required, within the Proposed Project Boundary, to allow this waste dump optimisation and to ensure the ongoing operation of the B4 Project is 950 ha. Refer to Figure 4-2 which depicts the new conceptual B4 footprint against the approved conceptual footprint.

4.3.3 Mineral Waste Characteristics

The majority of waste material at B4 is competent rocky material (over 80 percent of waste in comprises Joffre, Dales Gorge and Hydrated Zone material).

Several pits at B4 (Pit 1, 2, 3 and 5) have been identified as containing potentially acid forming material (**PAF**); however it is a relatively small amount of material (2.1 Mt) which, based on the current B4 mine plan, is scheduled to be intercepted by mining in 2015. Dump DP2 is the designated storage location for this material as no pit void is available for use at the time of interception.

The PAF material will be managed (encapsulated) during operations in accordance with the Mineral Waste Management Plan (**WMP**) and the Spontaneous Combustion and Acid Rock Drainage (**SCARD**) Management Plan for the B4 Project (SCARD and WMP are provided in Appendix 6 and Appendix 7 respectively). PAF will remain encapsulated at closure.

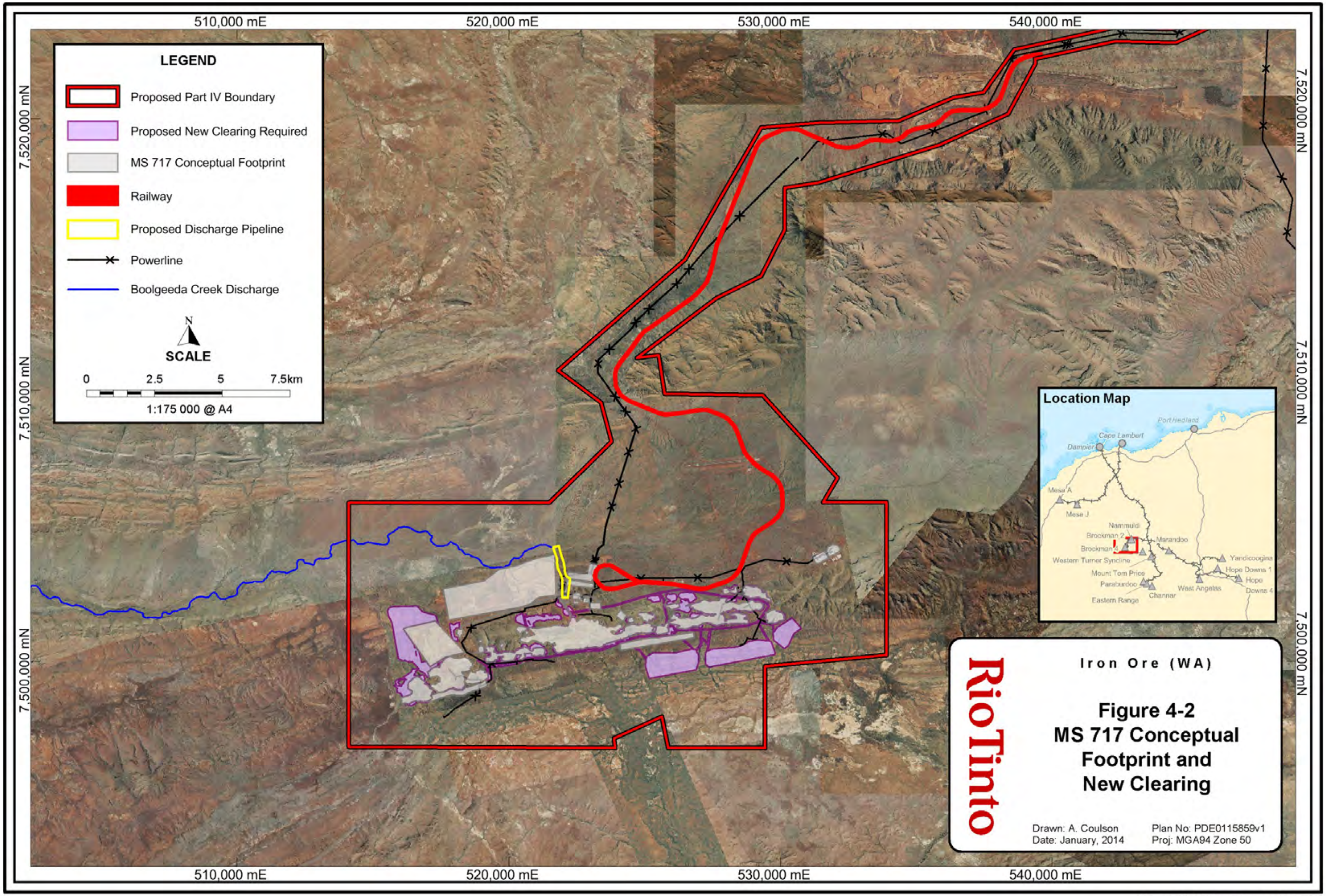


Figure 4-2 MS 717 Conceptual Footprint and New Clearing

Geospatial Information and Mapping

5 MANAGEMENT OF SURPLUS DEWATER

5.1 WATER BALANCE

The initial groundwater modelling for the B4 Project predicted that water generated from dewatering could be entirely used to meet onsite demand (Aquaterra 2005; 2008a and 2008b). It was also determined that later in the mine life an additional external source of water would be required to meet demand following reduction in predicted dewatering production. Consequently, management of surplus water was not considered necessary.

When approval was obtained in December 2008 for an increase in throughput at B4 (from 22 to 42 Mtpa) the water demand for the site was estimated at approximately 4.53 GL/a (4.38GL/annum plus 0.15GL/annum for the mine camp). To date, this volume of water use has not been required (refer to Table 5-1 below). With an improved understanding of the hydrogeology of the area from monitoring data and hydrogeological drilling and testing programs, an update to dewatering predictions has been undertaken. A demand-based dewatering strategy can no longer be used to meet the mine plan and therefore a surplus water management strategy is required.

Table 5-1: B4 Annual Abstraction

Year	Water Use (GL/yr)
2008	0.67
2009	0.74
2010	1.15
2011	2.39
2012	2.66
2013	2.68

Figure 5-1 below depicts the expected water demand and the predicted surplus water volume.

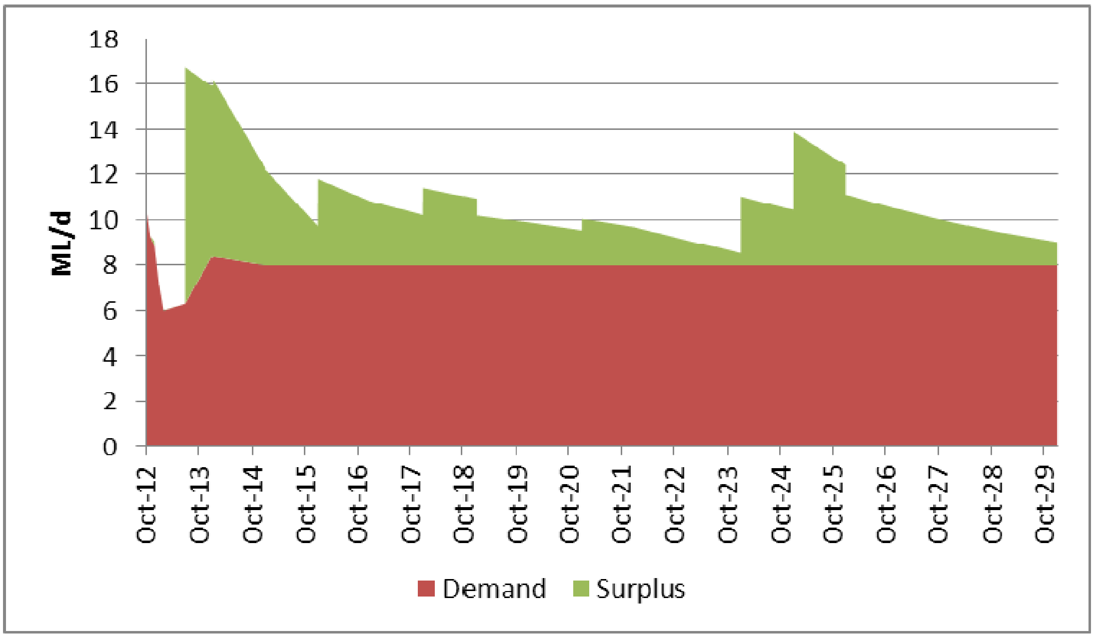


Figure 5-1: Predicted B4 water demand and surplus water volumes

Figure 5-1 depicts an assumption that the water demand will remain relatively constant around 8ML/day and that the proposed surplus discharge will be no more than 4-5ML/day except for two modelled period towards the commencement of (2014-2015) and completion of dewatering (2025-2026) where peaks of up to 17.5ML/day may be discharged.

Key improvements to the hydrogeological conceptual model since 2008 include (refer to Figure 5-2) (Rio Tinto 2013b and Rio Tinto 2013c):

- The lower value than originally thought for the permeability of the dolerite sill within the Brockman Iron Formation appears to hydraulically disconnect the Boolgeeda Valley and the Hamersley Group that lie above the sill (Zone 1) from the mineralised Brockman Iron Formation (Zone 2). This disconnect is confirmed by a difference in groundwater levels of up to 10m between the two zones.
- The lower un-mineralised Marra Mamba Iron Formation and the Fortescue Group (Zone 4) are now thought to be disconnected from the mineralised Marra Mamba Iron Formation and Wittenoom Formation (Zone 3) due to their very low permeability and are now an inactive zone in the groundwater model.
- The mineralised Brockman Iron Formation (Zone 2) and the Wittenoom Formation (Zone 3) are juxtaposed by faulting between the Centre and Western Pits which allows for hydraulic connection.

This improved understanding has resulted in the predicted end of mine life drawdown extent to be less extensive that that predicted in 2008 (refer to Figure 5-3). This is due to the lower permeability of the sill and the lower un-mineralised Marra Mamba and Fortescue Group. However, the required peak dewatering rate is predicted to be 16.7 ML/d (6.12 GL/a). The increase in peak dewatering is due in part to the hydraulic connection with the Wittenoom Formation and is compounded by the over estimation of water demand resulting in lower than planned dewatering volume modelled over the life of the mine resulting in a deeper drawdown but with a reduced lateral footprint. In view of this and other uncertainties associated with the groundwater model, this Proposal is seeking approval for a maximum dewatering rate of 6.4GL/a (based on 17.5ML/d).

Site water demand is highly variable depending on plant shuts, weather and equipment utilisation. From a dewatering management perspective this results in varying abstraction rates and intermittent pumping of bores and the inability to adjust rates based on monitoring.

A surplus water management option will improve dewatering management and reduce the risk of impacting mining operations in addition to existing water use requirements. It is therefore preferred that the maximum discharge rate be equivalent to the expected dewatering rate. This will allow full flexibility with all aspects of the predicted water balance.

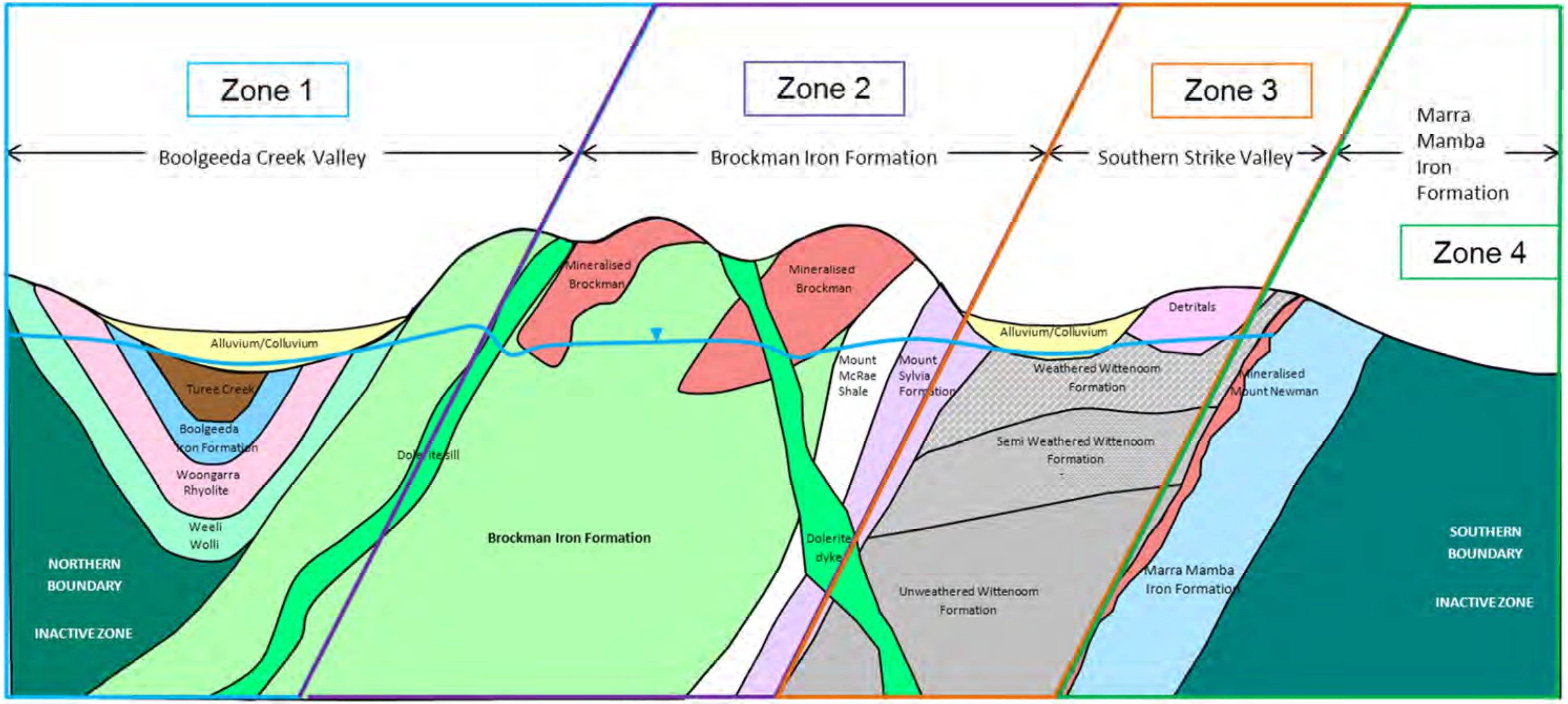
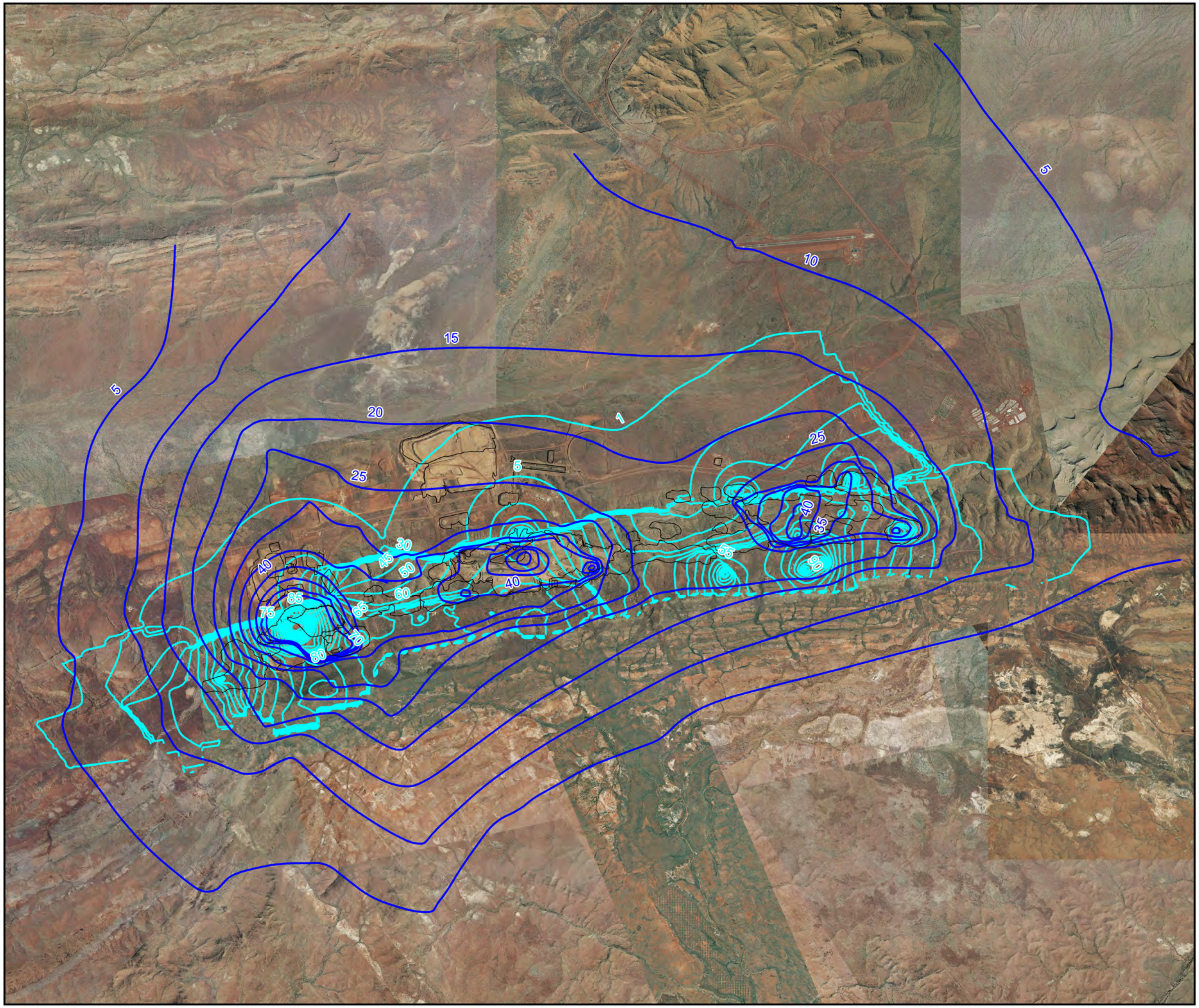


Figure 5-2 B4 conceptual hydrogeological model



LEGEND

Modelled drawdown 2008

Modelled drawdown 2013

BS4 Mine Layout

N

SCALE

1:75,000

RioTinto

Figure 5-3
Comparison of predicted end of mining drawdown

Drawn: E McGivern
Date: 12/12/13

Plan No:
Proj: MGA94 zone 50

5.2 CONSIDERATION OF ALTERNATIVES

Management of water on Rio Tinto sites follows environmental and water use standards that align with the Western Australian DoW's preferred options for surplus water disposal options (DoW 2013). The DoW recommended disposal options are:

- use on site;
- transfer to another site or industrial location;
- reintroduction to aquifer(s);
- controlled discharge to natural watercourses (e.g. irrigation, storage and periodic discharge); and
- uncontrolled discharge to watercourses.

In line with this, Rio Tinto has considered the following alternatives to manage the expected surplus water:

- *Use on site* - Dewatering will supply 100% of the B4 water demand (approximately 8ML/day); however the demand is not sufficient to account for all dewatering volumes (refer to Figure 5-1).
- *Transfer to another mine site* - Nearby Rio Tinto operations include Brockman 2/Nammuldi (~23km) and Western Turner Syncline (WTS) B1 (~28km) and Section 10 (~38km) all of which have or will have surplus water over life of mine. Transferring of surplus dewater from the B4 Project to these Rio Tinto operations would compound the water management for these receiving operations. There is currently no non-Rio Tinto operations in the vicinity that have a water deficiency issue to enable transfer of surplus dewater from the B4 Project. Rio Tinto will continue to monitor development of other mining operations in the vicinity should a future water-deficit mine commence operations and hence making transfer to another mine site a viable consideration.
- *Transfer for irrigated agriculture* – the B4 Project is within the boundary of the Rio Tinto managed Rocklea Station which provides an opportunity for irrigated agriculture. However, the relatively small surplus water volume and the expected fluctuations in volume make this alternative impractical. Supplementing the approved Nammuldi-Silvergrass agriculture project would require construction of additional pivots and of a 30 km pipeline with no material environmental benefit but significant additional costs.
- *Passive reinjection via a disused pit* – this is not considered feasible due to the planned mining sequence for the B4 Project and also known hydraulic connections between pits which would result in recycling of water and increased dewatering.
- *Reinjection to aquifer via bores* - the permeability and storage potential of the formations around the B4 Project area mean the Paraburdoo Member is the only realistic target for reinjection. It is not certain if a sufficient number of boreholes could be developed in the Paraburdoo Member within a reasonable distance to the B4 Project. The capacity of the Paraburdoo Member aquifer, to accommodate the additional surplus water from B4, is also unknown. The Paraburdoo Member is also in hydraulic connection with the potential future

Marra Mamba deposits and in poor connection with the Brockman Iron deposits which are being mined. There are production bores located within the Paraburdoo Member to the south of the current B4 pits that may be used for water supply, therefore reinjection near the mine would potentially compromise present mining and dewatering and certainly compromise future mining.

Reinjection into the Boolgeeda creek alluvium is not feasible either as the valley fill material underlying the basement units are of low permeability and typically less than 20m thick with no significant inflow or outflow of groundwater (Aquaterra 2005).

- *Surface discharge to natural watercourses* – the B4 Project lies on the catchment divide between the Boolgeeda Creek and the Beasley River catchments. Boolgeeda Creek lies approximately 2.5km north (at the closest point) from the B4 central pit and the Beasley River lies approximately 16km south east (at the closest point) to the B4 central pit. Surface discharge to either Boolgeeda Creek or Beasley River was therefore considered feasible and is discussed in detail in Section 5.3 and 5.4.
- *Uncontrolled discharge to watercourses* has not been considered as part of this Proposal.

Development of the surplus water management strategy involved the consideration of a number of different alternatives in accordance with the DoW list of water use options published in the WA Water in mining guidelines (DoW 2013). A number of alternatives considered were excluded due to the prohibitively high costs, potential environmental impacts, or because they represent a substantial technical risk to the Proposal.

It was concluded that surface discharge to a natural watercourse was the most feasible option for further consideration. This is discussed in detail in the following section.

5.3 SURFACE DISCHARGE OPTIONS

Surface discharge options have been modelled within the Boolgeeda Creek and the Beasley River systems (RTIO 2013a). The maximum wetting front has been estimated for a range of discharge volumes from 2.5–20 ML/day in 2.5 ML/day increments (refer to Table 5-2 below). Wetting fronts were determined on the assumption that steady state conditions were established.

Table 5-2: Estimated discharge footprint in Boolgeeda Creek and Beasley River System

Discharge Volume (ML/d)	Maximum wetting front (km)	
	Boolgeeda	Beasley
2.5	12.0	5.0
5	22.0	10.0
7.5	31.0	15.0
10	33.0	18.0
12.5	34.0	23.0
15	35.0	30.0
17.5	37.0	36.0
20	38.0	39.7

Beasley River

The underlying basement of the Beasley River tributary and Beasley River is the Fortescue Group. Aquifers associated with this group are generally of low permeability. Overlying the Fortescue Group is a laterally discontinuous cover of alluvium, colluvium and pisolite of Cainozoic age. Transient pools within the tributary and river are likely to depend on rainfall, surface water and shallow alluvial interflow rather than regional groundwater. In close proximity to the tributary of the Beasley River to the south of B4 is the Beasley River Limonite Channel Iron Deposits (CID). The deposit occurs as a series of flat topped mesas occupying a 30 km palaeochannel. The present drainage has dissected the original continuous deposit to leave a series of mesas. The majority of the resource is above water table (Rio Tinto 2008). A drilling program in 2011/2012 indicated a groundwater level of 440-445 mRL within the deposit. The interaction between the Beasley River tributary and the Beasley River Limonite deposit has not been investigated.

Boolgeeda Creek

The underlying basement of the Boolgeeda Creek valley comprises Tertiary valley fill and Quaternary alluvial gravels overlying the Hamersley Group (Boolgeeda Iron Formation and Woongarra Volcanics) and Turee Creek Group basement. Aquifers associated with the basement units (Hamersley Group and Turee Creek Group) are generally of low permeability. The valley fill material underlying the alluvium is typically less than 20 m thick with no significant inflow or outflows of groundwater (Aquaterra 2005). Transient pools within the creek bed are likely to depend on rainfall, surface water and shallow alluvial interflow rather than regional groundwater.

This Proposal is seeking approval to discharge surplus water to Boolgeeda Creek for the following reasons:

- The construction of the discharge pipeline will be shorter (approximately 2.5km shorter) than that required to reach Beasley River.
- Cumulative impacts to Boolgeeda Creek is not considered an issue as a result of this Proposal. The Nammuldi-Silvergrass project has approval to discharge to Duck Creek and the Western Turner Syncline Stage 2 project has approval to discharge to a tributary of the Beasley River (where the maximum wetting front is predicted to reach approximately 12km upstream of where the closest tributary to the B4 Project joins the Beasley River.

5.4 SURFACE DISCHARGE TO BOOLGEEDA CREEK

The Boolgeeda Creek catchment covers an area of approximately 1,650 km^2 and is a tributary of Duck Creek within the regional Ashburton River catchment. The headwaters of the Boolgeeda Creek catchment rise from the mountain ranges of Mount Brockman and the Hamersley Range. It is characterised by a braided, meandering creek dominated by multiple active and inactive flow channels within a broad valley. The creek becomes more defined when it enters a gorge system downstream of B4 operation, before discharging into Duck Creek at Lowlait Range. The general absence of permanent and semi-permanent water features suggests it is a relatively dry system, typical of ephemeral creeks in the Pilbara.

The Boolgeeda Creek is characterised by active creek beds of coarse sand and gravel that are likely to be reworked during flow events. There is also evidence of the development of a new secondary flow channel following these flood events which indicates that the system is dynamic and naturally capable of changing course and flow conditions (refer to Appendix 4).

There are no permanent stream gauging stations in the Boolgeeda Creek catchment. The Index Flood method has been used to estimate the ARI design peak flows following rainfall within the area of discharge. The proposed discharge outlet (MGA50 coordinates 521783E; 7504099N) is located at the upper reach of the main stream, requiring approximately 1.4km extension from the existing pipe network at B4. The peak flow of rainfall runoff estimated at this outlet is 148m^3/s for a 2 year ARI event and 3,310 m^3/s for a 100 year ARI flood. Compared to the peak flows of rainfall runoff, the predicted maximum discharge volume (17.5ML/day, equivalent to 0.2m^3/s) would be negligible during a flood event.

Results for the modelled scenario for Boolgeeda Creek discharge are summarised in Appendix 4 and Figure 4-1 depicts the estimated discharge footprint along Boolgeeda Creek. In summary the baseline hydrology modelling (Rio Tinto 2013d) indicated the following:

- The wetting footprint in Boolgeeda Creek would extend approximately 37 km down gradient from the proposed discharge outlet for a modelled volume of 17.5 ML/day.
- The surface water expression footprint was less than the steady state distance which indicates that the water released into the creek is likely to move in and out of the creek bed, creating transient pools into topographical depressions and associated saturated bank conditions within the reach.
- The peak flow volume of water discharging into Boolgeeda Creek is significantly smaller than the peak flow volume generated by the catchment during any flood event. However, the change in duration of flow events (from days to weeks for flood events, and months for discharge events) represent a change to the current hydrological regime.
- Given the largest discharge volume scenario of 20 ML/day that was modelled and the natural dimension of the creek bed (Appendix 4), overtopping of the creek banks is not anticipated as all potential movement discharge water is likely to be confined within the channel. While the creek bed will remain saturated, the creek banks are likely to remain unsaturated such that bank vegetation should be largely unaffected by the flows. However, the discharge will increase water availability close to the creek to the extent that the presence of continuously available water within the unsaturated zone may increase vegetation vigour and/or encourage sapling growth. It was determined that the bedrock units underlying the Boolgeeda Creek valley are of low permeability, as a result discharge water will be retained within the surface alluvials.

5.5 DISCHARGE WATER QUALITY

At present the Eastern Borefield is used for potable water supply to the B4 camp and B4 Project office facilities as well as mineral processing and dust suppression. The Western and Southern Strike Valley Bore fields supply water for mineral processing and dust suppression, with some used for potable purposes. The Eastern Borefield is the preferred source for potable water because of its superior water quality compared with that of the Western and Southern Strike Valley Borefield.

Overall, the current groundwater quality at B4 is fresh to brackish with a neutral to slightly basic pH (Table 5-3). The surface water quality measured is not dissimilar to that observed in the existing B4 groundwater bores (Rio Tinto 2013d).

Table 5-3: B4 Water Quality

Groundwater	pH	EC (µS/cm)	TDS (mg/L)
Borefield*			
Eastern Borefield	6.57-8.03	521-849	344-444
Western Borefield	6.71-7.71	946-1452	620-776
Southern Strike Valley Borefield	6.3-8.36	623-2310	576-1580
All	**6.57-8.36**	**521-2310**	**344-1580**
Surface Water**			
Boolgeeda Creek (BC1)***	8.72	1676	1000
Beasley River (BR1 & BR2, BRWC1, BRWC2, BRWC3 & BRWC4)	8.16-9.03	674-3820	650-3820

*Rio Tinto 2013d

**Wetland Research and Management 2011a; 2011b; and 2012

***Only one sample is available, therefore no range is provided

6 ENVIRONMENTAL IMPACTS AND MANAGEMENT

6.1 ENVIRONMENTAL IMPACTS AND MANAGEMENT

In accordance with the EPA's principles for environmental protection, the preliminary key environmental factors relating to this Proposal are identified as:

- flora and vegetation;
- terrestrial fauna;
- hydrological processes and inland waters (surface water) environmental quality; and
- rehabilitation and closure.

Studies and surveys utilised to support the impact assessment of this Proposal are summarised in Table 6-1 and Figure 6-1 depicts the survey coverage of the Proposal area.

Environmental impacts and management of these preliminary key environmental factors are addressed in a series of Tables (Table 6-2 to Table 6-5), whilst the assessment of impacts and management of other factors is presented in Section 7.

6.2 ENVIRONMENTAL MANAGEMENT OVERVIEW

Rio Tinto has developed and refined environmental management objectives, systems and procedures over decades of operational mining experience in the Pilbara region that are successfully applied at multiple iron ore mine sites.

The key components to be implemented for this Proposal include:

1. The Rio Tinto Iron Ore Group Health, Safety, Environment, Communities and Quality Policy (**HSECQ Policy**). The HSECQ Policy is the guiding document for environmental management and provides context and direction for continuous improvement.

2. Rio Tinto Iron Ore (WA) operates under an ISO14001 certified Environmental Management System (**EMS**), contained within the HSEQ Management System. The HSEQ Management System is a continuous improvement model covering:

   - systematic assessment of environmental risk and legal requirements; systems for training, operational control, communication, emergency response and corrective actions;
   - the development of objectives and targets for improvements; and
   - audits and review.

3. The existing B4 Project EMP that will interface with the HSEQ Management System.

4. The Rio Tinto Closure Standard will continue to guide closure planning for the B4 Project including this Proposal. This standard governs:

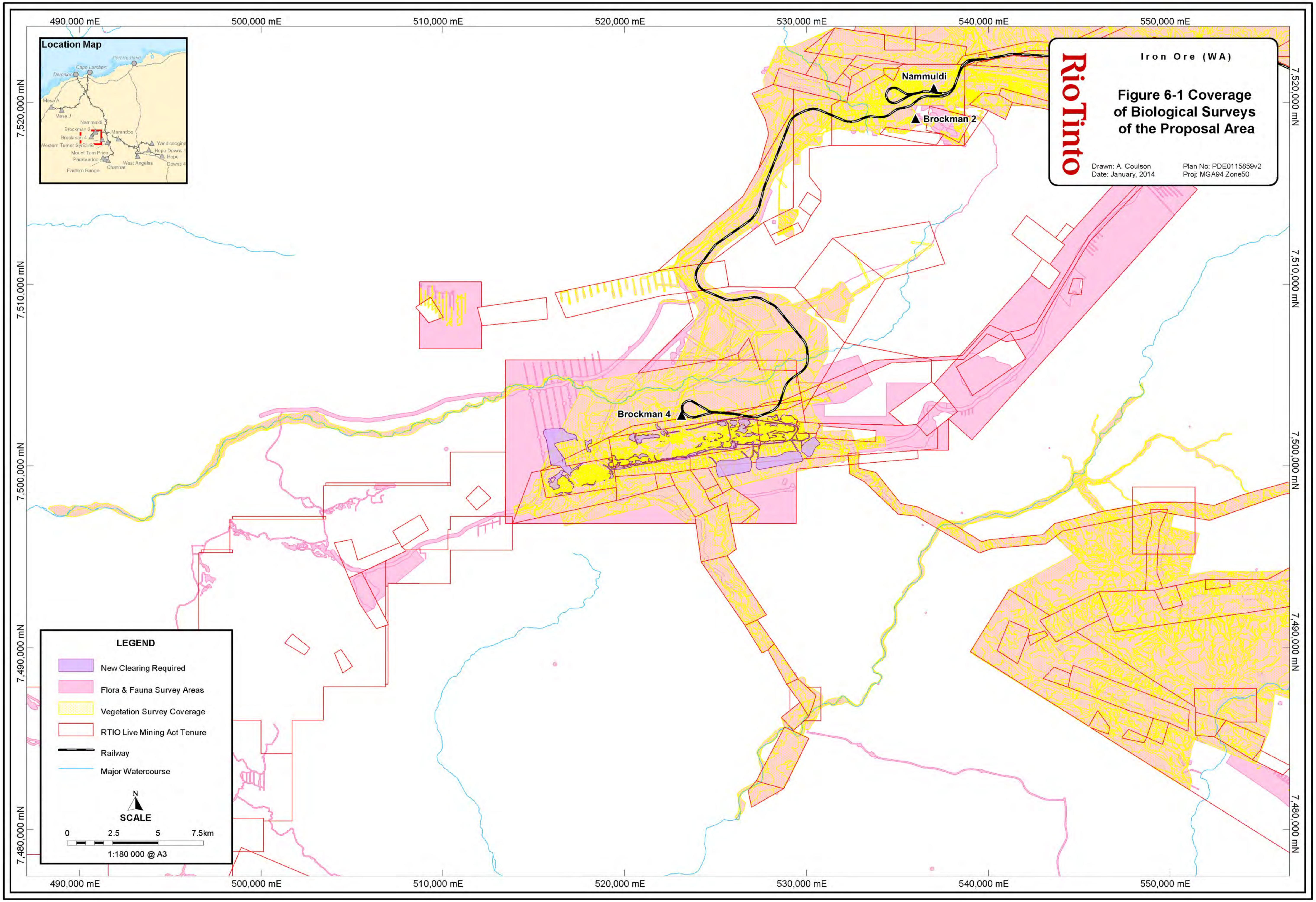
   - commencement of planning for closure prior to project commencement;

- the development and content of closure plans;
- stakeholder consultation regarding closure;
- financial provisioning for closure;
- the review of closure plans; and
- the development of Decommissioning Plans five years prior to scheduled closure.

Table 6-1: Summary of Supporting Studies

Author & year	Report Title	Study Type / Timing	Relevant Standard/Guidance
Ground water			
Aquaterra (2005)	Brockman 4 Hydrogeology Pre-Feasibility Report	Hydrogeological Study, April 2005.	
Biological			
Biota Environmental Sciences (2013a) Appendix 5	Brockman 4 Riparian Vegetation Mapping	Desktop Review, Level 2 vegetation and flora survey: 21-28 August 2013	Western Australian Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004a) and EPA Position Statement No 3 (EPA 2002).
Biota Environmental Sciences (2013b)	Brockman Syncline 4 Marra Mamba Vegetation and Flora Survey	Level 2 vegetation and flora survey: 30 August – 4 September 2012	Western Australian Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004a) and EPA Position Statement No 3 (EPA 2002).
Biota Environmental Sciences (2013c)	Brockman Syncline 4 Marra Mamba Targeted Fauna Survey	Desktop review, targeted fauna survey: 28 August - 4 September 2012	The survey was planned and implemented in accordance with the Environmental Protection Authority's (EPA) Guidance Statement 20, "Sampling Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia" (EPA 2009), Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002), and Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004b).
Biota Environmental Sciences (2010)	Brockman Syncline 4 Water Pipeline Corridor Biological Review	Desktop review and a NVCP level biological assessment including rare flora searches and a compilation of existing survey data Rare flora searches – June 2010	EPA Position Statement No.3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.
Biota Environmental Sciences (2007)	Rare Flora Searches of B4 Rail Loop Extension, Airport Extension and Plant Sites	Rare flora searches – January 2007	EPA Position Statement No.3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.

Author & year	Report Title	Study Type / Timing	Relevant Standard/Guidance
Biota Environmental Sciences, (2005a)	A Vegetation and Flora Survey of the B4Project Area, near Tom Price	Desktop review, rare flora searches and a single phase field survey Rare flora searches – February to June 2003 Flora and Vegetation Survey – October 2004	EPA Position Statement No.3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA 2002) and Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.
Biota Environmental Sciences (2005b)	Fauna Habitats and Fauna Assemblage of the B4 Project, near Tom Price	18/10/2004 and 30/10/2004 12/04/2005 and 21/04/2005	Environmental Protection Authority (EPA) Position Statement No. 3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA 2002) and Guidance Statement No. 56 “Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia” (EPA 2004b).
Surface and Ground water			
Rio Tinto (2013a)	Baseline Hydrology Assessment for B4 Discharge at Boolgeeda Creek and Beasley River	Hydrological modelling	Internal Document
Rio Tinto (2013b)	B4 – BSSM Groundwater Modelling Report	Groundwater modelling	Internal Document
Rio Tinto (2013c)	Brockman Syncline 4 Drawdown Distribution Map	Drawdown Distribution Map	Internal Document
Rio Tinto (2013d)	Baseline Hydrology Assessment for Brockman 4 Discharge at Boolgeeda Creek	Hydrological modelling	Internal Document



490,000 mE
500,000 mE
510,000 mE
520,000 mE
530,000 mE
540,000 mE
550,000 mE
7,520,000 mN
7,510,000 mN
7,500,000 mN
7,490,000 mN
7,480,000 mN
Location Map
Nammuldi
Brockman 2
Brockman 4
Iron Ore (WA)
Rio Tinto
Figure 6-1 Coverage of Biological Surveys of the Proposal Area
Drawn: A. Coulson
Date: January, 2014
Plan No: PDE0115859v2
Proj: MGA94 Zone50
LEGEND
New Clearing Required
Flora & Fauna Survey Areas
Vegetation Survey Coverage
RTIO Live Mining Act Tenure
Railway
Major Watercourse
N
SCALE
0
2.5
5
7.5km
1:180 000 @ A3

Table 6-2: Flora and Vegetation: Description of Factor, Impact Assessment and Management

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
EPA Objective To maintain representation, diversity, viability and ecological function at the species population and community level. **Summary of how Proposal meets EPA objective** This Proposal can be managed to meet the EPA environmental objective for this factor, as detailed in adjacent columns: • Nothing new or potentially significant has been recorded within the Proposal area. • Flora and vegetation potentially impacted by the Proposal is well represented outside the Proposal boundary, on a local and regional scale. • The spatial and temporal extent of discharge is limited. • Clearing will be restricted to the additional 950 ha within the Project Boundary. • Appropriate management measures to avoid, minimise and mitigate potential impacts of the Proposal on flora and vegetation will be implemented (and where applicable have been implemented during Proposal design and operation of the B4 Project). • The predicted spatial extent of groundwater drawdown of the B4 deposit is less that that assessed and approved for the original B4 Project (MS 717).	**Flora – additional clearing** B4 requires up to 950 ha of additional clearing supporting ongoing operations including waste dump optimisation. Figure 4-2 depicts the new conceptual B4 Project footprint within the Proposal Boundary. Figure 6-2 depicts recorded Priority Flora within the Proposal area. Numerous biological surveys have been completed over the broader B4 Project area and all but 65 ha (7%) of the area is covered by this survey coverage. • ***Ptilotus subspinescens* Priority 3** *P. subspinescens* has been recorded from multiple locations on rocky plains within the wider B4 Project area. The additional clearing areas intersect with four records of this species. However, as the area has not been systematically traversed for Priority Flora, more individuals may be present within the vicinity of these records and also within the wider B4 area. The small population located within the additional clearing area is not considered to be of significance due to the number, and wide distribution, of records in the vicinity. Populations of this species have also been recorded nearby at Brockman 2, Silvergrass, Western Turner Syncline and Beasley River. • ***Eremophila magnifica* subsp. *magnifica* Priority 4** *Eremophila magnifica* subsp. *magnifica* has been recorded 25 times from the broader B4 Project area. All records were from the stony hill slopes associated with Mt West which represents typical habitat for this species. The additional clearing areas intersect five records of this species on Mt West. Given that the habitat present in this area is now heavily fragmented due to disturbance associated with the approved B4 Project, these records are considered to be of low value. *Eremophila magnifica* subsp. *magnifica* is distributed through the central-eastern Hamersley Ranges, and nearby records exist from the Tom Price and Silvergrass localities. **Flora - Riparian Impact Zone** • No threatened flora species protected under the *Wildlife Conservation Act 1950* (WC Act) were recorded, or expected to occur within the riparian impact zone (Biota 2013). • One Priority 1 (P1) Species – *Peplidium sp*. Fortescue Marsh (S. Van leeuwen 4865) was recorded in the riparian survey area. • One Priority 2 (P2) Species – *Pentalepis trichodesmoides subsp. hispida* was recorded in the riparian survey area. • One Priority 3 (P3) Species – *Indigofera sp*. Bungaroo Creek (S. Van Leeuwen) was recorded in the riparian survey area. • One Priority 4 (P4) Species – *Goodenia nuda* was recorded in the riparian survey area. **Vegetation – additional clearing** Vegetation mapping for the B4 Project area has been completed (Figure 6-3) and does not indicate the presence of any vegetation types that qualify for specific	**Flora & Vegetation – LOM Clearing** This Proposal will result in the clearing up to 950 ha of native vegetation. Some of the Priority 3 species, *Ptilotus subspinescens,* will potentially be impacted by this Proposal. The effect of the proposed change to flora and vegetation values is not considered significantly different or additional to that of the approved B4 Project as the potential impacts to flora and vegetation values are considered to remain unchanged from that assessed in the PER given the proposed changes will: • Not affect any new vegetation communities that have not been previously assessed. • Not affect any known TEC's or PEC's in the area. • Not affect any known occurrences of DRF and will minimise impacts to known locations of the Priority 3, Ptilotus subspinescens where practicable. **Vegetation – Dewatering Discharge** No TECs or PECs occur in proximity to the Boolgeeda Creek watercourse; however six vegetation units of varying conservation significance occur in proximity. Hydrological modelling was performed along a 52km section downstream of the proposed discharge point. The creek was divided into three different reaches with unique morphology, soil conditions and vegetation types. For each of these reaches, the modelling suggests that the water discharged into the creek is likely to be contained in the existing channel; hence no overtopping of the creek banks is anticipated (Appendix 4). Therefore the potential impact due to waterlogging is expected to be confined to vegetation growing within or immediately adjacent to the low flow channel, and the root systems of trees growing on the banks of these watercourses are likely to be partially, rather than completely waterlogged. The key species within vegetation units are considered tolerant (*E. Camaldulensis* subsp. *refulgens*) or relatively tolerant (*E. Victrix*) to waterlogging based on a review of previous studies and observations in the Pilbara (Rio Tinto 2011). Detrimental impacts due to waterlogging may range from reduced growth and health to tree death, with the degree of impact dependent on the species tolerance, complete or partial waterlogging of the root system, and the duration of waterlogging. Based on these considerations, for the scattered populations of *E.victrix* on the banks of the discharge watercourse, reduced growth and health, and some tree death, is considered possible. For *E. camaldulensis* subsp. *refulgens* some reduced growth and health is possible but widespread tree death is unlikely. The vegetation communities would be expected to recover after cessation of discharge (as only the areas/individuals immediately adjacent to the low flow channel may be detrimentally affected), with timeframe to recovery dependent on the degree of detrimental impact. Potential detrimental impact to these vegetation units due to dewatering discharge is not considered significant, based on the following:	The following key management measures for vegetation and flora will be implemented (and where applicable have been implemented during Proposal design and operation of the B4 Project to date): • Proposal design has minimised planned vegetation clearing to areas necessary for safe construction and operation. • Proposal design has, and will continue to, avoid and minimise clearing of elevated conservation significance vegetation and flora, including the Priority 3 *Ptilotus subspinescens*. • Ground truthing of the unsurveyed area (65 ha) will be conducted prior to clearing to identify DRF. • Proposal design has incorporated consideration of surface water management, including minimising disruption to watercourses where possible. • A discharge water management and monitoring strategy (including site specific water quality trigger values) will be developed in accordance with ANZECC/ARMCANZ (2000) water quality management framework, to manage the potential impacts of discharge water on the downstream environment. This will be managed under Part V of the EP Act. • Prior to discharging water to Boolgeeda Creek a Water Discharge Management and Monitoring Plan will be developed to ensure that the associated environmental and conservation values are maintained. • The Rio Tinto Iron Ore (WA) internal ground disturbance authorisation procedure will be implemented, including internal assessment and authorisation prior to any clearing of vegetation. • Management of weeds will be carried out in accordance with the Rio Tinto Iron Ore (WA) Weed Management Strategy, Equipment Hygiene Expectations Procedure, the and the Soli Resource Management Procedure, including the following actions: o Weed monitoring will be undertaken at the discharge point and management implemented as appropriate. o The existing B4 Project weed action plan will be updated to include activities within this Proposal. o All earth engaging equipment brought onto site will be inspected to ensure they are clean and free of built up mud, rock, soil, vegetation. o Areas to be cleared will be assessed for weeds; topsoil cleared from weed infested areas will be separated from other stockpiles and/or managed to prevent the spread of weeds.

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
	legislative protection (i.e. TECs). Similarly, no PECs have been identified within the B4 Project area. The additional clearing areas intersect with the following vegetation types previously identified by Biota (Biota 2005b) as being of Moderate Significance (refer to Figure 6-3): • **P11 - *Acacia synchronicia* scattered shrubs over *Triodia angusta* hummock grassland.** This vegetation type does not belong to a restricted floristic group, but is the main associated vegetation type for a significant sized population of the Priority 3 species *Ptilotus subspinescens*. Although this vegetation type is considered unlikely to be well represented in the Hamersley subregion, it does occur extensively outside the B4 Project area on similar substrates along White Quartz Road (Michi Maier, Biota Environmental Sciences, pers.obs.). • **H10, H11, H12, H13 and H16 - Mixed shrublands over hummock grasslands dominated by suites of species preferring rocky habitats.** These vegetation types of narrow gorges, gullies and breakaways belong to a floristic group apparently restricted in the region, and support cryptic species restricted to such rocky habitats. These habitats, while widespread within the Hamersley subregion, comprise a small proportion of the total area. • **P2, P3, and P10 - *Triodia wiseana / T. angusta* hummock grasslands with variable overstoreys occurring on stony plains).** These vegetation types belong to floristic groups that are apparently not widespread in the region; calcrete areas in particular are not well represented in the Hamersley subregion and these vegetation types may have a somewhat restricted distribution. These communities are however, relatively abundant in the habitats present within the vast valley stretching between the B4 and Western Turner Syncline ranges. The P3 represents potential habitat for the *Rhagada* sp. "Mt Brockman" snail. • **C20 – Creekline vegetation dominated by Mulga.** This vegetation type is likely to be restricted in terms of area of extent in the Hamersley subregion. **Vegetation – Riparian Impact Zone** • The riparian study area is located on the Hamersley Plateau, which is within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The riparian study area intersects two of Beard's vegetation units (Biota 2013a). • Fifteen (15) vegetation units were identified within the riparian study area which were grouped into 5 broad categories: o Creekline dominated by *Corymbia hamersleyana* (C1); o Creekline dominated by *Eucalyptus victrix* and/or *E. camuldulensis* (C2, C3, C4, C5, C6 and C7);	• These vegetation units are widespread regionally (Biota 2013a). • On a local scale, the area of these creekline vegetation units in the vicinity of the maximum discharge extent comprises the following extent in the riparian study area (refer to Figure 6-3): o C2:EvAciAtuAPyTHtTe - 0.5%; o C3:EvEcAciAPyTErEUa - 2.33%; o C4:EvEcAciEUa – 2.02%; o C5:EvEcAciCEc - 13.83%; o C6:EvEcAciMGAam - 3.6%; o C7:EvEcAciMgCEcTe - 11.74%. Based on helicopter and ground reconnaissance, and examination of aerial photography, extensive areas of eucalypt woodland occur locally on the Beasley and Hardey Rivers outside the extent of current vegetation surveys, and therefore the area of eucalypt woodland potentially impacted is relatively minor on a local scale. • The total length of Boolgeeda Creek is approximately 106km and the maximum discharge extent is approximately 37km for the highest discharge volume scenario – this equates to approximately 30% of the creek being within the maximum extent of discharge. **Vegetation – Pipeline Corridor** • Modelling of surface hydrology indicates no 'overland flow' is likely in the vicinity of the infrastructure corridor from the current B4 operations to the pipeline outlet (Rio Tinto 2013a).	

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
	o Floodplains with *Corymbia hamersleyana* (F1, F4 and F7); o Floodplains dominated by *Acacia citrinoviridis* and *A. pyrifolia* (F2, F3, F5 and F8); o Floodplains supporting *Acacia sclerosperma* subsp. *sclerosperma* (F6 and F7). • No vegetation comprising TECs or PECs were recorded within the riparian study area. • Six vegetation units (C1, C3, C4, C5, C6 and C7) recorded in the riparian study area were considered to be of conservation significance as they are equally at risk from a number of threats (including grazing and invasion by weeds) known to impact on the vegetation of major ephemeral watercourses. The vegetation condition of the creek bed was ranked as being Very Good despite the presence of **Cenchrus ciliaris*, which was found to be growing both as scattered grasses and very open tussock grasslands. The vegetation conditions of surrounding floodplains was categorised as Good due to the higher degree of invasion of **Cenchrus ciliaris*. **Vegetation – Pipeline Corridor** Six previously mapped vegetation units are located within the study area. Three units are considered to be of moderate conservation significance (Biota 2005a): • C1 – comprised of *Eucalyptus victrix* scattered low trees to open woodland over *Goodenia lamprosperma*, *Pluchea dentex* very open herbland is considered. This unit occurs in habitats that are of value as surface drainage features and support species restricted to such habitat (Biota, 2005a). • C2 – comprised of *Acacia pyrifolia*, *Acacia ancistrocarpa*, *Petalostylis labicheoides* shrubland over *Bonamia rosea*, *Tephrosia rosea* var. *glabrior* low open shrubland over *Triodia epactia* hummock grassland and *Themeda triandra* very open tussock grassland. This unit occurs in habitats that are of value as surface drainage features and support species restricted to such habitat. This unit also appeared to be in a floristic group that did not appear to be widespread in the region (Biota 2005a). • P3 – comprised of *Eucalyptus leucophloia* scattered low trees over *Acacia aneura* (various forms), *Acacia ayersiana* tall open shrubland over *Triodia epactia*, *Triodia wiseana* mid-dense hummock grassland. Biota (2005a) reported that this unit appeared not to be widespread across the region. In addition, C1 contains *Eucalyptus victrix* and *Eucalyptus camaldulensis*, which may behave as a phreatophyte and thus be influenced by groundwater drawdown (Biota, 2005a). Impacts to groundwater dependent vegetation were assessed for the approved B4 Project and are not considered a key environmental factor for this Proposal – particularly as the predicted extent of groundwater drawdown is expected to reduce in lateral footprint.		

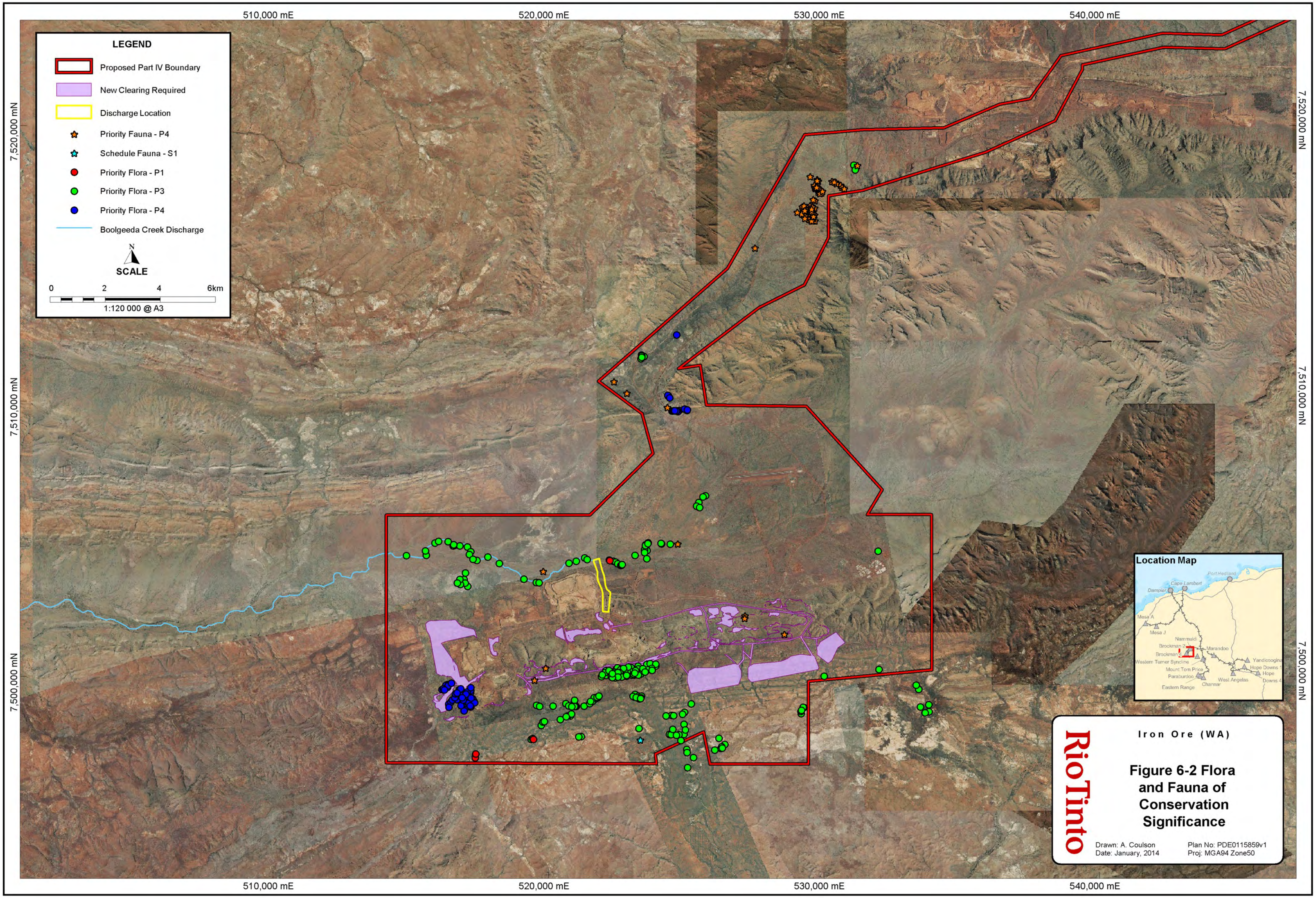


Figure 6-2 Flora and Fauna of Conservation Significance

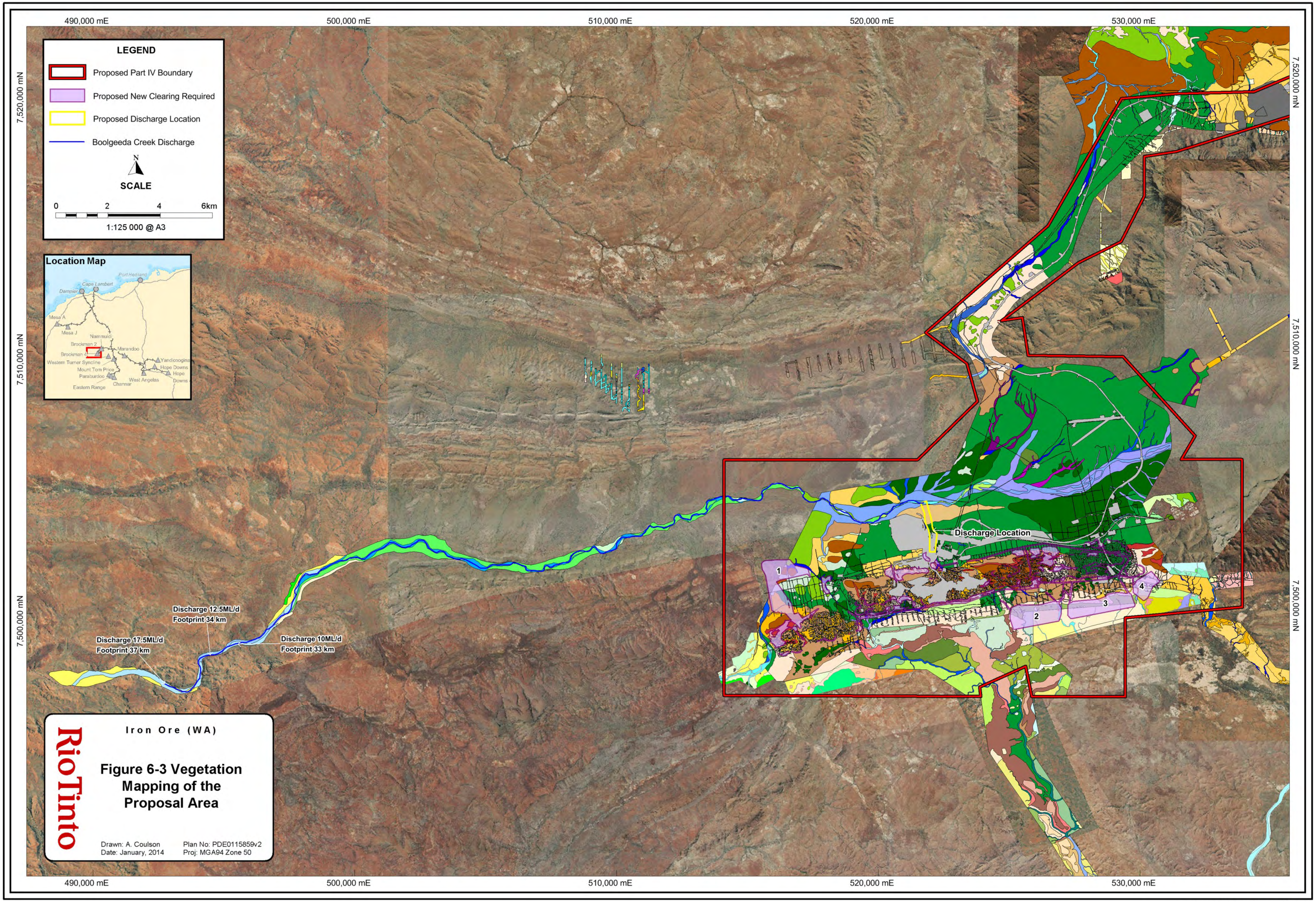


Figure 6-3 Vegetation Mapping of the Proposal Area

Geospatial Information and Mapping

No mapping

AbAsHl
Acacia bivenosa, Acacia sibirica and Hakea lorea open shrubland over Eremophila forrestii subsp. forrestii and Ptilotus obovatus very open shrubland over Triodia pungens hummock grassland.

AmoAmAatTeTw
Acacia monticola, A. maitlandii, A. atkinsiana tall open shrubland over Triodia epactia, T. wiseana open hummock grassland

AsyAbCApCAlTbr
Acacia synchronicia, A. bivenosa, Cassia pungens, C. luerssenii shrubland over Triodia brizoides hummock grassland

AxTeTlo
Acacia xiphophylla tall open shrubland over Triodia epactia, T. longiceps hummock grassland

C11
Acacia citrinoviridis, A. ancistrocarpa tall open shrubland to tall closed scrub over Triodia epactia mid-dense hummock grassland

C12
Acacia monticola, A. maitlandii, A. atkinsiana tall open shrubland over Triodia epactia, T. wiseana mid-dense to open hummock grassland

C14
Eucalyptus leucophloia low woodland over Acacia citrinoviridis, Acacia monticola, Dodonaea pachyneura tall shrubland over Triodia epactia mid-dense hummock grassland

C15
Stylobasium spathulatum shrubland over Triodia epactia hummock grassland

C16
Corymbia hamersleyana scattered low trees over Acacia bivenosa, Petalostylis labicheoides shrubland over Triodia epactia hummock grassland

C20
Acacia aff. aneura (narrow fine veined; site 1259) low open forest over Acacia citrinoviridis tall open shrubland over Triodia epactia open hummock grassland

C21
Petalostylis labicheoides shrubland over Triodia epactia mid-dense hummock grassland

ChElTwTp
Corymbia hamersleyana and Eucalyptus leucophloia subsp. leucophloia low scattered trees over Triodia wiseana and Triodia pungens hummock grassland occurring on rocky hills and lower slopes.

D2: ExAciPlAbTHtTe
Eucalyptus xerothermica, Acacia citrinoviridis low open woodland over Petalostylis labicheoides scattered tall shrubs over Acacia bivenosa open shrubland over Triodia epactia very open hummock grassland with Themeda triandra scattered tussock grasses

D3: ElAciPlSsGOrTe
Eucalyptus leucophloia, Acacia citrinoviridis scattered low trees over Petalostylis labicheoides, Stylobasium spathulatum, Gossypium robinsonii tall shrubland over T. epactia very open hummock grassland

ElAanAayTeTw
Eucalyptus leucophloia scattered low trees over Acacia aneura, A. ayersiana tall open shrubland over Triodia epactia, T. wiseana hummock grassland

ElAcApAb
Eucalyptus leucophloia subsp. leucophloia low scattered trees over Acacia citrinoviridis, Acacia pruinocarpa and Acacia bivenosa open shrubland over Triodia pungens hummock grassland occurring on drainage lines.

ElAprTe
Eucalyptus leucophloia subsp. leucophloia scattered trees over Acacia pruinocarpa open shrubland over Triodia epactia, T. pungens hummock grassland

ElGrTp
Eucalyptus leucophloia subsp. leucophloia low open woodland over Gossypium robinsonii scattered tall shrubs over Triodia pungens very open hummock grassland occurring on draingage lines dissecting rocky hills.

ElTloTaTbr
Eucalyptus leucophloia subsp. leucophloia scattered trees over Triodia longiceps, T. angusta, T. brizoides hummock grassland

ElTw
Eucalyptus leucophloia scattered low trees over Triodia wiseana hummock grassland

ExAciAbTe
Eucalyptus xerothermica scattered trees to open woodland over Acacia citrinoviridis, A. bivenosa (tall) shrubs to closed shrubland over Triodia epactia very open hummock grassland to open hummok grassland

H10
Eucalyptus leucophloia low open woodland over Acacia bivenosa open shrubland over Triodia brizoides, T. epactia hummock grassland and Themeda sp. Mt. Barricade, Cymbopogon ambiguus open tussock grassl

H11
Eucalyptus leucophloia scattered low trees over Gossypium robinsonii, Dodonaea pachyneura (Acacia maitlandii) open shrubland over Triodia epactia mid-dense hummock grassland

H12
Eucalyptus leucophloia low open woodland over Acacia hamersleyensis open shrubland over Triodia brizoides, T. epactia mid-dense hummock grassland and Themeda triandra, Eriachne mucronata open tussock

H13
Corymbia ferriticola, Eucalyptus leucophloia scattered low trees over Acacia hamersleyensis scattered tall shrubs over Dodonaea pachyneura open shrubland over Eriachne mucronata, E. tenuiculmis, Cymbo

H14
Eucalyptus leucophloia scattered low trees over Triodia wiseana mid-dense hummock grassland

H15
Eucalyptus leucophloia scattered low trees over Triodia epactia mid-dense hummock grassland

H16
Eucalyptus leucophloia scattered low trees to low open woodland over Astrotricha hamptonii, Ficus brachypoda scattered tall shrubs over Themeda sp. Mt Barricade, Eriachne mucronata open tussock grassl

H2
Eucalyptus leucophloia scattered low trees over Acacia atkinsiana open shrubland over Triodia wiseana mid-dense hummock grassland

H2/H16

H2: ElAexAprTw
Eucalyptus leucophloia scattered low trees over Acacia exilis, A. pruinocarpa open shrubland over Triodia wiseana open hummock grassland

H3
Eucalyptus leucophloia scattered low trees over Acacia maitlandii shrubland to open heath over Triodia wiseana mid-dense hummock grassland

H4
Acacia hamersleyensis tall open shrubland over Triodia wiseana closed hummock grassland

H6
Acacia pruinocarpa tall open shrubland over Acacia stowardii open shrubland over Acacia exilis low shrubland over Triodia wiseana mid-dense hummock grassland

H8
Acacia ancistrocarpa open heath to tall open shrubland over Triodia wiseana mid-dense to closed hummock grassland

H9
Eucalyptus leucophloia scattered low trees over Acacia inaequilatera tall shrubland over Triodia wiseana mid-dense hummock grassland

P10
Eucalyptus leucophloia, E. xerothermica scattered low trees over Acacia bivenosa, A. exilis open shrubland to tall open shrubland over Triodia wiseana, T. angusta mid-dense hummock grassland

P11
Acacia synchronicia scattered shrubs over Triodia angusta mid-dense hummock grassland

P12
Acacia synchronicia, A. bivenosa, Cassia pruinosa, C. luerssenii mixed shrubland over Triodia brizoides closed hummock grassland

P12: AxTbr
Acacia xiphophylla low woodland over Triodia brizoides scattered hummock grasses

P13
Acacia ancistrocarpa, A. bivenosa, A. synchronicia open shrubland over Triodia epactia mid-dense hummock grassland

P15
Acacia bivenosa, A. exilis, A. ancistrocarpa open shrubland over Triodia wiseana mid-dense hummock grassland

P1: ElAiTwTeTbrTaTlo
Eucalyptus leucophloia scattered low trees over Acacia inaequilatera scattered tall shrubs over Triodia wiseana, T. epactia, T. brizoides, T. angusta, T. longiceps open hummock grassland

P2
Acacia ayersiana low open forest/woodland over Eremophila forrestii open shrubland over Triodia epactia, T. wiseana hummock grassland

P2: ElAiTwTbrTloTa
Eucalyptus leucophloia scattered low trees over Acacia inaequilatera scattered tall shrubs over Triodia wiseana, T. brizoides, T. longiceps, T. angusta open hummock grassland

P3
Eucalyptus leucophloia scattered low trees over Acacia aneura (various forms), A. ayersiana tall open shrubland over Triodia epactia, T. wiseana mid-dense hummock grassland

P4
Acacia xiphophylla, A. aneura (flat curved; MET 15,548) low woodland to tall open shrubland over Eremophila cuneifolia, Rhagodia eremaea low open shrubland over Triodia wiseana open to mid-dense hummo

P4: ElTeTwTaTlo
Eucalyptus leucophloia scattered low trees over Triodia epactia, T. wiseana, T. angusta, T. longiceps very open hummock grassland

P5
Acacia xiphophylla, A. aff. aneura (narrow fine veined; site 1259) tall shrubland over Triodia brizoides, T. epactia open hummock grassland

P6
Corymbia deserticola scattered low trees over Acacia atkinsiana, A. exilis tall open shrubland over Triodia wiseana closed hummock grassland

P7
Corymbia deserticola low open woodland over Acacia atkinsiana shrubland to tall shrubland over Triodia epactia, T. wiseana mid-dense hummock grassland

C1
Eucalyptus victrix scattered low trees to open woodland over Goodenia lamprosperma, Pluchea dentex very open herbland

C2
Acacia pyrifolia, A. ancistrocarpa, Petalostylis labicheoides shrubland over Bonamia rosea, Tephrosia rosea var. glabrior low open shrubland over Triodia epactia hummock grassland and Themeda triandra

C4: EvEcAciEUa
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over Eulalia aurea very open tussock grassland over very open mixed herbland

C5: EvEcAciCEc
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over *Cenchrus ciliaris scattered tussock grasses

C6: EvEcAciMgAco
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over Melaleuca glomerata, Acacia ampliceps tall shrubland

C7: EvEcAciMgCEcTe
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over Melaleuca glomerata tall shrubland over *Cenchrus ciliaris scattered tussock grasses over Triodia epactia scattered hummock grasses

F3: AciApyEUaTHtCEcTe
Acacia citrinoviridis low open woodland over A. pyrifolia tall open shrubland over Eulalia aurea, Themeda triandra, *Cenchrus ciliaris tussock grassland over Triodia epactia very open hummock grassland

F4: ChAciApyCEcTe
Corymbia hamersleyana scattered trees over Acacia citrinoviridis low woodland over A. pyrifolia tall shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia open hummock grassland

F5: AciApyCEcTe
Acacia citrinoviridis open woodland over A. pyrifolia tall open shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia very open hummock grassland

F6: PlAsclTe
Petalostylis labicheoides, Acacia sclerosperma tall open shrubland over Triodia epactia very open hummock grassland

F7: ChAciPlAsclCEcTe
Corymbia hamersleyana scattered trees over Acacia citrinoviridis low woodland over A. pyrifolia, Petalostylis labicheoides, A. sclerosperma tall shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia scattered hummock grasses

F8: AciApyPlCEcTe
Acacia citrinoviridis open woodland over A. pyrifolia, Petalostylis labicheoides tall open shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia very open hummock grassland

Table 6-3: Terrestrial Fauna: Description of Factor, Impact Assessment and Management

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
EPA Objective: To maintain representation, diversity, viability and ecological function at the species, population and assemblage level. **Summary of how Proposal meets EPA objective** The Proposal can be managed to meet the EPA environmental objective for this factor, as detailed in the adjacent columns: • Fauna habitats potentially impacted by the Proposal (including habitat of higher value for conservation significant fauna species) are well represented outside of the Proposal boundary, on a local and regional scale. • Of the four conservation significant vertebrate fauna species recorded in the B4 area only the priority species *Notoscincus butleri* (skink) was recorded within the Proposal's riparian impact zone. • The predicted extent of groundwater drawdown will be reduced from that assessed for the approved B4 Project. Therefore no new or additional impacts to subterranean fauna are expected to result from implementation of this Proposal. • None of the recorded taxa that may represent SRE species are considered likely to be restricted to the B4 area, and the majority of records of each of these taxa were collected from outside of the Project Boundary. • Appropriate management measures to avoid, minimise and mitigate potential impacts of the Proposal on	**Vertebrate terrestrial fauna and fauna habitat** Fauna surveys have been undertaken over approximately 13,337 ha of the B4 Project area. Summaries of the findings of the three main surveys (in the B4 Project area and adjacent, nearby areas) that are relevant to the additional clearing areas are provided below and depicted in Figure 6-1. Figure 6-2 depicts the conservation fauna that have been recorded within the Project Boundary. • **Fauna Habitats and Fauna Assemblage of the B4 Project Area** Biota (2005b) recorded 159 taxa of terrestrial vertebrate fauna belonging to 54 families comprising two frogs, 54 reptiles, 83 birds, seven bats and 13 non-volant mammals. Six primary habitats were identified within the B4 Project area, largely based on vegetation structure and landforms. Four priority vertebrate fauna species were recorded in the B4 survey area (Biota 2005b): o Western Pebble –mound Mouse *Pseudomys chapmani* o Australia Bustard *Ardeotis australis* o Bush Stonecurlew *Burhinus grallarius* o A skink *Notoscincus butleri* • **Brockman Syncline 4 Marra Mamba Targeted Fauna Survey** The Marra Mamba deposit is located immediately south of the B4 Project area and comprises an area of approximately 1,921 ha. No vertebrate fauna of conservation significance were recorded during systematic trapping, or encountered opportunistically during traverses of the Marra Mamba survey area (Biota 2013c). A variety of fauna habitats were sampled including rocky breakaways, gorges, stony hills, Triodia plains, and broad drainage lines. These habitats are all well represented throughout the Hamersley subregion, and are not restricted to the Marra mamba survey area. There was very limited core (preferred) habitat for Northern Quolls or Pilbara Olive Pythons observed within the study area. • **Beasley River Limonites Fauna Survey** The Beasley River is located approximately 10 kms south-east of the B4 project area. Biota (2009b) recorded the following three species that are considered to be of conservation significance: • The Pilbara Orange Leaf-nosed Bat (*Rhinonicteris aurantius*), listed as a Schedule 1 species under the state WC Act and 'Vulnerable' under the EPBC Act. • The Short-tailed Mouse (*Leggadina lakedownensis*), listed as Priority 4 species under the WC Act. • The Pilbara Olive Python (*Liasis olivaceus barroni*), listed as a Schedule 1 species under the WC Act and the EPBC Act.	**Terrestrial fauna – additional clearing** This Proposal will result in the clearing of up to 950 ha of potential fauna habitat, therefore habitat loss is likely to continue to be the biggest threat to fauna, including several Priority 4 fauna species (namely: the Western Pebble-mound Mouse; the Australian bustard, the Bush Stone curlew; and the *Notoscincus butleri* skink). Habitat fragmentation also has the potential to disrupt the movement of fauna. However the potential impacts to fauna populations from the Proposal are considered to remain unchanged from that assessed in the PER of the Approved B4 Project, given the proposed changes in this Proposal will: • Not affect regional population levels of any fauna species. • Not contribute to new/additional fragmentation of habitat. • Not affect any new fauna species or habitat types that have not been previously assessed. • Not contribute a new or additional threat to conservation significant fauna species. **Relevance of the above Reports to the Proposal** The detection of both the Pilbara Orange Leaf-nosed Bat and Pilbara Olive Python at the Beasley River Study area represent the most significant faunal findings to the overall environmental value of the Proposal area. However, the Pilbara Olive Python record was the result of finding a skin slough believed to belong to this species, and was recorded at a site approximately 2.5 km south of the Proposal area. In addition, the Pilbara Orange Leaf-nosed Bat records were made at a site approximately 22km south of the Proposal area. The presence of the Pilbara Olive Python to the south of the Proposal area suggests that populations of this species may exist in the area. However, the lack of suitable habitat combined with the lack of additional records from the other two surveys nearer the B4 project area suggests that their presence is unlikely within the Proposal area. The failure to detect the Pilbara Orange Leaf-nosed Bat during other fauna surveys conducted throughout the wider B4 Project area, combined with the 22 km separation between the Beasley River records and the Proposal area, suggests this species is unlikely to be roosting in the vicinity of the Proposal. Whilst it is possible that this species may use parts of the Proposal area for foraging, it is highly unlikely that development of these areas would have any impact on the conservation status of this species. While there is some chance of conservation significant fauna such as the Pilbara Olive Python, Orange Leaf-nosed Bat, and the Northern Quoll, existing in the Proposal area, the lack of previous records, combined with the lack of suitable habitat within these areas, suggests that their presence is unlikely. Consequently, it is considered highly unlikely that the	The key potential impacts of the Proposal on terrestrial fauna (e.g. loss of habitat due to clearing) will be minimised via management measures to reduce potential impacts on flora and vegetation, as detailed in Table 6-2. In addition, the following key management measures will be implemented to manage potential impacts on fauna (and where applicable have been implemented in Proposal design and operation of the B4 Project to date): • Ensure sightings of conservation significant fauna species (primarily species listed under the EPBC Act) encountered by the B4 Project workforce are reported to site Environmental Advisors. • Proposal design has, and will continue to, avoid and minimise clearing of higher value fauna habitat. • Food wastes appropriately disposed of in bins/waste facilities to discourage scavenging by both feral and native animals, and bin lids securely closed. • Internal reporting of incidents involving native fauna. • Implementing and enforcing appropriate vehicular speed limits on site access roads. • Monitoring of feral herbivores and predators will be undertaken along the Boolgeeda Creek wetting front and management measures will be put in place to reduce the risk of significant increases in feral herbivores being attracted by the supply of discharge water. It is not proposed to fence the 37km creekline along Boolgeeda Creek. Prior to discharging water to Boolgeeda Creek a Water Discharge Management and Monitoring Plan will be developed to ensure that the associated environmental and conservation values are maintained.

