EPBC 6003/2011

A – Referral Documentation

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

Referral of proposed action

What is a referral?

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides for the protection of the environment, especially matters of national environmental significance (NES). Under the EPBC Act, a person must not take an action that has, will have, or is likely to have a significant impact on any of the matters of NES without approval from the Australian Government Environment Minister or the Minister's delegate. (Further references to 'the Minister' in this form include references to the Minister's delegate.) To obtain approval from the Environment Minister, a proposed action should be referred. The purpose of a referral is to obtain a decision on whether your proposed action will need formal assessment and approval under the EPBC Act.

Your referral will be the principal basis for the Minister's decision as to whether approval is necessary and, if so, the type of assessment that will be undertaken. These decisions are made within 20 business days, provided that sufficient information is provided in the referral.

Who can make a referral?

Referrals may be made by or on behalf of a person proposing to take an action, the Commonwealth or a Commonwealth agency, a state or territory government, or agency, provided that the relevant government or agency has administrative responsibilities relating to the action.

When do I need to make a referral?

A referral must be made for actions that are likely to have a significant impact on the following matters protected by Part 3 of the EPBC Act:

- World Heritage properties (sections 12 and 15A)
- National Heritage places (sections 15B and 15C)
- Wetlands of international importance (sections 16 and 17B)
- Listed threatened species and communities (sections 18 and 18A)
- Listed migratory species (sections 20 and 20A)
- Protection of the environment from nuclear actions (sections 21 and 22A)
- Commonwealth marine environment (sections 23 and 24A)
- Great Barrier Reef Marine Park (sections 24B and 24C)
- The environment, if the action involves Commonwealth land (sections 26 and 27A), including:
    - actions that are likely to have a significant impact on the environment of Commonwealth land (even if taken outside Commonwealth land);
    - actions taken on Commonwealth land that may have a significant impact on the environment generally;
- The environment, if the action is taken by the Commonwealth (section 28)
- Commonwealth Heritage places outside the Australian jurisdiction (sections 27B and 27C)

You may still make a referral if you believe your action is not going to have a significant impact, or if you are unsure. This will provide a greater level of certainty that Commonwealth assessment requirements have been met.

To help you decide whether or not your proposed action requires approval (and therefore, if you should make a referral), the following guidance is available from:

- the Policy Statement titled Significant Impact Guidelines 1.1 – Matters of National Environmental Significance. Additional sectoral guidelines are also available.
- the Policy Statement titled Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies.

- the interactive map tool (enter a location to obtain a report on what matters of NES may occur in that location).

Can I refer part of a larger action?

In certain circumstances, the Minister may not accept a referral for an action that is a component of a larger action and may request the person proposing to take the action to refer the larger action for consideration under the EPBC Act (Section 74A, EPBC Act). If you wish to make a referral for a staged or component referral, read 'Fact Sheet 6 Staged Developments/Split Referrals' and contact the Referral Business Entry Point (1800 803 772).

Do I need a permit?

Some activities may also require a permit under other sections of the EPBC Act or another law of the Commonwealth. Information is available on the Department's web site.

Is your action in the Great Barrier Reef Marine Park?

If your action is in the Great Barrier Reef Marine Park it may require permission under the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act). If a permission is required, referral of the action under the EPBC Act is deemed to be an application under the GBRMP Act (see section 37AB, GBRMP Act). This referral will be forwarded to the Great Barrier Reef Marine Park Authority (the Authority) for the Authority to commence its permit processes as required under the Great Barrier Reef Marine Park Regulations 1983. If a permission is not required under the GBRMP Act, no approval under the EPBC Act is required (see section 43, EPBC Act). The Authority can provide advice on relevant permission requirements applying to activities in the Marine Park.

The Authority is responsible for assessing applications for permissions under the GBRMP Act, GBRMP Regulations and Zoning Plan. Where assessment and approval is also required under the EPBC Act, a single integrated assessment for the purposes of both Acts will apply in most cases. Further information on environmental approval requirements applying to actions in the Great Barrier Reef Marine Park is available from http://www.gbrmpa.gov.au/ or by contacting GBRMPA's Environmental Assessment and Management Section on (07) 4750 0700.

The Authority may require a permit application assessment fee to be paid in relation to the assessment of applications for permissions required under the GBRMP Act, even if the permission is made as a referral under the EPBC Act. Further information on this is available from the Authority:

Great Barrier Reef Marine Park Authority

2-68 Flinders Street PO Box 1379
Townsville QLD 4810
AUSTRALIA

Phone: + 61 7 4750 0700
Fax: + 61 7 4772 6093

www.gbrmpa.gov.au

What information do I need to provide?

Completing all parts of this form will ensure that you submit the required information and will also assist the Department to process your referral efficiently.

You can complete your referral by entering your information into this Word file.

Instructions

Instructions are provided in green text throughout the form.

Attachments/supporting information

The referral form should contain sufficient information to provide an adequate basis for a decision on the likely impacts of the proposed action. You should also provide supporting documentation, such as environmental reports or surveys, as attachments.

Coloured maps, figures or photographs to help explain the project and its location should also be submitted with your referral. Aerial photographs, in particular, can provide a useful perspective and context. Figures should be good quality as they may be scanned and viewed electronically as black and white documents. Maps should be of a scale that clearly shows the location of the proposed action and any environmental aspects of interest.

Please ensure any attachments are below two megabytes (2mb) as they will be published on the Department's website for public comment. To minimise file size, enclose maps and figures as separate files if necessary. If unsure, contact the Referral Business Entry Point for advice. Attachments larger than two megabytes (2mb) may delay processing of your referral.

Note: the Minister may decide not to publish information that the Minister is satisfied is commercial-in-confidence.

How do I submit a referral?

Referrals may be submitted by mail, fax or email.

Mail to:

Referral Business Entry Point
Environment Assessment Branch
Department of Sustainability, Environment, Water, Population and Communities
GPO Box 787
CANBERRA ACT 2601

- If submitting via mail, electronic copies of documentation (on CD/DVD or by email) are appreciated.

Fax to: 02 6274 1789

- Faxed documents must be of sufficiently clear quality to be scanned into electronic format.
- Address the fax to the mailing address, and clearly mark it as a 'Referral under the EPBC Act'.
- Follow up with a mailed hardcopy including copies of any attachments or supporting reports.

Email to: epbc.referrals@environment.gov.au

- Clearly mark the email as a 'Referral under the EPBC Act'.
- Attach the referral as a Microsoft Word file and, if possible, a PDF file.
- Follow up with a mailed hardcopy including copies of any attachments or supporting reports.

What happens next?

Following receipt of a valid referral (containing all required information) you will be advised of the next steps in the process, and the referral and attachments will be published on the Department's web site for public comment.

The Department will write to you within 20 business days to advise you of the outcome of your referral and whether or not formal assessment and approval under the EPBC Act is required. There are a number of possible decisions regarding your referral:

The proposed action is NOT LIKELY to have a significant impact and does NOT NEED approval

No further consideration is required under the environmental assessment provisions of the EPBC Act and the action can proceed (subject to any other Commonwealth, state or local government requirements).

The proposed action is NOT LIKELY to have a significant impact IF undertaken in a particular manner

The action can proceed if undertaken in a particular manner (subject to any other Commonwealth, state or local government requirements). The particular manner in which you must carry out the action will be identified as part of the final decision. You must report your compliance with the particular manner to the Department.

The proposed action is LIKELY to have a significant impact and does NEED approval

If the action is likely to have a significant impact a decision will be made that it is a *controlled action*. The particular matters upon which the action may have a significant impact (such as World Heritage values or threatened species) are known as the *controlling provisions*.

The controlled action is subject to a public assessment process before a final decision can be made about whether to approve it. The assessment approach will usually be decided at the same time as the controlled action decision. (Further information about the levels of assessment and basis for deciding the approach are available on the Department's web site.)

The proposed action would have UNACCEPTABLE impacts and CANNOT proceed

The Minister may decide, on the basis of the information in the referral, that a referred action would have clearly unacceptable impacts on a protected matter and cannot proceed.

Compliance audits

If a decision is made to approve a project, the Department may audit it at any time to ensure that it is completed in accordance with the approval decision or the information provided in the referral. If the project changes, such that the likelihood of significant impacts could vary, you should write to the Department to advise of the changes. If your project is in the Great Barrier Reef Marine Park and a decision is made to approve it, the Authority may also audit it. (See "*Is your action in the Great Barrier Reef Marine Park,"* p.2, for more details).

For more information

- call the Department of Sustainability, Environment, Water, Populations and Communities Community Information Unit on 1800 803 772 or
- visit the web site www.environment.gov.au/epbc

All the information you need to make a referral, including documents referenced in this form, can be accessed from the above web site.

Referral of proposed action

Project title:

Forrestania Nickel Project (FNP) – Spotted Quoll-Cosmic Boy Haul Road

1 Summary of proposed action

NOTE: You must also attach a map/plan(s) showing the location and approximate boundaries of the area in which the project is to occur. Maps in A4 size are preferred. You must also attach a map(s)/plan(s) showing the location and boundaries of the project area in respect to any features identified in 3.1 & 3.2, as well as the extent of any freehold, leasehold or other tenure identified in 3.3(i).

1.1 **Short description**

Western Areas NL (WANL) operates the Forrestania Nickel Project (FNP) in the Goldfields of Western Australia (Figure 1). WANL proposes to develop a haul road between the Spotted Quoll Open Pit operation and the Cosmic Boy processing plant (Figure 2). The haul road will be approximately 15.8 km in length, 5.7 km of which follows an existing 3 m wide track.

1.2 **Latitude and longitude**

Latitude and longitude details are used to accurately map the boundary of the proposed action. If these coordinates are inaccurate or insufficient it may delay the processing of your referral.

	Latitude			Longitude		
location point	degrees	minutes	seconds	degrees	minutes	seconds
Start (at Spotted Quoll)	32	35	2.612	119	44	30.88
	32	35	6.104	119	44	14.487
	32	35	5.786	119	43	58.363
	32	35	5.364	119	43	51.065
	32	35	4.373	119	43	43.839
	32	35	0.551	119	43	29.522
	32	34	56.519	119	43	20.275
	32	34	50.174	119	43	10.026
	32	34	42.331	119	43	0.801
	32	34	36.611	119	42	55.692
	32	34	4.496	119	42	42.994
	32	33	46.008	119	42	42.075
	32	32	23.645	119	42	38.39
	32	32	10.026	119	42	37.77
	32	31	48.633	119	42	36.551
	32	31	28.517	119	42	35.999
	32	31	12.953	119	42	35.281
	32	31	4.85	119	42	34.81
	32	31	1.283	119	42	34.665
	32	30	41.829	119	42	33.716
	32	30	31.776	119	42	33.309
	32	29	53.192	119	42	31.556
	32	29	40.552	119	42	28.844
	32	29	20.423	119	42	13.686
	32	29	15.146	119	42	6.044
	32	28	58.699	119	41	33.07
	32	28	58.123	119	41	32.305
	32	28	57.225	119	41	30.096
Finish (at Cosmic Boy)	32	28	43.649	119	41	2.713

The Interactive Mapping Tool may provide assistance in determining the coordinates for your project area.

If area less than 5 hectares, provide the location as a single pair of latitude and longitude references. If area greater than 5 hectares, provide bounding location points.

If the proposed action is linear (eg. a road or pipeline), provide coordinates for each turning point.

Do not use AMG coordinates.

1.3 **Locality and property description**

Provide a brief physical description of the property on which the proposed action will take place and the project location (eg. proximity to major towns, or for off-shore projects, shortest distance to mainland).

The FNP is located within the Shire of Kondinin, Western Australia. The project is situated approximately 160 kilometres south of Southern Cross and 80 kilometres east of Hyden (Figure 2). The proposed haul road will be constructed on Mining Leases 77/583, 77/584, 77/586, 77/587, 77/588, 77/589, 77/399 which are 100% owned by WANL.

1.4 **Size of the development footprint or work area (hectares)**

Tenement	Haul road (ha) (includes surface drainages)	Topsoil stockpiles (ha)	Vegetation stockpiles (ha)	Gravel Pit (ha)	Total disturbance (ha)	Clearing required (ha)
M77/583	5.80	0.52	0.03		**6.35**	**5.61***
M77/584	0.50	0.03	0.03	2.99	**3.55**	**3.54**
M77/586	5.45	0.3	0.03	0.01	**5.79**	**5.78**
M77/587	5.30	0.6	0.03		**5.93**	**5.61***
M77/588	4.58	0.3	0.03		**4.91**	**4.90**
M77/589	7.69	0.6	0.03		**8.32**	**8.01***
M77/399	5.69	0.55	0.03		**6.27**	**5.16***
TOTAL	**35.01**	**2.99**	**0.21**	**3.00**	**41.12**	**38.61**

Table 1. Disturbance (ha) in each mining tenement

The haul road will be approximately 15.8 km long and 13 m wide. The total area of disturbance including associated infrastructure will be a maximum of 41.12 ha with only 38.61 ha of clearing required (Table 1).

1.5 **Street address of the site**

Forrestania Nickel Project
Marvel Loch – Forrestania Road
Forrestania
Western Australia

1.6 **Lot description**

Describe the lot numbers and title description, if known.

The haul road will occur within the mining tenements listed in Table 2 and shown in Figure 2.

Table 2. Tenements within disturbance area

AREA	HOLDER	SIZE
M77/583	Western Areas NL	989 ha
M77/584	Western Areas NL	961 ha
M77/586	Western Areas NL	845 ha
M77/587	Western Areas NL	975 ha
M77/588	Western Areas NL	992 ha
M77/589	Western Areas NL	903 ha
M77/399	Western Areas NL	890 ha

1.7 **Local Government Area and Council contact (if known)**

If the project is subject to local government planning approval, provide the name of the relevant council contact officer.

The Shire of Kondinin: Peter Webster (CEO).

1.8 **Time frame**

Specify the time frame in which the action will be taken including the estimated start date of construction/operation.

Pending statutory approvals, the construction of the haul road is planned to commence at the end of 2011 and will take approximately 3 – 4 months to construct.

1.9	**Alternatives to proposed action** Were any feasible alternatives to taking the proposed action (including not taking the action) considered but are not proposed?		No
		X	Yes, you must also complete section 2.2
1.10	**Alternative time frames etc** Does the proposed action include alternative time frames, locations or activities?	X	No
			Yes, you must also complete Section 2.3. For each alternative, location, time frame, or activity identified, you must also complete details in Sections 1.2-1.9, 2.4-2.7 and 3.3 (where relevant).
1.11	**State assessment** Is the action subject to a state or territory environmental impact assessment?		No
		X	Yes, you must also complete Section 2.5 A Mining Proposal will be submitted to the Western Australian Department of Mines and Petroleum for approval
1.12	**Component of larger action** Is the proposed action a component of a larger action?	X	No
			Yes, you must also complete Section 2.7
1.13	**Related actions/proposals** Is the proposed action related to other actions or proposals in the region (if known)?		No
		X	Yes, provide details: WANL owns the Spotted Quoll open pit and underground mine to the north of the proposed haul road and Cosmic Boy processing plant to the south of the proposed haul road.
1.14	**Australian Government funding** Has the person proposing to take the action received any Australian Government grant funding to undertake this project?	X	No
			Yes, provide details:
1.15	**Great Barrier Reef Marine Park** Is the proposed action inside the Great Barrier Reef Marine Park?	X	No
			Yes, you must also complete Section 3.1 (h), 3.2 (e)

2 Detailed description of proposed action

NOTE: It is important that the description is complete and includes all components and activities associated with the action. If certain related components are not intended to be included within the scope of the referral, this should be clearly explained in section 2.7.

2.1 Description of proposed action

This should be a detailed description outlining all activities and aspects of the proposed action and should reference figures and/or attachments, as appropriate.

WANL are currently mining the Flying Fox underground mine and the Spotted Quoll Open Pit. WANL also operate a processing plant and Tailings Storage Facility (TSF) at Cosmic Boy and have commenced development of the Diggers South mining project at Digger Rocks.

In April 2011, WANL commenced development of the Spotted Quoll underground mine. Currently ore is being hauled by truck, via a mix of public and "on-lease" roads to be processed at WANL's Cosmic Boy nickel concentrator. The number of loaded cycles on these roads has increased significantly over the past 24 months and will continue to do so as all three mines reach maximum production levels.

WANL propose to construct a 15.8 km haul road between the Spotted Quoll mine and Cosmic Boy processing plant. The road will be 13 m wide and is designed to allow two-way traffic for double road trains and light vehicle traffic at a maximum speed of 80 km/hr. This haul road will remove haul trucks from currently used public roads. Pending statutory approvals, the construction of the haul road is planned to commence in the second half of 2011 and will take approximately 3 - 4 months to construct.

2.2 Alternatives to taking the proposed action

This should be a detailed description outlining any feasible alternatives to taking the proposed action (including not taking the action) that were considered but are not proposed (note, this is distinct from any *proposed* alternatives relating to location, time frames, or activities – see section 2.3).

An alternative to constructing the haul road would be to continue using the public and 'on-lease' roads. Public safety is being compromised by the increased heavy vehicular use of these roads.

2.3 Alternative locations, time frames or activities that form part of the referred action

If you have identified that the proposed action includes alternative time frames, locations or activities (in section 1.10) you must complete this section. Describe any alternatives related to the physical location of the action, time frames within which the action is to be taken and alternative methods or activities for undertaking the action. For each alternative location, time frame or activity identified, you must also complete (where relevant) the details in sections 1.2-1.9, 2.4-2.7, 3.3 and 4. Please note, if the action that you propose to take is determined to be a controlled action, any alternative locations, time frames or activities that are identified here may be subject to environmental assessment and a decision on whether to approve the alternative.

Not applicable.

2.4 Context, planning framework and state/local government requirements

Explain the context in which the action is proposed, including any relevant planning framework at the state and/or local government level (e.g. within scope of a management plan, planning initiative or policy framework). Describe any Commonwealth or state legislation or policies under which approvals are required or will be considered against.

There are no State planning provisions applicable to this project. The haul road will be constructed and operated under the provisions of the *Mining Act 1978.*

WANL will comply with the provisions in applicable Acts and regulations which include but are not limited to the following:

- *Aboriginal Heritage Act 1972.*
- *Conservation and Land Management Act 1984.*

- *Dangerous Goods Safety Act 2004.*
- *Environmental Protection Act 1986 (and Administrative Procedures 1993).*
- *Environmental Protection (Noise) Regulations 1997.*
- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004.*
- *Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).*
- *Heritage of Western Australia Act 1990.*
- *Land Administration Act 1997.*
- *Local Government Act 1995.*
- *Local Government (Miscellaneous Provisions) Act 1960.*
- *Native Title Act 1973 (Commonwealth).*
- *National Greenhouse and Energy Reporting Act 2007 (Commonwealth).*
- *Occupation Safety and Health Act 1984.*
- *Rights in Water and Irrigation Act 1914.*
- *Wildlife Conservation Act 1950.*

2.5 Environmental impact assessments under Commonwealth, state or territory legislation

If you have identified that the proposed action will be or has been subject to a state or territory environmental impact statement (in section 1.11) you must complete this section. Describe any environmental assessment of the relevant impacts of the project that has been, is being, or will be carried out under state or territory legislation. Specify the type and nature of the assessment, the relevant legislation and the current status of any assessments or approvals. Where possible, provide contact details for the state/territory assessment contact officer.

Describe or summarise any public consultation undertaken, or to be undertaken, during the assessment. Attach copies of relevant assessment documentation and outcomes of public consultations (if available).

A Mining Proposal for the proposed haul road was submitted to the Department of Mines and Petroleum for approval under the *Mining Act 1978* on the 21 April 2011.

2.6 Public consultation (including with Indigenous stakeholders)

Your referral must include a description of any public consultation that has been, or is being, undertaken. Where Indigenous stakeholders are likely to be affected by your proposed action, your referral should describe any consultations undertaken with Indigenous stakeholders. Identify the relevant stakeholders and the status of consultations at the time of the referral. Where appropriate include copies of documents recording the outcomes of any consultations.

Consultation has been undertaken with Sandra Thomas from the Department of Environment and Conservation (Wheatbelt Region) and with representatives from the Ballardong Native Title Claimant group.

In June 2010, WANL commissioned Gleason and Associates to undertake an archaeological and ethnographical survey along the proposed Spotted Quoll-Cosmic Boy haul road with representatives of the Ballardong Native Title Claimants. No Aboriginal heritage sites or ethnographic sites of significance were recorded during the survey.

A confidential report was prepared and provided to the Department of Indigenous Affairs.

2.7 A staged development or component of a larger project

If you have identified that the proposed action is a component of a larger action (in section 1.12) you must complete this section. Provide information about the larger action and details of any interdependency between the stages/components and the larger action. You may also provide justification as to why you believe it is reasonable for the referred action to be considered separately from the larger proposal (eg. the referred action is 'stand-alone' and viable in its own right, there are separate responsibilities for component actions or approvals have been split in a similar way at the state or local government levels).

Not applicable.

3 Description of environment & likely impacts

3.1 Matters of national environmental significance

Describe the affected area and the likely impacts of the proposal, emphasising the relevant matters protected by the EPBC Act. Refer to relevant maps as appropriate. The interactive map tool can help determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in your area of interest.

Your assessment of likely impacts should refer to the following resources (available from the Department's web site):

- specific values of individual World Heritage properties and National Heritage places and the ecological character of Ramsar wetlands;
- profiles of relevant species/communities (where available), that will assist in the identification of whether there is likely to be a significant impact on them if the proposal proceeds;
- *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance*; and
- associated sectoral and species policy statements available on the web site, as relevant.

Note that even if your proposal will not be taken in a World Heritage area, Ramsar wetland, Commonwealth marine area, the Great Barrier Reef Marine Park or on Commonwealth land, it could still impact upon these areas (for example, through downstream impacts). Consideration of likely impacts should include both direct and indirect impacts.

3.1 (a) World Heritage Properties

Description

No World Heritage Properties are listed for the proposed project area.

Nature and extent of likely impact

Address any impacts on the World Heritage values of any World Heritage property.

3.1 (b) National Heritage Places

Description: Natural

Great Western Woodlands of Western Australia

Nature and extent of likely impact

Address any impacts on the National Heritage values of any National Heritage place.

The area proposed to be disturbed comprises a linear track up to 15.8 km long with a width of 13 to 20 m. Total disturbance including the area compromising the existing track, borrow pit and area for stockpiles is estimated at 41.12 ha. The proposed haul road is located between two existing mining operations (Spotted Quoll and Cosmic Boy). The Great Western Woodlands extends over an area of approximately 16 million ha. The area proposed for disturbance represents less than 0.0008% of the Great Western Woodlands.

3.1 (c) Wetlands of International Importance (Declared Ramsar wetlands)

Description

No wetlands of International Importance are located within, or near to, the project area.

Nature and extent of likely impact

Address any impacts on the World Heritage values of any World Heritage property.

3.1 (d) Listed threatened species and ecological communities

Description

There are no listed Threatened Ecological Communities listed in the project area. The EPBC Act Protected Matters report lists:

- three threatened bird species,
- two threatened mammals species,
- five migratory bird species,
- seven threatened plant species, and
- one place on the Register of National Estate (Table 3).