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
fauna will be implemented (and where applicable, have been implemented during Proposal design and operation of the B4 Project to date).		development of the Proposal would have an impact on the conservation status of such species. **Terrestrial fauna – riparian impact zone** 53 vegetation types were identified within the B4 Project area, most of which have been previously recorded outside the B4 Project area or are likely to occur in the vicinity, as the landforms are widespread and the dominant species are relatively common. Fourteen vegetation types were considered unlikely to be widespread in the region (Biota 2005a), and it follows that aspects of these fauna habitats may therefore also have limited distribution: • Creekline vegetation types C2, C6, C13, C17 and C20 (variously dominated by *Mulga, Eucalyptus xerothermica*, *Acacia pyrifolia, A*. *citroniviridis* or *Gastrolobium grandflorum*) (Biota 2005a) Of the four conservation significant vertebrate fauna recorded, the priority species *Notoscincus butleri* was recorded in the Biota 2005 survey in creekline habitat at Boolgeeda Creek. However the conservation status of this species was deemed unlikely to be impacted by the proposed mining activities at the bioregion and subregion level. There are no apparent areas of sheet flow dependent habitat in the B4 Project area; however Boolgeeda Creek exists as a broad drainage channel where appropriate culverts will be required to eliminate erosion and avoid weed introduction and spread. A potential impact of surplus water discharge to Boolgeeda Creek, which was highlighted during consultation with the Cheela Plain pastoral station, is the attraction of feral herbivores to surface water. Whilst this has not been a significant issue at other Rio Tinto mine operations, it may be a for the B4 Project given the reported presence of such animals in the area. Reconnaissance of Boolgeeda Creek in November 2009 and April 2010 revealed no surface water present in the area currently modelled for this Proposal (WRM 2011a). Pools in Boolgeeda Creek are likely to be transient and ephemeral and water quality will vary with the season. They are likely to be dependent on rainfall, surface water and shallow alluvial interflow rather than regional groundwater. The pools noted by Biota during the August 2013 survey have not been identified in previous studies. However, they are likely to be a result of the unseasonably high rainfall recorded at B4 in May and June 2013 (32.8mm and 52.8mm respectively, compared with 8.8mm and 16.4mm in 2011 and 0mm and 12.4mm in 2012). As pooling of discharge water is not expected, impacts to aquatic fauna have not been considered in this Proposal.	

Table 6-4: Hydrological Processes and Inland Water Environmental Quality (Surface Water): Description of Factor, Impact Assessment and Management

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
EPA objectives • To maintain hydrological regimes of surface water so that existing and potential uses, including ecosystem maintenance, are protected. • To maintain the quality of surface water, sediment and/or biota so that the environmental values, both ecological and social, are protected. **Summary of how Proposal meets EPA objective:** The Proposal can be managed to meet the EPA environmental objective for this factor, as detailed in adjacent columns: • Groundwater from the B4 orebody aquifer that will be discharged is fresh to brackish with a neutral to slightly basic pH. • Appropriate monitoring and management of discharge water quality will be undertaken in accordance with the ANZECC/ARMCANZ (2000) water quality management framework. • The spatial and temporal extent of dewatering discharge is relatively limited, and substantial areas of similar watercourses occur outside the discharge extent within the Boolgeeda Creek sub-catchment. • The discharge pipeline corridor is unlikely to impact overland flow. • Appropriate management measure to avoid and minimise potential impacts of the Proposal on surface water will be implemented	**Dewatering discharge** • Surplus water will be discharged into Boolgeeda Creek from a pipeline north of the B4 deposit (refer to Figure 4-1). • A maximum predicted discharge of 6.4 GL/a (17.5 ML/day) will be required. The predicted waster demand will remain steady at approximately 8ML/day and the proposed surface discharge will average at 4ML/day however peaks of up to 17.5ML/day are expected. **Boolgeeda Creek** • B4 lies on the divide between the Boolgeeda Creek and Beasley River catchments. Boolgeeda Creek lies approximately 2.5km north (at is closest point) from the B4 Central Pit. • Boolgeeda Creek catchment covers an area of approximately 1,650 km^2 and is a tributary of Duck Creek within the regional Ashburton River catchment. The creek becomes more defined when it enters a gorge system downstream of B4 operation, before discharging into Duck Creek at Lawloit Range. • The vegetation condition of the creek bed was ranked as being Very Good despite the presence of **Cenchrus ciliaris,* which is growing both as scattered grasses and very open tussock grasslands. The creek line supports a healthy and diverse range of flora species. • A total of six pools where observed. Reconnaissance of Boolgeeda creek in November 2009 and April 2010 revealed no surface water present in the area currently modelled for this Proposal (WRM 2011a). One control site was sampled in Boolgeeda Creek 70km downstream from the proposed B4 discharge point. Pools in Boolgeeda Creek are likely to be transient and ephemeral and water quality will vary with the season. They are likely to be dependent on rainfall, surface water and shallow alluvial interflow rather than regional groundwater. The pools noted by Biota during the August 2013 survey have not been identified in previous studies. However, they are likely to be a result of the unseasonably high rainfall recorded at B4 in May and June 2013 (32.8mm and 52.8mm respectively, compared with 8.8mm and 16.4mm in 2011 and 0mm and 12.4mm in 2012). • An updated hydrological model was completed in June 2013 (Rio Tinto, 2013a) to predict the hydrological reaction of Boolgeeda Creek to the release of surplus dewater from the B4 Project. An extra 1.36km discharge pipe is required to be extended from the existing B4 discharge pipe network to the proposed outlet. The response of the creek systems through the continual discharge for a range of discharge options varying from 2.5 ML/day to 20 ML/day was investigated (the estimated peak watering demand is 17.5 ML/d). **Pipeline Corridor** Modelling of surface hydrology in the vicinity of the discharge pipeline corridor indicates the following outcomes: • All potential water movement is likely to be confined within the channel,	**Vegetation – dewatering discharge** Detrimental impacts to vegetation bordering the watercourses affected by dewatering discharge may occur (refer to Table 6-2), however it is not considered significant, primarily due to the widespread occurrence of the relevant vegetation communities in the local area, and the relatively limited temporal and spatial extent of the discharge. **Vegetation – pipeline corridor** No significant impact is expected. Refer to the assessment in Table 6-2 Vegetation and Flora.	The following key management measures for surface water will be implemented and, where applicable, have been implemented during Proposal design and operation of the B4 Project to date: • Surface water management is included within the existing B4 Project EMP which will continue to be implemented with the objective of minimising the adverse impacts to water courses, water quality and the downstream environment. • Proposal design has incorporated consideration of surface water management, including minimising disruption to watercourses. • A discharge water quality management and monitoring strategy (including site specific water quality trigger values) will be developed in accordance with the ANZECC/ARMCANZ (2000) water quality management framework to manage the potential impacts of discharge water on the downstream environment. This will be managed under Part V of the EP Act. • Prior to discharging water to Boolgeeda Creek a Water Discharge Management and Monitoring Plan will be developed to ensure that the associated environmental and conservation values are maintained. • Management of weeds will be carried out in accordance with commitments made in Table 6-2.

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
(and where applicable have been implemented during Proposal design).	hence overtopping of the creek banks is not anticipated. While the creek bed will remain saturated, the creek banks are likely to remain unsaturated such that bank vegetation should be largely unaffected by the flow. However, the continuous flow will increase the water availability close to the creek. Thus the content of water in unsaturated zones moving away from the saturated creek bed may increase vegetation vigour and/or encourage sapling growth. The peak flow volume of water discharged into Boolgeeda Creek is significantly smaller than the peak flow volume generated by the catchment during any flood events; a 2 year ARI flood event would deliver 148 m^3/s at the proposed discharge outlet, compared with peak modelled discharge rates of 17.5 ML/ day which is equivalent to 0.2m^3/s (Rio Tinto 2013a, 2013d). **Surface water flows** Modelling of surface hydrology indicates the following outcomes (Rio Tinto 2013e): • No 'overland flow' is likely to occur as discharge will be confined to the creek bed. • Creek banks will remain unsaturated. • The bedrock units of Boolgeeda Creek valley are low permeability so discharge water will be retained within the surface alluvials.		

Table 6-5: Rehabilitation and Closure: Description of Factor, Impact Assessment and Management

Summary of how the Proposal meets the EPA Objective	Description of Factor	Impacts and Assessment of Significance	Management and Mitigation
EPA Objectives To ensure that premises can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State. **Summary of Proposal meets the EPA objective** The Proposal can be managed to meet the EPA objectives for this factor, as detailed in adjacent columns: • Mineral waste dumps are unlikely to have significant environmental impacts, based on analysis of mineral waste volumes, and physical and chemical properties, which indicates the majority of mineral waste is relatively benign and only a very small amount of PAF material (2.1Mt) is expected. • A Closure Plan for the B4 Project was prepared in 2007 and submitted with the original proposal. This Plan provides appropriate management measures regarding closure and rehabilitation and is currently being reviewed in accordance with MS 717 Condition 10.2.	**Mineral waste physical characteristics** The majority of waste material at B4 is competent rocky material (over 80 percent of waste in Dumps DP2 and DP4 comprises Joffre, Dales Gorge and Hydrated Zone material). Appropriate rehabilitation design criteria of 20 metre lifts, 18 degree slopes and 10 metre berms will be implemented for waste dumps on site. This will be further detailed in the 2015 update to the B4 Closure Plan. **Mineral waste geochemical characteristics** Several pits at B4 (Pit 1, 2, 3 and 5) have been identified as containing PAF; however it is a relatively small amount of material (2.1 Mt). This material is scheduled to be intercepted by mining in 2015 based on the current mine plan. Dump DP2 has been designated as the storage location of this material as no pit void is available for use at the time the material is intercepted. PAF material will be managed (encapsulated) during operations in accordance with the Mineral Waste Management Plan (WMP) and the Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan for the B4 Project. PAF will remain encapsulated at closure. The SCARD and WMP are provided in Appendix 6 and Appendix 7 respectively.	**Waste dumps** The additional waste dumps and changes to existing waste dumps is considered unlikely to have significant additional environment impact to that assessed in the original B4 Project PER. This is based on the following consideration: • Waste dump designs will consider the physical and chemical properties of waste material. • A substantial volume of competent waste is available, enabling design/construction of waste dumps that are stable and not susceptible to excessive erosion. • A substantial volume of inert waste material is available, enabling design/construction of waste dumps that encapsulate the lower volumes of waste rock that poses a potential Acid Mine Drainage (**AMD**) risk.	• The Rio Tinto Iron Ore (WA) Landform Design Guidelines will continue to be implemented to ensure waste dumps at B4 are safe and stable during operations and at closure. • The Rio Tinto Iron Ore (WA) Mineral Waste Management Plan, and the Spontaneous Combustion and ARD (SCARD) Management Plan will continue to be implemented, to ensure waste material is adequately geochemically characterised (via static testing, and kinetic testing where warranted) during B4 operations, and PAF material that poses an AMD risk is appropriately managed. • The Rio Tinto Iron Ore (WA) Soil Resource Management Work Practice will continue to be implemented to manage recovery and storage of topsoil and subsoil resources. • Planning for closure will continue to be undertaken throughout the operation of B4. The first Closure Plan for B4 was developed in 2007 (RTIO-HSE-0063820). The site is subject to Ministerial Statement 717 Condition 10.2 which requires submission of a revised Closure Plan within 5 years of mine commissioning. As mining commenced in 2010, this Closure Plan is due for submission in 2015. Work commenced in 2013 on review and update of this plan and will continue throughout 2014. In terms of this Proposal, this revised Closure Plan will address waste dump rehabilitation design, progressive rehabilitation and the management of PAF material.

7 OTHER ENVIRONMENTAL FACTORS

Table 7-1 briefly outlines environmental factors that were not considered in this Environmental Review as the Proposal, if implemented, will not result in any significant change in addition to or different from that originally assessed and approved under Ministerial Statement 717.

Table 7-1: Factors Considered Not Relevant to this Proposal

Factor	EPA Objective	Description of Factor	Impacts	Existing Management and Mitigation Measures
Heritage	To ensure that historical and cultural associations are not adversely affected.	This Proposal is located within the traditional lands of the Eastern Guruma people and the PKKP people. Discharge into Boolgeeda Creek is not expected to impact the heritage values of the place, as water will be restricted within the current creek banks. The additional clearing for waste dump optimisation will only be undertaken following heritage surveys and any s18's if required.	Surveys undertaken to date indicate the Proposal is unlikely to have significant impact on Aboriginal heritage, in addition to or different from the existing B4 Project: • No ethnographic sites have been identified to date within the Proposal boundary. • Some archaeological sites identified to date may be impacted by the Proposal; however, these sites are of low to moderate significance. • Additional clearing required for waste dump optimisation is likely to result in the loss of several heritage sites. If sites cannot otherwise be avoided, the impacts will be managed in accordance with the *Aboriginal Heritage Act 1972* (**AHA**) Section 18, and in consultation with Traditional Owners.	Heritage values will be addressed during planning and implementation of the Proposal, in accordance with existing B4 Project management plans, by: • Avoiding disturbance to heritage sites where practical. • Obtaining approval for any required disturbance to identified sites in accordance with s18 of the AHA and in consultation with the Eastern Guruma or PKKP people as applicable. • Protecting all identified sites located near construction or operational areas that are not approved to be disturbed under s18 of the AHA (e.g. through the installation of physical barriers and buffer zones). • Documenting the location of all protected sites in the Rio Tinto Geographic Information System (**GIS**) database and on site plans, and designating buffer zones around these sites.

Factor	EPA Objective	Description of Factor	Impacts	Existing Management and Mitigation Measures
Amenity (Visual)	To ensure that impacts to amenity are reduced as low as reasonably practicable.	The visual landscape of the Pilbara is generally characterised by rugged ridges and ranges supporting spinifex grasslands, with land uses generally comprising pastoralism and mining infrastructure. The visual character of the landscape in the broader area around the Proposal is predominantly natural in appearance, with localised areas of highly modified landscapes due to multiple mining developments (e.g. Brockman 4, Brockman 2 and Nammuldi-Silvergrass).	In general, visual impact of the Proposal from public roads and publicly accessible viewpoints is not expected to be different or additional to that of the existing B4 Project, in consideration of the following : • The Proposal is a small extension to the existing B4 operation. • The Proposal is not overlooked by or adjacent to populated or sensitive areas such as scenic outlooks, settlements or National Parks. • Access to the Proposal area is via a sealed road and can only be approached from the south via the White Quartz Road. • There are no known plans for future tourism ventures in the immediate vicinity.	Visual amenity will continue to be managed in accordance with existing B4 Project management plans by: • Undertaking waste dump design in accordance with the Rio Tinto Iron Ore (WA) Landform Design Guidelines and with consideration of closure objectives for the Proposal, to achieve final landforms that are considered aesthetically compatible with the surrounding landscape. • Rehabilitating waste dumps with native vegetation. • Rehabilitating any long-term low grade stockpiles that remain in-situ at mine closure with native vegetation (as per waste dumps). • Removing infrastructure (other than pits and dumps not used for backfilling) at closure and rehabilitate remaining disturbed areas with native vegetation.
Groundwater	To maintain hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected. To maintain the quality of groundwater and surface water, sediment and/or biota so that the environmental values, both ecological and social, are protected.	Water is sourced for processing, dust suppression, BWT mining and potable water purposes from groundwater production bores and mine dewatering bores, with dewatering production prioritised over external borefields.	Groundwater levels through the B4 Project area are naturally deep and do not support phreatophytic vegetation (with the exception of C1 – Coolibah *Eucalyptus victrix* woodlands mainly along Boolgeeda Creek, and possibly P1 – the Mulga woodlands in the broad drainage area within the valley south of the B4 Range), and there is no indication of shallow water table aquifers within the B4 Project area.	The dewatering rate is increasing to ensure the original approved dewatering targets can met, however this will not result in an increase in the predicted extent of drawdown or method of dewatering from that assessed and approved via MS 717 for the B4 Project. Therefore no impacts from drawdown (different from, or additional to, the approved B4 Project) will occur as a result of implementation of this Proposal. Impacts to groundwater will continue to be managed in accordance with existing B4 Project EMP.

Factor	EPA Objective	Description of Factor	Impacts	Existing Management and Mitigation Measures
Air Quality (Dust, Noise and Vibration and Greenhouse Gas Emissions)	To maintain air quality for the protection of the environment and human health and amenity.	The Proposal will generate dust, noise, vibration and GHG emissions.	The potential impacts to air quality are not considered to be different from, or in addition to, the approved activities and impacts for the B4 Project.	The generation of noise, dust, GHG and vibration from the Proposal will be managed in accordance with existing B4 Project EMP.

8 OTHER LEGISLATION AND APPROVALS

Other legislation applicable to regulation of the potential environmental impacts of the Proposal, and approvals required, are outlined in Table 8-1. Rio Tinto will comply with all relevant legislation (including obtaining specific approvals where required) prior to, and during implementation of the Proposal.

Table 8-1: Other Legislation and Approvals

Environmental factor	Secondary Approval	Responsible Agency	Statute
Flora and Vegetation	Licence to take rare flora.	DPaW	*Wildlife Conservation Act 1950*
Fauna	Licence to take protected fauna.	DPaW	
Interference with watercourses	26D Permit to obstruct or interfere with bed/banks.	DoW	*Rights in Water and Irrigation Act 1914*
Groundwater abstraction	5C Licence to construct or alter wells. Licence to take groundwater/amendment to existing groundwater licences.	DoW	
Rehabilitation and closure	Mining proposal and mine Closure Plan – for infrastructure on Mining Act tenure.	DMP	*Mining Act 1978*
Heritage	S18	DAA	*Aboriginal Heritage Act 1972*

9 PRINCIPLES OF ENVIRONMENTAL PROTECTION AND EIA

This section describes how the objectives of the EP Act and the principles of EIA have been addressed and how the Proposal meets the criteria for an API (Category A) assessment as described in the 2012 Administrative Procedures.

9.1 PRINCIPLES OF ENVIRONMENTAL PROTECTION

The objective of the EP Act is to protect the environment of the State, having regard to five principles. These principles have been considered in the EIA for the Proposal and are summarised in Table 9-1 below.

Table 9-1: Principles of Environmental Protection

Principle	Consideration Given in Proposal
1. Precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: • Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment. • An assessment of the risk-weighted consequences of various options.	During the Proposal planning and design phase, Rio Tinto undertook comprehensive baseline studies, investigations and modelling of aspects of the Proposal that may affect the surrounding environment. Where significant environmental impacts were identified, measures have been, and will continue to be, incorporated into Proposal design and management to avoid or minimise predicted impacts.
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 Rio Tinto Iron Ore HSECQ Policy incorporates the principle of sustainable development and includes the following commitments: • Prioritising research and implementation programs through technology to reduce impacts to land, enhancing our contribution to biodiversity and improving our efficiency in water and energy use. • Identifying climate change improvement solutions through dedicated optimisation work programs. • Contributing to the health and well-being of local communities.

Principle	Consideration Given in Proposal
3. Conservation of biological diversity and ecological integrity. Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Biological investigations are undertaken by Rio Tinto during the Proposal planning process to identify aspects of the environment that are of conservation significance. Where significant potential environmental impacts are identified, measures have been, and will continue to be, incorporated into Proposal design and management to avoid or minimise these impacts where practical. The Rio Tinto HSEQ Management System has well established rehabilitation procedures for restoring disturbed environments.
4. Improved valuation, pricing and incentive mechanisms • Environmental factors should be included in the valuation of assets and services. • The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. • 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 wastes. • Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentives structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	Environmental factors have been considered during the Proposal planning phase, and will continue to be considered during the operational and closure phases of the Proposal. Proposal planning, design and operational management will continue to investigate and implement opportunities to reduce impact to land, and improve efficiency in water and energy use, in accordance with the Rio Tinto Iron Ore Group HSECQ Policy.
5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	All reasonable and practicable measures are taken to minimise the generation of waste and its discharge into the environment through the existing B4 project EMP and procedures.

9.2 PRINCIPLES OF EIA FOR THE PROPONENT

Table 9-2 outlines the principles of EIA as described in clause 5 of the 2012 Administrative Procedures.

Table 9-2: Principles of EIA for the Proponent

The principles of EIA for the Proponent		Discussed in the Document
1.	Consult with all stakeholders, including the EPA, DMAs, other relevant government agencies and the local community as early as possible in the planning of their proposal, during the environmental review and assessment of their proposal, and where necessary during the life of the project.	Table 2-1 details the stakeholder consultation undertaken to date. This consultation includes the OEPA, relevant DMAs, Traditional Owners and Pastoral Station managers. Rio Tinto will continue to consult with relevant stakeholders during the environmental approval process, and during implementation of the Proposal.
2.	Ensure the public is provided with sufficient information relevant to the EIA of a proposal to be able to make informed comment, prior to the EPA completing the assessment report.	Table 6-2 to Table 6-5 provide an EIA of the Proposal, for the preliminary key environmental factors identified by the EPA, based on: • a summary of the key findings of studies and investigations (full reports provided as appendices, where relevant); • assessment of potential impacts of the Proposal; and • key environmental management measures. Table 7-1 provides a brief EIA of the Proposal for other environmental factors.
3.	Use best practicable measures and genuine evaluation of options or alternatives in locating, planning and designing their proposal to mitigate detrimental environmental impacts and to facilitate positive environmental outcomes and a continuous improvement approach to environmental management.	As stated in Table 6-2 to Table 6-5, avoiding and minimising impacts to the environment where practical is a key management commitment for the Proposal, and has been implemented during Proposal design. For example, modification of the Proposal boundary since referral has been undertaken, to exclude extensive areas of vegetation of elevated conservation significance, and several occurrences of a Priority 1 flora species. As detailed in Section 6.2, continuous improvement is a key aspect of the Rio Tinto Iron Ore (WA) HSEQ Management System.
4.	Identify the environmental factors likely to be impacted and the aspects likely to cause impacts in the early stages of planning for their proposal. The onus is on the proponent through the EIA process to demonstrate that the unavoidable impacts will meet the EPA objectives for environmental factors and therefore their proposal is environmentally acceptable.	Table 6-2 to Table 6-5 identifies the preliminary key environmental factors relevant to the Proposal, potential impacts, key management measures, and how the EPA objectives relevant to each environmental factor can be met by the Proposal. Table 7-1 provides a brief EIA of the Proposal for other environmental factors.

The principles of EIA for the Proponent		Discussed in the Document
5.	Consider the following, during project planning and discussions with the EPA, regarding the form, content and timing of their environmental review: a. The activities, investigations (and consequent authorisations) required to undertake the environmental review. b. The efficacy of the investigations to produce sound scientific baseline data about the receiving environment. c. The documentation and reporting of investigations. d. The likely timeframes in which to complete the environmental review; e. Use best endeavours to meet assessment timelines.	The form and content of the environmental review has incorporated advice provided by the OEPA in several meetings, and addressed OEPA comment on drafts of the environmental review. Comprehensive studies and investigations, of high standard, have been undertaken to support the environmental review, and are provided as appendices. Project planning has considered the expected timeframes for completion of supporting studies, environmental review preparation and assessment, and timings for key milestones are regularly discussed with the OEPA.
6.	Identify in their environmental review, subject to EPA guidance: a. Best practicable measures to avoid, where possible, and otherwise minimise, rectify, reduce, monitor and manage impacts on the environment. b. Responsible corporate environmental policies, strategies and management practices, which demonstrate how the proposal can be implemented to meet the EPA environmental objectives for environmental factors.	Table 6-2 to Table 6-5 and Table 7-1 identifies key management measures to avoid, where possible, and otherwise minimise, rectify, reduce, monitor and manage impacts on the environment. These tables also provide an assessment of how the Proposal meets EPA environmental objectives for relevant environmental factors, based on implementation of key management practices, and corporate environmental policies and strategies (summarised in Section 9).

9.3 CRITERIA FOR API CATEGORY A

Clause 10.1.1 in the 2012 Administrative Procedures states that the OEPA applies an API A level of assessment where the proponent has provided sufficient information about the proposal, its environmental impacts, proposed management, and it appears that the proposal is consistent with Category A criteria. Consistency of the Proposal with these criteria is addressed in Table 9-3.

Table 9-3: Criteria for API Category A

Category A Criteria	Discussion
The proposal raises a limited number of key environmental factors that can be readily managed and for which there is an established condition-setting framework.	The Proposal raises four preliminary key environmental factors and assessed in Table 6-2 to Table 6-5. These factors are typical of iron ore mining in the Pilbara and can be readily managed under the existing B4 Project EMP and other regulatory approvals. Numerous operating iron ore mines in the region subject to Ministerial Conditions provide appropriate precedents for assessment and condition-setting.
The proposal is consistent with established environmental policies, guidelines and standards.	The Proposal is consistent with established environmental policies, guidelines and standards, as set out in Table 6-2 to Table 6-5 and Table 7-1.

Category A Criteria	Discussion
The proponent can demonstrate that it has conducted appropriate and effective stakeholder consultation, in particular with DMAs.	Section 2 details the stakeholder consultation that has been undertaken to date, issues raised, and Proponent response to issues raised. This consultation included the OEPA and other DMAs.
There is limited or local concern only about the likely effect of the proposal, if implemented, on the environment.	Stakeholder consultation has been undertaken to date; stakeholders have not raised any major concerns with the Proposal (refer to Section 2). The key issued raised, by downstream pastoral station managers, includes the potential attraction of feral herbivores to discharge waters.

10 REFERENCES

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Rio Tinto 2013b, Brockman 4 BSSM Groundwater Modelling Report, Rio Tinto internal memo, RTIO-PDE-0105955

Rio Tinto 2013c, Brockman Syncline 4 Drawdown Distribution Map, RTIO-PDE-0116230

Rio Tinto 2013d, Pilbara Borefields Triennial Aquifer Review 2012, RTIO-HSE-0181047

Rio Tinto 2013e, Baseline Hydrology Assessment for Brockman 4 Discharge at Boolgeeda Creek (RTIO-HSE-0188700)

Wetland Research & Management 2011a, Nammuldi-Silvergrass Project: Dry 2010 / Wet 2011 Sampling Final Report, December 2011, RTIO-HSE-0126753

Wetland Research & Management 2011b, Nammuldi-Silvergrass Project: November 2009 & April 2010 Sampling Final Report, December 2011, RTIO-HSE-0123909

Wetland Research & Management 2012, Western Turner Syncline Project: Wet and Dry 2012 Sampling Final Report, January 2012, RTIO-HSE-0134269

APPENDICES

The following supporting documents are contained on CD_ROM inside the back cover of this API Environmental Review Document.

Appendix 1 S38 Referral Form

Appendix 2 Ministerial Statement 717

Appendix 3 Proposed Environmental Conditions for Revised B4 Project

Appendix 4 Modelled Scenario for Boolgeeda Creek Discharge

Appendix 5 Biota Environmental Sciences (Biota) 2013a, Brockman 4 Riparian Vegetation Mapping, Level 2 Vegetation and Flora Survey.

Appendix 6 Brockman Syncline 4 Spontaneous Combustion and ARD Management Plan

Appendix 7 Mineral Waste Management Plan

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
If yes, what level of assessment? √ Assessment on Proponent Information

PROPONENT DECLARATION (to be completed by the proponent)

I, Tammy Souster declare that I am authorised on behalf of Hamersley Iron Pty Limited submit this form and further declare that the information contained in this form is true and not misleading.

Signature	Tammy Souster
Position	Rio Tinto Iron Ore (on behalf of Hamersley Iron Pty. Limited)
Date	

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	Hamersley Iron Pty Limited.
Joint Venture parties (if applicable)	Not applicable
Australian Company Number (if applicable)	ABN: 49 004 558 276
Postal Address	GPO Box A42, Perth, WA 6837
Key proponent contact for the proposal:	Tammy Souster Senior Advisor Environmental Approvals Rio Tinto 152-158 St Georges Terrace, Perth WA 6000 Telephone: (08) 6211 6985 Email: tammy.souster@riotinto.com
Consultant for the proposal (if applicable):	Not applicable

1.2 Proposal

Title	Brockman Syncline 4 Iron Ore Project – Revised Proposal
Description	This Proposal is a revision of the approved Brockman Syncline 4 Iron Ore Project (MS 717), located approximately 60 km west-north-west of Tom Price in the Central Pilbara. The new factor relates to discharge of surplus dewater, as the dewatering rate is increasing from 4.53 GL/a to 6.4 GL/a over the life of the Proposal. The surplus water management will include onsite use and controlled discharge to Boolgeeda Creek.
Extent (area) of proposed ground disturbance.	950 ha in addition to the approved footprint of 2,610 ha
Timeframe in which the activity or development is proposed to occur (including start and finish dates where applicable).	Discharge to commence in Q1 2015.
Details of any staging of the proposal.	Not applicable
Is the proposal a strategic proposal?	No
Is the proponent requesting a declaration that the proposal is a derived proposal?	No.
Please indicate whether, and in what way, the proposal is related to other proposals in the region.	This Proposal is a revision of the approved Brockman Syncline 4 Iron Ore Project (MS 717)
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?	No, the proponent holds Mining Lease 4SA over most of the Proposal area. Infrastructure related to the B4 project is located on a number of Miscellaneous Licenses and General Purpose leases granted under the *Mining Act 1978*.
What is the current land use on the property, and the extent (area in hectares) of the property?	The current land use on ML4SA (total area approximately 58 800 ha) in the vicinity of the Proposal is mineral exploration. Mining and processing of iron ore occurs on ML4SA at the existing WTS S10 and Tom Price mine sites

1.3 Location

Name of the Shire in which the proposal is located.	Shire of Ashburton
For remote localities: • nearest town; and • distance and direction from that town to the proposal site.	The proposal is located approximately 60km from the town of Tom Price
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

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?	NA

1.5 Government Approvals

Is rezoning of any land required before the proposal can be implemented? If yes, please provide details.		No
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.		Yes
Department of Water	Licences to construct wells and take groundwater under the *Rights in Water and Irrigation Act 1914*.	No. Requires amendment to existing License GWL164398

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;

2.2 fauna;

2.3 rivers, creeks, wetlands and estuaries;

2.4 significant areas and/ or land features;

2.5 coastal zone areas;

2.6 marine areas and biota;

2.7 water supply and drainage catchments;

2.8 pollution;

2.9 greenhouse gas emissions;

2.10 contamination; and

2.11 social surroundings.

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?

√ Yes **If yes**, complete the rest of this section.

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

950 ha

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

√ 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 Multiple flora and vegetation surveys have been undertaken within the approved B4 Project area and surrounds.
A flora and vegetation survey along Boolgeeda Creek was completed by Biota Environmental Sciences (2013) to support this Proposal. This report is provided as Appendix 5 in the supporting documentation.

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

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

√ Yes

No Declared Rare Flora or Threatened Ecological Communities have been recorded within the Proposal boundary, or are expected to.

Six Priority species could potentially be impacted by the Proposal:

- *Ptilotus subspinescens* Priority 3
- *Eremophila magnifica* subsp. *magnifica* Priority 4
- *Peplidium sp*. Fortescue Marsh (S. Van leeuwen 4865) Priority 1
- *Pentalepis trichodesmoides subsp. hispida* Priority 2
- *Indigofera sp*. Bungaroo Creek (S. Van Leeuwen) Priority 3
- *Goodenia nuda* Priority 4

Further information is provided in Section 6 of the Environmental Review document

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

Vegetation condition is from poor to excellent using the Trudgen scale.
Further information on the vegetation condition is contained in the report by Biota Environmental Sciences (2013) Brockman 4 riparian vegetation mapping report located as Appendix 3 in the Environmental Review document.

2.2 Fauna

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

√ Yes

2.2.2 Describe the nature and extent of the expected impact.

The nature and extent of the expected impact is outlined in Section 6 of the Environmental Review document.

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

√ Yes

Multiple fauna surveys have been undertaken within the approved B4 Project area and surrounds.
Details of these studies are provided in Section 6 of the Environmental Review document.

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

√ Yes

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

√ Yes

Four priority vertebrate fauna species have been recorded in the B4 survey area (Biota 2005b):

- Western Pebble –mound Mouse *Pseudomys chapmani*
- Australia Bustard *Ardeotis australis*
- Bush Stonecurlew *Burhinus grallarius*
- A skink *Notoscincus butleri*

2.3 Rivers, Creeks, Wetlands and Estuaries

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

√ Yes

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

√ No

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

√ No

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

√ No

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

√ Yes Dewatering in excess of operational requirements will be discharged to Boolgeeda Creek with a maximum wetting front of 37km.

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

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?

√ No

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?

√ No **If yes**, please provide details.

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?

√ 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?

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

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?

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

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 The Proposal is located within the Pilbara Groundwater Area proclaimed under the *Rights in Water and Irrigation Act 1914,* in which licences will be required for construction of wells to access groundwater and to abstract groundwater.
Rio Tinto is liaising with DoW regarding amending the existing GWL164398 to increase the abstraction from 4.53GL/a to 6.4 GL/a. The water abstracted will be used for mine operations such as processing and excess disposed to a local watercourse.

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)

√ No

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.)

√ No

2.7.4 Is there sufficient water available for the proposal?

√ Yes

2.7.5 Will the proposal require drainage of the land?

√ No

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

√ Yes

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

Ongoing operational demand for water is approximately 8ML/day.

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

Water supply during operation will be preferentially sourced from mine dewatering.

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?

√ No No different or additional pollutants, to those assessed and approved for the B4 Project (via MS 717), will result from implementation of this Proposal.

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)?

√ No

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?

√ No

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

√ No

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)

√ No

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 Aboriginal heritage surveys of the Proposal area are at various stages of completion. Heritage surveys will be completed prior to any clearing requested as part of this proposal.

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)?

√ No

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

√ No

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
2.	The principle of intergenerational equity.	Yes
3.	The principle of the conservation of biological diversity and ecological integrity.	Yes
4.	Principles relating to improved valuation, pricing and incentive mechanisms.	Yes
5.	The principle of waste minimisation.	Yes

A discussion on the Principles is provided in Section 9 of the Environmental Review document.

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

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 Further information is provided in Section 2 of the Environmental Review document.

Hon Mark McGowan MLA
Minister for the Environment;
Racing and Gaming

197 St George's Terrace, Perth WESTERN AUSTRALIA 6000
Telephone: (+61 8) 9222 9111 Facsimile: (+61 8) 9222 9410
Email: mark-mcgowan@dpc.wa.gov.au • Website: www.ministers.wa.gov.au/mcgowan/

Statement No.

000717

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

BROCKMAN SYNCLINE 4 IRON ORE PROJECT
60 KM WEST-NORTH-WEST OF TOM PRICE
SHIRE OF ASHBURTON

Proposal: Three open pits, dry processing plant, associated iron ore mine infrastructure and an extension to the Brockman 2 rail spur in the Central Pilbara area, as documented in schedule 1 of this statement.

Proponent: Hamersley Iron Pty Limited

Proponent Address: GPO Box A42,
PERTH WA 6837

Assessment Number: 1543

Report of the Environmental Protection Authority: Bulletin 1214

The proposal referred to in the above report of the Environmental Protection Authority may be implemented subject to the following conditions and procedures:

1 Proposal Description

1-1 The proponent shall implement the proposal as documented and described in schedule 1 of this statement subject to the conditions and procedures of this statement.

2 Proponent Environmental Management Commitments

2-1 The proponent shall fulfil the environmental management commitments contained in schedule 2 of this statement.

Published on
24 MAR 2006

3 Proponent Nomination and Contact Details

3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person as the proponent for the proposal.

3-2 If the proponent wishes to relinquish the nomination, the proponent shall apply for the transfer of proponent under section 38(6a) and provide the name and address of the person who will assume responsibility for the proposal, together with a letter from that person which states that the proposal will be carried out in accordance with the conditions and procedures of this statement, and documentation on the capability of that person to implement the proposal and fulfil the conditions and procedures.

3-3 The nominated proponent shall notify the Department of Environment of any change of the name and address of the proponent within 60 days of such change.

4 Time Limit of Approval to Commence

4-1 The proponent shall provide evidence to the Department of Environment that the proposal has been substantially commenced within five years from the date of this statement or the approval granted in this statement shall lapse and be void.

4-2 The proponent shall make an application for any extension of approval for the substantial commencement of the proposal to the Minister for the Environment prior to the expiration date of this statement, which shall demonstrate that:

1. the environmental factors of the proposal reported in Environmental Protection Authority Bulletin 1214 have not changed significantly;
2. new, significant, environmental factors have not arisen; and
3. all relevant government authorities and stakeholders have been consulted.

5 Compliance Reporting

5-1 The proponent shall submit compliance reports in accordance with a schedule approved by the Department of Environment and with the compliance monitoring guidelines, and shall:

1. describe, or update, the state of implementation of the proposal;
2. provide verifiable evidence of compliance with the conditions, procedures and commitments;
3. review the effectiveness of corrective and preventative actions contained in the environmental management plans and programs;

4. provide verifiable evidence of the fulfilment of requirements specified in the environmental management plans and programs;
5. identify all confirmed non-conformities and non-compliances and describe the related corrective and preventative actions taken; and
6. identify potential non-conformities and non-compliances and provide evidence of how appropriate corrective action is being determined.

6 Performance Review

6-1 The proponent shall submit a Performance Review Report every six years after commissioning to the Environmental Protection Authority, which addresses:

1. the major environmental issues associated with implementing the project; the environmental objectives for those issues; the methodologies used to achieve these; and the key indicators of environmental performance measured against those objectives;
2. the level of progress in the achievement of sound environmental performance, including industry benchmarking, and the use of best available technology where practicable;
3. significant improvements gained in environmental management, including the use of external peer reviews;
4. stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed; and
5. the proposed environmental objectives over the next six years, including improvements in technology and management processes.

7 Vegetation

7-1 Prior to commencement of ground disturbance within the rail spur and infrastructure corridor route, the proponent shall:

1. carry out a wet season flora survey to determine the number and distribution of identifiable Declared Rare, Priority and significant flora species which may be impacted by the proposed activities; and

2. provide a report of the findings of the survey to the Environmental Protection Authority and the Department of the Conservation and Land Management.

7-2 In the event that any Declared Rare, Priority or significant flora species are recorded during the survey required by condition 7-1, the proponent shall prepare a Flora Management Plan in accordance with requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Conservation and Land Management.

The objective of this Plan is to maintain the abundance, diversity, geographic distribution, conservation status and productivity of Declared Rare, Priority and significant flora species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

This Plan shall describe the significant, identified species of Declared Rare, Priority and significant flora, and describe significant vegetation associations and habitat areas along the rail spur and infrastructure corridor routes, and shall set out procedures to:

1. demarcate identified populations and/or individuals of conservation-significant species of flora and vegetation associations and habitat areas;
2. modify land clearing plans and evaluate alternative mine plans, to minimise or avoid impacts on the conservation-significant, identified species of flora and vegetation associations and habitat areas;
3. minimise impacts where proposed mining activities are likely to impact on flora, vegetation associations and habitat areas of conservation significance, and demonstrate that such impacts have been minimised;
4. monitor and record impacts on conservation-significant, identified species of flora and vegetation associations and habitat areas; and
5. implement appropriate contingency measures where impacts on conservation-significant, identified species of flora and vegetation associations and habitat areas are identified.

7-3 The proponent shall review and revise the Flora Management Plan required by condition 7-2 at intervals not exceeding five years.

7-4 The proponent shall implement the Flora Management Plan required by condition 7-2 and subsequent revisions required by condition 7-3.

7-5 The proponent shall make the Flora Management Plan required by condition 7-2 and subsequent revisions required by condition 7-3 publicly available.

Note: In the preparation of advice to the Minister for the Environment, the Environmental Protection Authority expects the proponent to obtain the advice of the Department of Conservation and Land Management.

8 Land Snails

8-1 Prior to the commencement of mining activities, the proponent shall prepare a Snail Management Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority and the Department of Conservation and Land Management.

This plan shall:

1. provide protection to the genetically distinct *Rhagada* sp. "Mt Brockman" snail population and the *Triodia* under Mulga vegetation community and drainage features which support it at survey site BROMD from impacts of the development/activities by locating the pipeline along an alternate track on the north of BROMD; and

2. include a program for monitoring of the *Rhagada* sp "Mt Brockman" population at survey site BROMD to ensure that the development/activities do not adversely impact the population.

8-2 The proponent shall implement the Snail Management Plan required by condition 8-1.

8-3 The proponent shall make the Snail Management Plan required by condition 8-1 publicly available.

8-4 The proponent shall submit the findings of the Snail Management Plan to the Environmental Protection Authority, the Department of Conservation and Land Management and the Western Australian Museum.

9 Groundwater

9-1 At least 12 months prior to commencement of groundwater abstraction from any alternative borefield which may supply water for the proposal and/or dewatering, the proponent shall provide the results of relevant hydrogeological investigations to the Department of Environment and the Water and Rivers Commission.

10 Mine Rehabilitation and Closure

10-1 The proponent shall rehabilitate and decommission the project areas in accordance with the Preliminary Rehabilitation and Closure Management Plan in the Public Environmental Review document (Appendix G, Hamersley Iron 2005), or subsequent revisions of the Plan.

Note: In the preparation of advice to the Minister for the Environment, the Environmental Protection Authority expects the proponent to obtain the advice of the Department of Industry and Resources, the Department of Conservation and Land Management and the Water and Rivers Commission.

10-2 The proponent shall review and revise the Preliminary Rehabilitation and Closure Management Plan at intervals not exceeding five years, with the first revision submitted to the Department of Environment within five years following commissioning of the mine.

The objective of this plan is to ensure that closure planning and rehabilitation are carried out in a coordinated, progressive manner and are integrated with development planning, consistent with the Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia *Strategic Framework for Mine Closure* (2000), current best practice, and the agreed land uses.

Each revision of the Preliminary Rehabilitation and Closure Management Plan shall set out procedures and measures to:

1. manage over the long term ground and surface water systems affected by the open pits and waste rock dumps;

2. progressively rehabilitate all disturbed mine and infrastructure corridor areas to stable landforms with cover of resilient, self-sustaining vegetation comprised of local provenance species as established by measurable criteria based on site survey data;
3. backfill the pits to minimise impacts on groundwater quality, subterranean fauna and surface drainage patterns, and to encourage appropriate revegetation;
4. identify contaminated areas, including provision of evidence of notification and propose management measures to relevant statutory authorities; and
5. develop management strategies and/or contingency measures in the event that operational experience and/or monitoring indicate that a closure objective is unlikely to be achieved.

10-3 The proponent shall make revisions of the Preliminary Rehabilitation and Closure Management Plan required by condition 10-2 publicly available.

Notes

1. Where a condition states "on advice of the Environmental Protection Authority", the Environmental Protection Authority will provide that advice to the Department of Environment for the preparation of written notice to the proponent.

2. The Environmental Protection Authority may seek advice from other agencies or organisations, as required, in order to provide its advice to the Department of Environment.

3. The Minister for the Environment will determine any dispute between the proponent and the Environmental Protection Authority or the Department of Environment over the fulfilment of the requirements of the conditions.

4. The proponent is required to apply for a Works Approval and Licence for this project under the provisions of Part V of the *Environmental Protection Act 1986*.

HON MARK McGOWAN MLA
MINISTER FOR THE ENVIRONMENT;
RACING AND GAMING

24 MAR 2006

Schedule 1

The Proposal (Assessment No. 1543)

The proposal is to construct and operate an open-cut iron ore mine in the Central Pilbara, approximately 60 km west-north-west of Tom Price and 25 km south-west of the existing Brockman 2 mine, as shown in Figure 1 (attached). The project footprint will disturb approximately 2 470 ha of native vegetation, as shown in Figure 2 (attached). The processing plant will produce a nominal capacity of 20 Mt/pa of ore.

The proposal also includes:

- three new mine pits;
- a dry processing plant;
- associated mine infrastructure;
- an extension to the existing Brockman 2 rail spur; and
- a power transmission line.

The main characteristics of the proposal are summarised in Table 1 below.

Table 1 - Key Proposal Characteristics

Element	Description
General	
Project life	Estimated 30 years
Area of disturbance	Approximately 2,470 ha
Potential ore reserves	600 Mt high-grade (>60% Fe) 280 Mt low-grade (>50% Fe)
Mining rate	Minimum 20 Mt/pa
Waste rock	420 Mt (approx 150 Mt of which will be used to backfill pits)
Greenhouse gas emissions	5.59 kg CO_{2e} per tonne of production per annum.
Mine and mining	
Pits and ore type	Three pits with high phosphorus Brockman ore. The deposit extends approximately 14 km in length, is 1 km wide and averages 150 m deep.
Ore below water table	Approximately 20% of total ore (variable between each pit)
Stripping ratio	Ranges from 0.5:1 to 1.5:1 waste to ore depending on processing and stockpile strategies (average 1.2:1)
Waste rock disposal	Surface dumps until mined-out pit voids become available, then backfilled to above pre-mine water table.

Element	Description
Dewatering	
	Dewatering required to access ore from below the water table.
Infrastructure	
Water Supply	6,200 kL/d (plus additional 300 kL/d for the mine camp). Supplied from the Orebody and Wittenoom Dolomite aquifers. Boolgeeda borefield as an additional source via pipeline along infrastructure corridor.
Power Supply	13.5 MW supplied from the Dampier – Tom Price 220 kV transmission system via a 66 kV sub-transmission system. Power lines will approach the mine within the infrastructure corridor.
Processing Plant	A dry plant with a crushing and screening circuit for 20 Mt/pa of ore.
Product transport	By rail via a 35 km long rail spur from the project area to Brockman 2 mine, then along the existing Brockman 2 rail spur and main railway to port.
Airstrip	Approximately 2 000 m airstrip
Workforce	
Construction Operation	Peak of 700 300 (plus approximately 40 during periodic shutdown maintenance periods).
Accommodation	A permanent village and contractor's camp, plus small rail spur camps.

Abbreviations
e – equivalent
Fe – iron
ha – hectare
km – kilometre
kL/d – kilolitres per day
kV – kilo volts
m – metres
Mt – mega tonnes
Mt/pa – mega tonnes per annum
MW – mega watts

Figures (attached)

Figure 1 - Site location
Figure 2 - Site layout

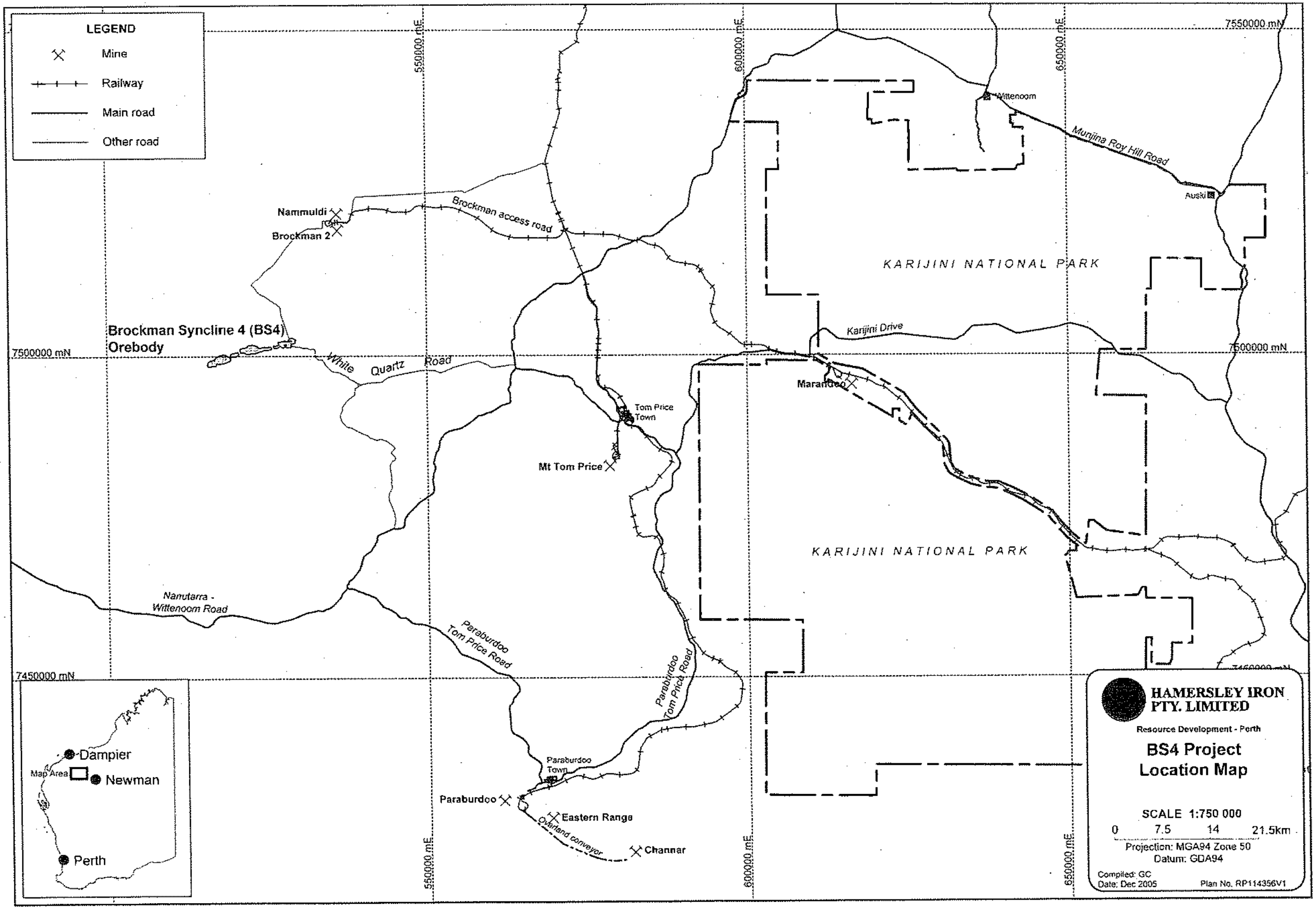


Figure 1: Site location of BS4 project area

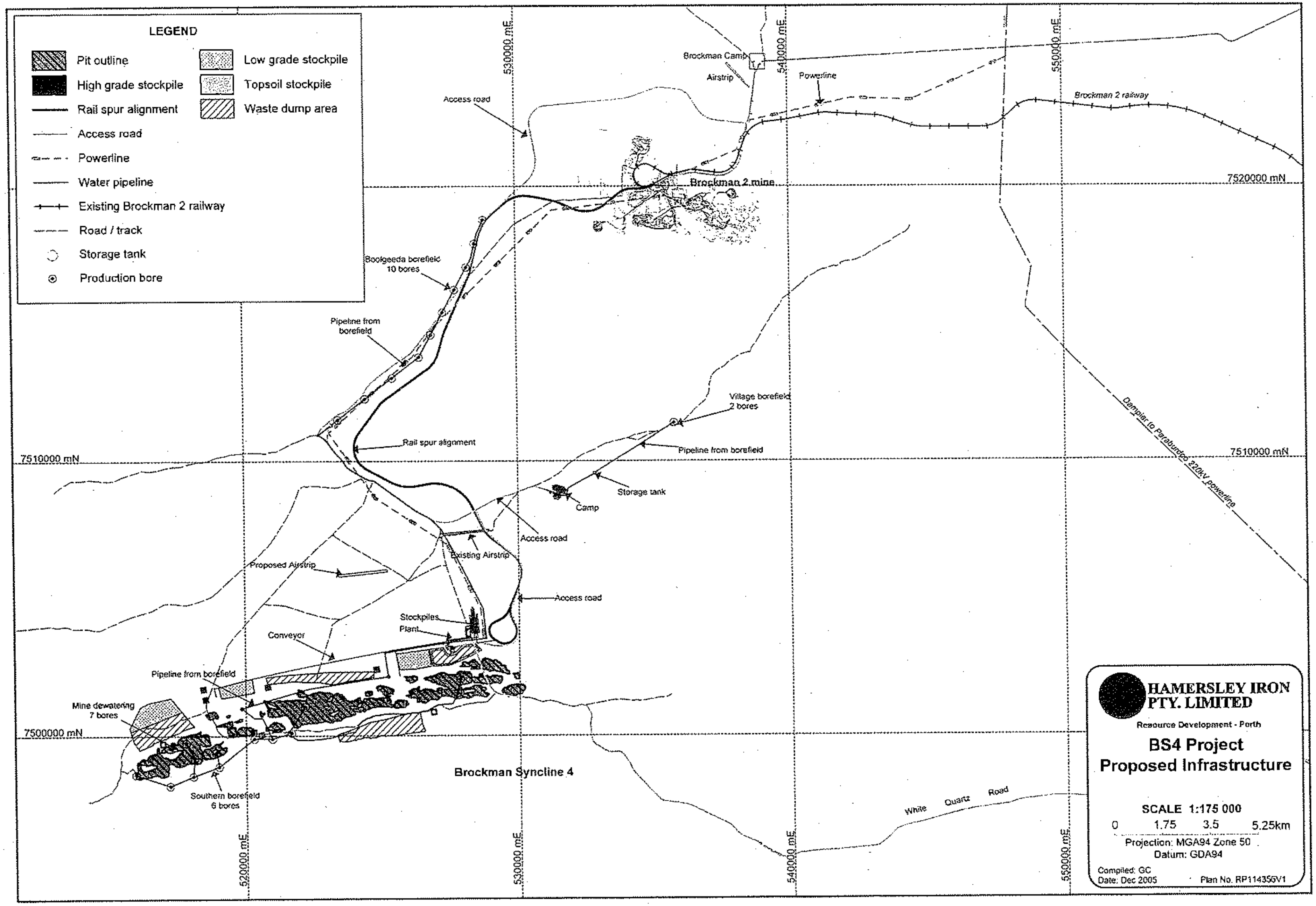


Figure 2: Site layout of BS4 mine

Schedule 2

Proponent's Environmental Management Commitments

January 2006

BROCKMAN SYNCLINE 4 IRON ORE PROJECT
60 KM WEST-NORTH-WEST OF TOM PRICE
SHIRE OF ASHBURTON

(Assessment No. 1543)

HAMERSLEY IRON PTY LIMITED

Schedule 2

Proponent's Environmental Management Commitments

Brockman Syncline 4 Iron Ore Project, 60 km West-North-West of Tom Price, Shire of Ashburton (Assessment No. 1543)

Topic	Objective	Commitments	Timing	Advice
Environmental Management Plan (EMP)	Manage environmental impacts of the BS4 Project.	1. Prepare separate EMP's for construction and operation of the BS4 Project which address relevant environmental issues, including: 1. Flora (including Priority sp.); 2. Fauna (including stygofauna); 3. Weeds; 4. Topsoil; 5. Fire; 6. Dust; 7. Noise; 8. Waste (non-mineral and mineralised waste); 9. Hydrocarbons; 10. Water (surface and groundwater); 11. Acid rock drainage; 12. Greenhouse gases; 13. Rehabilitation; 14. Aboriginal heritage; and 15. Monitoring, reporting and auditing processes	Prior to construction and operation.	CALM

Topic	Objective	Commitments	Timing	Advice
Priority Flora	Re-establishment of Priority flora species in rehabilitation areas.	2. Collect seed from existing Priority flora species in the BS4 project area for use in rehabilitation to re-establish Priority flora species. 3. Conduct research into the re-establishment of Priority flora species in rehabilitation areas.	During operations	CALM
Land Snails	Gain further information on the distribution and population diversity of land snails found in the Project area.	4. Fund a taxonomic, biogeographic and genetic study on *Rhagada* sp. land snails found in the BS4 Project area.	Within six months of commissioning.	CALM
Stygofauna	Identify and manage any subterranean fauna found within the BS4 project area.	5. Install sampling bores, incorporating slotted casing suitable for stygofauna sampling at alluvial creek systems in the valley north of the BS4 area (ie. Proposed Boolgeeda borefield). 6. In the event that results from sampling of the bores referred to in commitment 4 indicate that stygofauna will be impacted by the BS4 project, prepare a Subterranean Fauna Management Plan. 7. Make the plan prepared in commitment 6 publicly available.	Prior to ground disturbance.	CALM
Stygofauna	Sampling and study.	8. Incorporate the BS4 Project into the Hamersley Iron stygofauna research program. 9. Collate results of the BS4 stygofauna sampling with other studies on the distribution and ecology of Pilbara stygofauna by BHP Billiton Iron Ore and the Western Australian Museum.	During operations phase.	

Topic	Objective	Commitments	Timing	Advice
Groundwater Quality	Prevent the formation of pit lakes derived from groundwater.	10. Backfill mined-out pits to above pre-mine water table levels.	Ongoing during operations phase, closure and decommissioning.	DoIR
Groundwater Resources	Sustainable management of borefields.	11. Prepare a Borefield Management Plan incorporating a Water Operating Strategy which includes a monitoring program. 12. Make the plan prepared under commitment 9 publicly available.	Prior to groundwater abstraction.	WRC
Rail Spur Drainage	Ensure rail spur drainage design appropriate.	13. Consult with CALM on detailed design plans for rail spur drainage.	Prior to construction.	CALM
Aboriginal Heritage	Protect/manage Aboriginal heritage sites in accordance with the *Aboriginal Heritage Act 1972*.	14. Complete Aboriginal heritage surveys of all areas not yet surveyed within the BS4 Project area, and avoid any Aboriginal heritage sites identified where practicable.	Pre-construction.	Aboriginal Groups, DIA

Abbreviations

CALM – Department of Conservation and Land Management
DoIR – Department of Industry and Resources
DIA – Department of Indigenous Affairs
WRC – Water and Rivers Commission

Attachment 1 to Statement 717

Change to Proposal

Proposal: Brockman Syncline 4 Iron Ore Project, 60 km West-north-west of Tom Price, Shire of Ashburton

Proponent: Pilbara Iron (on behalf of Hamersley Iron Pty. Limited).

Change: Redesign of approved mine site layout – plant, administration office, workshops, stacker reclaimer stockpiles, village, camp, waste dumps and stockpiles. Redesign of the rail spur. An increase in throughput from 20 to 22 Megatonnes per year. An increase in water usage. The bitumen sealing of White Quartz Road. Removal of the conveyor and airstrip.

Features of previously approved Proposal, as presented in Schedule 1 or the Public Environmental Review:

Element	**Quantities/Description**
Mining Rate	20 Megatonnes per year.
Water Supply	6,200 kL/d (plus additional 300 kL/d for the mine camp). Supplied from the Orebody and Wittenoom Dolomite aquifers. Boolgeeda borefield as an additional source via pipeline along infrastructure corridor.
Processing Plant	A dry plant with a crushing and screening circuit for 20 Megatonnes per year of ore.
Rail Spur	300 ~~hectare footprint.~~
Plant, Administration, Workshops, and Stockpiles – location	As shown in figure 2 of statement 717.
Village and Camp - Operational village capacity - Construction village capacity - Location	 350 rooms. 700. As shown in figure 2 of statement 717.
Waste Dumps, High Grade and Low Grade Stockpiles – location	As shown in figure 2 of statement 717.
Mine Access Road	Unsealed.
Airstrip	Approximately 2000 metres long.

Features of changed Proposal:

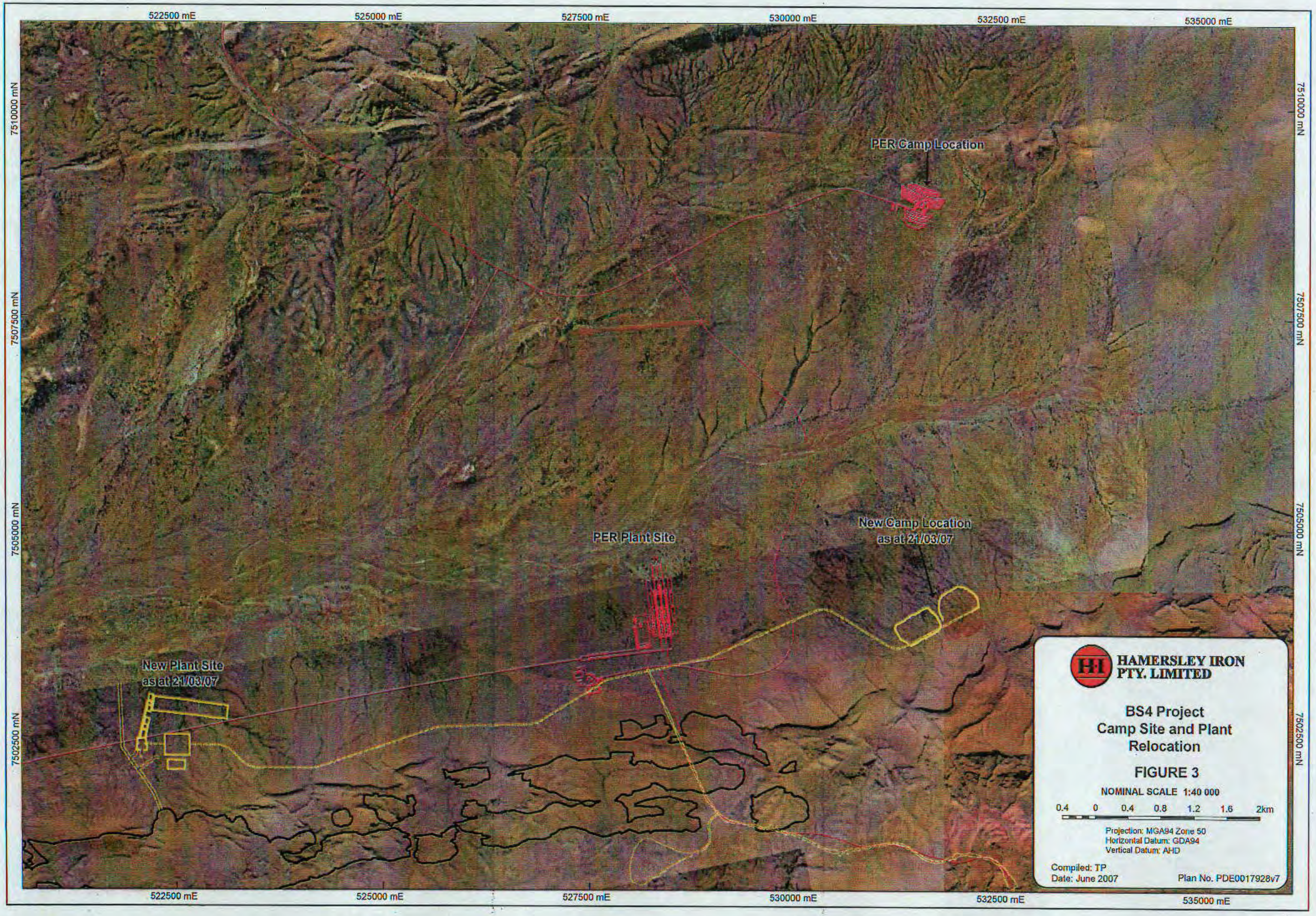
Element	Quantities/Description
Mining Rate	22 Megatonnes per year.
Water Supply	8,000 kL/d (plus additional 300 kL/d for the mine camp). Supplied from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor.
Processing Plant	A dry plant with a crushing and screening circuit for 22 Megatonnes per year of ore.
Rail Spur	330 hectare footprint (See figures 1a and 1b).
Plant, Administration, Workshops, and Stockpiles – location	More central position in relation to the mine pits (See figures 1a and 3).
Village and Camp - Operational village capacity - Construction village capacity - Location	 450 rooms. 850 plus a contingency in design for the potential addition of 150. See figure 3.
Waste Dumps, High Grade and Low Grade Stockpiles – location	As shown in figure 1a.
Mine access road	Bitumen sealed.
Airstrip	Not required - deleted from proposal.

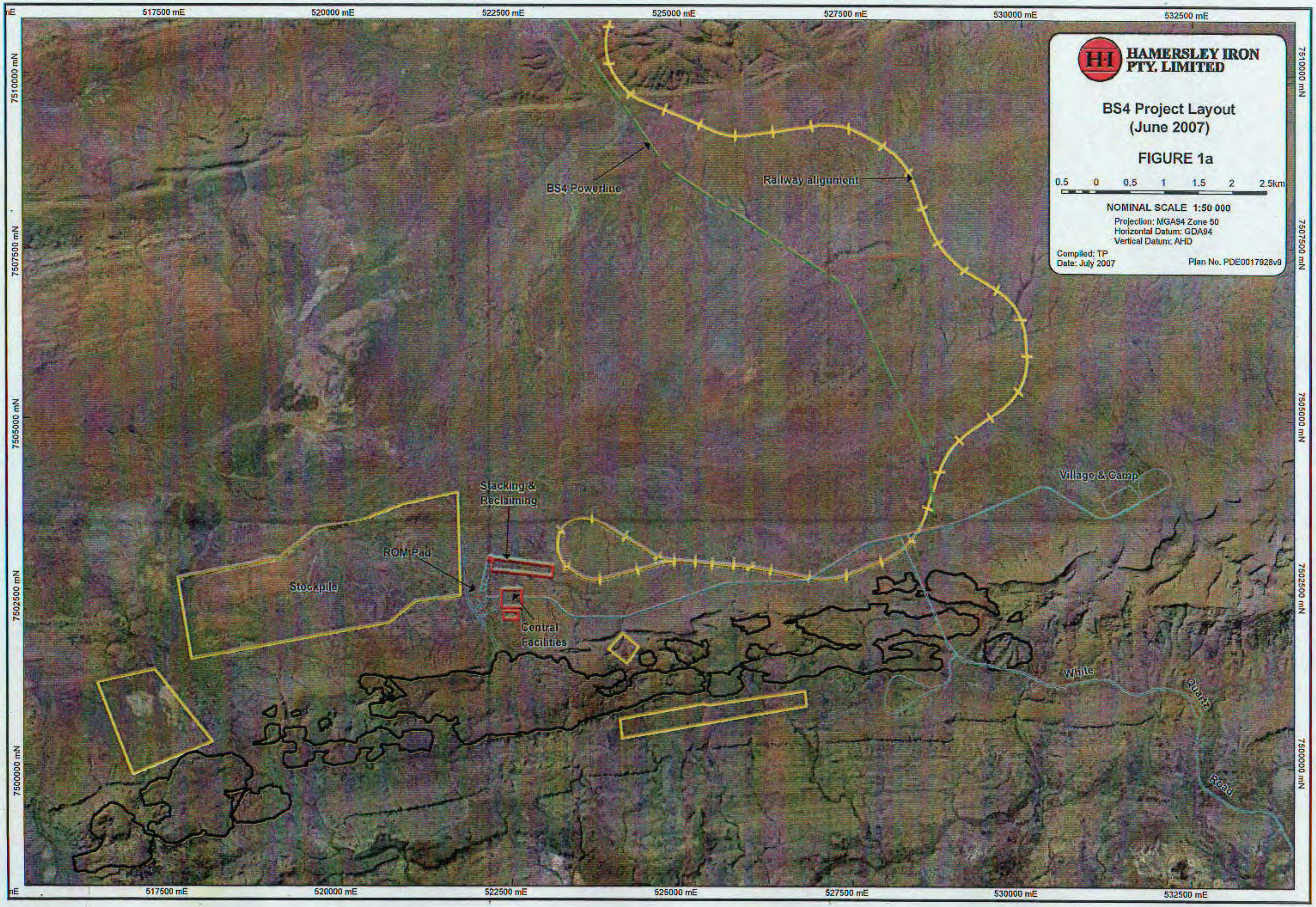
Figures (attached)
Figures 1a and 1b – BS4 Project Layout (June 2007).
Figure 2 – Site Layout of BS4 Mine (Statement 717).
Figure 3 – BS4 Project – Camp Site and Plant Relocation (June 2007).

Approved under delegation
from the Minister for the Environment:

EPA Chairman

Approval Date: 19 SEP 2007


522500 mE
525000 mE
527500 mE
530000 mE
532500 mE
535000 mE
7510000 mN
7507500 mN
7505000 mN
7502500 mN
PER Camp Location
PER Plant Site
New Camp Location
as at 21/03/07
New Plant Site
as at 21/03/07
HAMERSLEY IRON
PTY. LIMITED
BS4 Project
Camp Site and Plant
Relocation
FIGURE 3
NOMINAL SCALE 1:40 000
0.4 0 0.4 0.8 1.2 1.6 2km
Projection: MGA94 Zone 50
Horizontal Datum: GDA94
Vertical Datum: AHD
Compiled: TP
Date: June 2007
Plan No. PDE0017928v7


HAMERSLEY IRON PTY. LIMITED
BS4 Project Layout
(June 2007)
FIGURE 1a
0.5 0 0.5 1 1.5 2 2.5km
NOMINAL SCALE 1:50 000
Projection: MGA94 Zone 50
Horizontal Datum: GDA94
Vertical Datum: AHD
Compiled: TP
Date: July 2007
Plan No. PDE0017928v9
BS4 Powerline
Railway alignment
Village & Camp
Stacking & Reclaiming
ROM Pad
Stockpile
Central Facilities
White Quartz Road
517500 mE
520000 mE
522500 mE
525000 mE
527500 mE
530000 mE
532500 mE
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7502500 mN
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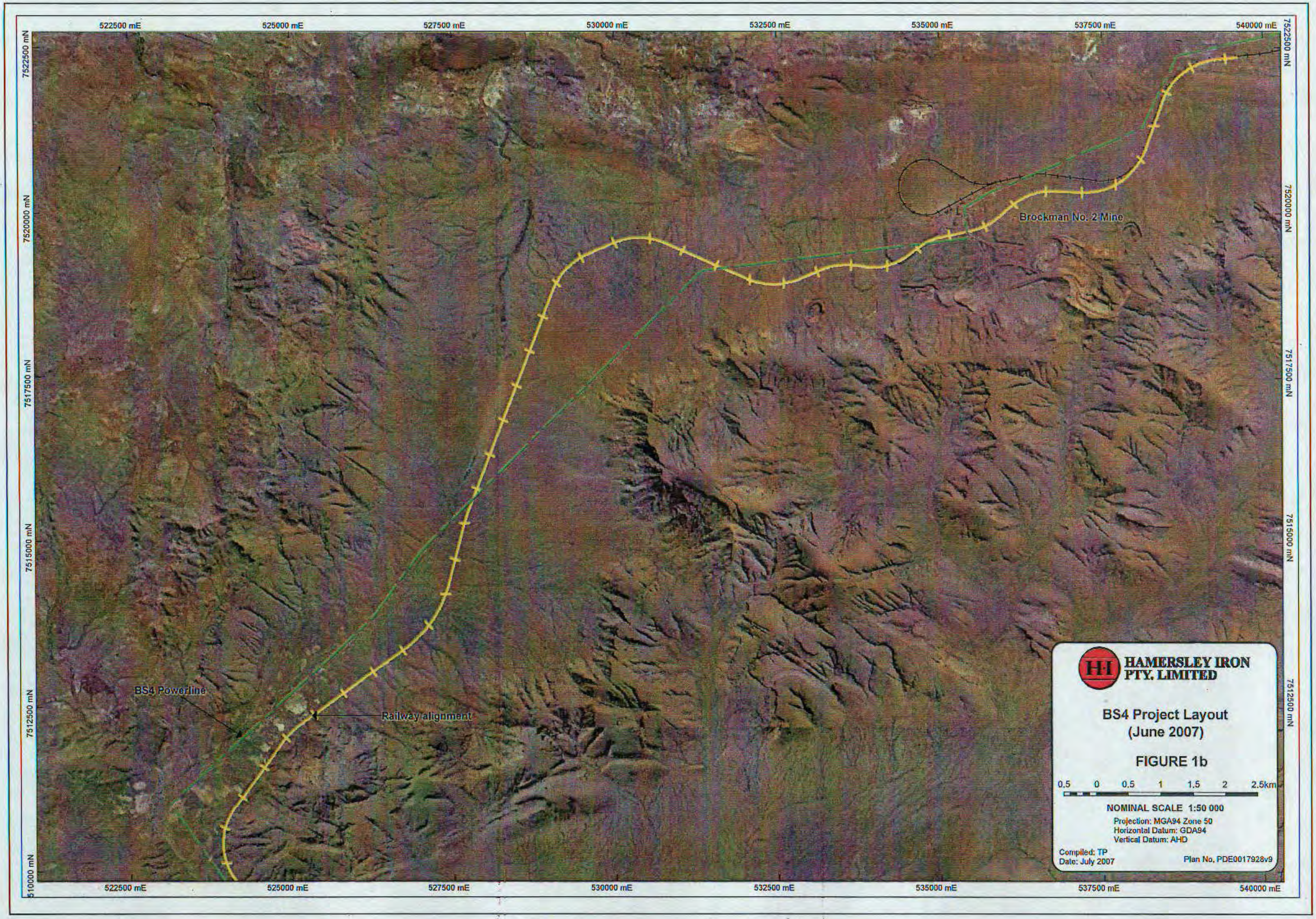

522500 mE
525000 mE
527500 mE
530000 mE
532500 mE
535000 mE
537500 mE
540000 mE
7522500 mN
7520000 mN
7517500 mN
7515000 mN
7512500 mN
7510000 mN
Brockman No. 2 Mine
BS4 Powerline
Railway alignment
HAMERSLEY IRON PTY. LIMITED
BS4 Project Layout
(June 2007)
FIGURE 1b
0.5 0 0.5 1 1.5 2 2.5km
NOMINAL SCALE 1:50 000
Projection: MGA94 Zone 50
Horizontal Datum: GDA94
Vertical Datum: AHD
Compiled: TP
Date: July 2007
Plan No. PDE0017928v9

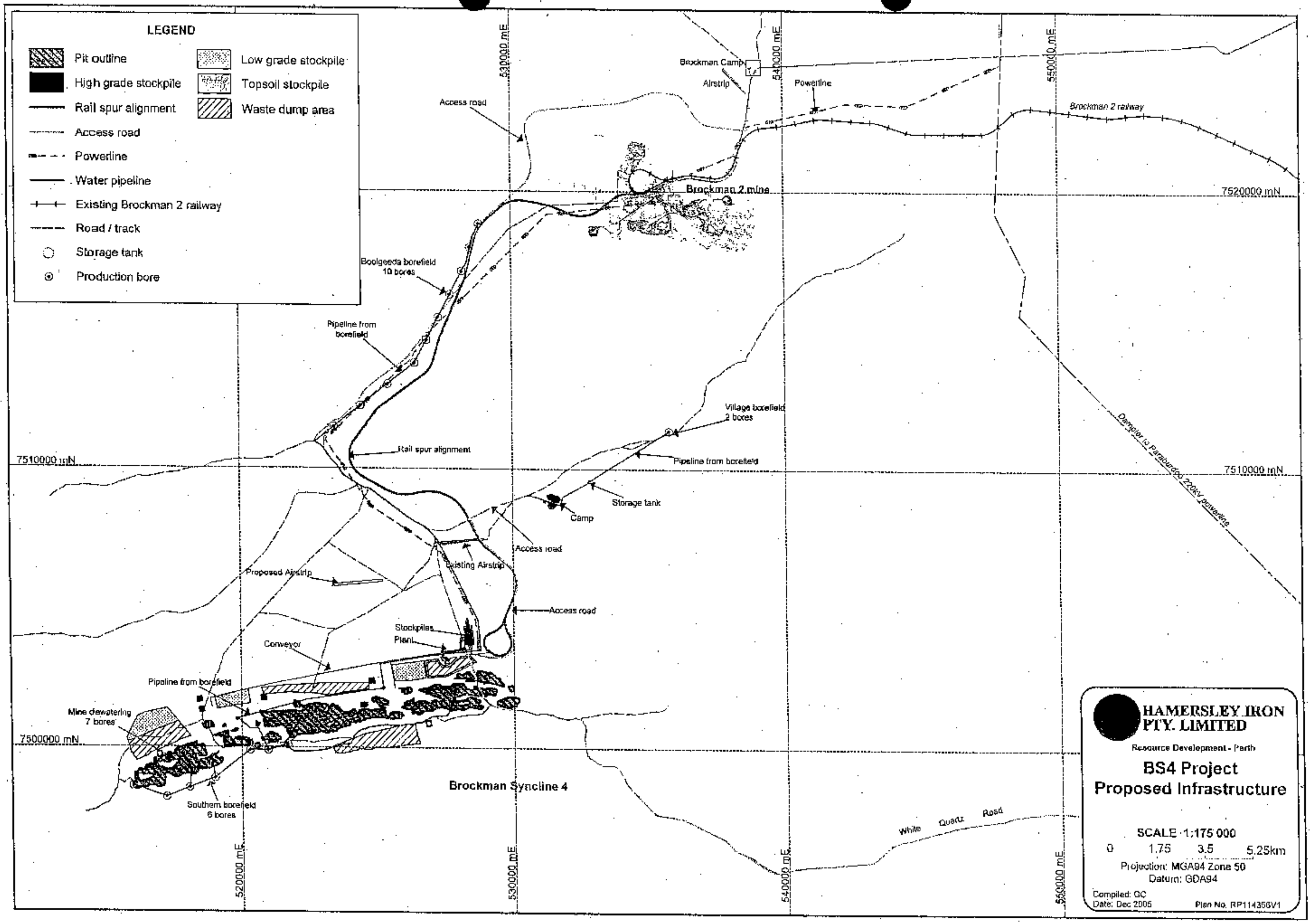


Figure 2: Site layout of BS4 mine

Attachment 2 to Statement 717

Change to Proposal

Proposal: **Broekman Syncline 4 Iron Ore Project, 60 Km West-north-west of Tom Price, Shire of Ashburton**

Proponent: Hamersley Iron Pty Limited

Changes: To change the route of the power line at its southern end to diverge from the rail infrastructure corridor and follow the Boolgeeda Valley and to change the power line capacity to 25 MW, operating at 33kV

Amendment of Schedule 1 – Key Proposal Characteristics

Features of previously approved Proposal:

Element	**Description**
Infrastructure	
Power Supply	13.5 MW supplied from the Dampier – Tom Price 220 kV transmission system via a 66 kV sub-transmission system. Power lines will approach the mine within the infrastructure corridor.

Abbreviations:

kV – kilo volts
MW – mega watts

Figure 2

Features of changed Proposal:

Element	Description
Infrastructure	
Power Supply	25 MW supplied from the Dampier – Tom Price 220 kV transmission system via a 33 kV sub-transmission system. Power lines will approach the mine within the infrastructure corridor, except at the southern end where the route diverges from the infrastructure corridor (Figure 4).

Abbreviations:

kV – kilo volts
MW – mega watts

Figure 4: Change to power line corridor route (route supersedes that shown in Figure 2 of statement 717 and Figure 1a of Attachment 1 to statement 717)

Approved under delegation
from Minister for the Environment:

Approval Date: 22-9-08

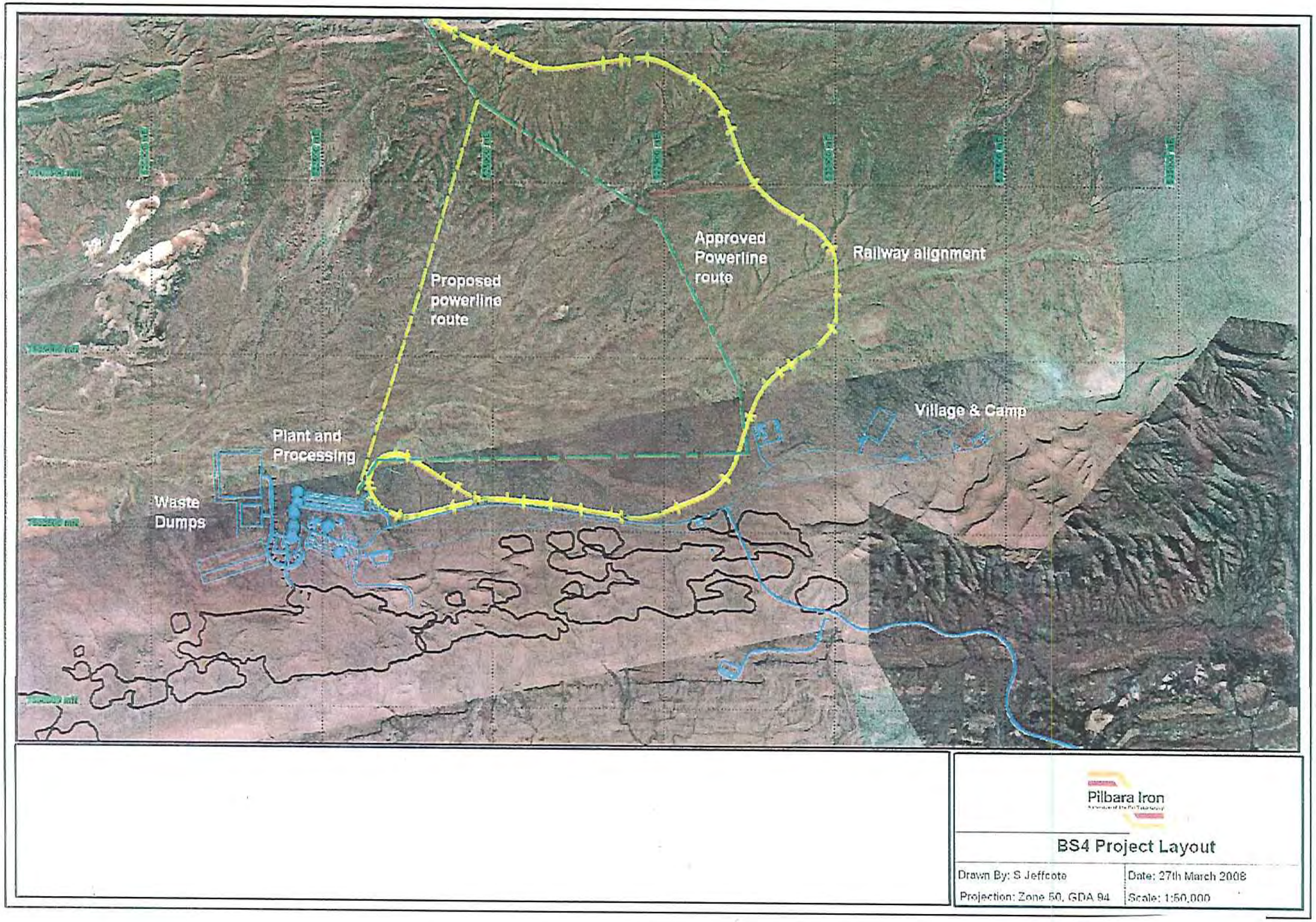


Figure 4: Change to power line corridor route (shown by yellow dash line)

Attachment 3 to Statement 717

Change to Proposal

Proposal: Brockman Syncline 4 Iron Ore Project, 60 km West-north-west of Tom Price, Shire of Ashburton

Proponent: Pilbara Iron (on behalf of Hamersley Iron Pty. Limited).

Change: An increase in throughput from 22 to 42 Megatonnes per year. Increase in waste dump height and additional locations. Plant, crusher, stockpiles, and camp and village. An increase in water usage. Mine access road. Product transport route.

Features of previously approved Proposal, as presented in Schedule 1

Element	Quantities/Description
Mining Rate	22 Megatonnes per year.
Water Supply	8,000 kL/d (plus additional 300 kL/d for the mine camp). Supplied from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor.
Processing Plant	A dry plant with a crushing and screening circuit for 20 Megatonnes per year of ore.
Product Transport	By rail via a 35 km long rail spur from the project area to Brockman 2 mine, then along the existing Brockman 2 rail spur and the main railway to port.
Plant, Administration, Workshops, and Stockpiles – location	As shown in figure 2 of statement 717.
Village and Camp - Operational village capacity - Construction village capacity - Location	 450 rooms. 850. As shown in figure 2 of statement 717.
Waste Dumps High Grade and Low Grade Stockpiles – location	As shown in figure 2 of statement 717.
Mine Access Road	Unsealed.

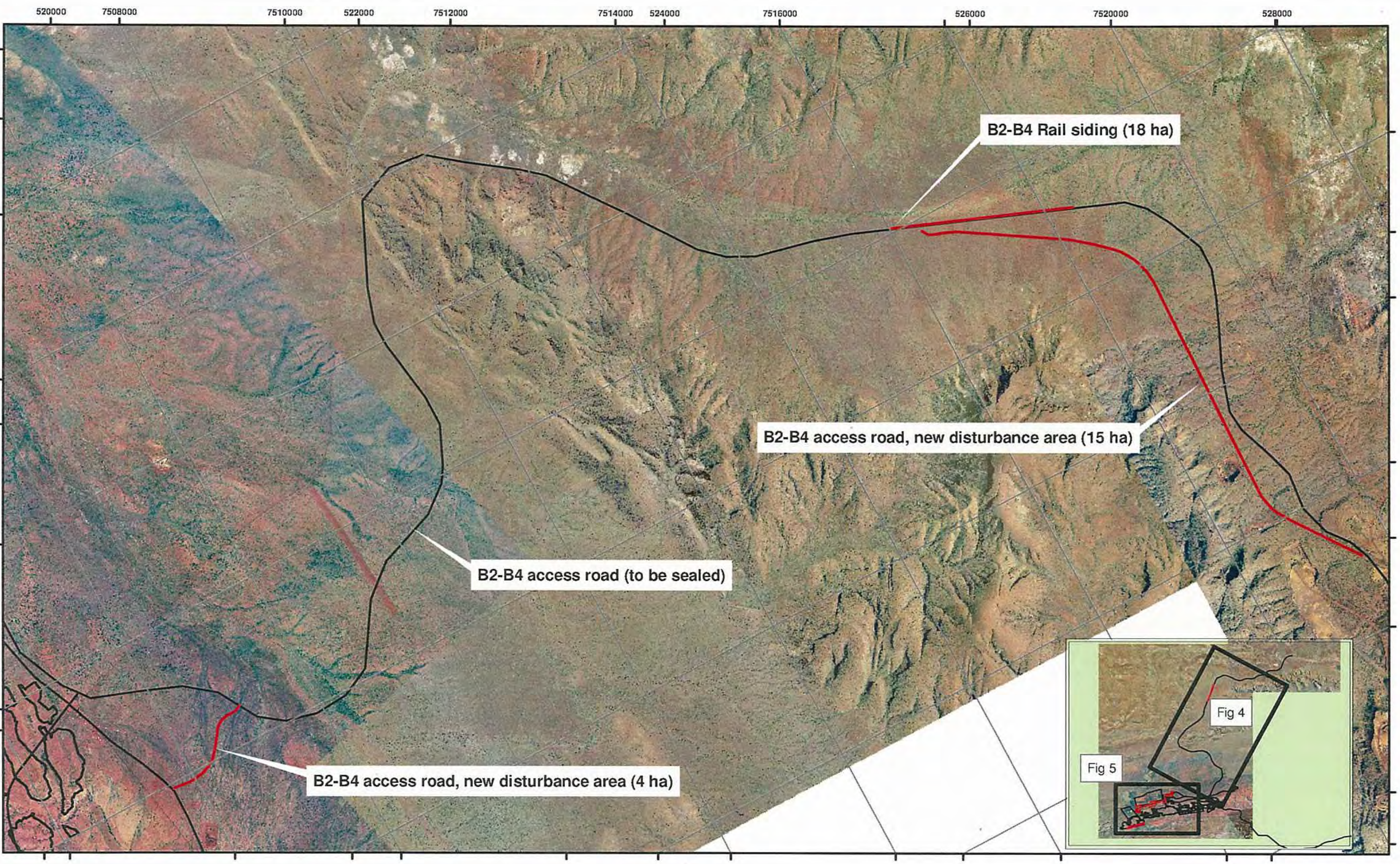
Features of changed Proposal:

Element	Quantities/Description
Mining Rate	42 Megatonnes per year.
Water Supply	Supplied from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor. 4.38GL/annum (dust management) plus additional 0.15GL/annum for the mine camp.
Processing Plant	A dry plant with a crushing and screening circuit for a total 42 Megatonnes per year of ore.
Product Transport	By rail via a 35 km long rail spur from the project area to Brockman 2 mine, then along the existing Brockman 2 rail spur and the main railway to port including rail siding earthworks between Brockman 2 and BS4.
Plant, Administration, Workshops, and Stockpiles – location	Original site as shown in figure 2 of attachment 1 and a stockpile area adjacent to rail loop as shown in figure 5 of attachment 2 in statement 717.
Village and Camp - Operational village capacity - Construction village capacity	 Total 570 rooms. Total 1350.
Waste Dumps High Grade and Low Grade Stockpiles – location Height	Original site as shown in figure 2 of attachment 1 and a stockpile area adjacent to rail loop as shown in figure 5 of attachment 2 in statement 717. Height of waste dumps to be total height of 50 m.
Mine access road	Construction of a sealed access road from BS2 that will mostly be provided by bitumen sealing of the approved BS4 infrastructure corridor service road (no additional footprint); some deviations from the approved track are required and these will create additional footprint.

Figures (attached)
Figure 4-5 – Site Layout of BS4 Mine (Proposed changes)

Approved under delegation
from the Minister for the Environment

Approval Date: 17.12.08.



strategen

Fig 4 Approved mine layout and proposed changes

Horizontal Datum: GDA 94 | Projection: MGA Zone 50

Date: 11/06/08 1:50,000 at A3 | Author: JM | Note that positional errors may occur in some areas | Source: Pilbara Iron Pty Ltd

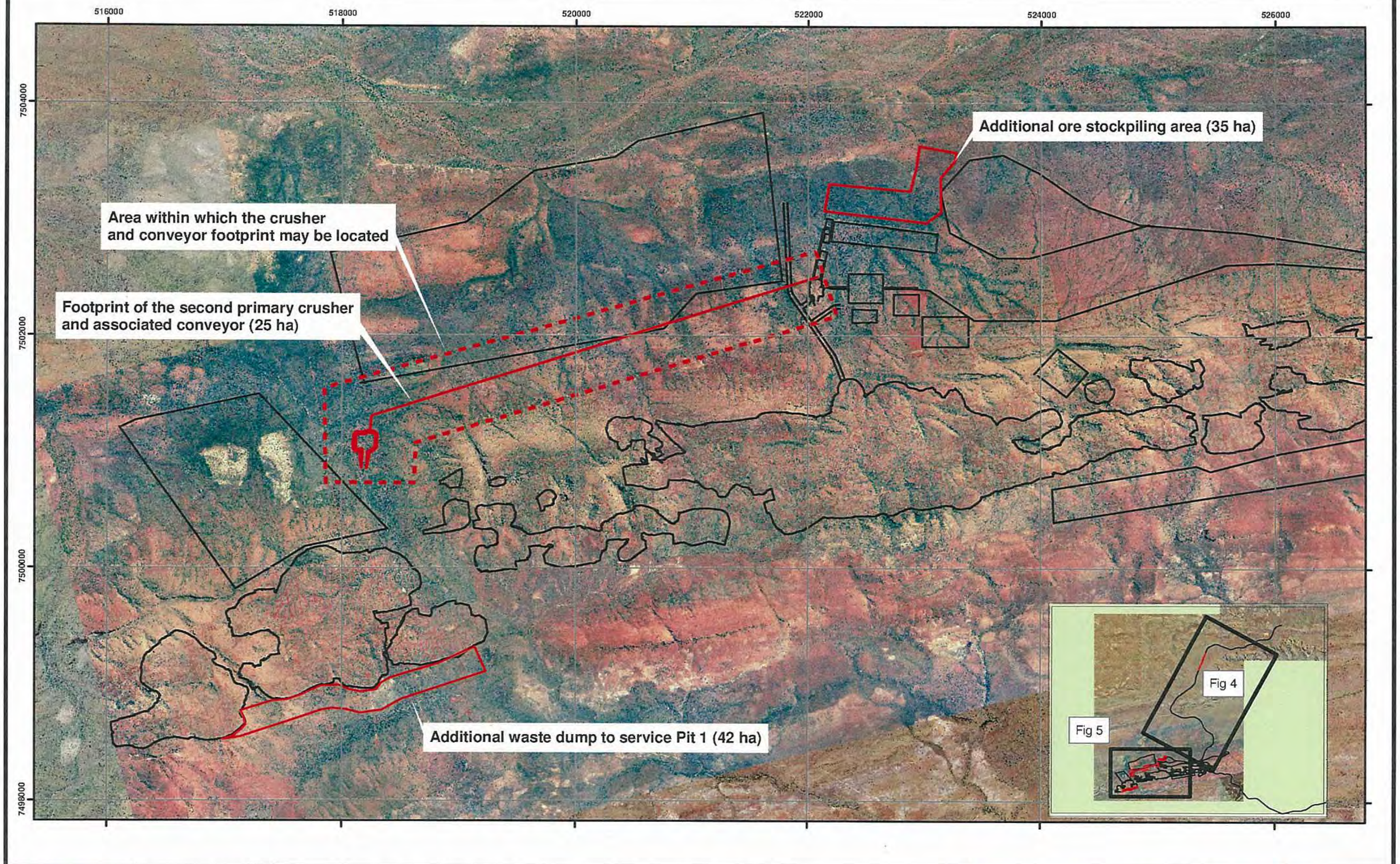


Figure 5 Proposed changes to BS4 mine

— Approved (notification) mine layout

— Proposed changes

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Horizontal Datum: GDA 94 | Projection: MGA Zone 50

Date: 11/06/08 1:30,000 at A3 | Author: JM | Note that positional errors may occur in some areas | Source: Pilbara Iron Pty Ltd

File Location: C:\GIS\Consult\xxdata for entry\2008\PIR - Pilbara Iron\PIR08035.01\Arcmap documents

Appendix 3 - PROPPOSED ENVIRONMENTAL CONDITIONS

Revised Brockman Syncline 4 Iron Ore Project

Proposal: The proposal the Brockman Syncline 4 Iron Ore Project which is located approximately 60 km west-north-west of Tom Price in the Central Pilbara.

The proposal is further documented in Schedule 1 of this statement.

Proponent: Hamersley Iron Pty. Limited

Australian Company Number: 004558276

Proponent Address: Level 22

152-158 St George's Terrace

PERTH WA 6000

Assessment Number: xxxx

Previous Assessment Number: 1543

Report of the Environmental Protection Authority Number: xxxx

Previous Report of the Environmental Protection Authority Number: 1214

Previous Statement Number: 717 (Published 24 March 2006)

The implementation conditions of this Statement supersede the implementation conditions of Statement 717 in accordance with section 45B of the *Environmental Protection Act 1986*. The proposal referred to in the above report of the Environmental Protection Authority may be implemented. The implementation of this proposal is subject to the following implementation conditions and procedures, unless specifically stated otherwise within this Statement, and Schedule 1 details definitions of terms and phrases used in the implementation conditions and procedures.

Published on:

1. Proposal Implementation

1-1 When implementing the proposal, the proponent shall not exceed the authorised extent of the proposal as defined in Column 3 of Table 2 in Schedule 1, unless amendments to the proposal and the authorised extent of the proposal have been approved under the EP Act.

2. Contact Details

2-1 The proponent shall notify the CEO of any change of its name, physical address or postal address for the serving of notices or other correspondence within 28 days of such change. Where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State.

3. Compliance Reporting

3-1 The proponent shall prepare and maintain a compliance assessment plan to the satisfaction of the CEO.

3-2 The proponent shall submit to the CEO the compliance assessment plan required by Condition 3-1 at least six months prior to the first compliance assessment report required by Condition 3-6, or prior to implementation, whichever is sooner.

The compliance assessment plan shall indicate:

(1) the frequency of the compliance reporting;

(2) the approach and timing of compliance assessments;

(3) the retention of compliance assessments;

(4) the method of reporting of potential non-compliances and corrective actions taken;

(5) the table of contents of compliance assessment reports; and

(6) public availability of compliance assessment reports.

3-3 The proponent shall assess compliance with conditions in accordance with the compliance assessment plan required by Condition 3-1.

3-4 The proponent shall retain reports of all compliance assessments described in the compliance assessment plan required by Condition 3-1 and shall make those reports available when requested by the CEO.

3-5 The proponent shall advise the CEO of any potential non-compliance within seven days of that non-compliance being known.

3-6 The proponent shall submit to the CEO a compliance assessment report by 30 April each year addressing compliance of the previous calendar year. The first compliance assessment report shall be submitted by 30 April 2015 addressing compliance for the previous calendar year and shall replace the compliance assessment report required for Statement 717.

The compliance assessment report shall:

(1) be endorsed by the proponents Managing Director/General Manager/Chief Executive Officer or a person delegated to sign on the Managing Director's/General Manager's/Chief Executive Officer's behalf;

(2) include a statement as to whether the proponent has complied with the conditions;

(3) identify all potential non-compliances and describe corrective and preventative actions taken;

(4) be made publically available in accordance with the approved compliance assessment plan; and

(5) indicate any proposed changes to the compliance assessment plan required by Condition 3-1.

4. Public Availability of Data

4-1 Subject to Condition 4-2, within a reasonable time period approved by the CEO of the issue of this statement and for the remainder of the life of the proposal the proponent shall make publically available, in a manner approved by the CEO, all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products {e.g. maps}) relevant to the assessment of this proposal and implementation of this statement.

4-2 If any data referred to in Condition 4-1 contains particulars of:

(1) A secret formula or process; or

(2) Confidential commercially sensitive information;

the proponent may submit a request for approval from the CEO to not make the data publically available. In making such a request the proponent shall provide the CEO with an explanation and reasons why the data should not be made publically available.

5. Surface Water Discharge (Protection of Boolgeeda Creek)

5-1 The proponent shall ensure that the discharge of surplus water from the Brockman Syncline 4 Iron Ore Project as a result of mining does not cause unacceptable long term impacts on the receiving environment.

5-2 To verify that Condition 5-1 is being met, the proponent shall develop a high level environmental and conservation values statement for Boolgeeda Creek to the satisfaction of the CEO.

5-3 Prior to discharging water from the Brockman Syncline 4 Iron Ore Project, the proponent shall develop a Water Discharge Management and Monitoring Plan in consultation with the DoW, to the satisfaction of the CEO, to ensure that the environmental and conservation values associated with Boolgeeda Creek are maintained.

This plan will describe the water discharge management and monitoring program and actions to be implemented should monitoring indicate Condition 5-1 may not be met.

5-4 The proponent shall implement the Water Discharge Management and Monitoring Plan from the commencement of discharge of excess water from the Brockman Syncline 4 Iron Ore Project until such time as approved by the CEO of the OEPA.

6. Decommissioning and Closure

6-1 The proponent shall implement the Brockman Syncline 4 Mine Closure Plan in accordance with the *Guidelines for Preparing Mine Closure Plans*, June 2011 and any updates, to the requirements of the CEO on advice of the Department of Mines and Petroleum.

6-2 The proponent shall ensure that closure planning and rehabilitation for Brockman Syncline 4 is carried out in a coordinated progressive manner and is integrated into relevant business processes, consistent with current best practice and the agreed land uses.

6-3 The Mine Closure Plan required by Condition 6-1 shall set out procedures to:

(1) manage long term hydrogeological impacts of mining Brockman iron ore deposits;

(2) model the long-term hydrogeological impacts, particularly the water levels and quality downstream of waste material landforms;

(3) identify pits to be backfilled;

(4) progressively rehabilitate available disturbed areas to a standard suitable for the agreed end land use (s), with consideration of:

a) the characteristics of the pre-mining ecosystems within the project area (through baseline surveys);

b) the performance of previously rehabilitated areas within the mining lease;

c) the performance of rehabilitation areas at the proponent's other operations in the Pilbara; and

d) best practice rehabilitation techniques used elsewhere in the mining industry.

(5) develop closure objectives and corresponding indicative completion criteria for these objectives;

(6) monitor rehabilitation to assess the performance of all rehabilitated areas against the completion criteria;

(7) report on rehabilitation and monitoring results;

(8) develop management strategies and/or contingency measures in the event that operational experience and/or monitoring identify any significant environmental impact as a result of the proposal;

(9) manage mineral waste including physical characteristics and acid or neutral metalliferous drainage using national and international standards and updates; and

(10) close the mine in a manner which does not result in unacceptable liability to the State.

6-4 The proponent shall review and revise the Mine Closure Plan required by Condition 6-1 at intervals not exceeding six years.

Table 1: Summary of the Proposal

Proposal title	Brockman Syncline 4
Short description	This proposal is a revision of the approved Brockman Syncline 4 Iron Ore Project (MS 717), located approximately 60 km west-north-west of Tom Price in the Central Pilbara. Associated infrastructure includes: • three mining areas; • dry processing plant; • associated mine infrastructure and supporting utilities; • a bitumen sealed access road from Brockman 2 to Brockman 4; • a 35 km extension to the existing Brockman 2 rail spur; The dewatering rate is increasing to 6.4GL per year over the life of the Proposal. The surplus water management will include onsite use and controlled discharge to Boolgeeda Creek.

Table 2: Location and authorised extent of physical and operational elements

Column 1	Column 2	Column 3
Physical Element	**Location**	**Authorised Extent**
Area of disturbance	See Figure 3-1 for Project Boundary and geographic coordinates in Schedule 2	Clearing of up to 3,560 ha within the Project Boundary
Pits and ore type	See Figure 3-1 for Project Boundary	Three mining areas with high phosphorus Brockman ore, the deposit averages at 150m depth. Dewatering is required to access approximately 20% of the total ore from below the water table.
Dewatering	See Figure 3-1 for Project Boundary	Dewatering from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional water source via pipeline along infrastructure corridor.
Management of surplus water	Refer to Figure 3-1 for location of discharge outlet and estimated wetting front in Boolgeeda Creek	Dewater disposal through use on site and controlled surface discharge to Boolgeeda Creek (maximum discharge limit of 6.4GL/annum).
Waste rock and dumps	See Figure 3-1 for Project Boundary	620 Mt: • approximately 150 Mt will be used to backfill pits; and • approximately 470 Mt will remain as external waste dumps within the Project Boundary.

Rio Tinto

Rio Tinto Iron Ore

Appendix 4 – Hydrological Modelled Scenario for Discharge to Boolgeeda Creek

Brockman Syncline 4

January 2014

1 MODELLING SCENARIOS

The total maximum predicted discharge to Boolgeeda Creek may approach 17.5 ML/day, although the expected average discharge into the natural watercourse will be in the region of 10-12.5ML/day.

Surplus water discharge will be released from an outlet to Boolgeeda Creek and an extra 1.4 km discharge pipe will be required to be extended from the existing B4 discharge pipe network to the proposed outlet.

The response of the creek system through a continual discharge for a range of discharge options varying from 2.5 ML/day to 20 ML/day was investigated. Discharge footprints were determined based on the assumption that steady state conditions were established.

2 MODELLING RESULTS

2.1 REACH CHARACTERISTICS

A 52 km long section of Boolgeeda Creek was modelled from the proposed discharge outlet. The creek was subdivided into three reaches with similar creek morphology, soil conditions and vegetation type and patterns. The reach locations are illustrated in Figure 2-1. Descriptions of the average reach characteristics (subsequently used in the water balance equations) and the predicted reaction of the creek to the selected discharge volumes (10 ML/day, 12.5 ML/day, 15 ML/day and 17.5 ML/day) are provided in Table 2-1, Table 2-2 and Table 2-3.

Results for all of the modelling scenarios are subsequently presented in the next section.

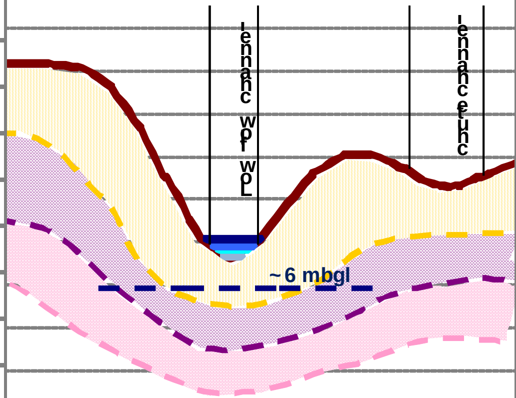
Figure 2-1: Reach locations along Boolgeeda Creek

Table 2-1: Reach 1 characteristics used for the water balance modelling and predicted response to scheduled modelled discharge to Boolgeeda Creek

Reach characteristics

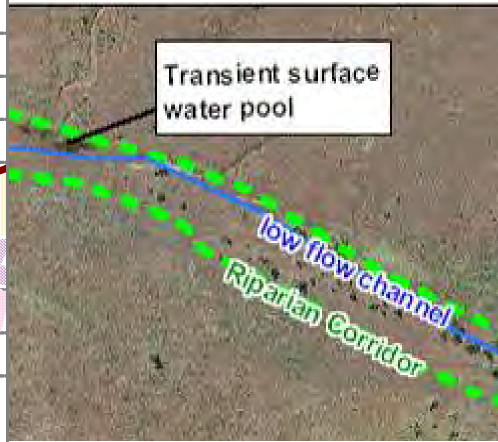
Reach length (m)	**12,508**
Low flow channel - base width (m)	13
Bed slope (m/m)	0.003
Manning's roughness	0.045
Riparian width (m)	42
Common riparian veg types	Ev; H
ET (mm/year)	530
Alluvial/colluvial depth (m)	~ 20
SW&GW interactions	Losing
Recharge rate (m/s)	1.16×10^{-9}
Limiting factor to water loss	Subsurface geology

Typical cross section



Not to scale

Riparian vegetation corridor



Flow conditions

Peak discharge	Water depth (m)	Flow width (m)	Velocity (m/s)
10ML/d $0.12\ m^3/s$	0.05	20	0.14
12.5 ML/d $0.14\ m^3/s$	0.06	21	0.15
15 ML/d $0.17\ m^3/s$	0.065	22	0.16
17.5 ML/d $0.20\ m^3/s$	0.07	23	0.17

Key

Alluvium/Colluvium
Woongara Volcanics
Boolgeeda Iron Formation
Estimated groundwater level

Modelled discharge rates:
10 ML/d
12.5 ML/d
15 ML/d
17.5 ML/d

Riparian vegetation types
Ev - *Eucalyptus victrix* (Coolibah)
H - Open herbland

Summary

Reach 1 defines the first reach of the Boolgeeda Creek, immediately downstream from the Brockman 4 discharge outlet. It is located within a wide, flat floodplain that stretches several hundred metres across and is defined by a braided, meandering creek system that is capable of changing course during a large flood event. Water will be distributed across a wide area during floods in this reach, hence reduces the average flood water levels and velocities. It potentially allows deposition of sediments along this reach. Riparian vegetation commonly found in Reach 1 includes *Eucalyptus victrix* (Coolibah) and some herb species.

The average groundwater elevation along Reach 1 was estimated to be approximately 6 m below ground level. Surface water pools can be observed from aerial photograph but they are likely to depend on rainfall, creek runoff and shallow alluvial interflow rather than groundwater. These pools are likely to be transient and accumulated water is expected to dissipate via infiltration and evaporation during dry periods.

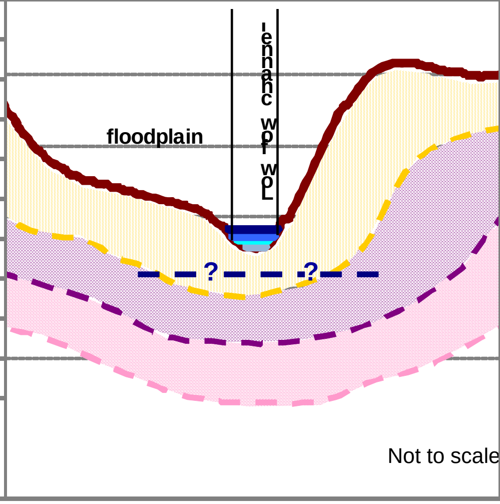
Reach 1 is recognised as a losing system and subsurface geological constraints are identified as the likely limiting factor for the volume of water lost from the system. It was determined that the bedrock units underlying Reach 1 are generally of low permeability, hence recharge into the regional groundwater system is likely to be limited, which may lead to build up of water within the alluvials and/or valley fill materials following prolong surplus water discharge.

Water released into the creek is likely to be contained within the channel.

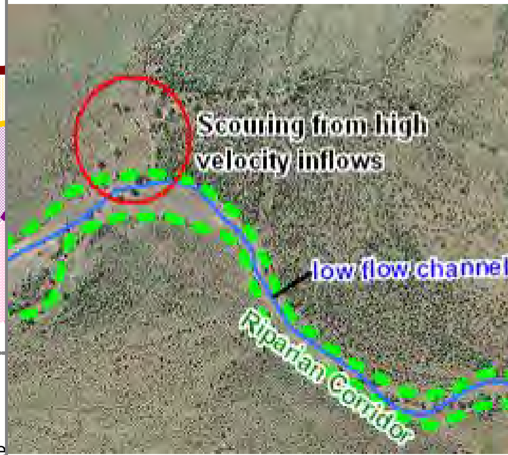
Table 2-2: Reach 2 characteristics used for the water balance modelling and predicted response to scheduled modelled discharge to Boolgeeda Creek

Reach characteristics	
Reach length (m)	**18,780**
Low flow channel - base width (m)	13
Bed slope (m/m)	0.006
Manning's roughness	0.05
Riparian width (m)	61
Common riparian veg types	Ev; Ac; Tu
ET (mm/year)	600
Alluvial/colluvial depth (m)	~ 20
SW&GW interactions	Losing
Recharge rate (m/s)	1.16×10^{-9}
Limiting factor to water loss	Subsurface geology

Typical cross section



Riparian vegetation corridor



Flow conditions			
Peak discharge	**Water depth (m)**	**Flow width (m)**	**Velocity (m/s)**
10ML/d 0.08 m^3/s	0.04	19	0.15
12.5 ML/d 0.11 m^3/s	0.04	20	0.16
15 ML/d 0.14 m^3/s	0.05	21	0.17
17.5 ML/d 0.17 m^3/s	0.05	22	0.18

Key

Alluvium/Colluvium
Woongara Volcanics
Boolgeeda Iron Formation
Estimated groundwater level

Modelled discharge rates:
10 ML/d
12.5ML/d
15 ML/d
17.5 ML/d

Riparian vegetation types
Ev - *Eucalyptus victrix* (Coolibah)
H - Open herbland

Summary

Reach 2 is characterised by a meandering creek with an active floodplain that varies in width. Reach 2 is differentiated from Reach 1 by a slightly more incised channel with more defined banks and a floodplain that supports denser riparian vegetation. Common plant species found in Reach 2 includes *Eucalyptus. victrix* (Coolibah), *Acacia citrinovirdis* (Black Mulga) and some tussock grasses. Scouring observed at tributary outlets along Reach 2 (an example is highlighted in the aerial imagery above) indicates high velocity runoffs can be generated from the northern and southern valley slopes.

Groundwater elevations along this reach are unknown but increase in vegetation density may indicate increased water availability. There is a distinctive water source contributing to Reach 2, originating from the southern valley, which results in the sudden increase in vegetation density within the floodplain (adjacent figure).

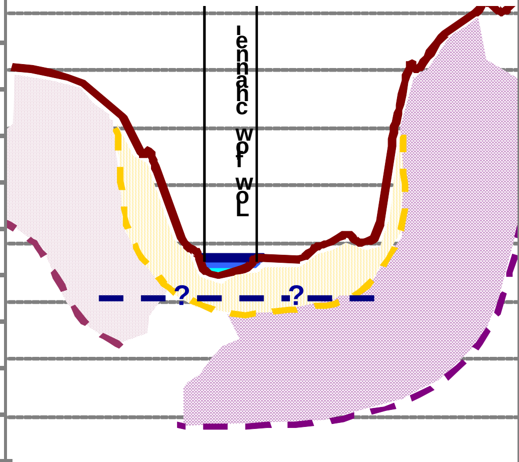
Reach 2 is recognised as a losing system and subsurface geological constraints are identified as the likely limiting factor for the volume of water lost from the system. Similar to Reach 1, the bedrock units underlying this reach are generally of low permeability thus limits recharge into the regional groundwater table and may lead to build up of water within the alluvials and/or valley fill materials following prolong surplus water discharge.

Water discharged into the creek is likely to be contained within the channel, hence overtopping of the creek banks is not anticipated.

Table 2-3: Reach 3 characteristics used for the water balance modelling and predicted response to scheduled modelled discharge to Boolgeeda Creek

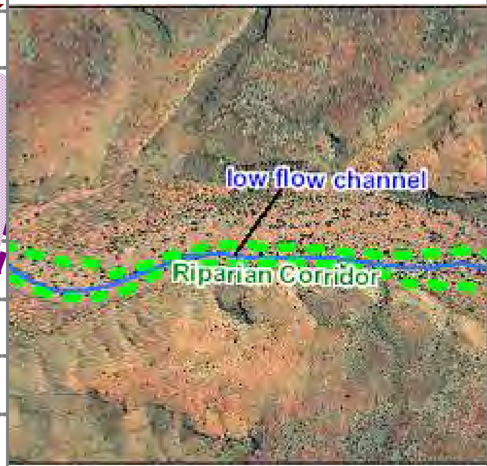
Reach characteristics	
Reach length (m)	**20,765**
Low flow channel - base width (m)	13
Bed slope (m/m)	0.003
Manning's roughness	0.045
Riparian width (m)	81
Common riparian veg types	Ev; A; Tu
ET (mm/year)	600
Alluvial/colluviall depth (m)	~ 10
SW&GW interactions	Losing
Recharge rate (m/s)	2 x 10^{-7}
Limiting factor to water loss	Subsurface geology

Typical cross section



Not to scale

Riparian vegetation corridor



Flow conditions			
Peak discharge	**Water depth (m)**	**Flow width (m)**	**Velocity (m/s)**
10ML/d 0.02 m^3/s	0.02	16	0.08
12.5 ML/d 0.05 m^3/s	0.03	17	0.11
15 ML/d 0.08 m^3/s	0.04	18	0.13
17.5 ML/d 0.10 m^3/s	0.05	19	0.14

Key

Alluvium/Colluvium
Woongara Volcanics
Boolgeeda Iron Formation
Estimated groundwater level

Modelled discharge rates:
10 ML/d
12.5ML/d
15 ML/d
17.5 ML/d

Riparian vegetation types
Ev - *Eucalyptus victrix* (Coolibah)
H - Open herbland

Summary

Reach 3 illustrates the section of Boolgeeda Creek that drains the gorge system. The creek is flanked north and south by outcropping Boolgeeda Iron Formation and Robe Pisolite mesas, which constricts flows, thus increases the average water levels and velocities and may cause water to back up during large flood events. Similar to Reach 2, Reach 3 is likely to receive high velocity runoff generated from local sub-catchments that may scour the creek bed.

Riparian vegetation commonly found in Reach 3 may include *Eucalyptus. victrix* (Coolibah), some *Acacia* (Mulga) species and tussock grasses.

Groundwater elevations are unknown along this reach but are expected to be deep, possibly > 5 m below ground level; riparian vegetation maintained within this reach is unlikely to be groundwater dependent but sustained by water available within the soil layer, recharged by surface flows and rainfall infiltration.

Reach 3 is recognised as a losing system and subsurface geological constraints are identified as the likely limiting factor for the volume of water lost from the system. Although the outcropping rock units are believed to be of low permeability, faults/fracture zones (generally found in this reach) will significantly increase the permeability of the rocks thus increase the recharge potential of this reach.

Water released into the creek is likely to be contained within the channel, hence overtopping of the creek banks is not anticipated. The footprint is terminated within this reach.

3 RESULTS

Results for the modelled discharge options are summarised in Table 3-1 and wetting fronts, measured from the proposed discharge outlet, for selected volumes 10, 12.5 and 17.5 ML/day are presented in Figure 3-1.

Table 3-1: Estimated wetting fronts, for modelled volumes 2.5 to 20 ML/day, along Boolgeeda Creek

Discharge volume (ML/day)	Surface water expression (km)	Steady state distance (km)	Maximum wetting front (km)
2.5	1.0	12.0	12.0
5	13.0	22.0	22.0
7.5	14.0	31.0	31.0
10	32.0	33.0	33.0
12.5	33.0	34.0	34.0
15	34.0	35.0	35.0
17.5	34.0	37.0	37.0
20	35.0	38.0	38.0

For all modelled discharge rates, the surface water expression footprint was less than the steady state distance. This suggests water released into the creek is likely to move in and out of the creek bed, creating transient pools in topographical depressions and associated saturated bank conditions within the reach. Modelling indicated that the maximum wetting front would extend from approximately 12 km to 38 km down gradient from the proposed discharge outlet for modelled volumes 2.5 ML/day to 20 ML/day.

The peak flow volume of water discharged into Boolgeeda Creek is significantly smaller than the peak flow volume generated by the catchment during any flood events (a 2 year ARI flood event would deliver 148 m^3/s at the proposed discharge outlet, compared with peak modelled discharge rates of 17.5 ML/day which is equivalent to 0.2m^3/s). However the duration of flow events, days to weeks for flood events and months for discharge events, pose a change to the current hydrological regime.

All potential water movement is likely to be confined within the channel, hence overtopping of the creek banks is not anticipated. While the creek bed will remain saturated, the creek banks are likely to become saturated such that riparian vegetation should be largely unaffected by the flows. However, the continuous flow will increase water availability close to the creek. Thus the content of water in unsaturated zones moving away from the saturated creek bed may increase vegetation vigour and/or encourage sapping growth.

It was determined that the bedrock units underlying the Boolgeeda Creek valley are of low permeability. Hence water loss to the environment via recharge will be minimal.

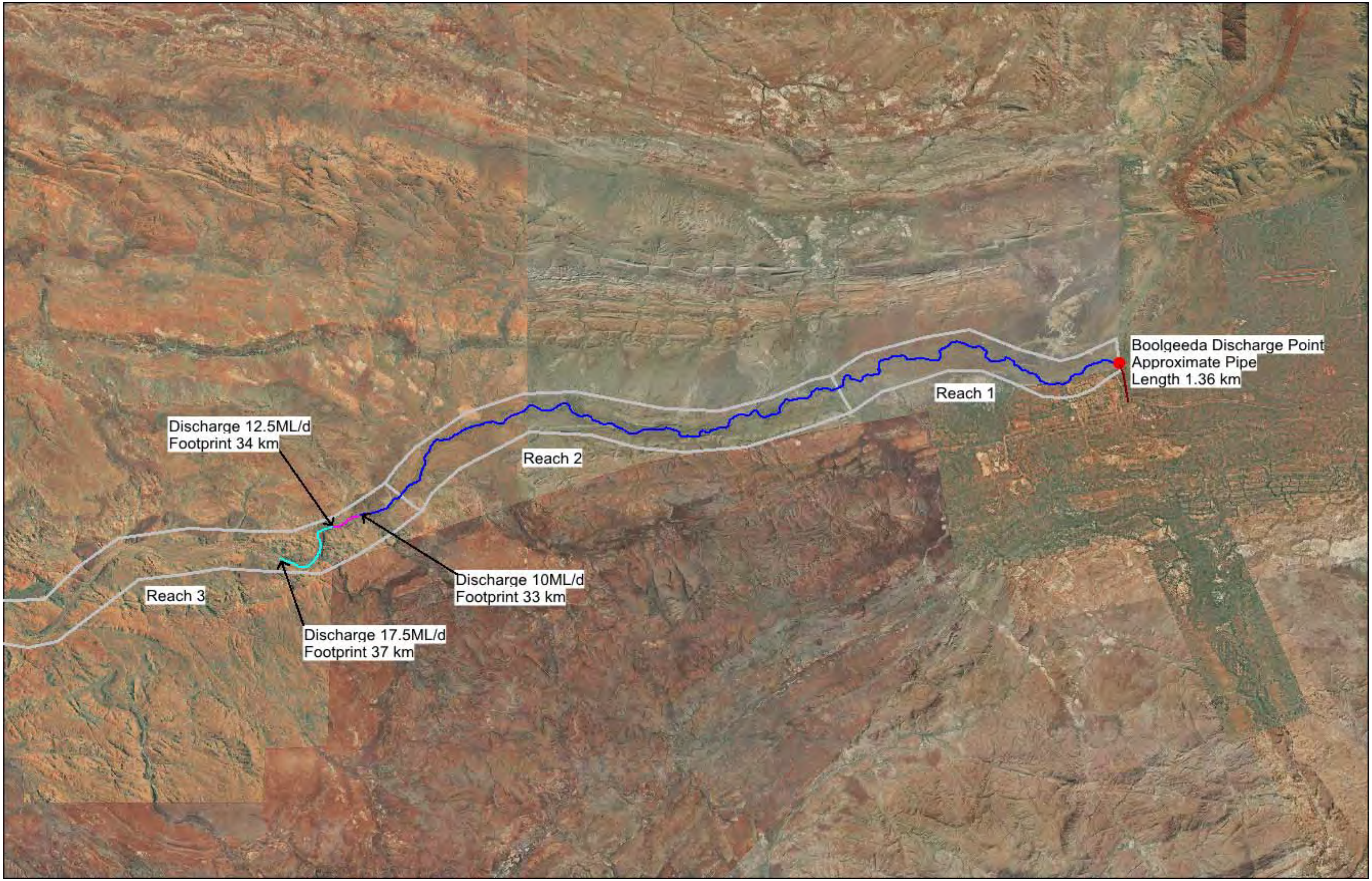


Figure 3-1: Estimated wetting front for Boolgeeda Creek for selected volumes 10, 12 and 17.5ML/day

Biota Environmental Sciences

Brockman 4 Riparian Vegetation Mapping

Prepared for Rio Tinto Pty Ltd

November 2013

ABN 49 092 687 119
Level 1, 228 Carr Place
Leederville Western Australia 6007
Ph: (08) 9328 1900 Fax: (08) 9328 6138

Project No.: 919

Prepared by: S. Venkatasamy

Document Quality Checking History

Version: 7	Peer review:	R. Butler
Version: 10	Director review:	M. Maier
Version: 10	Format review:	F. Hedley

Approved for issue: M. Maier

Brockman 4 Riparian Vegetation Mapping

Contents

Tables

Figures

Plates

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1.0 Summary

Rio Tinto Pty Ltd is considering discharging excess dewatering water generated by the Brockman 4 iron ore mine into the Boolgeeda Creek system, which is located 60 km west-northwest of Tom Price. Biota Environmental Sciences was commissioned to survey the flora and vegetation of the Boolgeeda Creek, with a view to providing information to support an Assessment on Proponent Information process for the proposed project. The objectives of the survey were to determine the floristic composition, map the vegetation communities and assess the condition of the riparian vegetation along a 42 km section of Boolgeeda Creek (the study area).

The field survey was conducted in August 2013 by four botanists. A total of 17 permanent quadrats and two relevés were established to collect floristic information. Some 110 mapping notes were also taken during foot traverses along the length of the creekline. The data obtained were combined to define the vegetation units of the study area.

Fifteen vegetation units were described for the study area, highlighting some notable differences between the vegetation communities of the western and eastern sections. None of the vegetation units described represented Threatened Ecological Communities or Priority Ecological Communities. However, six riparian vegetation units (C2, C3, C4, C5, C6 and C7) were considered to be of conservation significance, as they are at risk from a number of threats (including grazing and invasion by weeds), which are known to negatively impact the vegetation of major ephemeral watercourses. These six vegetation units represented 34% of the study area (443 ha) and were distributed over the length of the study area except for the easternmost section. Similar vegetation units dominated by *Eucalyptus victrix* and *Eucalyptus camaldulensis* (representing an area of over 618 ha) have been previously described in the locality of the study area.

An additional feature of interest in the study area was the presence of six small ephemeral pools in a segment of the western meandering channel in vegetation unit C6.

A total of 226 native vascular flora species from 116 genera belonging to 42 families were recorded for the study area. No Threatened flora species were recorded within the study area and none would be expected to occur. Four Priority flora species were recorded in the study area: the Priority 1 *Peplidium* sp. Fortescue Marsh (S. van Leeuwen 4865), Priority 2 *Pentalepis trichodesmoides* subsp. *hispida*, Priority 3 *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) and Priority 4 *Goodenia nuda*.

Thirteen introduced flora species were recorded. The most prolific introduced species, Buffel Grass *(*Cenchrus ciliaris),* was distributed throughout the study area. Mexican Poppy (**Argemone ochroleuca* subsp. *ochroleuca*), which is a declared pest species, occurred mostly as dense patches of seedlings in open areas of the creek bed.

The vegetation condition of the creek bed was ranked as being Very Good despite the presence of **Cenchrus ciliaris,* which was growing both as scattered grasses and very open tussock grasslands. In fact, the creekline supported a healthy and diverse range of flora species. Compared to the creek bed, the floodplains were subject to a higher degree of invasion by **Cenchrus ciliaris,* which occurred as an open tussock to tussock grassland. In general, the vegetation condition of the floodplains was categorised as Good. Disturbance factors included a dirt track running along part of the creek bed in the westernmost section of the study area, and pronounced erosion at three sites located on the braided part of channel on the eastern section where the creek banks were less stable.

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2.0 Introduction

2.1 Project Background

Rio Tinto Pty Ltd (Rio Tinto) operates Brockman 4, an iron ore mine located 58 km west-northwest of Tom Price in the Pilbara region of Western Australia. The current preferred management option for disposal of excess water from Brockman 4 is discharge to the Boolgeeda Creek system. Boolgeeda Creek is a tributary of Duck Creek within the regional Ashburton River catchment, and is located approximately 60 km to the west-northwest of Tom Price (Figure 2.1).

Biota Environmental Sciences (Biota) was commissioned to undertake a flora and vegetation survey of the discharge footprint for the Boolgeeda Creek option. Based on a maximum discharge footprint of 37 km calculated for a peak discharge volume of 17.5 ML/day, the survey area was designed to include the section of creek extending approximately 38 km downstream and 4 km upstream of the discharge point. The survey area also included the adjacent floodplain habitat. A further 3 km section of creekline located between a main access track and the upstream end of the survey area (as outlined in the scope of work) was also subsequently assessed, with a view to provide additional information on the vegetation communities further upstream of the discharge point. Collectively, these survey areas are hereafter referred to as the study area.

2.2 Scope and Objectives of this Study

A botanical survey of Boolgeeda Creek was conducted in order to collate supporting information suitable for an Assessment on Proponent Information (API) process.

The primary objective of this investigation of the riparian flora and vegetation assemblages of the Boolgeeda Creek system was to provide baseline information to assist in evaluating its potential as a receiving water body for the excess water. This report documents the findings of the riparian flora and vegetation survey conducted by Biota of a section of the Boolgeeda Creek.

The objectives of the survey were to:

- undertake a Level 2 vegetation and flora survey consistent with the Western Australian Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004) and EPA Position Statement No 3 (EPA 2002);
- describe and map the vegetation units occurring within the study area;
- document the flora assemblage of the study area using accepted sampling techniques, including quadrat-based floristic sampling;
- assess local and regional significance of vegetation units within the study area, including discussion of any Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) as well as areas of potential conservation significance such as ephemeral pools;
- identify and record Threatened and Priority flora species and assess their local and regional significance;
- record populations of introduced flora (weeds) and map the vegetation condition; and
- identify the occurrence of erosion processes and other disturbance factors .

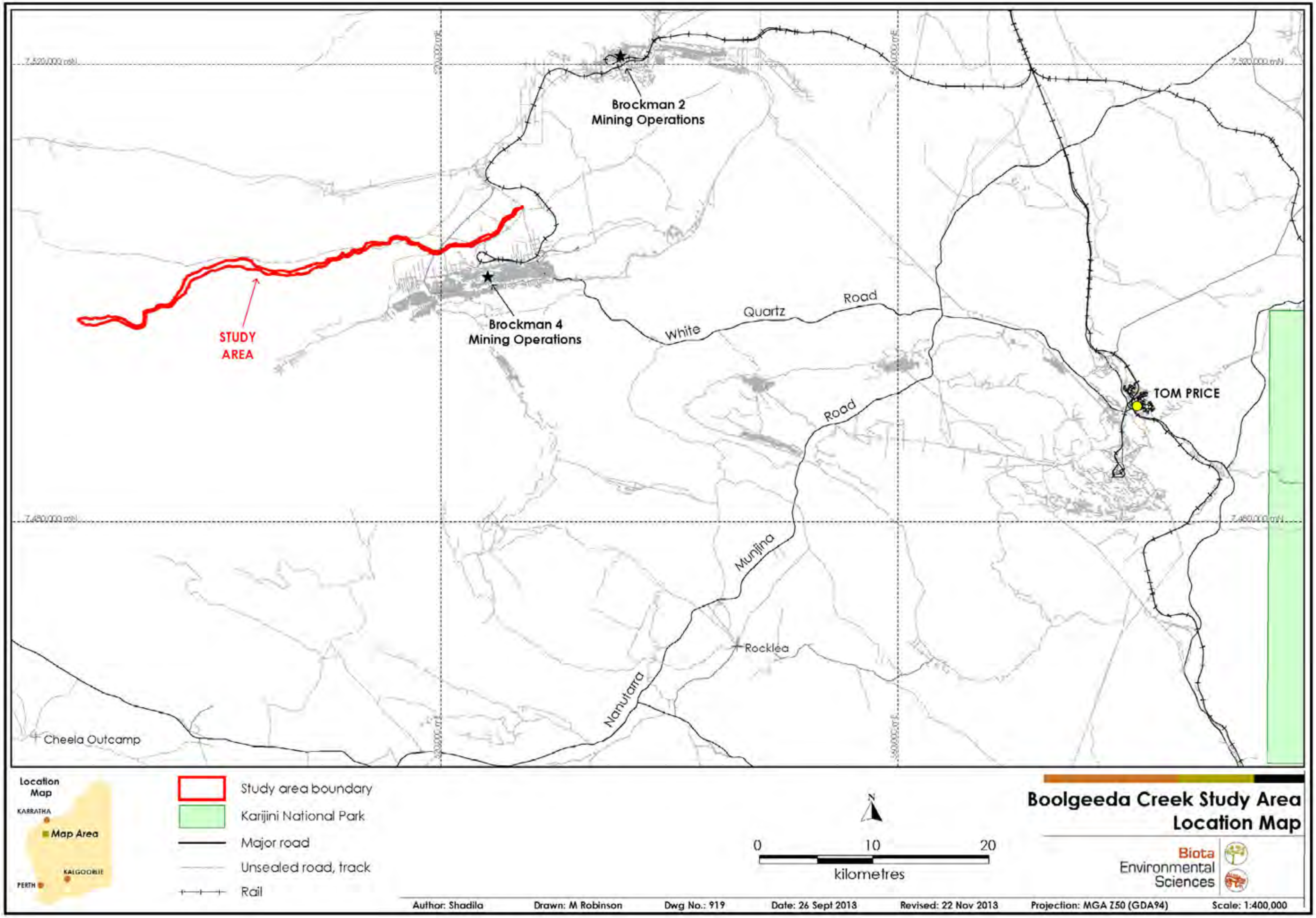

Figure 2.1: Location of the Boolgeeda Creek study area.

3.0 Methodology

3.1 Desktop Review

A search of the NatureMap[1] database was conducted on the 17th of September 2013 to identify all flora species previously recorded within a 40 km radial distance of the study area. The centre of the study area (22ª 35’ 18”S; 117ª 04’ 34”E) was buffered by 40 km for this search. The results of the NatureMap search are presented in Appendix 2. Various botanical surveys completed in the locality were also reviewed, together with records of species of conservation significance held by Rio Tinto.

The desktop review identified one Threatened species and 29 Priority flora species as having been previously recorded in the Boolgeeda locality. Each species was assigned a ranking to reflect the likelihood that it would occur in the study area, based on a combination of the known distribution of the species, the proximity of other records, and whether suitable habitat is present (see Table 3.1 and Table 4.2).

Table 3.1: Ranking system used to assign the likelihood that a species would occur in the study area.

Rank	Criteria
Recorded	1. The species has been previously recorded in the study area.
Likely	1. There are existing records of the species in close proximity to the study area, or from the locality; and • the species is strongly linked to a specific habitat, which is present in the study area; or • the species has more general habitat preferences, and suitable habitat is present.
May potentially occur	1. There are existing records of the species from the locality, however • the species is strongly linked to a specific habitat, of which only a small amount is present in the study area; or • the species has more general habitat preferences, but only some suitable habitat is present. 2. There is suitable habitat in the study area, but the species is recorded infrequently in the region.
Unlikely	1. The species is linked to a specific habitat, which is absent from the study area; or 2. Suitable habitat is present, however there are no existing records of the species from the locality despite reasonable previous search effort in suitable habitat; or 3. There is some suitable habitat in the study area, however the species is very infrequently recorded in the region.
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the study area; and/or 2. The species’ range is very restricted and would not include the study area.

[1] NatureMap is a collaborative project between the Western Australian Museum and the Department of Parks and Wildlife (DPaW). http://naturemap.dec.wa.gov.au.

3.2 Flora and Vegetation Survey

3.2.1 Field Survey and Climatic Conditions

The field survey was carried out by a team of Biota botanists (comprising Ms Cassie Adam, Ms Preeti Chukowry, Mr Ben Eckermann and Dr Shadila Venkatasamy) from 21 to 28 August 2013. A total of 32 person days were spent on the field component of the study.

Rainfall data from the nearest Bureau of Meteorology (BoM) recording station (Hamersley and where data were unavailable, Paraburdoo Aero) were collated for the six months preceding the survey (Figure 3.1). Although minimal rainfall was recorded in July and August, 78.4 mm occurred in June, equating to almost three times the long-term average rainfall of 23.6 mm. Above average rainfall was also recorded for the months of April and May (Figure 3.1). The flora and vegetation of the study area were observed to be in very good condition, with many annual species present and the majority of species being in flower. Consequently, seasonal conditions for conducting the survey were favourable.

Figure 3.1: Monthly rainfall data for the six months preceding the survey taken from the Hamersley (#5005) weather recording station and Paraburdoo Aero (#7185) weather recording station (July and August 2013 only), compared to the long-term average for Hamersley. Data from BoM (http://www.bom.gov.au). Green arrow indicates survey timing.

3.2.2 Establishment and Assessment of Quadrats and Relevés

Indicative sampling sites were selected prior to the field survey based on the broad habitats and changes in vegetation communities apparent on aerial imagery. Once in the field, final locations of sampling sites were adjusted when necessary.

Quadrats (flora sampling sites of a fixed area) were established at each indicative sampling site wherever possible. Most quadrats established were 50 m x 50 m in size. This quadrat area of 2,500 m^2 is recognised as providing an adequate sample of species presence for the Pilbara vegetation and is the standard quadrat size for botanical survey work in the region (Clarke 2009). Where a square quadrat was unsuitable for sampling the vegetation type (e.g. along narrow creeklines), a rectangular quadrat of equivalent area (e.g. 40 m x 62.5 m) was established instead. The quadrats were permanently marked using steel fence droppers on all four corners. An optical square and measuring tapes were used to accurately position the quadrat boundaries.