Table 3: Results from EPBC Act Protected Matters Tool

Birds	Common Name	Status
Acanthiza iredalei iredalai	Slender-billed Thornbill	Vulnerable
Calyptorhynchus latirostris	Carnaby's Cockatoo	Endangered
Leipoa ocellata	Malleefowl	Vulnerable
Mammals		
Dasyurus geoffroii	Chuditch	Vulnerable
Phascogale calura	Red-tailed Phascogale	Endangered
MIGRATORY SPECIES		
Migratory Marine Birds		
Apus pacificus	Fork-tailed Swift	
Ardea modesta (alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Migratory Terrestrial Species		
Leipoa ocellata	Malleefowl	Vulnerable
Merops ornatus	Rainbow Bee-eater	
Migratory Wetland Species		
Ardea modesta(alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Listed Marine Species		
Apus pacificus	Fork-tailed Swift	
Ardea modesta(alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Merops ornatus	Rainbow Bee-eater	
Plants		
Acacia lanuginophylla	Woolly Wattle	Endangered
Banksia sphaerocarpa var. *dolichostyla*	Ironcap Banksia	Vulnerable
Boronia revoluta	Ironcap Boronia	Endangered
Eremophila viscida	Varnish Bush	Endangered
Eucalyptus steedmanii	Steedman's Gum	Vulnerable
Grevillea involucrata	Lake Varley Grevillea	Endangered
Roycea pycnophylloides	Saltmat	Endangered

Nature and extent of likely impact

Address any impacts on the members of any listened threatened species (except a conservation dependent species) or any threatened ecological community, or their habitat.

Comprehensive fauna and flora surveys have been conducted for the proposed haul road (Biota 2010, KLA 2011 and Botanica Consulting 2011). Of the species listed above in Table 3, the following species or evidence of their presence have been recorded in the vicinity of the proposed haul road area (Table 4).

Table 4: Species (or evidence of presence) recorded during surveys

Birds	**Common Name**
Calyptorhynchus latirostris	Carnaby's Cockatoo
Leipoa ocellata	Malleefowl
Mammals	
Dasyurus geoffroii	Chuditch
Plants	
Eucalyptus steedmanii	Steedman's Gum
Migratory Terrestrial Species	
Leipoa ocellata	Malleefowl

The nature and extent of likely impacts is addressed for each species in the Spotted Quoll – Cosmic Boy Haul Road Supplement to EPBC Referral Document which is attached as Attachment 1.

3.1 (e) Listed migratory species

Description

Five migratory species, or species' habitat, were identified as likely to occur within the area (Table 5).

Table 5: Migratory species recorded for the area

Species	**Common Name**	**Status**
Migratory Marine Birds		
Apus pacificus	Fork-tailed Swift	
Ardea modesta(alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Migratory Terrestrial Species		
Leipoa ocellata	Malleefowl	Vulnerable
Merops ornatus	Rainbow Bee-eater	
Migratory Wetland Species		
Ardea modesta(alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Listed Marine Species		
Apus pacificus	Fork-tailed Swift	
Ardea modesta(alba)	Great Egret, White Egret	

Ardea ibis	Cattle Egret	
Merops ornatus	Rainbow Bee-eater	

Nature and extent of likely impact

Address any impacts on the members of any listed migratory species, or their habitat.

It is not likely that the construction and establishment of the haul road is likely to have any impact on these migratory species. Please refer to Attachment 1 for details.

3.1 (f) Commonwealth marine area

(If the action is in the Commonwealth marine area, complete 3.2(c) instead. This section is for actions taken outside the Commonwealth marine area that may have impacts on that area.)

Description

There are no Commonwealth marine areas located near the project areas that may be affected by the proposal.

Nature and extent of likely impact

Address any impacts on any part of the environment in the Commonwealth marine area.

3.1 (g) Commonwealth land

(If the action is on Commonwealth land, complete 3.2(d) instead. This section is for actions taken outside Commonwealth land that may have impacts on that land.)

Description
If the action will affect Commonwealth land also describe the more general environment. The Policy Statement titled *Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies* provides further details on the type of information needed. If applicable, identify any potential impacts from actions taken outside the Australian jurisdiction on the environment in a Commonwealth Heritage Place overseas.

No commonwealth land is located within the project area.

Nature and extent of likely impact

Address any impacts on any part of the environment in the Commonwealth land. Your assessment of impacts should refer to the *Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies* and specifically address impacts on:
- ecosystems and their constituent parts, including people and communities;
- natural and physical resources;
- the qualities and characteristics of locations, places and areas;
- the heritage values of places; and
- the social, economic and cultural aspects of the above things.

3.1 (h) The Great Barrier Reef Marine Park
Description

Not applicable

Nature and extent of likely impact

Address any impacts on any part of the environment of the Great Barrier Reef Marine Park.

Note: If your action occurs in the Great Barrier Reef Marine Park you may also require permission under the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act). If so, section 37AB of the GBRMP Act provides that your referral under the EPBC Act is deemed to be an application under the GBRMP Act and Regulations for necessary permissions and a single integrated process will generally apply. Further information is available at www.gbrmpa.gov.au

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3.2 Nuclear actions, actions taken by the Commonwealth (or Commonwealth agency), actions taken in a Commonwealth marine area, actions taken on Commonwealth land, or actions taken in the Great Barrier Reef Marine Park

You must describe the nature and extent of likely impacts (both direct & indirect) on the whole environment if your project:
- is a nuclear action;
- will be taken by the Commonwealth or a Commonwealth agency;
- will be taken in a Commonwealth marine area;
- will be taken on Commonwealth land; or
- will be taken in the Great Barrier Reef marine Park.

Your assessment of impacts should refer to the *Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies* and specifically address impacts on:
- ecosystems and their constituent parts, including people and communities;
- natural and physical resources;
- the qualities and characteristics of locations, places and areas;
- the heritage values of places; and
- the social, economic and cultural aspects of the above things.

3.2 (a)	**Is the proposed action a nuclear action?**	X	No
			Yes (provide details below)

If yes, nature & extent of likely impact on the whole environment

3.2 (b)	**Is the proposed action to be taken by the Commonwealth or a Commonwealth agency?**	X	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment		

3.2 (c)	**Is the proposed action to be taken in a Commonwealth marine area?**	X	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(f))		

3.2 (d)	**Is the proposed action to be taken on Commonwealth land?**	X	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(g))		

3.2 (e)	**Is the proposed action to be taken in the Great Barrier Reef Marine Park?**	X	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(h))		

3.3 Other important features of the environment

Provide a description of the project area and the affected area, including information about the following features (where relevant to the project area and/or affected area, and to the extent not otherwise addressed above). If at Section 2.3 you identified any alternative locations, time frames or activities for your proposed action, you must complete each of the details below (where relevant) for each alternative identified.

3.3 (a) Flora and fauna

A search of the Department of Environment and Conservation (DEC) Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) revealed there are three Priority 3 PEC's located in the region: North Ironcap, Middle Ironcap and South Ironcap (Figure 3). These PEC's relate to the vegetation complexes located on the Ironcap hills in the region.

3.3 (b) Hydrology, including water flows

Twenty catchment areas were identified along the course of the haul road with several creek crossings of varying sizes along the road alignment (See Attachment 5).

3.3 (d) Outstanding natural features

There are no outstanding natural features present within the project area.

3.3 (e) Remnant native vegetation

The vegetation within the survey area comprise Beard Vegetation Associations 511 ' Medium woodland; Salmon Gum and Morrel' and 1413 ' Shrublands '*Acacia, Casuarina* and *Melaleuca* thicket (Table 6).

Greater than 70% of the original pre-European extent of these vegetation associations remains with 17-19% represented in DEC managed lands.

Table 6 - Beard Vegetation Associations (DEC 2009)

Beard Vegetation Association	Current Extent (ha)	Pre-European extent (ha)	Remaining (%)	Current extent in DEC managed lands (%)
511 Medium woodland; Salmon Gum and Morrel	499,599.71	700,409.58	71.33	19.35
1413 Shrublands; *Acacia*, *Casuarina* and *Melaleuca* thicket	1,252,585.65	1,679,916.99	74.56	17.28

The majority of the proposed haul road lies within Vegetation Association 511 and a small portion (<1 km in length) is located within Vegetation Association 1413 at the southern extent of the haul road within M77/399. The vegetation proposed to be disturbed for the proposed haul road represents <0.0001% of both Vegetation Associations.

3.3 (f) Gradient (or depth range if action is to be taken in a marine area)

The area has low relief and lies 300 to 500 metres above sea level. Forrestania lies within the Salt Lake or Salinaland physiographic division, which includes most of the Wheatbelt region of Western Australia. This division is characterised by chains of salt lakes, which are relic river systems. Normally the salt lakes act as surface water sinks, but in exceptionally wet years, floodwater moves along the palaeodrainages.

The majority of the project area is on relatively flat land (gradient between 0.5 to 1.5%) intersecting occasional laterite ridges with steeper gradients (up to 3%).

3.3 (g) Current state of the environment

Include information about the extent of erosion, whether the area is infested with weeds or feral animals and whether the area is covered by native vegetation or crops.

The area proposed for the haul road comprises remnant vegetation including the following disturbance areas:

- Spotted Quoll Open Pit at the northern extent,
- Processing Plant and TSF at Cosmic Boy at the southern extent,
- Existing access track approximately 3 m wide and 5.7 km along the length of the proposed haul road route.

Comprehensive fauna and flora surveys have been conducted recently for the proposed haul road (Botanica Consulting 2011, Biota 2010 and KLA 2011) these reports have been attached as Attachments 2, 3 and 4 respectively.

The condition of the vegetation was assessed using the condition rating scale of Keighery (1994). In accordance with Keighery (1994), the condition of the vegetation in one of the eleven vegetation groups and three sub-groups was "Degraded", the condition of the vegetation in three was determined to be "Good" and the condition of the vegetation in the remaining vegetation groups was deemed to be "Very Good". No vegetation was considered in "Excellent" or "Pristine" condition (Botanica Consulting 2011). Overall, the condition rating of the vegetation was determined to be "Very Good".

Two weed species, as defined by Florabase (WAHERB, 2011), were recorded, neither of which are classified as Declared Weeds by the Department of Agriculture and Food of Western Australia (DAFWA, 2009).

For the fauna, *Vulpes vulpes* Red Fox, *Felis catus* House Cat, *Mus musculus* House mouse and *Oryctolagus cuniculus* European Rabbit have been recorded in the proposed haul road area.

3.3 (h) Commonwealth Heritage Places or other places recognised as having heritage values

There are no Commonwealth Heritage Places present within the project area.

Lake Cronin Class A Nature Reserve is listed on the Register of National Estate and is recognised as an Environmentally Significant Area (ESA) under the *Environmental Protection Act 1986.* The Reserve is located approximately 2.5 km from the northern section of the proposed haul road.

3.3 (i) Indigenous heritage values

Previous archaeological and ethnographic surveys have been undertaken within the Forrestania project area with no sites of Aboriginal significance recorded for the area.

In June 2010, WANL commissioned Gleason and Associates to undertake an archaeological and ethnographical survey along the proposed Spotted Quoll-Cosmic Boy haul road with representatives of the Ballardong Native Title Claimants. No Aboriginal heritage sites or ethnographic sites of significance were recorded during the survey.

A confidential report was prepared and provided to the Department of Indigenous Affairs.

3.3 (j) Other important or unique values of the environment

Describe any other key features of the environment affected by, or in proximity to the proposed action (for example, any national parks, conservation reserves, wetlands of national significance etc).

There are no other important or unique values of the environment present within the project area.

3.3 (k) Tenure of the action area (eg freehold, leasehold)

The project area is located within Mining Leases 77/399, 77/589, 77/588, 77/587, 77/586, 77/584 and 77/583 which are 100% owned by WANL.

3.3 (l) Existing land/marine uses of area

The current land uses for the project area includes Unoccupied Crown Land (UCL), and mining and mineral exploration.

3.3 (m) Any proposed land/marine uses of area

The proposed land use for the area is mining.

4 Measures to avoid or reduce impacts

Note: If you have identified alternatives in relation to location, time frames or activities for the proposed action at Section 2.3 you will need to complete this section in relation to each of the alternatives identified.

Provide a description of measures that will be implemented to avoid, reduce, manage or offset any relevant impacts of the action. Include, if appropriate, any relevant reports or technical advice relating to the feasibility and effectiveness of the proposed measures.

For any measures intended to avoid or mitigate significant impacts on matters protected under the EPBC Act, specify:
- what the measure is,
- how the measure is expected to be effective, and
- the time frame or workplan for the measure.

Examples of relevant measures to avoid or reduce impacts may include the timing of works, avoidance of important habitat, specific design measures, or adoption of specific work practices.

Provide information about the level of commitment by the person proposing to take the action to implement the proposed mitigation measures. For example, if the measures are preliminary suggestions only that have not been fully researched, or are dependent on a third party's agreement (e.g. council or landowner), you should state that, that is the case.

Note, the Australian Government Environment Minister may decide that a proposed action is not likely to have significant impacts on a protected matter, as long as the action is taken in a particular manner (section 77A of the EPBC Act). The particular manner of taking the action may avoid or reduce certain impacts, in such a way that those impacts will not be 'significant'. More detail is provided on the Department's web site.

For the Minister to make such a decision (under section 77A), the proposed measures to avoid or reduce impacts must:
- clearly form part of the referred action (eg be identified in the referral and fall within the responsibility of the person proposing to take the action),
- be must be clear, unambiguous, and provide certainty in relation to reducing or avoiding impacts on the matters protected, and
- must be realistic and practical in terms of reporting, auditing and enforcement.

More general commitments (eg preparation of management plans or monitoring) and measures aimed at providing environmental offsets, compensation or off-site benefits CANNOT be taken into account in making the initial decision about whether the proposal is likely to have a significant impact on a matter protected under the EPBC Act. (But those commitments may be relevant at the later assessment and approval stages, including the appropriate level of assessment, if your proposal proceeds to these stages).

WANL have undertaken extensive investigations into the existing environment of the Forrestania Nickel Project, including comprehensive flora and fauna surveys of the proposed Spotted Quoll-Cosmic Boy Haul Road. In addition, a targeted survey was undertaken for four species of conservation significance and their habitat along the route of the proposed haul road. These species included the Chuditch, Malleefowl, Carnaby's Cockatoo and Western Rosella, the latter of which is listed under the *Wildlife Conservation Act 1950* as a Schedule 1 species: Rare and likely to become extinct (Attachment 4).

WANL is committed to mitigation plans and measures to reduce or minimise any impact on the environment and all threatened species and their habitat that may possibly be affected by the construction of the haul road and associated disturbances.

The following measures will be adopted to ensure that the project proceeds with minimal impacts on matters of national environmental significance.

General

In October 2008, the Spotted Quoll Mining Proposal was referred to the then Department of Environment, Water, Heritage and the Arts (DEWHA) and the project was determined to be a 'controlled action'. Approval for the Spotted Quoll Mining Project was issued following approval of a Chuditch Conservation Plan and a Malleefowl Conservation Plan (Attachments 5 and 6).

The project will be subject to Western Australia's mining approvals process under the *Mining Act 1978*.

Protected Species of conservation significance
The following actions have/will be taken:

- *Increase onsite awareness*
  Onsite awareness will be increased to minimise accidental damage to the species or species habitat. This will be undertaken through implementation of the following measures:
  - Environmental induction for all personnel before entering site and/or commencing the haul road project.
  - Regular reminders at presentations, tool box meetings etc of the value of remnant vegetation and habitat for species of conservation significance.
  - Adequate signage erected to alert personnel of the potential for species of conservation significance to occur within the area.

- *Identification of potential sensitive sites*
  Prior to commencement of construction activities, clearing boundaries will be clearly marked with purpose-made signage. Environmental staff will oversee the critical stages of the development to make sure that no matters of national interest are impacted more than absolutely necessary.

- *Restrict vegetation disturbance*
  Vegetation disturbance will be minimised by undertaking the following steps:
  - The clearing corridor will be kept to a minimum.
  - Areas of vegetation disturbed temporarily during the construction of the haul road will be rehabilitated as soon after construction as practicable.
  - No driving off road and no incursions into native vegetation.

- *Feral Animal Control Programme*
  WANL will continue with the feral animal control measures implemented to protect native fauna from competition and predation. Strategies include the following:
  - Implementing a feral animal control programme to reduce predation and competition of native fauna.
  - Annual 1080 baiting will occur at strategic locations around Cosmic Boy Camp, Spotted Quoll and along the length of the haul road.
  - Local rubbish tips near Cosmic Boy and Spotted Quoll are fenced and compacted with soil regularly to limit the availability of edible waste to both feral and native animals.

- *Workforce/Site restrictions*
  WANL's implemented restrictions at the mine site and associated roads to reduce the risk of damaging potential habitat will continue and will include the area of the proposed new haul road. These include:
  - Restricted vehicular access to established tracks only.
  - Limited speed limits appropriate to the area and potential fauna habitat.

- *DRF Monitoring programmes*

  WANL will continue to undertake weekly visual observations of *E. steedmanii* populations closest to the haul road. Based on monitoring results to date, no deterioration in the health of the populations has been observed. Given these results, WANL are preparing to reduce the frequency of the monitoring of the populations to monthly (to be discussed with DEC). Written and photographic records are kept of the visual inspections of plant condition.

WANL has and will continue to undertake dust monitoring at each *E. steedmanii* population and control locations. These monitors are analysed monthly and results correlated with visual plant health observations. WANL will continue to complete regular monitoring of *E. steedmanii* populations as per the monitoring commitments in the existing DRF management plan.

5 Conclusion on the likelihood of significant impacts

Identify whether or not you believe the action is a controlled action (ie. whether you think that significant impacts on the matters protected under Part 3 of the EPBC Act are likely) and the reasons why.

5.1 Do you THINK your proposed action is a controlled action?

X	No, complete section 5.2
	Yes, complete section 5.3

5.2 Proposed action IS NOT a controlled action.

Specify the key reasons why you think the proposed action is NOT LIKELY to have significant impacts on a matter protected under the EPBC Act.

WANL considers that the Spotted Quoll-Cosmic Boy Haul Road does not constitute a controlled action as defined by the EPBC Act 1999 as it will not impact on:

- World Heritage Property;
- National Heritage Place;
- Wetlands of International Significance;
- Commonwealth Marine Areas;
- Threatened Ecological Communities;
- Is not a nuclear action;
- Does not affect Commonwealth Land; and
- Is not being implemented by a Commonwealth Agency.

The distribution and likelihood of each species of conservation significance occurring in and surrounding the project area is detailed in Attachment 1.

The vegetation complexes and fauna habitat located within the project area are not limited to the proposed haul road route and extend beyond the zone of impact. Given the narrow linearity of the area proposed for disturbance, the development of a haul road between Spotted Quoll and Cosmic Boy is unlikely to have a significant impact on the habitat potential for Carnaby's Cockatoo, Chuditch or Malleefowl and is unlikely to alter the conservation status of any of these species.

No DRF will be directly impacted by the development of the haul road. WANL currently implements a DRF Management Plan for *E. steedmanii* which incorporates management and monitoring procedures to protect these populations (Attachment 1). All aspects of the haul road construction and operation will continue to be undertaken in accordance with this Management Plan.

In consideration of the management strategies identified to be implemented, the proposal will have minimal potential impact on matters of national environmental significance and is therefore not considered to be a controlled action.

5.3 Proposed action IS a controlled action

Type 'x' in the box for the matter(s) protected under the EPBC Act that you think are likely to be significantly impacted. (The 'sections' identified below are the relevant sections of the EPBC Act.)

	Matters likely to be impacted
	World Heritage values (sections 12 and 15A)
	National Heritage places (sections 15B and 15C)
	Wetlands of international importance (sections 16 and 17B)
	Listed threatened species and communities (sections 18 and 18A)
	Listed migratory species (sections 20 and 20A)

	Protection of the environment from nuclear actions (sections 21 and 22A)
	Commonwealth marine environment (sections 23 and 24A)
	Great Barrier Reef Marine Park (sections 24B and 24C)
	Protection of the environment from actions involving Commonwealth land (sections 26 and 27A)
	Protection of the environment from Commonwealth actions (section 28)
	Commonwealth Heritage places overseas (sections 27B and 27C)

Specify the key reasons why you think the proposed action is likely to have a significant adverse impact on the matters identified above.

6 Environmental record of the responsible party

NOTE: If a decision is made that a proposal needs approval under the EPBC Act, the Environment Minister will also decide the assessment approach. The EPBC Regulations provide for the environmental history of the party proposing to take the action to be taken into account when deciding the assessment approach.

		Yes	No
6.1	**Does the party taking the action have a satisfactory record of responsible environmental management?** **Provide details** WANL's operations are inspected regularly (generally on an annual basis but this varies) by both the DMP and the DEC. Inspections involve checking the operational performance of the project against tenement and operating license conditions set for the project.	X	
6.2	**Has either (a) the party proposing to take the action, or (b) if a permit has been applied for in relation to the action, the person making the application - ever been subject to any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources?** **If yes, provide details**		X
6.3	**If the party taking the action is a corporation, will the action be taken in accordance with the corporation's environmental policy and planning framework?** **If yes, provide details of environmental policy and planning framework** WANL has a site Environmental Management Plan active across the whole site which prescribes management strategies to be undertaken to mitigate any environmental impacts identified. Regular (monthly) environmental inspections are undertaken and an incidents and actions register is kept updated on a weekly basis. Site environmental procedures manual is also being developed. WANL will undertake all actions in accordance with its Environmental Policy	X	
6.4	**Has the party taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?**	X	

Provide name of proposal and EPBC reference number (if known) WANL has previously referred an action under the EPBC Act. Details for this are as follows: **Referral: #** 2008/4443 **Title:** *Forrestania Nickel Project – Develop a Nickel Sulphide Open Cut Mine, Underground Mine and Associated Infrastructure Environmental Protection and Biodiversity Conservation Act 1999 Referral* **Referral #:** 2006/2904 **Title:** *Forrestania Nickel Project Flying Fox T5 and water pipeline Environmental Protection and Biodiversity Conservation Act 1999 Referral*		

7 Information sources and attachments

(For the information provided above)
To be updated/completed

7.1 References

- List the references used in preparing the referral.
- Highlight documents that are available to the public, including web references if relevant.

Department of Agriculture and Food, 2009.

DEC (2009). *CAR Reserve Analysis.* Department of Environment and Conservation WA.

Department of Sustainability, Environment, Water, Population and Communities (2011). *Leipoa ocellata* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 5 Apr 2011 15:24:22 +1000

Department of Sustainability, Environment, Water, Population and Communities (2011). *Acanthiza iredalei iredalei* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 5 Apr 2011 16:02:38 +1000.

Department of Sustainability, Environment, Water, Population and Communities (2011). *Phascogale calura* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 5 Apr 2011 17:14:11 +1000.

Department of Sustainability, Environment, Water, Population and Communities (2011). *Boronia revoluta* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 5 Apr 2011 18:24:16 +1000.