In cases where quadrats could not be established (e.g. due to the small size or irregular shape of the habitat), the sampling sites were either surveyed as relevés or recorded in the form of mapping notes (see Section 3.2.3). A relevé is an unbounded flora sampling site with a similar area to a standard quadrat; essentially the same information is recorded as for a quadrat, however the sampling of flora is typically not as thorough. A mapping note includes a brief collection of flora and vegetation data at a point location. A total of 17 quadrats and two relevés were sampled in the study area (see Appendix 3). Mapping notes are discussed in Section 3.2.3.

The following information was recorded for each quadrat and relevé:

- Location: Australian Map Grid (AMG) coordinates recorded in WGS84 datum (to an accuracy of typically ±5 m) using a handheld Global Positioning System (GPS); coordinates were recorded for all four corners of a quadrat, and either the central point of a circular relevé or the start and end points of a linear relevé (e.g. a 100 m long drainage line);
- Vegetation description: a broad description based on the height and estimated cover value of dominant species (after Muir 1977 and Aplin 1979; Appendix 5);
- Habitat description: a description of the landform and habitat;
- Broad soil type: a description of the soil colour, texture and any stony surface mantle;
- Fire history: approximate time since last fire, where applicable;
- Vegetation condition ranking: considering evidence of grazing, physical disturbance, weed invasion etc. (based on Trudgen 1988; Appendix 5);
- The estimated percentage foliar cover of each flora species present within the quadrat or a relevé; and
- A colour photograph of each site (typically taken from the northwest corner of a quadrat, facing southeast).

3.2.3 Vegetation Description, Mapping and Condition Assessment

The vegetation units in the study area were described and mapped using a combination of the information from the quadrats, relevés and mapping notes.

Mapping notes were recorded during foot traverses along the creek system. The objective was to mark boundaries and changes in the vegetation types, and the notes therefore included details regarding habitat and vegetation type. A short list of associated species was also typically recorded. A total of 110 mapping notes were taken during the foot traverses and mapping exercises. The locations of these mapping notes are provided in Appendix 4.

Vegetation descriptions that were considered alike shared a suite of perennial species with a similar range of cover values. These descriptions were grouped to form the vegetation mapping units for the study area.

Each vegetation unit mapped for this report was given two unique codes:

1. A detailed alphabetic code represented the dominant flora species from the tallest to lowest stratum. Species names were abbreviated to capital letter(s) for the genus, followed by lower case letter(s) for species, with multiple letters used where necessary to ensure a unique code (for example: *Acacia citrinoviridis* = Aci; *Themeda triandra* = THt).
2. To aid interpretation, each vegetation unit was also assigned an alpha-numeric code as a unique precursor to the species-driven code. This was a short string comprising a character representing the broad landform group (for example: 'C' for Creeklines, 'F' for floodplains) followed by a number sequence (e.g. F1: AciApyCEcTe was a particular vegetation sub-association occurring on a floodplain). The simplified coding was used on the vegetation maps and in the map legend (see Appendix 3), while both codes and a full description for each vegetation unit are presented in Section 5.2.

The vegetation condition assessments were based on a condition ranking scale developed by Trudgen (1988), which comprised a ranking from Excellent to Completely Degraded (see Appendix 5). The rankings were based on the degree of perceived impact arising from (a) vegetation clearing and other human impacts, (b) the presence of weeds and (c) grazing as well as trampling from livestock and feral animals. Vegetation condition was assessed at each sampling site (quadrat, relevé or mapping note) and the results are mapped in Appendix 10.

3.2.4 Searches for Conservation Significant Flora and Weeds

Searches for conservation significant flora were undertaken within quadrats and relevés, as well as during the foot traverses conducted for the vegetation mapping.

All locations of significant flora were recorded using a GPS (WGS84 datum). The number of individuals, habitat and associated species were also recorded for each location. Threatened and Priority Flora Report Forms will be lodged with DPaW for all flora of conservation significance found.

Introduced flora species (weeds) were also recorded within quadrats and relevés and during foot traverses as part of the survey. Any additional native flora species that had not been previously recorded in the study area were also noted as opportunistic collections during the foot traverses, to improve the list of flora recorded for the area..

3.2.5 Specimen Identification, Nomenclature and Data Management

Common species that were well known to the survey botanists were identified in the field. Voucher specimens of all other species were collected and assigned a unique number to facilitate tracking of data. These were pressed in the field, and dried immediately using portable heaters.

The voucher specimens were identified by (a) using flora keys and relevant publications, (b) checking voucher reference collections, and (c) comparing the specimens to the collections held at the WA Herbarium. Biota botanists (Dr Shadila Venkatasamy, Ms Rachel Butler and Mr Ben Eckermann) identified most specimens, the majority of which were confirmed by Biota's principal botanist (Ms Michi Maier). A few plant samples, particularly those exhibiting uncommon phenotypic variation, were sent to Mr Andrew Perkins (taxonomist at the WA Herbarium) for further examination. These included the specimens of *Peplidium* sp. Fortescue Marsh (S. van Leeuwen 4865) and *Pentalepis trichodesmoides* subsp. *hispida*.

Nomenclature was checked against the current listing of scientific names recognised by the WA Herbarium and updated when necessary. A list of vascular flora species found in the study area is given in Appendix 6.

3.3 Limitations of this Study

Overall, this report provides comprehensive flora and vegetation data for the riparian vegetation along Boolgeeda Creek and its associated floodplains. However, there are limitations to the study that must be considered when reviewing and applying the results detailed in this report:

- While foot traverses and quadrats covered the length of the study area, systematic searches were not conducted through the entire area for Threatened and Priority flora or introduced flora.
- The species list presented in this report includes only names currently recognised by the WA Herbarium[2]. Some specimens collected from the area are unresolved; it is possible that some of these may represent new taxa, or they may represent named species that are already listed for the study area (see Section 6.2.3). These have been referred to the closest possible recognised taxon for this report. Further taxonomic work (preferably including genetic analysis) would be required to determine whether these entities represent separate species.

2 See FloraBase website: http://florabase.dec.wa.gov.au/

- Whilst the climatic conditions at the time of the survey were adequate for recording most ephemeral and cryptic perennial flora, the study area was not systematically searched and only a single phase of sampling was conducted. The list of vascular flora documented from the study area is therefore representative but should not be considered exhaustive.
- Fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not sampled, as is typical for surveys of this nature.
- The vegetation types for the study area were defined through a combination of quadrat/relevé data and mapping notes recorded in the field, together with interpretation of aerial photography. The mapping provides a spatial representation of the vegetation of the study area, and vegetation boundaries should be treated as indicative rather than absolute.
- A small section of the creek bed in the vicinity of quadrat BRV18 was not traversed on foot. This was due to safety concerns regarding threatening behaviour from herds of livestock and feral donkeys, which had congregated near the pools of water and more shaded areas of the creekline.

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4.0 Existing Environment

4.1 IBRA Bioregion and Subregion

The Interim Biographic Regionalisation for Australia (IBRA) defines 26 bioregions for Western Australia (DoE 2013). The study area lies within the Pilbara bioregion. The Pilbara is further divided into four subregions: Chichester (PIL1), Fortescue Plains (PIL2), Hamersley (PIL3) and Roebourne Plains (PIL4).

The study area is located in the Hamersley subregion (see Kendrick 2003) which is described as a "mountainous area of Proterozoic ranges and plateaus with low Mulga (*Acacia aneura*) woodland over bunch grasses on fine textured soils, and Snappy Gum (*Eucalyptus leucophloia*) over *Triodia brizoides* on the skeletal sandy soils of the ranges."

4.2 Conservation Reserves in the Locality

The main conservation reserve in the locality, and also the closest to the study area, is Karijini National Park, which is located 66 km to the east.

4.3 Land Systems

Land systems mapping covering the study area has been prepared by Agriculture Western Australia (now the Department of Agriculture and Food) (Payne et al. 1988). Land systems are comprised of repeating patterns of topography, soils and vegetation (Chapple 2003) (i.e. a series of "land units" that occur on characteristic physiographic units within the land system).

A total of 105 land systems have been identified and mapped for the Pilbara bioregion[3]. Four of these are mapped within the study area as outlined in Table 4.1.

The distribution of the land systems in the locality is illustrated in Figure 4.1. It is apparent that the broad scale of the land systems mapping does not recognise the continuous drainage feature of Boolgeeda Creek, which should be mapped entirely as River land system. Instead, the active floodplains and major channels of the River land system are only mapped over two broad areas in the eastern and western sections of the study area. The remainder of the study area is variously mapped as the Boolgeeda land system (central and eastern sections of the study area), Robe land system (parts of the western and central sections) or Newman land system (parts of the western section of the study area). The area of each land system mapped within the study area is a very small percentage of their overall representation in the Pilbara bioregion.

The majority of the land systems mapped for the study area are generally not susceptible to erosion. However, the River land system becomes highly, or very highly, susceptible to erosion if vegetation cover is removed. This land system is generally stabilised by Buffel Grass (**Cenchrus ciliaris*), or by spinifex and native tussock grasses in undisturbed areas.

3 This information was obtained by merging the Ashburton land system mapping (Payne et al. 1988) and Pilbara land system mapping (Van Vreeswyk et al. 2004) and intersecting this with the Pilbara bioregion (Environment Australia 2000) in ArcView (v. 3.2).

4.4 Beard's Vegetation Mapping

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The study area is located on the Hamersley Plateau, which is within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts.

The study area intersects two of Beard's vegetation units (Figure 4.2), namely:

- Hamersley 18: *Acacia pyrifolia* shrubland over *Triodia pungens* hummock grassland; 838 ha in the study area.
- Hamersley 82: Snappy Gum (*Eucalyptus leucophloia*) scattered low trees over *Triodia wiseana* hummock grasslands; 463 ha in the study area.

Given the broad scale of Beard's vegetation mapping, these two units provide only limited information about the vegetation occurring in the study area.

Table 4.1: Land systems intersected by the study area (Payne et al. 1988, van Vreeswyk et al. 2004)

Land System	Description	Total Area of Land System in the Hamersley Subregion (ha)	Area of Land System in Study Area (ha)	Percentage of Study Area in Hamersley Subregion (%)
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands. Component landforms include low hills and rises (4%), stony slopes and upper plains (20%), stony lower plains (65%), groves (1%), and narrow drainage and channels (10%). System not susceptible to erosion.	606, 771	256.1	0.04
Newman	Rugged jaspilite plateaus, ridges and mountains supporting hard spinifex grasslands. Component landforms include plateaus, ridges, mountains and hills (70%), lower slopes (20%), stony plains (5%), and narrow drainage floors with channels (5%). System not susceptible to erosion.	1,853,935	208.7	0.01
River	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands. Component landforms include sandy levees and sand sheets (15%), upper terraces (5%), floodplains and lower terraces (50%), stony plains (10%), and minor and major channels (20%). Accelerated erosion uncommon unless vegetation cover is removed.	72,628	611.5	0.84
Robe	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands. Component landforms include low plateaus, mesas and buttes (60%), lower slopes (20%), gravelly plains (15%), and drainage floors and channels (5%). System not generally susceptible to erosion.	103,116	225.0	0.22

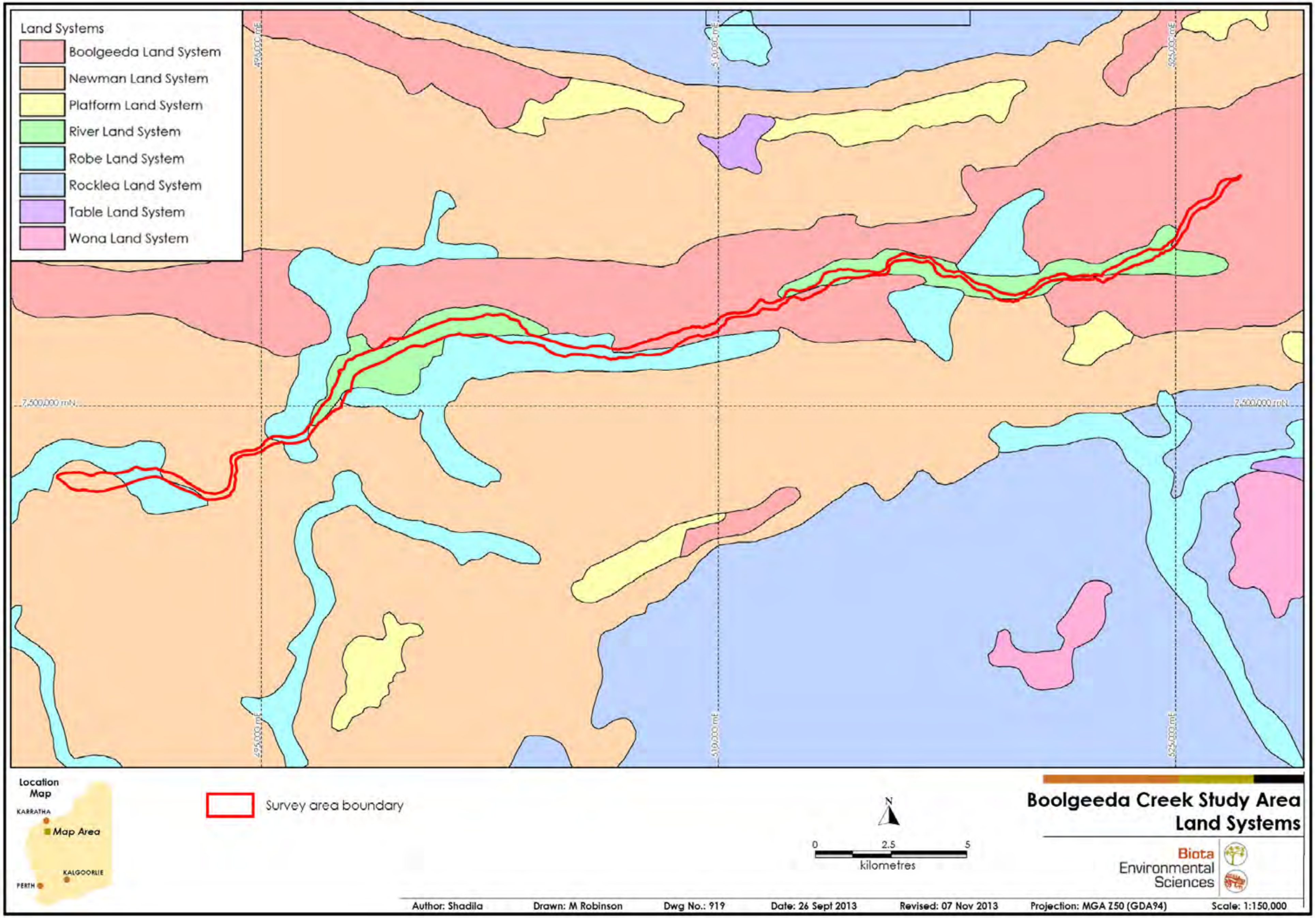

Figure 4.1: Land systems for the study area (Payne et al. 1988).

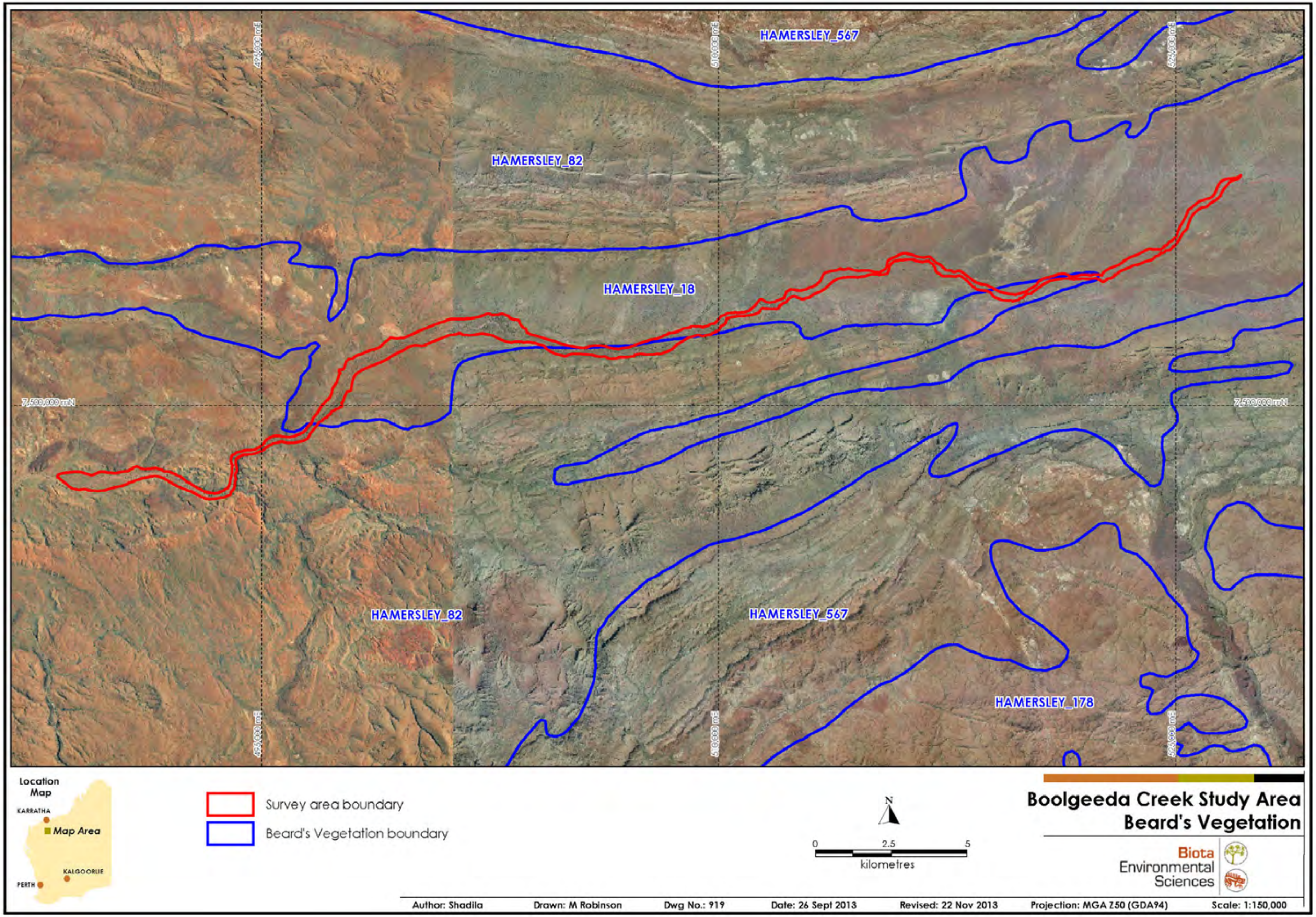

Figure 4.2: Beard's (1975) vegetation mapping for the study area.

4.5 Vegetation Communities of Conservation Significance in the Locality

The framework for ranking communities of conservation significance is presented in Appendix 1.

4.5.1 TECs Known from the Locality

TECs are described by DPaW as biological assemblages occurring in a particular habitat, which are under threat of modification or destruction from various processes. TECs listed by DPaW are conservation significant at the State level and are protected as Environmentally Sensitive Areas under Schedule 5 of the *Environmental Protection Act 1970*. Twenty-three of the 69 TECs listed in Western Australia are also nationally recognised and listed under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. This does not include either of the two TECs listed for the Pilbara bioregion.

No TECs listed for WA have been recorded in the study area. The '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)' TEC is mapped as occurring approximately 26 km north of the study area. This TEC is considered to be at risk from (a) grazing and trampling by livestock, (b) weed invasion, (c) changed fire regimes and (d) alteration of hydrology (DEC 2012a). There is no suitable habitat for this TEC in the current study area and it would not occur.

4.5.2 PECs Known from the Locality

PECs are biological communities that are recognised to be of significance, but do not meet the criteria to be classified as a TEC (DEC 2012b). There are five categories of PECs, none of which are protected under legislation (see Appendix 1). Based on data available for current PEC locations, only the 'Brockman Iron cracking clay communities of the Hamersley Range' has been identified as occurring in the locality, approximately 25 km north of the study area. This PEC is a rare tussock grassland dominated by *Astrebla lappacea* in the Hamersley Range, occurring on the Newman land system. It is considered to be at risk from heavy grazing and infrastructure developments. There is no suitable habitat for this PEC in the current study area and it would not occur.

4.6 Conservation Significant Flora in the Locality

The framework under which significant species are classified in WA is provided in Appendix 1.

4.6.1 Threatened Flora

Three Threatened Flora species (*Lepidium catapycnon*, *Thryptomene wittweri* and *Aluta quadrata*) are known from the Pilbara bioregion. *Lepidium catapycnon* and *Thryptomene wittweri* are listed as Threatened flora under the Commonwealth *EPBC Act 1999* as well as the WA *Wildlife Conservation Act 1950*. *Aluta quadrata* has only recently been listed as a Threatened species in WA (State of Western Australia 2012) and is currently only recognised as such under the *Wildlife Conservation Act 1950.*

These species are described briefly below:

- *Lepidium catapycnon* (Hamersley Lepidium) is a woody perennial herb or low shrub occurring mainly on hillsides in skeletal soils, particularly in association with the Newman land system. It typically occurs in hummock grasslands on low stony hills and occasionally stony plains. This relatively short-lived shrub species is often recorded from areas that have been recently disturbed, apparently persisting for only a few years. Now known from a number of locations in the Hamersley Range, *Lepidium catapycnon* extends broadly from Tom Price across to Newman. *Lepidium catapycnon* has been previously recorded within 40 km of the study area (Rio Tinto data; see Table 4.2), but there is no suitable habitat for this species in the study area and it would not occur.

- *Thryptomene wittweri* is a spreading, perennial shrub occurring in skeletal stony soils on breakaways and in drainage channels, typically high in the landscape on mountains of greater than 1,000 m elevation. *Thryptomene wittweri* has not been previously recorded within 40 km of the study area. There is no suitable habitat for this species in the study area and it would not occur.
- *Aluta quadrata* is a perennial shrub occurring mainly in rocky gullies, although it sometimes extends down along the creeklines draining the gullies, or out onto the adjacent ridge slopes and crests. This species is currently thought to be restricted to the southern flanks of the range of hills surrounding Paraburdoo, where it occurs over an east-west range of approximately 40 km. *Aluta quadrata* has not been previously recorded within 40 km of the study area. Due to its restricted distribution and a lack of suitable habitat in the study area, it would not be expected to occur.

4.6.2 Priority Flora

Based on the database searches and literature reviews conducted for this study, a total of 29 Priority flora species have been recorded within a 40 km radius of the study area. A brief description of each of these species and the corresponding survey/data source from which they were recorded is provided in Table 4.2.

There is suitable habitat in the study area for nine of these Priority species, for which the following likelihood rankings were assigned (see Table 3.1):

1. <u>Likely to occur in the study area</u>:
   - *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3); and
   - *Goodenia nuda* (Priority 4).
2. <u>May potentially occur in the study area:</u>
   - *Ipomoea racemigera* (Priority 2);
   - *Oxalis* sp. Pilbara (M.E Trudgen 12725) (Priority 2);
   - *Eragrostis surreyana* (Priority 3);
   - *Glycine falcata* (Priority 3);
   - *Nicotiana umbratica* (Priority 3);
   - *Rostellularia adscendens* var. *latifolia* (Priority 3); and
   - *Rhynchosia bungarensis* (Priority 4).

The remaining 20 Priority species are considered unlikely to occur in the study area or would not occur, as there is either no suitable habitat, or only limited suitable habitat but no records in close proximity.

Table 4.2: Threatened and Priority flora species previously recorded from the Boolgeeda locality.

Species	Habit	Habitat	Source of Record														Likelihood of Occurrence within Study Area
			NatureMap	Biota 2005	Biota 2007	Biota 2009a	Biota 2009b	Biota 2010a	Biota 2010b	Biota 2011	Biota 2012a	Biota 2012b	Biota 2013a	Biota 2013b	Biota 2013c	Rio Tinto data	
Threatened																	
Lepidium catapycnon	Perennial herb or shrub.	Skeletal soils on stony plains and hill slopes.	✔													✔	Would not occur; no suitable habitat.
Priority 1																	
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01)	Small tree or tall shrub.	Steep, rocky hill slopes, often with Mulga.									✔		✔				Would not occur; no suitable habitat.
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	Erect spindly shrub.	Rocky areas on hill crests and slopes; rocky gullies.	✔								✔						Would not occur; no suitable habitat.
Sida sp. Hamersley Range (K. Newbey 10692)	Low shrub.	Skeletal stony soils; rocky hills, breakaways.	✔				✔					✔				✔	Would not occur; no suitable habitat.
Priority 2																	
Ipomoea racemigera	Annual creeper.	Along watercourses.										✔			✔		May potentially occur; the creekline in the study area may represent suitable habitat; recorded from Beasley River and Caves Creek in the broader locality.
Oxalis sp. Pilbara (M.E Trudgen 12725)	Rhizomatous, perennial herb	Loamy soil with a stony mantle/in association with creek banks, gullies and spinifex grasslands.										✔					May potentially occur; the creek banks in the study area may represent suitable habitat; recorded from Caves Creek in the broader locality.

Species	Habit	Habitat	Source of Record														Likelihood of Occurrence within Study Area
			NatureMap	Biota 2005	Biota 2007	Biota 2009a	Biota 2009b	Biota 2010a	Biota 2010b	Biota 2011	Biota 2012a	Biota 2012b	Biota 2013a	Biota 2013b	Biota 2013c	Rio Tinto data	
Spartothamnella puberula	Spindly shrub.	Rocky loam, sandy or skeletal soils, usually in gullies in the Pilbara.														✔	Would not occur; no suitable habitat.
Priority 3																	
Astrebla lappacea	Tufted perennial grass.	Clay to clay-loam on plains.	✔						✔							✔	Would not occur; no suitable habitat.
Dampiera anonyma	Low perennial shrub.	Skeletal soils over banded ironstone; hill summits, slopes (above 1,000 m).	✔								✔			✔			Would not occur; no suitable habitat.
Eragrostis surreyana	Small annual grass.	Seasonal wetland areas in the Hamersley and Roebourne subregions.										✔					May potentially occur; the creek beds in the study area may represent suitable habitat; recorded from Caves Creek in the broader locality.
Eremophila magnifica subsp. *velutina*	Shrub.	Skeletal soils over ironstone on tall hills and breakaways.	✔							✔				✔		✔	Would not occur; no suitable habitat.
Glycine falcata	Perennial herb.	Occurs mainly on clay soil plains in the Pilbara, but also along creeklines.	✔									✔					May potentially occur; recorded from Caves Creek in the broader locality.
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	Annual to biennial herb.	Low undulating calcrete plains.	✔							✔				✔			Would not occur; no suitable habitat.

Species	Habit	Habitat	Source of Record														Likelihood of Occurrence within Study Area
			NatureMap	Biota 2005	Biota 2007	Biota 2009a	Biota 2009b	Biota 2010a	Biota 2010b	Biota 2011	Biota 2012a	Biota 2012b	Biota 2013a	Biota 2013b	Biota 2013c	Rio Tinto data	
Iotasperma sessilifolium	Erect herb.	Cracking clay, black loam; edges of waterholes in clay plains.	✔														Unlikely to occur; no suitable habitat.
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Low to medium shrub.	Drainage lines.	✔			✔		✔			✔	✔		✔	✔	✔	Likely to occur; drainage lines and floodplains in the study area may represent suitable habitat.
Nicotiana umbratica	Erect, short-lived annual or perennial herb.	Shallow soils, rock outcrops, riverbeds.	✔											✔			May potentially occur; the creek beds in the study area may represent suitable habitat.
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	Spreading, annual herb.	Cracking clay.				✔										✔	Unlikely to occur; no suitable habitat.
Ptilotus subspinescens	Low shrub.	Stony plains with a calcareous silty-clay substrate, occasionally extending up onto adjacent gentle rocky scree slopes; semi-saline colluvial plains.	✔	✔	✔	✔					✔		✔	✔		✔	Would not occur; no suitable habitat.
Rostellularia adscendens var. *latifolia*	Herb or low shrub	Various; creeks, rocky hills, calcrete.			✔						✔				✔		May potentially occur; recorded from a wide variety of habitats.

Species	Habit	Habitat	Source of Record														Likelihood of Occurrence within Study Area
			NatureMap	Biota 2005	Biota 2007	Biota 2009a	Biota 2009b	Biota 2010a	Biota 2010b	Biota 2011	Biota 2012a	Biota 2012b	Biota 2013a	Biota 2013b	Biota 2013c	Rio Tinto data	
Sida sp. Barlee Range (S. van Leeuwen 1642)	Low spreading shrub.	Skeletal soils on steep rocky slopes, breakaways, and in gullies.	✔				✔	✔		✔	✔			✔		✔	Would not occur; no suitable habitat.
Swainsona thompsoniana R.W Davis & P.J.H Hurter	Prostrate annual herb.	Open floodplains on heavy clay soils.	✔														Unlikely to occur; no suitable habitat.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	Annual tussock grass.	Clay pans, grass plains.	✔													✔	Unlikely to occur; no suitable habitat.
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	Soft spinifex.	Crests and upper slopes of mesas; ironstone substrates, sometimes on clay loam.	✔													✔	Would not occur; no suitable habitat.
Priority 4																	
Acacia bromilowiana	Tree or tall shrub.	Skeletal loamy soils on rocky hills, breakaways, scree slopes, gorges and associated creek beds.	✔						✔		✔					✔	Would not occur; no suitable habitat.
Goodenia nuda	Herb.	Clay loam to clay soils, particularly in drainage areas.	✔											✔		✔	Likely to occur; a widespread and frequently recorded species; creeklines in the study area would represent suitable habitat.

Species	Habit	Habitat	Source of Record														Likelihood of Occurrence within Study Area
			NatureMap	Biota 2005	Biota 2007	Biota 2009a	Biota 2009b	Biota 2010a	Biota 2010b	Biota 2011	Biota 2012a	Biota 2012b	Biota 2013a	Biota 2013b	Biota 2013c	Rio Tinto data	
Eremophila magnifica subsp. *magnifica*	Shrub.	Rocky slopes of tall hills, breakaways.		✔			✔				✔			✔		✔	Would not occur; no suitable habitat.
Livistona alfredii	Tree-like monocot (palm).	Edges of permanent pools.										✔					Would not occur; no suitable habitat. Only ephemeral pools are present in the study area.
Ptilotus mollis	Compact perennial shrub.	Stony hills and screes.	✔								✔						Would not occur; no suitable habitat.
Ptilotus trichocephalus	Prostrate herb.	Sandy soils and colluvial plains, typically with an open surface layer of manganese 'gibber'.	✔			✔											Would not occur; no suitable habitat.
Rhynchosia bungarensis	Compact prostrate shrub.	Creeklines through rocky gullies; moderate to major creeklines.	✔														May potentially occur; creeklines may provide suitable habitat.

5.0 Vegetation

5.1 Overview

A total of 15 vegetation units were defined for the study area. Table 5.1 shows the area that each vegetation unit occupied, with units divided into two groups according to whether they occurred in creeklines or on floodplains.

Table 5.1: Area covered by each vegetation unit in the study area.

Mapping Unit / Vegetation Sub-Association	Area (ha)	Proportion of Study Area (%)
Vegetation of Creeklines		
C1: ChAciAtuGOr	10.52	0.81
C2: EvAciAtuAPyTHtTe	6.48	0.50
C3: EvEcAciAPyTErEUa	30.28	2.33
C4: EvEcAciEUa	26.29	2.02
C5: EvEcAciCEc	179.90	13.83
C6: EvEcAciMgAam	46.85	3.60
C7: EvEcAciMgCEcTe	152.74	11.74
Vegetation of Floodplains		
F1: ChAciAtuGOrCEcTe	26.71	2.05
F2: AciAPyTErTHtCEcTe	69.30	5.33
F3: AciAPyEUaTHtCEcTe	37.44	2.88
F4: ChAciAPyCEcTe	26.77	2.06
F5: AciAPyCEcTe	463.27	35.60
F6: PlAsclTe	13.29	1.02
F7: ChAciPlAsclCEcTe	40.83	3.14
F8: AciAPyPlCEcTe	170.56	13.11

The topography of Boolgeeda Creek varied significantly, with the western end being classified as a meandering creek while the eastern end formed a braided channel. The central section of the creek was a mosaic of meandering and braided features. A meandering planform[4] is characterised by a single and sinuous main channel with a few point bars (accumulation of sediment), cut-banks (eroded, concave bank) and well-defined banks (Taylor 2002). Pools usually occur at the outer edges of the bends and at shallower sections on the straighter segments between bends. In contrast, a braided planform is distinguished by poorly defined channels with numerous interlaced channels that divide and rejoin around unstable bars and small islands. In addition, the floodplains of braided creeks vary in extent and architecture (Taylor 2002). They are also less stable than the floodplains of meandering creeks.

Reflecting these differences in creek morphology, some notable differences were observed between the vegetation communities of the western and eastern sections of the study area. Species like *Melaleuca glomerata* and *Acacia ampliceps* were present only in the western section. In contrast, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Themeda triandra* and *Eulalia aurea* were more prevalent along the eastern section of the creekline. *Acacia tumida* var. *pilbarensis* was restricted to the easternmost segment, where the channel was more defined and the creek bed was deeper. The tree and shrub strata were also denser in the western section compared to the eastern section, with the latter having a more open overstorey and therefore supporting more grasses and herbs in the understorey.

4 Planform refers to the form of a river as seen from above; i.e. from a 'bird's eye' or 'plan' view.

Reflecting these differences in species composition, the 15 vegetation units can be grouped into five broad vegetation classes:

1. Creekline dominated by *Corymbia hamersleyana* (C1): *Corymbia hamersleyana* dominated open woodland over *Acacia citrinoviridis*, *Acacia tumida* var. *pilbarensis* and *Gossypium robinsonii*. The absence of *Eucalyptus victrix* and *E. camaldulensis* subsp. *refulgens* resulted in this vegetation assemblage being distinctly different from the remainder of the creekline.
2. Creekline dominated by *Eucalyptus victrix* and/or *E. camaldulensis* (C2, C3, C4, C5, C6 and C7): *Eucalyptus victrix* or *E. camaldulensis* subsp. *refulgens* (the latter usually co-dominant with *E. victrix*) dominated open woodland over *Acacia citrinoviridis* and/or *Melaleuca glomerata* over tussock grasses (**Cenchrus ciliaris, Eulalia aurea, Themeda triandra*).
3. Floodplains with *Corymbia hamersleyana* (F1 and F4): Floodplains with *Corymbia hamersleyana* as scattered trees or open woodland over *Acacia citrinoviridis* over tussock grasses (**Cenchrus ciliaris, Eulalia aurea, Themeda triandra*) and the hummock grass *Triodia epactia.*
4. Floodplains dominated by *Acacia citrinoviridis* and *A. pyrifolia* (F2, F3, F5 and F8): Floodplains with a significant cover of *Acacia citrinoviridis* and *A. pyrifolia* over tussock grasses (**Cenchrus ciliaris, Eulalia aurea, Themeda triandra*).
5. Floodplains supporting *Acacia sclerosperma* subsp. *sclerosperma* (F6 and F7): Floodplains supporting an assemblage of *Petalostylis labicheoides*, *Acacia sclerosperma* subsp. *sclerosperma* and *Triodia epactia*.

5.2 Descriptions of Vegetation Units

Most vegetation units were represented by one or more quadrats and/or relevés on which the vegetation descriptions were based, however the following units were described from mapping notes only:

- Two vegetation units (C1 and C2) were restricted to a segment of the creek located outside the survey area that was originally designated in the scope of work. Although not supported by quadrat or relevé sampling points, descriptions of these units have been included to provide additional information on the gradual transitions in species composition along the creekline further upstream from the proposed discharge point.
- Four vegetation units (F3, F4, F7 and F8) were very similar to other vegetation units, but have been mapped separately rather than being incorporated into these similar units. Although described only from mapping notes, these units were retained in order to highlight the subtle changes in vegetation that otherwise would have been overlooked. Inclusion of these units has strengthened the baseline data by providing information on the shifting pattern of species dominance along the creekline.
- Unit F6 was considered to be relatively degraded, and therefore no quadrats or relevés were established.

At the infraspecific level, *Acacia pyrifolia* var. *pyrifolia, Acacia tumida* var. pilbarensis, *Eucalyptus camaldulensis* subsp. *refulgens* and *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) were the taxa within these species that were found to be dominant in vegetation of the study area. For simplicity, these have been referred to as "*Acacia pyrifolia*", "*Acacia tumida*", "*Eucalyptus camaldulensis*" and "*Tephrosia rosea*" in the following vegetation descriptions.

5.2.1 Vegetation of Creeklines

C1: ChAciAtuGOr — *Corymbia hamersleyana* open woodland over *Acacia citrinoviridis* low open woodland over *Acacia tumida*, *Gossypium robinsonii* scattered tall shrubs

Habitat	This unit occurred in a channel exhibiting mostly braided features with broad floodways. However some meandering characteristics like distinct banks were present in some areas and the creek beds there were also relatively incised. This unit occurred in the easternmost section of the study area. It was distinguished from the adjoining unit F1 by the absence of **Cenchrus ciliaris* and *Triodia epactia*.
Other associated species	Trees and Tall Shrubs: *Acacia pyrifolia* var. *pyrifolia, Androcalva luteiflora, Eremophila longifolia, Gossypium robinsonii, Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301). Low Shrubs: *Isotropis atropurpurea, Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186). Grasses: **Cenchrus ciliaris*, *Enneapogon lindleyanus, Eulalia aurea*, *Themeda triandra.* Herbs: *Phyllanthus maderaspatensis*, *Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Mapping notes; this unit was located outside the original designated survey area.
Notes	The morphology of this segment of the creekline gradually changed to become a shallow channel, which supported vegetation unit C2.
Photo	Plate 5.1.

C2: EvAciAtuAPyTHtTe — *Eucalyptus victrix* open woodland over *Acacia citrinoviridis* scattered low trees over *Acacia tumida*, *A. bivenosa*, *A. pyrifolia* tall open shrubland over *Themeda triandra* very open tussock grassland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred on a channel exhibiting braided characteristics with broad floodways and no distinct banks. It occurred in the easternmost section of the study area.
Other associated species	Trees and Tall Shrubs: *Androcalva luteiflora, Gossypium robinsonii.* Low Shrubs: *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Corchorus crozophorifolius.* Grasses: **Cenchrus ciliaris, Eriachne tenuiculmis, Eulalia aurea.* Herbs: *Phyllanthus maderaspatensis*, *Stemodia grossa.*
Vegetation condition	Very good: scattered **Cenchrus ciliaris* in the grass understorey.
Described from	Mapping notes; this unit was located outside the original designated survey area.
Photo	Plate 5.2.

C3: EvEcAciAPyTErEUa *Eucalyptus victrix*, *E. camaldulensis* open woodland over *Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Tephrosia rosea* low open shrubland over very open mixed herbland over *Eulalia aurea* open tussock grassland

Habitat	This unit occurred on a channel exhibiting braided characteristics with broad floodways and no distinct banks. It occurred towards the eastern end of the study area. The herb stratum was dominated by patches of mixed herbs including *Goodenia lamprosperma, G. stobbsiana* and *Stemodia grossa.*
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa*, *Androcalva luteiflora, Gossypium robinsonii, Grevillea pyramidalis, Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301). Low Shrubs: *Corchorus crozophorifolius.* Grasses: **Cenchrus ciliaris*, *Eriachne pulchella, Eriachne tenuiculmis*, *Themeda triandra.* Herbs: *Gomphrena canescens* subsp*. canescens, Goodenia lamprosperma, G. stobbsiana*, *Phyllanthus maderaspatensis, Stemodia grossa.*
Vegetation condition	Very Good: scattered **Cenchrus ciliaris* in the grass understorey.
Described from	Quadrat BRV02 and mapping notes.
Photo	Plate 5.3.

C4: EvEcAciEUa *Eucalyptus victrix*, *E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Eulalia aurea* very open tussock grassland over very open mixed herbland

Habitat	This unit occurred on part of a channel exhibiting braided characteristics. It occurred towards the eastern section of the study area. The herb stratum was again dominated by patches of mixed herbs, including *Goodenia lamprosperma, G. stobbsiana* and *Stemodia grossa.*
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa*, *A. pyrifolia* var. *pyrifolia*, *Androcalva luteiflora, Gossypium robinsonii, Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301). Low Shrubs: *Corchorus crozophorifolius, Dipteracanthus australasicus* subsp. *australasicus*, *Waltheria indica.* Grasses: **Cenchrus ciliaris, Eragrostis cumingii*, *E. tenellula.* Herbs: *Centipeda minima* subsp. *macrocephala, Cleome viscosa, Evolvulus alsinoides* var. *villosicalyx*, *Goodenia stobbsiana, G. lamprosperma*, *Phyllanthus exilis, Pluchea rubelliflora, Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Quadrat BRV05 and mapping notes.
Notes	The understorey vegetation consisted of a mixed very open herbland. This was not included in the broad vegetation description due to its short-lived nature.
Photo	Plate 5.4.

C5: EvEcAciCEc *Eucalyptus victrix*, *E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over **Cenchrus ciliaris* scattered tussock grasses

Habitat	This unit occurred on a channel exhibiting intermediate characteristics between meandering and braided planforms. It occurred in the central section and towards the western end of the study area. It also occurred on a channel exhibiting braided characteristics with broad floodways and no distinct banks. In this channel, the unit was observed towards the eastern section of the study area.
Other associated species	<u>Trees and Tall Shrubs</u>: *Acacia bivenosa*, *Androcalva luteiflora, Gossypium robinsonii*, *Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301), *Melaleuca glomerata.* <u>Low Shrubs</u>: *Corchorus crozophorifolius*, *Ptilotus astrolasius*, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Waltheria indica.* <u>Grasses</u>: *Digitaria brownii, Eriachne pulchella*, *Eulalia aurea*, *Themeda triandra.* <u>Herbs</u>: *Centipeda minima* subsp. *macrocephala, Goodenia lamprosperma*, *Phyllanthus maderaspatensis, Ptilotus nobilis* subsp. *nobilis, Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Quadrats BRV06, BRV10 and BRV15; and mapping notes.
Photo	Plate 5.5.

C6: EvEcAciMgAam *Eucalyptus victrix*, *E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Melaleuca glomerata*, *Acacia ampliceps* tall shrubland

Habitat	This unit occurred in the western section of the study area, in a channel exhibiting a meandering planform with a few point bars and well defined banks.
Other associated species	<u>Trees and Tall Shrubs</u>: *Acacia coriacea* subsp. *pendens, A. pyrifolia* var. *pyrifolia*, *Androcalva luteiflora, Gossypium robinsonii*, *Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301), *Petalostylis labicheoides.* <u>Low Shrubs</u>: *Dipteracanthus australasicus* subsp. *australasicus*, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Waltheria indica.* <u>Grasses</u>: **Cenchrus ciliaris, *C. setiger, Eragrostis cumingii*, *Eriachne tenuiculmis*, *Eulalia aurea.* <u>Sedges</u>: *Cyperus vaginatus, Schoenoplectus subulatus.* <u>Herbs</u>: **Argemone ochroleuca* subsp. *ochroleuca*, *Goodenia forrestii, G. lamprosperma, Pluchea rubelliflora, Pterocaulon sphacelatum, Stemodia grossa.*
Vegetation condition	Very Good: scattered **Cenchrus ciliaris* in the grass understorey.
Described from	Quadrat BRV19 and mapping notes.
Notes	The six ephemeral pools in the study area were all recorded from this vegetation unit (see Section 7.1).
Photo	Plate 5.6.

C7: EvEcAciMgCEcTe *Eucalyptus victrix*, *E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Melaleuca glomerata* tall shrubland over **Cenchrus ciliaris* scattered tussock grasses over *Triodia epactia* scattered hummock grasses

Habitat	This unit occurred in the western section of the study area on two main channel planforms: a meandering planform with a few point bars and well defined banks in the westernmost part of the study area, and a more braided channel with no distinct banks at the eastern end.
Other associated species	<u>Trees and Tall Shrubs</u>: *Acacia coriacea* subsp. *pendens, A. pyrifolia* var. *pyrifolia*, *Androcalva luteiflora, Gossypium robinsonii, Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301). <u>Low Shrubs</u>: *Dipteracanthus australasicus* subsp. *australasicus, Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Waltheria indica.* <u>Grasses</u>: *Eragrostis cumingii, Eriachne pulchella, Eulalia aurea, Themeda triandra.* <u>Sedges</u>: *Cyperus vaginatus, Schoenoplectus subulatus.* <u>Herbs</u>: **Argemone ochroleuca* subsp. *ochroleuca*, *Cleome viscosa*, *Goodenia lamprosperma, G. stobbsiana, Heliotropium pachyphyllum, Pluchea rubelliflora, Pterocaulon sphacelatum, Stemodia grossa.*
Vegetation condition	Very Good. A few patches in the vicinity of BRV18 were deemed as being in Poor condition due to the presence of **Cenchrus ciliaris* and trampling by cattle and donkeys. However, in general, the condition of this vegetation unit was Very Good.
Described from	Quadrats BRV13, BRV17, BRV18 and BRV20; and mapping notes.
Photo	Plate 5.7.

Plate 5.1: Vegetation unit C1.

Plate 5.2: Vegetation unit C2.

Plate 5.3: Vegetation unit C3.

Plate 5.4: Vegetation unit C4.

Plate 5.5: Vegetation unit C5.

Plate 5.6: Vegetation unit C6.

Plate 5.7: Vegetation unit C7.

5.2.2 Vegetation of Floodplains

F1: ChAciAtuGOrCEcTe — *Corymbia hamersleyana* open woodland over *Acacia citrinoviridis* low open woodland over *A. tumida*, *Gossypium robinsonii* scattered tall shrubs over **Cenchrus ciliaris* very open tussock grassland over *Triodia epactia* scattered hummock grasses

Habitat	This unit occurred on the floodplains located in the easternmost section of the study area. This area appeared more stable than the adjoining braided associated floodplain and was at a relatively higher elevation compared to the creek bed.
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa*, *A. pyrifolia* var. *pyrifolia*, *Androcalva luteiflora, Gossypium robinsonii, Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301). Low Shrubs: *Eremophila longifolia, Isotropis atropurpurea*, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186). Grasses: *Aristida holathera* var. *holathera*, *Eulalia aurea, Themeda triandra.* Herbs: *Phyllanthus maderaspatensis*, *Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Relevé BRV-SA and mapping notes. This unit was located outside the originally designated survey area.
Notes	The architecture of the floodplain gradually changed to be less demarcated from the creek bed when moving downstream, and supported a dense stratum of grasses as described for vegetation unit F2.
Photo	Plate 5.8.

F2: AciAPyTErTHtCEcTe *Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Tephrosia rosea* low open shrub over *Themeda triandra*, **Cenchrus ciliaris* tussock grassland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred on the floodplains located towards the eastern section of the study area. The floodplain in this section was broad, flat and extended over several hundred metres from the creekline. It was interlaced with drainage lines.
Other associated species	Trees and Tall Shrubs: *Acacia ancistrocarpa, Androcalva luteiflora, Gossypium robinsonii, Grevillea wickhamii, Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301). Low Shrubs: *Corchorus crozophorifolius, Indigofera monophylla, Ptilotus astrolasius, Waltheria indica.* Grasses: *Eulalia aurea, Eriachne pulchella, E. tenuiculmis, Themeda triandra.* Herbs: *Evolvulus alsinoides* var. *villosicalyx, Goodenia lamprosperma,* **Malvastrum americanum*, *Phyllanthus maderaspatensis, Pluchea rubelliflora, Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey and **Malvastrum americanum* in the herb stratum.
Described from	Quadrat BRV01 and mapping notes.
Notes	The ground layer was dominated by a dense cover of the grasses mentioned in the vegetation description.
Photo	Plate 5.9.

F3: AciAPyEUaTHtCEcTe *Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Eulalia aurea*, *Themeda triandra,* **Cenchrus ciliaris* tussock grassland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred on the floodplains located towards the eastern section of the study area. The floodplain in this section was broad, flat and extended over several hundred metres from the creekline. It was interlaced with drainage lines.
Other associated species	Trees and Tall Shrubs: *Androcalva luteiflora, Gossypium robinsonii, Hakea lorea* subsp. *lorea*, *Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301), *Petalostylis labicheoides, Stylobasium spathulatum.* Low Shrubs: *Corchorus crozophorifolius, Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Waltheria indica.* Grasses: *Aristida holathera* var. *holathera.* Herbs: *Evolvulus alsinoides* var. *villosicalyx, Goodenia lamprosperma, G. stobbsiana, Pluchea rubelliflora, Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Mapping notes.
Notes	This unit showed a high degree of similarity to vegetation unit F2, except for a lower cover of *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) and a higher cover of *Eulalia aurea*. The ground layer was dominated by a dense cover of grasses.
Photo	Plate 5.10.

F4: ChAciAPyCEcTe — *Corymbia hamersleyana* scattered trees over *Acacia citrinoviridis* low woodland over *A. pyrifolia* tall shrubland over *Cenchrus ciliaris* open tussock grassland over *Triodia epactia* open hummock grassland

Habitat	This unit occurred on a floodplain located in the central section of the study area. The width of the floodplain in this section was intermediate, ranging from a narrow floodplain at the western end to a flat broad floodplain at the eastern end.
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa*, *Androcalva luteiflora*, *Hakea lorea* subsp. *lorea.* Low Shrubs: *Ptilotus obovatus*, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Waltheria indica.* Grasses: *Aristida holathera* var. *holathera*, *Chrysopogon fallax, Eulalia aurea, Themeda triandra.* Herbs: *Goodenia forrestii*, *Phyllanthus maderaspatensis.*
Vegetation condition	Good: presence of *Cenchrus ciliaris* in the grass understorey. Some patches were trampled by cattle and were heavily grazed. However, in general, the condition of this vegetation unit was Good.
Described from	Mapping notes.
Notes	This unit showed a high degree of similarity to vegetation unit F5, except for the presence of *Corymbia hamersleyana* in the tree stratum of F4.
Photo	Plate 5.11.

F5: AciAPyCEcTe — *Acacia citrinoviridis* open woodland over *A. pyrifolia* tall open shrubland over *Cenchrus ciliaris* open tussock grassland over *Triodia epactia* very open hummock grassland

Habitat	This unit was the most common vegetation unit encountered. It was more predominant in the central section of the study area on floodplains and an island within the creek channel. The width of the floodplain in this section was intermediate, ranging from a narrow floodplain at the western end to a flat broad floodplain at the eastern end. It also occurred to a lesser extent towards the eastern and western ends of the study area.
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa*, *Androcalva luteiflora, Gossypium robinsonii*, *Hakea lorea* subsp. *lorea, Indigofera sp.* Bungaroo Creek (S. van Leeuwen 4301), *Petalostylis labicheoides*. Low Shrubs: *Corchorus crozophorifolius, Dipteracanthus australasicus* subsp. *australasicus*, *Senna artemisioides* subsp. *oligophylla*, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186). Grasses: *Aristida contorta*, *Cenchrus setiger*, *Enneapogon caerulescens*, *Eulalia aurea, Themeda triandra.* Herbs: *Evolvulus alsinoides* var. *villosicalyx*, *Gomphrena canescens* subsp. *canescens*, *Goodenia stobbsiana, G. lamprosperma*, *Pluchea rubelliflora, Stemodia grossa.*
Vegetation condition	Good: presence of *Cenchrus ciliaris* in the grass understorey. A few patches in the vicinity of quadrats BRV16 and BRV07 were ranked as Poor due to a dense cover of *Cenchrus ciliaris* and trampling by cattle. In general, however, the condition of this vegetation unit was Good.
Described from	Quadrats BRV07, BRV08, BRV09, BRV12, BRV14 and BRV16; relevé BRVC; and mapping notes.
Notes	*Acacia bivenosa* and *Gossypium robinsonii* were the dominant species in a small area of the floodplain bordering the slope of a ridge.
Photo	Plate 5.12.

F6: PlAsclTe *Petalostylis labicheoides*, *Acacia sclerosperma* tall open shrubland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred on a floodplain located in the western section of the study area. This section was flanked to the north and south by outcropping Boolgeeda Iron Formation and Robe Pisolite mesas, resulting in narrow or no floodplains.
Other associated species	Trees and Tall Shrubs: *Acacia pyrifolia var. pyrifolia, A. inaequilatera, Eucalyptus victrix, Gossypium robinsonii, Stylobasium spathulatum.* Low Shrubs: *Corchorus crozophorifolius, Ptilotus astrolasius, Senna notabilis, Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Waltheria indica.* Grasses: *Aristida contorta, *Cenchrus ciliaris, Themeda triandra.* Herbs: *Evolvulus alsinoides* var. *villosicalyx, Pluchea rubelliflora, Stemodia grossa.*
Vegetation condition	Very Good: presence of a few individuals of **Cenchrus ciliaris* in the grass understorey.
Described from	Mapping notes.
Notes	This unit comprised a small area degraded by cattle activity, which supported a patch of *Acacia sclerosperma*. The ground surface consisted of deteriorated soil with little tussock grass or herb cover. The observed species diversity was consequently very low. This unit is similarity to vegetation unit F7, but was considered too degraded to warrant a formal relevé. It has been mapped as a separate unit to capture the existence of an *Acacia sclerosperma* dominated vegetation community in this area.
Photo	Plate 5.13.

F7: ChAciPlAsclCEcTe *Corymbia hamersleyana* scattered trees over *Acacia citrinoviridis* low woodland over *A. pyrifolia*, *Petalostylis labicheoides*, *A. sclerosperma* tall shrubland over **Cenchrus ciliaris* open tussock grassland over *Triodia epactia* scattered hummock grasses

Habitat	This unit occurred on a floodplain located in the western section of the study area. This section was flanked north and south by outcropping Boolgeeda Iron Formation and Robe Pisolite mesas, resulting in narrow or no floodplains.
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa*, *Gossypium robinsonii*, *Grevillea wickhamii*, *Hakea lorea* subsp. *lorea*, *Stylobasium spathulatum.* Low Shrubs: *Corchorus crozophorifolius, Gossypium australe*, *Ptilotus astrolasius, P. obovatus.* Grasses: *Eragrostis cumingii*, *Eulalia aurea*, *Themeda triandra.* Herbs: *Evolvulus alsinoides* var. *villosicalyx*, *Goodenia forrestii, Ptilotus nobilis.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Mapping notes.
Notes	Both this unit and vegetation unit F1 showed a marked dominance of *Corymbia hamersleyana*, *Acacia citrinoviridis*, **Cenchrus ciliaris* and *Triodia epactia* compared to the other floodplain vegetation units.
Photo	Plate 5.14.

F8: AciAPyPlCEcTe — *Acacia citrinoviridis* open woodland over *A. pyrifolia*, *Petalostylis labicheoides* tall open shrubland over **Cenchrus ciliaris* open tussock grassland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred in the western section of the study area on floodplains and islands within the creek channel. This section was flanked north and south by outcropping Boolgeeda Iron Formation and Robe Pisolite mesas, resulting in narrow or no floodplains.
Other associated species	<u>Trees and Tall Shrubs</u>: *Androcalva luteiflora, Gossypium robinsonii*, *Hakea lorea* subsp. *lorea*, *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301), *Melaleuca glomerata.* <u>Low Shrubs</u>: *Corchorus crozophorifolius, Dipteracanthus australasicus* subsp. *australasicus*, *Senna artemisioides* subsp. *oligophylla*, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186), *Waltheria indica.* <u>Grasses</u>: *Aristida contorta*, *Eriachne tenuiculmis*, *E. pulchella*, *Eulalia aurea, Themeda triandra.* <u>Herbs</u>: **Argemone ochroleuca* subsp. *ochroleuca*, *Evolvulus alsinoides* var. *villosicalyx, Gomphrena canescens* subsp. *canescens*, *Goodenia stobbsiana, G. lamprosperma, Pluchea rubelliflora*, *Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey and **Argemone ochroleuca* subsp. *ochroleuca* in the herb stratum.
Described from	Mapping notes.
Notes	This unit showed a high degree of similarity to vegetation unit F5, except for a higher cover of *Petalostylis labicheoides*.
Photo	Plate 5.15.


Plate 5.8: Vegetation unit F1.


Plate 5.9: Vegetation unit F2.


Plate 5.10: Vegetation unit F3.


Plate 5.11: Vegetation unit F4.

Plate 5.12: Vegetation unit F5.

Plate 5.13: Vegetation unit F6.

Plate 5.14: Vegetation unit F7.

Plate 5.15: Vegetation unit F8.

5.3 Vegetation Condition

In general, the vegetation condition of the creek bed was ranked as being Very Good, while that of the floodplain was categorised as Good. Thirteen weed species were recorded in the study area. **Cenchrus ciliaris* and **Argemone ochroleuca* subsp*. ochroleuca* were the most abundant species and were widespread along the length of the creek bed. **Cenchrus ciliaris* occurred as scattered grasses or very open tussock grasslands along the creekline, while **Argemone ochroleuca* subsp*. ochroleuca* was observed in the open areas of the creek bed as dense patches of mostly seedlings. The floodplains had a higher degree of invasion by **Cenchrus ciliaris,* which occurred there as open tussock grasslands to tussock grasslands. Moreover, the patches of **Cenchrus ciliaris* encountered between quadrats BRV19 and BRV18 (in the western section of the study area) were mostly grazed but covered a broad area. The diversity of native grasses and herbs in this area was observed to be very low. Furthermore, this zone was trampled by herds of cattle and donkeys, leading to an apparent deterioration in the structure of the topsoil layer. **Cenchrus ciliaris* also occurred as a few small high-density patches in areas around quadrats BRV16 (western section of the study area) and BRV07 (eastern section), leading to a Poor vegetation condition ranking for those minor segments.

The vegetation was cleared along a stretch of single dirt track running along the creek bed between quadrats BRV18 and BRV20. However, as the creek was broad in that segment, the condition of the vegetation on either side of the track was still Very Good.

5.4 Conservation Significance of the Vegetation Units

5.4.1 Threatened Ecological Communities

No TECs occur within the study area. The nearest mapped TEC, the '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)', is located approximately 25 km north of the study area and would not occur in the study area due to a lack of suitable habitat (clay plains; see Section 4.5.1).

5.4.2 Priority Ecological Communities

No PECs have been recorded within the study area. The nearest mapped PEC, the 'Brockman Iron cracking clay communities of the Hamersley Range', is located approximately 25 km north of the study area. This unit would not occur in the study area due to a lack of suitable habitat (clay plains; see Section 4.5.2).

5.4.3 Ecosystems at Risk

A number of ecosystems in each WA IBRA subregion are listed as being "at risk" from various threatening processes. Of those listed for the Hamersley subregion (see Kendrick 2003), only one is of relevance to the study area:

- "All major ephemeral water courses" – *Eucalyptus* forests with a shrubby understorey; these communities are under threat from cattle grazing, feral animals (particularly donkeys, horses and cattle) and invasive weeds (particularly Buffel Grass **Cenchrus ciliaris* and Ruby Dock **Acetosa vesicaria*).

Such habitats occur throughout the Pilbara, from near the northern coast to the southern edge of the bioregion. Their distribution is approximated by the mapping of the River land system (Payne et al. 1988, van Vreeswyk et al. 2004) but this does not adequately capture a number of significant drainage systems (e.g. Boolgeeda Creek, Beasley River and the Caves Creek / Duck Creek system in the Brockman locality).

Although none of the vegetation units described for study area are Eucalypt forests, Boolgeeda Creek is a major ephemeral watercourse and several of the units would be similarly at risk from these threats. These units have therefore been identified as being of some conservation significance (Section 5.4.4).

5.4.4 Other Vegetation Communities of Conservation Significance – Riparian Eucalypt Woodlands

Six vegetation units (C2, C3, C4, C5, C6 and C7) have been defined as *Eucalyptus victrix* and *Eucalyptus camaldulensis* woodland to open woodland. These riparian vegetation units occur along the major ephemeral watercourse and are at risk from similar threats to the *Eucalyptus* forests discussed in Section 5.4.3. These have been classified as units of conservation significance. These vegetation units represent 34% (443 ha) of the study area and are distributed along the length of the creekline except for the easternmost section.

Other vegetation units similarly dominated by *Eucalyptus victrix* and *Eucalyptus camaldulensis* have been recorded in the vicinity of the study area, as indicated in Table 5.2. With regard to the broader extent of such vegetation, riparian vegetation with mixed scattered *Eucalyptus camaldulensis, E. victrix* trees over *Acacia citrinoviridis* tall shrubs/low trees has been recorded over a range of approximately 200 km through the southern half of the Pilbara bioregion, from Caves Creek in the west to the vicinity of Hope Downs in the east (Biota unpubl. data).

Table 5.2: Vegetation units comprising riparian Eucalypts on major ephemeral water courses in the vicinity of the study area.

Location	Distance from Study Area	Broad Description	Area (ha)
West Turner (Biota 2013b)	35 km southeast	*Eucalyptus* spp. woodland over tall open scrub	408.0
West Turner (Biota 2013b)	35 km southeast	*Eucalyptus victrix* low open woodland over tall open shrubland over very open tussock grassland	4.3
Beasley River (Biota 2009c)	9 km south-southeast	*Eucalyptus camaldulensis*, *E. victrix* open woodland over *Acacia citrinoviridis*, *A. coriacea* subsp. *pendens*, *Melaleuca glomerata* tall shrubland over **Cenchrus ciliaris* very open tussock grassland	151.9
Beasley River (Biota 2009c)	9 km south-southeast	*Eucalyptus victrix*, *E. xerothermica* open woodland over *Acacia citrinoviridis* tall closed scrub over **Cenchrus ciliaris* closed tussock grassland	1.6
Boolgeeda Creek (upstream of survey area) (Biota 2005)	3 km northeast	*Eucalyptus victrix*, *E. xerothermica* low open woodland over *Acacia citrinoviridis* tall open shrubland over *Themeda triandra*, *Chrysopogon fallax* tussock grassland	42.9
Caves Creek and Duck Creek (Biota 2012b)	28 km north	*Eucalyptus victrix, E. camaldulensis* low open woodland to closed forest	NA (not mapped).

6.0 Flora

6.1 Overview

A total of 226 native vascular flora taxa from 116 genera belonging to 42 families were recorded in the study area (Appendix 6). Data collected for the quadrats and relevés are provided in Appendix 7.

The most speciose families and genera across both sampling phases are listed in Table 6.1. These are typical of the most well represented families and genera for the Pilbara bioregion.

Table 6.1: The most speciose families and genera recorded within the study area.

Family	No. of Native Taxa
Fabaceae	45
Poaceae	34
Malvaceae	22
Amaranthaceae	14
Asteraceae	10
Chenopodiaceae	10
Genus	No. of Native Taxa
Acacia	21
Senna	12
Ptilotus	7
Abutilon	6

6.2 Flora of Conservation Significance

6.2.1 Threatened Flora

No Threatened Flora listed under the *EPBC Act 1999* or the *Wildlife Conservation Act 1950* have been recorded within the study area and none would be expected to occur (see Section 4.5.1).

6.2.2 Priority Flora

Four Priority species were recorded in the study area: *Goodenia nuda* (P4), *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (P3), *Pentalepis trichodesmoides* subsp. *hispida* (P2) and *Peplidium* sp. Fortescue Marsh (S. van Leeuwen 4865) (P1). The locations of the four Priority species are provided in Appendix 8 and mapped in Appendix 9.

Goodenia nuda and *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) were previously recorded within 40 km of the study area, and had been considered likely to occur in the study area (Table 4.2). However, neither *Pentalepis trichodesmoides* subsp. *hispida* nor *Peplidium* sp. Fortescue Marsh (S. van Leeuwen 4865) had been previously recorded in the locality. *Pentalepis trichodesmoides* subsp. *hispida* has only recently been discriminated (Orchard and Cross 2012), and subsequently listed as a Priority taxon. This species is likely to be poorly vouchered as a result. *Peplidium* sp. Fortescue Marsh (S. van Leeuwen 4865) is a small annual species, which is currently known from only one other location in the Pilbara. This species would be under-collected due to its habit, and the fact that it would only be recorded during favourable collecting conditions.

Each species is described further below:

- *Goodenia nuda* Priority 4
  Goodenia nuda is an erect to ascending, slender herb growing to 50 cm in height (Plate 6.1 and Plate 6.2), with narrow, pale green glaucous leaves (DPaW 2013). The basal leaves are entire or narrowly toothed. This species is typically found growing near creeklines and in wet areas. Specimens of *Goodenia nuda* were collected from five locations from both creek bed (vegetation units C4 and C7) and floodplain (vegetation units F2 and F5) habitats.

  This species has a broad distribution; most records occur over a range of approximately 450 km through the Pilbara bioregion, with populations known from Karijini and Millstream-Chichester National Parks. There is also an outlying record from the Canning Stock Route in the Gascoyne bioregion.

Plate 6.1: Growth form of *Goodenia nuda*.

Plate 6.2: Flowers of *Goodenia nuda*.

- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) Priority 3
  Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) is a perennial shrub that grows to 2 m in height Plate 6.3 and Plate 6.4), and prefers gully and creekline habitats (DPaW 2013). Some 1,626 individuals of this taxon were recorded from 134 locations within the study area. *Indigofera* sp. Bungaroo Creek (S. van Leeuwen) was recorded from both creek bed and floodplain habitats.

Plate 6.3: Growth form of *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301).

Plate 6.4: Flowering stem of *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301).

- *Pentalepis trichodesmoides* subsp. *hispida* Priority 2
  Pentalepis trichodesmoides subsp. *hispida* is an upright shrub found in *Triodia* hummock grasslands. *Pentalepis trichodesmoides* subsp. *hispida* has only recently been discriminated (Orchard and Cross 2012), and subsequently listed as a Priority taxon. On the basis of the current voucher specimens, this species occurs over a broad range of over 200 km, from the vicinity of Roebourne in the north and Tom Price in the south. Specimens have been collected from both Millstream-Chichester National Park and Karijini National Park. *Pentalepis trichodesmoides* subsp. *hispida* was collected from a floodplain in the central section of the study area (vegetation unit F5), and has also been collected from West Turner (Biota 2013b). It is likely that the range of this species will be extended as further collections are made.

- *Peplidium* sp. Fortescue Marsh (S. van Leeuwen 4865) Priority 1
  Peplidium sp. Fortescue Marsh (S. van Leeuwen 4865) is small herb growing up to 4 cm tall and 30 cm across and it flowers in August (DPaW 2013). One specimen of this taxon was collected from the study area from an open creek bed supporting vegetation unit C3. There is only one other record of this species, from a saline flat on the northern apron of the Fortescue Marsh, approximately 270 km east of the study area. This small annual herb would only be visible for a short period following adequate rainfall, which may explain the lack of additional records of this species from the region.

6.2.3 Unresolved taxa

Other species, while not formally listed as Threatened or Priority flora may be considered to be of conservation interest for a number of reasons; for instance, if they represent apparently new (undescribed) taxa, if they are poorly collected, or the record represents a considerable range extension).

- Malvaceae family

Numerous undescribed taxa within the Malvaceae family have been recorded from the Pilbara bioregion. Four apparently undescribed entities belonging to the genera *Abutilon* and *Gossypium* were identified from the study area, however as these are not yet formally recognised, they have not been separately recognised in the species list (Appendix 6). All of the entities have been recorded from other areas in the Pilbara (Biota internal records). It is not clear at this stage whether these specimens represent new species or simply variations within existing species. Further work (including genetic analysis) would be required to determine their taxonomic status.

  - *Abutilon* aff*. lepidum*

  Two phenotypic variants in the *Abutilon "lepidum"* species complex were identified from the study area; these were informally designated *Abutilon* aff. l*epidum* and *Abutilon* aff. *lepidum* (1) (MET 15 352) using the reference set held by M.E. Trudgen & Associates.

  - *Gossypium australe*

  Two forms of *Gossypium australe* were identified from the study area; these were informally designated *Gossypium australe* (Burrup Peninsula form) and *G. australe* (Whim Creek form) using the reference set held by M.E. Trudgen & Associates. Both entities are widespread in the Pilbara: the former is more common, occurring in drainage areas and on plains, while the latter occurs mainly on hillslopes and rocky areas and can be distinguished by the more dense, felty indumentum on the leaves. Further work is required to allocate formal phrase names to these taxa.

- **Portulaca oleracea/P. intraterranea*

  The taxonomy of "*Portulaca oleracea*" in the Pilbara is currently unresolved. It is not clear whether collections from this region belong to the introduced species **Portulaca oleracea,* the native species *P. intraterranea* and/or one or more undescribed taxa (S. Dillon, WA Herbarium, pers. comm. 2012). For the purpose of this report, all specimens have been allocated to **Portulaca oleracea/P. intraterranea*" and this taxon has been treated as a potential weed species.

6.3 Introduced Flora

Thirteen introduced flora (weed) species were recorded in the study area (see Appendix 8 for the locations and Appendix 10 for their distribution on maps). These species are typically found in creekline systems and habitats disturbed by livestock.

One of the introduced species recorded in the study area, **Argemone ochroleuca* subsp. *ochroleuca*, is listed as a declared pest for the whole of Western Australia under the *Biosecurity and Agriculture Management Act 2007*. However **Cenchrus ciliaris* and **C. setiger* are considered to be serious environmental weeds according to the Draft Environmental Weed Strategy for Western Australia (EWSWA) (CALM 1999) and DPaW's Invasive Plant Prioritisation Process (IPPP) weed list for the Pilbara region (DEC 2012c). Of the other introduced species recorded, those considered to be rapidly invasive by the IPPP are **Argemone ochroleuca* subsp. *ochroleuca*, **Bidens bipinnata*, **Malvastrum americanum*, **Setaria verticillata*, **Sigesbeckia orientalis*, **Sonchus oleraceus*, **Tribulus terrestris* and **Vachellia farnesiana*. Traits for the successful colonisation of invasive weeds include prolific seed production, rapid vegetative reproduction and good seed viability among others.

A brief description of each introduced species is provided in Table 6.2, including an ecological impact and invasiveness rating based on the IPPP recommendation.

Table 6.2: Introduced species recorded in the study area.