Descriptions by the Western Australian Herbarium, Department of Environment and Conservation. Text used with permission (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Tuesday, 5 April 2011.

Keighery, B. J. (1994). *Bushland Plant Survey; A guide to plant community survey for the community.* Wildflower Society of Western Australia (Inc.), Nedlands.

KLA (2010). *Spotted Qoll Project – Targeted Malleefowl Survey.* Unpublished report, December 2010. Keith Lindbeck and Associates, Perth, WA.

7.2 Reliability and date of information

For information in section 3 specify:

- source of the information;
- how recent the information is;
- how the reliability of the information was tested; and
- any uncertainties in the information.

Source of the information:
All information supplied in this referral submission was taken from the references listed in *Section 7.1*, and information gathered as part of the compilation of the Spotted Quoll-Cosmic Boy Haul Road mining proposal and Spotted Quoll EPBC Referral document (Attachment 1).

How recent is the information:
All information supplied in this submission use the most recent sources, which are the most current and up-to-date to the best of WANL's knowledge.

Reliability of information used in compiling this submission
All information supplied has been compiled as part of the Spotted Quoll-Cosmic Boy Haul Road mining proposal and Spotted Quoll EPBC Referral. The information contained in the surveys has been prepared by qualified consultants, and only authenticated references have been used.

Uncertainties in the information
Specifications related to the project may be subject to change if/when more information becomes available regarding the requirements of the project; these will not affect the potential impacts of the proposal.

7.3 Attachments

Indicate the documents you have attached. All attachments must be less than two megabytes (2mb) so they can be published on the Department's website. Attachments larger than two megabytes (2mb) may delay the processing of your referral.

		✓ attached	Title of attachment(s)
You must attach	figures, maps or aerial photographs showing the project locality (section 1)	✓	Figures 1 and 2
	figures, maps or aerial photographs showing the location of the project in respect to any matters of national environmental significance or important features of the environments (section 3)	✓	Figure 3
If relevant, attach	copies of any state or local government approvals and consent conditions (section 2.5)	N/A	
	copies of any completed assessments to meet state or local government approvals and outcomes of public consultations, if available (section 2.6)	N/A	
	copies of any flora and fauna investigations and surveys (section 3)	✓	Attachment 1: Spotted Quoll-Cosmic Boy Haul Road Supplement to the EPBC Referral Attachment 2: Spotted Quoll/Cosmic Boy Haul Road Flora and Vegetation Survey Attachment 3: Spotted Quoll Haul Road Single Phase Fauna Survey Attachment 4:– Spotted Quoll – Cosmic Boy Haul Road Targeted Fauna Survey
	technical reports relevant to the assessment of impacts on protected matters that support the arguments and conclusions in the referral (section 3 and 4)	✓	Attachment 5 – Waterway Crossings and Roadside Drainage Requirements
	report(s) on any public consultations undertaken, including with Indigenous stakeholders (section 3)	N/A	Confidential report - may be supplied be request

8 Contacts, signatures and declarations

NOTE: Providing false or misleading information is an offence punishable on conviction by imprisonment and fine (s 489, EPBC Act).

Under the EPBC Act a referral can only be made by:

- the person proposing to take the action (which can include a person acting on their behalf); or
- a Commonwealth, state or territory government, or agency that is aware of a proposal by a person to take an action, and that has administrative responsibilities relating to the action[1].

Project title:

8.1 Person proposing to take action

This is the individual, government agency or company that will be principally responsible for, or who will carry out, the proposed action.

If the proposed action will be taken under a contract or other arrangement, this is:

- the person for whose benefit the action will be taken; or
- the person who procured the contract or other arrangement and who will have principal control and responsibility for the taking of the proposed action.

If the proposed action requires a permit under the Great Barrier Reef Marine Park Act[2], this is the person requiring the grant of a GBRMP permission.

The Minister may also request relevant additional information from this person.

If further assessment and approval for the action is required, any approval which may be granted will be issued to the person proposing to take the action. This person will be responsible for complying with any conditions attached to the approval.

If the Minister decides that further assessment and approval is required, the Minister must designate a person as a proponent of the action. The proponent is responsible for meeting the requirements of the EPBC Act during the assessment process. The proponent will generally be the person proposing to take the action[3].

Name	Dan Lougher
Title	Operations Director
Organisation	Western Areas N.L.
ACN / ABN (if applicable)	ABN: 68 091 049 357 ACN: 091 049 357
Postal address	Western Areas N.L. Suite 3, Level 1 11 Ventnor Avenue WEST PERTH WA 6005

[1] *If the proposed action is to be taken by a Commonwealth, state or territory government or agency, section 8.1 of this form should be completed. However, if the government or agency is aware of, and has administrative responsibilities relating to, a proposed action that is to be taken by another person which has not otherwise been referred, please contact the Referrals Business Entry Point (1800 803 772) to obtain an alternative contacts, signatures and declarations page.*

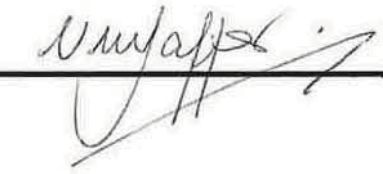
[2] *If your referred action, or a component of it, is to be taken in the Great Barrier Reef Marine Park the Minister is required to provide a copy of your referral to the Great Barrier Reef Marine Park Authority (GBRMPA) (see section 73A,* EPBC Act*). For information about how the GBRMPA may use your information, see http://www.gbrmpa.gov.au/privacy/privacy_notice_for_permits.*

[3] *If a person other than the person proposing to take action is to be nominated as the proponent, please contact the Referrals Business Entry Point (1800 803 772) to obtain an alternative contacts, signatures and declarations page.*

Telephone	(08) 9334 7777
Email	dlougher@westernareas.com.au
Declaration	I declare that the information contained in this form is, to my knowledge, true and not misleading. I agree to be the proponent for this action.
Signature	D.R. Lougher Date 3/6/11

8.2 Person preparing the referral information (if different from 8.1)

Individual or organisation who has prepared the information contained in this referral form.

Name	Keith Lindbeck
Title	Principal
Organisation	Keith Lindbeck & Associates
ACN / ABN (if applicable)	36 150 274 469
Postal address	PO Box 144, Bull Creek WA 6149
Telephone	08 9332 0671
Email	keith@keithlindbeck.com.au
Declaration	I declare that the information contained in this form is, to my knowledge, true and not misleading.
Signature	 Date 03/06/11

REFERRAL CHECKLIST

NOTE: This checklist is to help ensure that all the relevant referral information has been provided. It is not a part of the referral form and does not need to be sent to the Department.

HAVE YOU:

- ☒ Completed all required sections of the referral form?
- ☒ Included accurate coordinates (to allow the location of the proposed action to be mapped)?
- ☒ Provided a map showing the location and approximate boundaries of the project area?
- ☒ Provided a map/plan showing the location of the action in relation to any matters of NES?
- ☒ Provided complete contact details and signed the form?
- ☒ Provided copies of any documents referenced in the referral form?
- ☒ Ensured that all attachments are less than two megabytes (2mb)?
- ☒ Sent the referral to the Department (electronic and hard copy preferred)?


Forrestania Nickel Project
South West of Western Australia
INDIAN OCEAN
SOUTHERN OCEAN
PERTH
MANDURAH
BUNBURY
BUSSELTON
COLLIE
NORTHAM
ALBANY
ESPERANCE
KALGOORLIE- BOULDER
GERALDTON
Mt Magnet
Leonora
Menzies
Southern Cross
Coolgardie
Kambalda
Widgemooltha
Norseman
Esperance
Lake King
Lake Grace
Ravensthorpe
Gibson
Hyden
Narembeen
Merredin
Bonnie Rock
Koolyanobbing
Mukinbudin
Wongan Hills
Koorda
Moora
Dandaragan
Lancelin
Cervantes
Jurien Bay
Leeman
Eneabba
Carnamah
Three Springs
Perenjori
Morawa
Mingenew
Dongara
Port Denison
Northampton
Nabawa
Mullewa
Yalgoo
Paynes Find
Wubin
Dalwallinu
Goomalling
Toodyay
York
Quairading
Beverley
Armadale
Fremantle
Rottnest Island
Garden Island
Brookton
Corrigin
Kondinin
Kulin
Wickepin
Pingelly
Narrogin
Williams
Harvey
Boddington
Pinjarra
Waroona
Wagin
Dumbleyung
Kojonup
Kalanning
Gnowangerup
Jerramungup
Bremer Bay
Cranbrook
Mt Barker
Denmark
Walpole
Augusta
Margaret River
Nannup
Bridgetown
Greenbushes
Manjimup
Pemberton
Busselton
Dunsborough
Capel
Boyanup
Donnybrook
Dardanup
Australind
Binningup
Waroona
Yarloop
Lake Moore
Lake Barlee
Lake Ballard
Lake Deborah East
Lake Deborah West
Lake Dunbar
Lake King
Lake Grace
Lake Magenta
Lake Johnston
Lake Cowan
Lake Lefroy
Lake Carnegie
Lake Mackay
Lake Ninga
Lake Noondie
Mongers Lake
Salmon Gums
Gibson
Hyden
Ravensthorpe
Jerramungup
Gnowangerup
Kojonup
Cranbrook
Mt Barker
Albany
Denmark
Walpole
Pemberton
Manjimup
Nannup
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Jerramungup
Bremer Bay

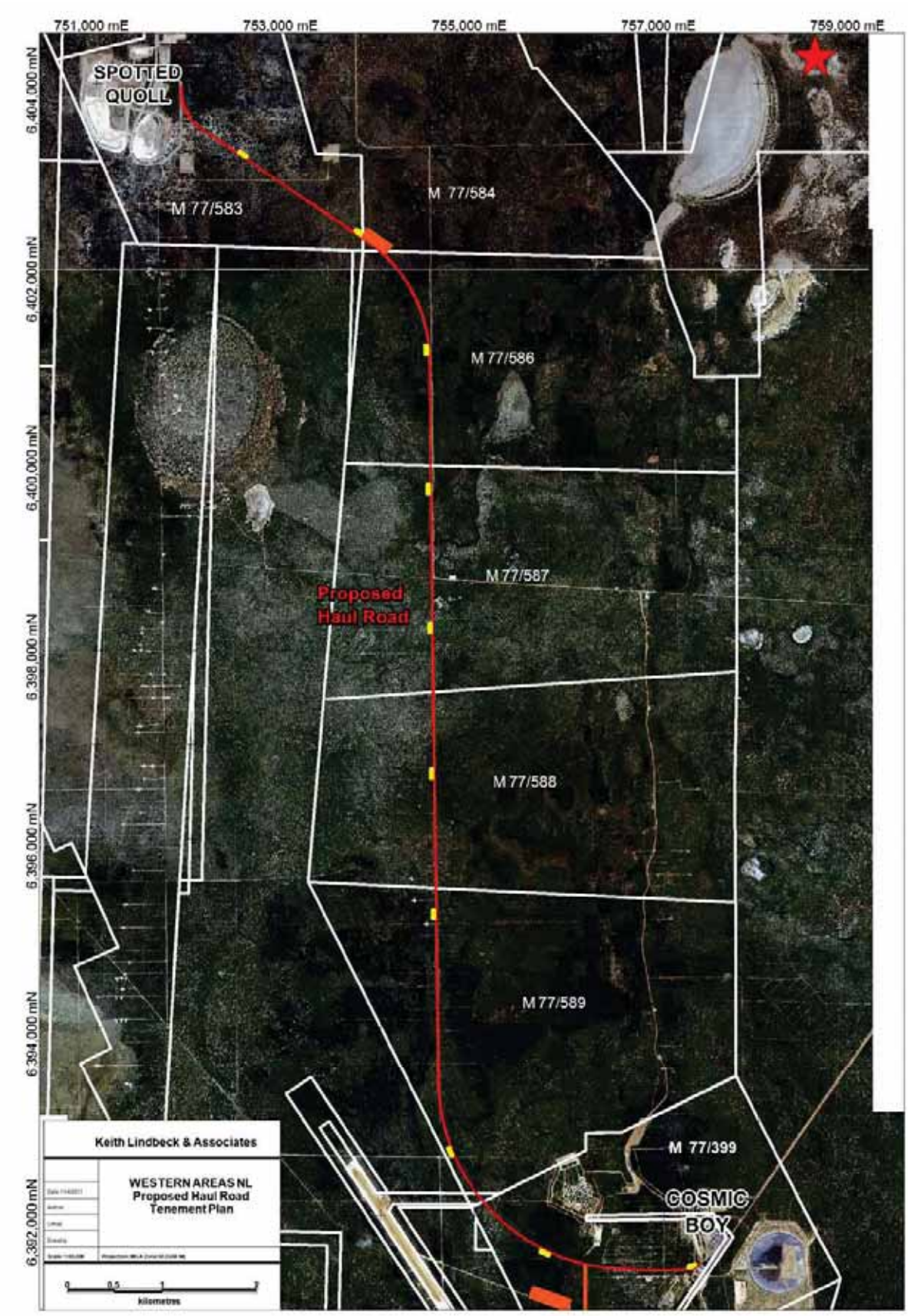


Figure 2 - Proposed Location of Haul Road

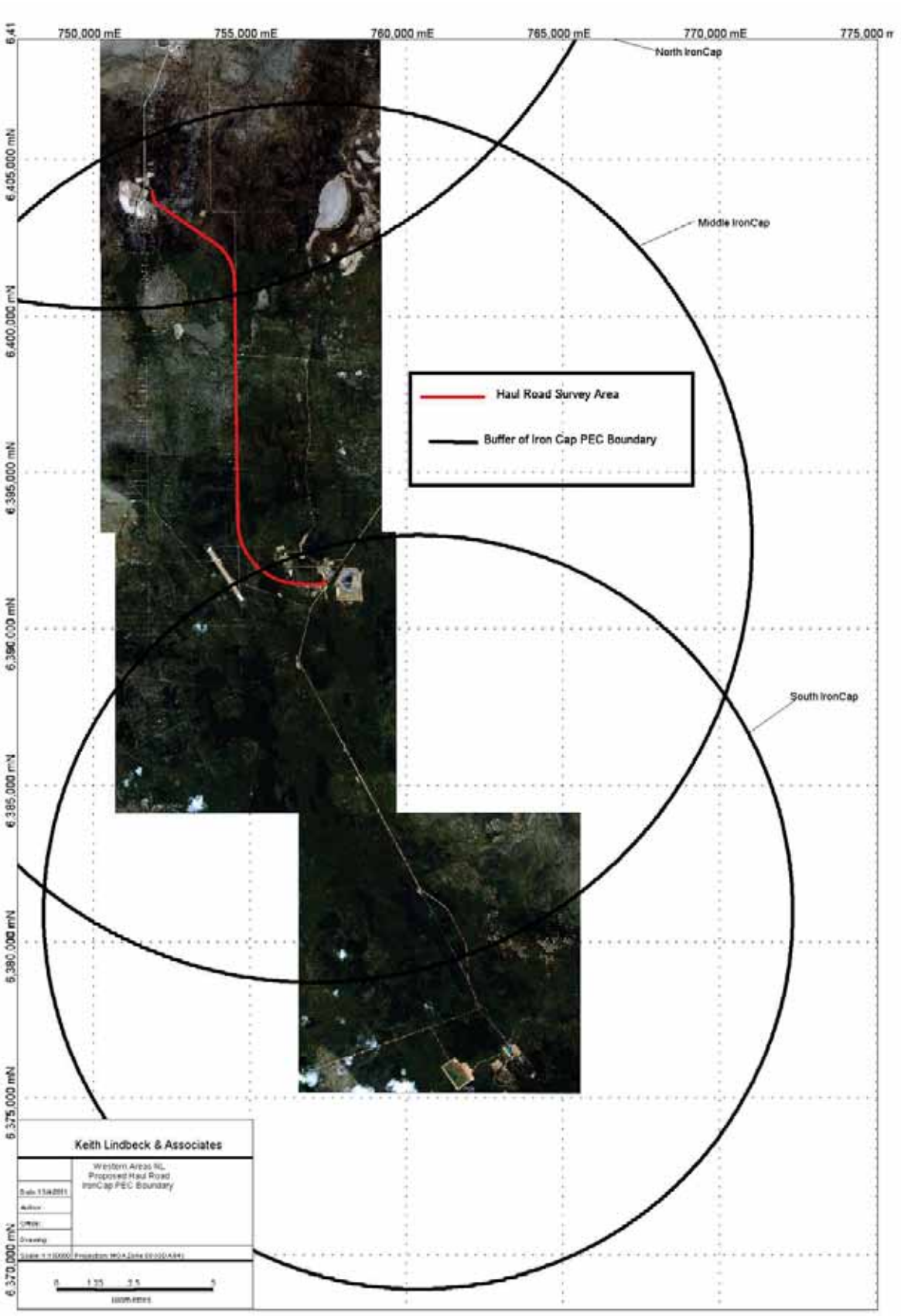


Figure 3 - Location of PEC (with buffer)

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EUCALYPTUS STEEDMANII MANAGEMENT PLAN - SPOTTED QUOLL MINE, SHIRE OF KONDININ

Prepared for:

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1 INTRODUCTION

1.1 Background

Western Areas NL (WSA) proposes to develop an open pit nickel mine at its Spotted Quoll deposit (M77/583) as part of its Forrestania project. Along with the Flying Fox mine (located approximately 6km north of the proposed Spotted Quoll mine) and other deposits under development, WSA aims to be producing 35,000 tonnes of nickel concentrate per annum by 2011.

The proposed Spotted Quoll mine is situated approximately 160 kilometres south of Southern Cross and 80 kilometres east of Hyden in the Shire of Kondinin (Figure 1). The mining operation will be carried out on Mining Leases 77/583 and 77/545 (Figure 2) that are 100% owned by WSA.

The proposed mining operation involves the establishment of an open pit mine. The proposed pit will be approximately 150m deep and 600m long in a north-south alignment. It will have an operational life of four years.

The works associated with the mine will comprise site preparation, operation and rehabilitation (including landform reconstruction).

Pre-mine establishment works will involve the clearing of native vegetation, topsoil stripping, removal of overburden, drainage works and the establishment of haul roads and infrastructure.

Overburden removed from the proposed open cut put area will be used to construct infrastructure such as the run of mine pad, access roads, internal haul roads, ramps, parking bays and the water storage pond. A haul road will be constructed between the Spotted Quoll operation and the Flying Fox mine located 6km to the north.

Approximately 140ha of native vegetation will be removed during the course of the Spotted Quoll mining operation. Clearing in the proposed area of the waste rock stockpile will be undertaken as an incremental process in line with waste dump requirements, which will minimise the length of time that topsoil materials will be stored.

The nickel ore will be removed extracted via open pit mining. The operation will involve:

- Drilling and blasting;
- Excavation of wet ore;
- Haulage of ore to run of mine pad; and
- Loading of ore to road trains for transport to Cosmic Boy concentrator via Flying Fox mine.

No processing of extracted ore will be undertaken at the Spotted Quoll operation. The extracted ore will be transported by road train along a constructed haul road to the Flying Fox mine, and then via a gazetted road (already constructed) to the Cosmic Boy site for processing (Figure 2).

The extraction of the ore will require dewatering of groundwater to lower the groundwater by approximately 130m below ground surface. The mine water will be piped from the Spotted Quoll operation to a settling pond located to the north of the open cut pit and then to the abandoned Lounge Lizard and McMahon's gold pits which is located 1 to 1.5km to the south of Flying Fox mine site via an underground pipeline. The pipeline will be installed within the proposed infrastructure corridor between the Spotted Quoll operation and the Flying Fox mine.

Waste rock will be disposed of in waste rock dumps located to the northwest of the open cut pit.

On completion of mining activities the mine site will be decommissioned and rehabilitated. It is proposed that rehabilitation will be progressively undertaken during mining operations.

Vegetation and flora surveys conducted for WSA by Botanica Consulting (2008 & 2009) identified the presence of Declared Rare Flora (DRF) (*Eucalyptus steedmanii*) adjacent to the proposed mine site.

DRF are 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 (DEC, 2008). DRF are protected under the Western Australian *Wildlife Conservation Act 1950* and in some instances under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

1.2 Purpose and Scope

The purpose of this Management Plan is to outline proposed measures to ensure the protection of *Eucalyptus steedmanii* (Steedman's Mallet) populations adjacent to the proposed Spotted Quoll mine site.

The plan applies to the following phases of the project:

- Pre-construction
- Construction and operation
- Post Closure.

The plan applies to activities conducted on Mining Leases 77/583 and 77/545.

1.3 Objectives

The objectives of this plan are to:

- Prevent potential adverse impacts on *Eucalyptus steedmanii* populations in, or adjacent to the proposed Spotted Quoll mine site and its associated operations; and
- Raise awareness about *Eucalyptus steedmanii*.

The above objectives are proposed to be achieved by:

- Documenting the distribution of the species in the vicinity of the proposed Spotted Quoll operations;
- Providing detailed species description and its preferred habitat;
- Identifying threatening processes to the species arising from the implementation of the Spotted Quoll operation;
- Developing strategies to reduce avoidable adverse impacts on the species;
- Identifying offsets to mitigate potential adverse impacts on the species;
- Outlining a monitoring program that aims to detect a decline in the health of local *Eucalyptus steedmanii* populations associated with the proposed mining activities; and
- Allocating responsibilities for the implementation of this Management Plan.

2 SITE DESCRIPTION

2.1 Climate

The climate in the general area of the Spotted Quoll Mine is semi-arid to arid and can be characterised by its relatively low annual rainfall and large temperature range.

Mean annual maximum temperature is 24.6°C and mean annual minimum 9.7°C. Daily maxima above 40°C are common from November to March. The coldest month is July and diurnal temperature variations are commonly high throughout the year (Keith Lindbeck and Associates, 2008).

The area is semi arid and the annual average rainfall at Hyden is 344.7 mm. Most of the rain falls between May and August and this amount varies greatly both seasonally and annually (Keith Lindbeck and Associates, 2008).

Climate data for Hyden (approximately 80km east of the Spotted Quoll operation) indicates that the average wind speeds vary throughout the year from 6.2 - 10.3 km/hr in the morning to 8.1 -10.7 km/hr in the afternoon. During summer the prevailing winds are easterlies in the morning and strong south easterlies in the afternoon. Throughout winter the morning winds are more north-westerly in direction, with lighter, more directionally variable winds experienced in the afternoon.

2.2 Geology and Soils

The Spotted Quoll project lies in the Forrestania Greenstone Belt (FGB), a southern extension of the Southern Cross Greenstone Belt. The greenstone belts of the Yilgarn craton are major sequences of basic to ultramafic rocks with varying levels of entrained sedimentary rocks laid down semi-contemporaneously.

The FGB is constrained by granitoid rocks that developed during the late Archaean / Proterozoic and form the western and eastern boundaries to the FGB. During the period of granite emplacement significant alteration, folding and faulting occurred within the FGB. The most significant alteration to the greenstone "stack" of mafics, ultramafics, and sediments was the formation of a major synclinal structure. This feature dominates the structural geology of the region.

The Spotted Quoll deposit is located within the traditional footwall, away from the basal ultramafic-footwall metasediment contact, which was probably the original locus for sulphide deposition from an overlying pile of komatiite flows. Subsequent metamorphism, deformation and intrusion of granitoid dykes/sills has contributed to a complex setting, with mineralisation now occupying a possible shear zone within the footwall metasediments.

Common soils are sandy duplexes (often alkaline), with ironstone gravely soils, loamy earths (often calcareous) with some loamy duplexes, sandy earths, deep sands and saline wet soils (Tille, 2006).

2.3 Vegetation and Flora

2.3.1 Vegetation Types

WSA commissioned Botanica Consulting to complete a flora and vegetation survey of the New Morning to Spotted Quoll area within Tenements M77/583 and M77/545. The flora and vegetation survey included the Spotted Quoll mine site, waste dump and pipeline/access roads.

Botanica Consulting (2009) mapped six vegetation types which are described below and shown in Figure 3. All of these vegetation types are found in the proposed project area (clearing envelope).

***Eucalyptus* Woodland:** The dominant overstorey species in this vegetation type include *Eucalyptus flocktoniae*, *E. urna*, and *E. salubris* over an understorey of *Melaleuca adnata, Grevillea obliquistigma, Acacia eremophila, Eremophila densiflora, Melaleuca cardiophylla*. The dominant small shrubs of this vegetation type included *Microcybe multiflora, Dodonaea stenozyga, Wilsonia humilis* and *Acacia intricate*.

***Eucalyptus* Mallee Woodland:** The dominant overstorey species in this vegetation type were *Eucalyptus eremophila* subsp. *eremophila*, *E. cylindrocarpa* and *E. leptophylla* over an understorey of *Acacia coolgardiensis, Melaleuca hamata, M. pauperiflora* subsp. *Pauperiflora, Acacia hemiteles, Melaleuca cordata* and *M. cucullata*. The dominant small shrubs of this vegetation type included *Dodonaea bursariifolia, Phebalium tuberculosum* and *Grevillea acuaria*.

Salmon Gum Woodland: The dominant overstorey species in this vegetation type was *Eucalyptus salmonophloia* over an understory of *Melaleuca adnata, M. hamata, M. pauperiflora* subsp. *pauperiflora, Eremophila decipiens* subsp. *decipiens* and *Daviesia benthamii*. The dominant small shrubs of this vegetation type included *Dodonaea stenozyga, Phebalium tuberculosum* and *Grevillea acuaria*.

Sand Plain Heath: This vegetation type was dominated by shrubs up to 2m in height. The dominant speciesof this vegetation type included *Allocasuarina corniculata, Acacia fragilis , Leptospermum erubescens, Melaleuca uncinata, Thyrptomene kochii, Banksia cirsioides, Leptosema daviesioides, Verticordia chrysanthella* and *Darwinia inconspicua*.

***Allocasuarina* Shrubland:** This vegetation type was a shrubland dominated by *Allocasuarina campestris, A. acutivalvis* and *Acacia steedmanii*. Understorey species were dominated by *Melaleuca pentagona, M. laxiflora* and *Conospermum brownie*.

Rocky Outcrop: The dominant overstorey species in this vegetation type were *Eucalyptus calycogona* and *E. pileata*. Understorey species were dominated by *Melaleuca hamata, Hakea subsulcata* and *Acacia hemiteles, Atriplex stipitata* and *Hibbertia pungens*.

Botanica (2008) reported that the survey area does not contain any threatened ecological communities (TECs). According to the Department of the Environment, Water, Heritage and the Arts' (DEWHA) *Protected Matters Search Tool*, the survey area has no regional significance (Botanica, 2009).

2.3.2 Vegetation Condition

The condition of vegetation in the survey area was assessed by Botanica (2009) using the condition rating scale of Keighery (1994) published in Bush Forever (Government of Western Australia, 2000). Keighery's condition rating scale ranges from Pristine (where vegetation exhibits no visible signs of disturbance) to Completely Degraded (where vegetation structure is no longer intact and without native plant species).

Botanica (2009) considered the majority of the vegetation to be in Good condition (Figure 4). According to the Keighery (1994) condition rating scale, Good is defined as: the vegetation structure being significantly altered, by very obvious signs of multiple disturbance, but retains basic vegetation structure or the ability to regenerate it.

Botanica's (2008) classification of the vegetation condition as Good was influenced by evidence of historic exploration lines and an existing track. Fire had burnt part of the survey area in 1994. There was no evidence of broad scale clearing for agricultural purposes, or invasive weed species.

A portion of the project area was classified as being in a Degraded condition. Degraded is defined as: the structure is severely disturbed, but has the ability to regenerate to a good condition with intensive management. Botanica's classification of vegetation as being in a degraded condition was largely due to disturbance resulting from drilling activities.

A small portion of the project area, largely adjacent to the haul road is in Very Good condition (Figure 4).

2.3.3 Flora

A total of 158 plant taxa represented across 62 Genera and 28 families were recorded in the survey area. No exotic species were identified during the surveys.

The dominant families represented from the survey included Myrtaceae, Proteaceae and Mimosaceae.

Dominant species in the area included:

- *Acacia steedmanii*
- *Allocasuarina campestris, A. acutivalvis* and *A. corniculata*
- *Eucalyptus calycogona, E. pileata, E. salmonophloia, E. eremophila, E. cylindrocarpa, E. leptophylla, E. flocktoniae, E. urna* and *E. salubris*

A complete list of flora recorded during the Botanica surveys (2009) is provided in Appendix A.

2.3.4 Conservation Significant Flora

The DEC Declared Rare and Priority Flora database search identified the potential for 93 DRF or Priority Flora (Appendix B) to be in, or within 10km of the survey area. Of these 93 species, 1 was DRF – presumed extinct, 6 were DRF, 24 were Priority 1 species, 18 were Priority 2 species, 31 were Priority 3 species and 13 were Priority 4 species.

One DRF and two Priority Flora were recorded by Botanica (2008 & 2009) during the surveys. These were:

- *Eucalyptus steedmanii* (DRF);
- *Eremophilia racemosa* (Priority 4); and
- *Microcorys sp.* Forrestania (Priority 4).

In addition to the above two priority species, the DEC has previously recorded one Priority 2 species (*Stylidium sejunctum*) within the survey area. This species was searched for by Botanica during the spring 2007 and autumn 2008 surveys but not recorded.

The three Priority species (including the DEC recorded *Stylidium sejunctum*) were recorded within one kilometre of the Spotted Quoll project area and pipeline corridor. The DRF species was located within the Spotted Quoll project area. The location of conservation significant flora is shown in Figure 3.

3 SPECIES PROFILE

3.1 Conservation Status

3.1.1 *Wildlife Conservation Act 1950*

The Western Australian *Wildlife Conservation Act 1950* defines rare flora as species that:

- Are likely to become extinct or are rare, or otherwise in need of special protection; or
- Are presumed to be extinct in the wild and therefore in need of special protection should they be re-discovered.

It is an offence 'to take' rare flora for any purpose and on any lands without written consent of the responsible Minister. Under the Act 'to take' is any direct or indirect action that may impact on the DRF.

Eucalyptus steedmanii is classified as a DRF. This status means that the species has 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.

Brown *et al.* (1998) noted that this species is considered Vulnerable as there were (then) six known populations of this species on vacant Crown Land, with no known populations in conservation reserves. All populations were burnt by a fire in 1994, and are being monitored (Brown *et al.*, 1998).

Following consultation with Dr Ken Atkins (DEC), Jim's Seeds, Weeds and Trees Pty Ltd (2006) noted that it was DEC's general view that *Eucalyptus steedmanii* should remain on the DRF list until seed banks have reached sufficient levels that will support regeneration of populations. If seed levels were to increase to a sustainable level, then the DEC would consider nominating for the conservation status of the species to be reduced to a Priority level.

3.1.2 *Environment Protection and Biodiversity Conservation Act 1999*

Eucalyptus steedmanii is listed for protection under the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. Under this legislation, the species has been assigned a protection status of 'Vulnerable'.

3.2 Description of *Eucalyptus steedmanii*

The species was first discovered in 1928, described in 1933 and then not recorded for many years (Brown *et al.*, 1998). Despite this, it became a well-known ornamental tree, as seed was propagated from the original collections (Brown *et al.*, 1998). Until 1978, this species had not been found in the field since 1938 despite several searches for it (Leigh *et al.*, 1984).

Steedman's mallet was named after Henry Steedman, head gardener at the Zoological Gardens, Perth, who collected many botanical specimens throughout Western Australia (Leigh *et al.*, 1984).

It is a small erect tree or mallee up to 8m to 12m high (Plate 1, Plate 2), has a distinctive habit of producing numerous ascending branches from low on the trunk to form a very dense crown (Brown *et al.*, 1998; Leigh *et al.*, 1984). The smooth bark ranges from grey to bright coppery in colour. Stalked juvenile leaves are 9cm long and 3cm wide, while adult leaves are a glossy olive green, up to 8cm long and 1.5cm wide, and are crowded with oil veins (Brown *et al.*, 1998). Each inflorescence contains three flowers. The

flowers are usually cream or yellow, but occasionally pink or red. The species flowers in the January to March period (Brown *et al.*, 1998), although Leigh *et al.* (1984) reported the species flowering time as December to January.

The buds are yellowish-brown, held on long stalks and are square in cross-section (Brown *et al.*, 1998). The pendulous buds are in threes in the leaf axils (Brown *et al.*, 1998). They are an elongated diamond shape, 3.3cm long and 1.3cm wide with a pyramidal cap (Brown *et al.*, 1998). The fruits, up to 2.2cm long and 1.7cm in diameter, are longitudinally winged (Brown *et al.*, 1998).

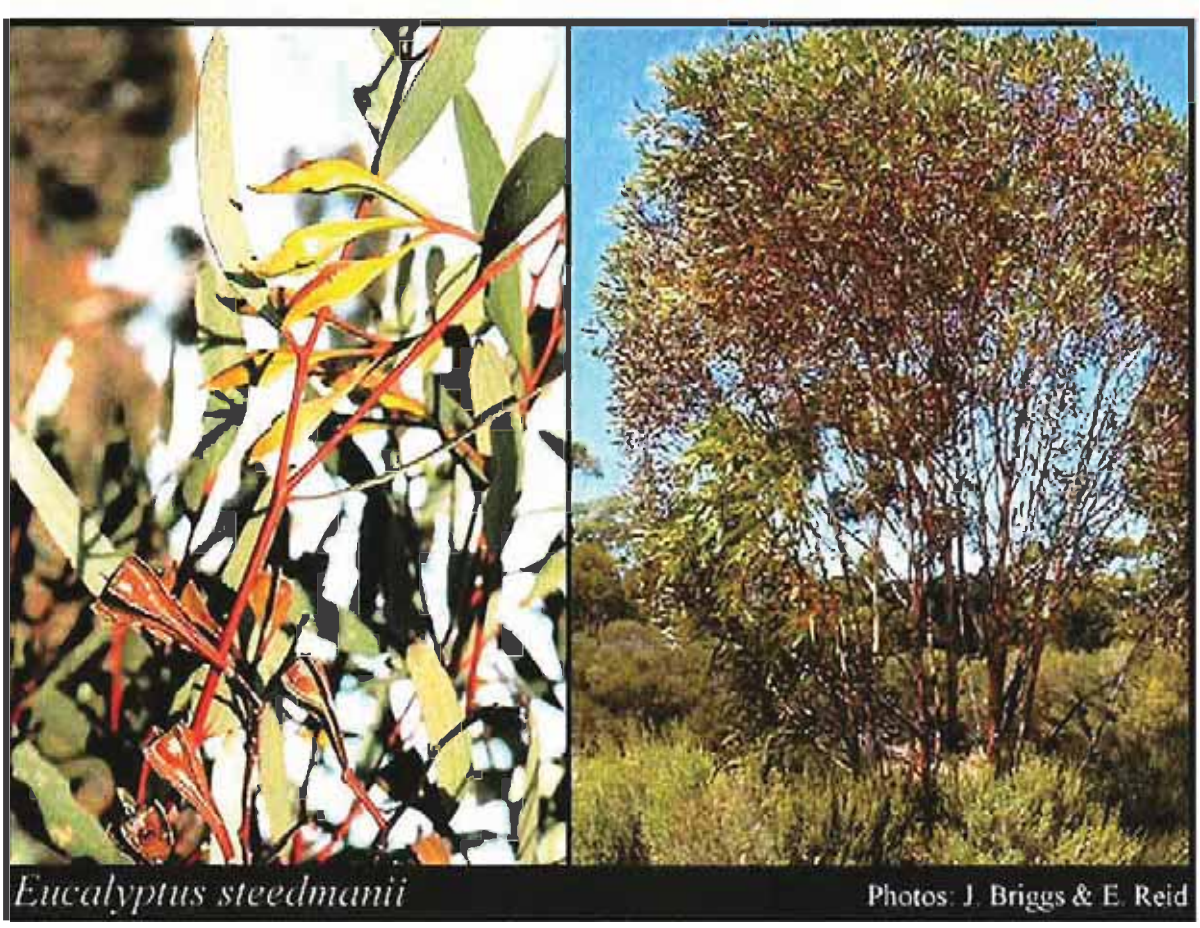


Plate 1 Mallee form of *Eucalyptus steedmanii* *Image from DEC (2008).*

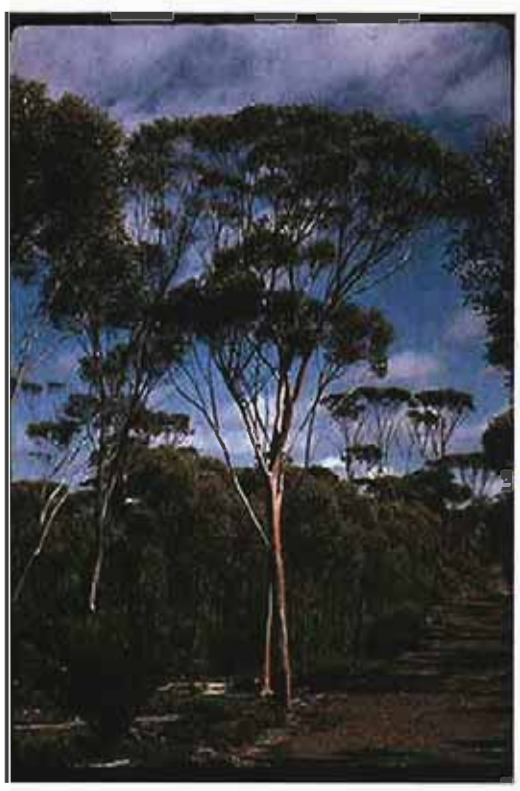


Plate 2 Tree Form of *Eucalyptus steedmanii* *(Image by Brooker & Kleinig, ANBG Image No 17363)*

3.3 Distribution and Population Size of *Eucalyptus steedmanii*

Steedman's Gum is endemic to Western Australia where it is confined to undulating country approximately 80km east of Hyden in the Forrestania to North Ironcaps areas (Brown *et al.*, 1998).

The species grows in pure stands and typically inhabits gravelly loam sites in dense woodlands (Brown et al, 1998). Its habitat is primarily on very gently undulating country on low ironstone rises where it occurs in patches of low woodland at the edge of more open heath scrub (Leigh *et al.*, 1984).

There are seven known populations of this species with one population divided into two subpopulations. The locations of these populations are provided in Figure 5. Populations 1 – 6 are known to DEC and the WA Herbarium, however Population 7 was only recently discovered, and is not yet listed on the DEC's *Threatened (Declared Rare) Flora* database or the Western Australian Herbarium database. The populations, which are geographically restricted, are located up to approximately 24km between the most southern and northern populations in a north – south belt, and within a narrow east – west belt of a few kilometres. Population 6 (the most northern population) is isolated from Populations 4 and 5 which in turn is separated from Populations 1, 2 and 3A/3B. Population 7, recorded by Botanica Consulting (2009) is approximately 1000m north of population 2 and 3.5km south of Population 1. All populations are located within Eucalypt woodland. The (Cth) Department of the Environment (DEWHA, 2008) describes the extent of the species occurrence as 83.6km^2.

A search of the DEC's *Threatened (Declared Rare) Flora* database (lodged 12/12/08 and received 16/12/08, Reference Number 42-1208) returned two records with population estimates (refer to Appendix C for search results). Populations 2 and 3A are estimated at 8,000 and 4,000 respectively. The DEC Native Vegetation Conservation Branch (Appendix D) advised WSA on the 11/12/08 that Populations 2,

3A and 3B had been incorrectly plotted, and that this error had been corrected. Coffey Environments has assumed that the locations supplied by DEC (Reference Number 42-1208) were the amended coordinates.

The Western Australian Herbarium database was searched for records of *Eucalyptus steedmanii* (refer to Appendix C for search results). A number of records exist on the database. Where population estimates have been recorded in the Western Australian Herbarium database, coordinates were cross-referenced with those from the DEC database search results. The Western Australian Herbarium database search results and population numbers are presented in Appendix C and Table 1. DEC advises that the development of the Perth Herbarium database was not originally intended for electronic mapping and that the latitude and longitude coordinates for each entry are not verified prior to being entered into the database.

TABLE 1: DEC *Eucalyptus steedmanii* Population Locations

Population	Coordinates		DEC Population Size Estimate (1994)	WA Herbarium Records of Population Size Estimate and Year of Record	Comment
	Latitude	Longitude			
1	32°26'49.5"	119°41'04.3"	-	Several hundred (1978) 3 plants (1978) 3000+ (2002)	• Population on Unallocated Crown Land • Coordinates for WA Herbarium record in 1978 match closest to Population 1
2	32°28'44.6"	119°41'38.4"	8,000		• Population on Unallocated Crown Land
3a	32°28'52.2"	119°40'39.7"	4,000		• Population on Unallocated Crown Land
3b	32°28'52.2"	119°40'39.7"	-	30+ (1989) 1 (2006)	• Population on Road Verge • Herbarium record in 1989 and 2006 match closest to Population 3a/3b. 1989 record estimates population in excess of 100,000.
4	32°18'55.5"	119°42'05.3"	-	2,500+ (2002) 4,000+ (2002) 1,000s of plants (2003)	• Population on Unallocated Crown Land. • 2002 Herbarium record estimates in excess of 5,000 plants possibly at this location, or population 6.
5	32°20'45.5"	119°43'05.3"	-		• Population on Unallocated Crown Land
6	32°12'55.5"	119°39'05.3"	-		• Population on Unallocated Crown Land • 2002 Herbarium record estimates in excess of 5,000 plants possibly at this location, or population 4.

Information on the known population estimates is not clear. The (Cth) Department of the Environment (DEWHA, 2008) estimates that there is a population of 24,500 mature plants recorded from 3 of the 6

known populations. DEC records indicate that there are six populations, of which two populations (2 and 3A) have been estimated at 8,000 and 4,000 plants respectively. The WA Herbarium records dating back from 1978 suggest the known population to be in excess of 100,000 across the six populations (Appendix C). Botanica's population estimates included in the monitoring results (Appendix E) are based on extrapolation of transect data, suggest the total number of plants across all seven populations to be in excess of 5,400,000 plants (Table 2).

TABLE 2: Botanica Extrapolated *Eucalyptus steedmanii* Population Estimates

DEC Population Name	Extrapolated Population Estimate by Botanica – Autumn 2008	Extrapolated Population Estimate by Botanica – Spring 2008	Extrapolated Population Estimate by Botanica – Autumn 2009
1	276,489	297,300	NA
2	8,940	8,940	9387
3	4,272	4,272	1000's
4	3,854,360	3,877,440	NA
5	1,224,694	1,246,370	NA
6	NA	NA	NA
7			9387
TOTAL	**5,368,755**	**5,434,322**	

NA: Not Assessed

3.4 Distribution of *Eucalyptus steedmanii* at Spotted Quoll

Botanica's recorded eight occurrences of *Eucalyptus steedmanii* during its 2007 flora survey (Botanic Consulting, 2008). An additional population was recorded during a survey in February 2009 (Botanica, 2009). The number of plants in each population ranged from one to more than a 1,000 plants (Botanica, 2008). All populations of the species were in association with the *Eucalyptus* Woodland vegetation type.

The location of known populations in relation to the proposed mining operation are shown in Figure 3.

3.5 Threatening Processes to *Eucalyptus steedmanii*

Eucalyptus steedmanii has a limited geographic distribution. No populations are located within the Conservation Estate.

The (Cth) Department of Environment, Water, Heritage and the Arts has identified fire as the key threatening process to the species. Fire kills adult plants but regeneration by seed has been observed following fire (DEWHA, 2008). All populations were thought to be burnt in a fire in 1994. Monitoring undertaken by Botanica on behalf of WSA, suggests that the populations are recovering since the fire in 1994 and in particular, the results suggest that the seed levels are increasing (Appendix E).

The main potential threat to the species have been identified as mining operations, firebreak maintenance and recreational activities. Populations near mining activities may be damaged through mining exploration (DEWHA, 2008).

3.6 Potential Threats to *Eucalyptus steedmanii* at the Proposed Spotted Quoll Mine Site

The principal threats to the *Eucalyptus steedmanii* populations at the Spotted Quoll mine site are:

- Direct loss attributable to native vegetation clearing activities;
- Unintentional clearing of individual plants or populations;
- Indirect loss due to associated mining impacts, e.g. dust, spillage of saline water;
- Loss of plants or populations due to fire or fire management activities; and
- Impact on pollinators.

While dewatering is required at the Spotted Quoll mine site, it is considered highly unlikely that the dewatering activities would result in the death of individual plants or populations. *Eucalyptus steedmanii* populations are considered highly unlikely to rely on local groundwater supplies due to the depth to groundwater (30m below ground level) and the hypersaline characteristics of the groundwater.

4 PROPOSED MANAGEMENT STRATEGIES

4.1 Avoidance

The preferred strategy for managing impacts on DRF is avoidance. No individual plants or populations are located in the area proposed to be cleared of native vegetation (Figure 3). However, several plants and populations are located in close proximity to the proposed clearing envelope. Plants are located within 27m of the haul road, 73m to the south of the proposed pit and 60m east of the proposed administration area.

Prior to the commencement of construction activities, WSA will undertake a targeted site survey to accurately delineate the populations in close proximity to the proposed clearing areas. As part of this survey, the location of each population will recorded using GPS as well as details relating to population size (in terms of area occupied and numbers of plants). This information will be incorporated into the mine plan and used to identify individual plants or populations that may be at threat of being impacted as a result of the construction or operational activities. Where there is uncertainty about the ability to avoid adverse impacts on the DRF species, WSA will apply to the Minister for the Environment for approval 'to take' DRF.

The design of the mining operation has been designed to avoid local populations of *Eucalyptus steedmanii*. For example:

- The waste rock dump has been positioned to be more than 340m from the nearest *Eucalyptus steedmanii* population.
- The proposed alignment of the haul road and infrastructure corridor has been designed to avoid *Eucalyptus steedmanii* populations. The road and infrastructure corridor deviates in a northeast direction, with the closest point being located approximately 25m from the nearest population (Figure 3).
- The open cut pit is located approximately 70m from the nearest *Eucalyptus steedmanii* population.