Weed Species	Habit	Habitat	Locations	IPPP rating
**Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy)	Annual herb growing up to 1 m tall, with yellow, cream or white flowers and deeply divided, large prickly leaves (Hussey et al. 1997). This robust annual is difficult to control as it produces very large quantities of seed, and flooding of its habitat can spread the seed large distances.	Typically occurs in open, gravelly creek beds.	Mexican Poppy is a relatively common weed of major creeklines in the Hamersley subregion. It was recorded from 160 locations in the study area.	Ecological Impact: Low. Invasiveness: Rapid.
**Bidens bipinnata* (Bipinnate Beggartick)	Annual daisy, which grows to 90 cm tall and produces yellow flowers between March and September.	Commonly observed in Mulga vegetation and along creeklines in the Pilbara. It may occur in high densities within suitable habitats and given appropriate conditions, but on its own does not appear to cause exclusion of native flora species.	Bipinnate Beggartick is distributed across the north of the State from Kununurra to Carnarvon and is scattered throughout the Pilbara and Gascoyne regions (Hussey et al. 1997). It was recorded from 1 location in the study area.	Ecological Impact: Unknown. Invasiveness: Rapid.
**Cenchrus ciliaris* (Buffel Grass)	Tufted or sometimes stoloniferous perennial grass growing to a height of 0.2-1.5 m. It produces a purplish inflorescence from February to October. Buffel Grass was introduced by pastoralists as a fodder species. It has demonstrated allelopathic capacities whereby it releases chemicals that inhibit the growth of other plants (Cheam 1984). It is an aggressive and effective competitor with native flora species, forming dense tussock grasslands in susceptible habitats.	Occurs along creeklines, floodplains and in sandy coastal areas.	It is common in the Pilbara, Gascoyne, Carnarvon and Kimberley regions, and is also found throughout desert areas in central Western Australia, as well as in Perth. It was recorded from 153 locations within the study area.	Ecological Impact: High. Invasiveness: Rapid.
**Cenchrus setiger* (Birdwood Grass)	Erect stoloniferous perennial grass usually to 1 m tall, producing cream-purplish flowers from April to May. Less common than Buffel Grass, but appears equally invasive and occurs in many of the same areas.	Occurs along creeklines, floodplains and in sandy coastal areas.	Birdwood Grass occurs mainly in the Pilbara, Gascoyne, Carnarvon and Kimberley regions. It was recorded from seven locations in the study area.	Ecological Impact: High. Invasiveness: Rapid.
**Cucumis melo* subsp. *agrestis* (Ulcardo Melon)	Trailing annual herb with bristly or softly hairy leaves and yellow flowers in autumn and spring. The mature fruit are ellipsoid, 2-5 cm in length, green to yellow in colour, and become glabrescent with age.	Grows in a variety of habitats including grasslands on cracking clays, *Eucalyptus*, *Corymbia*, *Acacia*, or *Grevillea* grassy woodlands on clay flats.	Ulcardo Melon is a widespread weed throughout the Kimberley, Pilbara and Gascoyne bioregions. It was recorded from seven locations in the study area.	Not rated.
**Flaveria trinervia* (Speedy Weed)	Annual, erect herb growing up to 1.5 m tall. The inflorescence consists of a large dense cluster of yellowish flower heads.	This species occurs in a variety of habitats, including drainages and disturbed areas.	Speedy Weed is common in the Pilbara. It was recorded from two locations in the study area.	Not rated.

Weed Species	Habit	Habitat	Locations	IPPP rating
**Malvastrum americanum* (Spiked Malvastrum)	Erect, perennial herb or shrub growing to 1.3 m tall, with yellow or orange flowers produced from April to July.	Common weed of Mulga vegetation, hillsides, floodplains and drainage lines.	Spiked Malvastrum is widespread throughout the Kimberley, Pilbara, Gascoyne and Carnarvon bioregions. It was recorded from 33 locations within the creek system.	Ecological Impact: High. Invasiveness: Rapid.
**Portulaca oleracea* (Purslane)	Succulent, usually prostrate, annual herb that can grow to 20 cm tall. It produces yellow flowers from April to May.	Purslane prefers sandy or clay-loam soils and is often found at sites that have been previously disturbed, although it is also recorded in apparently intact native vegetation.	It is not clear whether the *Portulaca* specimens from the study area represent **P. oleracea, P. intraterranea* or another species. The taxon designated as **Portulaca oleracea / P. intraterranea* was recorded from three locations in the study area.	Not rated.
**Setaria verticillata* (Whorled Pigeon Grass)	Loosely tufted, annual grass species growing to 1.3 m tall with a dense, spike-like inflorescence (Hussey et al. 1997).	Whorled Pigeon Grass is a common species of creeklines and Mulga vegetation in the Pilbara, but rarely occurs in large numbers.	Whorled Pigeon Grass is widespread around the State from Kununurra to Albany. It was recorded from one location in the study area.	Ecological Impact: High. Invasiveness: Rapid.
**Sigesbeckia orientalis* (Indian Weed)	Annual daisy growing to 1 m in height.	Indian Weed has been found in rocky gullies, limestone ranges and creek beds.	Indian Weed occurs from the Pilbara to the Southwest region of Western Australia. It was recorded from one location in the study area.	Ecological Impact: Unknown. Invasiveness: Rapid to Moderate.
**Sonchus oleraceus* (Common Sowthistle)	Erect annual growing to 1.5 m tall with yellow flowers produced year round.	Common Sowthistle is a widespread annual weed of creeklines, floodplains, wasteland and disturbed areas.	Common Sowthistle is common from Exmouth to the Nullarbor and is also found scattered in the Kimberley, Pilbara and Murchison bioregions (Hussey et al. 1997). It was recorded from five locations in the study area.	Ecological Impact: Low. Invasiveness: Rapid.
**Tribulus terrestris* (Caltrop)	Prostrate and villous annual herb producing flowers all year.	Caltrop grows on sandy soils and waste places.	Caltrop is widespread around the State from Kununurra to Albany. It was recorded from one location in the study area.	Ecological Impact: Low. Invasiveness: Slow.

Weed Species	Habit	Habitat	Locations	IPPP rating
**Vachellia farnesiana* (Mimosa Bush)	Spreading, thorny shrub growing to 4 m tall, with dark grey bark, pinnate leaves and yellow flowers in winter.	Mimosa Bush occurs along drainage systems and in adjacent low-lying areas.	Mimosa Bush is widespread from the Kimberley to near Perth. It is thought to have been introduced prior to European settlement and now occurs as scattered shrubs to dense thickets (Hussey et al. 1997). It was recorded from 16 locations in the study area.	Ecological Impact: High. Invasiveness: Rapid.

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7.0 Other Environmental Features

7.1 Ephemeral pools

Ephemeral pools (Plate 7.1 to Plate 7.6) were observed solely in the vicinity of quadrat BRV19 in the western section of the study area in vegetation unit C6. In this part of the creekline, the channel was meandering and flanked on both sides by the slopes of a continuous range of hills. Herds of cattle and donkeys were observed in this locality. It was noted that the density of Buffel Grass (**Cenchrus ciliaris*) in this particular area was higher, albeit grazed, and the native ground cover vegetation was almost non-existent. However, *Eucalyptus victrix* and *E. camaldulensis* subsp. *refulgens* occurred as an open forest to a woodland over a low open woodland to a woodland of *Acacia citrinoviridis*, thus providing a shaded environment. Details on the ephemeral pools are provided in Table 7.1.

Table 7.1: Ephemeral pools observed in the study area.

Feature	Location		Dimension	Associated Species
	Easting	Northing		
Pool 1	494191	7498346	20 m x 25 m	*Melaleuca glomerata*, *Acacia ampliceps*, *Schoenoplectus subulatus*.
Pool 2	496225	7498956	5 m x 35 m	*Eucalyptus victrix*, *Acacia ampliceps*, *Melaleuca glomerata*.
Pool 3	496452	7499152	3 m x 6 m	*Eucalyptus victrix*, *Acacia ampliceps*, *Melaleuca glomerata*, *Schoenoplectus subulatus*.
Pool 4	496495	7499200	1.5 m x 10 m	*Eucalyptus camaldulensis* subsp. *refulgens*, *Eucalyptus victrix*, *Acacia ampliceps*, *Cyperus vaginatus*.
Pool 5	496652	7499331	25 m x 40 m	*Eucalyptus camaldulensis* subsp. *refulgens*, *Eucalyptus victrix*.
Pool 6	494035	7498059	5 m x 25 m	*Melaleuca glomerata*, *Cyperus vaginatus*, *Schoenoplectus subulatus*, *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186).

Plate 7.1: Ephemeral pool 1.

Plate 7.2: Ephemeral pool 2.

Plate 7.3: Ephemeral pool 3.

Plate 7.4: Ephemeral pool 4.

Plate 7.5: Ephemeral pool 5.

Plate 7.6: Ephemeral pool 6.

7.2 Erosion

Pronounced erosion was recorded at three sites, which were located on the braided part of the creek channel where the banks appeared less stable. These sites were in the vicinity of quadrats BRV09 and BRV05 in the eastern section of the study area. The locations of the erosion sites are provided in Table 7.2.

Table 7.2: Locations where erosion was recorded in the study area.

Location		Photograph
Easting	Northing	
517117	7504497	
511488	7503313	 

Location		Photograph
Easting	Northing	
517801	7504371	 

8.0 Glossary and Acronyms

*	Used prior to a species name to denote a weed species.
Annual (plant)	A plant that lives for only one year.
Braided channel	A braided planform is distinguished by poorly defined channels with numerous interlaced channels that divide and rejoin around unstable bars and small islands.
Conservation Significant	A plant that is recognised to be rare, unusual, new or poorly sampled; may have a formally assigned conservation ranking (see Appendix 1 for more on the WA conservation framework).
Cover value	Species are quantified by estimating the "birds-eye-view" percentage of the ground occupied in a survey area; the percentage is called the cover value.
Cut banks	An eroded, concave bank formed at a bend of a river or creek by the flow of water around the bend.
Cryptic	Plants that die back to a perennial root-stock under dry conditions; considered cryptic (meaning hidden) because although they are consistently present, it is difficult to tell unless suitable conditions prevail.
DEC	Former Department of Environment and Conservation, currently known as Department of Parks and Wildlife.
Dominant species	The species that occur most abundantly in an area or vegetation stratum.
DPaW	Department of Parks and Wildlife, formally known as the Department of Environment and Conservation.
EPA	Environmental Protection Authority of Western Australia.
EPBC Act 1999	The Federal *Environment Protection and Biodiversity Conservation Act 1999.*
Ephemeral	A plant that lives a very short time; less than one year or, usually, less than six months.
Ephemeral pools	Temporary pools of water.
Flora keys	Botanical publications containing a series of questions (regarding the plant's characteristics) aiding in the identification of a taxon.
Foot traverse	Consists of walking through an area to confirm or note the vegetation and/or species presence (usually sampling a narrow corridor/cross section of vegetation).
IBRA	Interim Biogeographical Regionalisation for Australia.
Infraspecific	Taxon designation below species level; e.g. variety (var.) or subspecies (subsp.).
Meandering channel	A meandering planform is characterised by a single and sinuous main channel with a few point bars, cut-banks and well-defined banks.
Opportunistic	A plant species collected from outside the formal quadrat sites; sometimes abbreviated to "Opp."
Perennial	A plant that lives for more than two growing seasons.
PEC	Priority Ecological Community (see Appendix 1 for more on the WA conservation framework).
Planform	Form of a river seen from above; i.e. from a 'bird's eye' or 'plan' view.
Point bar	Accumulation of sediment located on the inside of a meander bend.
Priority flora	Flora listed by DPaW as requiring additional information to properly evaluate their conservation significance; see Appendix 1 for more on the WA conservation framework.
Quadrat	A bounded sample area of uniform vegetation in which all species present are recorded; the standard quadrat size for the Pilbara is 50 m by 50 m, or an equivalent area (2,500 m^2).

Relevé	An unbounded flora sampling site, with a similar area to a quadrat, in which most species present are recorded.
Riparian	Vegetation associated with water and characterised by hydrophilic plants.
Stratum (plural: strata)	A horizontal level of vegetation defined by growth habit (and sometimes height); e.g. low trees, tall trees, tussock grasses, hummock grasses).
Taxon (plural: taxa)	An entity at species level or below.
TEC	Threatened Ecological Community (see Appendix 1 for more on the WA conservation framework).
Threatened flora	Flora protected by legislation, either listed under the Commonwealth *EPBC Act 1999* or the WA *Wildlife Conservation Act 1950* (species formerly known as Declared Rare Flora); see Appendix 1 for more on the WA conservation framework.

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Appendix 1

Framework for Conservation Significance Ranking of Communities and Species in WA

A. Definitions, Categories and Criteria for Threatened and Priority Ecological Communities

1. General Definitions

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

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

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

Possible threatened ecological communities that do not meet survey criteria are added to DPaW’s Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An assemblage is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (e.g. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
“An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts.”

Community structure is defined as follows:
“The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage” (e.g. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, e.g. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: “changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention.”

Destruction: “modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention.”

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

<u>Modification of ecological processes:</u> The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

<u>Modification of structure:</u> The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

<u>Modification of species composition:</u> Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced micro-organisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. Definitions and Criteria for Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable Ecological Communities

ECOLOGICAL COMMUNITIES

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

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

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

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

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

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

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

   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

   ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

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

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

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

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

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

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

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

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

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

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

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

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

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

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

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

3. Definitions and Criteria for Priority Ecological Communities

PRIORITY ECOLOGICAL COMMUNITY LIST
Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities
Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities
Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;

(iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities
Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

B. Threatened Flora Statutory Framework

In Western Australia, all native flora species are protected under the *Wildlife Conservation Act 1950-1979,* making it an offence to remove or harm native flora species without approval. In addition to this basic level of statutory protection, a number of plant species are assigned an additional level of conservation significance based on the fact that there are a limited number of known populations, some of which may be under threat.

Species of the highest conservation significance are designated Threatened, either extant or presumed extinct:

- X: Presumed Extinct (Threatened Flora - Presumed Extinct): taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee;
- T: Threatened Flora (Threatened Flora - Extant): taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee (Atkins 2008). *(= Threatened Flora = Endangered + Vulnerable)*

Species that appear to be rare or threatened, but for which there is insufficient information to properly evaluate their conservation significance, are assigned to one of four Priority flora categories:

- P1: Priority One - Poorly Known: taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
- P2: Priority Two - Poorly Known: taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
- P3: Priority Three - Poorly Known: taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.
- P4: Priority Four - Rare: taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5–10 years.
- P5: Priority Five – Conservation Dependent: taxa that are subject to a specific conservation program, the cessation of which would result in the taxon becoming Threatened within five years.

Note that of the above classifications, only 'Threatened' has statutory standing. The Priority Flora classifications are employed by the Department of Environment and Conservation to manage and classify their database of species considered potentially rare or at risk, but these categories have no legislative status. Note also that proposals that appear likely to affect Threatened flora require formal written approval from the Minister for the Environment under Section 23(f) of the *Wildlife Conservation Act 1950-1979* in addition to the requirements of the *Environmental Protection (Native Vegetation Clearing) Regulations 2004*.

Appendix 2

Nature Map Search Results

FAMILY	SPECIES	CONSERVATION STATUS
Acanthaceae	*Dicladanthera forrestii*	
	Rostellularia adscendens var. *clementii*	
	Rostellularia adscendens var. *latifolia*	P4
	Trianthema oxycalyptra var. *oxycalyptra*	
	Zaleya galericulata subsp. *galericulata*	
Amaranthaceae	*Alternanthera angustifolia*	
	Alternanthera denticulata	
	Alternanthera nana	
	Amaranthus cuspidifolius	
	Amaranthus undulatus	
	Gomphrena canescens	
	Gomphrena canescens subsp. *canescens*	
	Gomphrena kanisii	
	Ptilotus aervoides	
	Ptilotus astrolasius	
	Ptilotus auriculifolius	
	Ptilotus calostachyus	
	Ptilotus clementii	
	Ptilotus fusiformis	
	Ptilotus gomphrenoides	
	Ptilotus mollis	P4
	Ptilotus obovatus	
	Ptilotus rotundifolius	
	Ptilotus schwartzii	
	Ptilotus subspinescens	P3
Apiaceae	*Daucus glochidiatus*	
Apocynaceae	*Carissa lanceolata*	
	Cynanchum floribundum	
Araliaceae	*Trachymene oleracea*	
	Trachymene oleracea subsp. *oleracea*	
	Trachymene pilbarensis	
Arecaceae	*Livistona alfredii*	P4
Asphodelaceae	*Bulbine pendula*	
Asteraceae	**Bidens bipinnata*	
	Blumea tenella	
	Calocephalus beardii	
	Calocephalus sp. Wittenoom (A.S. George 1082)	
	Calotis hispidula	
	Centipeda crateriformis subsp. *crateriformis*	
	Centipeda minima	
	Centipeda minima subsp. *macrocephala*	
	Chrysocephalum gilesii	
	**Flaveria trinervia*	
	Helichrysum luteoalbum	
	Iotasperma sessilifolium	P3
	Olearia fluvialis	
	Olearia xerophila	
	Peripleura arida	
	Pluchea rubelliflora	
	Pterocaulon sphacelatum	
	Rhodanthe humboldtiana	
	Rhodanthe margarethae	
	**Sonchus oleraceus*	
	Streptoglossa bubakii	
	Streptoglossa cylindriceps	
	Streptoglossa decurrens	
	Streptoglossa tenuiflora	
Boraginaceae	*Heliotropium crispatum*	

FAMILY	SPECIES	CONSERVATION STATUS
	Heliotropium ovalifolium	
	Heliotropium tanythrix	
	Heliotropium tenuifolium	
	Trichodesma zeylanicum var. *zeylanicum*	
Brassicaceae	*Lepidium muelleri-ferdinandii*	
	Lepidium oxytrichum	
	Lepidium phlebopetalum	
	Lepidium pholidogynum	
	Stenopetalum anfractum	
Campanulaceae	*Lobelia arnhemiaca*	
	Wahlenbergia caryophylloides	
	Wahlenbergia tumidifructa	
Capparaceae	*Capparis lasiantha*	
	Capparis umbonata	
Caryophyllaceae	*Polycarpaea holtzei*	
	Polycarpaea involucrata	
Celastraceae	*Stackhousia intermedia*	
Chenopodiaceae	*Dysphania glomulifera* subsp. *eremaea*	
	Dysphania kalpari	
	Dysphania rhadinostachya subsp. *rhadinostachya*	
	Dysphania sphaerosperma	
	Enchylaena tomentosa var. *tomentosa*	
	Maireana carnosa	
	Maireana eriosphaera	
	Maireana georgei	
	Maireana melanocoma	
	Maireana planifolia	
	Maireana suaedifolia	
	Maireana trichoptera	
	Salsola australis	
	Sclerolaena costata	
	Sclerolaena cuneata	
	Sclerolaena eriacantha	
	Sclerolaena lanicuspis	
	Sclerolaena minuta	
	Tecticornia disarticulata	
Convolvulaceae	*Convolvulus angustissimus*	
	Duperreya commixta	
	Ipomoea muelleri	
	Polymeria ambigua	
	Polymeria longifolia	
Cyperaceae	*Bulbostylis barbata*	
	Bulbostylis turbinata	
	Cyperus cunninghamii	
	Cyperus iria	
	Cyperus squarrosus	
	Eleocharis atropurpurea	
	Eleocharis geniculata	
	Eleocharis spiralis	
	Fimbristylis microcarya	
	Fimbristylis simulans	
	Lipocarpha microcephala	
	Schoenoplectus laevis	
	Schoenoplectus subulatus	
Dilleniaceae	*Hibbertia glaberrima*	
Elatinaceae	*Bergia ammannioides*	
Euphorbiaceae	*Adriana tomentosa*	
	Euphorbia australis	

FAMILY	SPECIES	CONSERVATION STATUS
	Euphorbia boophthona	
	Euphorbia inappendiculata var. *inappendiculata*	
	Euphorbia tannensis subsp. eremophila	
	Euphorbia trigonosperma	
Fabaceae	*Acacia adsurgens*	
	Acacia ampliceps	
	Acacia aneura	
	Acacia aptaneura	
	Acacia arida	
	Acacia atkinsiana	
	Acacia bivenosa	
	Acacia bromilowiana	P4
	Acacia coriacea subsp. *coriacea*	
	Acacia cowleana	
	Acacia elachantha	
	Acacia exilis	
	Acacia hamersleyensis	
	Acacia kempeana	
	Acacia marramamba	
	Acacia monticola	
	Acacia pruinocarpa	
	Acacia pyrifolia	
	Acacia pyrifolia var. *pyrifolia*	
	Acacia sclerosperma subsp. *sclerosperma*	
	Acacia sibirica	
	Acacia spondylophylla	
	Acacia tenuissima	
	Cullen graveolens	
	Cullen leucanthum	
	Cullen leucochaites	
	Cullen pogonocarpum	
	Gastrolobium grandiflorum	
	Glycine canescens	
	Glycine falcata	P3
	Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3
	Isotropis atropurpurea	
	Lotus cruentus	
	Mirbelia viminalis	
	Rhynchosia australis	
	Rhynchosia bungarensis	P4
	Rhynchosia minima	
	Senna artemisioides subsp. *oligophylla*	
	Senna glutinosa	
	Senna hamersleyensis	
	Senna stricta	
	Senna symonii	
	Swainsona kingii	
	Swainsona maccullochiana	
	Swainsona thompsoniana	
	Templetonia egena	
	Tephrosia oxalidea	
	Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	
	Tephrosia sp. Fortescue (A.A. Mitchell 606)	
	Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)	
	Tephrosia stipuligera	

FAMILY	SPECIES	CONSERVATION STATUS
Goodeniaceae	*Dampiera anonyma*	P3
	Dampiera candicans	
	Dampiera dentata	
	Goodenia lamprosperma	
	Goodenia microptera	
	Goodenia muelleriana	
	Goodenia pascua	
	Goodenia stellata	
	Goodenia stobbsiana	
	Goodenia tenuiloba	
	Scaevola acacioides	
Gyrostemonaceae	*Codonocarpus cotinifolius*	
Haloragaceae	*Haloragis gossei*	
	Haloragis gossei var. *inflata*	
	Haloragis maierae	
Hydrocharitaceae	*Najas tenuifolia*	
Lamiaceae	*Prostanthera albiflora*	
Loranthaceae	*Amyema fitzgeraldii*	
	Amyema miquelii	
	Amyema sp. Fortescue (M.E. Trudgen 5358)	
	Diplatia grandibractea	
	Lysiana casuarinae	
Malvaceae	*Abutilon amplum*	
	Abutilon malvifolium	
	Abutilon sp. Pilbara (W.R. Barker 2025)	
	Androcalva luteiflora	
	Brachychiton acuminatus	
	Brachychiton gregorii	
	Corchorus crozophorifolius	
	Corchorus lasiocarpus subsp. *parvus*	
	Corchorus sidoides	
	Corchorus tridens	
	Gossypium australe	
	Gossypium sturtianum var. *sturtianum*	
	Hibiscus coatesii	
	Hibiscus goldsworthii	
	Hibiscus leptocladus	
	Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	P1
	Hibiscus sturtii var. campylochlamys	
	Keraudrenia nephrosperma	
	Keraudrenia velutina subsp. elliptica	
	Lawrencia densiflora	
	**Malvastrum americanum*	
	**Melochia pyramidata*	
	Sida arsiniata	
	Sida echinocarpa	
	Sida fibulifera	
	Sida sp. Articulation below (A.A. Mitchell PRP 1605)	
	Sida sp. Barlee Range (S. van Leeuwen 1642)	P3
	Sida sp. Hamersley Range (K. Newbey 10692)	P1
	Sida sp. Shovelanna Hill (S. van Leeuwen 3842)	
	Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	
	Sida sp. verrucose glands (F.H. Mollemans 2423)	
	Sida spinosa	
	Sida trichopoda	
	Triumfetta clementii	
	Triumfetta leptacantha	
	Waltheria indica	

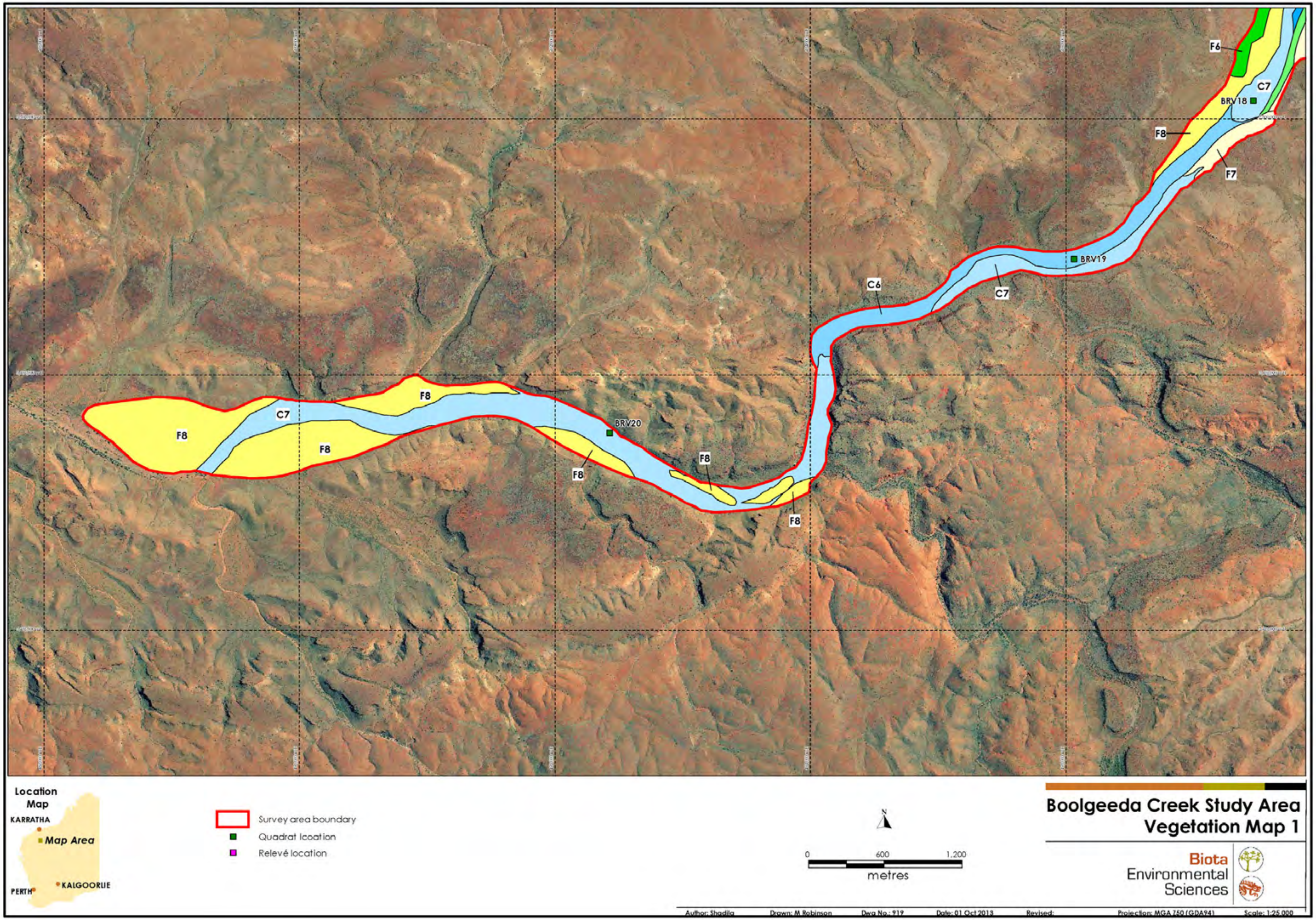
FAMILY	SPECIES	CONSERVATION STATUS
	Waltheria virgata	
Marsileaceae	*Marsilea hirsuta*	
Molluginaceae	*Glinus lotoides*	
	Mollugo molluginea	
Moraceae	*Ficus brachypoda*	
Myrtaceae	*Calytrix carinata*	
	Corymbia deserticola	
	Corymbia hamersleyana	
	Eucalyptus camaldulensis subsp. *obtusa*	
	Eucalyptus camaldulensis subsp. *refulgens*	
	Eucalyptus kingsmillii subsp. *kingsmillii*	
	Eucalyptus leucophloia	
	Eucalyptus leucophloia subsp. *leucophloia*	
	Eucalyptus lucasii	
	Eucalyptus pilbarensis	
	Eucalyptus socialis	
	Eucalyptus trivalva	
	Melaleuca bracteata	
	Melaleuca glomerata	
	Melaleuca leiocarpa	
Nyctaginaceae	*Boerhavia repleta*	
	Boerhavia schomburgkiana	
Oleaceae	*Jasminum didymum* subsp. *lineare*	
Papaveraceae	**Argemone ochroleuca* subsp. *ochroleuca*	
Phrymaceae	*Peplidium muelleri*	
Phyllanthaceae	*Notoleptopus decaisnei* var. Orbicularis (A.B. Craig 428)	
Plantaginaceae	*Plantago cunninghamii*	
	Stemodia grossa	
Poaceae	*Aristida contorta*	
	Aristida holathera	
	Aristida latifolia	
	Astrebla elymoides	
	Astrebla lappacea	P3
	Bothriochloa ewartiana	
	Brachyachne convergens	
	Brachyachne prostrata	
	Chloris pectinata	
	Chloris pumilio	
	Cymbopogon obtectus	
	Dactyloctenium radulans	
	Dichanthium fecundum	
	Dichanthium sericeum subsp. *humilius*	
	Digitaria ammophila	
	Elytrophorus spicatus	
	Enneapogon avenaceus	
	Enneapogon caerulescens	
	Enneapogon lindleyanus	
	Enneapogon polyphyllus	
	Enneapogon robustissimus	
	Eragrostis exigua	
	Eragrostis setifolia	
	Eragrostis tenellula	
	Eragrostis xerophila	
	Eriachne aristidea	
	Eriachne benthamii	
	Eriachne flaccida	
	Eriachne mucronata	

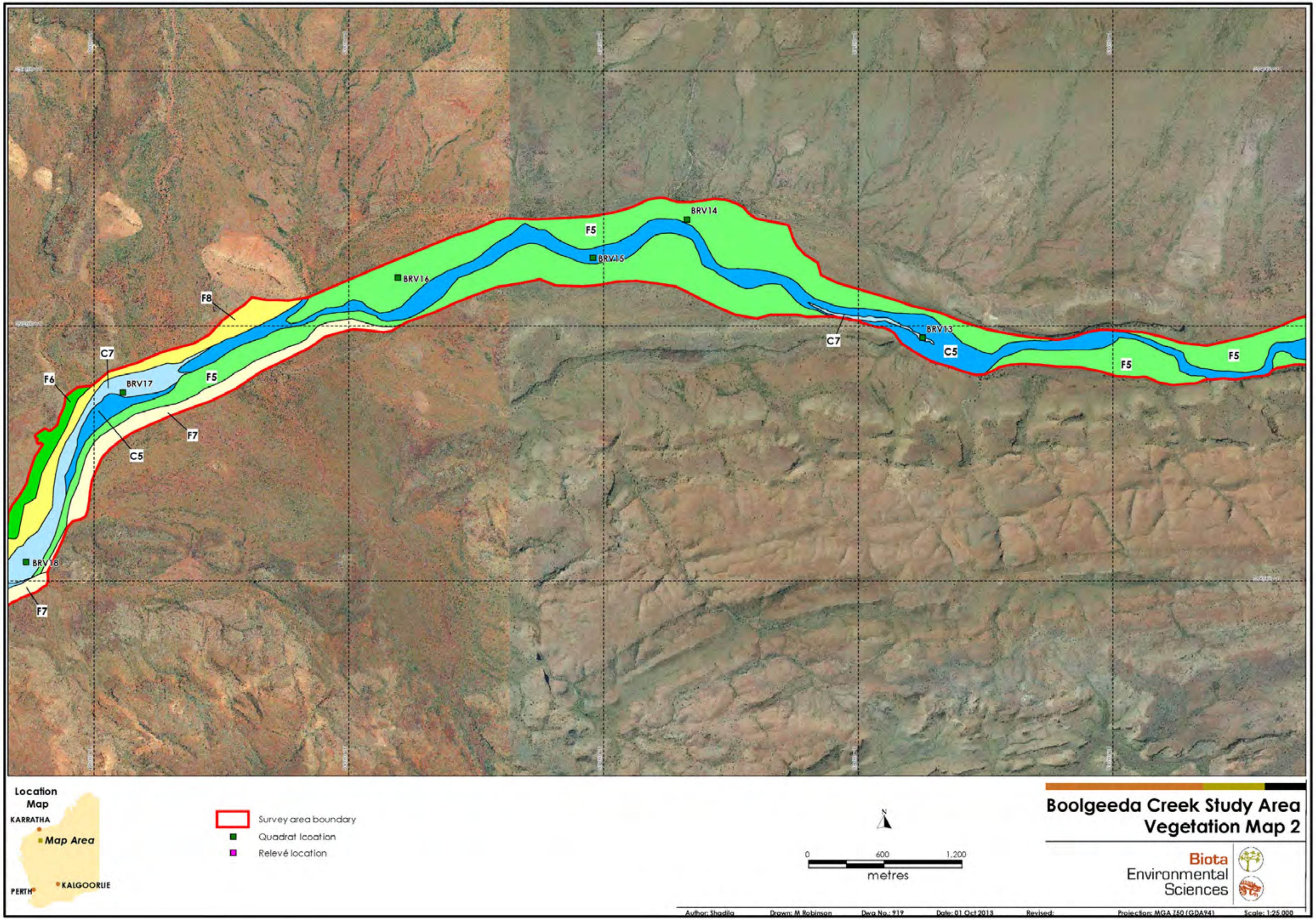
FAMILY	SPECIES	CONSERVATION STATUS
	Eriachne pulchella subsp. *pulchella*	
	Eulalia aurea	
	Iseilema dolichotrichum	
	Iseilema fragile	
	Iseilema macratherum	
	Iseilema vaginiflorum	
	Paspalidium clementii	
	Setaria dielsii	
	Sporobolus australasicus	
	Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3
	Triodia angusta	
	Triodia epactia	
	Triodia longiceps	
	Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	P3
	Triodia wiseana	
	Triraphis mollis	
Polygalaceae	*Polygala glaucifolia*	
Portulacaceae	**Portulaca oleracea*	
Primulaceae	*Samolus* sp. Millstream (M.I.H. Brooker 2076)	
Proteaceae	*Grevillea pyramidalis*	
	Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01)	P1
	Grevillea striata	
Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	
Rhamnaceae	*Cryptandra monticola*	
Rubiaceae	*Oldenlandia crouchiana*	
	Pomax rupestris	
Sapindaceae	*Dodonaea coriacea*	
	Dodonaea lanceolata var. *lanceolata*	
	Dodonaea pachyneura	
	Dodonaea petiolaris	
	Dodonaea viscosa subsp. *mucronata*	
Scrophulariaceae	*Eremophila cuneifolia*	
	Eremophila forrestii	
	Eremophila forrestii subsp. *hastieana*	
	Eremophila fraseri subsp. *fraseri*	
	Eremophila latrobei subsp. *filiformis*	
	Eremophila latrobei subsp. *glabra*	
	Eremophila latrobei subsp. *latrobei*	
	Eremophila magnifica subsp. *magnifica*	
	Eremophila magnifica subsp. *velutina*	
	Eremophila tietkensii	
Solanaceae	**Datura leichhardtii*	
	Nicotiana occidentalis	
	Nicotiana rosulata	
	Nicotiana umbratica	
	Solanum diversiflorum	
	Solanum horridum	
	Solanum lasiophyllum	
Stylidiaceae	*Stylidium fluminense*	
Thymelaeaceae	*Pimelea ammocharis*	
	Pimelea forrestiana	
Violaceae	*Hybanthus aurantiacus*	
Zygophyllaceae	*Zygophyllum iodocarpum*	

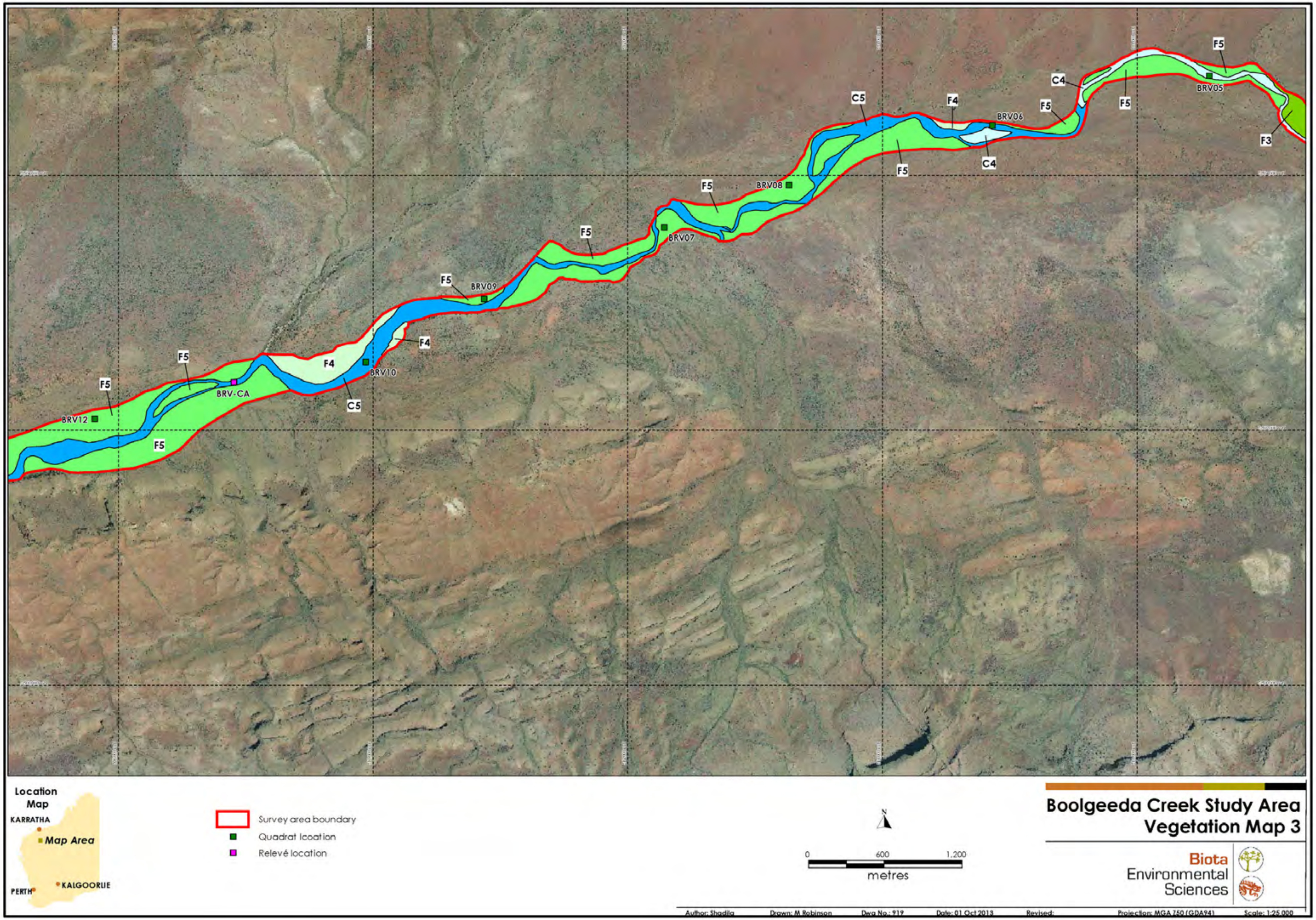
* denotes an introduced (weed) species.

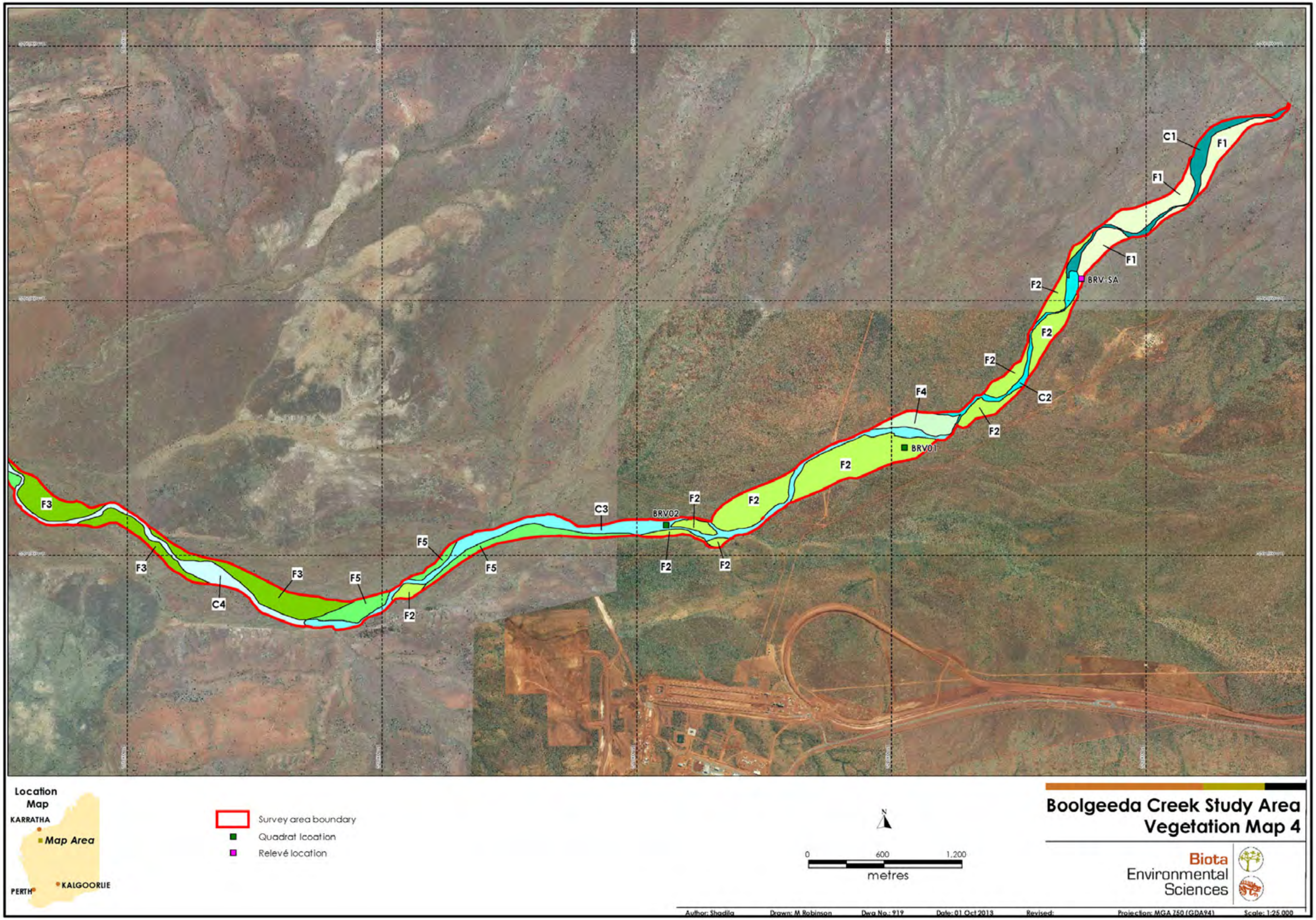
Appendix 3

Vegetation Maps of the Study Area, with Locations of Quadrats and Relevés


F6
C7
BRV18
F8
F7
BRV19
C6
C7
F8
C7
F8
F8
BRV20
F8
F8
F8
F8
Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area boundary
Quadrat location
Relevé location
0
600
1,200
metres
Boolgeeda Creek Study Area
Vegetation Map 1
Biota
Environmental
Sciences


BRV14
F5
BRV15
BRV16
F8
C7
F6
BRV17
F5
F7
C5
BRV18
F7
BRV13
C7
C5
F5
F5
Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area boundary
Quadrat lcoation
Relevé location
N
0
600
1,200
metres
Boolgeeda Creek Study Area
Vegetation Map 2
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 01 Oct 2013
Revised:
Projection: MGA Z50 (GDA94)
Scale: 1:25 000


F5
C4
BRV05
F5
F5
C5
F4
BRV06
F3
C4
F5
F5
BRV08
F5
BRV07
F5
BRV09
F4
F5
F4
BRV10
BRV-CA
F5
BRV12
C5
F5
Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area boundary
Quadrat location
Relevé location
N
0
600
1,200
metres
Boolgeeda Creek Study Area
Vegetation Map 3
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 01 Oct 2013
Revised:
Projection: MGA Z50 (GDA94)
Scale: 1:25,000


C1
F1
F1
F1
F2
BRV-SA
F2
F2
C2
F4
F2
BRV01
F2
F2
F2
C3
BRV02
F2
F2
F2
F3
F3
C4
F3
F5
F5
F5
F2
Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area boundary
Quadrat lcoation
Relevé location
0
600
1,200
metres
Boolgeeda Creek Study Area
Vegetation Map 4
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 01 Oct 2013
Revised:
Projection: MGA Z50 (GDA94)
Scale: 1:25,000

Vegetation of Brockman 4 Riparian

Vegetation of Creeklines

C1: ChAciAtuGOr	*Corymbia hamersleyana* open woodland over *Acacia citrinividis* low open woodland over *A. tumida, Gossypium robinsonii* scattered tall shrubs
C2: EvAciAtuAPyTHtTe	*Eucalyptus victrix* open woodland over *Acacia citrinoviridis* scattered low trees over *A. tumida, A. bivenosa, A. pyrifolia* tall open shrubland over *Themeda triandra* very open tussock grassland over *Triodia epactia* very open hummock grassland
C3: EvEcAciAPyTErEUa	*Eucalyptus victrix, E. camaldulensis* open woodland over *Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Tephrosia rosea* low open shrubland over very open mixed herbland over *Eulalia aurea* open tussock grassland
C4: EvEcAciEUa	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Eulalia aurea* very open tussock grassland over very open mixed herbland
C5: EvEcAciCEc	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over **Cenchrus ciliaris* scattered tussock grasses
C6: EvEcAciMgAam	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Melaluca glomerata, Acacia ampliceps* tall shrubland
C7: EvEcAciMgCEcTe	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Melaluca glomerata* tall shrubland over **Cenchrus ciliaris* scattered tussock grasses over *Triodia epactia* scattered hummock grasses

Vegetation Type Descriptions for the Brockman 4 Riparian Vegetation Maps

Legend Sheet 1

Biota Environmental Sciences

Vegetation of Brockman 4 Riparian

Vegetation of Floodplains

F1: ChAciAtuGOrCEcTe	*Corymbia hamersleyana* open woodland over *Acacia citrinoviridis* low open woodland over *A. tumida*, *Gossypium robinsonii* scattered tall shrubs over **Cenchrus ciliaris* open tussock grassland over *Triodia epactia* scattered hummock grasses
F2: AciAPyTErTHtCEcTe	*Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Tephrosia rosea* low open shrub over *Themeda triandra*, **Cenchrus ciliaris* tussock grassland over *Triodia epactia* very open hummock grassland
F3: AciAPyEUaTHtCEcTe	*Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Eulalia aurea*, *Themeda triandra* **Cenchrus ciliaris* tussock grassland over *Triodia epactia* very open hummock grassland
F4: ChAciAPyCEcTe	*Corymbia hamersleyana* scattered trees over *Acacia citrinoviridis* low woodland over *A. pyrifolia* tall shrubland over **Cenchrus ciliaris* open tussock grassland over *Triodia epactia* open hummock grassland
F5: AciAPyCEcTe	*Acacia citrinoviridis* open woodland over *A. pyrifolia* tall open shrubland over **Cenchrus ciliaris* open tussock grassland over *Triodia epactia* very open hummock grassland
F6: PlAsclTe	*Petalosylis labicheoides*, *Acacia sclerosperma* tall open shrubland over *Triodia epactia* very open hummock grassland
F7: ChAciPlAsclCEcTe	*Corymbia hamersleyana* scattered trees over *Acacia citrinoviridis* low woodland over *A. pyrifolia*, *Petalostylis labicheoides*, *A. sclerosperma* tall shrubland over **Cenchrus ciliaris* open tussock grassland over *Triodia epactia* scattered hummock grasses
F8: AciAPyPlCEcTe	*Acacia citrinoviridis* open woodland over *A. pyrifolia*, *Petalostylis labicheoides* tall open shrubland over **Cenchrus ciliaris* open tussock grassland over *Triodia epactia* very open hummock grassland

Vegetation Type Descriptions for the Brockman 4 Riparian Vegetation Maps

Legend Sheet 2

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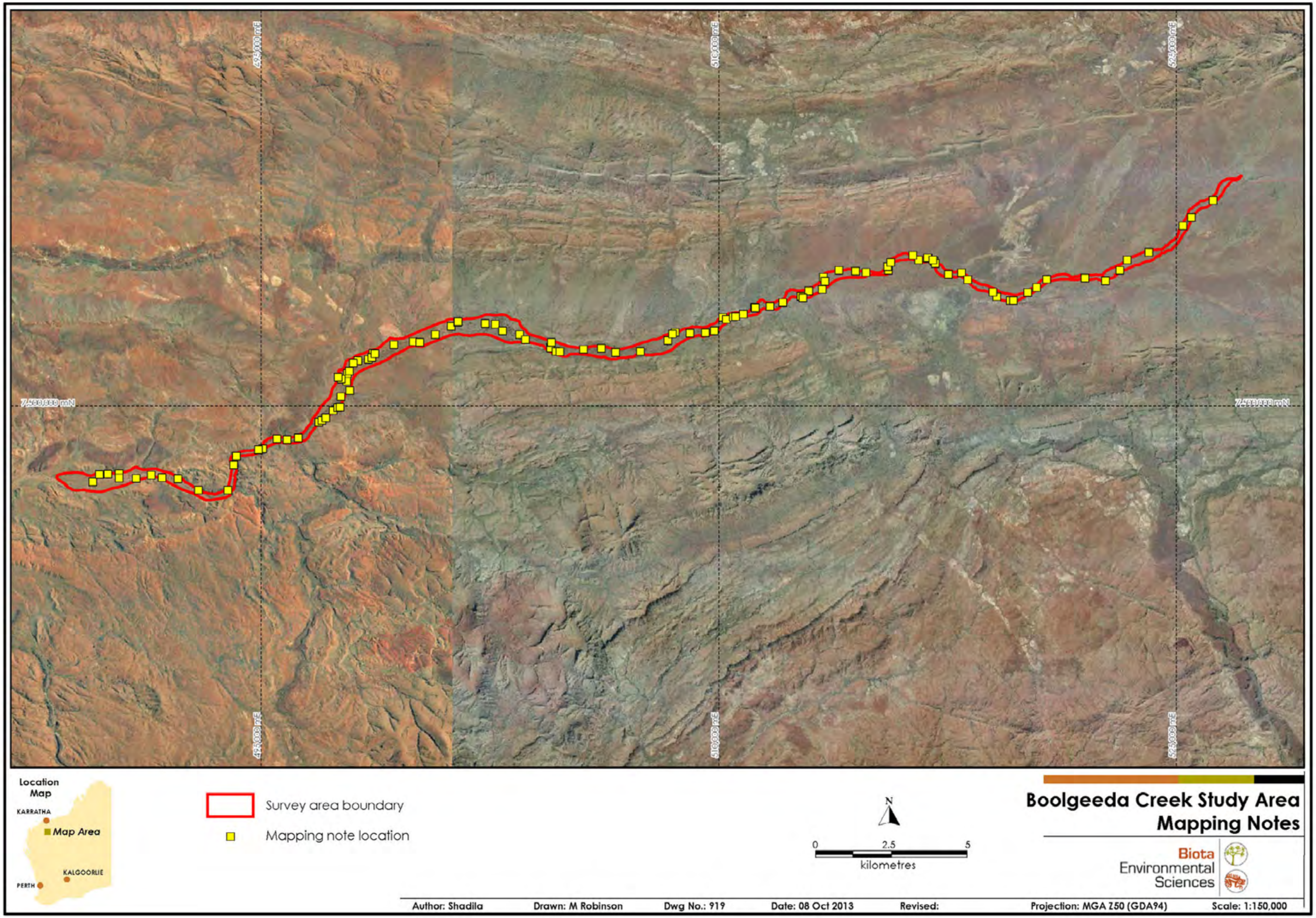
Appendix 4

Location of Mapping Notes Recorded within the Study Area


Location Map
KARRATHA
Map Area
KALGOORLIE
PERTH
Survey area boundary
Mapping note location
N
0
2.5
5
kilometres
Boolgeeda Creek Study Area
Mapping Notes
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 08 Oct 2013
Revised:
Projection: MGA Z50 (GDA94)
Scale: 1:150,000

Appendix 5

Vegetation Structural Classes and Condition Scale

Vegetation Structural Classes*

Stratum	Canopy Cover (%)				
	70-100%	30-70%	10-30%	2-10%	<2%
Trees over 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees under 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs over 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs under 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, Sedges, Herbs	Closed tussock grassland / bunch grassland / sedgeland / herbland	Tussock grassland / bunch grassland / sedgeland / herbland	Open tussock grassland / bunch grassland / sedgeland / herbland	Very open tussock grassland / bunch grassland / sedgeland / herbland	Scattered tussock grasses / bunch grasses / sedges / herbs

* Based on Muir (1977), and Aplin's (1979) modification of the vegetation classification system of Specht (1970):
Aplin T.E.H. (1979). The Flora. Chapter 3 *In* O'Brien, B.J. (ed.) (1979). *Environment and Science.* University of Western Australia Press; Muir B.G. (1977). Biological Survey of the Western Australian Wheatbelt. Part II: Vegetation and habitat of Bendering Reserve. *Records of the Western Australian Museum, Suppl.* No. 3; Specht R.L. (1970). Vegetation. *In The Australian Environment.* 4th edn (Ed. G.W. Leeper). Melbourne.

Vegetation Condition Scale*

E = Excellent (=Pristine of BushForever) Pristine or nearly so; no obvious signs of damage caused by the activities of European man.
VG = Very Good (= Excellent of BushForever) Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as **Bidens bipinnata* or **Malvastrum americanum*, or occasional vehicle tracks.
G = Good (= Very Good of BushForever) More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as **Cenchrus* spp.
P = Poor (= Good of BushForever) Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some more aggressive ones such as **Cenchrus* spp.
VP = Very Poor (= Degraded of BushForever) 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 (= Completely Degraded of BushForever) Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Based on Trudgen M.E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth

Appendix 6

Vascular Flora Species List

*Denotes introduced (weed) species.

Family: Acanthaceae

Dicladanthera forrestii
Dipteracanthus australasicus subsp. *australasicus*
Rostellularia adscendens var. *clementii*

Family: Amaranthaceae

Alternanthera denticulata
Alternanthera nana
Amaranthus cuspidifolius
Amaranthus undulatus
Gomphrena canescens subsp. *canescens*
Gomphrena cunninghamii
Gomphrena kanisii
Ptilotus astrolasius
Ptilotus calostachyus
Ptilotus fusiformis
Ptilotus nobilis subsp. *nobilis*
Ptilotus obovatus var. *obovatus*
Ptilotus polystachyus
Ptilotus rotundifolius

Family: Apocynaceae

Cynanchum pedunculatum

Family: Araliaceae

Trachymene oleracea subsp. *oleracea*

Family: Asteraceae

**Bidens bipinnata*
Centipeda minima subsp. *macrocephala*
Chrysocephalum apiculatum
**Flaveria trinervia*
Helichrysum luteoalbum
Pentalepis trichodesmoides subsp. *hispida* Priority 2
Peripleura arida
Pluchea dentex
Pluchea rubelliflora
Pterocaulon sphacelatum
Rutidosis helichrysoides subsp. *helichrysoides*
**Sigesbeckia orientalis*
**Sonchus oleraceus*
Streptoglossa decurrens

Family: Boraginaceae

Ehretia saligna var. *saligna*
Heliotropium cunninghamii
Heliotropium pachyphyllum
Trichodesma zeylanicum var. *zeylanicum*

Family: Brassicaceae

Lepidium muelleri-ferdinandii

Family: Campanulaceae

Wahlenbergia tumidifructa

Family: Capparaceae

Capparis lasiantha
Capparis spinosa var. *nummularia*

Family: Caryophyllaceae

Polycarpaea holtzei
Polycarpaea longiflora

Family: Chenopodiaceae

Dysphania rhadinostachya subsp. *inflata*
Dysphania rhadinostachya subsp. *rhadinostachya*
Enchylaena tomentosa var. *tomentosa*
Maireana georgei
Maireana melanocoma
Maireana planifolia x *villosa*
Maireana triptera
Salsola australis
Sclerolaena cornishiana
Sclerolaena densiflora

Family: Cleomaceae

Cleome viscosa

Family: Convolvulaceae

Bonamia erecta
Convolvulus clementii
Convolvulus remotus
Duperreya commixta
Evolvulus alsinoides var. *decumbens*
Evolvulus alsinoides var. *villosicalyx*
Ipomoea muelleri
Operculina aequisepala
Polymeria ambigua

Family: Cucurbitaceae

**Cucumis melo* subsp. *agrestis*
Cucumis variabilis

Family: Cyperaceae

Bulbostylis barbata
Bulbostylis turbinata
Cyperus vaginatus
Fimbristylis simulans
Lipocarpha microcephala
Schoenoplectus subulatus

Family: Elatinaceae

Bergia pedicellaris
Bergia trimera

Family: Euphorbiaceae

Adriana tomentosa var. *tomentosa*
Euphorbia australis var. *erythrantha*
Euphorbia australis var. *subtomentosa*
Euphorbia biconvexa
Euphorbia coghlanii
Euphorbia trigonosperma

Family: Fabaceae

Acacia ampliceps
Acacia ancistrocarpa
Acacia atkinsiana
Acacia bivenosa
Acacia citrinoviridis
Acacia coriacea subsp. *pendens*
Acacia exilis
Acacia inaequilatera
Acacia maitlandii
Acacia marramamba
Acacia orthocarpa
Acacia pyrifolia

Family: Fabaceae (cont.)

Acacia pyrifolia var. *morrisonii*
Acacia pyrifolia var. *pyrifolia*
Acacia sclerosperma subsp. *sclerosperma*
Acacia synchronicia
Acacia tenuissima
Acacia tetragonophylla
Acacia tumida var. *pilbarensis*
Acacia victoriae var. *victoriae*
Crotalaria medicaginea var. *neglecta*
Cullen leucanthum
Glycine canescens
Indigofera colutea
Indigofera monophylla
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) Priority 3
Isotropis atropurpurea
Petalostylis labicheoides
Rhynchosia minima
Senna artemisioides subsp. *helmsii*
Senna artemisioides subsp. *oligophylla* x *S. artemisioides* subsp. *helmsii*
Senna artemisioides subsp. *oligophylla*
Senna glaucifolia
Senna glutinosa subsp. *glutinosa*
Senna glutinosa subsp. *glutinosa* x *Senna stricta*
Senna glutinosa subsp. *pruinosa*
Senna glutinosa subsp. *luerssenii* x *Senna stricta*
Senna glutinosa subsp. x *luerssenii*
Senna notabilis
Senna sp. Meekatharra (E. Bailey 1-26)
Senna stricta
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186) PN
**Vachellia farnesiana*
Vigna lanceolata var. *lanceolata*

Family: Goodeniaceae

Goodenia forrestii
Goodenia lamprosperma
Goodenia microptera
Goodenia nuda Priority 4
Goodenia stobbsiana
Goodenia triodiophila

Family: Gyrostemonaceae

Codonocarpus cotinifolius

Family: Loranthaceae

Amyema sanguinea var. *sanguinea*

Family: Lythraceae

Ammannia baccifera

Family: Malvaceae

Abutilon aff. *Lepidum*
Abutilon amplum
Abutilon fraseri subsp. *fraseri*
Abutilon otocarpum
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618) PN
Abutilon sp. Pilbara (W.R. Barker 2025)
Androcalva luteiflora
Corchorus crozophorifolius
Corchorus lasiocarpus subsp. *parvus*
Gossypium australe

Family: Malvaceae (cont.)

Gossypium robinsonii
Gossypium sturtianum var. *sturtianum*
Hibiscus sturtii var. *grandiflorus*
**Malvastrum americanum*
Melhania oblongifolia
Sida aff. *fibulifera*
Sida arsiniata
Sida clementii
Sida fibulifera
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)
Sida sp. verrucose glands (F.H. Mollemans 2423)
Triumfetta clementii
Waltheria indica

Family: Marsileaceae

Marsilea hirsuta

Family: Molluginaceae

Glinus lotoides
Mollugo molluginea

Family: Myrtaceae

Corymbia hamersleyana
Eucalyptus camaldulensis subsp. *refulgens*
Eucalyptus leucophloia subsp. *leucophloia*
Eucalyptus victrix
Eucalyptus sp.
Melaleuca glomerata

Family: Nyctaginaceae

Boerhavia coccinea
Boerhavia repleta
Boerhavia sp.

Family: Oleaceae

Jasminum didymum subsp. *lineare*

Family: Papaveraceae

**Argemone ochroleuca* subsp. *ochroleuca*

Family: Phrymaceae

Mimulus gracilis
Peplidium sp. Fortescue Marsh (S. van Leeuwen 4865) — Priority 1

Family: Phyllanthaceae

Notoleptopus decaisnei var. *decaisnei*
Notoleptopus decaisnei var. *orbicularis* (A.B. Craig 428)
Phyllanthus erwinii
Phyllanthus exilis
Phyllanthus maderaspatensis

Family: Plantaginaceae

Stemodia grossa

Family: Poaceae

Aristida contorta
Aristida holathera var. *holathera*
Bothriochloa ewartiana
**Cenchrus ciliaris*
**Cenchrus setiger*
Chrysopogon fallax
Cymbopogon ambiguus
Cymbopogon procerus
Cymbopogon sp.
Dichanthium sericeum subsp. *humilius*

Family: Poaceae (cont.)

Digitaria brownii
Digitaria ctenantha
Elytrophorus spicatus
Enneapogon caerulescens
Enneapogon lindleyanus
Enneapogon polyphyllus
Enneapogon robustissimus
Enteropogon ramosus
Eragrostis cumingii
Eragrostis eriopoda
Eragrostis leptocarpa
Eragrostis tenellula
Eriachne aristidea
Eriachne mucronata
Eriachne pulchella
Eriachne tenuiculmis
Eulalia aurea
Paraneurachne muelleri
Paspalidium clementii
**Setaria verticillata*
Sporobolus australasicus
Themeda triandra
Triodia angusta
Triodia epactia
Triodia longiceps
Triodia wiseana
Triraphis mollis

Family: Portulacaceae

Calandrinia ptychosperma
**Portulaca oleracea/intraterranea*

Family: Proteaceae

Grevillea berryana
Grevillea pyramidalis subsp. *leucadendron*
Grevillea wickhamii (sterile material)
Hakea lorea subsp. *lorea*

Family: Rubiaceae

Oldenlandia crouchiana
Oldenlandia galioides
Synaptantha tillaeacea var. *tillaeacea*

Family: Santalaceae

Santalum lanceolatum

Family: Sapindaceae

Dodonaea lanceolata var. *lanceolata*

Family: Scrophulariaceae

Eremophila longifolia

Family: Solanaceae

Nicotiana occidentalis subsp. *occidentalis*
Solanum diversiflorum
Solanum lasiophyllum

Family: Surianaceae

Stylobasium spathulatum

Family: Violaceae

Hybanthus aurantiacus

Family: Zygophyllaceae

Tribulus astrocarpus

Family: Zygophyllaceae (cont.)

Tribulus suberosus
**Tribulus terrestris*
Zygophyllum eichleri
Zygophyllum iodocarpum

Appendix 7

Raw Data Collected from the Study Area

Brockman 4 Riparian Vegetation Survey Site BRV01

Described by: BECA Date: 25-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 524080 mE 7504873 mN 117.234217 E -22.562660 S

Habitat Floodplain.

Soil Loamy sand with a large gravel content (>2mm).

Rock Type Continuous lag gravel.

Vegetation *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) scattered tall shrubs over *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) low shrubland over *Triodia epactia* very open hummock grassland over *Eriachne mucronata* very open tussock grassland with *Eriachne pulchella*, (*Aristida holathera* var. *holathera*) open bunch grassland.

Veg Condition Very Good (**Cenchrus ciliaris*, **Malvastrum americanum*).

Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen
Acacia ancistrocarpa	+	130	
Acacia pyrifolia var. *pyrifolia*	+	220	BRV01-20
Alternanthera nana	+	50	=BRV17-31
Amaranthus cuspidifolius	+	40	BRV01-06
Aristida contorta	+	10	
Aristida holathera var. *holathera*	3	30	BRV01-19
Cenchrus ciliaris	+	40	
Chrysopogon fallax	+	80	
Cleome viscosa	+	20	
Corchorus crozophorifolius	+	20	
Corchorus lasiocarpus subsp. *parvus*	+	30	BRV01-05
Cucumis variabilis	+	110	
Cymbopogon ambiguus	+	90	BRV01-09
Cynanchum pedunculatum	+	10	BRV01-14
Enneapogon lindleyanus	+	40	=BRV15-16
Enneapogon polyphyllus	+	40	BRV01-18
Eriachne aristidea	+	30	BRV01-17
Eriachne mucronata	3	40	
Eriachne pulchella	25	10	
Eriachne tenuiculmis	+	20	BRV01-15
Eucalyptus sp.	+	350	
Euphorbia australis var. *subtomentosa*	+	1	BRV01-02
Evolvulus alsinoides var. *villosicalyx*	+	30	
Gomphrena kanisii	+	10	
Goodenia microptera	+	30	BRV01-21
Goodenia nuda	+	10	BRV01-04
Grevillea wickhamii	+	120	
Heliotropium cunninghamii	+	20	BRV01-13
Indigofera monophylla	+	50	BRV01-12
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	1	220	BRV01-08
Jasminum didymum subsp. *lineare*	+	120	
Malvastrum americanum	+	90	
Melhania oblongifolia	+	10	
Phyllanthus exilis	+	20	BRV01-22
Pluchea dentex	+	30	BRV01-11
Polycarpaea longiflora	+	20	
Pterocaulon sphacelatum	+	40	BRV01-23
Ptilotus astrolasius	+	20	
Ptilotus nobilis subsp. *nobilis*	+	20	
Salsola australis	+	40	
Sida arsiniata	+	20	BRV01-16
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	120	BRV01-10
Solanum diversiflorum	+	40	
Stemodia grossa	+	50	
Synaptantha tillaeacea var. *tillaeacea*	+	5	BRV01-07
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	12	80	
Themeda triandra	+	80	
Trachymene oleracea subsp. *oleracea*	+	70	
Trichodesma zeylanicum var. *zeylanicum*	+	80	
Triodia epactia	12	70	BRV01-01

Species	Cover (%)	Height (cm)	Specimen
Waltheria indica	+	60	

Brockman 4 Riparian Vegetation Survey Site BRV02

Described by: BECASVPC Date: 27-August 2013 Type: Quadrat 50 x 50 m

MGA Zone	50	522203 mE	7504263 mN	117.215973 E	-22.568196 S

Habitat Broad (ill-defined) creek bed.

Soil Coarse, gravelly loamy sand.

Rock Type Riverstones. Mix of ironstone, quartz and basalt. Sub-angular-rounded 2-200 mm.

Vegetation *Eucalyptus victrix* low woodland over *Melaleuca glomerata, Acacia citrinoviridis* tall open shrubland over mixed herbs.

Veg Condition Very Good (**Cenchrus ciliaris*, old cow pats and old tyre tracks).

Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen
Acacia citrinoviridis	1	300	
Acacia pyrifolia	+	70	
Alternanthera denticulata	+	5	BRV02-04
Bergia pedicellaris	+	5	BRV02-03
Bergia trimera	+	10	BRV02-05
Boerhavia coccinea	+	2	=BRV20-01
Cenchrus ciliaris	+	40	
Centipeda minima subsp. *macrocephala*	+	10	=BRV17-07
Chrysopogon fallax	+	60	
Cleome viscosa	+	20	
Corchorus crozophorifolius	+	40	
Corchorus lasiocarpus subsp. *parvus*	+	50	BRV02-14
Crotalaria medicaginea var. *neglecta*	+	20	
Cucumis variabilis	+	60	
Elytrophorus spicatus	+	7	BRV02-01
Enneapogon caerulescens	+	20	BRV02-15
Eragrostis cumingii	+	25	
Eragrostis tenellula	+	8	
Eriachne pulchella	+	15	
Eriachne tenuiculmis	+	35	
Eucalyptus victrix	25	500	
Eulalia aurea	+	120	
Euphorbia australis var. *subtomentosa*	+	3	BRV02-16
Evolvulus alsinoides var. *villosicalyx*	+	10	
Fimbristylis simulans	+	10	
Gomphrena canescens subsp. *canescens*	+	20	BRV02-07
Gomphrena cunninghamii	+	10	
Goodenia lamprosperma	+	25	=BRV17-01
Gossypium australe	+	120	
Heliotropium cunninghamii	+	15	BRV02-02
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	150	
Lipocarpha microcephala	+	8	BRV02-09
Marsilea hirsuta	+	4	BRV02-11
Melaleuca glomerata	3	380	
Mollugo molluginea	+	3	
Oldenlandia galioides	+	5	BRV02-10
Peplidium sp. Fortescue Marsh (S. van Leeuwen 4865)	+	1	BRV02-13
Phyllanthus exilis	+	8	BRV02-08
Phyllanthus maderaspatensis	+	30	
Pluchea rubelliflora	+	40	=BRV20-04
Polycarpaea longiflora	+	10	
Pterocaulon sphacelatum	+	30	=BRV19-12
Rhynchosia minima	+	50	
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	60	
Sigesbeckia orientalis	+	10	BRV02-12
Stemodia grossa	+	120	
Synaptantha tillaeacea var. tillaeacea	+	5	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	60	BRV02-06
Themeda triandra	+	100	
Trichodesma zeylanicum var. *zeylanicum*	+	15	
Triodia epactia	+	60	
Wahlenbergia tumidifructa	+	15	=BRV17-22

Species	Cover (%)	Height (cm)	Specimen
Waltheria indica	+	40	

Brockman 4 Riparian Vegetation Survey Site BRV05

Described by: SVPC Date: 27-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 516561 mE 7504815 mN 117.161082 E -22.563279 S

Habitat Bed (and portion of bank) of minor ephemeral creek.