Where the proposed operations are in close proximity to the populations, special care will be needed to avoid adverse impacts. Specific strategies are described below to address these potential adverse impacts.

4.2 Demarcation

All known locations of *Eucalyptus steedmanii* populations will be accurately mapped using a GPS, and incorporated into all mine planning.

Prior to the commencement of construction or operational activities, any known locations of *Eucalyptus steedmanii* will be identified and marked. This will be undertaken by:

- Delineating clearing boundaries with high visibility flagging;
- Erection of protective fencing to protect populations at risk of being cleared, i.e. those populations immediately adjacent to the proposed clearing area;
- Installing signage at DRF exclusion zones to warn personnel that DRF is present;
- Environmental staff supervising clearing activities.

4.3 On-site Awareness

Awareness of staff and contractors is considered an important aspect of managing the risk to *Eucalyptus steedmanii* at Spotted Quoll minesite. Raising awareness will assist in minimising the accidental damage or loss of *Eucalyptus steedmanii* plants. Prior to the commencement of construction:

- WSA will provide information about environmental management and responsibilities (including to DRF management) in the staff and contractor site induction process.
- WSA personnel will provide information to construction staff at toolbox meetings as well as regular presentations at site meetings. In particular photos and details about *Eucalyptus steedmanii* will be provided to assist in identification of the species in the field. Information about the known locations of the species, species management and incidents will be provided to staff and contractors.

4.4 Access Management

Vehicle access into areas with *Eucalyptus steedmanii* has the potential to adversely impact on the species. To manage this risk, access will be restricted to designated haul roads including the infrastructure and haul road corridor between Spotted Quoll site and the Flying Fox mine to the north.

Access to areas containing *Eucalyptus steedmanii* will be prohibited except for monitoring purposes. Signage will be installed warning personnel of the presence of DRF. In the event that access is required, permission will be required from the Environmental Manager and access is to be undertaken with the presence of the Environmental Manager.

4.5 Dust Management

Dust is generated from mining activity as a result of the disturbance of fine particles derived from soil and rock, the handling of bulk construction materials such as crushed hard rock aggregate, and the removal of the layer of vegetation and stable soil. Consequent environmental effects are usually localised and depend on the size of the dust particles and the strength of distributing factors and usually decrease rapidly with separation from the source.

Dust is likely to be a hazard close to the mine (e.g. less than 1,000m), while further away from the mine dispersion reduces this hazard for a given wind speed and direction. However, under adverse weather conditions dust can travel considerable distances, potentially resulting in its deposition in otherwise remote locations. In the immediate vicinity of the source, dust can stress vegetation through blocking stomata (adversely affecting gas exchange) and reducing light availability (reducing photosynthetic ability and limiting plant growth).

Climate data for Hyden (approximately 80km east of the Spotted Quoll operation) indicates that the average wind speeds vary throughout the year from 6.2 - 10.3 km/hr in the morning to 8.1 -10.7 km/hr in the afternoon. During summer the prevailing winds are easterlies in the morning and strong south easterlies in the afternoon. Throughout winter the morning winds are more north-westerly in direction, with lighter, more directionally variable winds experienced in the afternoon.

Under the prevailing wind regime experienced at Hyden, the populations of *Eucalyptus steedmanii* at greatest risk of dust impacts in summer are those located to the west of the proposed haul road. In winter, the wind direction can be more variable and therefore monitoring of all populations adjacent to the haul roads and pit will be necessary.

Mining activities are likely to generate dust as a result of activities such as:

- Removal of vegetation and topsoil;
- Light and heavy vehicle movements over unpaved surfaces;
- Construction of haul roads and tracks;
- Drilling and blasting;
- Mining operations such as pit excavation and overburden and waste removal;
- Ore handling;
- Ore transport; and
- Stockpiling.

The project is located in a semi-arid environment, experiencing dry summer months, during which time dust generation is expected to be at a peak. The greatest potential for impact will be within the immediate environs of mining activities and on the surrounding vegetation. Accordingly, dust suppression measures will be necessary to mitigate any consequent adverse effects of construction or operation related dust.

Figure 3 depicts the known locations of local *Eucalyptus steedmanii* populations with respect to the proposed mining operations. Specific dust management activities will include, but not be limited to:

- Stabilisation of topsoil stockpiles with either salvaged vegetation or stabilising emulsion;
- Restriction of vehicle speeds in high risk dust-generating areas;
- Application of dust suppression methods along haul roads to minimise dust emissions using watercarts with dribble bars during dry, dusty periods. Water used for damping down of roads will be water from the dewatering operations. Dust suppression methods will need to ensure that water quality and application methods will not adversely impact native vegetation, and in particular populations of *Eucalyptus steedmanii*. Where DRF is located adjacent to areas being watered, earth bunds will be constructed to prevent runoff affecting local DRF populations. Earth bunds will be stabilised as required to prevent dust.
- Climatic conditions will be monitored and the data used to assist with planning blast events. Prevailing wind information will be utilised to, where possible, undertake blasting when wind directions are blowing away from the protected DRF areas in the immediate vicinity of the mining site.

Dust deposition gauges will be installed at each *Eucalyptus steedmanii* population that is at a greater risk of being adversely impacted (i.e. those adjacent to the haul road and the population to the south of the pit) and at control locations and monitored monthly. Indicative locations for dust monitoring locations are shown on Figure 6. The final locations of the dust deposition gauges will be identified in consultation with the DEC and results will be provided to the DEC on an annual basis.

Additional dust management procedures will be implemented as required, depending on the results of the dust deposition monitoring.

In addition, WSA will undertake weekly visual assessments of the populations located adjacent to the haul road and mining operations to detect any potential changes in plant health.

4.6 Fire Management

Coffey Environments understands that the Forrestania region was last burnt in 1994. This fire contributed to pressures on seed levels of *Eucalyptus steedmanii* and placed the conservation of this species at risk from further fires.

Fires can start from natural sources (e.g. lightning strikes) or human sources (e.g. accidental or intentional ignition). To manage the risk of fire starting from the Spotted Quoll operations, WSA will operate under the principle of fire avoidance, and it will implement (but not limited to) the following fire management strategies:

- Construct and maintain firebreaks around the Spotted Quoll operations in line with legislative requirements (i.e. the *Bush Fires Act 1954*) while avoiding DRF populations;
- Provide appropriate on-site fire-fighting equipment including water tanker with pumps, fire extinguishers on vehicles and equipment etc.;
- Provide adequate training for on-site staff in fire prevention and management. Fire fighting staff will be informed of the presence of DRF; and
- Undertake annual fuel-loading assessments in the areas surrounding the Spotted Quoll operations followed by consultation with DEC and FESA to consider appropriate management options.

4.7 Monitoring

Eucalyptus steedmanii populations will be monitored to enable early detection of adverse impacts as a result of construction and mining activities. The proposed monitoring actions have been outlined for each of the three phases, these being:

- Prior to commencement of construction and operation;
- During construction and operation; and
- Post closure.

4.7.1 Prior to Commencement of Construction and Operation

Before commencement of construction and operation at Spotted Quoll, WSA will:

- Undertake a targeted site survey prior to the commencement of construction activities in and adjacent to the proposed clearing area to accurately delineate DRF populations and to ascertain accurately the number of plants in each population located adjacent to WSA's operations.
- Undertake a population census of all seven known *Eucalyptus steedmanii* populations in the Forrestania Region every four years until completion of the mining operation. The census should record numbers of plants in each population, plant health, reproductive status and location. This action is in accordance with the Conservation Advice developed by DEHWA (2008) for the management of *Eucalyptus steedmanii*.
- Establish permanent 100m transects for plant health monitoring. Refer to Figure 6 for indicative locations of transects. These locations incorporate control transects to enable comparison of data. The final locations will be determined in consultation with DEC.

- Undertake baseline monitoring of plant health and reproductive status of *Eucalyptus steedmanii* populations on transects. Plant condition for each individual that intersects the transect will be assessed using a rating method that assigns a score based on species health/vigour (e.g. 0 = dead, 1 = poor health (i.e. extensive crown decline), 2 = moderate health (i.e. some evidence of crow decline) and 3 = very healthy (i.e. no evidence of crown decline)), as well as noting information relating to the stage of seed development. Results from the baseline monitoring will be provided to DEC.
- Commence monthly baseline dust deposition monitoring at control sites and at each *Eucalyptus steedmanii* population at greatest risk of being adversely impacted by dust (i.e. those adjacent to the haul road and the population to the south of the pit). Indicative locations for dust monitoring locations are shown on Figure 6. The final locations of the dust deposition gauges will be identified in consultation with the DEC and results will be provided to the DEC on an annual basis.

4.7.2 During Construction and Operation

During construction and operation phases, WSA will:

- Undertake weekly visual observations of *Eucalyptus steedmanii* populations in close proximity to the haul road and operations (i.e. Populations 1, 3A/3B and other plants identified by Botanica, 2009). Written and photographic records will be kept of the visual inspections of plant conditions.
- Undertake monthly transect monitoring of Populations 1, 2 3A/3B and 7, and annual transect monitoring in Populations 4, 5 and 6. Transect monitoring will address plant health, recruitment and reproductive status of *Eucalyptus steedmanii* populations. Plant condition for each individual that intersects the transect will be assessed using a rating method that assigns a score based on species health/vigour (e.g. 0 = dead, 1 = poor health (i.e. extensive crown decline), 2 = moderate health (i.e. some evidence of crow decline) and 3 = very healthy (i.e. no evidence of crown decline)), as well as noting information relating to the stage of seed development.
- Undertake monthly collection and analysis of dust deposition gauges. Results will be correlated with visual plant health observations and monthly transect monitoring results.
- After 12 months of monitoring dust deposition and DRF plant health, in consultation with the DEC, assess the feasibility of developing appropriate operational dust deposition targets.
- In the event that dust levels exceed acceptable limits, dust suppression measures will be immediately reviewed and more stringent measures implemented as appropriate. Remediation actions will be undertaken on the affected plants on consultation with the DEC.
- Undertake annual fuel-loading assessments in the areas surrounding the Spotted Quoll operations followed by consultation with DEC and FESA to consider appropriate management options.
- Undertake a population census of all seven known *Eucalyptus steedmanii* populations in the Forrestania Region every four years until completion of the mining operation. The census should record numbers of plants in each population, plant health, reproductive status and location. This action is in accordance with the Conservation Advice developed by DEHWA (2008) for the management of *Eucalyptus steedmanii*.

4.7.3 Post-Closure

Monitoring will continue as outlined in section 4.7.2 until completion of rehabilitation activities on site by WSA. Following completion of rehabilitation, monitoring of plant condition and population size will be undertaken biannually for a period of two years by WSA.

4.8 Contingency Planning

In the event that any adverse change is detected in the plant condition or population size, the Registered Manager will advise the DEC and Department of Mines and Petroleum (DMP). The cause of the change will be further investigated to determine if the change is a result of the Spotted Quoll operations. If the cause of the change is attributable to WSA operations, mining operations will be modified to ensure further adverse impacts are avoided. WSA will continue to liaise with DEC to determine appropriate remedial actions.

4.9 Offsets

4.9.1 Seed Collection

WSA is currently working with the DEC and the Threatened Flora Seed Centre to sustainably harvest seed from local *Eucalyptus steedmanii* populations. This proposed offset is in accordance with the Conservation Advice developed by DEHWA (2008) for the management of *Eucalyptus steedmanii*. WSA is being guided by the DEC with respect to:

- Optimal timing for collection of *Eucalyptus steedmanii* seed;
- Preferred techniques for collecting seed; and
- Required documentation.

The Threatened Flora Seed Centre is undertaking the cleaning, drying, packaging, storage and viability testing of collected seed.

To date the following seed has been collected by WSA and provided to the Threatened Flora Seed Centre:

TABLE 3: *Eucalyptus steedmanii* Seed Collection Summary

DEC Population Name	Date Collected	Number of trees collected from	Seed Weight collected (kg)
1	31 Mar 2009	50-60	1.29
2	31 Mar 2009	30-40	1.55
3	31 Mar 2009	30-40	0.59
4	31 Mar 2009	>100	0.62
5	31 Mar 2009	>100	0.75
6	31 Mar 2009	No plants located	0
New population –	N/C	NC	-

Jan 2009			
NC: Not Collected		**TOTAL**	**4.80**

4.9.2 Formalised Agreement

WSA will consider opportunities for entering into a formalised agreement for the protection of the DRF populations within its mining tenement.

This proposed offset is in accordance with the Conservation Advice developed by DEHWA (2008) for the management of *Eucalyptus steedmanii.*

4.10 Reporting

All non-compliances with this Management Plan are to be reported to the Registered Manager within 24 hours of the breach.

Site Personnel and Mine Manager will be responsible for recording the details of the breach and providing the details to the Registered Manager. WSA will be responsible for notifying the DEC and DMP.

An internal monitoring report will be prepared every six months and submitted to the Registered Manager.

All records of *Eucalyptus steedmanii* monitoring kept in accordance with this plan will be summarised in the Annual Environmental Report, which will be submitted to the DMP and DEC.

5 RESPONSIBILITIES

5.1 Registered Manager

Overall responsibility for ensuring that the site environmental management requirements are met during the life of the project will rest with the Registered Manager. This responsibility will include:

- Ensuring that all construction and operational site personnel are aware of their environmental responsibilities and obligations;
- Ensuring that all contractor staff are fully inducted and are aware of their environmental responsibilities and obligations; and
- Allocating resources to ensure that commitments can be met.

5.2 Environmental Manager

The Site Environmental Manager is responsible for:

- Ensuring that annual and monthly monitoring requirements for monitoring *Eucalyptus steedmanii* populations are undertaken in accordance with this Management Plan.
- Reporting the monitoring results to the Registered Manager in accordance with this Management Plan.
- Coordinating seed collection in consultation with the DEC.

5.3 Mine Manager

The Mine Manager is responsible for ensuring that all staff and contractors are provided a copy of this procedure.

5.4 Site Personnel

Site Personnel are responsible for:

- Working in accordance with this Management Plan;
- Reporting non-compliance with this Management Plan, environmental incidents or emergencies to their Supervisor; and
- Attending inductions and environmental awareness training sessions.

6 CONCLUSIONS

Eucalyptus steedmanii is classified as a DRF and is afforded protection under the *Environmental Protection Act 1986* and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

The species is restricted to seven known populations within the Forrestania area, where it inhabits gravelly loam in dense low woodlands. The total population is not accurately known.

WSA will implement this management plan to minimise the potential risk to *Eucalyptus steedmanii* resulting from the proposed Spotted Quoll operations. Key elements of this management plan relate to:

- Avoidance of populations, including the establishment of exclusion zones;
- Field demarcation and signage to protect known populations;
- Supervision of native vegetation clearing activities;
- Raising awareness of staff through induction processes and on-going training;
- DRF Seed collection undertaken in consultation with the DEC;
- Managing dust emissions generated during the mining and transportation activities;
- Implementing fire management techniques to reduce the potential for anthropogenic sources of fire and to maximise opportunities for control of fire;
- Undertaking DRF monitoring and dust monitoring to detect changes in population size and plant condition.

The approach outlined in this management plan, if followed by WSA, will significantly reduce the risk of potential damage to *Eucalyptus steedmanii* and is in accordance with the Conservation Advice provided by the (Cth) Department of the Environment for *Eucalyptus steedmanii* (DEWHA, 2008).

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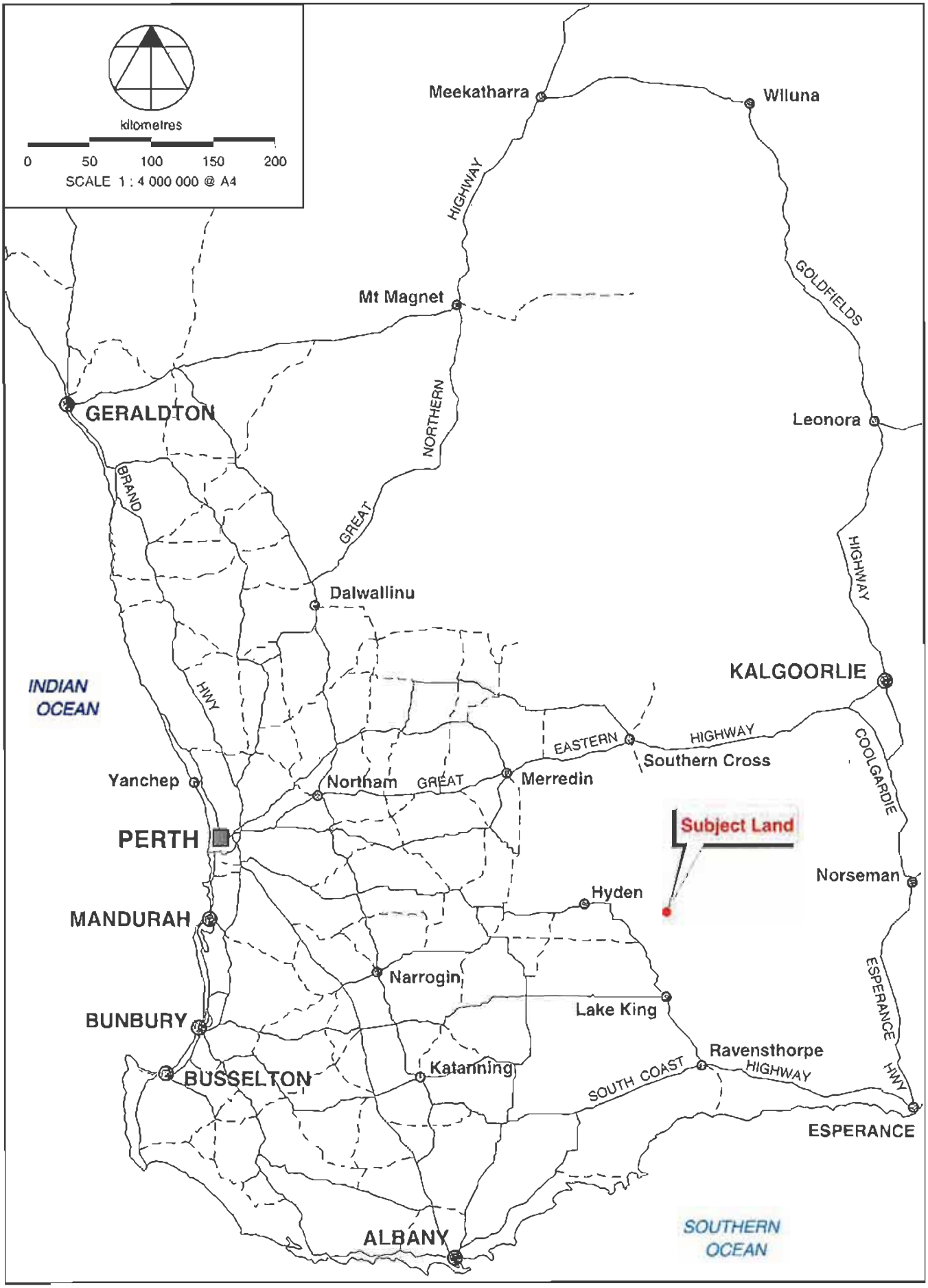
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Figures

Eucalyptus steedmanii Management Plan
Spotted Quoll Mine



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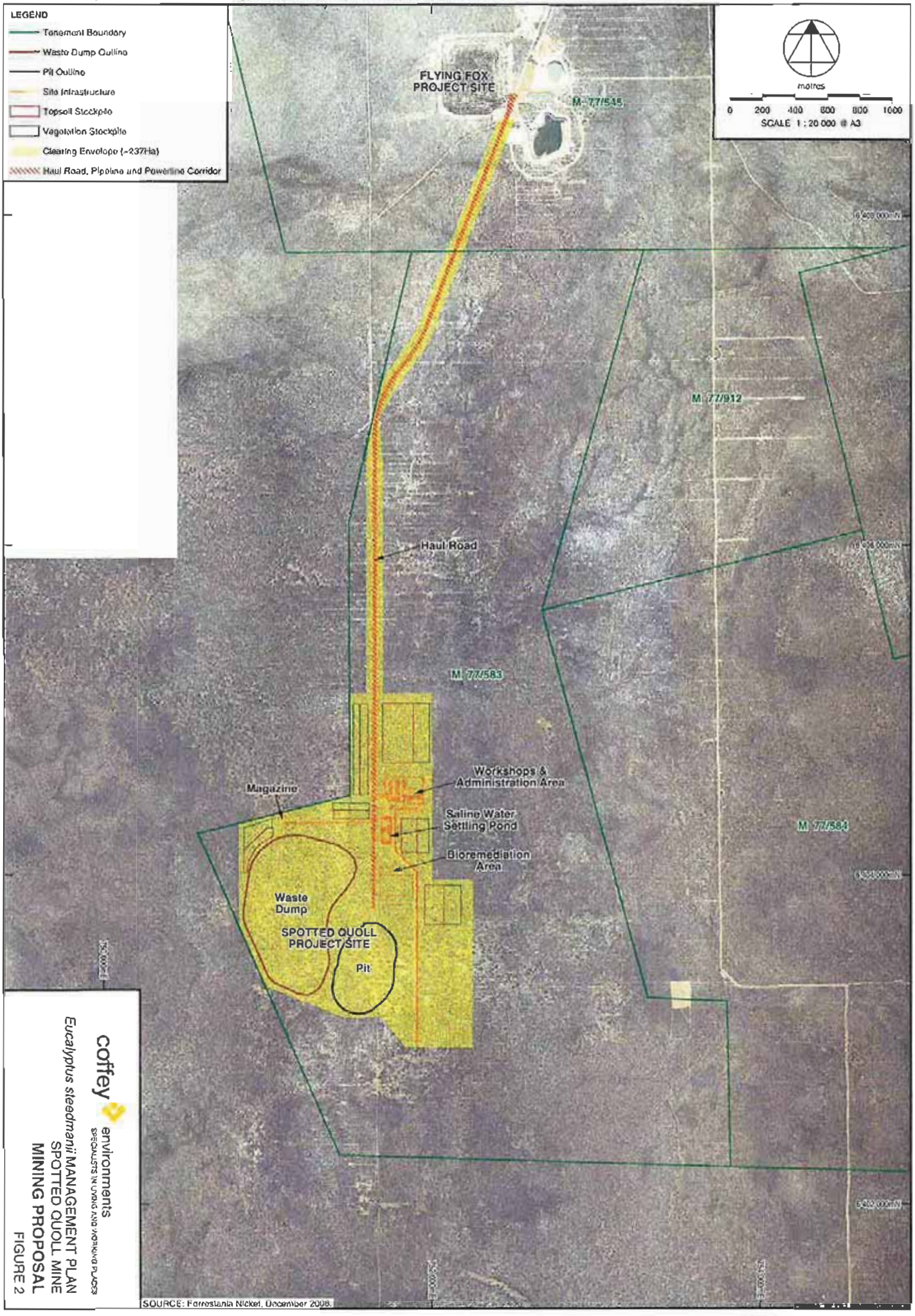
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SPECIALISTS IN LIVING AND WORKING PLACES

Eucalyptus steedmanii MANAGEMENT PLAN
SPOTTED QUOLL MINE

REGIONAL LOCATION

FIGURE 1

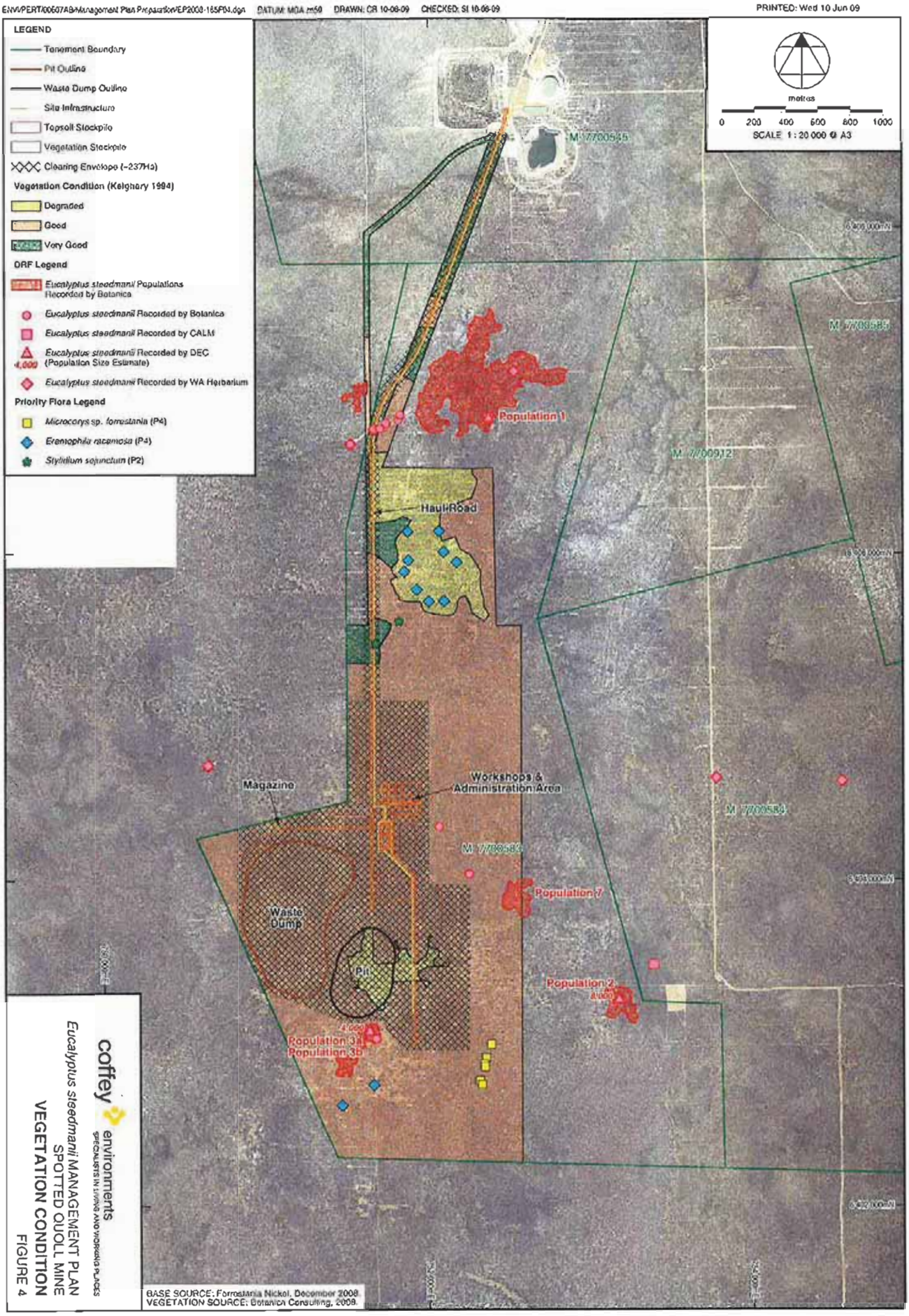
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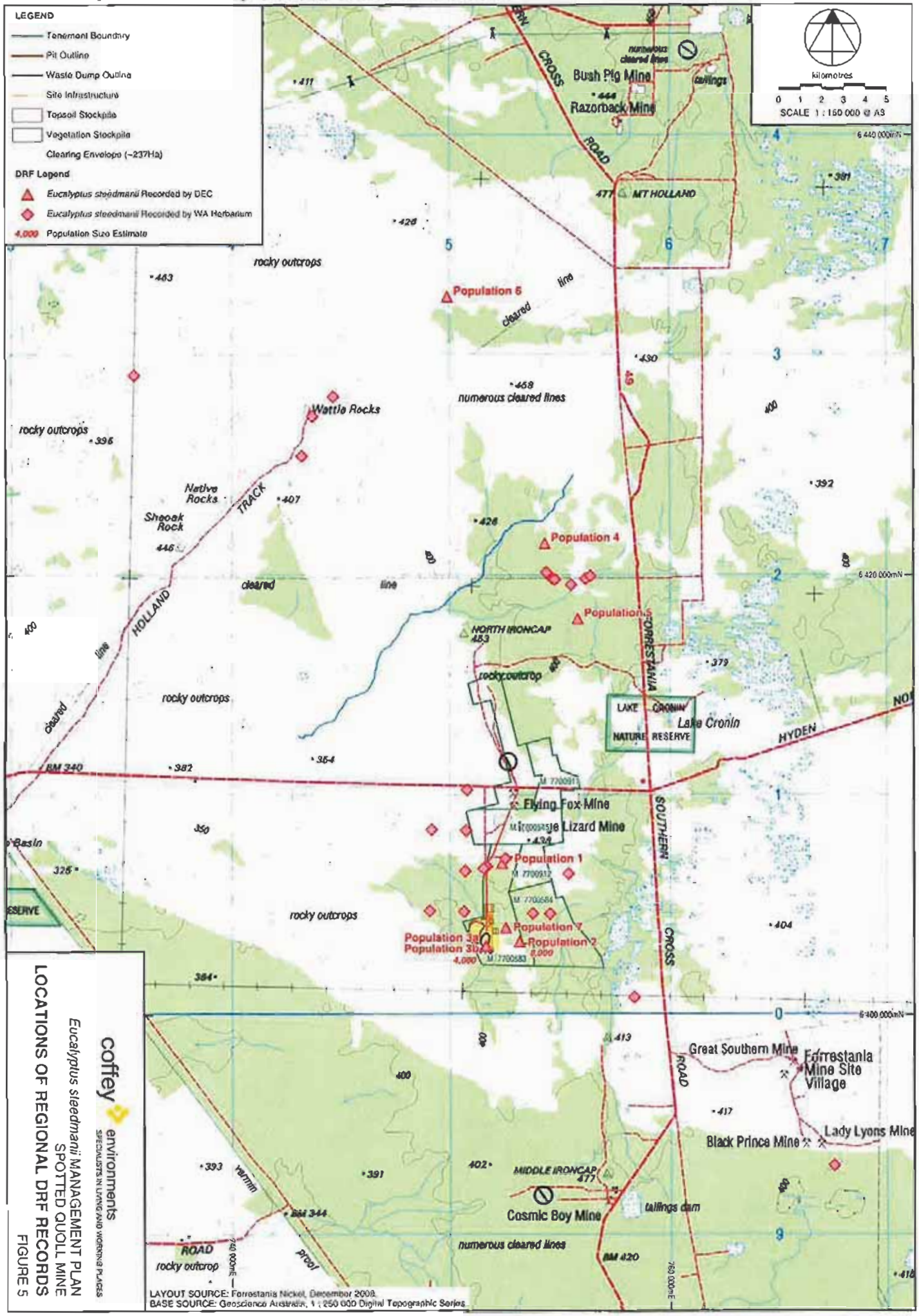
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Eucalyptus steedmanii MANAGEMENT PLAN
SPOTTED QUOLL MINE
MINING PROPOSAL
FIGURE 2

SOURCE: Forrestania Nickel, December 2008.


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LEGEND
Tenement Boundary
Pit Outline
Waste Dump Outline
Site Infrastructure
Topsoil Stockpile
Vegetation Stockpile
Clearing Envelope (~237Ha)
Vegetation Condition (Keighery 1994)
Degraded
Good
Very Good
DRF Legend
Eucalyptus steedmanii Populations Recorded by Botanica
Eucalyptus steedmanii Recorded by Botanica
Eucalyptus steedmanii Recorded by CALM
Eucalyptus steedmanii Recorded by DEC (Population Size Estimate)
4,000
Eucalyptus steedmanii Recorded by WA Herbarium
Priority Flora Legend
Microcorys sp. forrestania (P4)
Eremophila racemosa (P4)
Stylidium sejunctum (P2)
metres
0 200 400 600 800 1000
SCALE 1 : 20 000 @ A3
M 7700545
M 7700912
M 7700584
Haul Road
Population 1
Magazine
Workshops & Administration Area
Waste Dump
Pit
Population 7
Population 2
4,000
Population 3a
Population 3b
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SPECIALISTS IN LIVING AND WORKING PLACES
Eucalyptus steedmanii MANAGEMENT PLAN
SPOTTED QUOLL MINE
VEGETATION CONDITION
FIGURE 4
BASE SOURCE: Forrestania Nickel, December 2008.
VEGETATION SOURCE: Botanica Consulting, 2008.

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LAYOUT SOURCE: Forrestania Nickel, December 2008.
BASE SOURCE: Geoscience Australia, 1 : 250 000 Digital Topographic Series

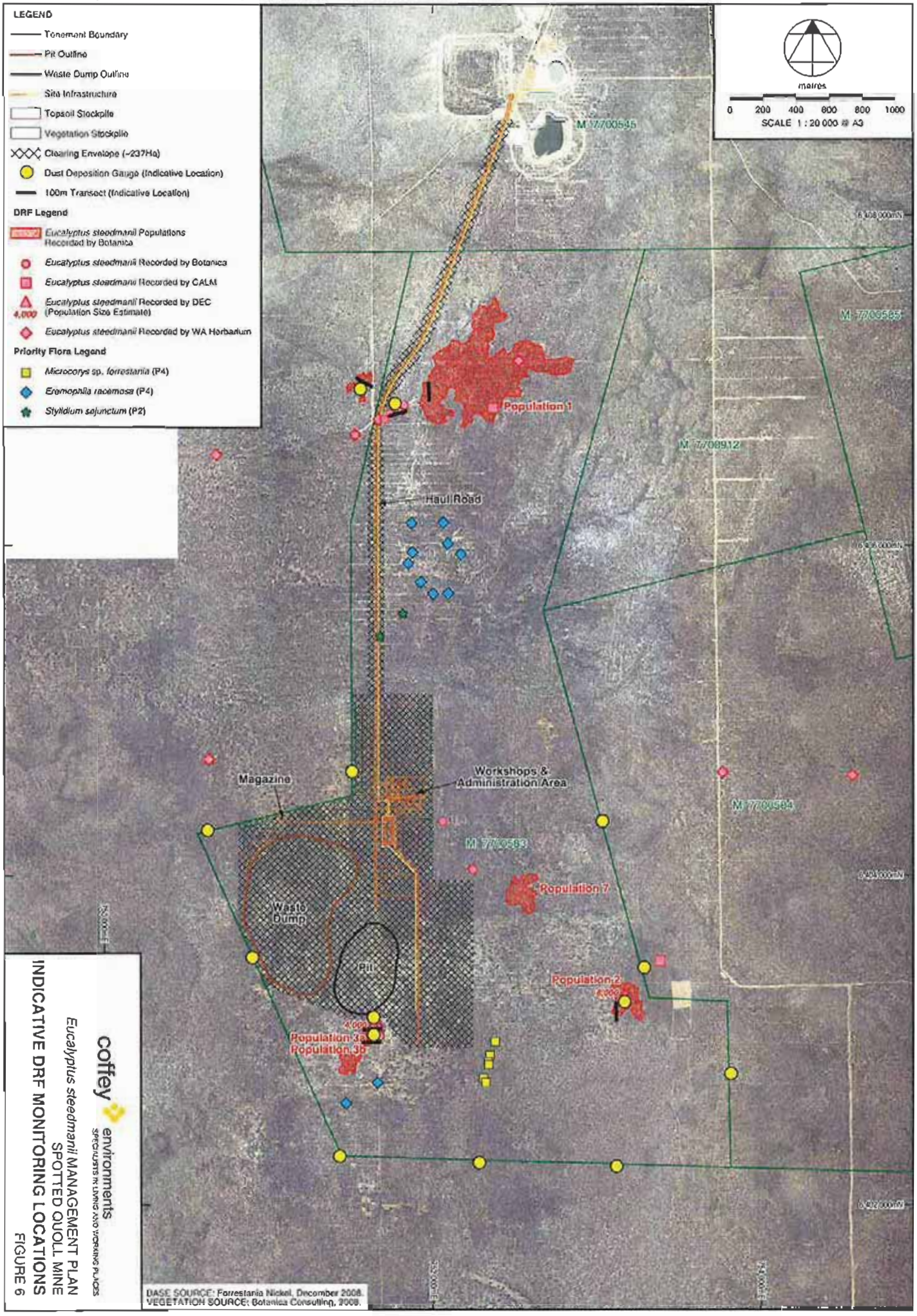
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Eucalyptus steedmanii MANAGEMENT PLAN
SPOTTED QUOLL MINE

LOCATIONS OF REGIONAL DRF RECORDS

FIGURE 5

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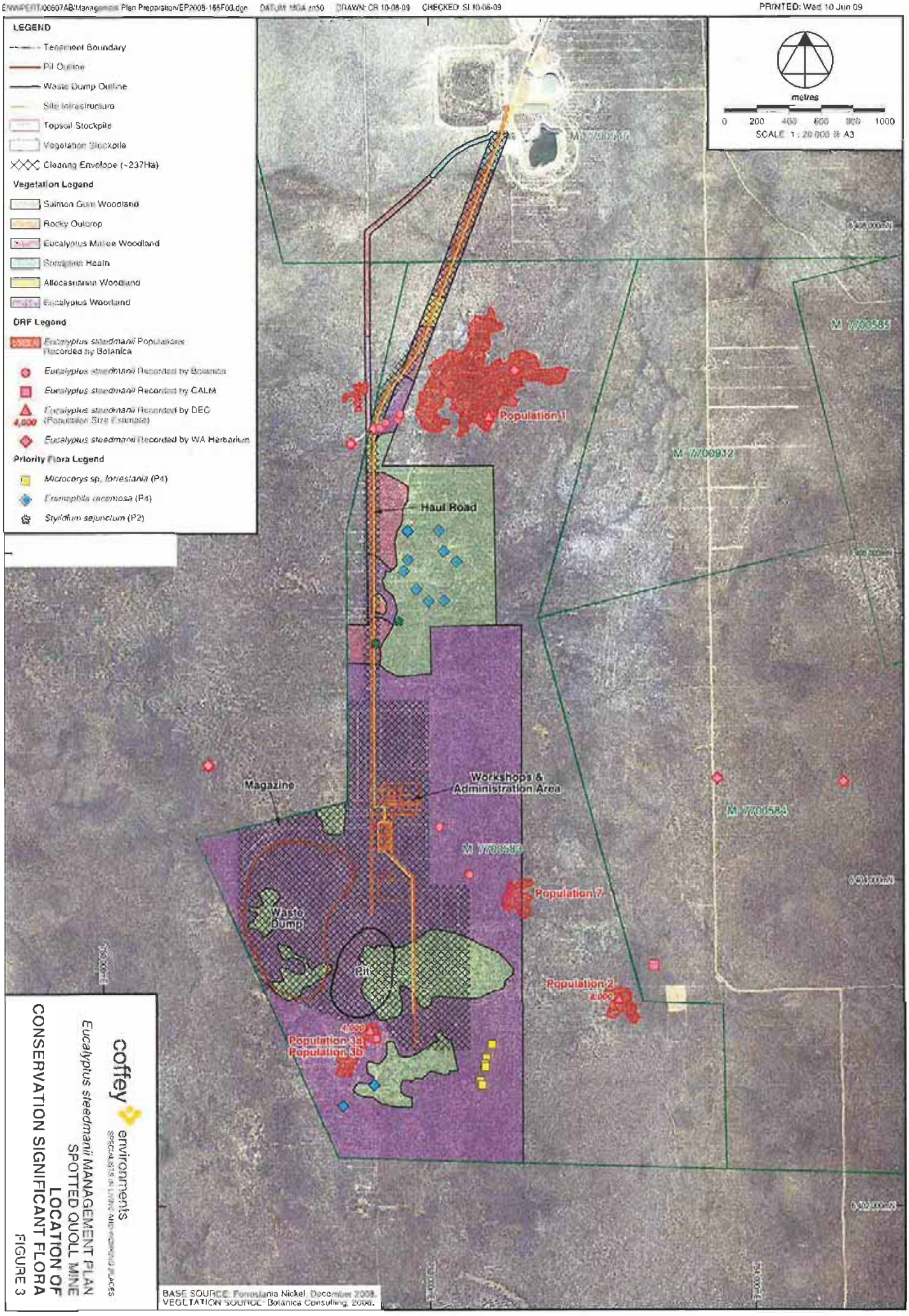
Eucalyptus steedmanii MANAGEMENT PLAN
SPOTTED QUOLL MINE

INDICATIVE DRF MONITORING LOCATIONS

FIGURE 6

DASE SOURCE: Forrestania Nickel, December 2008.
VEGETATION SOURCE: Botanica Consulting, 2008.

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BASE SOURCE: Forrestania Nickel, December 2008.
VEGETATION SOURCE: Botanica Consulting, 2008.

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Eucalyptus steedmanii MANAGEMENT PLAN
SPOTTED QUOLL MINE

LOCATION OF CONSERVATION SIGNIFICANT FLORA

FIGURE 3

Appendix A
Botanica (2009) Flora List

Eucalyptus steedmanii Management Plan
Spotted Quoll Mine

. Species list of the survey area

Family	Genus	Species	Eucalyptus woodland	Eucalyptus mallee woodland	*Eucalyptus salmonophloia* woodland	Sandplain heath	Rocky outcrop	Allocasuarina thicket
Anthericaceae	*Thysanotus*	*sparteus*	•					
Asphodelaceae	*Bulbine*	*semibarbata*			•			
Asteraceae	*Angianthus*	*tomentosus*	•				•	
Asteraceae	*Calotis*	*hispidula*	•					
Asteraceae	*Gnephosis*	*tenuissima*	•					
Asteraceae	*Olearia*	*muelleri*	•	•				•
Asteraceae	*Olearia*	*pimeleoides*	•					
Caesalpiniaceae	*Senna*	*artemisioides* subsp. *filifolia*	•				•	
Casuarinaceae	*Allocasuarina*	*acutivalvis* subsp. *acutivalvis*		•				•
Casuarinaceae	*Allocasuarina*	*campestris*	•	•			•	•
Casuarinaceae	*Allocasuarina*	*corniculata*		•		•		•
Casuarinaceae	*Allocasuarina*	*helmsii*	•	•				
Casuarinaceae	*Allocasuarina*	*microstachya*				•		
Chenopodiaceae	*Atriplex*	*stipitata*	•		•		•	
Chenopodiaceae	*Atriplex*	*vesicaria*			•			
Chenopodiaceae	*Maireana*	*georgei*	•		•			
Chenopodiaceae	*Maireana*	*oppositifolia*	•					
Chenopodiaceae	*Sclerolaena*	*diacantha*	•		•			
Chenopodiaceae	*Sclerolaena*	*uniflora*	•	•	•			
Convolvulaceae	*Wilsonia*	*humilis*	•	•	•			
Cupressaceae	*Callitris*	*preissii*	•	•				
Cyperaceae	*Gahnia*	*ancistrophylla*			•	•	•	
Cyperaceae	*Lepidosperma*	*brunonianum*	•	•	•	•		•
Cyperaceae	*Lepidosperma*	*drummondii*		•		•		
Dilleniaceae	*Hibbertia*	*pungens*		•		•	•	•
Epacridaceae	*Astroloma*	*serratifolium*		•		•		
Epacridaceae	*Leucopogon*	*cuneifolius*		•				
Epacridaceae	*Lysinema*	*ciliatum forma* Lake King (J.S. Beard 3698)				•		•
Euphorbiaceae	*Bertya*	*?dimerostegia*				•		
Goodeniaceae	*Coopernookia*	*strophiolata*		•	•			
Goodeniaceae	*Dampiera*	*angulata* subsp. *angulata*		•			•	•
Goodeniaceae	*Goodenia*	*pinifolia*		•		•		•
Goodeniaceae	*Goodenia*	*viscida*	•	•				
Haloragaceae	*Glischrocaryon*	*roei*		•				
Lamiaceae	*Microcorys*	*obovata*		•				
Lamiaceae	*Microcorys*	*sp. Forrestania (P4)*	•		•			
Lamiaceae	*Westringia*	*cephalantha* var. Lake King		•	•	•		

Family	Genus	Species	Eucalyptus woodland	Eucalyptus mallee woodland	*Eucalyptus salmonophloia* woodland	Sandplain heath	Rocky outcrop	Allocasuarina thicket
Lamiaceae	*Westringia*	*rigida*	*		*			
Lauraceae	*Cassytha*	*melantha*	*	*	*	*		
Mimosaceae	*Acacia*	*acuminata*	*	*				*
Mimosaceae	*Acacia*	*camptoclada*	*					
Mimosaceae	*Acacia*	*coolgardiensis*		*	*	*		*
Mimosaceae	*Acacia*	*deficiens*	*	*	*			
Mimosaceae	*Acacia*	*densiflora*	*					
Mimosaceae	*Acacia*	*enervia* subsp. *enervia*	*					
Mimosaceae	*Acacia*	*eremophila* var. *eremophila*	*		*			
Mimosaceae	*Acacia*	*erinacea*	*	*	*	*		
Mimosaceae	*Acacia*	*fragilis*		*		*		*
Mimosaceae	*Acacia*	*hemiteles*	*	*	*		*	
Mimosaceae	*Acacia*	*hystrix* subsp. *hystrix*		*		*		
Mimosaceae	*Acacia*	*intricata*	*	*	*		*	
Mimosaceae	*Acacia*	*longispinea*		*				
Mimosaceae	*Acacia*	*merrallii*	*	*	*			*
Mimosaceae	*Acacia*	*poliochroa*	*	*				
Mimosaceae	*Acacia*	*sphacelata* subsp. *sphacelata*	*	*	*	*	*	
Mimosaceae	*Acacia*	*steedmanii* subsp. *borealis*	*	*			*	*
Mimosaceae	*Acacia*	*uncinella*	*	*				
Mimosaceae	*Acacia*	*viscifolia*		*				
Myoporaceae	*Eremophila*	*decipiens* subsp. *decipiens*	*		*			
Myoporaceae	*Eremophila*	*densifolia* subsp. *capitata*	*	*	*			
Myoporaceae	*Eremophila*	*drummondii*	*	*		*		
Myoporaceae	*Eremophila*	*maculata* subsp. *brevifolia*	*					
Myoporaceae	*Eremophila*	*racemosa P4*	*		*			
Myrtaceae	*Baeckea*	*crispiflora* subsp. Kulin (R. Hnatiuk 780026)		*		*		*
Myrtaceae	*Beaufortia*	*interstans*				*		
Myrtaceae	*Beaufortia*	*schaueri*				*		
Myrtaceae	*Calytrix*	*breviseta*				*		
Myrtaceae	*Darwinia*	*inconspicua* N.G.Marchant & Keighery ms		*		*		*
Myrtaceae	*Eucalyptus*	*annulata*	*		*			
Myrtaceae	*Eucalyptus*	*calycogona*					*	
Myrtaceae	*Eucalyptus*	*cylindrocarpa*	*	*				
Myrtaceae	*Eucalyptus*	*eremophila* subsp. *eremophila*	*	*	*	*		*
Myrtaceae	*Eucalyptus*	*flocktoniae* Maiden subsp. *flocktoniae*	*	*	*			
Myrtaceae	*Eucalyptus*	*gracilis*	*					