Soil Red-brown sand.

Rock Type Riverstones.

Vegetation *Eucalyptus camaldulensis* subsp. *refulgens*, *E. victrix* open forest over *Acacia citrinoviridis* scattered low trees over *Androcalva luteiflora*, *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) tall open shrubland over *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) scattered shrubs over *Eulalia aurea*, **Cenchrus ciliaris*, *Themeda triandra*, *Chrysopogon fallax* very open tussock grassland.

Veg Condition Good (**Cenchrus* spp. and old cow pats).

Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen
Acacia bivenosa	+	300	
Acacia citrinoviridis	2	400	
Acacia pyrifolia var. pyrifolia	+	210	BRV05-04
Adriana tomentosa var. *tomentosa*	+	80	BRV05-13
Alternanthera nana	+	15	BRV05-07
Androcalva luteiflora	2	280	
Aristida contorta	+	20	
Bonamia erecta	+	60	
Cenchrus ciliaris	2	80	
Chrysopogon fallax	0.5	140	
Cleome viscosa	+	25	
Corchorus crozophorifolius	+	100	
Corchorus lasiocarpus subsp. *parvus*	+	40	BRV05-05
Cullen leucanthum	+	100	BRV05-12
Digitaria brownii	+	70	
Dipteracanthus australasicus subsp. *australasicus*	+	30	
Enneapogon caerulescens	+	30	
Enneapogon robustissimus	+	60	BRV05-08
Eriachne pulchella	+	12	
Eriachne tenuiculmis	+	30	
Eucalyptus camaldulensis subsp. *refulgens*	20	1200	
Eucalyptus victrix	15	1000	
Eulalia aurea	5	120	
Euphorbia australis var. *subtomentosa*	+	10	BRV05-03
Euphorbia biconvexa	+	15	BRV05-02
Evolvulus alsinoides var. *decumbens*	+	15	
Evolvulus alsinoides var. *villosicalyx*	+	15	
Glycine canescens	+	120	BRV05-14
Gomphrena canescens subsp. *canescens*	+	10	BRV05-11
Gomphrena cunninghamii	+	20	
Goodenia nuda	+	30	BRV05-10
Gossypium robinsonii	+	110	
Heliotropium cunninghamii	+	20	BRV05-06
Hybanthus aurantiacus	+	25	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	2	210	
Jasminum didymum subsp. *lineare*	+	120	
Melhania oblongifolia	+	35	
Phyllanthus maderaspatensis	+	20	
Pluchea rubelliflora	+	25	BRV05-09
Ptilotus obovatus var. *obovatus*	+	50	
Ptilotus rotundifolius	+	7	
Rhynchosia minima	+	20	
Stemodia grossa	+	30	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	1	100	BRV05-01
Themeda triandra	0.5	90	
Triodia epactia	+	70	
Waltheria indica	+	70	

Brockman 4 Riparian Vegetation Survey Site BRV06

Described by: BECA Date: 27-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 514840 mE 7504419 mN 117.144353 E -22.566875 S

Habitat Braided creek bed.

Soil Coarse gravelly loamy sand.

Rock Type Continuous lag gravel of sub-angular to rounded ironstone/quartz/basalt coarse fragments, 2-300mm.

Vegetation *Eucalyptus victrix* low open woodland over *Acacia citrinoviridis* scattered tall shrubs over *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) low open shrubland over *Pluchea rubelliflora, Goodenia lamprosperma, Stemodia grossa* very open herbland over *Eulalia aurea, Eriachne tenuiculmis, *Cenchrus ciliaris* tussock grassland.

Veg Condition Very Good (*Cenchrus ciliaris*, some evidence of cattle).

Fire Age Very long unburnt.

Notes Grass layer is actually taller than the low shrub layer.

Species	Cover (%)	Height (cm)	Specimen
Acacia ancistrocarpa	+	260	
Acacia bivenosa	+	150	
Acacia citrinoviridis	1	250	
Acacia pyrifolia	+	60	
Alternanthera nana	+	25	=BRV17-31
Amaranthus cuspidifolius	+	50	=BRV20-03
Boerhavia coccinea	+	10	=BRV20-01
Cenchrus ciliaris	1	50	
Centipeda minima subsp. *macrocephala*	+	5	BRV17-07
Cleome viscosa	+	40	
Corchorus crozophorifolius	+	50	
Crotalaria medicaginea var. *neglecta*	+	15	BRV06-07
Cucumis variabilis	+	30	
Dipteracanthus australasicus subsp. *australasicus*	+	10	=BRV17-20
Eragrostis tenellula	+	10	
Eriachne pulchella	+	10	
Eriachne tenuiculmis	2	50	
Eucalyptus sp.	+	200	
Eucalyptus victrix	8	900	
Eulalia aurea	6	70	BRV06-05
Euphorbia australis var. *subtomentosa*	+	3	BRV06-06
Euphorbia biconvexa	+	30	BRV06-03
Evolvulus alsinoides var. *villosicalyx*	+	5	
Gomphrena canescens subsp. *canescens*	+	20	BRV06-10
Goodenia lamprosperma	3	40	=BRV17-01
Heliotropium cunninghamii	+	10	BRV06-02
Hybanthus aurantiacus	+	25	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	140	
Jasminum didymum subsp. *lineare*	+	140	
Malvastrum americanum	+	30	
Phyllanthus exilis	+	20	BRV06-01
Phyllanthus maderaspatensis	+	30	
Pluchea rubelliflora	4	60	=BRV20-04
Rhynchosia minima	+	5	
Rutidosis helichrysoides subsp. *helichrysoides*	+	40	BRV06-08
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	90	BRV06-04
Stemodia grossa	1	60	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	5	90	
Themeda triandra	+	40	
Triodia epactia	+	60	BRV06-09
Waltheria indica	+	40	

Brockman 4 Riparian Vegetation Survey Site BRV07

Described by: BECA Date: 25-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 512259 mE 7503610 mN 117.119250 E -22.574202 S

Habitat	Floodplain.
Soil	Sandy clay loam.
Rock Type	Scattered ironstone fragments, sub-angular to rounded, 2-50 mm.
Vegetation	*Acacia citrinoviridis, A. pyrifolia* var. *morrisonii* tall shrubland over *Ptilotus obovatus* var. *obovatus* scattered low shrubs over *Triodia epactia* scattered hummock grasses over **Cenchrus ciliaris, *C. setiger* open tussock grassland.
Veg Condition	Very Poor (**Cenchrus* spp., high cattle activity).
Fire Age	No sign of recent fire.
Notes	Heavy grazing. Stand of *A. citrinoviridis* in SE corner that has not been burnt for over 10 years.

Species	Cover (%)	Height (cm)	Specimen
Abutilon aff. *lepidum*	+	20	BRV07-15
Abutilon otocarpum	+	5	BRV07-06
Abutilon sp. Pilbara (W.R. Barker 2025)	+	15	BRV07-29
Acacia citrinoviridis	15	550	
Acacia pyrifolia var. *morrisonii*	5	350	BRV07-03
Alternanthera nana	+	5	=BRV16-13
Androcalva luteiflora	+	170	
Boerhavia coccinea	+	2	BRV07-31
Cenchrus ciliaris	15	30	
Cenchrus setiger	4	20	
Codonocarpus cotinifolius	+	60	BRV07-02
Convolvulus clementii	+	5	BRV07-17
Corchorus crozophorifolius	+	70	
Corchorus lasiocarpus subsp. *parvus*	+	30	BRV07-21
Dipteracanthus australasicus subsp. *australasicus*	+	10	=BRV17-20
Duperreya commixta	+	400	
Dysphania rhadinostachya subsp. *rhadinostachya*	+	10	BRV07-28
Enneapogon lindleyanus	+	10	=BRV15-16
Enneapogon polyphyllus	+	10	BRV07-12, 19
Eriachne pulchella	+	10	BRV07-16
Euphorbia australis var. *subtomentosa*	+	5	BRV07-14
Evolvulus alsinoides var. *decumbens*	+	10	
Evolvulus alsinoides var. *villosicalyx*	+	10	
Goodenia forrestii	+	20	=BRV16-03
Goodenia lamprosperma	+	20	=BRV17-01
Goodenia nuda	+	10	BRV07-10
Gossypium australe	+	10	BRV07-32
Gossypium robinsonii	+	250	
Hibiscus sturtii var. *grandiflorus*	+	10	BRV07-01
Hybanthus aurantiacus	+	30	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	120	
Jasminum didymum subsp. *lineare*	+	80	
Malvastrum americanum	+	40	
Melhania oblongifolia	+	10	
Notoleptopus decaisnei var. *orbicularis* (A.B. Craig 428)	+	10	BRV07-05
Pentalepis trichodesmoides subsp. *hispida*	+	80	BRV07-24
Phyllanthus maderaspatensis	+	10	
Polycarpaea longiflora	+	10	
Polymeria ambigua	+	1	BRV07-22
Portulaca oleracea/intraterranea	+	1	
Pterocaulon sphacelatum	+	40	BRV07-33
Ptilotus obovatus var. *obovatus*	1	70	
Ptilotus polystachyus	+	20	BRV07-30
Sclerolaena cornishiana	+	5	=BRV12-16
Senna artemisioides subsp. *helmsii*	+	40	BRV07-26
Senna artemisioides subsp. *oligophylla*	+	40	BRV07-25
Senna glutinosa subsp. x *luerssenii*	+	130	BRV07-23
Sida aff. *fibulifera*	+	5	BRV07-09

Species	Cover (%)	Height (cm)	Specimen
Sida arsiniata	+	40	BRV07-07
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	20	BRV07-04
Solanum lasiophyllum	+	30	BRV07-13
Sporobolus australasicus	+	15	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	40	
Triodia epactia	1	40	BRV07-08, 18
Triraphis mollis	+	10	BRV07-27
Triumfetta clementii	+	20	BRV07-20
Waltheria indica	+	30	
Zygophyllum eichleri	+	3	BRV07-11

Brockman 4 Riparian Vegetation Survey Site BRV08

Described by: BECA Date: 23-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 513245 mE 7503955 mN 117.128843 E -22.571079 S

Habitat Floodplain.

Soil Coarse gravelly sandy loam.

Rock Type Continuous lag gravel of sub-angular to rounded ironstone.

Vegetation *Acacia citrinoviridis, A. pyrifolia* tall shrubland over *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) scattered shrubs over *Triodia epactia* very open hummock grassland over **Cenchrus ciliaris* open tussock grassland.

Veg Condition Not recorded.

Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen
Abutilon aff. *lepidum*	+	80	BRV08-10
Acacia citrinoviridis	11	400	
Acacia pyrifolia	2	220	
Alternanthera nana	+	5	=BRV17-31
Androcalva luteiflora	+	220	
Aristida contorta	+	10	
Aristida holathera var. *holathera*	+	30	BRV08-03
Boerhavia coccinea	+	10	BRV08-14
Bulbostylis barbata	+	15	
Cenchrus ciliaris	25	60	
Cenchrus setiger	+	30	
Cleome viscosa	+	30	
Corchorus crozophorifolius	+	100	
Corchorus lasiocarpus subsp. *parvus*	+	80	BRV08-23
Crotalaria medicaginea var. *neglecta*	+	10	BRV08-05
Cucumis variabilis	+	80	
Duperreya commixta	+	260	
Enneapogon lindleyanus	+	30	=BRV15-16
Enneapogon polyphyllus	+	20	BRV08-01, 19
Eriachne aristidea	+	10	
Eriachne pulchella	+	10	BRV08-04
Eulalia aurea	+	120	BRV08-16
Euphorbia australis var. *subtomentosa*	+	5	BRV08-02
Euphorbia trigonosperma	+	40	BRV08-09
Evolvulus alsinoides var. *decumbens*	+	10	
Evolvulus alsinoides var. *villosicalyx*	+	10	
Gomphrena canescens subsp. *canescens*	+	20	BRV08-20
Goodenia nuda	+	15	BRV08-07
Goodenia triodiophila	+	20	
Gossypium australe	+	15	BRV08-12
Hibiscus sturtii var. *grandiflorus*	+	35	BRV08-21
Hybanthus aurantiacus	+	10	
Indigofera monophylla	+	40	BRV08-11
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	1	120	BRV08-24
Jasminum didymum subsp. *lineare*	+	60	
Malvastrum americanum	+	10	
Melhania oblongifolia	+	30	
Notoleptopus decaisnei var. *decaisnei*	+	20	
Petalostylis labicheoides	+	220	
Phyllanthus maderaspatensis	+	10	
Pluchea dentex	+	50	BRV08-08
Polycarpaea longiflora	+	10	
Polymeria ambigua	+	1	BRV08-13
Pterocaulon sphacelatum	+	BRV08-22	
Ptilotus astrolasius	+	100	
Ptilotus obovatus var. *obovatus*	+	70	
Senna artemisioides subsp. *oligophylla x* subsp. *helmsii*	+	60	BRV08-06
Senna glaucifolia	+	130	BRV08-18
Senna notabilis	+	40	
Sida arsiniata	+	40	BRV08-15
Sporobolus australasicus	+	15	

Species	Cover (%)	Height (cm)	Specimen
Stemodia grossa	+	40	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	30	
Themeda triandra	+	80	
Triodia epactia	8	40	BRV08-23
Waltheria indica	+	30	

Brockman 4 Riparian Vegetation Survey Site BRV09

Described by: BECA Date: 24-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 510878 mE 7503063 mN 117.105817 E -22.579147 S

Habitat Floodplain.

Soil Light clay, scattered ironstone.

Rock Type Scattered ironstone.

Vegetation *Acacia citrinoviridis, A. pyrifolia*, (*Gossypium robinsonii*) tall open scrub over *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) scattered shrubs over *Triodia epactia* open hummock grassland over **Cenchrus ciliaris, Eriachne tenuiculmis* very open tussock grassland.

Veg Condition Good (**Cenchrus ciliaris*, **Malvastrum americanum*).

Fire Age Very long unburnt.

Notes Cattle pad next to through site.

Species	Cover (%)	Height (cm)	Specimen
Abutilon aff. *lepidum*	+	40	BRV09-18
Abutilon fraseri subsp. fraseri	+	15	BRV09-02
Acacia citrinoviridis	18	450	
Acacia pyrifolia	25	350	
Acacia sclerosperma subsp. *sclerosperma*	+	220	BRV09-01
Alternanthera nana	+	10	=BRV17-31
Androcalva luteiflora	+	180	
Aristida contorta	+	10	
Boerhavia sp.	+	1	
Capparis lasiantha	+	50	
Cenchrus ciliaris	7	60	
Cenchrus setiger	+	40	
Chrysopogon fallax	+	60	
Cleome viscosa	+	20	
Corchorus crozophorifolius	+	100	
Corymbia hamersleyana	+	500	
Cymbopogon ambiguus	+	60	BRV09-13
Dipteracanthus australasicus subsp. *australasicus*	+	5	=BRV17-20
Duperreya commixta	+	400	
Enneapogon caerulescens	+	10	BRV09-06
Enneapogon polyphyllus	+	20	
Eragrostis cumingii	+	10	BRV09-17, 22
Eriachne aristidea	+	10	BRV09-14
Eriachne pulchella	+	10	BRV09-09
Eriachne tenuiculmis	5	30	
Euphorbia australis var. *subtomentosa*	+	1	BRV09-05
Euphorbia coghlanii	+	30	BRV09-11
Evolvulus alsinoides var. *decumbens*	+	10	
Gomphrena cunninghamii	+	10	BRV09-19
Gomphrena kanisii	+	10	
Goodenia triodiophila	+	15	
Gossypium australe	+	120	
Gossypium robinsonii	2	400	
Hibiscus sturtii var. *grandiflorus*	+	10	BRV09-16
Hybanthus aurantiacus	+	60	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	1	120	BRV09-20
Jasminum didymum subsp. *lineare*	+	300	
Malvastrum americanum	+	40	
Melhania oblongifolia	+	40	
Paraneurachne muelleri	+	30	
Phyllanthus maderaspatensis	+	10	
Polycarpaea longiflora	+	10	
Pterocaulon sphacelatum	+	30	BRV09-21
Ptilotus fusiformis	+	20	BRV09-12
Ptilotus nobilis subsp. *nobilis*	+	10	
Ptilotus obovatus var. *obovatus*	+	40	
Rhynchosia minima	+	120	
Sida aff. *fibulifera*	+	10	BRV09-07
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	40	BRV09-10

Species	Cover (%)	Height (cm)	Specimen
Sida sp. verrucose glands (F.H. Mollemans 2423)	+	10	BRV09-23
Solanum lasiophyllum	+	30	
Sporobolus australasicus	+	15	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	40	
Themeda triandra	+	80	BRV09-03
Triodia epactia	12	60	BRV09-04
Triraphis mollis	+	15	BRV09-08
Waltheria indica	+	30	

Brockman 4 Riparian Vegetation Survey Site BRV10

Described by: BECA Date: 27-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 509934 mE 7502569 mN 117.096637 E -22.583620 S

Habitat Braided creek line, mostly bank features but some good channels through site.

Soil Coarse gravelly loamy sand.

Rock Type Continuous lag gravel of sub-angular to rounded ironstone/quartz/basalt coarse fragments, 2-250 mm diameter.

Vegetation *Acacia citrinoviridis, A. pyrifolia* tall open shrubland over *Corchorus crozophorifolius, Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) open shrubland over *Eriachne pulchella* very open bunch grassland.

Veg Condition Very Good (**Cenchrus ciliaris*, **Malvastrum americanum*).

Fire Age Very long unburnt.

Notes Some cattle scats and tracks evidence.

Highly eroded site: number of channels with approx. 1m relief from high points of bank, number of the larger shrubs have their roots exposed at the micro bank edges, typical near creekline features.

Species	Cover (%)	Height (cm)	Specimen
Acacia citrinoviridis	7	600	
Acacia pyrifolia	1	250	
Alternanthera nana	+	10	BRV10-05
Boerhavia coccinea	+	10	=BRV20-01
Cenchrus ciliaris	+	40	
Cleome viscosa	+	40	
Corchorus crozophorifolius	7	160	
Cucumis variabilis	+	10	
Duperreya commixta	+	40	
Enchylaena tomentosa var. *tomentosa*	+	50	BRV18-10
Eriachne mucronata	+	50	
Eriachne pulchella	2	20	
Eriachne pulchella	+	10	BRV10-03
Eucalyptus camaldulensis subsp. *refulgens*	+	700	
Eulalia aurea	+	80	
Euphorbia australis var. *subtomentosa*	+	10	BRV10-04
Euphorbia trigonosperma	+	20	BRV10-02
Evolvulus alsinoides var. *decumbens*	+	10	
Hybanthus aurantiacus	+	50	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	1	170	
Jasminum didymum subsp. *lineare*	+	50	
Malvastrum americanum	+	40	
Phyllanthus maderaspatensis	+	25	
Ptilotus calostachyus	+	120	
Ptilotus nobilis subsp. *nobilis*	+	20	
Rhynchosia minima	+	10	
Sporobolus australasicus	+	20	
Stemodia grossa	+	40	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	30	
Themeda triandra	+	60	
Triodia epactia	+	50	BRV10-01
Waltheria indica	+	50	

Brockman 4 Riparian Vegetation Survey Site BRV12

Described by: BECA Date: 24-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 507795 mE 7502120 mN 117.075836 E -22.587686 S

Habitat Floodplain.

Soil Light clay with scattered ironstone and quartz fragments.

Rock Type Scattered ironstone and quartz fragments.

Vegetation *Acacia sclerosperma* subsp. *sclerosperma, A. citrinoviridis, A. synchronicia, Stylobasium spathulatum* tall shrubland over *Triodia epactia* very open hummock grassland over **Cenchrus ciliaris* very open tussock grassland.

Veg Condition Good (**Cenchrus ciliaris*).

Fire Age No sign of recent fire.

Notes High level of cattle grazing; many cattle tracks.

Most of the **Cenchrus ciliaris* is grazed to 10 cm.

Species	Cover (%)	Height (cm)	Specimen
Acacia citrinoviridis	11	400	
Acacia pyrifolia	+	200	
Acacia sclerosperma subsp. *sclerosperma*	20	260	
Acacia synchronicia	2	250	BRV12-01
Acacia tetragonophylla	+	130	
Boerhavia coccinea	+	10	BRV12-04
Capparis lasiantha	+	30	
Cenchrus ciliaris	7	40	
Cleome viscosa	+	10	
Corchorus crozophorifolius	+	20	
Duperreya commixta	+	110	
Euphorbia australis var. *subtomentosa*	+	5	BRV12-09, 13
Evolvulus alsinoides var. *villosicalyx*	+	5	
Goodenia forrestii	+	10	BRV12-06
Gossypium robinsonii	+	220	
Gossypium sturtianum var. *sturtianum*	+	180	BRV12-10
Hakea lorea subsp. *lorea*	+	360	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	160	BRV12-17
Malvastrum americanum	+	10	
Portulaca oleracea/intraterranea	+	1	BRV12-03
Pterocaulon sphacelatum	+	20	BRV12-19
Ptilotus obovatus var. *obovatus*	+	40	
Santalum lanceolatum	+	250	BRV12-02
Sclerolaena cornishiana	+	10	BRV12-16
Senna artemisioides subsp. *oligophylla*	+	40	BRV12-15
Senna artemisioides subsp. *oligophylla x* subsp. *helmsii*	+	30	BRV12-05
Sida fibulifera	+	10	BRV12-07
Solanum lasiophyllum	+	10	BRV12-12
Sporobolus australasicus	+	10	
Stylobasium spathulatum	1	240	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	40	
Tribulus astrocarpus	+	1	
Tribulus terrestris	+	1	BRV12-11, 18
Triodia epactia	3	50	BRV12-08
Zygophyllum iodocarpum	+	1	BRV12-14

Brockman 4 Riparian Vegetation Survey Site BRV13

Described by: BECA Date: 25-August 2013 Type: Quadrat 62.5 x 40 m

MGA Zone 50 504481 mE 7501942 mN 117.043597 E -22.589311 S

Habitat Incised creek with islands.

Soil Gravelly loamy sand with ironstone fragments (with some quartz, basalt); outcropping.

Rock Type Ironstone fragments (with some quartz, basalt); outcropping.

Vegetation *Eucalyptus victrix* low woodland over *E. camaldulensis* subsp. *refulgens* low open woodland over *Melaleuca glomerata* tall shrubland over **Cenchrus ciliaris* open tussock grassland.

Veg Condition Good (**Cenchrus ciliaris*, **Malvastrum americanum*, **Vachellia farnesiana*, **Sonchus oleraceus*, **Argemone ochroleuca* subsp. *ochroleuca*).

Fire Age No sign of recent fire.

Notes Quadrat a bit skewed to fit in creekline; consider when re-scoring in future.

Species	Cover (%)	Height (cm)	Specimen
Abutilon amplum	+	160	BRV13-08
Acacia pyrifolia	+	170	
Acacia sclerosperma subsp. *sclerosperma*	+	400	=BRV16-05
Alternanthera nana	+	10	=BRV17-31
Amaranthus undulatus	+	20	BRV13-01
Argemone ochroleuca subsp. *ochroleuca*	+	30	
Boerhavia coccinea	+	20	BRV13-05
Cenchrus ciliaris	11	60	
Centipeda minima subsp. *macrocephala*	+	5	=BRV17-07
Cleome viscosa	+	20	
Corchorus crozophorifolius	+	20	
Cucumis variabilis	+	150	
Cymbopogon sp.	+	80	
Cyperus vaginatus	+	80	
Enneapogon lindleyanus	+	40	=BRV15-16
Eragrostis tenellula	+	20	
Eucalyptus camaldulensis subsp. *refulgens*	5	750	
Eucalyptus victrix	15	1500	
Eulalia aurea	+	60	
Euphorbia biconvexa	+	10	BRV13-07
Evolvulus alsinoides var. *decumbens*	+	20	
Goodenia lamprosperma	+	20	=BRV17-01
Gossypium robinsonii	+	190	
Helichrysum luteoalbum	+	10	BRV13-03
Heliotropium pachyphyllum	+	10	BRV13-04
Hybanthus aurantiacus	+	30	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	160	
Jasminum didymum subsp. *lineare*	+	200	
Malvastrum americanum	+	40	
Melaleuca glomerata	13	350	=BRV17-10
Notoleptopus decaisnei var. *orbicularis* (A.B. Craig 428)	+	10	BRV13-06
Phyllanthus maderaspatensis	+	10	
Phyllanthus maderaspatensis	+	15	
Pluchea rubelliflora	+	40	BRV13-02
Ptilotus nobilis subsp. *nobilis*	+	30	
Rhynchosia minima	+	30	
Senna artemisioides subsp. *oligophylla*	+	180	BRV13-09
Sonchus oleraceus	+	10	
Sporobolus australasicus	+	10	
Stemodia grossa	+	30	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	50	
Themeda triandra	+	60	
Triodia epactia	+	40	
Vachellia farnesiana	+	250	
Vigna lanceolata var. *lanceolata*	+	20	=BRV17-35
Wahlenbergia tumidifructa	+	10	=BRV17-22
Waltheria indica	+	60	

Brockman 4 Riparian Vegetation Survey Site BRV14

Described by: BECA Date: 23-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 502670 mE 7502870 mN 117.025976 E -22.580925 S

Habitat Floodplain/bank between two arms of creek.

Soil Grading from coarse gravelly sandy loam to a light clay.

Rock Type Discontinuous lag gravel of ironstone and quartz sub-angular to rounded.

Vegetation *Acacia citrinoviridis*, (*A. pyrifolia*) tall shrubland over *Ptilotus obovatus* var. *obovatus* scattered low shrubs over *Triodia epactia* very open hummock grassland over **Cenchrus ciliaris* open tussock grassland.

Veg Condition Good (**Cenchrus ciliaris*).

Fire Age Very long unburnt.

Notes Fire age: 5-10 years.

Species	Cover (%)	Height (cm)	Specimen
Abutilon fraseri subsp. *fraseri*	+	20	BRV14-04
Acacia citrinoviridis	33	320	
Acacia pyrifolia	1	220	
Acacia tetragonophylla	+	210	
Alternanthera nana	+	20	BRV14-02
Cenchrus ciliaris	20	60	
Cleome viscosa	+	20	
Codonocarpus cotinifolius	+	250	BRV14-08
Corchorus crozophorifolius	+	80	
Cucumis melo subsp. *agrestis*	+	200	
Dipteracanthus australasicus subsp. *australasicus*	+	20	=BRV17-20
Duperreya commixta	+	320	
Enneapogon polyphyllus	+	10	BRV14-07
Eulalia aurea	+	20	
Euphorbia australis var. *subtomentosa*	+	5	BRV14-10
Goodenia forrestii	+	20	BRV14-05
Goodenia lamprosperma	+	20	=BRV17-01
Gossypium robinsonii	+	300	
Gossypium sturtianum var. *sturtianum*	+	240	BRV14-06
Hakea lorea subsp. *lorea*	+	300	
Hybanthus aurantiacus	+	40	
Jasminum didymum subsp. *lineare*	+	60	
Ptilotus obovatus var. *obovatus*	1	60	
Senna artemisioides subsp. *oligophylla*	+	120	BRV14-03
Senna artemisioides subsp. *oligophylla x* subsp. *helmsii*	+	60	BRV14-09
Sida fibulifera	+	10	BRV14-11
Triodia epactia	2	60	BRV14-01

Brockman 4 Riparian Vegetation Survey Site BRV15

Described by: BECA Date: 23-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 501895 mE 7502562 mN 117.018438 E -22.583713 S

Habitat Braiding creekline.

Soil Coarse gravelly sandy loam with riverstones.

Rock Type Riverstone.

Vegetation *Eucalyptus victrix* woodland over **Cenchrus ciliaris* scattered tussock grasses.

Veg Condition Good (**Malvastrum americanum*, **Cenchrus ciliaris*, **Argemone ochroleuca* subsp. *ochroleuca*).

Fire Age Not recorded.

Species	Cover (%)	Height (cm)	Specimen
Acacia pyrifolia	+	40	
Acacia sclerosperma subsp. *sclerosperma*	+	190	=BRV16-05
Alternanthera nana	+	10	=BRV16-13
Amaranthus undulatus	+	40	BRV15-08
Argemone ochroleuca subsp. *ochroleuca*	+	10	
Bergia trimera	+	1	BRV15-11
Boerhavia coccinea	+	10	BRV15-12
Cenchrus ciliaris	1	40	
Cenchrus setiger	+	10	
Cleome viscosa	+	30	
Convolvulus clementii	+	10	BRV15-13
Corchorus crozophorifolius	+	15	
Cucumis variabilis	+	10	
Cymbopogon procerus	+	60	BRV15-07
Duperreya commixta	+	100	
Enneapogon lindleyanus	+	10	BRV15-16
Eragrostis cumingii	+	10	BRV15-10
Eragrostis tenellula	+	10	BRV15-15
Eriachne mucronata	+	40	
Eriachne pulchella	+	10	BRV15-02
Eucalyptus victrix	12	1400	BRV15-01
Eulalia aurea	+	60	BRV15-06
Euphorbia biconvexa	+	10	BRV15-04
Evolvulus alsinoides var. *decumbens*	+	10	
Evolvulus alsinoides var. *villosicalyx*	+	10	
Gomphrena canescens subsp. *canescens*	+	10	BRV15-03
Goodenia forrestii	+	20	=BRV16-03
Goodenia lamprosperma	+	30	=BRV17-01
Gossypium robinsonii	+	40	
Hybanthus aurantiacus	+	20	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	60	
Jasminum didymum subsp. *lineare*	+	180	
Malvastrum americanum	+	60	
Phyllanthus maderaspatensis	+	10	BRV15-09
Pluchea rubelliflora	+	30	=BRV17-34
Polycarpaea longiflora	+	20	
Pterocaulon sphacelatum	+	60	=BRV17-29
Ptilotus astrolasius	+	40	
Ptilotus nobilis subsp. *nobilis*	+	10	
Rhynchosia minima	+	10	
Sonchus oleraceus	+	20	
Sporobolus australasicus	+	10	
Stemodia grossa	+	20	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	60	BRV15-14
Vachellia farnesiana	+	40	
Vigna lanceolata var. *lanceolata*	+	1	=BRV17-35
Waltheria indica	+	60	

Brockman 4 Riparian Vegetation Survey Site BRV16

Described by: BECA Date: 22-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 500399 mE 7502411 mN 117.003880 E -22.585079 S

Habitat Floodplain.

Soil Self mulching light clay.

Rock Type Ironstone and quartz fragments.

Vegetation *Acacia citrinoviridis*, (*Hakea lorea* subsp. *lorea, A. pyrifolia* var. *pyrifolia*) tall open scrub over **Cenchrus ciliaris* closed tussock grassland.

Veg Condition Very Poor (**Cenchrus ciliaris, *Malvastrum americanum*).

Fire Age No sign of recent fire.

Notes Cattle and donkeys in area.

Species	Cover (%)	Height (cm)	Specimen
Acacia citrinoviridis	40	420	BRV16-14a
Acacia pyrifolia var. *pyrifolia*	1	220	=BRV17-15
Acacia sclerosperma subsp. *sclerosperma*	+	140	BRV16-04, 05
Acacia victoriae subsp. *victoriae*	+	80	BRV16-15
Alternanthera nana	+	10	=BRV17-31
Alternanthera nana	+	10	BRV16-13
Boerhavia repleta	+	1	BRV16-11
Cenchrus ciliaris	75	60	
Chrysopogon fallax	+	90	
Cleome viscosa	+	40	
Convolvulus clementii	+	2	BRV16-12
Cucumis variabilis	+	80	
Dichanthium sericeum subsp. *humilius*	+	10	BRV16-16
Duperreya commixta	+	140	
Dysphania rhadinostachya subsp. *inflata*	+	10	BRV16-08
Glycine canescens	+	20	BRV16-17
Goodenia forrestii	+	10	BRV16-03
Goodenia microptera	+	4	BRV16-10
Hakea lorea subsp. *lorea*	1	500	BRV16-14b
Jasminum didymum subsp. *lineare*	+	40	
Malvastrum americanum	+	30	
Pluchea rubelliflora	+	2	BRV16-18
Portulaca oleracea/intraterranea	+	1	BRV16-06
Pterocaulon sphacelatum	+	30	BRV16-02
Ptilotus nobilis subsp. *nobilis*	+	10	
Ptilotus obovatus var. *obovatus*	+	50	
Rhynchosia minima	+	30	
Sida fibulifera	+	3	BRV16-07
Sporobolus australasicus	+	10	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	40	BRV16-09
Tribulus astrocarpus	+	1	
Triodia epactia	+	50	BRV16-01

Brockman 4 Riparian Vegetation Survey Site BRV17

Described by: BECA Date: 22-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 498200 mE 7501500 mN 116.982486 E -22.593309 S

Habitat Incised creekline with island.

Soil 2.5YR 2.5/4 dark reddish brown sandy clay loam.

Rock Type Ironstone with coarse fragments of 2-300 mm sub-angular to sub-rounded.

Vegetation *Eucalyptus camaldulensis* subsp. *refulgens* woodland over *Melaleuca glomerata, Acacia citrinoviridis* tall shrubland over *Cyperus vaginatus* very open sedgeland over **Cenchrus ciliaris, *C. setiger* tussock grassland.

Veg Condition Good to Poor (**Cenchrus ciliaris, *C. setiger, *Bidens bipinnata, *Vachellia farnesiana, *Malvastrum americanum, *Argemone ochroleuca* subsp. *ochroleuca*).

Fire Age No sign of recent fire.

Notes Cattle and donkeys in area.

Species	Cover (%)	Height (cm)	Specimen
Abutilon amplum	+	70	BRV17-12
Acacia citrinoviridis	9	700	BRV17-11, 38
Acacia coriacea subsp. *pendens*	+	500	BRV17-32b
Acacia pyrifolia var. *pyrifolia*	+	90	BRV17-15
Alternanthera nana	+	20	BRV17-06, 31
Argemone ochroleuca subsp. *ochroleuca*	+	10	
Bidens bipinnata	+	10	
Boerhavia coccinea	+	5	BRV17-23
Bothriochloa ewartiana	+	15	BRV17-39
Cenchrus ciliaris	25	60	
Cenchrus setiger	10	60	
Centipeda minima subsp. *macrocephala*	+	5	BRV17-07
Cleome viscosa	+	10	
Corchorus crozophorifolius	+	60	
Crotalaria medicaginea var. *neglecta*	+	20	BRV17-26
Cucumis variabilis	+	10	BRV17-09
Cyperus vaginatus	9	100	BRV17-32a
Dichanthium sericeum subsp. *humilius*	+	15	BRV17-05
Dipteracanthus australasicus subsp. *australasicus*	+	10	BRV17-20
Duperreya commixta	+	10	
Enneapogon lindleyanus	+	60	BRV17-36
Enteropogon ramosus	+	60	BRV17-18
Eragrostis cumingii	+	5	BRV17-02
Eragrostis tenellula	+	10	BRV17-03
Eriachne mucronata	+	40	
Eriachne pulchella	+	20	BRV17-24
Eucalyptus camaldulensis subsp. *refulgens*	25	1400	BRV17-37
Eulalia aurea	+	90	BRV17-08
Euphorbia coghlanii	+	10	BRV17-25
Evolvulus alsinoides var. *decumbens*	+	10	BRV17-13
Evolvulus alsinoides var. *villosicalyx*	+	10	BRV17-21
Glycine canescens	+	15	BRV17-28
Goodenia lamprosperma	+	10	BRV17-01
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	30	BRV17-19
Jasminum didymum subsp. *lineare*	+	250	
Lepidium muelleri-ferdinandii	+	5	BRV17-16
Malvastrum americanum	+	40	
Melaleuca glomerata	15	450	BRV17-10
Melhania oblongifolia	+	20	
Pluchea rubelliflora	+	40	BRV17-34
Pterocaulon sphacelatum	+	10	BRV17-29
Ptilotus obovatus var. *obovatus*	+	40	
Rhynchosia minima	+	10	
Rostellularia adscendens var. *clementii*	+	10	BRV17-17
Sida fibulifera	+	10	BRV17-04
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	40	BRV17-27
Sporobolus australasicus	+	10	
Stemodia grossa	+	10	BRV17-14
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	30	BRV17-33

Species	Cover (%)	Height (cm)	Specimen
Triumfetta clementii	+	40	BRV17-30
Vachellia farnesiana	+	160	
Vigna lanceolata var. *lanceolata*	+	10	BRV17-35
Wahlenbergia tumidifructa	+	20	BRV17-22
Waltheria indica	+	40	

Brockman 4 Riparian Vegetation Survey Site BRV18

Described by: BECA Date: 26-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 497451 mE 7500179 mN 116.975195 E -22.605236 S

Habitat Floodplain, near drainage bank.

Soil Sandy loam.

Rock Type Ironstone, basalt, quartz discontinuous lag gravel, sub-angular to rounded 2-200 mm diameter.

Vegetation *Eucalyptus camaldulensis* subsp. *refulgens* scattered trees over *Acacia citrinoviridis, Hakea lorea* subsp. *lorea* tall open scrub over **Cenchrus ciliaris, *C. setiger* open tussock grassland.

Veg Condition Poor (**Cenchrus ciliaris, *Malvastrum americanum*, presence of cattle).

Fire Age Very long unburnt.

Notes Cattle pads, grazed heavily.

A lot of cattle/donkey pads throughout the site.

Species	Cover (%)	Height (cm)	Specimen
Abutilon sp. Pilbara (W.R. Barker 2025)	+	10	BRV18-04
Acacia citrinoviridis	40	600	
Acacia pyrifolia	+	160	
Acacia sclerosperma subsp. *sclerosperma*	+	200	
Alternanthera nana	+	10	=BRV16-13
Aristida contorta	+	20	BRV18-17
Boerhavia coccinea	+	20	BRV18-07
Capparis lasiantha	+	40	
Cenchrus ciliaris	20	40	
Cenchrus setiger	1	10	
Cleome viscosa	+	30	
Corchorus crozophorifolius	+	40	
Cucumis variabilis	+	40	
Dicladanthera forrestii	+	20	BRV18-14
Dipteracanthus australasicus subsp. *australasicus*	+	10	=BRV17-20
Dodonaea lanceolata var. *lanceolata*	+	60	=BRV19-06
Duperreya commixta	+	160	
Dysphania rhadinostachya subsp. *rhadinostachya*	+	10	=BRV20-06
Ehretia saligna var. saligna	+	230	BRV18-15
Enchylaena tomentosa var. *tomentosa*	+	15	BRV18-10
Enneapogon lindleyanus	+	40	=BRV15-16
Eriachne mucronata	+	40	
Eriachne pulchella	+	20	
Eucalyptus camaldulensis subsp. *refulgens*	2	1200	
Euphorbia australis var. *subtomentosa*	+	15	BRV18-08
Euphorbia coghlanii	+	20	BRV18-02
Evolvulus alsinoides var. *decumbens*	+	10	
Evolvulus alsinoides var. *villosicalyx*	+	10	
Glycine canescens	+	150	BRV18-01
Goodenia forrestii	+	10	BRV18-06
Goodenia lamprosperma	+	20	=BRV17-01
Goodenia nuda	+	20	BRV18-03
Hakea lorea subsp. *lorea*	2	500	
Hybanthus aurantiacus	+	10	
Indigofera colutea	+	5	BRV18-09
Lepidium muelleri-ferdinandii	+	10	=BRV19-11
Malvastrum americanum	+	20	
Melhania oblongifolia	+	15	
Peripleura arida	+	15	BRV18-11
Petalostylis labicheoides	+	220	
Phyllanthus maderaspatensis	+	15	
Polymeria ambigua	+	10	BRV18-12
Pterocaulon sphacelatum	+	40	=BRV19-12
Ptilotus obovatus var. *obovatus*	+	40	
Rhynchosia minima	+	5	
Santalum lanceolatum	+	280	=BRV12-02
Sida aff. *fibulifera*	+	10	BRV18-05
Sida clementii	+	40	BRV18-16

Species	Cover (%)	Height (cm)	Specimen
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	25	BRV18-13
Solanum diversiflorum	+	20	
Solanum lasiophyllum	+	10	
Sporobolus australasicus	+	10	
Stylobasium spathulatum	+	40	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	10	
Triodia epactia	+	30	BRV18-18
Vigna lanceolata var. *lanceolata*	+	5	

Brockman 4 Riparian Vegetation Survey Site BRV19

Described by: BECA Date: 26-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 496079 mE 7498943 mN 116.961849 E -22.616398 S

Habitat Wide creek bed with islands.

Soil Coarse sand.

Rock Type River wash lag gravel of ironstone, quartz, basalt fragments from 2-200 mm.

Vegetation *Eucalyptus camaldulensis* subsp. *refulgens, E. victrix* woodland over *Melaleuca glomerata, Acacia citrinoviridis, Petalostylis labicheoides* tall open scrub over **Cenchrus ciliaris, *C. setiger* very open tussock grassland.

Veg Condition Good (**Malvastrum americanum, *Vachellia farnesiana, *Argemone ochroleuca* subsp. *ochroleuca*, **Cenchrus ciliaris*, **C. setiger*).

Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen
Acacia citrinoviridis	8	600	
Acacia coriacea subsp. *pendens*	+	400	BRV19-05
Acacia pyrifolia	+	230	
Acacia sclerosperma subsp. *sclerosperma*	+	280	=BRV16-05
Alternanthera nana	+	10	=BRV17-31
Amaranthus cuspidifolius	+	40	=BRV20-03
Amyema sanguinea var. *sanguinea*	+	800	BRV19-10
Argemone ochroleuca subsp. *ochroleuca*	+	40	
Bulbostylis barbata	+	20	BRV19-09
Capparis spinosa var. *nummularia*	+	40	BRV19-07
Cenchrus ciliaris	3	30	
Cenchrus setiger	1	30	
Cleome viscosa	+	40	
Convolvulus remotus	+	1	BRV19-04
Corchorus crozophorifolius	+	120	
Cucumis variabilis	+	70	
Cymbopogon ambiguus	+	80	=BRV20-08
Cyperus vaginatus	+	120	
Dipteracanthus australasicus subsp. *australasicus*	+	30	=BRV17-20
Dodonaea lanceolata var. *lanceolata*	+	120	BRV19-06
Duperreya commixta	+	250	
Eriachne mucronata	+	40	
Eucalyptus camaldulensis subsp. *refulgens*	18	1600	
Eucalyptus victrix	7	1500	
Euphorbia australis var. *subtomentosa*	+	10	BRV19-03
Euphorbia trigonosperma	+	30	=BRV20-02
Evolvulus alsinoides var. *decumbens*	+	10	
Evolvulus alsinoides var. *villosicalyx*	+	10	
Goodenia forrestii	+	20	=BRV16-03
Goodenia lamprosperma	+	30	=BRV20-07
Indigofera colutea	+	20	BRV19-01
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	160	
Ipomoea muelleri	+	5	=BRV20-11
Jasminum didymum subsp. *lineare*	+	120	
Lepidium muelleri-ferdinandii	+	15	BRV19-11
Malvastrum americanum	+	60	
Melaleuca glomerata	33	400	
Petalostylis labicheoides	2	220	
Phyllanthus maderaspatensis	+	30	
Pluchea rubelliflora	+	40	=BRV20-04
Pterocaulon sphacelatum	+	70	BRV19-12
Rhynchosia minima	+	20	
Sida aff. *fibulifera*	+	20	BRV19-08
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	40	
Triodia wiseana	+	30	BRV19-02
Vachellia farnesiana	+	310	
Waltheria indica	+	40	

Brockman 4 Riparian Vegetation Survey Site BRV20

Described by: BECA Date: 26-August 2013 Type: Quadrat 50 x 50 m

MGA Zone 50 492419 mE 7497583 mN 116.926226 E -22.628678 S

Habitat Wide creek bed.

Soil Coarse sand.

Rock Type River wash lag gravel of ironstone, quartz and basalt fragments from 2mm-200mm.

Vegetation *Eucalyptus victrix* woodland over *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) scattered low shrubs over *Pluchea rubelliflora* very open herbland over *Eriachne pulchella* very open bunch grassland.

Veg Condition Very Good (*Cenchrus ciliaris, *Argemone ochroleuca* subsp. *ochroleuca*).

Fire Age No sign of recent fire.

Notes No signs of cattle/donkey.

Species	Cover (%)	Height (cm)	Specimen
Acacia citrinoviridis	+	300	
Acacia pyrifolia	+	160	
Alternanthera nana	+	10	BRV20-05
Amaranthus cuspidifolius	+	40	BRV20-03
Argemone ochroleuca subsp. *ochroleuca*	+	60	
Boerhavia coccinea	+	10	BRV20-01
Cenchrus ciliaris	+	30	
Cenchrus setiger	+	30	
Cleome viscosa	+	40	
Corchorus crozophorifolius	+	70	
Cucumis variabilis	+	50	
Cymbopogon ambiguus	+	50	BRV20-08
Cyperus vaginatus	+	80	
Dysphania rhadinostachya subsp. *rhadinostachya*	+	20	BRV20-06
Eriachne mucronata	+	40	
Eriachne pulchella	2	10	
Eucalyptus victrix	20	1200	
Euphorbia trigonosperma	+	20	BRV20-02
Goodenia lamprosperma	+	40	BRV20-07
Heliotropium cunninghamii	+	10	BRV20-10
Heliotropium pachyphyllum	+	10	BRV20-09
Ipomoea muelleri	+	1	BRV20-11
Melaleuca glomerata	+	250	
Phyllanthus maderaspatensis	+	20	
Pluchea rubelliflora	4	40	BRV20-04
Polycarpaea longiflora	+	15	
Ptilotus nobilis subsp. *nobilis*	+	50	
Sporobolus australasicus	+	10	
Stemodia grossa	+	30	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	2	60	
Triodia epactia	+	20	

Brockman 4 Riparian Vegetation Survey Site BRVR-CBA

Described by: BECA Date: 24-August 2013 Type: Relevé

MGA Zone	50	508905 mE	7502376 mN	117.086631 E	-22.585291 S
Habitat	Incised creek bed (~30m wide) curving.				
Soil	Not recorded.				
Rock Type	Not recorded.				
Vegetation	*Eucalyptus victrix* woodland.				
Veg Condition	Very Good (**Cenchrus ciliaris*).				
Fire Age	No sign of recent fire.				
Notes	**Cenchrus* cover in bed is +/-1% but much higher on banks. A lot of juvenile *Eucalyptus* sp.				

Species	Cover (%)	Height (cm)	Specimen
Acacia pyrifolia	+		
Cenchrus ciliaris	+		
Centipeda minima subsp. *macrocephala*	+		
Corchorus crozophorifolius	+		
Eragrostis tenellula	+		
Eucalyptus sp.	+		
Eucalyptus victrix	20		
Evolvulus alsinoides var. *villosicalyx*	+		
Goodenia lamprosperma	+		=BRV17-01
Gossypium robinsonii	+		
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+		
Phyllanthus maderaspatensis	+		
Pluchea rubelliflora	+		=BRV17-34
Rhynchosia minima	+		
Stemodia grossa	+		
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+		
Wahlenbergia tumidifructa	+		=BRV17-22

Brockman 4 Riparian Vegetation Survey Site BRVR-SA

Described by: SVPC Date: 28-August 2013 Type: Relevé

MGA Zone 50 525479 mE 7505741 mN 117.247814 E -22.554724 S

Habitat Ill-defined creekline.

Soil Red-brown sand.

Rock Type Riverstones (continuous).

Vegetation *Eucalyptus victrix, Corymbia hamersleyensis* open woodland over *Acacia tumida* var. *pilbarensis, A. pyrifolia* (var. not determined), *A. citrinoviridis* tall open shrubland over *Triodia epactia* very open hummock grassland over *Themeda triandra*, (*Chrysopogon fallax*) very open tussock grassland.

Veg Condition Very Good (**Malvastrum americanum*, **Cenchrus ciliaris*).

Fire Age No sign of recent fire.

Notes Low number of scats.

Relevé ends near small track.

Species	Cover (%)	Height (cm)	Specimen
Acacia ancistrocarpa	+	70	
Acacia citrinoviridis	1	280	
Acacia pyrifolia	1	150	
Acacia tumida var. *pilbarensis*	1	250	
Alternanthera denticulata	+	10	=BRV02-04
Androcalva luteiflora	+	180	
Boerhavia coccinea	+	15	=BRV20-01
Bulbostylis barbata	+	10	
Cenchrus ciliaris	+	50	
Chrysopogon fallax	0.5	110	
Cleome viscosa	+	30	
Corchorus lasiocarpus subsp. *parvus*	+	45	=BRV02-14
Corymbia hamersleyana	3	800	
Cucumis variabilis	+	16	
Cymbopogon ambiguus	+	110	
Dichanthium sericeum subsp. *humilius*	+	15	
Digitaria brownii	1	60	
Enneapogon caerulescens	+	30	
Enneapogon polyphyllus	+	15	
Eragrostis cumingii	+	15	
Eragrostis tenellula	+	25	
Eremophila longifolia	+	150	
Eriachne pulchella	+	20	
Eriachne tenuiculmis	+	30	
Eucalyptus victrix	2	1300	
Evolvulus alsinoides var. *villosicalyx*	+	10	
Goodenia forrestii	+	25	
Goodenia triodiophila	+	30	BRVR-SA02
Gossypium australe	+	120	
Gossypium robinsonii	+	250	
Grevillea pyramidalis subsp. *leucadendron*	+	200	
Hakea lorea subsp. *lorea*	+	210	
Heliotropium cunninghamii	+	20	BRVR-SV03
Hibiscus sturtii var. *grandiflorus*	+	20	BRVR-SA09
Hybanthus aurantiacus	+	25	
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	+	220	
Jasminum didymum subsp. *lineare*	+	250	
Malvastrum americanum	+	35	
Melhania oblongifolia	+	25	
Mollugo molluginea	+	20	
Phyllanthus maderaspatensis	+	10	
Pluchea dentex	+	25	BRVR-SA01
Polycarpaea longiflora	+	25	
Pterocaulon sphacelatum	+	50	BRVR-SA05
Ptilotus astrolasius	+	30	
Ptilotus obovatus var. *obovatus*	+	90	
Senna artemisioides subsp. *oligophylla*	+	120	BRVR-SA06
Setaria verticillata	+	20	

Species	Cover (%)	Height (cm)	Specimen
Sida aff. *fibulifera*	+	40	BRVR-SA07
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	+	160	
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	+	40	=BRV02-06
Themeda triandra	7	60	
Trachymene oleracea subsp. *oleracea*	+	110	BRVR-SV08
Trichodesma zeylanicum var. *zeylanicum*	+	40	
Triodia epactia	6	40	BRVR-SA04
Waltheria indica	+	45	

Appendix 8

Records of Conservation Significant Flora and Introduced (Weed) Species from the Study Area

Records of Priority flora within the study area.

Species	Conservation Status	Easting	Northing	Number of Individuals
Goodenia nuda	Priority 4	524106	7504851	1
Goodenia nuda	Priority 4	516577	7504786	1
Goodenia nuda	Priority 4	512290	7503593	1
Goodenia nuda	Priority 4	513267	7503928	1
Goodenia nuda	Priority 4	497466	7500148	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	498217	7501449	20
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	498184	7501456	12
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	498124	7501461	7
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	499061	7501858	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	499326	7501954	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	499353	7501996	50-100
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	500779	7502415	40
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	501929	7502542	12
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	502334	7502695	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	502550	7502813	9
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	502597	7502803	7
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	503001	7502367	9
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	503384	7502361	18
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	503666	7502161	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	503736	7502118	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	503894	7502077	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504005	7502089	27
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504234	7502057	7
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	497827	7501060	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	498171	7501484	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	499982	7502104	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	501224	7502611	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	502339	7502702	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504492	7501901	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504515	7501995	20
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504515	7502079	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504542	7502077	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504563	7501949	30+
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504569	7501861	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504677	7501796	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504671	7501779	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504643	7501798	8
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504776	7501736	55
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	504791	7501769	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	505234	7501837	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	505866	7501862	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	506095	7501934	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	506531	7501737	18

Species	Conservation Status	Easting	Northing	Number of Individuals
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	506844	7501583	4
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	507203	7501638	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	507428	7501780	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	507921	7501920	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	508108	7501941	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	508892	7502362	13
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509123	7502537	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509217	7502486	15
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509378	7502319	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509446	7502309	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509550	7502335	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509566	7502397	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509879	7502426	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509885	7502458	48
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	510247	7502842	7
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	517056	7504742	20
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	517173	7504564	16
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	517129	7504459	15
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	517259	7504293	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	517398	7504253	17
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	517801	7504371	8
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	518211	7504137	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	519109	7503568	14
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	519555	7503451	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	519654	7503441	11
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	520743	7504147	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	521012	7504223	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	521312	7504340	4
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	521403	7504285	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	522357	7504224	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	522440	7504194	20
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	522512	7504133	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	522620	7504070	4
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	522661	7504074	8
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	522668	7504095	7
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	523141	7504436	14
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	489599	7497581	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	489750	7497621	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	489978	7497760	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	490238	7497756	14
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	490342	7497781	4
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	490875	7497687	20
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	491404	7497723	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	492348	7497436	9

Species	Conservation Status	Easting	Northing	Number of Individuals
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	492651	7497365	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	492952	7497242	4
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	493002	7497167	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	494911	7498562	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	495057	7498594	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	495086	7498664	4
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	495170	7498779	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	495462	7498851	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	495524	7498916	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	495850	7498898	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	496565	7499265	13
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	525695	7506594	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	525608	7506554	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	525459	7506357	8
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	525372	7506220	12
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	510810	7502993	8
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	510812	7502925	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	510952	7502959	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	511310	7503338	15
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	511890	7503310	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	512136	7503379	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	512340	7503753	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	512536	7503614	15
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	512950	7503759	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	513391	7503811	8
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	513473	7504080	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	513428	7504208	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	513528	7504292	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	514026	7504447	40
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	515562	7504437	3
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	515530	7504598	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	515878	7504880	10
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	516005	7504937	4
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	516352	7504932	5
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	516551	7504820	9
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	516543	7504781	8
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	510606	7504787	50
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	516784	7504774	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	497799	7500812	40
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	497764	7500815	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	522203	7504263	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	510878	7503063	73
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	513245	7503955	33
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	514840	7504419	19

Species	Conservation Status	Easting	Northing	Number of Individuals
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	516561	7504815	40
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	524080	7504873	11
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	509934	7502569	108
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	507795	7502120	2
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	501895	7502562	6
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	498200	7501500	1
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	496032	7498924	135
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	525490	7506172	26
Pentalepis trichodesmoides subsp. *hispida*	Priority 2	512290	7503593	1
Peplidium sp. Fortescue Marsh (S. van Leeuwen 4865)	Priority 1	522229	7504240	1

Records of introduced (weed) species within the study area.

Species	Common Name	Easting	Northing	Number of Individuals
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	489487	7497512	50
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	489707	7497747	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	489750	7497621	50
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	489978	7497760	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	490342	7497781	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	490346	7497637	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	490899	7497627	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	491404	7497723	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	491752	7497648	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	492277	7497608	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	492430	7497546	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	492952	7497242	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	492979	7497060	1000's
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	493916	7497238	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	494096	7498062	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	494184	7498342	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	494911	7498562	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	495057	7498594	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	495524	7498916	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	495850	7498898	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	496032	7498924	187
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	496062	7498909	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	496225	7498956	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	496890	7499468	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	496996	7499532	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497117	7499597	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497362	7499842	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497465	7500148	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497508	7499940	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497531	7500937	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497592	7499958	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497609	7500297	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497627	7500866	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497799	7500812	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497827	7501060	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497869	7501188	150+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497898	7501138	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497908	7500500	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	497988	7501377	2
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498016	7501404	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498171	7501484	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498200	7501500	55
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498223	7501479	20-30

Species	Common Name	Easting	Northing	Number of Individuals
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498228	7501450	150+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498336	7501479	50+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498513	7501512	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498623	7501582	5
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498673	7501720	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	498727	7501713	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	499147	7501880	50
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	499282	7501925	100+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	499358	7501998	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	499982	7502104	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	499984	7502106	50+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	500196	7502077	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	500385	7502379	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	500411	7502128	80
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	500714	7502328	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	501224	7502611	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	501448	7502738	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	501454	7502766	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	501895	7502562	230
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	501914	7502535	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	501929	7502542	200+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	502339	7502702	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	502597	7502803	100+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	502654	7502837	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	502675	7502674	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	502706	7502983	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	502762	7502772	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	502920	7502458	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	503001	7502367	50
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	503384	7502361	1000+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	503470	7502326	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	503666	7502161	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504005	7502089	100+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504481	7501942	450
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504492	7501901	15
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504504	7501908	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504515	7502079	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504563	7501949	100+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504569	7501861	80
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504671	7501779	40
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504677	7501796	20
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504791	7501769	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504847	7501713	200+
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	504981	7501719	1,000's. Dense cover

Species	Common Name	Easting	Northing	Number of Individuals
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	505234	7501837	100's. Dense cover since last point
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	505564	7501847	1000's
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	505866	7501862	1000's
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	506148	7501885	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	506623	7501743	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	506797	7501642	15
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	507428	7501780	100
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	507812	7502091	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	507863	7501901	Dense cover
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	508333	7502143	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	508487	7502354	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	508570	7502401	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	508905	7502376	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	509056	7502385	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	509550	7502335	100's
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	509566	7502397	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	509854	7502461	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	509941	7502535	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	510133	7502896	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	510247	7502842	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	510472	7502912	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	510555	7502928	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	510807	7503004	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	510870	7503032	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	511165	7503224	75
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	511197	7503199	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	511682	7503254	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	512101	7503379	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	512288	7503594	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	512688	7503581	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	512762	7503537	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	512952	7503761	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	513266	7503927	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	513391	7503811	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	513428	7504208	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	513473	7504080	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	513936	7504436	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	514480	7504406	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	514822	7504375	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	514864	7504394	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	515026	7504363	50
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	515533	7504561	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	515562	7504437	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	515632	7504701	20-30

Species	Common Name	Easting	Northing	Number of Individuals
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	516361	7504933	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	516363	7504953	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	516543	7504781	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	516568	7504786	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	516843	7504837	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	516861	7504833	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	517014	7504774	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	517056	7504742	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	517088	7504669	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	517529	7504308	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	517962	7504360	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	518159	7504135	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	518987	7503722	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	519109	7503568	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	519555	7503451	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	519654	7503441	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	520127	7503715	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	520416	7503875	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	520743	7504147	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	521997	7504181	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	522230	7504240	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	522668	7504095	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	523141	7504436	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	523384	7504775	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	524095	7505030	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	524104	7504851	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	525214	7505895	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	525490	7506172	20-30
**Argemone ochroleuca* subsp. *ochroleuca*	Mexican Poppy	526205	7506728	20-30
**Bidens bipinnata*	Bipinnate Beggartick	498200	7501500	1
**Cenchrus ciliaris*	Buffel Grass	489487	7497512	10
**Cenchrus ciliaris*	Buffel Grass	489707	7497747	10
**Cenchrus ciliaris*	Buffel Grass	489978	7497760	10
**Cenchrus ciliaris*	Buffel Grass	490342	7497781	20-30
**Cenchrus ciliaris*	Buffel Grass	490346	7497637	50-70
**Cenchrus ciliaris*	Buffel Grass	490899	7497627	50-70
**Cenchrus ciliaris*	Buffel Grass	491404	7497723	50-70
**Cenchrus ciliaris*	Buffel Grass	491752	7497648	50-70
**Cenchrus ciliaris*	Buffel Grass	492277	7497608	50-70
**Cenchrus ciliaris*	Buffel Grass	492395	7497536	10
**Cenchrus ciliaris*	Buffel Grass	492430	7497546	50-70
**Cenchrus ciliaris*	Buffel Grass	492952	7497242	50-70
**Cenchrus ciliaris*	Buffel Grass	493916	7497238	50-70
**Cenchrus ciliaris*	Buffel Grass	494096	7498062	50-70

Species	Common Name	Easting	Northing	Number of Individuals
**Cenchrus ciliaris*	Buffel Grass	494184	7498342	5
**Cenchrus ciliaris*	Buffel Grass	494911	7498562	50-70
**Cenchrus ciliaris*	Buffel Grass	495057	7498594	50-70
**Cenchrus ciliaris*	Buffel Grass	495524	7498916	50-70
**Cenchrus ciliaris*	Buffel Grass	495850	7498898	50-70
**Cenchrus ciliaris*	Buffel Grass	496062	7498909	50-70
**Cenchrus ciliaris*	Buffel Grass	496225	7498956	50-70
**Cenchrus ciliaris*	Buffel Grass	496890	7499468	50-70
**Cenchrus ciliaris*	Buffel Grass	496996	7499532	50-70
**Cenchrus ciliaris*	Buffel Grass	497117	7499597	50-70
**Cenchrus ciliaris*	Buffel Grass	497362	7499842	50-70
**Cenchrus ciliaris*	Buffel Grass	497451	7500179	4000
**Cenchrus ciliaris*	Buffel Grass	497465	7500148	50-70
**Cenchrus ciliaris*	Buffel Grass	497508	7499940	50-70
**Cenchrus ciliaris*	Buffel Grass	497531	7500937	50-70
**Cenchrus ciliaris*	Buffel Grass	497592	7499958	50-70
**Cenchrus ciliaris*	Buffel Grass	497609	7500297	50-70
**Cenchrus ciliaris*	Buffel Grass	497627	7500866	50-70
**Cenchrus ciliaris*	Buffel Grass	497696	7500074	40-50
**Cenchrus ciliaris*	Buffel Grass	497799	7500812	20-30
**Cenchrus ciliaris*	Buffel Grass	497827	7501060	20-30
**Cenchrus ciliaris*	Buffel Grass	497898	7501138	20-30
**Cenchrus ciliaris*	Buffel Grass	497908	7500500	50-70
**Cenchrus ciliaris*	Buffel Grass	498016	7501404	20-30
**Cenchrus ciliaris*	Buffel Grass	498077	7501434	50
**Cenchrus ciliaris*	Buffel Grass	498171	7501484	10
**Cenchrus ciliaris*	Buffel Grass	498200	7501500	2500
**Cenchrus ciliaris*	Buffel Grass	498204	7501453	40-50
**Cenchrus ciliaris*	Buffel Grass	498223	7501479	50-70
**Cenchrus ciliaris*	Buffel Grass	498513	7501512	10
**Cenchrus ciliaris*	Buffel Grass	498623	7501582	40-50
**Cenchrus ciliaris*	Buffel Grass	498673	7501720	10
**Cenchrus ciliaris*	Buffel Grass	498727	7501713	10
**Cenchrus ciliaris*	Buffel Grass	499147	7501880	20
**Cenchrus ciliaris*	Buffel Grass	499358	7501998	10
**Cenchrus ciliaris*	Buffel Grass	499982	7502104	20-30
**Cenchrus ciliaris*	Buffel Grass	500196	7502077	50-70
**Cenchrus ciliaris*	Buffel Grass	500354	7502392	7500
**Cenchrus ciliaris*	Buffel Grass	500385	7502379	50-70
**Cenchrus ciliaris*	Buffel Grass	500714	7502328	50-70
**Cenchrus ciliaris*	Buffel Grass	501224	7502611	20-30
**Cenchrus ciliaris*	Buffel Grass	501448	7502738	50-70
**Cenchrus ciliaris*	Buffel Grass	501454	7502766	50-70
**Cenchrus ciliaris*	Buffel Grass	501895	7502562	80

Species	Common Name	Easting	Northing	Number of Individuals
**Cenchrus ciliaris*	Buffel Grass	501914	7502535	50-70
**Cenchrus ciliaris*	Buffel Grass	502339	7502702	10
**Cenchrus ciliaris*	Buffel Grass	502619	7502854	2000
**Cenchrus ciliaris*	Buffel Grass	502654	7502837	50-70
**Cenchrus ciliaris*	Buffel Grass	502675	7502674	50-70
**Cenchrus ciliaris*	Buffel Grass	502706	7502983	50-70
**Cenchrus ciliaris*	Buffel Grass	502762	7502772	50-70
**Cenchrus ciliaris*	Buffel Grass	502920	7502458	50-70
**Cenchrus ciliaris*	Buffel Grass	503470	7502326	50-70
**Cenchrus ciliaris*	Buffel Grass	503666	7502161	50-70
**Cenchrus ciliaris*	Buffel Grass	504481	7501942	1200
**Cenchrus ciliaris*	Buffel Grass	504492	7501901	10
**Cenchrus ciliaris*	Buffel Grass	504504	7501908	50-70
**Cenchrus ciliaris*	Buffel Grass	504515	7502079	50-70
**Cenchrus ciliaris*	Buffel Grass	504542	7502077	500
**Cenchrus ciliaris*	Buffel Grass	504671	7501779	50-70
**Cenchrus ciliaris*	Buffel Grass	504791	7501769	20-30
**Cenchrus ciliaris*	Buffel Grass	505564	7501847	10
**Cenchrus ciliaris*	Buffel Grass	506148	7501885	50-70
**Cenchrus ciliaris*	Buffel Grass	506623	7501743	50-70
**Cenchrus ciliaris*	Buffel Grass	507428	7501780	50-70
**Cenchrus ciliaris*	Buffel Grass	507795	7502120	40-50
**Cenchrus ciliaris*	Buffel Grass	507812	7502091	50-70
**Cenchrus ciliaris*	Buffel Grass	508333	7502143	50-70
**Cenchrus ciliaris*	Buffel Grass	508487	7502354	50-70
**Cenchrus ciliaris*	Buffel Grass	508570	7502401	10
**Cenchrus ciliaris*	Buffel Grass	508905	7502376	50-70
**Cenchrus ciliaris*	Buffel Grass	509056	7502385	50-70
**Cenchrus ciliaris*	Buffel Grass	509566	7502397	50-70
**Cenchrus ciliaris*	Buffel Grass	509854	7502461	50-70
**Cenchrus ciliaris*	Buffel Grass	509934	7502569	80
**Cenchrus ciliaris*	Buffel Grass	509941	7502535	50-70
**Cenchrus ciliaris*	Buffel Grass	510133	7502896	2
**Cenchrus ciliaris*	Buffel Grass	510247	7502842	50-70
**Cenchrus ciliaris*	Buffel Grass	510472	7502912	50-70
**Cenchrus ciliaris*	Buffel Grass	510555	7502928	50-70
**Cenchrus ciliaris*	Buffel Grass	510807	7503004	2
**Cenchrus ciliaris*	Buffel Grass	510870	7503032	50-70
**Cenchrus ciliaris*	Buffel Grass	510878	7503063	150
**Cenchrus ciliaris*	Buffel Grass	511165	7503224	2
**Cenchrus ciliaris*	Buffel Grass	511197	7503199	100-120
**Cenchrus ciliaris*	Buffel Grass	511682	7503254	50-70
**Cenchrus ciliaris*	Buffel Grass	512101	7503379	50-70
**Cenchrus ciliaris*	Buffel Grass	512259	7503610	200

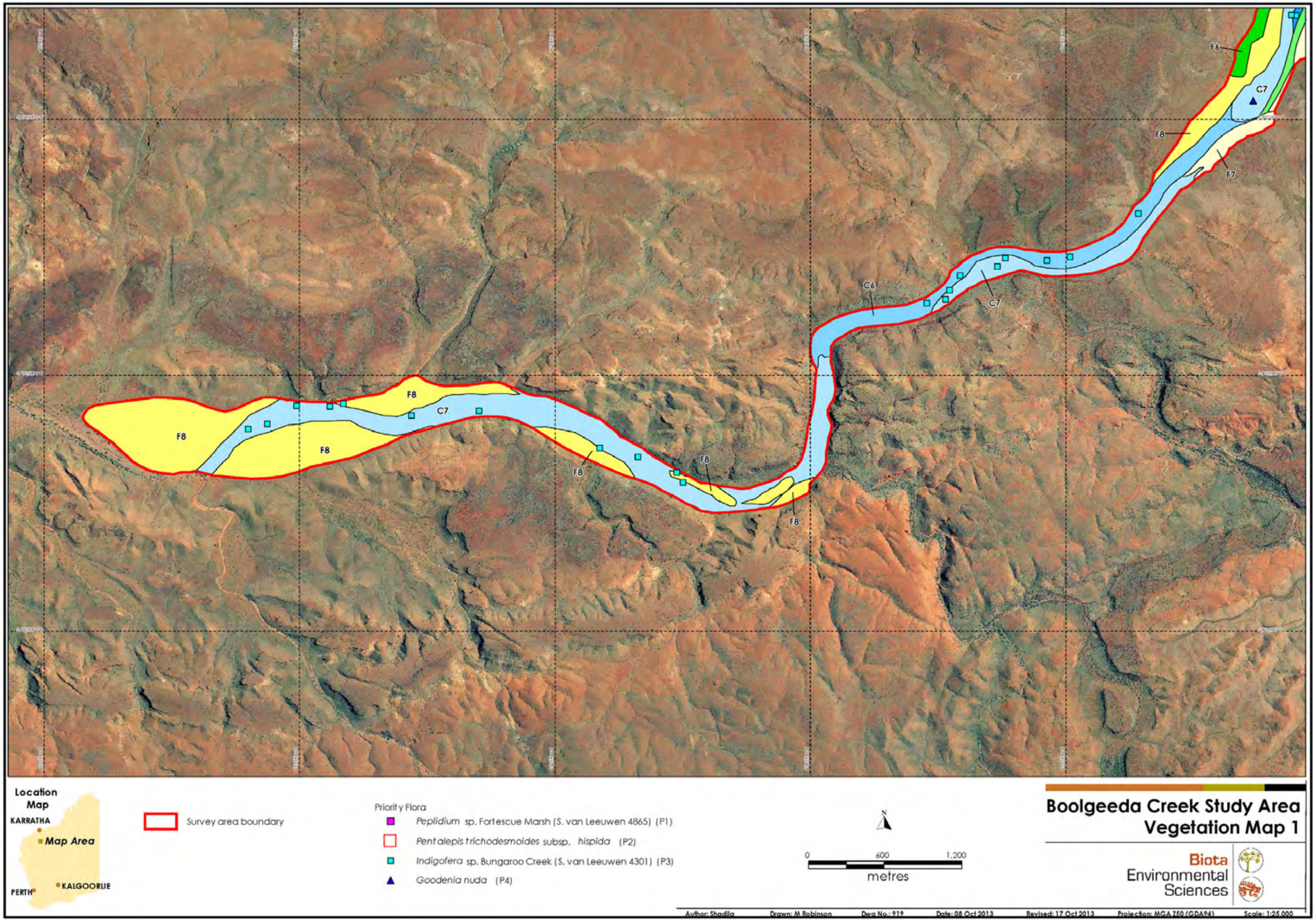
Species	Common Name	Easting	Northing	Number of Individuals
**Cenchrus ciliaris*	Buffel Grass	512288	7503594	50-70
**Cenchrus ciliaris*	Buffel Grass	512688	7503581	50-70
**Cenchrus ciliaris*	Buffel Grass	512762	7503537	50-70
**Cenchrus ciliaris*	Buffel Grass	512952	7503761	20-30
**Cenchrus ciliaris*	Buffel Grass	513245	7503955	40-50
**Cenchrus ciliaris*	Buffel Grass	513266	7503927	50-70
**Cenchrus ciliaris*	Buffel Grass	513391	7503811	2
**Cenchrus ciliaris*	Buffel Grass	513428	7504208	20-30
**Cenchrus ciliaris*	Buffel Grass	513473	7504080	50-70
**Cenchrus ciliaris*	Buffel Grass	513936	7504436	50-70
**Cenchrus ciliaris*	Buffel Grass	513979	7504498	40-50
**Cenchrus ciliaris*	Buffel Grass	514480	7504406	50-70
**Cenchrus ciliaris*	Buffel Grass	514822	7504375	50-70
**Cenchrus ciliaris*	Buffel Grass	514840	7504419	50
**Cenchrus ciliaris*	Buffel Grass	514864	7504394	50-70
**Cenchrus ciliaris*	Buffel Grass	515533	7504561	50-70
**Cenchrus ciliaris*	Buffel Grass	515562	7504437	3
**Cenchrus ciliaris*	Buffel Grass	515632	7504701	50-70
**Cenchrus ciliaris*	Buffel Grass	516361	7504933	50-70
**Cenchrus ciliaris*	Buffel Grass	516363	7504953	2
**Cenchrus ciliaris*	Buffel Grass	516543	7504781	20-30
**Cenchrus ciliaris*	Buffel Grass	516561	7504815	40-50
**Cenchrus ciliaris*	Buffel Grass	516568	7504786	50-70
**Cenchrus ciliaris*	Buffel Grass	516843	7504837	20-30
**Cenchrus ciliaris*	Buffel Grass	516861	7504833	10
**Cenchrus ciliaris*	Buffel Grass	517014	7504774	50-70
**Cenchrus ciliaris*	Buffel Grass	517056	7504742	1
**Cenchrus ciliaris*	Buffel Grass	517088	7504669	50-70
**Cenchrus ciliaris*	Buffel Grass	517529	7504308	50-70
**Cenchrus ciliaris*	Buffel Grass	517962	7504360	50-70
**Cenchrus ciliaris*	Buffel Grass	518159	7504135	50-70
**Cenchrus ciliaris*	Buffel Grass	518987	7503722	50-70
**Cenchrus ciliaris*	Buffel Grass	519109	7503568	20-30
**Cenchrus ciliaris*	Buffel Grass	519555	7503451	20-30
**Cenchrus ciliaris*	Buffel Grass	519654	7503441	10
**Cenchrus ciliaris*	Buffel Grass	520127	7503715	50-70
**Cenchrus ciliaris*	Buffel Grass	520416	7503875	50-70
**Cenchrus ciliaris*	Buffel Grass	520743	7504147	50-70
**Cenchrus ciliaris*	Buffel Grass	521997	7504181	50-70
**Cenchrus ciliaris*	Buffel Grass	522203	7504263	40-50
**Cenchrus ciliaris*	Buffel Grass	522230	7504240	500
**Cenchrus ciliaris*	Buffel Grass	522357	7504224	2
**Cenchrus ciliaris*	Buffel Grass	522668	7504095	50-70
**Cenchrus ciliaris*	Buffel Grass	523141	7504436	1

Species	Common Name	Easting	Northing	Number of Individuals
**Cenchrus ciliaris*	Buffel Grass	523384	7504775	1
**Cenchrus ciliaris*	Buffel Grass	524080	7504873	40-50
**Cenchrus ciliaris*	Buffel Grass	524095	7505030	50-70
**Cenchrus ciliaris*	Buffel Grass	524104	7504851	50-70
**Cenchrus ciliaris*	Buffel Grass	525214	7505895	40-50
**Cenchrus ciliaris*	Buffel Grass	525490	7506172	21
**Cenchrus ciliaris*	Buffel Grass	526205	7506728	40-50
**Cenchrus setiger*	Birdwood Grass	492395	7497536	2
**Cenchrus setiger*	Birdwood Grass	497451	7500179	150
**Cenchrus setiger*	Birdwood Grass	498200	7501500	1000
**Cenchrus setiger*	Birdwood Grass	501895	7502562	1
**Cenchrus setiger*	Birdwood Grass	504515	7502079	40
**Cenchrus setiger*	Birdwood Grass	512259	7503610	70
**Cenchrus setiger*	Birdwood Grass	516543	7504781	45
**Cucumis melo* subsp. *agrestis*	Ulcardo Melon	502670	7502870	NA
**Flaveria trinervia*	Speedy Weed	506095	7501934	1
**Flaveria trinervia*	Speedy Weed	507863	7501901	1
**Malvastrum americanum*	Spiked Malvastrum	496032	7498924	6
**Malvastrum americanum*	Spiked Malvastrum	497451	7500179	18
**Malvastrum americanum*	Spiked Malvastrum	497898	7501138	11
**Malvastrum americanum*	Spiked Malvastrum	498016	7501404	5
**Malvastrum americanum*	Spiked Malvastrum	498200	7501500	100
**Malvastrum americanum*	Spiked Malvastrum	498204	7501453	2
**Malvastrum americanum*	Spiked Malvastrum	498513	7501512	1
**Malvastrum americanum*	Spiked Malvastrum	499147	7501880	1
**Malvastrum americanum*	Spiked Malvastrum	499982	7502104	1
**Malvastrum americanum*	Spiked Malvastrum	500354	7502392	320
**Malvastrum americanum*	Spiked Malvastrum	501454	7502766	7
**Malvastrum americanum*	Spiked Malvastrum	501895	7502562	33
**Malvastrum americanum*	Spiked Malvastrum	503736	7502118	1
**Malvastrum americanum*	Spiked Malvastrum	504481	7501942	12
**Malvastrum americanum*	Spiked Malvastrum	504569	7501861	2
**Malvastrum americanum*	Spiked Malvastrum	504643	7501798	2
**Malvastrum americanum*	Spiked Malvastrum	504677	7501796	1
**Malvastrum americanum*	Spiked Malvastrum	504791	7501769	3
**Malvastrum americanum*	Spiked Malvastrum	506423	7501808	1
**Malvastrum americanum*	Spiked Malvastrum	506797	7501642	1
**Malvastrum americanum*	Spiked Malvastrum	507795	7502120	1
**Malvastrum americanum*	Spiked Malvastrum	509378	7502319	1
**Malvastrum americanum*	Spiked Malvastrum	510878	7503063	1
**Malvastrum americanum*	Spiked Malvastrum	512259	7503610	13
**Malvastrum americanum*	Spiked Malvastrum	512847	7503531	300+
**Malvastrum americanum*	Spiked Malvastrum	513245	7503955	1
**Malvastrum americanum*	Spiked Malvastrum	513391	7503811	1

Species	Common Name	Easting	Northing	Number of Individuals
**Malvastrum americanum*	Spiked Malvastrum	514840	7504419	5
**Malvastrum americanum*	Spiked Malvastrum	522512	7504133	18
**Malvastrum americanum*	Spiked Malvastrum	522620	7504070	50+
**Malvastrum americanum*	Spiked Malvastrum	522661	7504074	20
**Malvastrum americanum*	Spiked Malvastrum	524080	7504873	1
**Malvastrum americanum*	Spiked Malvastrum	525490	7506172	11
**Portulaca oleracea/intraterranea*	Purslane	500354	7502392	1
**Portulaca oleracea/intraterranea*	Purslane	507795	7502120	1
**Portulaca oleracea/intraterranea*	Purslane	512259	7503610	3
**Setaria verticillata*	Whorled Pigeon Grass	525479	7505741	4
**Sigesbeckia orientalis*	Indian weed	522203	7504263	NA
**Sonchus oleraceus*	Common Sowthistle	499147	7501880	2
**Sonchus oleraceus*	Common Sowthistle	501895	7502562	1
**Sonchus oleraceus*	Common Sowthistle	504481	7501942	3
**Sonchus oleraceus*	Common Sowthistle	505653	7501847	1
**Sonchus oleraceus*	Common Sowthistle	508892	7502362	5
**Tribulus terrestris*	Caltrop	507795	7502120	NA
**Vachellia farnesiana*	Mimosa Bush	494184	7498342	1
**Vachellia farnesiana*	Mimosa Bush	496032	7498924	4
**Vachellia farnesiana*	Mimosa Bush	497508	7499940	1
**Vachellia farnesiana*	Mimosa Bush	498077	7501434	2
**Vachellia farnesiana*	Mimosa Bush	498200	7501500	10
**Vachellia farnesiana*	Mimosa Bush	499061	7501858	1
**Vachellia farnesiana*	Mimosa Bush	501895	7502562	1
**Vachellia farnesiana*	Mimosa Bush	503736	7502118	2
**Vachellia farnesiana*	Mimosa Bush	504341	7501987	4
**Vachellia farnesiana*	Mimosa Bush	504481	7501942	3
**Vachellia farnesiana*	Mimosa Bush	504643	7501798	6
**Vachellia farnesiana*	Mimosa Bush	504677	7501796	1
**Vachellia farnesiana*	Mimosa Bush	505866	7501862	1
**Vachellia farnesiana*	Mimosa Bush	506300	7501872	10
**Vachellia farnesiana*	Mimosa Bush	506844	7501583	1
**Vachellia farnesiana*	Mimosa Bush	508892	7502362	2

Appendix 9

Distribution of Conservation Significant Flora within the Study Area


F6
C7
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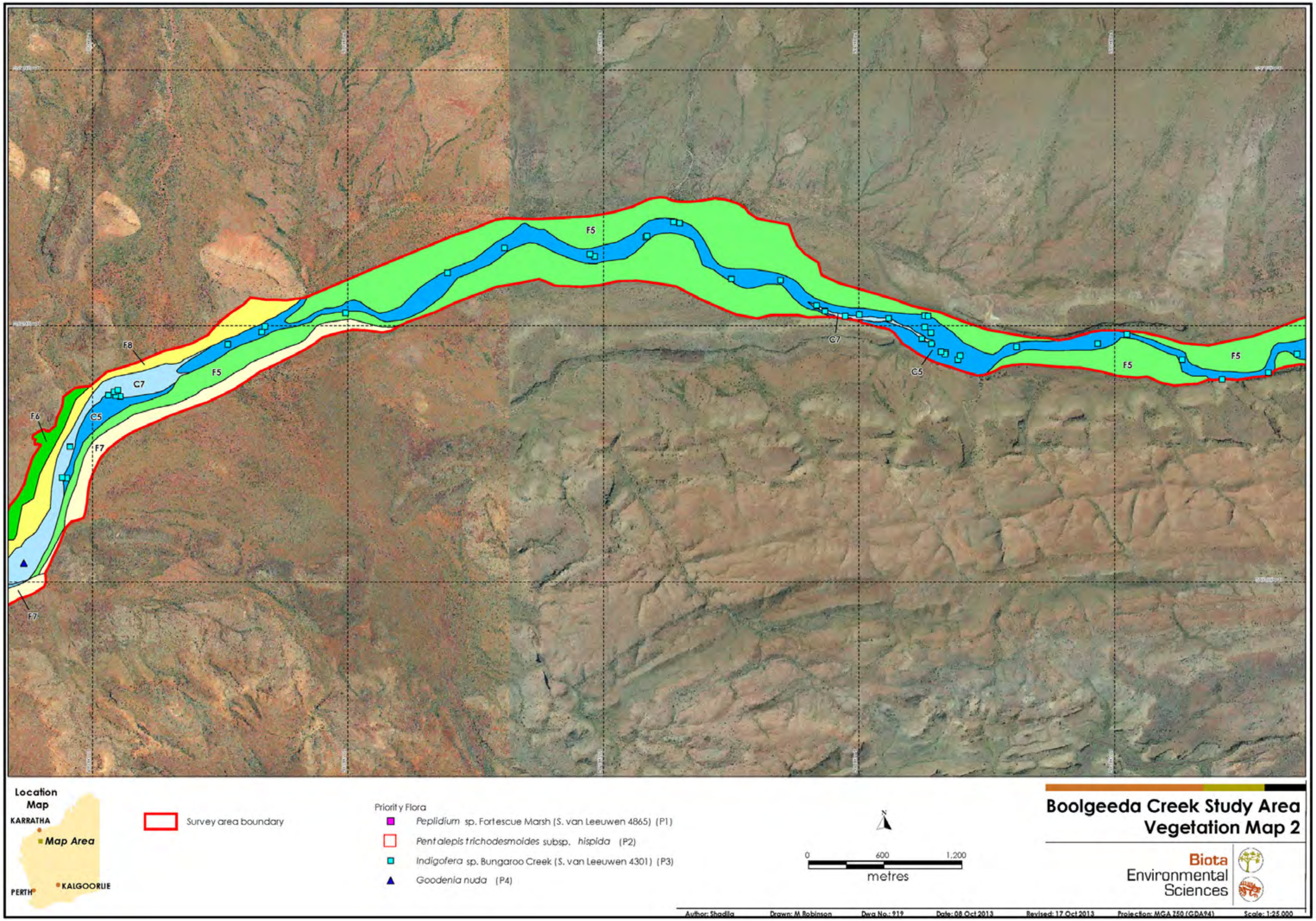
Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area boundary
Priority Flora
Peplidium sp. Fortescue Marsh (S. van Leeuwen 4865) (P1)
Pentalepis trichodesmoides subsp. hispida (P2)
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) (P3)
Goodenia nuda (P4)
N
0
600
1,200
metres
Boolgeeda Creek Study Area
Vegetation Map 1
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 08 Oct 2013
Revised: 17 Oct 2013
Projection: MGA Z50 (GDA94)
Scale: 1:25,000


F5
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Location Map
KARRATHA
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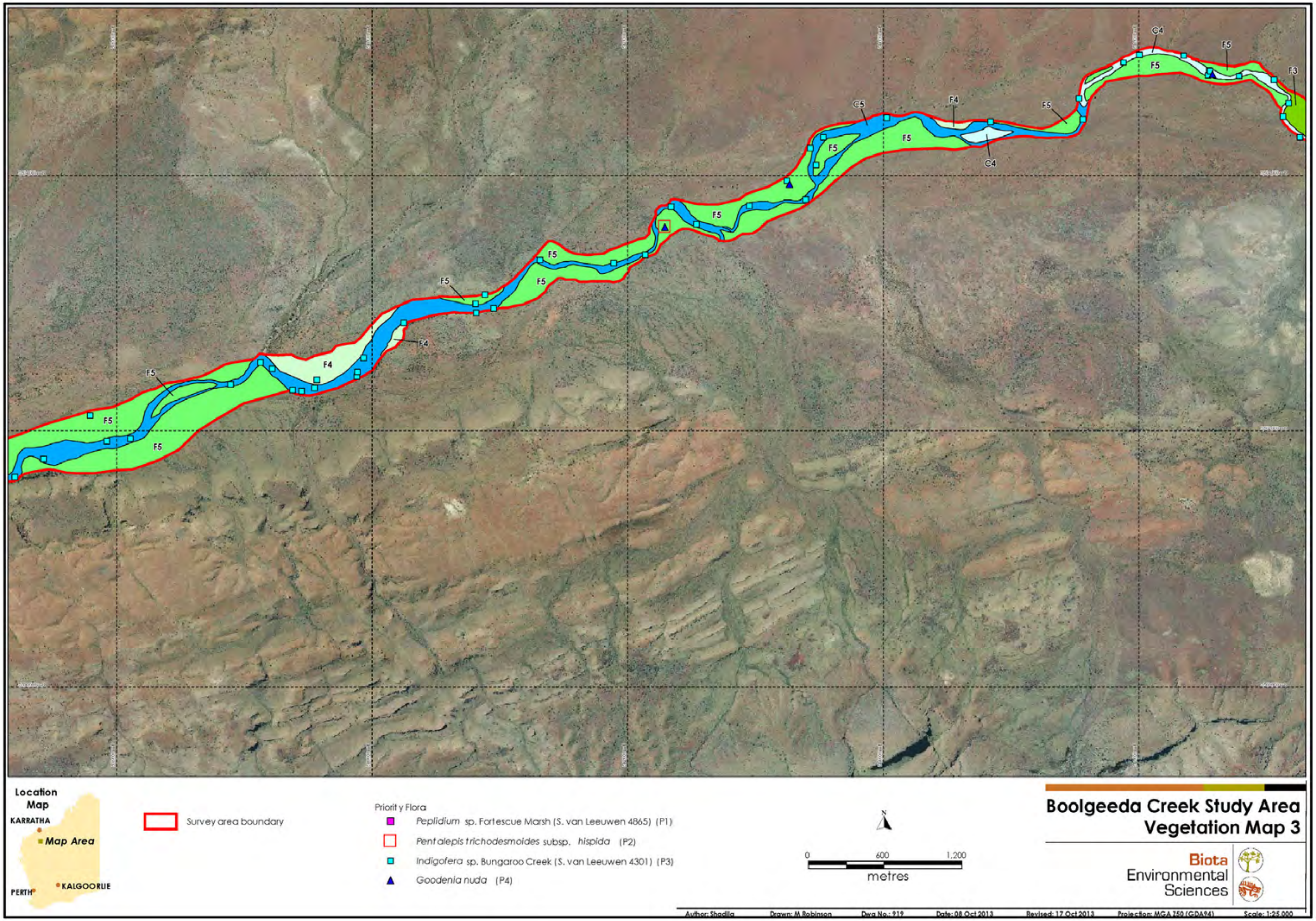
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) (P3)
Goodenia nuda (P4)
N
0 600 1,200
metres
Boolgeeda Creek Study Area
Vegetation Map 2
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 08 Oct 2013
Revised: 17 Oct 2013
Projection: MGA Z50 (GDA94)
Scale: 1:25,000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F5
Location Map
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600
1,200
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Boolgeeda Creek Study Area
Vegetation Map 3
Biota
Environmental
Sciences
Author: Shadila
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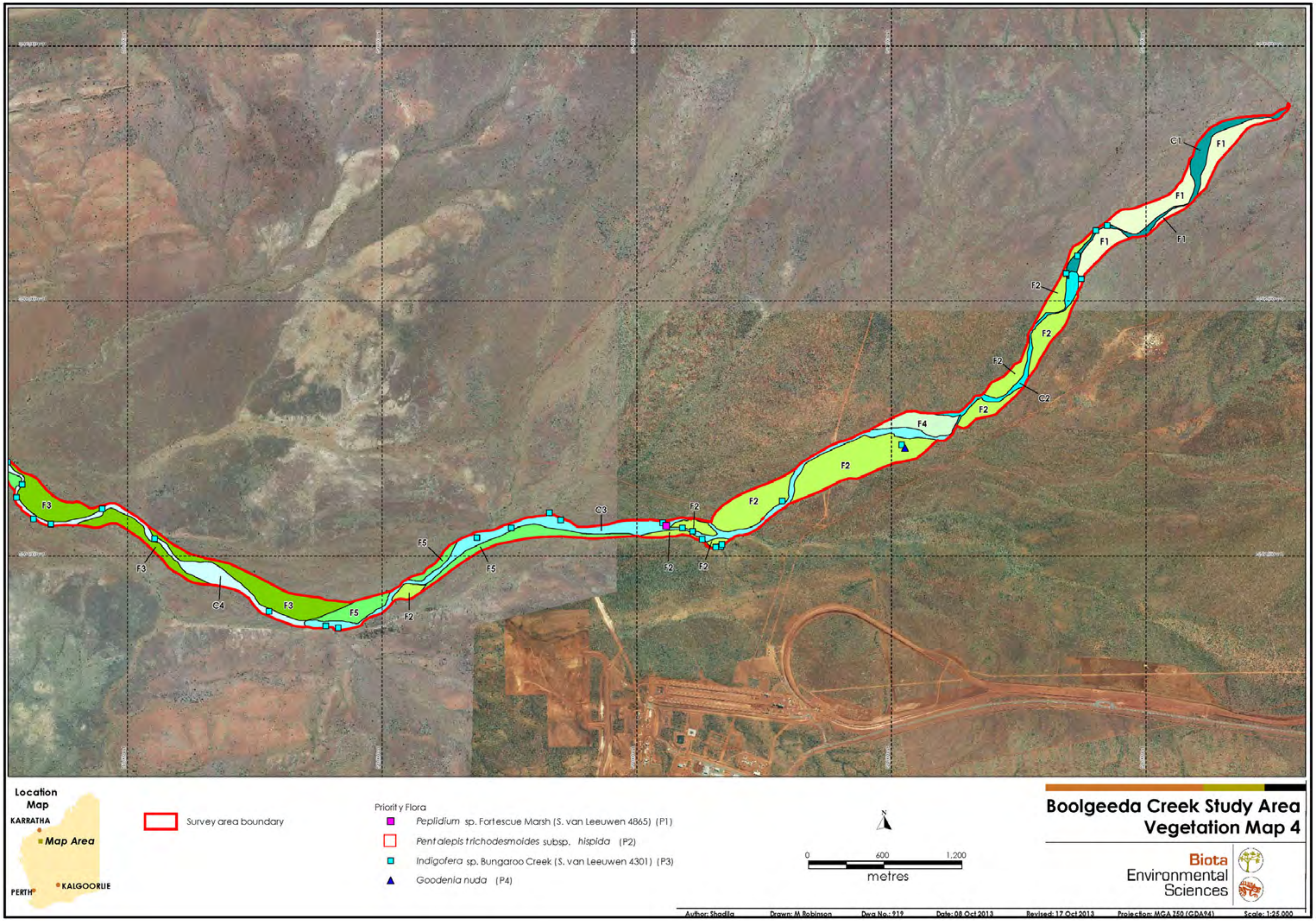
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C2
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F4
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C3
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F3
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F2
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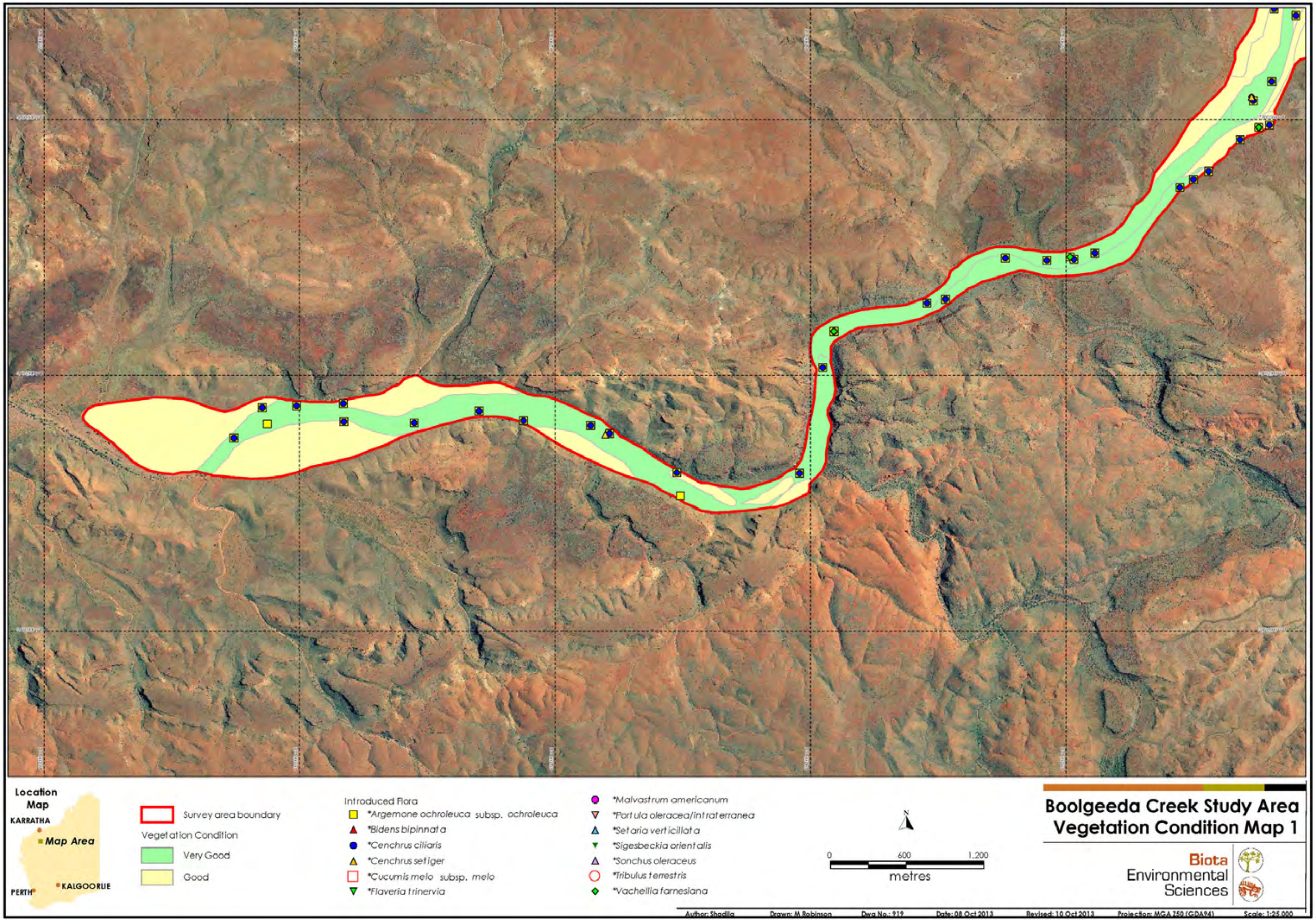
Boolgeeda Creek Study Area
Vegetation Map 4
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 08 Oct 2013
Revised: 17 Oct 2013
Projection: MGA Z50 (GDA94)
Scale: 1:25,000

Appendix 10

Vegetation Condition Map and Distribution of Introduced (Weed) Species within the Study Area


Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area boundary
Vegetation Condition
Very Good
Good
Introduced Flora
*Argemone ochroleuca subsp. ochroleuca
*Bidens bipinnata
*Cenchrus ciliaris
*Cenchrus setiger
*Cucumis melo subsp. melo
*Flaveria trinervia
*Malvastrum americanum
*Portula oleracea/intraterranea
*Setaria verticillata
*Sigesbeckia orientalis
*Sonchus oleraceus
*Tribulus terrestris
*Vachellia farnesiana
N
0
600
1,200
metres
Boolgeeda Creek Study Area
Vegetation Condition Map 1
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 08 Oct 2013
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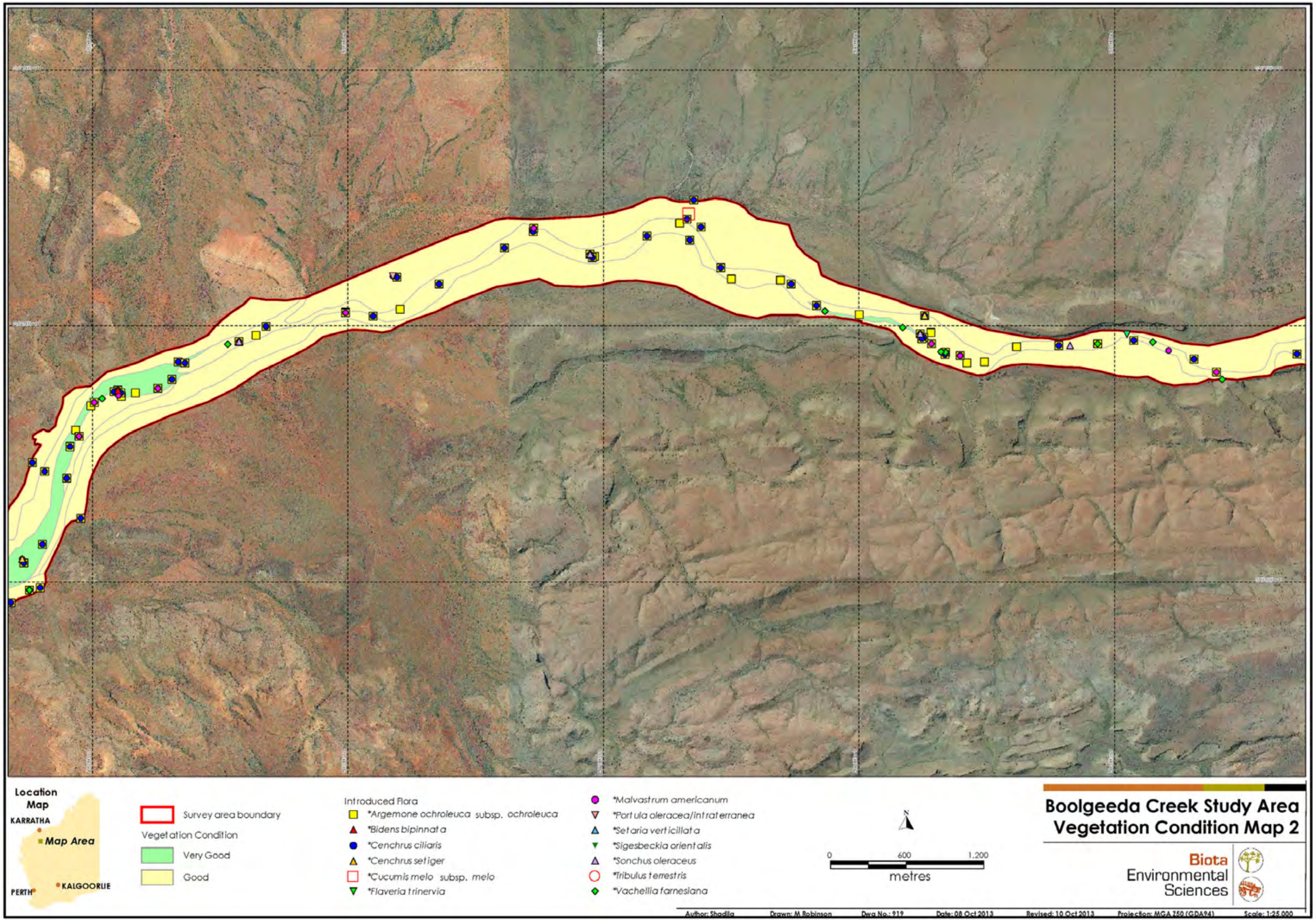
Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area boundary
Vegetation Condition
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Good
Introduced Flora
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metres
Boolgeeda Creek Study Area
Vegetation Condition Map 2
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
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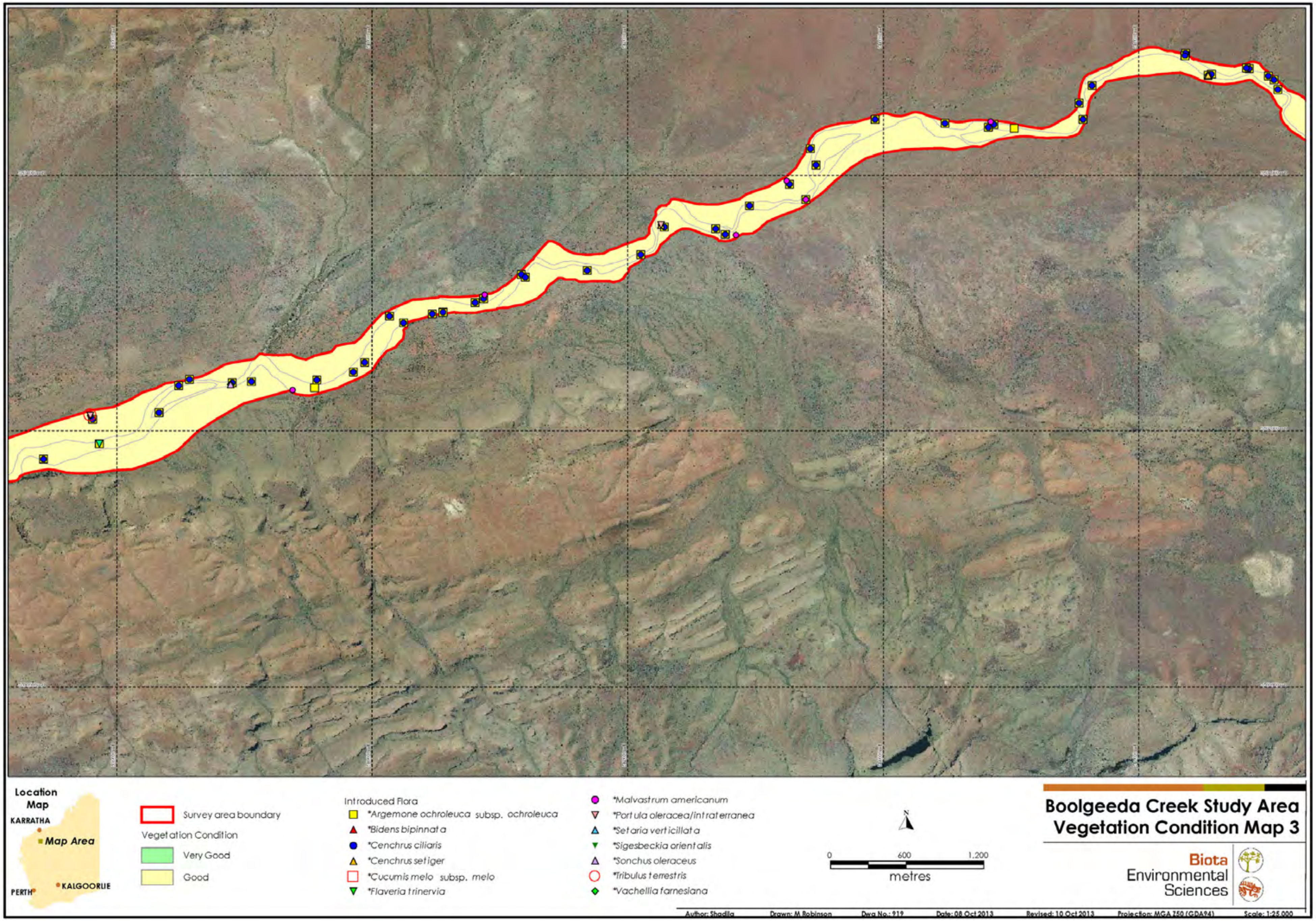
Location Map
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KALGOORLIE
Survey area boundary
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*Setaria verticillata
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*Sonchus oleraceus
*Tribulus terrestris
*Vachellia farnesiana
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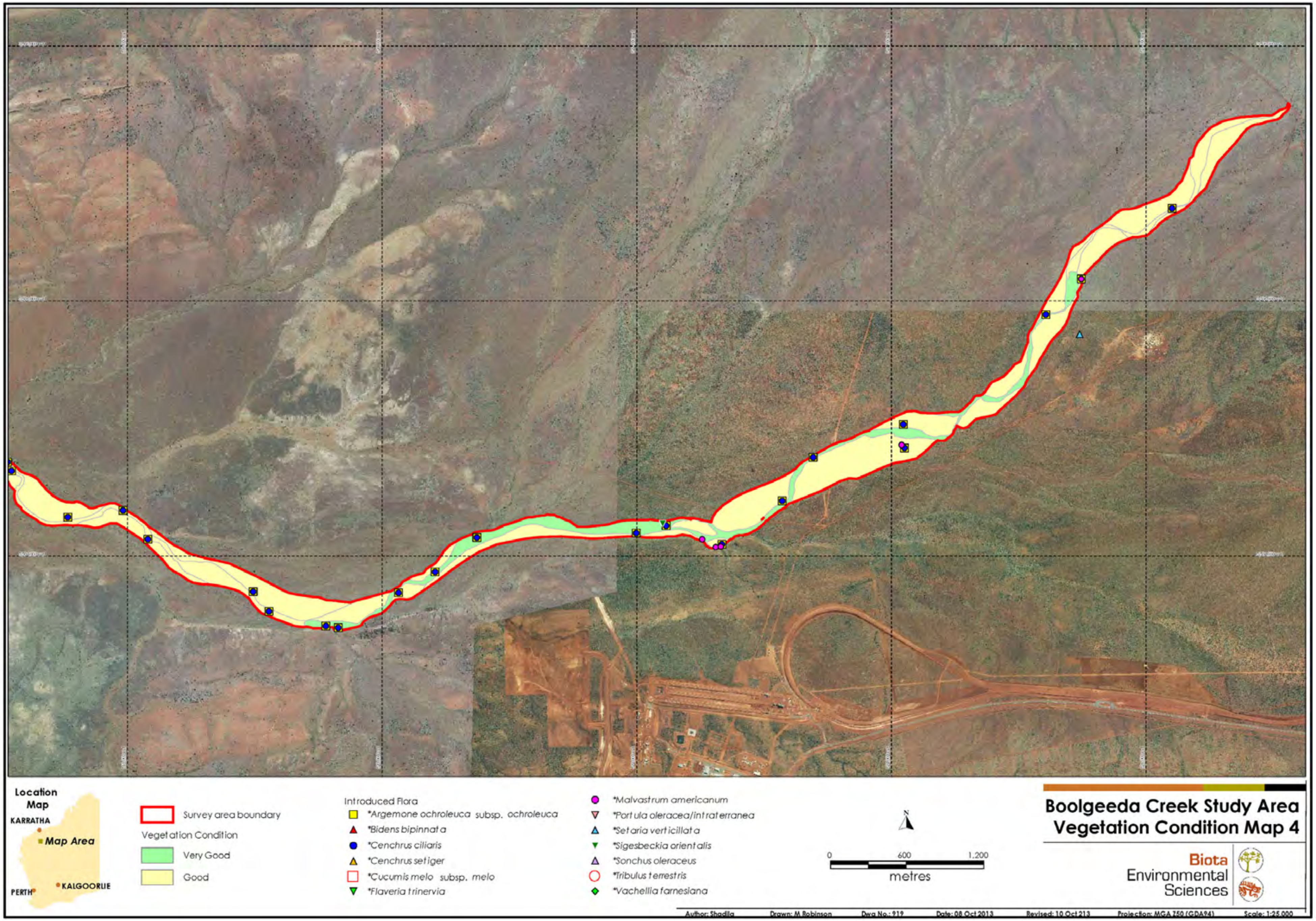
1,200
metres
Boolgeeda Creek Study Area
Vegetation Condition Map 3
Biota
Environmental
Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 08 Oct 2013
Revised: 10 Oct 2013
Projection: MGA Z50 (GDA94)
Scale: 1:25,000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Boolgeeda Creek Study Area
Vegetation Condition Map 4
Biota
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Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 919
Date: 08 Oct 2013
Revised: 10 Oct 213
Projection: MGA Z50 (GDA94)
Scale: 1:25,000

Rio Tinto Iron Ore (WA)

Brockman 4: Spontaneous Combustion and ARD (SCARD) Management Plan for Operations

Table of Contents

1 Purpose

The Spontaneous Combustion and Acid Rock Drainage (**SCARD**) Management Plan for operations outline the groups accountable and activities for the management of the environmental, safety and health risks associated with Black Shale (**BS**)

2 Assessing if a Site needs to implement this Management Plan

The RTIO (WA) Mineral Waste Management Plan describes the AMD, spontaneous combustion and mineral waste work that must be undertaken in the development of new deposits or significant expansions of current operations. A detailed AMD Risk Assessment should be undertaken for any new deposits or significant expansions of current operations to identify whether excavated sulfides will represent a risk to health, safety and environment. If risks are deemed to be minimal then a management plan will not be required. If a risk assessment has already been undertaken at a site then for any additional significant resource drilling or expansions of the operation the risk assessment should be updated. For any mine site that exposes or could potentially expose sulfidic material (with a S content >0.1%) then this SCARD Management Plan will need to be implemented.

3 Requirements, Accountabilities and References for Black Shale

The accountability for the management of Spontaneous Combustion and ARD issues associated with black shale are listed at superintendent and manager level in the following section. Figure 1 provides an overview of black shale management at Pilbara Iron from initial characterisation and modelling, through project development; mine planning, production and closure.

Pilbara Iron's black shale management strategy is broadly based upon the following principles:

1. identification of black shale distribution and character;
2. minimising the exposure and mining of black shale to the extent possible;
3. identification and special handling of black shale that must be mined;
4. encapsulation of black shale inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated; and
5. placement of black shale below the water table in backfilled open pits to limit oxygen contact.

Black shale management during mining operations is conducted in accordance with Figure 2. The mining protocols are designed to:

1. minimise the risk of unplanned detonations in charged blast holes;
2. ensure that hot and cold black shale truck loads are transported and placed in designated black shale dumps according to design requirements;
3. ensure that the location and geometry of all black shale repositories is recorded; and
4. refine geological block models and block-out procedures.

Requirements	
3.1	**Resources Studies and Technology / Technical Services**
3.1.1	For significant modification to the pit shell within MCS, use geological block models to predict hot and cold BS production volumes for different whittle shell, production and final pit designs.
3.1.2	Life of Mine Plans and Reserve Models must include estimates for hot and cold BS production.
3.1.3	Ensure that black shale dumps are sited to minimise long term environmental impacts and financial liabilities. Obtain signoff from Environment, Hydrogeology, and Hydrology.
3.1.4	Ensure that final pit and dump designs are consistent with Appendix 1, 0 and Appendix 3. Obtain signoff from Environment and Hydrogeology.
3.1.5	When planning open pits that will intersect black shale, the possibility of dewatering becoming acidic must be considered so that appropriate mitigation infrastructure can be installed.
3.2	**Planning**
3.2.1	Five year plans must estimate hot and cold BS production and compare to inert waste production to ensure that sufficient material will be available for dump construction.
3.2.2	Ensure that annual and quarterly (short and medium term) plans predict hot and cold BS production from each pit and delivery to each dump. Ensure that sufficient inert waste will be produced for encapsulation in accordance with the specifications in Appendix 1 and that sequencing will allow dump construction to occur as required.
3.2.3	Major changes to waste dump designs must be receive sign-off from Environment, Rehabilitation team; Hydrogeology and Hydrology before major modifications to BS dump designs are implemented.
3.2.4	Plan and design works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 1, 0 and Appendix 3.
3.2.5	Black shale exposures on the waste rock dumps must be minimised during the rainy season (Appendix 1).
3.2.6	During the five year planning process identify areas that are available for rehabilitation and inform the rehabilitation specialist.
3.3	**Geology**
<u>Blasting</u>	
3.3.1	Identify BS in drill hole cuttings and blue flag holes that contain BS. Place a white flag on holes that do not contain BS.
3.3.2	Alert key personnel in Operational Planning and Pit Operations of the location of BS blast holes via e-mail.
<u>Dumping</u>	
3.3.3	Based on visual inspection, total S values and stratigraphy, designate holes as cold BS, hot BS or inert waste. Create Block-outs that show contacts between waste types within blast pattern.
3.3.4	Enter Block-out data into the Modular Mining system to allow BS waste to be tracked.
3.3.5	Perform periodic reconciliations between the Block-outs and the geological block model.
3.3.6	Periodically provide representative samples of upper, middle and lower MCS for full ABA and NAG analysis. Also provide unoxidised black shale within Whaleback Shale and other black shale found within the BIF units. Ensure results are communicated to the site environment team.
3.3.7	Review as necessary the boundary between cold black shale and hot black shale to ensure it is still valid and has not changed as mining progresses deeper. Advise the

Requirements	
	Mineral Waste management team of the results and undertake change management if necessary.
3.4	**Survey**
3.4.1	Maintain as-built dump designs in Vulcan that include a 3D plan showing approximate locations and volumes of BS.
3.4.2	Ensure contacts between hot BS, cold BS and inert waste are pegged on the blasted bench consistent with the Mine Geology Block-outs.
3.4.3	Ensure that monthly face pick-up surveys are conducted on all active BS waste dumps
3.5	**Operational Planning**
3.5.1	Create a “Waste Dump Progression Plan” at least every three months to implement the detailed dump designs in the field.
3.5.2	Create “PLOD” sheets to aid dig operators in waste assignment and check that the modular mining system is working.
3.5.3	Monitor and adjust to reconcile rehabilitation plans with original designs as appropriate.
3.5.4	Perform field inspections to ensure that black shale is transported to the proper dump locations and placed as required. Register non-conformances in SAP.
3.5.5	Ensure monthly reports from PowerView contain hot and cold BS volumes delivered to every dump.
3.5.6	In consultation with Mine Geology perform six-monthly reconciliations between Block-outs, survey and Modular Mining data for hot and cold black shale volumes.
3.5.7	Black shale exposures on the waste rock dumps must be minimised during the rainy season.
3.6	**Drill, Blast and Development**
Drill and Blast	
3.6.1	Ensure all safety procedures related to BS management are followed during the charging and firing of blast holes i.e. temperature logging, timing.
3.6.2	Maintain site specific Drill and Blast SWPs and ensure it is consistent with this management plan and other SWPs and guidance notes.
Dewatering	
3.6.3	Runoff water in the open pits should be diverted around black shale exposures to the extent possible.
3.6.4	Any acidic contact water (pH of less than 5.0) will require special handling for both health and safety, operational and environmental reasons.
3.6.5	Acidic contact water must be contained on site and it should be segregated so it does not contaminate clean water. Acidic contact water must be stored in a manner that will not lead to groundwater quality degradation and potential loss of the beneficial use of down gradient aquifers. Where possible acidic water should be treated and put to a beneficial use rather than stored and discharged.
3.7	**Load and Haul**
3.7.1	Ensure that BS is properly identified and placed in the correct dump location consistent with PLOD sheets, modular mining assignments and the Waste Dump Progression Plan from Operations Planning.
3.7.2	Perform field inspections to ensure that black shale is transported to the proper dump locations and placed as required. Register non-conformances in SAP.
3.7.3	Ensure that “Exclusions” in Modular Mining are reviewed and corrected in the field as

Requirements	
	required.
3.7.4	The time between blasting and hauling of black shale should be minimised and generally should occur within three weeks or less during the wet season and within 12 weeks during the dry season. This will limit the amount of time the material has to oxidise in an uncontrolled manner.
3.7.5	Whenever possible the outer inert waste rock “skin” of a black shale lift should be constructed first. This will ensure that black shale lifts are not extended beyond the design footprint of the black shale dump, will limit convective oxygen transport through the uncompacted sides of the black shale dump lift, and will help contain contaminated contact water on the dump.
3.7.6	Hot black shale lifts should be covered as rapidly as possible with the overlying inert waste rock layer, particularly during the wet season. Ideally, hot black shale should be covered within two weeks of placement in the waste rock dump. If rapid covering is not possible the paddock-dumped hot black shale piles should at least be dozed into a planar surface as soon as possible. This will help minimise infiltration and oxygen transport into the material.
3.7.7	Modular data that are entered into the Vulcan system should be used to record the location and volume of all black shale repositories so that a three dimensional plan of black shale distribution within each dump is maintained by the survey group.
3.8	**Hydrogeology**
3.8.1	Maintain and implement a site specific plans and SWPs to deal with poor quality water that has contacted BS exposures or waste dumps.
3.8.2	Ensure that water management and storage practices do not cause offsite surface water impacts or groundwater quality degradation in down gradient aquifers.
3.8.3	Provide technical overview and support during planning for above-ground and in-pit BS waste disposal.
3.9	**Environment**
3.9.1	An annual documented ARD inspection program of all black shale dumps and open pits with black shale exposures should be performed. This should occur during the wet season or immediately after a significant rainfall event. Samples of key runoff water flows should be collected.
3.9.2	Perform field inspections to ensure BS management, dump construction, rehabilitation and store and release cover performance is consistent with the requirements of the SCARD Management Plan. Register non-conformances in SAP.
3.9.3	Ensure that routine sampling and visual inspection is performed of groundwater monitoring wells (surrounding black shale dumps and pits), dewatering water and surface water bodies (including inactive open pits that contain black shale exposures). The sampling should occur at least quarterly.
3.9.4	Ensure routine sampling for water quality and visual inspection of permanent or seasonal natural water bodies surrounding the mine. The sampling should occur at least quarterly.
3.9.5	Interpret the environmental data that is collected and ensure it is stored in a user-friendly database. All monitoring data should be assigned a unique sample number and sampling date. Ensure problems are brought to the attention of the Mineral Waste Management team and that corrective actions are taken if required.
3.9.6	Analysis of water quality trends for, at a minimum, sulfate, pH and dissolved metals should be made on an annual basis to monitor the long-term behaviour of the system. Significant changes in water quality, infiltration rate or other key parameters should be investigated and mitigation actions should be instituted if required.
3.9.7	Ensure that the SCARD Management Plan is periodically refined and updated so that it is

Requirements

consistent with the latest characterisation data and current best practice. Alert the Mineral Waste Management team at other mine sites of any changes that are necessary to this plan and that may impact other sites. Any changes to this management plan need to be approved by the Mineral Waste Steering Committee.

3.9.8 Perform all required reporting, permitting notifications and other external communications relating to ARD, closure and general black shale management issues.

3.9.9 Training modules on dust management and ARD should be presented every 2 years to groups working with black shale. The IEMS modules should be updated annually to reflect the current management plan and should describe the hazards, incident reporting and the relevant procedures to each working group that has responsibilities for any aspect of black shale management.

3.9.10 Report the tonnes of sulfidic material excavated and dumped at the end of each year.

3.9.11 Record black shale environment risks in a site risk register and annually review these risks.

Rehabilitation

3.9.12 Plan and implement rehabilitation works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 1, 0 and Appendix 3.

3.10 Rehabilitation

3.10.1 In consultation with relevant stakeholders identify monitoring requirements (e.g. lysimeters) for waste dumps following rehabilitation.

3.10.2 Coordinate the review and approval of the rehabilitation design by relevant stakeholders.

3.10.3 Complete a risk assessment for the rehabilitation design focussing on the SCARD risks.

3.11 Health and Safety

3.11.1 Monitor the occupational gas and dust exposures surrounding black shale. Ensure data is captured in a user friendly database. Ensure problems are brought to the attention of the Mineral Waste Management team.

3.11.2 Train occupational exposure groups on the correct use of respiratory equipment and monitors. Competency should be assessed and recorded in SAP.

3.11.3 Perform field inspections particularly during the wet season to ensure black shale health and safety procedures are followed. Register non-conformances in SAP.

3.11.4 Ensure the site specific guidance notes on acceptable gas levels, monitoring and demarcation are periodically refined and updated so it is consistent with current best practice.

3.11.5 Record black shale health and safety risks in a site risk register and annually review these risks.

3.12 Mineral Waste Management Team

3.12.1 A Mineral Waste Management Team must be formed and meet on a regular basis. It must include representatives of every Department that has responsibilities related to BS management.

3.12.2 The primary function of the Mineral Waste Management Team is to ensure on-going improvement and implementation of the SCARD Management Plan.

3.12.3 Agenda items and meeting minutes must be produced for every meeting.

3.12.4 Develop emergency and contingency plans related to spontaneous combustion, ARD and black shale management on an as need basis.

3.12.5 Coordinate a technical review of BS management by an external expert every four years. Track progress against outstanding actions at each meeting.

Requirements
3.12.6 Coordinate all research related to black shale characterisation, black shale management, spontaneous combustion and ARD. 3.12.7 Ensure the SCARD management plan, related SWPs and guidance notes represent current practise and are up to date.
3.13 Management
3.13.1 An overview of black shale issues must be included in any introductory environmental training provided to new employees and contractors. To aid in the training, role descriptions should include ARD-related responsibilities. 3.13.2 Ensure progress is made against outstanding spontaneous combustion and ARD audit actions.

Figure 1: Black Shale (BS) management overview.

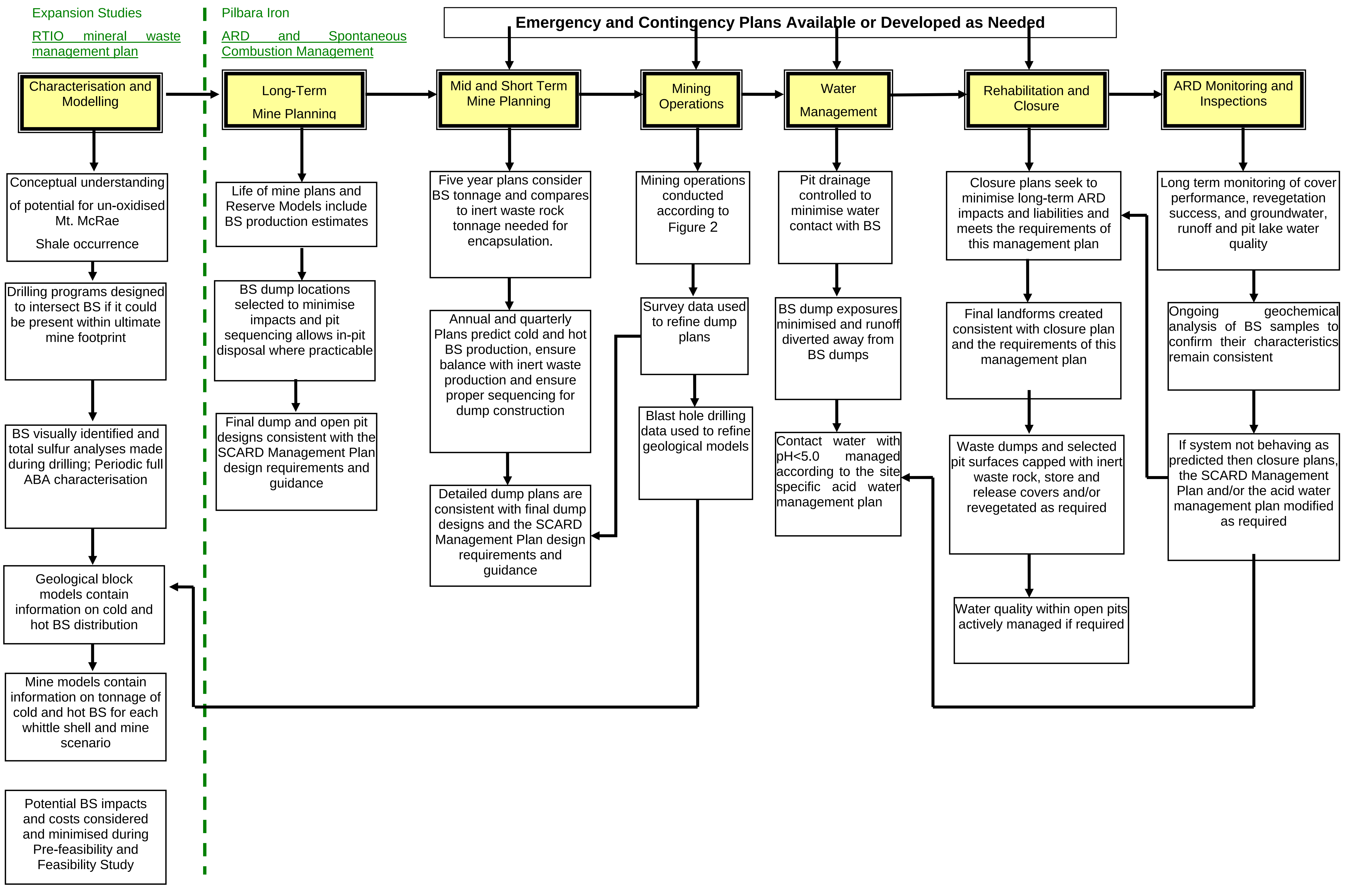
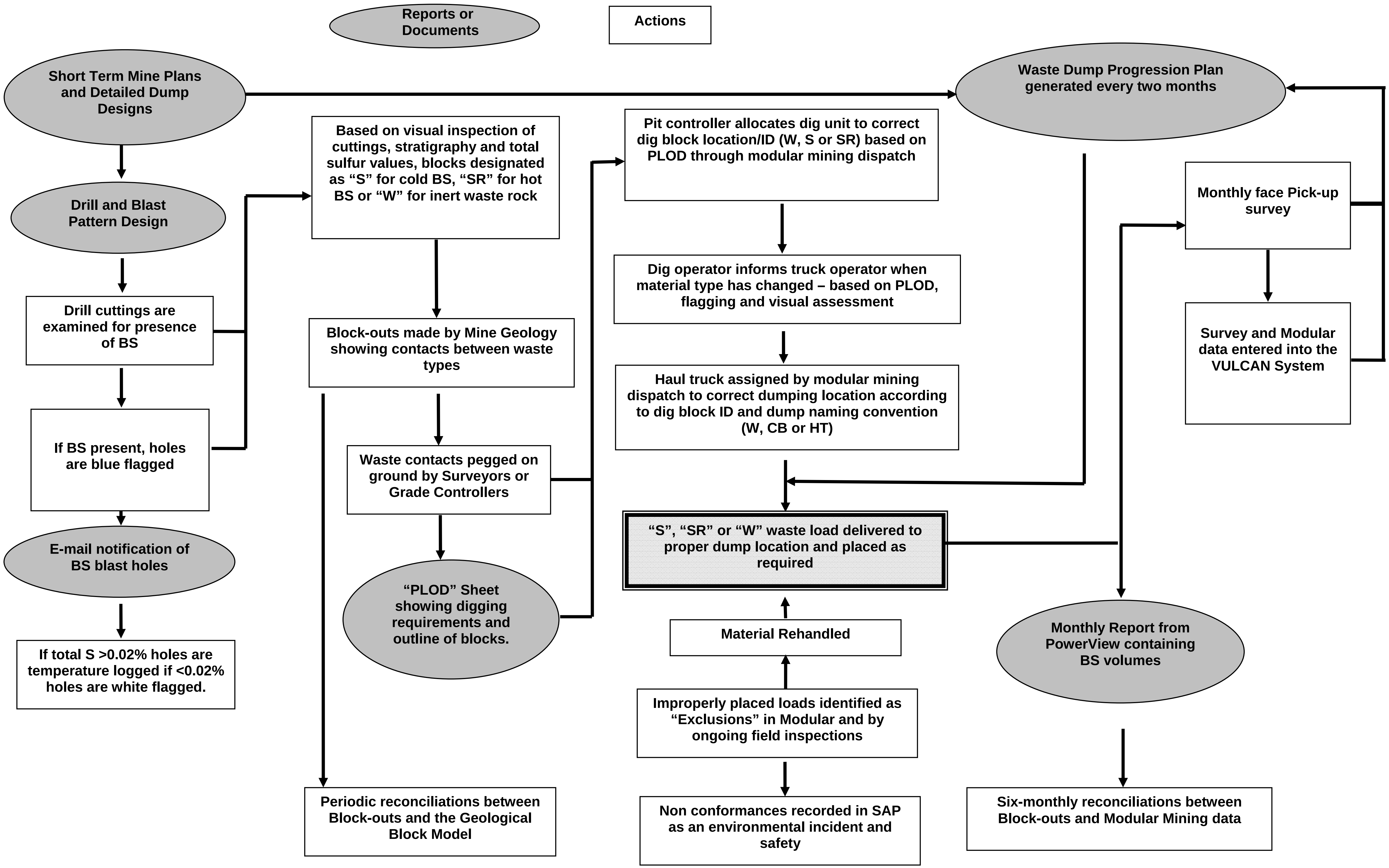


Figure 2: Black Shale (BS) management during mining operations



Appendix 1 Dump Specifications for Category S and Category SR Material

Management of sulfides within black shale, BIF and detritals needs to be considered during all phases of waste rock dump design, from initial selection of dump locations during the long-term planning process (five year and longer time horizon) to the detailed dump designs generated during short term planning (time horizon less than a year).

A1.1 Selection of Dump Locations

When designing new sulfide dumps, the dump location and footprint should be selected to minimise potential long term environmental impacts and financial liabilities. Selection and design criteria that must be considered include:

- Under no circumstances should material containing sulfides be used for works such as windrows, construction fill, ramps, fantails, roads or any other use that would disperse the material over a broad area in an uncontrolled manner.
- The sulfides dump location should not receive runoff from surrounding areas. In particular waste dumps must not be sited in established drainages with significant upstream catchments.
- In pit disposal should be considered a priority instead of the construction of above ground waste rock dumps.
- Placement of sulfides in pits that already contain sulfide exposures is preferable to placement in pits that do not have sulfides exposed on the pit walls.
- Sulfide dumps should not be placed over or adjacent to significant regional aquifers such as saturated valley fill alluvial deposits or fractured bedrock aquifers such as the Wittenoom formation.
- Sulfide dumps should not be placed over ore grade or near ore grade CID or BIF-derived deposits. These not only have potential economic value, but may act as significant local aquifers.
- Sulfide dumps should not be placed over or adjacent to significant seeps or springs.
- Avoid sitting new sulfide dumps in catchment basins that do not already contain sulfide dumps.
- The number of sites containing sulfides and the footprint of the sulfide dumps should be kept to a minimum.
- Sulfide dumps should be located near sources of clean waste rock for encapsulation.
- Background groundwater quality surrounding the dump location must be measured before any material is dumped. This will require the installation of groundwater monitoring bores. These bores will be used to provide a temporal record of groundwater quality in the vicinity of the dump.

A1.2 In-Pit Disposal Requirements

In pit disposal of sulfides is generally more secure than disposal in above ground waste rock dumps. Where practicable, in pit disposal should be considered the preferred disposal alternative because it:

- Reduces the risk of erosion exposing sulfides in the long term,
- Inhibits convective oxygen transport because the waste is surrounded by relatively impermeable rock walls,
- Reduces the footprint of the waste disposal facilities,
- Reduces the volume of inert or net neutralising waste needed to encapsulate the sulfides, and
- May help to prevent the formation of acidic or hyper-saline pit lakes if the pit can be filled to above the post-mining water table.

Note that in some pits it may be possible to place sulfides both above and below the water table with a minimum 10 metre thick inert waste layer placed against the predicted mean post-mining water table.

A1.2.1 In Pit Disposal Below the Water Table

If sulfides are placed below the post-mining water table, they will become permanently flooded and control subsequent pyrite oxidation and acid release. In the long term, placement below the water table is the most secure and low risk disposal option available for sulfidic material. It is particularly beneficial for Category SR material because it completely removes the long-term risk of spontaneous combustion. If a pit can be backfilled so that the fill elevation is above the pre-mining water table elevation, it is likely that the water table will eventually rebound to at or near the pre-mining elevation. If it is only partially backfilled to below the pre-mining water table, it is likely that a very shallow intermittent, seasonal or permanent pit lake will form on top of the fill material.

For sulfides placed below the post-mining water table the following minimum design criteria apply:

- For pits backfilled above the predicted post-mining water table, the top of the sulfide backfill must be at least 5 metres below the mean predicted post-mining water table (Figure 3).

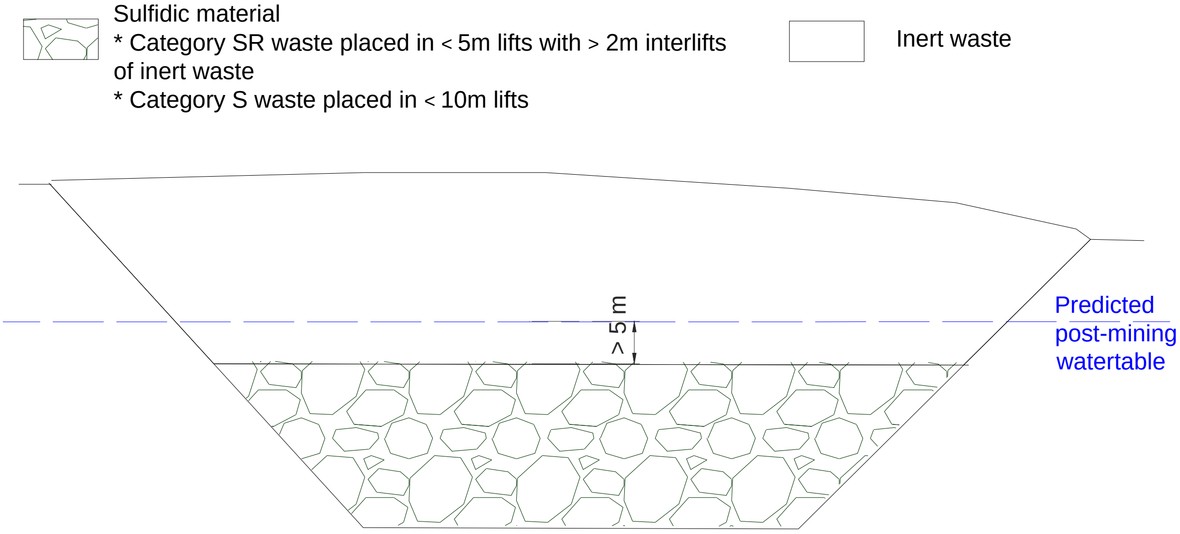


Figure 3: Example of sulfidic material placed below the water table and with the pit completely backfilled.

- For pits that are only partially backfilled to below the pre-mining water table, the top of the sulfide backfill must be at least 5 metres below the estimated mean pre-mining water table and at least 5 metres below the predicted post-backfilling water table (Figure 4). In this situation it can generally be assumed that the mean post-mining water table will be at the top of the backfill. Thus, the sulfidic waste will be covered by at least 5 metres of inert waste.

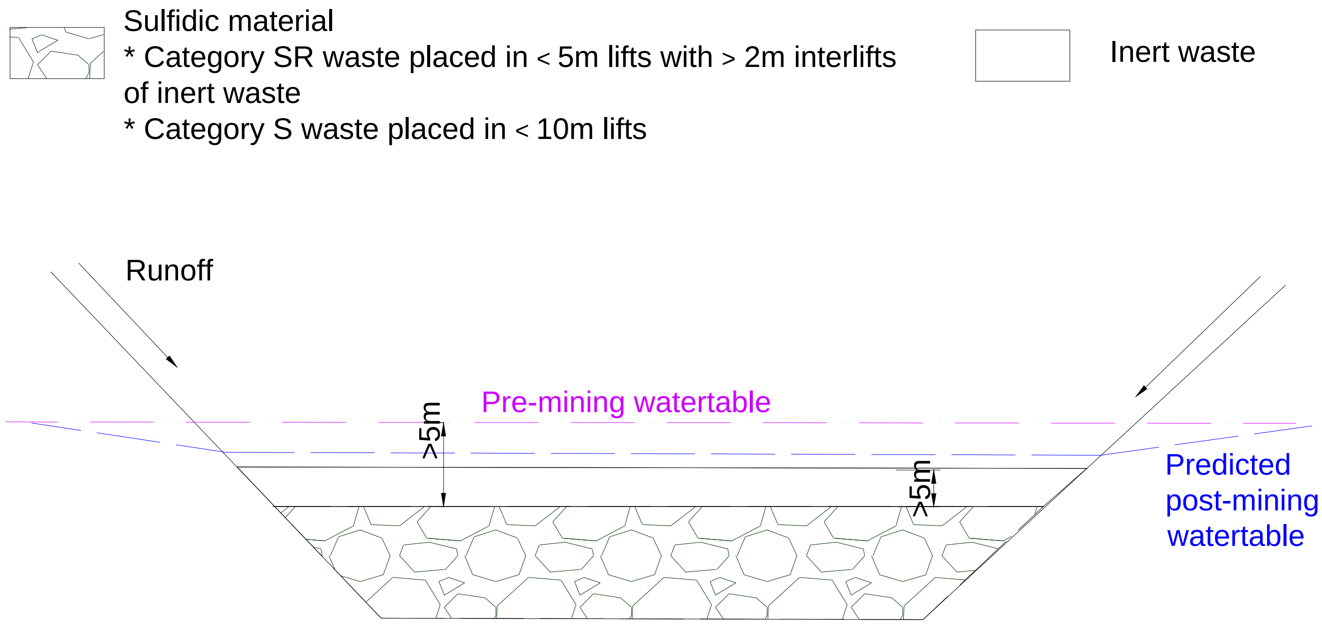


Figure 4: Example of sulfidic material placed below the water table and with the pit partially backfilled.

- The thickness of each Category SR material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each Category SR layer.
- The thickness of each Category S material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between Category S lifts.
- The uppermost lift of both Category S and Category SR material must be covered with a minimum 5 metre layer of inert or net neutralising waste rock.
- Each lift must be placed so that it ties into the pit walls on all sides to minimise the risk of convective oxygen transport until the waste is flooded.
- If backfilled to above the post-mining water table, the upper inert waste rock surface must be revegetated.
- A store and release cover is not needed if all sulfidic material in a pit is placed below the water table.

In addition to the minimum design requirements lists above, the optimum design for in-pit disposal below the water table also includes:

- Enough inert or net neutralising backfill should be placed on top of the sulfidic waste to raise the fill level to at least above the post-mining water table (preventing the formation of a pit lake) and preferably above the pit walls so that runoff is not directed into the pit fill. Figure 3 is an example of this preferred alternative.

- If required, flooding of the backfilled waste should be enhanced by diverting surface water flows into the pit or directing dewatering water from active open pits into the backfilled pit. The more rapidly the waste can be flooded, the less pyrite will ultimately oxidise. Rapid flooding will minimise the build up of soluble sulfide oxidation products in the material. As long as geotechnical safety requirements are met, construction of waste lifts into standing water on the pit floor is acceptable.