Family	Genus	Species	Eucalyptus woodland	Eucalyptus mallee woodland	*Eucalyptus salmonophloia* woodland	Sandplain heath	Rocky outcrop	Allocasuarina thicket
Myrtaceae	*Eucalyptus*	*kondininensis*	*	*				
Myrtaceae	*Eucalyptus*	*leptophylla*		*		*		
Myrtaceae	*Eucalyptus*	*melanoxylon*	*					
Myrtaceae	*Eucalyptus*	*pileata*		*			*	*
Myrtaceae	*Eucalyptus*	*platycorys*				*		
Myrtaceae	*Eucalyptus*	*polita*	*	*	*			
Myrtaceae	*Eucalyptus*	*salmonophloia*	*	*	*			
Myrtaceae	*Eucalyptus*	*salubris*	*	*	*			
Myrtaceae	*Eucalyptus*	*sporadica*	*					*
Myrtaceae	*Eucalyptus*	*steedmanii (DRF)*	*					
Myrtaceae	*Eucalyptus*	*urna*	*	*				
Myrtaceae	*Leptospermum*	*erubescens*		*	*	*		*
Myrtaceae	*Melaleuca*	*adnata*	*	*	*	*		
Myrtaceae	*Melaleuca*	*cordata*		*		*		*
Myrtaceae	*Melaleuca*	*cucullata*	*	*				
Myrtaceae	*Melaleuca*	*eleuterostachya*	*	*				
Myrtaceae	*Melaleuca*	*elliptica*	*	*	*			
Myrtaceae	*Melaleuca*	*hamata*		*	*	*	*	
Myrtaceae	*Melaleuca*	*laxiflora*		*	*			*
Myrtaceae	*Melaleuca*	*pauperiflora* subsp. *fastigiata*	*		*			
Myrtaceae	*Melaleuca*	*pauperiflora* subsp. *pauperiflora*	*	*	*			
Myrtaceae	*Melaleuca*	*pentagona*	*	*		*		*
Myrtaceae	*Melaleuca*	*pungens* var. *pungens*		*				*
Myrtaceae	*Melaleuca*	*sapientes*		*		*		
Myrtaceae	*Melaleuca*	*sparsiflora*	*					
Myrtaceae	*Melaleuca*	*teuthidoides*	*		*	*		
Myrtaceae	*Melaleuca*	*thyoides*	*					
Myrtaceae	*Melaleuca*	*uncinata*	*	*		*		
Myrtaceae	*Thryptomene*	*kochii*		*		*		*
Myrtaceae	*Verticordia*	*chrysantha*				*		
Myrtaceae	*Verticordia*	*plumosa* var. *incrassata*				*		
Myrtaceae	*Verticordia*	*roei*				*		
Papilionaceae	*Daviesia*	*benthamii subsp. acanthoclona*	*	*	*	*		
Papilionaceae	*Daviesia*	*benthamii subsp. benthamii*	*	*	*	*		
Papilionaceae	*Daviesia*	*lancifolia*		*		*		
Papilionaceae	*Daviesia*	*nematophylla*	*	*		*		*
Papilionaceae	*Gastrolobium*	*spinosum*			*	*		*
Papilionaceae	*Gompholobium*	*gompholobioides*	*		*			
Papilionaceae	*Leptosema*	*daviesioides*				*		

Family	Genus	Species	Eucalyptus woodland	Eucalyptus mallee woodland	*Eucalyptus salmonophloia* woodland	Sandplain heath	Rocky outcrop	Allocasuarina thicket
Papilionaceae	*Templetonia*	*egena*		*	*			*
Phormiaceae	*Dianella*	*revoluta* var. *revoluta*	*	*	*	*		
Proteaceae	*Banksia*	*cirsioides*				*		
Proteaceae	*Banksia*	*elderiana*				*		*
Proteaceae	*Banksia*	*erythrocephala* var. *erythrocephala*				*		
Proteaceae	*Conospermum*	*brownii*			*	*		*
Proteaceae	*Grevillea*	*acuaria*	*	*	*			*
Proteaceae	*Grevillea*	*cagiana*	*			*		
Proteaceae	*Grevillea*	*eriostachya*		*		*		*
Proteaceae	*Grevillea*	*huegelii*	*	*		*		
Proteaceae	*Grevillea*	*obliquistigma* subsp. *obliquistigma*	*			*		
Proteaceae	*Grevillea*	*oligantha*	*		*			
Proteaceae	*Grevillea*	*oncogyne*		*	*	*		*
Proteaceae	*Grevillea*	*pterosperma*		*		*		*
Proteaceae	*Grevillea*	*shuttleworthiana subsp. obovata*				*		
Proteaceae	*Hakea*	*commutata*	*	*				
Proteaceae	*Hakea*	*corymbosa*				*		*
Proteaceae	*Hakea*	*erecta*				*		*
Proteaceae	*Hakea*	*multilineata*		*		*		*
Proteaceae	*Hakea*	*newbeyana*		*				
Proteaceae	*Hakea*	*platysperma*				*		
Proteaceae	*Hakea*	*scoparia* subsp. *scoparia*		*				*
Proteaceae	*Hakea*	*subsulcata*					*	*
Proteaceae	*Isopogon*	*scabriusculus* subsp. *pubifloris*				*		
Proteaceae	*Persoonia*	*coriacea*				*		*
Proteaceae	*Persoonia*	*helix*				*		*
Proteaceae	*Petrophile*	*divaricata*				*		
Proteaceae	*Petrophile*	*squamata*				*		
Proteaceae	*Synaphea*	*interioris*				*		
Rhamnaceae	*Cryptandra*	*minutifolia* subsp. *brevistyla*	*	*		*		
Rhamnaceae	*Cryptandra*	*nutans*				*		
Rutaceae	*Drummondita*	*hassellii*				*		*
Rutaceae	*Microcybe*	*multiflora* subsp. *multiflora*	*					
Rutaceae	*Phebalium*	*ambiguum*			*	*		
Rutaceae	*Phebalium*	*tuberculosum*	*	*	*	*		
Rutaceae	*Philotheca*	*rhomboidea*	*					*
Santalaceae	*Exocarpos*	*aphyllus*	*	*	*			
Santalaceae	*Exocarpos*	*sparteus*		*	*	*		
Santalaceae	*Santalum*	*acuminatum*	*	*	*	*		*

Family	Genus	Species	Eucalyptus woodland	Eucalyptus mallee woodland	*Eucalyptus salmonophloia* woodland	Sandplain heath	Rocky outcrop	Allocasuarina thicket
Sapindaceae	*Dodonaea*	*bursariifolia*		*				
Sapindaceae	*Dodonaea*	*microzyga* var. *acrolobata*	*	*	*			
Sapindaceae	*Dodonaea*	*stenozyga*	*	*	*			
Sapindaceae	*Dodonaea*	*viscosa* subsp. *angustissima*	*					
Thymelaeaceae	*Pimelea*	*aeruginosa*		*		*		
Violaceae	*Hybanthus*	*floribundus* subsp. *curvifolius*					*	

Appendix B
DEC Declared Rare and Priority Flora Database Search Results

Eucalyptus steedmanii Management Plan
Spotted Quoll Mine

Total No. of Records = 7

Species Name	Cons. Code	Status	Pop ID	No. Plants	Latitude	Longitude	Purpose	Vest
Eucalyptus steedmanii	R		1		32^26'49.5"	119^41'04.3"	Un-allocated Crown land	NON
			2	8000	32^28'44.6"	119^41'38.4"	Un-allocated Crown land	NON
			3A	4000	32^28'52.2"	119^40'39.7"	Un-allocated Crown land	NON
			3B		32^28'52.2"	119^40'39.7"	Road Verge	SHI
			4		32^18'55.5"	119^42'05.3"	Un-allocated Crown land	NON
			5		32^20'45.5"	119^43'05.3"	Un-allocated Crown land	NON
			6		32^12'55.5"	119^39'05.3"	Un-allocated Crown land	NON

Appendix C
DEC and WA Herbarium Database Search Results for *Eucalyptus steedmanii*

Eucalyptus steedmanii Management Plan
Spotted Quoll Mine

WAHERB SPECIMEN DATABASE
GENERAL ENQUIRY

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: R.D. Royce s.n. Date: 07 1944 (PERTH 01506560)
LOCALITY Cultivated: Observatory Grounds, Perth WA
LAT Deg Min Sec LONG Deg Min Sec
From seed ex Type Locality.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: Teakle L.J. s.n. Date: 11 1929 (PERTH 1050788)
LOCALITY Near Forrestania WA
LAT 32 Deg 34 Min Sec S LONG 119 Deg 51 Min Sec E
Bushy tree, 25 ft.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: M.I.H. Brooker 6731 Date: 30 12 1979 (PERTH 1051237)
LOCALITY 8.3 km S of Hyden - Norseman road SW of crossroads (ca 80 km ESE of Hyden) WA
LAT 32 Deg 28 Min Sec S LONG 119 Deg 40 Min Sec E
Tree 6 m tall branching at 0.3 m into several stems, bark.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: C.F. Davies s.n. Date: 09 1966 (PERTH 1506110)
LOCALITY Ravensthorpe septen trionalem versus [N of Ravensthorpe] WA
LAT 33 Deg 34 Min 47.000 Sec S LONG 120 Deg 2 Min 36.000 Sec E
Frutex 2 m alt.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: T. Tapper s.n. Date: 08 06 1978 (PERTH 1051202)
LOCALITY At an old campsite 6-7 km SW of Lake Cronin, which is 80 km E of Hyden;
5 km SW of Hyden-Norseman/Southern Cross-Lake King crossroads WA
LAT 32 Deg 27 Min Sec S LONG 119 Deg 43 Min Sec E
Tree to 4 m in young stand. Odd trees to 8 m.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: L.D. Pryor & J.D. Briggs 96 Date: 13 09 1978 (PERTH 1043676)
LOCALITY Ca 80 km E of Hyden [For exact location see Perth Herbarium]. WA
LAT 32 Deg 25 Min Sec S LONG 119 Deg 40 Min Sec E
Young tree 4 m high, d.b.h. 3 cm, with a smooth grey stem. On an ironstone rise.
In a small (ca 1 ha.), pure stand of E. steedmanii, E. Gardneri and E. cylindrocarpa nearby.
The stand appeared to be mainly regeneration following fire within the last 10 years.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: L.D. Pryor & J.D. Briggs 96 Date: 13 09 1978 (PERTH 1043684)
LOCALITY Ca 80 km E of Hyden (For exact location see Perth Herbarium] WA
LAT 32 Deg 25 Min Sec S LONG 119 Deg 40 Min Sec E
Young tree 4 m high, d.b.h. 3 cm, with a smooth grey stem. On an ironstone rise.
In a small (ca 1 ha.), pure stand of E. steedmanii. E. Gardneri and E. cylindrocarpa nearby.
The stand appeared to be mainly regeneration following fire within the last 10 years.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: S.D. Hopper 1071 Date: 16 08 1978 (PERTH 1051326)
LOCALITY 74 km E of Hyden, 36 km NNE of Holt Rock WA
LAT 32 Deg 27 Min Sec S LONG 119 Deg 40 Min Sec E
Poles and mallees to 5 m tall (averaging 3 m). W side of ridge top. Red brown gravelly loam.
Growing in Open Eucalyptus salmonophloia woodland over E. salubris, E. steedmanii mallee over Callitris morrisoni ?, Acacia sp.,
Santalum sp, and Melaleuca sp. shrub.
Several hundred plants seen.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: S.D. Hopper 1073 Date: 17 08 1978 (PERTH 1051318)
LOCALITY 76 km E of Hyden, 36 km NNE of Holt Rock WA
LAT 32 Deg 26 Min Sec S LONG 119 Deg 40 Min Sec E
Trees 5-8 m tall which branch into several mallee-like stems within 1 m above
ground level to form a 'V'-shaped canopy; leaves grey-green and mostly held
erect, bark smooth, varying from grey to a rich red-brown.
Pale red-brown loam.
Growing in open woodland of Eucalyptus salmonophloia and E. steedmanii over open mallee of E. eremophila over low scrub.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: M.I.H. Brooker 6301 Date: 11 08 1979 (PERTH 1051229)
LOCALITY 7.2 km S of Hyden-Norseman road on road 6 km W of crossroads. [Ca 77 km E of Hyden] WA
LAT 32 Deg 25 Min Sec S LONG 119 Deg 40 Min Sec E
Tree 5 m tall, branching from near base, bark smooth light pink and grey satiny, leaves grey-green, glossy.
Growing on low sandy rise with quartz rubble. With E. salubris, E. eremophila, E. flocktoniae, E. salmonophloia*
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: C.F. Davies s.n. Date: 09 1966 (PERTH 1506129)
LOCALITY Ravensthorpe meridionalem versus [S of Ravensthorpe] WA
LAT 33 Deg 34 Min 47.000 Sec S LONG 120 Deg 2 Min 36.000 Sec E
Frutex erectus, 2 m alt.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: T. Tapper s.n. Date: 08 06 1978 (PERTH 1051210)
LOCALITY At an old campsite 6-7 km SW of Lake Cronin, which is 80 km E of Hyden;
5 km SW of Hyden-Norseman/Southern Cross-Lake King crossroads WA
LAT 32 Deg 27 Min Sec S LONG 119 Deg 43 Min Sec E
Tree to 4 m in young stand. Odd trees to 8 m.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K.R. Newbey 6179 Date: 03 10 1979 (PERTH 1050796)
LOCALITY 10 km SW of Lake Cronin, ca 75 km E of Hyden WA
LAT 32 Deg 28 Min Sec S LONG 119 Deg 42 Min 30.000 Sec E
Upright-spreading, moderately-dense, woody tree 3-5 x 0.8-1.5 m.
Well-drained clayey sand. Moderately exposed, gentle undulating plain. Almost pure stand of Eucalyptus steedmanii Low Forest B.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: S.D. Hopper 1073 Date: 17 08 1978 (PERTH 1051245)
LOCALITY 76 km E of Hyden, 36 km NNE of Holt Rock WA
LAT 32 Deg 26 Min Sec S LONG 119 Deg 40 Min Sec E
Trees 5-8 m tall which branch into several mallee-like stems within 1 m above
ground level to form a 'V'-shaped canopy; leaves grey-green and mostly held
erect, bark smooth, varying from grey to a rich red-brown.
Pale red-brown loam.
Growing in open woodland of Eucalyptus salmonophloia and E. steedmannii over open mallee of E. eremophila over low scrub.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: S.D. Hopper 1057 Date: 16 08 1978 (PERTH 1051288)
LOCALITY 73 km E of Hyden, 37 km NNE of Holt Rock WA
LAT 32 Deg 26 Min Sec S LONG 119 Deg 39 Min Sec E
Regenerating as poles up to 4 m high. Most plants have fruit, a few of the larger ones have buds.
Growing in lateritic loam, rich red-brown loam and ironstone gravel on ridge tops.
Growing sympatrically with Eucalyptus salubris in mallee vegetation over shrub.
Abundance: Several hundred plants located.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: D.F. Blaxell 1732 Date: 13 09 1978 (PERTH 1051334)
LOCALITY 80 km E of Hyden on track to Norseman WA
LAT 32 Deg 15 Min Sec S LONG 119 Deg 30 Min Sec E
Small tree 5 m. Bark smooth, shining, grey-green. Leaves with a grey cast. On low hills in gravelly loam over ironstone.
In woodland of this sp., Eucalyptus salubris, E. flocktoniae, E. gardneri, Callitris etc.
Spirit Collection Number: 1854 - buds - photo (NSW).
Previous det.: Eucalyptus steedmanii C. Gardner
Frequency:locally common.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K. Kershaw & L. Kerrigan KK 2359 Date: 28 02 2002 (PERTH 06397352)
LOCALITY Head 3.9 km W along gridline located 9.4 km N along Southern Cross-
Forrestania Road from intersection with Hyden-Norseman Road WA
LAT 32 Deg 19 Min 45.300 Sec S LONG 119 Deg 42 Min 20.300 Sec E
Mallet 4.5 m high. Ironstone/quartz. Red/brown clay and gravel.
Mallee Woodland. Eucalyptus sp. mallet x 2, Exocarpus sp., Acacia sp., Phebalium sp., Dodonaea sp.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K. Kershaw & L. Kerrigan KK 2360 Date: 28 02 2002 (PERTH 06397360)
LOCALITY 350 m N along gridline located 4.2 km W along gridline located 9.4 km
N along Southern Cross-Forrestania Road from intersection with Hyden-Norseman Road WA
LAT 32 Deg 19 Min 35.800 Sec S LONG 119 Deg 42 Min 9.200 Sec E
Small tree. Mallet-fire regeneration 2 m high. Quartz. Red/brown clay.
Mallet Woodland. Olearia muelleri, Acacia sp., Melaleuca sp., Eucalyptus sp x 2
Frequency:abundant. 4000+ plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: S. van Leeuwen s.n. Date: 04 1989 (PERTH 06121772)
LOCALITY Gridline N of Forrestania mining camp, SSW of Lake Cronin WA
LAT 32 Deg 30 Min Sec S LONG 119 Deg 45 Min Sec E
Mallet to 5 m with smooth coppery bark. On greenstone/red loam on gradual SW facing slope.
Previous det.: Eucalyptus steedmanii C.A.Gardner
Frequency:in dense population of over 100,000 plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R

Coll.: A.P. Brown 378 Date: 03 09 1986 (PERTH 06008186)
LOCALITY Low hill c. 7.25 km S of the Hyden - Norseman road on track which also heads N of the road to North Iron Cap WA
LAT 32 Deg 28 Min Sec S LONG 119 Deg 39 Min Sec E
In bud and fruit, no flowers. Low quartzite hill. Shrubland of Melaleuca, Callitris canescens, Allocasuarina and Santalum with emergent Eucalyptus steedmanii,
Previous det.: Eucalyptus steedmanii C.A.Gardner
Frequency:30+ plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: M.E. French 1499 Date: 01 03 2003 (PERTH 06405940)
LOCALITY NE of North Ironcap, W of Forrestania - Southern Cross Road WA
LAT 32 Deg 19 Min 39.500 Sec S LONG 119 Deg 43 Min 25.300 Sec E
Mallet, 6 m high. Smooth grey bark. Slight quartz rise with some ironstone.
Eucalyptus pileata, E. salubris, E. urna, E. salmonophloia.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: M. French 1505 Date: 16 04 2003 (PERTH 06419089)
LOCALITY Holland Track, SW of Wattle Rocks and SW of Mount Holland WA
LAT 32 Deg 16 Min 52.500 Sec S LONG 119 Deg 34 Min 57.300 Sec E
Mallet. Height: 3 m. Smooth tan bark, glossy olive-green leaves. Slight slope of white clay-loam.
Eucalyptus urna, E. salmonophloia, E. livioa.
Common North and South of Wattle Rocks.
Frequency:sparse clumps.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: M. French 1507 Date: 16 04 2003 (PERTH 06419097)
LOCALITY SE of Wattle Rocks on Holland Track, SW of Mount Holland WA
LAT 32 Deg 15 Min 53.500 Sec S LONG 119 Deg 35 Min 14.300 Sec E
Mallet. Height: 3 m. Smooth tan bark, glossy olive-green leaves. White clay loams, high in landscape.
Eucalyptus livida, E. densa subsp. densa, E. flocktoniae subsp. flocktoniae.
Frequency:common.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: E. Reid s.n. Date: 18 03 2006 (PERTH 07280165)
LOCALITY 75 km E of Hyden, 3.6 km S of Hyden Norseman Road, 7.8 km W of Forrestania South - Hyden Norseman crossroads WA
LAT 32 Deg 26 Min 55.400 Sec S LONG 119 Deg 40 Min 32.000 Sec E
Man made dame edge. Moist white/grey sand over laterite.
Eucalyptus salmonophloia, Hakea multilineata, Acacia hemiteles, Melaleuca elliptica.
Condition of Population: only three trees in area.
Frequency:3 mature plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: E. Reid s.n. Date: 18 03 2006 (PERTH 07280173)
LOCALITY 75 km E of Hyden, 3.6 km S of Hyden Norseman Road, 7.8 km W of Forrestania South - Hyden Norseman crossroads WA
LAT 32 Deg 26 Min 52.300 Sec S LONG 119 Deg 40 Min 37.400 Sec E
Man made dam edge. Moist white/grey sand over laterite. Melaleuca adnata, M. elliptica, Eucalyptus polita.
Frequency:1 mature plant.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R TYPE STATUS: HOL
Coll.: H. Steedman s.n. Date: 02 1928 (PERTH 1005960)
LOCALITY Forrestania. WA
LAT 32 Deg 34 Min Sec S LONG 119 Deg 51 Min Sec E
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R TYPE STATUS: ISO
Coll.: H. Steedman s.n. Date: 02 1928 (PERTH 1005979)
LOCALITY Forrestania. WA
LAT 32 Deg 34 Min Sec S LONG 119 Deg 51 Min Sec E

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: L.D. Pryor & J.D. Briggs 96 Date: 13 09 1978 (PERTH 1044095)
LOCALITY Ca 80 km E of Hyden (For exact location see Perth Herbarium) WA
LAT 32 Deg 25 Min Sec S LONG 119 Deg 40 Min Sec E
Young tree 4 m high, d.b.h. 3 cm, with a smooth grey stem. On an ironstone rise.
In a small (ca 1 ha.), pure stand of E. steedmanii. E. Gardneri and E. cylindrocarpa nearby.
The stand appeared to be mainly regeneration following fire within the last 10 years.
Previous det.: Eucalyptus steedmanii C. Gardner

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: S.D. Hopper 1057 Date: 16 08 1978 (PERTH 01051296)
LOCALITY 73 km E of Hyden, 37 km NNE of Holt Rock WA
LAT 32 Deg 26 Min Sec S LONG 119 Deg 39 Min Sec E
Regenerating as poles up to 4 m high, most plants have fruit, a few of the larger ones have buds.
Growing in lateritic loam, rich red-brown loam and ironstone gravel on ridge tops.
Growing sympatrically with Eucalyptus salubris in mallee vegetation over shrub.
Previous det.: Eucalyptus steedmanii C. Gardner
Frequency:several hundred plants located.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: J.A. Cochrane & A. Crawford JAC 4630 Date: 12 05 2003 (PERTH 07224710)
LOCALITY 9.4 km N of Forrestiana crossroad and 3.9 km W - on N side of grid line (S side burnt) WA

LAT 32 Deg 19 Min 45.900 Sec S LONG 119 Deg 42 Min 24.300 Sec E
Tall mallee with smooth red copper bark. Glossy grey-green leaves. Regeneration to 5 m tall.
Flattish/rise in landscape. Red clay. Laterite. Woodland.
Exocarpus spartus, Acacia sp., Phebalium sp., Eucalyptus spp.
Majority of plants on S side of grid line have not flowered and produced fruit since last fire.
Frequency:1000's of plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K. Kershaw & L. Kerrigan KK 2361 Date: 28 02 2002 (PERTH 06397344)
LOCALITY 250 m S along gridline located 3 km W along gridline located 9.4 km N
along Southern Cross-Forrestania Road from intersection with Hyden-Norseman Road WA
LAT 32 Deg 19 Min 53.100 Sec S LONG 119 Deg 42 Min 52.200 Sec E
Small tree 2.5 m high. Fire regeneration/Mallet species.
Ironstone/quartz. Red/brown clay.
Eucalyptus sp mallee x 3, Acacia sp., Melaleuca sp., Olearia muelleri, Exocarpus sp.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K. Kershaw & L. Kerrigan KK 2358 Date: 28 02 2002 (PERTH 06397301)
LOCALITY Head 2.4 km W along gridline located 9.4 km N along Southern Cross-
Forrestania Road from the intersection of Hyden-Norseman Road WA
LAT 32 Deg 19 Min 43.900 Sec S LONG 119 Deg 43 Min 16.900 Sec E
Small tree. Mallee 3 m high. Upslope. Ironstone and quartz. Red/brown clayey sand.
Mallee Woodland. Olearia muelleri, Acacia sp., Melaleuca sp. x 2, Dodonaea sp., Eucalyptus sp. x 2 (mallee).
Frequency:abundant. 2500+ plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K. Kershaw & L. Kerrigan KK 2362 Date: 28 02 2002 (PERTH 06397336)
LOCALITY 400 m E along gridline located 5.6 km S along gridline located 7.4 km
W along Hyden-Norseman Road from Southern Cross-Forrestania Road intersection WA
LAT 32 Deg 26 Min 40.100 Sec S LONG 119 Deg 41 Min 10.100 Sec E
Small tree. Mallee 2.5 m. Ironstone/quartz. Red/brown clayey sand.
Mallee Woodland. Olearia muellerii, Acacia sp., Exocarpus sp., Melaleuca sp., Eucalyptus sp. mallee x 2.
Frequency:abundant. 3000+ plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K. Kershaw & L. Kerrigan KK 2353 Date: 27 02 2002 (PERTH 06397328)
LOCALITY 23.5 km NE along Holland Track from Hyden-Norseman Road or 1 km NE of Wattle Rocks WA
LAT 32 Deg 15 Min 24.400 Sec S LONG 119 Deg 35 Min 49.700 Sec E
Small tree. Mallee 1.5 m. Upslope granite. Red/brown sandy clay.
Mallee Woodland. Olearia muelleri, Daviesia benthamii, Melaleuca lateriflora,
Acacia hemiteles, Microcorys sp., Melaleuca sp., Eucalyptus sp.
Frequency:abundant, 5000+ plants.