A1.2.2 In Pit Disposal Above the Water Table

If sulfidic material is placed above the post-mining water table it must be ensured that long-term variations in the water table elevation do not allow water to rise into the overlying sulfidic material. Intermittent contact with infiltrating water from above must also be minimised. For sulfidic material placed above the post-mining water table the following minimum design criteria apply:

- The base of the sulfidic material backfill must be at least 5 metres above the predicted mean post-mining water table.
- At least 5 metres of inert or net neutralising waste rock must be placed at the base of the open pit before sulfidic backfill is placed. The most likely location for a perched water table to form is at the base of the backfilled pit because of the permeability contrast between the bedrock and the backfill.
- The thickness of each Category SR material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each Category SR layer.
- The thickness of each Category S material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between Category S material lifts.
- The uppermost lift of both Category S and Category SR material must be covered with a minimum 2 metre layer of inert or net neutralising waste rock. This will prevent runoff water from contacting the underlying sulfidic material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- If the pit can be completely backfilled so that no high walls are exposed above the inert waste rock fill, then each inert, Category S and Category SR material layer should tie into the pit walls on all sides to minimise the risk of convective oxygen transport (see Figure 5 and Figure 6 for examples).

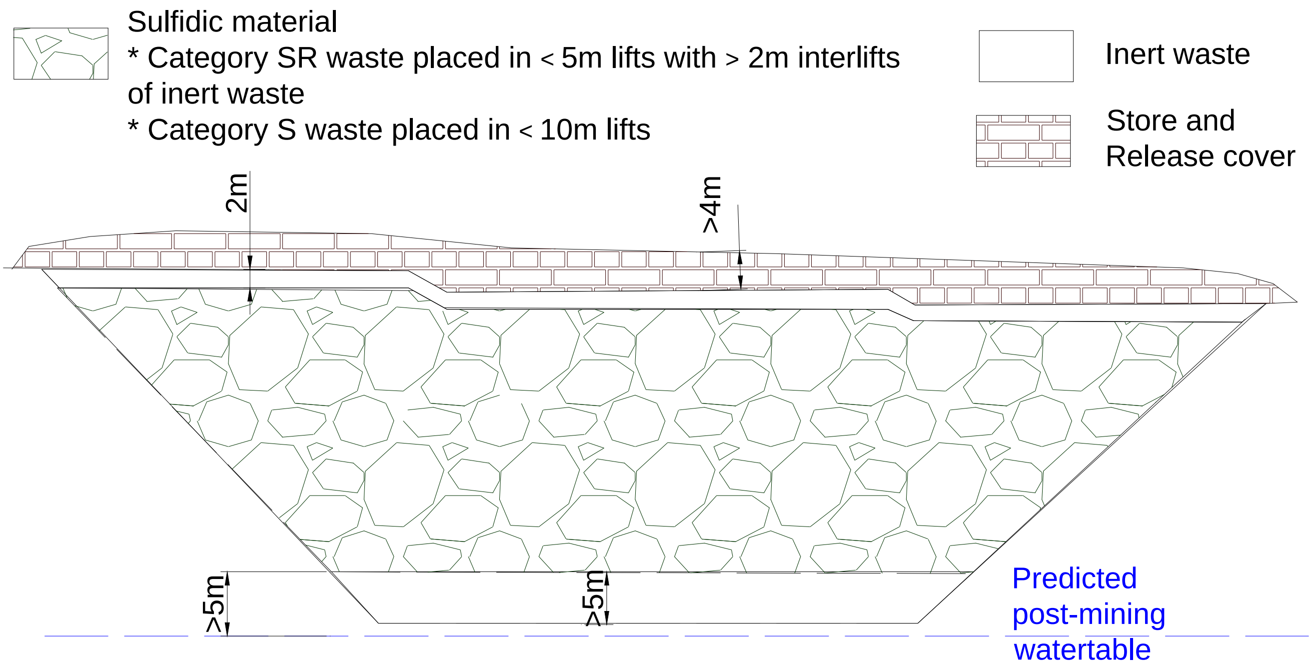


Figure 5: Example of sulfidic material placed in a dry pit that is completely backfilled.

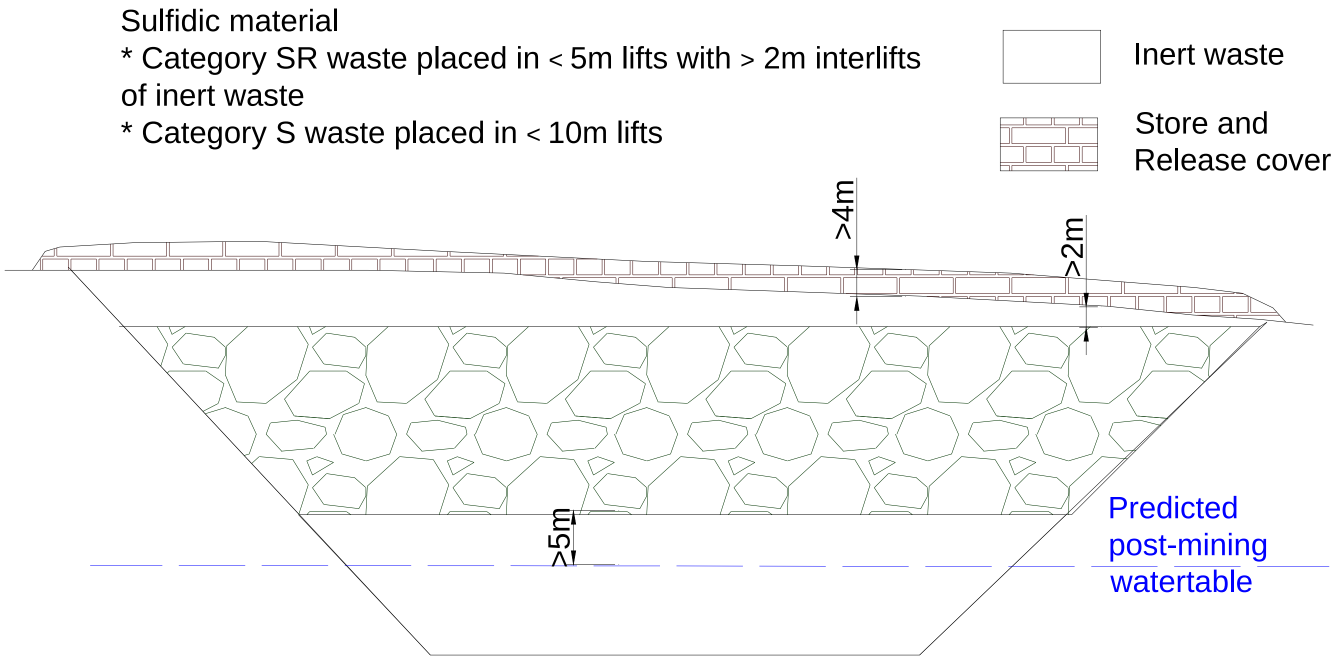


Figure 6: Example of sulfidic material placed above the water table and with the pit completely backfilled.

- If the pit will only be partially backfilled so that some highwalls are exposed above the final backfill surface and so that runoff from the remaining highwalls will flow towards the backfill, then a minimum five metre (measured both horizontally and vertically) buffer of inert waste rock must be placed between the pit walls and each sulfide material lift where possible (see Figure 7 for an example). A 2 meter high by 5 metre wide abandonment bund will also need to be placed adjacent to the exposed high walls to prevent run on water from infiltrating into the cover over the sulfidic material.

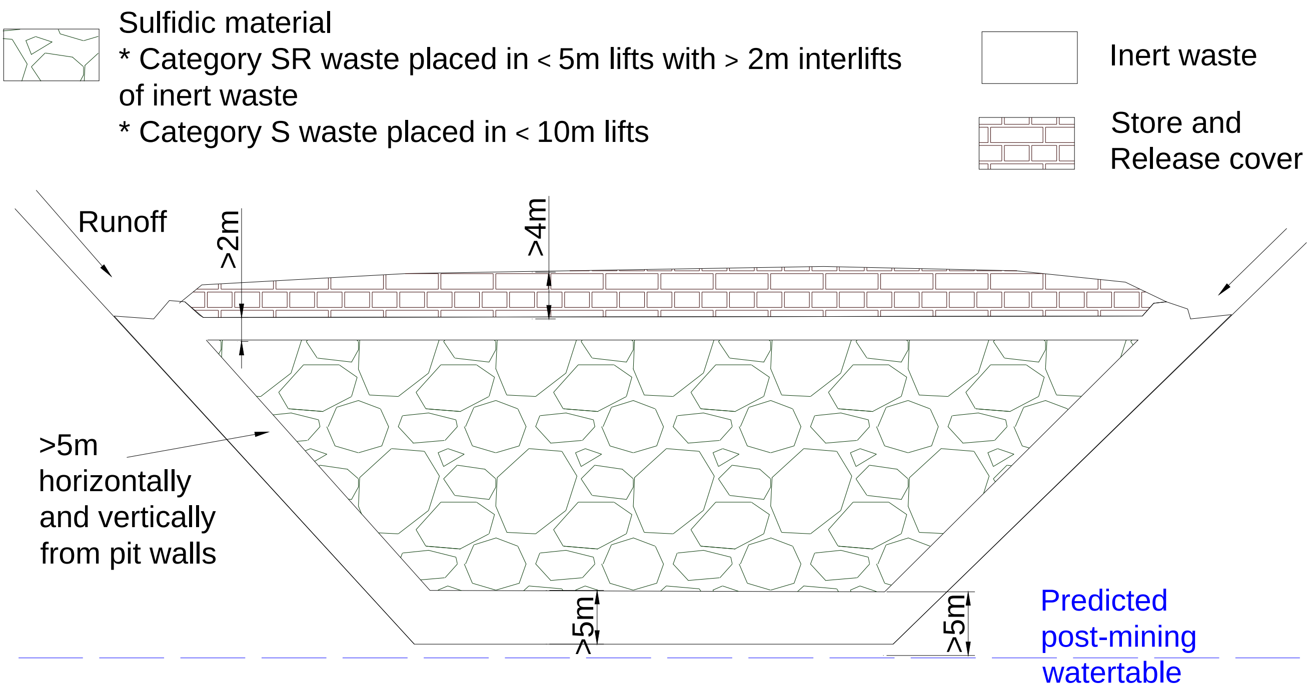


Figure 7: Example of sulfidic material placed above the water table and with the pit partially backfilled.

In addition to the minimum design requirements lists above, the optimum design for in-pit disposal above the water table also includes:

- If possible, the pit should be backfilled above the lowest point on the pits walls so that the final backfill surface can be sloped to allow runoff water to flow out of the pit footprint.
- The optimum design would be to backfill the pit so that there are no highwalls exposed that could direct runoff onto the store and release cover and underlying sulfidic material (Figure 5 and Figure 6).

A1.3 Above Ground Disposal Requirements

If sulfidic material waste rock dumps are to be constructed on top of the original ground surface, more stringent design criteria are required than for in-pit disposal because of the risk of erosion exposing encapsulated sulfidic material and because of the likelihood of the convective transport of oxygen through the side slopes of the dump. Design criteria for Category SR dumps are also more stringent than for Category S dumps.

A1.3.1 Design of Outer Waste Rock Dump Slopes

To the extent possible, Category S and Category SR material should be excluded from beneath final waste rock dump slopes. There are several issues associated with the placement of Category S and Category SR beneath waste rock dump slopes:

- There is an increased risk of slope erosion damaging vegetation and covers in the short term, or in the long term exposing the underlying material.
- The probability of convective oxygen transport to the sulfidic material is higher than for Category S and Category SR material only placed in the dump interior.
- Store and release covers cannot be built on slopes because they must be constructed with more erodable fine-grained materials. It is likely that infiltration rates into the

underlying Category S and Category SR material will be higher on slopes than on flat surfaces with a store and release cover, which could result in increased ARD.

- Uncertainties with the requirements for final dump slopes may require the importation of additional inert material to allow slopes to be reduced to less than 20 degrees if required while preserving the minimum 5 metres of inert cover over the sulfidic material.

The minimum design criteria in the following section reduce but do not completely mitigate these risks. For this reason, the volume of Category SR, and to a lesser extent Category S, material placed beneath final dumps slopes should be minimised wherever possible. The greatest benefit can be derived from excluding Category SR material from beneath the slopes because it not only has the potential to spontaneously combust, but also has anywhere from 2 to 70 times more acid producing potential on average than the Category S material.

A1.3.2 Category SR

Figure 8 shows the optimum design for the waste rock dumps in which Category SR is completely excluded from beneath the footprint of the final re-contoured slope.

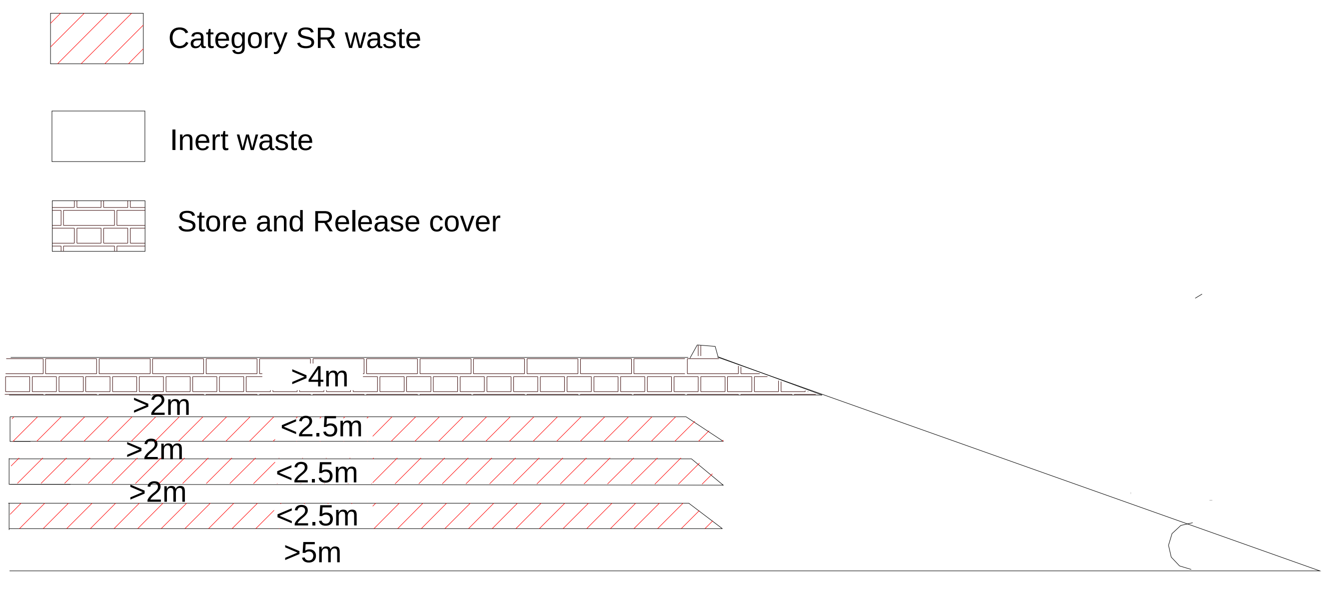


Figure 8: Example of optimum design for Category SR dumps.

An example of a Category SR waste rock dump constructed according to the minimum dump design criteria is shown in Figure 9. The minimum design criteria for Category SR dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.

- Enough inert waste rock must be placed against hillsides so that sulfidic material is not located within 5 metres of the hillside as measured both vertically and horizontally.

- The thickness of each Category SR sulfide material lift must not exceed 2.5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock. Lifts are to be constructed by paddock dumping so that Category SR sulfidic material can cool and so that incident vehicle traffic helps create a compacted layer every 2 to 2.5 metres to inhibit water movement and convective oxygen transport.

- Enough inert or net neutralising waste rock must be placed on the outer skin of the Category SR sulfidic material waste rock dump so that no sulfidic material is located within 5 metres (measured across the shortest distance) of the final dump surface after the slope has been recontoured at closure. For design purposes it should be assumed that all outer dump slopes will be reduced to 20 degrees or less at closure.
- The final lift on a Category SR sulfide material waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying sulfidic material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- During construction and at closure, the upper dump surface of the Category SR sulfidic material waste dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

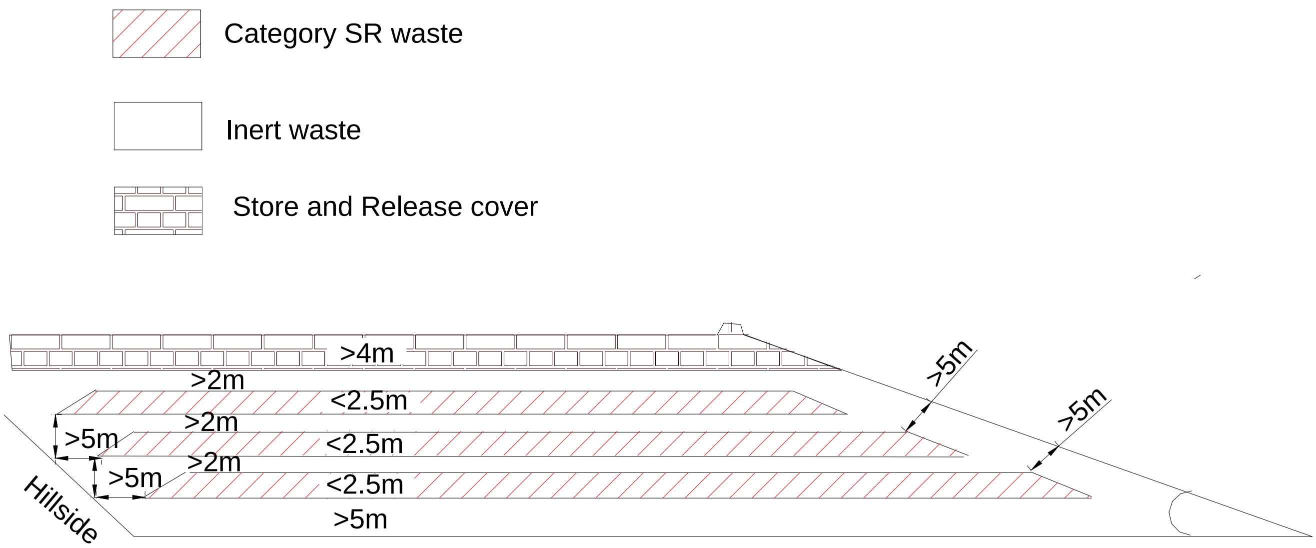


Figure 9: Example of the minimum design criteria for Category SR dumps (if Figure 8 can not be constructed).

A1.3.3 Category S

An example of a Category S waste rock dump constructed according to the minimum dump design criteria is shown in Figure 10. The minimum design criteria for Category S dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.
- Enough inert waste rock must be placed against hillsides so that Category S material is not located within 5 metres of the hillside as measured both vertically or horizontally.

- The thickness of each lift of Category S material must not exceed 10 metres. This will create a vehicle compacted layer every 10 metres in the dump to inhibit water movement and convective oxygen transport[1].
- No inert or net neutralising waste rock layer is needed between Category S lifts.
- Enough inert or net neutralising waste rock must be placed on the outer skin of the Category S waste rock dump so that no material is located within 5 metres of the final dump surface after the slope has been recontoured at closure. For design purposes it should be assumed that all outer dumps slopes will be reduced to 20 degrees or less at closure.
- The final lift on a Category S waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- During construction and at closure, the upper dump surface of the Category S dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

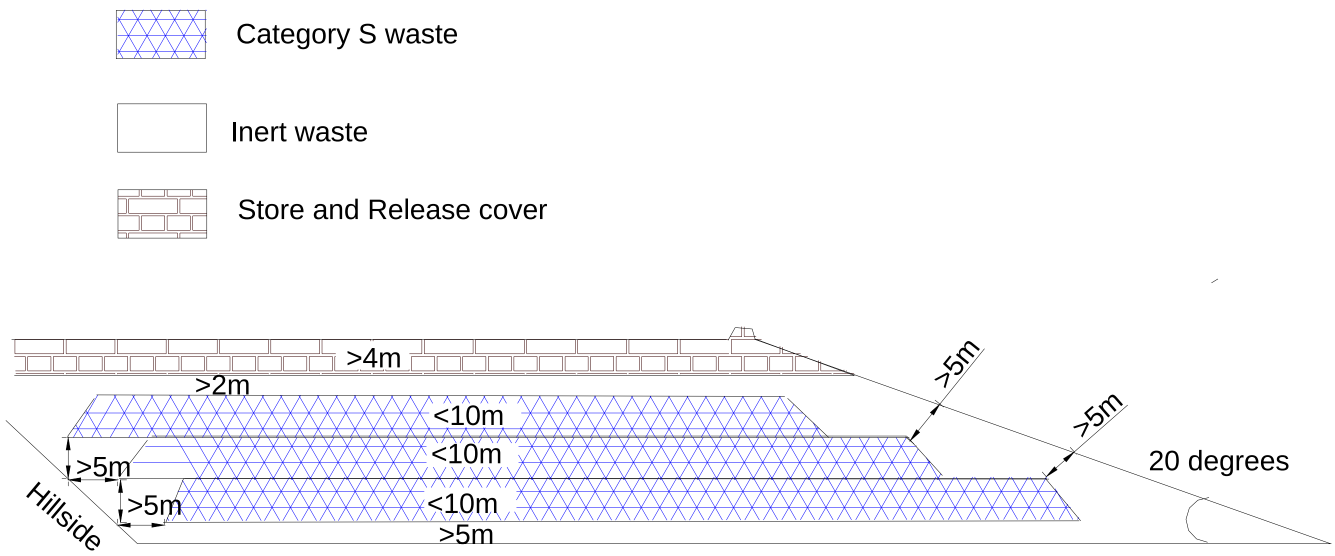


Figure 10: Example of the minimum design criteria for Category S dumps.

A1.3.4 Composite Designs

Figure 11 shows an example of a composite Category SR and Category S dump in which Category SR material is excluded from the beneath the slope and Category S material is placed below the slope. Composite dumps of this kind may significantly reduce the residual risk associated with the dump slopes without significantly reducing the total storage capacity for sulfidic material within the dump. There must be at least a one metre buffer (measured

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[1] Note that this has been changed from 5 m lifts as the gas movement through waste dumps has been shown during ANSTO testing to be diffusive and it is likely that the difference in ARD generation between 10 and 5 m lifts will be negligible.

horizontally or vertically) between the Category SR and Category S material where they are in close contact on the outer slopes of the Category SR repository.

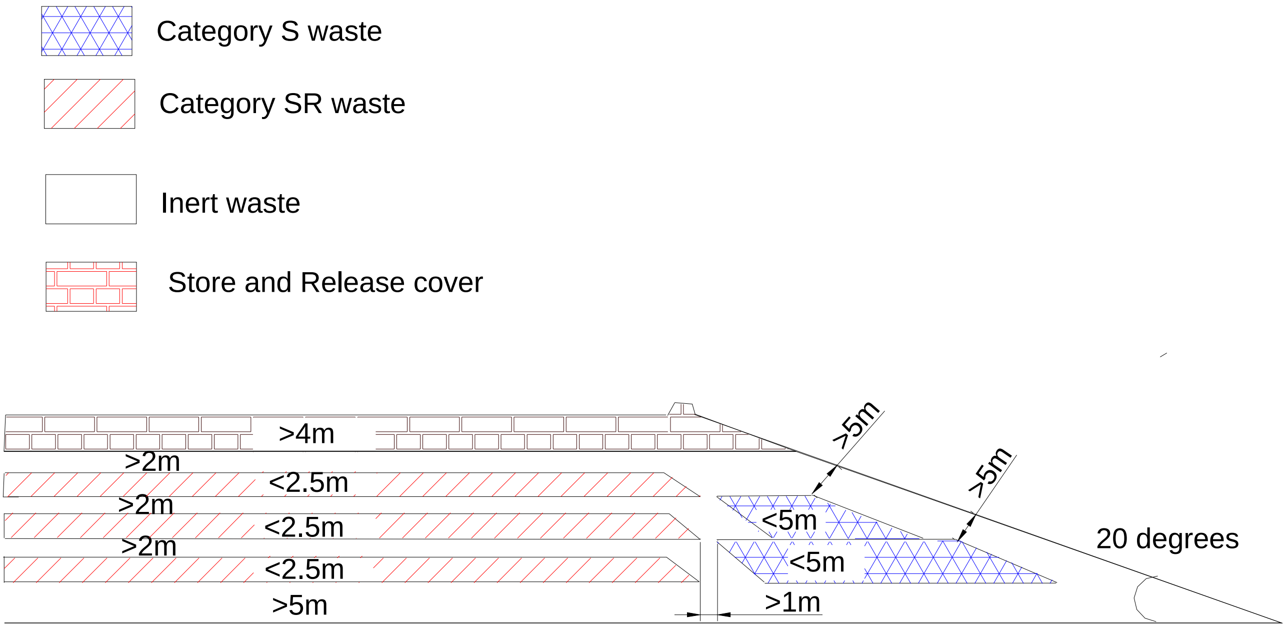

Figure 11: Example of optimum composite designs for Category S and SR dumps

Appendix 2 Rehabilitation and Closure

A2.1 Final Landforms

To reduce the risk of erosion and to minimise infiltration, final landforms should be designed in accordance with the following criteria:

- Final waste rock dump slopes should be designed taking into consideration the properties of the material. Designs of slopes will require signoff by key stakeholders.
- No sulfidic material should be within 5 metres of the shallow dipping recontoured dump slope as measured perpendicular to the slope. This will most likely require that inert waste rock fill be imported and placed at the toe of the slope rather than significantly expanding the cut made at the top of the slope.
- Final landforms must be designed so that runoff is not directed onto surfaces that are underlain by sulfidic material.
- A 2 metre high by 5 metre wide abandonment bund must be placed around the top of each dump slope. This will prevent runoff water flowing from the dump surface over the slopes and causing erosion.
- If sulfidic material is exposed during the recontouring of waste rock dumps that were created before waste rock segregation was practiced, it must be covered with at least 2 metres of inert waste rock. This will help ensure that the entire final dump surface is able to support vegetation.
- Wrapping of a sulfide dump is preferred rather than dozing down the slope.

A2.2 Store and Release Covers

Store and release covers must be constructed on all flat surfaces over Category S and Category SR repositories and over some sulfide/black shale exposures within open pits. Store and release covers are designed to limit infiltration into the underlying waste rock by maximising the evapo-transpiration of incident rain water. The cover is designed to store water near the surface during the wet season so that it can be removed from the cover material and returned to the atmosphere during the dry season by evaporation and plant transpiration.

Waste rock that is used to construct store and release covers must contain sufficient fine-grained material to have both a high moisture retention capacity and a relatively low permeability (i.e. large boulders should not be placed on the cover). Waste rock composed of well-graded clayey, silty, sandy gravel or clayey silty gravely sand makes the best store and release cover material. As a rough guide, waste rock containing more than 1/3 coarse sand size and finer particles (< 5 mm) will make a suitable cover material. **Blocky BIF composed of gravel with very little silt, sand or clay** is not ideal for use in cover construction and should be avoided if another more suitable waste type is available (Figure 12). When possible, oxidised shale should be used in preference to BIF on covers.

During construction there should be regular quality control checks to ensure large boulders have not been placed into the cover.

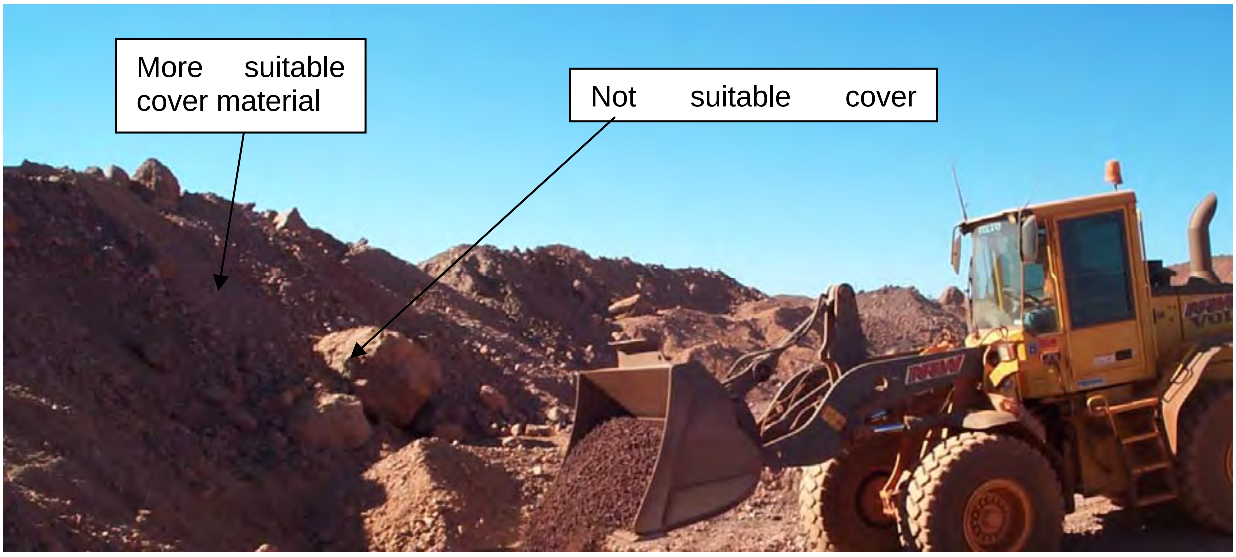

Figure 12: An example of suitable and not suitable material to be used in the construction of a store and release cover.

Waste rock that is used to construct store and release covers must also be able to support vegetation, so materials with high salinity, and acidic or very basic pH should be avoided. The waste rock should be placed in a manner that minimises segregation of the material into coarse and fine particles. For this reason covers should be paddock dumped, they should never be constructed by dumping in two or four metre lifts.

Store and release covers should be constructed as follows (Figure 13):

- Paddock-dump store and release cover material on top of a vehicle compacted surface so that the average depth of the cover material is greater than 2 metres.
- A dozer should then be used to knock down the crest of each paddock dump pile and to fill in the depressions between piles to create a trafficable surface.
- Paddock-dump a second layer of store and release cover material on top of the first lift so that the average depth of the second lift is greater than 2 metres. Vehicle traffic during this dumping will create a compacted layer on top of the first store and release cover layer.
- A dozer should again knock down the crest of each paddock dump pile in the second layer and fill in the depressions between piles to create a surface that is nearly planar.
- Topsoil should be placed on top of the second store and release cover layer. The surface should then be ripped and seeded. Ripping needs to be deep enough (> 0.3 metres) to mix in the topsoil and to ensure that there are not compacted zones that could inhibit plant growth and rooting on top of the upper layer.

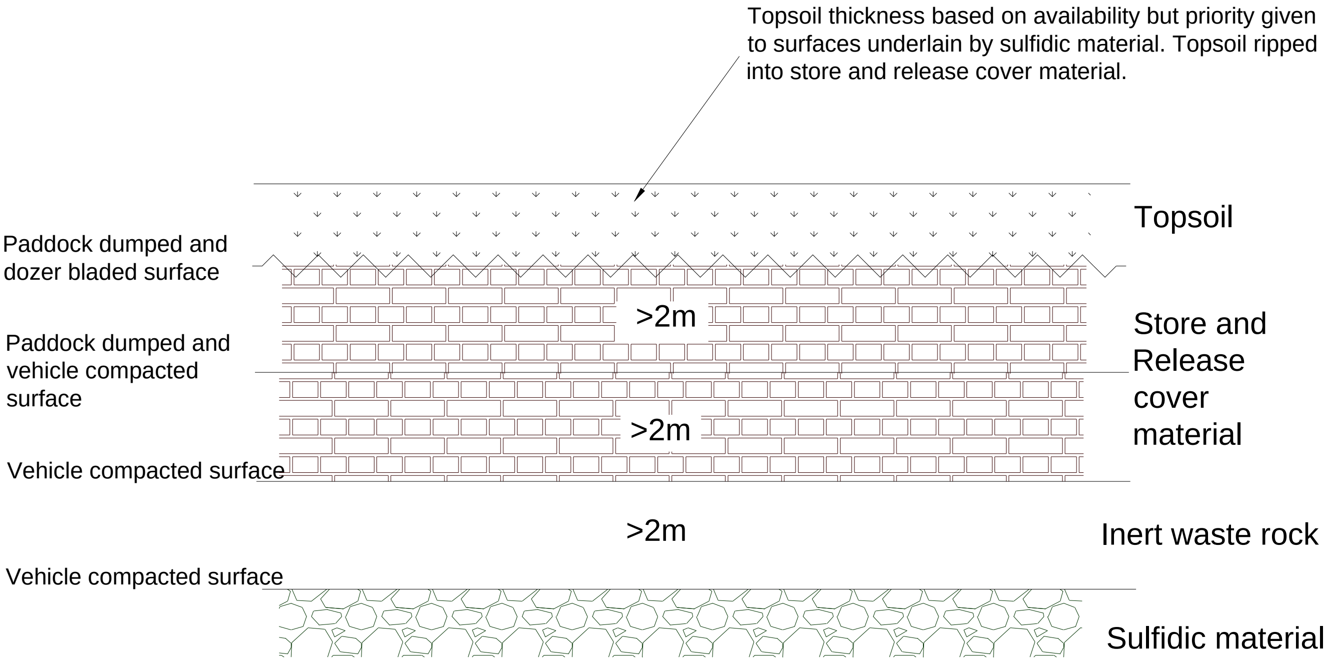

Figure 13: Detail of store and release cover design.

A2.3 Topsoil Management

Although direct planting into inert waste rock is feasible, topsoil placement can greatly accelerate the establishment of native vegetation on waste rock surfaces. This in turn will help to maximise evapo-transpiration, minimise infiltration into the underlying waste rock and inhibit erosion on dump slopes. If topsoil resources are limited, the most benefit for ARD management can be gained by preferentially utilising topsoil for the revegetation of waste rock dumps that contain sulfidic material. In decreasing order of importance, topsoil should be placed on:

1. Dump slopes underlain by Category SR material;
2. Dump slopes underlain by Category S material;
3. Flat store and release cover dump surfaces underlain by Category SR material;
4. Flat store and release cover dump surfaces underlain by Category S material;
5. Store and release covers within open pits;
6. Waste rock dumps that were created before waste rock segregation was practiced and which may contain dispersed black shale or material containing sulfides;
7. Assessable inert waste rock surfaces within pits that contain black shale or sulfidic material exposures; and
8. Waste rock dumps that do not contain any black shale or sulfidic material.

A2.4 Open Pit Closure

The geology and hydrogeology of an open pit will largely control the potential closure issues associated with the final void. Open pits that are located above the water table and which do not contain any black shale or sulfidic material exposures should not pose any geochemical risks at closure. Open pits that intersect the water table but do not contain any black shale or sulfidic material exposures may ultimately contain saline water bodies with neutral pH that could impact down gradient groundwater. Open pits that contain black shale or sulfidic material exposures will likely contain ephemeral or permanent acidic and potentially saline water bodies that could impact down gradient groundwater and could represent a direct exposure risk to wildlife or humans.

Government guidance clearly indicates that hypersaline pit lakes are considered acceptable as long as down-gradient beneficial use is not impacted. However, the existing guidance also indicates that mitigation measures are required if net acid generating materials such as pyritic black shale are exposed on the final pit walls. In pits with extensive exposures of pyritic black shale that will not be backfilled to above the water table, long term mitigation measures will likely be required to attain the proposed water quality criteria.

The hydrogeological and geochemical behaviour of each pit should be predicted so that it can be managed appropriately at closure to minimise significant groundwater impacts and surface water exposures to wildlife and humans. As discussed in Sections A1.2.1 and A1.2.2 the most protective pit closure strategy is to completely backfill the pit or to backfill the pit to above the estimated pre-mining water table where practicable. Backfilling to above the pre-mining water table should lead to a near complete recovery of the water table elevation and should cut off oxygen to the majority of black shale or sulfidic material exposed on the pit walls.

In order of decreasing benefit, pit backfilling should be prioritised as follows: 1) pits with black shale or sulfidic material exposures that intersect the water table and will discharge to groundwater at closure, 2) pits with black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, 3) pits with black shale or sulfidic material exposures that are above the water table, 4) pits without black shale or sulfidic material exposures that intersect the water table and that will discharge water to groundwater at closure, 5) pits without black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, and 6) pits that do not contain any black shale or sulfidic material exposures and that are above the water table. The proximity to nearby regionally significant aquifers or ecologically significant seeps and springs should also be considered when evaluating potential pit closure issues.

Extensive backfilling is not practicable for many open pits because of the size of the final void and because of pit sequencing issues. Where backfilling is not practicable the following actions should be taken:

- Haul roads and accessible benches that are underlain by inert waste rock should be ripped and seeded to minimise runoff, to promote vegetation establishment and to maximise evapo-transpiration.
- A minimum 4 metre store and release cover system should be constructed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located above the water table and that will not be periodically flooded by cyclone events.
- A minimum 5 metre lift of inert or net neutralising rock should be placed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located below the water table or that will be periodically flooded by cyclone events.
- Consideration should be given to covering black shale or sulfidic material exposed on pit highwalls with inert or net neutralising material pushed or dumped from the sides.

An example of these pit closure strategies is illustrated in ***Figure 14***.

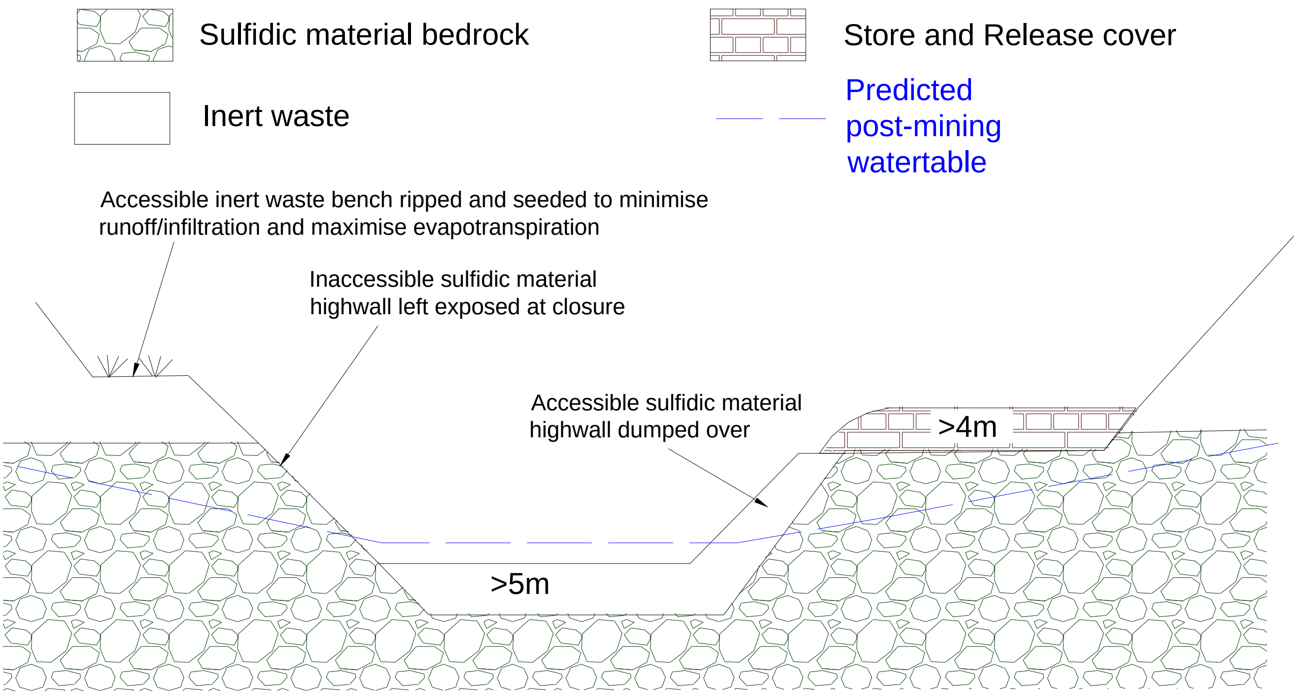

Figure 14: Examples of closure strategies for a pit with sulfidic material that will not be backfilled

Appendix 3 Contingency Planning

Contingency plans for most upset conditions and unexpected impacts related to sulfidic material management will need to be developed on a case by case basis. Contingency plans will generally be developed by the site Mineral Waste Management team or at a minimum they must be approved by the Team. Contingency plans for spontaneous combustion and inert materials shortages are outlined in the following sections.

A3.1 Spontaneous Combustion

Site specific pit safety procedures should be followed.

All occurrences of burning black shale or lignites must be reported to Mine 2 and the pit safety team as soon as possible. If possible, fires should be extinguished by rapid burial of the burning material under at least five metres of inert waste rock. For locations where this may be difficult such as beneath pit ramps, the black shale or lignite should be covered with as much inert material as practicable. The inert material should be placed so that the upper surface is well compacted and so that side slopes are adequately covered to prevent lateral convective transport of oxygen to the burning rock mass. If rapid coverage is not an option, the material can be excavated and transported to the toe of an advancing inert dump lift where it can be rapidly buried. Water should not be used to extinguish the fire because this could actually enhance the spontaneous combustion risk of black shale or lignite that is not already burning and because the volumes of water that would be required are generally prohibitively high.

A3.2 Inert Materials Shortages

Medium and short term mine plans should be designed so that inert waste rock is produced in adequate volumes and at appropriate times to allow timely encapsulation of sulfidic material. Category SR material requires the highest volumes of inert material (approximately 1:1) because of the requirement for an inert interlayer every 2.5 metres. If there were temporary shortages of inert material, Category SR dumps could be designed with Category S material if it contains a low sulfide concentration, some neutralising potential and low organic carbon (i.e. no black shale or lignite) material. The appropriate material to use in the heat dissipating interlayer should be confirmed as appropriate by Mine Geology. But under no circumstances should Category S material with both elevated sulfide and organic carbon concentrations (i.e. sulfidic shale or lignites) be used. If acid base accounting tests prove the material to be non-acid forming, coarse tails could be used as inert waste in dumps (i.e. EGi 2007). If there is a shortage of inert material then inert waste in other waste dumps may need to be rehandled and transported to the black shale waste dump.

A3.3 Surface Water Management

Every endeavour should be made to divert surface water runoff from contacting black shale or sulfides exposed on pit walls. Site specific cyclone water management plans should be developed for the appropriate disposal of potentially acidic water in pits with black shale exposures. Some strategies to manage surface water runoff include:

- Slope pit floor away from pit sulfide exposure
- A sump should be constructed below the sulfide exposure to collect acidic water.
- Surface water runoff from inert exposures should be segregated from coming in contact with acidic water.

- Bund upper catchment to run over competent material such as BIF rather than sulfide exposures.

Waste dumps should have all sulfide exposures covered with inert material during the wet season. A bund at the top of the waste dump surface will reduce any surface water from travelling over the sulfidic material and transporting contaminated drainage into the surrounding environment.

Pipelines transporting acidic water should be shut down and repaired if there is a leak. Acid water pipelines should be labelled with purple stripes and non-acidic pipelines can be labelled with green stripes (as per Australian Standards).

A3.4 Geotechnical Stability

A3.4.1 Pit Walls

Pit walls excavated in Mt McRae Shale are designed with the same concept as for other stratigraphic units. That is, generally we design for a Factor of Safety of at least 1.20 and a Probability of Failure of around 10% on the inter-ramp scale and up to 30% for the batter scale. The management of slopes excavated in Mt McRae Shale is therefore no different from that of any other stratigraphic unit, whereby a process called Geotechnical Design Management is utilised. This involves identifying hazards and hence risks associated with the geotechnical design and undertaking a risk management strategy to minimise these risks. Actions include design review, geotechnical investigation, mapping, conformance to design and monitoring. Contingency plans are established through Slope Management Plans in consultation with mine management.

The occurrence of Mt McRae Shale is of little consequence to the geotechnical management process.

A3.4.2 Dump failures

Whilst no specific stability analyses have been undertaken on Black Shale Waste Dumps, they can generally be considered stable due to the process of encapsulation of the material well within a dump. Also, the process of undertaking earthworks to prepare the encapsulation is considered to add a significant contribution to the stability of the dump location. It is anticipated that future stability analyses may be documented in a Waste Dump Management Plan.

Iron Ore (WA)
Brockman 4
Mineral Waste Management Work Practice

Table of Contents

1 Purpose

The objective of this plan is to detail the mineral waste activities and accountabilities during Expansion Studies and Mine Operation.

The purpose of this document is to plan for management of, and monitor, mineral waste risks. Once a risk is identified a separate plan is required to manage the risk i.e. the Spontaneous Combustion and ARD (SCARD) Management Plan for Operations, site specific process waste/tailings operating plans and site specific asbestiform management plans.

2 Scope

This procedure covers the management of mineral wastes at the Pilbara Iron and Expansion Projects business units of the RTIO (WA) product group. Mineral wastes generated at RTIO (WA) operations include:

- Non-mineralised waste rock (mining overburden)
- Mineralised waste rock (low grade)
- Processed waste rock (tailings)
- Waste rock exposures (pit walls)
- Dredging materials (spoil)
- Quarried rock extracted for construction

Although not a waste, mineralised waste rock or low-grade may have many of the same characteristics and pose many of the same risks as mineral wastes and should also be assessed as a potential contaminant sources.

For the purpose of this document mineral waste excludes:

- Management of landfills
- Products imported to site i.e. hydrocarbons (see Biofarm Remediation Facility and Spill Response procedures)
- Management of sewerage farms
- Dust

3 Requirements, Accountabilities and References for Expansion Studies

This plan provides guideline for mineral waste management that should be undertaken at the different phases of project development. The amount of work in the study stages of order of magnitude, pre-feasibility and feasibility can vary for different projects and therefore work programs should be adapted for each specific project. If a stage such as pre-feasibility is skipped then work that has been identified for this stage must be completed in the feasibility stage of the project (or preferably earlier).

Requirements	
3.1	**Resource and Mine Lease Evaluation Drilling**
	The level of mineral waste analysis required must be determined at the scoping stage of the model progression. If it is likely that the deposit will be developed then the Second Phase of mineral waste work can occur immediately without a First Phase program. The minimum amount of work is within Items 3.1.1 to 3.1.5 and work that must be completed before the end of the study is with Items 3.1.6 to 3.1.12.
First Phase	
Initial drilling program to broadly define a known mineral deposit (e.g. 400 m x 100 m program).	
3.1.1	Visually identify oxidised shale (SHL), black carbonaceous shale (SHC), lignite (LIG) and pyrite (PYT) in all drilled holes and log lithological sequences.
3.1.2	Perform total sulfur analyses on all sampled intervals. The total sulfur results must be compiled in a format that can be used to construct block models.
3.1.3	Analyse representative samples from each waste lithology that surrounds the ore body for the standard chemistry suite. Drill holes should extend past the orebody to define all waste that could be reasonably disturbed by mining. The samples should have adequate spatial and volumetric representation to reflect possible variability in the lithology and regional structural features.
3.1.4	Measure the water table elevation in all drill holes.
3.1.5	Follow relevant SWPs and site Management Plans for fibrous minerals. Fibre occurrence data should also be recorded. This information should be sent to the relevant Health and Safety Advisor/Divisional Ventilation Officer for notification to the DMP District Inspector.
Second Phase	
Infill drilling program to define the orebody for development (e.g. 50 m x 50m)	
	<u>ARD and Spontaneous Combustion - MCS</u> See Items 3.1.1 to 3.1.4
3.1.6	If MCS might be encountered during future mining, ensure that sufficient drill holes are extended into the MCS to accurately define the geometry of the Footwall Zone/upper MCS contact, define the transition from oxidised to un-oxidised MCS and to define the transition from cold to hot black shale. Sample for total sulfur and provide representative samples of FWZ, upper, middle and lower MCS to the Mineral Waste Management team for full acid/base accounting.
3.1.7	Develop resource models for ore bodies that can be used to predict cold and hot BS production for different pit scenarios. Ensure new resource models classify potential waste rock into no risk (0), low risk (1), moderate risk (2),high risk (3) or neutralising potential (4) sulfide categories.
3.1.8	Unless identified as fully oxidised by drill hole logging, occurrences of MCS below the water table must be assigned to one of the sulfide risk categories (2 or 3). <u>ARD and Spontaneous Combustion – Sulfides in other lithologies</u>
3.1.9	If elevated total sulfur concentrations are found in other lithologies contact the Mineral Waste Management team to arrange a laboratory to send the samples for full acid/base accounting analysis. Consult a recognised ARD expert to review the results.
3.1.10	For elevated sulfides (i.e. S > 0.1%) that are not within MCS (e.g. sulfides in detritals and BIF, whaleback shale, DG) assign it a sulfide risk variable in the resource block model. Sulfur should always be included in resource models. Assign material with neutralising potential (ie. calcrete in

Requirements	
	detritals and dolomite within the Wittenoom formation) to a 4th sulfide risk variable (if present in these deposits).
	Geochemical Risk
3.1.11	In all lithologies sufficient drill holes should extend below the ore body to allow geochemical characterisation of waste material that could be mined. The samples should have adequate spatial and volumetric representation to reflect possible variability in the lithology. In non-sulfide lithologies undertake geochemical analyses of ore and waste.
	Fibrous Minerals and Asbestiform Minerals
	See Item 3.1.5.
3.1.12	If fibrous minerals are likely to be exposed, the model should classify the material by one of the four fibre occurrence variables: unlikely fibre occurrence (0), possible fibre occurrence (1), likely fibre occurrence (2), or almost certain fibre occurrence (3).
3.2	**Conceptual/Order of Magnitude**
Geology See Item 3.1	
3.2.1	Consider the mineral waste risks of the deposit from know site specific geology information.
Water Resource Evaluation	
3.2.2	Consider the mineral waste risks of the deposit from known site specific geology information.
3.2.3	In consultation with relevant groups complete the AMD Hazard Screening Scorecard.
3.2.4	Assess the mineral waste risks based on known characteristics of the ore and waste that will be mined including the amount that will be below the water table.
Environment	
3.2.5	Include assessed risks in the Operational Environmental Risk Register (OERR).
3.3	**Pre-Feasibility**
Geology	
	See Item 3.2.1 to 3.2.4.
Environment	
	See Item 3.2.5
3.3.1	During pre-feasibility study at the latest there must be a conceptual understanding of all potential mineral waste related impacts. Consideration should be given to potential risks from: • ARD *From waste dumps, pits, dewatering of orebody, dewatering for geotechnical depressurisation*. • Spontaneous combustion in dumps or while using explosives *If pyrite and carbon are present in sufficient quantities.* • Fibrous minerals and asbestiform minerals *If intersected during drilling or if fresh BIF is identified for mining.* • Contaminated seepage or surface runoff *If enriched/elevated contaminants in waste leach into water.* • Salinity *From waste dumps (containing either reactive or inert waste), tailings or pits.* • Nitrogen compounds *From ANFO explosives.*
3.3.2	Based on the geochemistry of drillhole data collected by Resource Evaluation, determine the geochemical risk of any enriched contaminants in the waste and ore. Make recommendations for monitoring, management and further analysis. Consult a recognised mineral waste expert as necessary.
3.3.3	Quarry rock should be geochemically characterised. The likely presence of fibrous minerals and asbestiform minerals should be reviewed based on the geology.

Requirements

3.3.4 If the mineral waste is soil or dredged material ensure it is analysed. Site specific soil or dredge spoil management plans should be developed and followed.

3.3.5 Ensure background surface water quality information is collected (at a suitable frequency to build up the data). Make recommendations for site groundwater and surface water monitoring based on enriched elements identified by Resource Evaluation.

3.3.6 Make recommendations for monitoring of drinking water bores that potentially contain asbestiform material.

3.3.7 Provide advice for monitoring, management and analysis of mineral waste risks that are flagged by the Resource Evaluation and EP project environment groups.

Water Resource Evaluation

See Item 3.1.1.

3.3.8 For temporary water bores (< 3 months of use) that intersected sulfidic or black shale material in a location that will not be 100% submerged by water at all times (i.e. the black shale will have some exposure to oxygen) one representative sample should be collected and analysed for the appropriate water chemistry.

Compare the results to the relevant ANZECC (2000) or background water chemistry. A hydrogeologist should review the results and determine if the likely ongoing water quality is suitable for purpose. Measurements of pH and EC are regularly collected and are assessed to determine if results are acceptable and do not increase significantly over the period that water is extracted. If EC concentrations increase significantly, collect another full water chemistry sample should be collected.

3.3.9 For permanent water extraction bores that intercept sulfides or black shale in a location that will not be 100% submerged by water at all times (i.e. the black shale will have some exposure to oxygen), measure the full water chemistry during pump testing. Collect a sample 1 hour after the test begins and 1 hour before it finishes. Analyse for the appropriate water chemistry.

Prior to commissioning the bore, determine if the water is of acceptable quality. A hydrogeologist should review the results and determine if the likely ongoing water quality is suitable for purpose. Permanent water bores should be analysed for full water chemistry once a year.

3.3.10 For each new deposit that is assessed in pre-feasibility, ensure sufficient groundwater samples are collected to represent the background water quality and spatial variability at the site. Enough samples should be collected to represent seasonal variability.

3.3.11 See Item 3.1.5. Determine if there is a risk of intersecting fibrous minerals and if so ensure the appropriate drilling methods and precautions are taken, complying with the relevant SWPs and site management plans. Enter data into acQuire such that it is captured in new models that are developed for the site. Information on fibre occurrence should be sent to the relevant Health and Safety Advisor/Divisional Ventilation Officer for notification to the DMP District Inspector.

3.3.12 Based on the geochemistry of drillhole data collected by Resource Evaluation, determine the geochemical risk of any enriched contaminants in the waste and ore.

- Background and surrounding environment
- Lithology chemistry
- Spatial Distribution
- Chemical Enrichment
- Acid Base Accounting

Geotechnical Drilling

See Item 3.3.11

3.3.13 See Item 3.1.1. Collect waste samples that are in the mining zone for standard assaying.

3.3.14 If de-pressurisation horizontal dewatering is required (in black shale or sulfidic detritals/BIF) alert the Mineral Waste Management team so an AMD risk assessment can be undertaken.

Resources Studies and Technology

Requirement to consult with the SCARD Management Plan for dump specifications, dump locations and open pit closure.

Requirements	
3.3.15	Designs should attempt to minimise potential BS, sulfidic material or fibrous mineral intersection impacts and costs.
3.3.16	Use Reserve models to predict production volumes for potential acid forming and fibrous material.
3.3.17	Mine plans must estimate hot and cold BS production or sulfidic material production if the sulfides are not in MCS. Quantities should be compared to inert waste production to ensure that sufficient material will be available for dump construction. See the Category S and Category SR dump specifications in the SCARD Management Plan for operations. The tonnes of material with neutralising potential (i.e. calcrete in detritus and dolomite in the Wittenoom Formation) should also be estimated.
3.3.18	Ensure that dumps of black shale or sulfidic material (in BIF or detritals) are sited to minimise long term environmental impacts and financial liabilities. Ensure that appropriate Environment, Hydrogeology, and Hydrology groups have been consulted before finalisation of designs.
3.3.19	Ensure that final pit and dump designs are consistent with the requirements of the SCARD Management Plan for operations or existing site-specific fibrous mineral management plans. If management plans do not exist consult with EP Environment or a mineral waste expert. Obtain signoff from Environment, Hydrogeology, and Hydrology.
3.3.20	Estimate the extent of sulfidic material exposures on final pit walls.
Study	
3.3.21	During feasibility studies at the latest, financial analyses must include the additional costs associated with any mineral waste management
Closure Planning	
3.3.22	In consultation with stakeholders identify a closure vision, final landform plan and post-closure land use option. Closure studies should consider long term mineral waste risks in the knowledge base.
3.4	**Feasibility**
Geology	
	See Section 3.2: Pre-Feasibility
Resources Studies and Technology	
	See Section 3.2: Pre-Feasibility
Water Resource Evaluation/Geotechnical Drilling	
	See Section 3.2: Pre-Feasibility
Metallurgy	
3.4.1	Perform test work to determine the geochemical composition of likely fine and coarse process wastes to be produced from the ore of any new development.
Environment	
3.4.2	Review long term planning waste dump designs to ensure the long term environmental impact is minimised.
3.4.3	Review final pit and dump designs to ensure consistency with the SCARD Management Plan and the RTIO (WA) Mineral Waste Management Plan (this plan).
3.4.4	If existing management plans cannot be used, commission the development of an ARD, fibrous mineral, or other geochemical risk site specific management plans, as required.
Study	
3.4.5	See Item 3.3.21
3.5	**Mine Site Development**
Study	
3.5.1	Any material that is excavated from the site for fill or for the placement of mine infrastructure should be assessed geochemically. This material should also be assessed for the likely presence of fibrous minerals. If fibrous minerals may be present then a fibrous mineral management plan should be developed and applied during the excavation.

Requirements	
3.6	**Expansion Projects General Requirements**
Environment	
3.6.1	Ensure that Section 3 of this management plan is periodically refined and updated so that it is consistent with current best practice and other management plans and procedures. Any changes to this plan need to be approved by the RTIO Mineral Waste steering committee before it is accepted as final.
3.6.2	Coordinate a technical review of Expansion Studies compliance with this mineral waste management plan every two years. It will be sufficient to review 1 case study plus a general review of procedures and practices.
3.6.3	Develop, maintain and present a mineral waste training package on relevant aspects of this management plan to all groups involved with mineral waste management in Expansion Studies.
Study	
3.6.4	If there are a significant number of mineral waste related actions, develop a study mineral waste working group which meet on a monthly basis to discuss implementation of this management plan, progress, issues and the way forward. Agenda items and meeting minutes should be produced. Draw in expertise into this group from other RTIO, RT and external business units as necessary.

4 Requirements, Accountabilities and References for Operating Mine Sites

The mineral waste management plan for an operating mine site has been written with the following assumptions:

- No sulfidic material is put through processing plants (i.e. fresh FWZ from Southern Ridge at Tom Price); and
- Sulfides, fibrous minerals and process wastes are the only mineral waste risks in the Hamersley Group geology that require special management.

If there is a change to any of these assumptions then this management plan will need to be revised.

Requirements

4.1 Planning

Resources Studies and Technology

4.1.1 Ensure inert waste disposal facilities are located in accordance with the Pilbara Iron Landform Design Guidelines and sulfidic waste in accordance with the SCARD Management Plan. To minimise long term environmental impacts and financial liability the waste disposal design should:

- Be safe and stable;
- Be considered aesthetically compatible with the surrounding landscape;
- support native vegetation;
- be free draining and non-polluting;
- be compatible with agreed post mining land use; and
- be rehabilitated progressively.

4.1.2 In pit disposal should be considered as a priority over out of pit dumping. Especially mineral waste with suitably identified geochemical risks should be preferably dumped in pit.

4.1.3 Plan and design works for final inert waste rock dump surfaces and inactive open pits in a manner consistent with Pilbara Iron Landform guidelines and the Rehabilitation Handbook. Plan and design works for final sulfidic waste rock dump surfaces and inactive open pits in a manner consistent with the SCARD Management Plan.

4.1.4 All land disturbance projects must consider topsoil recovery and storage in accordance with the Soil Resource Management Plan.

4.1.5 Life of Mine Plans and Reserve models must include estimates of waste production by the different material types. Material with negligible risk can be grouped together however material with higher risk (i.e. fibrous minerals and sulfides) should be separated. The life of mine plan for overburden storage should include financial analysis of the different closure options.

4.1.6 Any material flagged with a geochemical or fibrous mineral risk should be managed in accordance with a specific management plan including the RTIO (WA) SCARD Management Plan for black shale.

4.1.7 Final pit walls for mine closure must be designed with consideration of geotechnical stability. An abandonment bund outside the zone of geotechnical stability should be included in the design.

Closure Planning

See Item 3.3.21

4.1.8 Review and update the closure management plan with significant changes to the knowledge base and cost estimates.

4.1.9 Undertake a comprehensive technical review of the closure management plan and ensure the review and plan is externally audited.

Technical Services/Site Planning

4.1.10 Five year plans should include estimates for the first two years:

- The material type, volume and source location of waste (pit by pit), separating out material with a mineral waste risk (i.e. fibrous minerals and sulfides) or neutralising potential;

Requirements

- The volume of process wastes;
- Waste dump locations, footprint and dump capacity;
- Pit and waste dump development strategies – land bridges;
- Clearance areas, topsoil volumes and dump locations;
- Available rehabilitation areas

Plans should be saved in the document management system and relevant stakeholders should be informed of their location. Any waste with a geochemical (see Section 3.1.7) or fibrous mineral risk (see Section 3.1.12) should be flagged as a different material type and waste volumes need to be calculated.

4.1.11 Medium term mine plans (current year + 2 i.e. 0-3 years) should be developed quarterly and include:

- Approval request status and action plan
- The material type, volume and source of waste (by pit), separating out material with a mineral waste risk (i.e. fibrous minerals and sulfides) or neutralising material;
- The volume of process wastes;
- Waste dump locations, footprint and dump capacity;
- Pit and waste dump development strategies;
- Clearance areas, topsoil and subsoil volumes and stockpile locations; and
- Available rehabilitation areas.

Any waste with a geochemical (see Section 3.1.7) or fibrous mineral risk (see Section 3.1.12) should be flagged as a different material type and waste volumes need to be calculated.

4.1.12 Short term plans (3 months) should detail:

- Material type, volume and source location of the waste (pit by pit), separating out material with a mineral waste risk (i.e. fibrous minerals and sulfides) or neutralising material;
- The volume of process wastes;
- Waste dump locations, 'footprint' and dump capacity;
- Pit and waste dump development strategies;
- As-built designs incorporated into the Mine Design Program; and
- Topsoil and subsoil volumes, source locations and stockpile locations.

Any waste with a geochemical (see Section 3.1.7) or fibrous mineral risk (see Section 3.1.12) should be flagged as a different material type and waste volumes need to be calculated.

4.1.13 Plan and design works for final inert waste rock dump surfaces and inactive open pits in a manner consistent with Pilbara Iron Landform guidelines and the Rehabilitation Handbook. Plan and design works for final sulfidic waste rock dump surfaces and inactive open pits in a manner consistent with the SCARD Management Plan.

4.1.14 All land disturbance projects should consider topsoil and subsoil recovery and storage in accordance with the Soil Resource Management Plan.

Mine Geology

4.1.15 Sulfidic material should be characterised according to the SCARD Management Plan and relevant SWPs.

4.1.16 Representative samples from each waste type (including process wastes) reflecting the spatial, physical and volumetric variation should be analysed for solid and liquid extract geochemistry. The samples should represent the spatial and volumetric variability of the lithology in the deposit and should not just be collected from the 1 location in 1 batch. Results should be compared to trigger concentrations and that of the previous year to ensure that they are consistent with the modelled geochemical characteristics of the waste (reactive or inert).

4.1.17 Undertake systematic geochemical characterisation of new materials (new rock types, changed ore mix or type, changed processing or deposition).

4.1.18 Undertake waste material characterisation through the process of blast hole logging and sampling. Waste grade blocks should be generated in the Mine Design Program based on the Mine Geology

Requirements

System (MGS) material type logging and assay results and should be saved in the production database (TPPS). All waste shots that do not have a geochemical risk (currently only sulfides in black shale, BIF and detritals have known risks) or fibrous mineral risk should be tagged by destination as 'W'. Sulfidic material should be tagged according to the SCARD Management Plan and fibrous minerals need to be managed according to the site-specific fibrous mineral management plans.

4.1.19 Examine any material that is suspected of containing fibrous minerals and follow the site-specific fibrous mineral management plans.

Water Resource Evaluation

4.1.20 For pits that intersect the water table, compile a 'Pit Conceptual Model'.

4.1.21 Determine the geochemical risk of the pit. Update the report for any significant changes.

4.1.22 Geochemical, hydrogeology and hydrology modelling to determine contaminant release from the pit should be undertaken if the report (in Item 4.1.20) finds a significant geochemical risk (i.e. a significant amount of sulfidic material exposed on the pit wall, a significant amount of dewatering occurring over many years, a likely saline and flow through water body etc).

4.1.23 A conceptual model should be completed for waste dumps where material with a mineral waste risk will be stored. Geochemical models should be undertaken if a significant risk is identified.

Operational Planning

4.1.24 Create a "Waste Dump Progression Plan" at least every three months to implement the detailed dump designs in the field.

4.1.25 Create "PLOD" sheets to aid dig operators in waste assignment and ensure the Fleet Dispatch Program is working.

4.1.26 In conjunction with the Rehabilitation Specialist and the Life of Mine team plan and implement rehabilitation works for the final

4.1.27 Monitor and adjust to reconcile rehabilitation designs with as built specifications as appropriate.

4.1.28 Track material placement so that the mass of inert waste, sulfidic waste, material with the potential to contain fibrous minerals, or any other material with geochemical risks delivered to each dump or impoundment is recorded. Record this information within Fleet Dispatch Program.

4.1.29 Perform field inspections to ensure waste is placed as required in dump designs from site planning.

Environment

4.1.30 With assistance of a mineral waste specialist where necessary, analyse the solid and liquid extract geochemistry results that are collected every two years by Mine Geology. If there is deemed to be a geochemical risk in a waste material type then further analytical work should be undertaken and a management plan should be written.

4.1.31 Develop, maintain and present a mineral waste training package on relevant aspects of this management plan to all groups involved with mineral waste management in active operating mine sites. Every 2 years present the training package with assessment of individual's competencies for recording within the Rio Tinto compliance database.

4.1.32 Identify the waste storage facilities at each site that contain mineral waste with a potential geochemical risk to the surrounding environment. The risk of waste within the dump leaching contaminants into the surrounding environment should be assessed and if a risk is identified consult a Mineral Waste expert. Column leach tests may be required to further investigate the risk.

4.1.33 For material identified in 4.1.32 with a mineral waste risk (i.e. sulfidic waste or waste containing fibrous minerals) compile a 'Conceptual Model' that considers the environmental risk.

4.1.34 A geochemical model should be created and updated as required for process waste/wet tailings dams.

4.1.35 Ensure that Section 4 of this management plan is periodically refined and updated so that it is consistent with current best practice and other management plans and procedures. Any changes to this plan need to be approved by the RTIO Mineral Waste steering committee before it is accepted as final.

4.2 Monitoring

Environment

4.2.1 Organise a once off independent and external review of major inert waste storage facilities. High risk

Requirements

facilities (i.e. sulfidic waste or waste containing fibrous minerals) should be reviewed every 4 years for compliance with the operational component of this management plan, SCARD Management Plan, the RTIO (WA) Fibrous Minerals Management Plan and site specific management plans. Process wastes/tailings audits are arranged by the plant manager and are excluded from this. Significant issues/actions are to be tracked internally.

4.2.2 Determine the environmental risk of the sites mineral waste based on the geochemical characterisation undertaken by the geologists. Consult a recognised mineral waste expert as required. If a mineral waste risk is identified organise the development of a management plan or modification to the SCARD Management Plan.

4.2.3 Monitor the groundwater levels and water chemistry surrounding geochemically reactive waste facilities and all process wastes/tailings facilities. Advise relevant operations personnel if there are significant changes or non compliance. All monitoring data should be stored in a user friendly database and assigned a unique sample number and sampling date.

4.2.4 Groundwater monitoring should be increased (spatially and temporally) as is deemed necessary in response to any groundwater changes.

4.2.5 Ensure that routine sampling and visual inspection is performed on dewatering discharges and any other water (including water bodies) that may occasionally discharge off site i.e. some tailings facilities. Advise relevant operational personnel if there are significant changes or new non-compliances. All monitoring data should be stored in a user friendly database and assigned a unique sample number and sampling date. Ensure problems are rectified.

4.2.6 Annually investigate the long term trends in water quality. Significant changes in water quality, infiltration rate or other key parameters should be investigated and mitigation actions should be instituted if required.

4.2.7 Perform field inspections to ensure sump construction, rehabilitation and store and release cover performance is consistent with the requirements of the RTIO (WA) Landform guidelines, Rehabilitation Handbook and SCARD Management Plan.

4.2.8 Monitor topsoil in accordance with the Soil Resource Management Plan.

4.2.9 Review annually the quantity of material with geochemical risk in each waste dump (i.e. sulfidic waste, waste containing fibrous minerals, and process wastes/tailings).

Water Resource Evaluation

4.2.10 For sites where water quality issues have been identified, investigate the long term trends in water quality.

Geotechnical

4.2.11 Undertake a regular waste dump audit (active and inactive dumps) to assess conformance to design, impacts on infrastructure and emergency access. Any hazards identified should be reported to Mine Operations.

4.2.12 Monitor the stability of pit wall excavations during operations and make recommendations to long term planners for stable pit walls on mine closure.

4.2.13 Inspect process waste/tailings storage facilities monthly. Record any non-conformities as incidents in the Rio Tinto compliance database. Recommend remedial action for any non-conformities. Distribute summaries of the monitoring results for the month and observations of any movements which may have occurred to Shift Supervisors and Superintendents at the plant.

4.2.14 Perform non-routine inspections of the process waste/tailings facility following a heavy rainfall event.

Follow the procedure specified in the site process waste/tailings operating manual.

Pit

4.2.15 Undertake remedial work for actions that arise from the quarterly geotechnical stability audit of waste dumps undertaken by Technical Services. Ensure there is continual follow up of remedial actions.

Plant/Process Wastes

4.2.16 Annually report on the tonnes of coarse and fine process wastes produced to the site environment advisor.

4.2.17 Ensure an independent (of design and ongoing management) audit and review of the wet tailings storage facility occurs annually. External reviews should occur every 2 years. Audit findings and

Requirements	
	recommended actions should be provided to the Plant Manager for distribution and action.
4.2.18	Undertake remedial work for actions arising from the monthly geotechnical stability audits and the annual external audit of the tailings facilities. Ensure there is continual tracking of remedial actions in the Rio Tinto compliance database.
4.2.19	Maintain a current operating plan for the wet tailings storage facility.
4.2.20	Inspect wet tailings facilities at least once per shift and complete a site specific inspection log. Record any non-conformities as incidents in the Rio Tinto compliance database.
4.2.21	Prior to entering the wet tailings facility cell for repairs to pumps or pipes the protocol in the site tailings operating manual should be followed.
4.2.22	Ensure the wet tailings facility is regularly maintained in accordance with the site process waste/tailings operating plan.
4.2.23	Maintain a tailings dam failure emergency plan.
4.2.24	Undertake progressive rehabilitation where possible.
4.2.25	Update the tailings management plan as required.
ALL	
4.2.26	Any significant modifications in mineral waste generation, handling and disposal processes should be accompanied by a change management process. Changes need to be made to this document by the Site Environment Advisor who will need to ensure the document is approved by the RTIO Mineral Waste steering committee.