Eucalyptus steedmanii
C.A.Gardner (Myrtaceae)
CONSERVATION STATUS:R
Coll.: K.R. Newbey 8331 Date: 21 07 1981 (PERTH 1050818)
LOCALITY 10.6 km SW of Lake Cronin, ca 75 km E of Hyden (Hyden 1:250,000 sheet) WA
LAT 32 Deg 28 Min Sec S LONG 119 Deg 42 Min Sec E
Upright-spreading, moderately-dense, woody tree 2.2-2.6 m x 0.8-1.0 m. Leaves dull medium green.
Well-drained, stony loamy sand. Moderately exposed, gentle undulating plain. In E. eremophila Open Shrub Mallee (Muir, 1977).
Previous det.: Eucalyptus steedmanii C. Gardner
Frequency:rare.

Appendix D
DEC Letter of Advice Regarding *Eucalyptus steedmanii* Locations

Eucalyptus steedmanii Management Plan
Spotted Quoll Mine

Department of
Environment and Conservation

Your ref:
Our ref:
Enquiries: Caron Macneall
Phone: 9219 8778
Fax: 9219 8701
Email: caron.macneall@dec.wa.gov.au

17 DEC 2008

BY:

Mr P Knapton
Western Areas NL
Suite 3, Level 1
11 Ventnor Avenue
WEST PERTH WA 6005

Dear Mr Knapton

INQUIRY INTO LOCATION OF ENVIRONMENTALLY SENSITIVE AREA ON MINING TENEMENT M77/583

Thank you for your inquiry into the accuracy of Environmentally Sensitive Areas (ESAs) on mining tenement M77/583 received 10 November 2008.

I have been advised by the Species and Communities Branch at the Department of Environment and Conservation (DEC) that the ESA's under question were incorrectly plotted based on inaccurate records of populations of *Eucalyptus steedmanii*.

From the information you have submitted our records have been updated with the new *E. steedmanii* population coordinates supplied by Botanica consulting. The ESA's should now be aligned with the new populations of *E. steedmanii*.

The areas previously associated with *E. steedmanii* populations 2, 3A and 3B are no longer considered as ESA's and therefore exemptions under *Regulation 5 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply.

If you have any further queries regarding the location of the ESA's on mining tenement M77/583, please do not hesitate to contact Caron Macneall at the Department's Native Vegetation Conservation Branch on 9219 8744.

Yours sincerely

Kelly Faulkner
MANAGER
NATIVE VEGETATION CONSERVATION BRANCH

11 December 2008

Appendix E
Botanica *Eucalyptus steedmanii* Seed Levels Monitoring Results

Eucalyptus steedmanii Management Plan
Spotted Quoll Mine

Population 1

Way Point: 071/ pic 79
Way Point: 070/ pic 80

Distance (m)	# of DRF trees with Fruit/ vegetation	Distance covered (m)
0		
2.7	other veg	2.7
3.6	X 1 no fruit	0.9
8.3	other veg	4.7
9.8	X 3 no fruit	1.5
10.2	other veg	0.4
10.6	X 1 no fruit, X 1 mature fruit	0.4
14.3	other veg	3.7
15.2	X 1 no fruit	0.9
21	other veg	5.8
23	X 3 mature fruit, X 1 no fruit	2
25.2	other veg	2.2
25.6	X 1 no fruit	0.4
27	other veg	1.4
28.1	X 1 mature fruit, X 1 no fruit	1.1
28.9	other veg	0.8
29.3	X 1 no fruit, X 1 mature fruit	0.4
30.6	other veg	1.3
30.9	X 1 no fruit	0.3
32.8	other veg	1.9
33.7	X 1 no fruit	0.9
35	other veg	1.3
35.5	X 2 no fruit	0.5
36.7	other veg	1.2
37.2	X 1 mature fruit	0.5
37.9	other veg	0.7
38.4	X 1 immature fruit	0.5
40.8	other veg	2.4
42.2	X 1 mature fruit, X 1 no fruit	1.4
46.4	other veg	4.2
47.3	X 1 mature fruit, X 1 no fruit	0.9
48.6	other veg	1.3
49.2	X 1 mature fruit	0.6
50	other veg	0.8

	no fruit	immature fruit	mature fruit	total
number	16	1	10	27
%	59.26%	3.70%	37.04%	100.00%

Cover	other veg	Euc steedmanii	total
Total distance covered (m)	36.8	13.2	50
(% of distance)	73.60%	26.40%	100.00%

Plants per 100 square metres	estimated area of population (ha)	extrapolated population numbers
100	29.73	297300

Population 2

Way point: 072/ pic 83
Way point: 073/ pic 84

Distance (m)	# of DRF trees with Fruit/ vegetation	Distance covered (m)
0		
10	X 5 mature fruit	10
10.6	other veg	0.6
11.4	X 1 mature fruit	0.8
14	other veg	2.6
17.4	X 3 mature fruit	3.4
20.4	other veg	3
21.5	X 3 mature fruit	1.1
22.4	other veg	0.9
25.8	X 2 mature fruit	3.4
27.8	other veg	2
29.9	X 3 mature fruit	2.1
35	other veg	5.1
38.2	X 2 mature fruit	3.2
47.1	other veg	8.9
47.7	X 2 mature fruit	0.6
50	other veg	2.3

	no fruit	immature fruit	mature fruit	total
number	0	0	21	21
%	0.00%	0.00%	100.00%	100.00%

Cover	other veg	Euc steedmanii	total
Total distance covered (m)	25.4	24.6	50
(% of distance)	50.80%	49.20%	100.00%

Plants per 100 square metres	estimated area of population	extrapolated population numbers
30	2.98	8940

Population 3

Way point: 068/ pic 81
Way point: 069/ pic 82

Distance (m)	# of DRF trees with Fruit/ vegetation	Distance covered (m)
0		
1.7	other veg	1.7
2.3	X 1 no fruit	0.6
3.8	other veg	1.5
4.2	X 1 no fruit	0.4
4.8	other veg	0.6
5.6	X 1 mature fruit, X 1 no fruit	0.8
7.9	other veg	2.3
8.2	X 1 no fruit	0.3
8.9	other veg	0.7
9.6	X 1 no fruit	0.7
16.4	other veg	6.8
17.2	X 1 mature fruit	0.8
38.2	other veg	21
39.2	X 1 mature fruit	1
41.9	other veg	2.7
43.1	X 1 no fruit	1.2
45.6	other veg	2.5
45.8	X 1 no fruit	0.2
47.1	other veg	1.3
48.1	X 2 no fruit	1
48.7	other veg	0.6
50	X 1 immature fruit, X 3 mature fruit	1.3

Maturity Count	no fruit	immature fruit	mature fruit	total
number	9	1	6	16
%	56.25%	6.25%	37.50%	100.00%

Cover	other veg	Euc steedmanii	total
Total distance covered (m)	41.7	8.3	50
(% of distance)	83.40%	16.60%	100.00%

Plants per 100 square metres	estimated area of population	extrapolated population numbers
16	2.67	**4272**

Population 4

Way point: 076/ pic 77
Way point: 077/ pic 78

Distance (m)	# of DRF trees with Fruit/ vegetation	Distance covered (m)
0		
2.8	other veg	2.8
3.9	X 1 mature fruit, X 3 no fruit	1.1
4.6	other veg	0.7
5.8	X 4 no fruit	1.2
6.2	other veg	0.4
6.4	X 1 no fruit	0.2
6.6	other veg	0.2
9.3	X 8 no fruit, X 3 immature fruit	2.7
9.6	other veg	0.3
10.8	X 1 mature fruit, X 3 no fruit	1.2
15.5	other veg	4.7
17.2	X 2 mature fruit, X 1 no fruit	1.7
21.4	other veg	4.2
22.5	X 2 mature fruit	1.1
25.2	other veg	2.7
25.7	X 1 mature fruit	0.5
26.3	other veg	0.6
27	X 1 mature fruit	0.7
28.8	other veg	1.8
29.8	X 3 mature fruit	1
32	other veg	2.2
36.9	X 18 mature fruit	4.9
39.8	other veg	2.9
40.2	X 1 no fruit	0.4
40.5	other veg	0.3
42	X 2 mature fruit	1.5
43	other veg	1
43.3	X 1 mature fruit	0.3
43.5	other veg	0.2
44.6	X 4 mature fruit	1.1
45.1	other veg	0.5
47	X 8 mature fruit	1.9
47.6	other veg	0.6
48.5	X 1 immature, X 2 no fruit	0.9
49.4	X 1 immature fruit, X 1 no fruit, X 1 mature fruit	0.9
50	other veg	0.6

	no fruit	immature fruit	mature fruit	total
number	24	5	45	74
%	32.43%	6.76%	60.81%	100.00%

Cover	other veg	Euc steedmanii	total
Total distance covered (m)	26.7	23.3	50
(% of distance)	53.40%	46.60%	100.00%

Plants per 100 square metres	estimated area of population	extrapolated population numbers
336	115.4	3877440

Population 5

Way point: 075/ pic 76
Way point: 074/ pic 75

Distance (m)	# of DRF trees with Fruit/ vegetation	Distance covered (m)
0		
0.9	other veg	0.9
1.4	X 2 *E. steedmanii* no fruit	0.5
4.6	other veg	3.2
4.8	X 1 *E. steedmanii* no fruit	0.2
7.7	other veg	2.9
8	X 1 mature fruit-seed	0.3
11.4	other veg	3.4
12.1	X 2 *E. steedmanii* immature fruit, X1 no fruit	0.7
13.9	other veg	1.8
14.7	X 3 *E. steedmanii no fruit*, 1 immature fruit	0.8
16.1	other veg	1.4
16.7	X 1 no fruit	0.6
17.9	other veg	1.2
18.2	X 1 no fruit	0.3
19.1	other veg	0.9
19.4	X 1 no fruit	0.3
20.2	other veg	0.8
20.7	X 2 no fruit	0.5
21.6	other veg	0.9
21.9	X 1 no fruit	0.3
23	other veg	1.1
23.5	X 1 no fruit	0.5
24.5	other veg	1
24.9	X 1 no fruit	0.4
25.8	other veg	0.9
27.8	X 5 no fruit	2
31.1	other veg	3.3
31.3	X 1 no fruit	0.2
35.8	other veg	4.5
36.7	X 2 immature fruit, X 1 no fruit	0.9
37.6	other veg	0.9
39.3	X 6 mature fruit	1.7
40.1	other veg	0.8
40.5	X 1 mature fruit	0.4
40.8	other veg	0.3
44	X 13 mature fruit	3.2
44.5	other veg	0.5
45.2	X 4 mature fruit	0.7
47.1	other veg	1.9
48.4	X 4 mature fruit	1.3
50	other veg	1.6

	no fruit	immature fruit	mature fruit	total
number	22	5	29	56
%	39.29%	8.93%	51.79%	100.00%

Cover	other veg	Euc steedmanii	total
Total distance covered (m)	34.2	15.8	50
(% of distance)	68.40%	31.60%	100.00%

Plants per 100 square metres	estimated area of population (ha)	extrapolated population numbers
230	54.19	**1246370**

Eucalyptus steedmanii monitoring data for Population 2, February 2009

Transect Distance (m)	# of DRF trees with Fruit/ vegetation	Distance covered (m)
0		
10	X 5 mature fruit	10
10.6	other veg	0.6
11.4	X 1 mature fruit	0.8
14	other veg	2.6
17.4	X 3 mature fruit	3.4
20.4	other veg	3
21.5	X 3 mature fruit	1.1
22.4	other veg	0.9
25.8	X 2 mature fruit	3.4
27.8	other veg	2
29.9	X 3 mature fruit	2.1
35	other veg	5.1
38.2	X 2 mature fruit	3.2
47.1	other veg	8.9
47.7	X 2 mature fruit	0.6
50	other veg	2.3

	no fruit	immature fruit	mature fruit	total
number	0	0	21	21
%	0.00%	0.00%	100.00%	100.00%

Cover	other veg	Euc steedmanii	total
Total distance covered (m)	25.4	24.6	50
(% of distance)	50.80%	**49.20%**	100.00%

	Plants per 100 square metres	estimated area of population (ha)	extrapolated population numbers*
plot 1	30	2.98	8940
plot 2	33	2.98	9834
average	**31.5**	**2.98**	**9387**

*plants per metre square x estimated area of population

Keith Lindbeck and Associates
Environmental Management Consultants
ABN 36 150 274 469



WESTERN AREAS NL



A.R.N. 68 091 049 357

SPOTTED QUOLL-COSMIC BOY HAUL ROAD

SUPPLEMENT TO EPBC REFERRAL

Prepared for: ***Western Areas NL***

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May 2011

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Appendix 1: *Eucalyptus Steedmanii* Management Plan

1.0 INTRODUCTION

1.1 BACKGROUND

Western Areas NL (WANL) operates the Forrestania Nickel Project (FNP) in the Goldfields of Western Australia. WANL proposes to develop a haul road between the Spotted Quoll operation and Cosmic Boy processing plant. The haul road will be approximately 15.8 km in length, 5.7 km of which follows an existing 3 m wide track. See Referral under Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) for all associated information.

1.2 PURPOSE OF DOCUMENT

This document has been prepared as a supplementary document for referral under the EPBC Act in relation to **Item 3.1 (d) Listed threatened species and ecological communities**.

While there are no listed threatened ecological communities that occur or may occur in the project area, there are 16 threatened species listed that occur or may occur and these include seven species of birds, two species of mammals and seven species of plants. This document will include a brief description of all 16 species including their occurrence, potential occurrence and the potential impact of the proposed activity.

2.0 THREATENED SPECIES

Table 1 provides a list of the threatened species derived from the online EPBC Act Protected Matters Report.

Table 1 - Threatened species listed under EPBC Act for proposed haul road area

Birds	**Common name**	**Status**
Acanthiza iredalei iredalai	Slender-billed Thornbill	Vulnerable
Calyptorhynchus latirostris	Carnaby's Cockatoo	Endangered
Leipoa ocellata	Malleefowl	Vulnerable
Mammals		
Dasyurus geoffroii	Chuditch	Vulnerable
Phascogale calura	Red-tailed Phascogale	Endangered
MIGRATORY SPECIES		
Migratory Marine Birds		
Apus pacificus	Fork-tailed Swift	
Ardea modesta (alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Migratory Terrestrial Species		
Leipoa ocellata	Malleefowl	Vulnerable
Merops ornatus	Rainbow Bee-eater	
Migratory Wetland Species		
Ardea modesta (alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Listed Marine Species		
Apus pacificus	Fork-tailed Swift	
Ardea modesta (alba)	Great Egret, White Egret	
Ardea ibis	Cattle Egret	
Merops ornatus	Rainbow Bee-eater	
Plants		
Acacia lanuginophylla	Woolly Wattle	Endangered
Banksia sphaerocarpa var. *dolichostyla*	Ironcaps Banksia	Vulnerable
Boronia revoluta	Ironcap Boronia	Endangered
Eremophila viscida	Varnish Bush	Endangered
Eucalyptus steedmanii	Steedman's Gum	Vulnerable
Grevillea involucrata	Lake Varley Grevillea	Endangered
Roycea pycnophylloides	Saltmat	Endangered

2.1 Birds

2.1.1 *Acanthiza iredalei iredalai* Slender-billed Thornbill

Family: Pardalotidae



Plate 1 - *Acanthiza iredalei iredalai*

EPBC Distribution and Status: The Slender-billed Thornbill is sparsely distributed in disjunct populations across the southern arid and semi-arid portion of Western Australia and western South Australia. It is listed as Vulnerable under the EPBC Act.

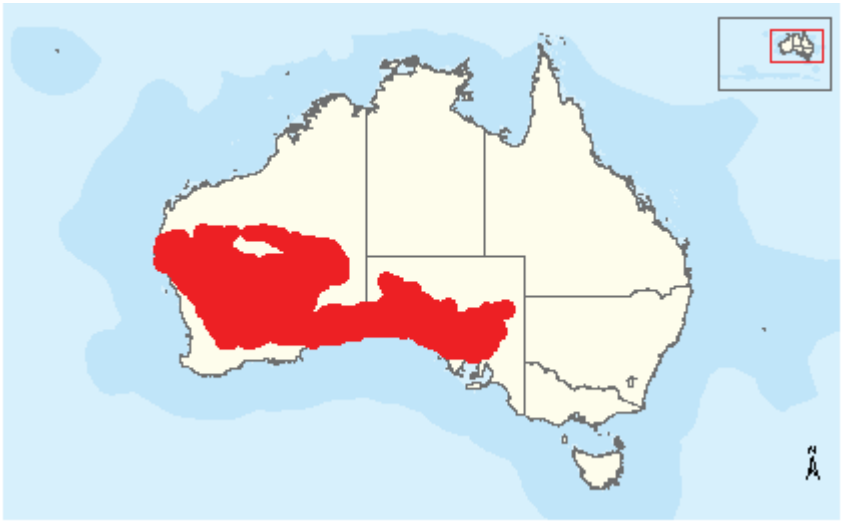


Figure 1 - Distribution of *Acanthiza iredalei iredalai*

Habitat and Ecology: The Slender-billed Thornbill generally occurs in flocks of up to ten birds, and breeds in solitary pairs. Its extent of occurrence does not appear to have declined; rather it has disappeared from several areas. A low-reliability estimate of the population size is 100,000 breeding birds, divided into seven subpopulations that are likely to be stable (DSEWPC 2011).

Chenopod shrub-lands dominated by samphires or *Maireana* and *Atriplex* associations are the Thornbill's preferred habitat (Morcombe, 2003). However, the Thornbill occasionally occurs in adjacent acacia shrub-lands and mangroves. This species is likely to be a resident that occupies an area of up to 8 200m^2 during the breeding season (DSEWPC 2011).

The birds feed on insects, spiders, and centipedes, as well as stems and foliage of *Maireana sedifolia*, *M. pyramidata*, *Atriplex vesicaria*, *Acacia tetragonophyllya* and *A. aneura* (DSEWPC 2011).

Little information concerning breeding age, life span or breeding success of the Slender-billed Thornbill is known, which in part is due to the shy and wary nature of the bird and the inaccessibility of its habitat. Breeding occurs from July to October, but may extend into November, with the bird laying between two and four eggs. The nests are generally placed in the upper branches of small samphire shrubs, or some *Acacias* such as *A. aneura*. The nests have a side entrance and are dome- or globular-shaped, and constructed of bark and grass bound by cobwebs, and lined with soft plant material (DSEWPC 2011).

Habitat degradation is the primary threat to the Slender-billed Thornbill, which is often caused by livestock and rabbits, and possibly the impact of mining activities. Nests are sometimes parasitised by cuckoos (DSEWPC 2011).

Recordings from the area and potential impacts: There are no known records from the Department of Environment and Conservation (DEC) or the Western Australian Museum (WAM) that show the species occurs within the area proposed for disturbance (WANL 2009). Further, this species has not been recorded in any of the many, recent surveys conducted in the area (Biota 2006a, 2006b, 2007a, 2007b, KLA 2011). There is also no preferred habitat within the area proposed for the haul road between Spotted Quoll and Cosmic Boy. Given the above, it is unlikely that there will be any impact on the conservation significance of this species.

2.1.2 *Calyptorhynchus latirostris* Carnaby's Cockatoo

Family: Psittacidae



Plate 2 - *Calyptorhynchus latirostris*

EPBC Distribution and Status: Carnaby's Cockatoo is endemic to southwest Western Australia, extending from the Murchison River to Esperance, and inland to Corrow, Kellerberrin and Lake Cronin (Johnstone and Storr 1998). Carnaby's Cockatoo is scarce and patchily distributed in the driest parts of its range and in the extreme south-west. It has shown a reduction in its range, particularly in the northern and eastern areas of the wheatbelt, largely because of clearing for agriculture (Cale 2003). It is listed as Endangered under the EPBC Act.

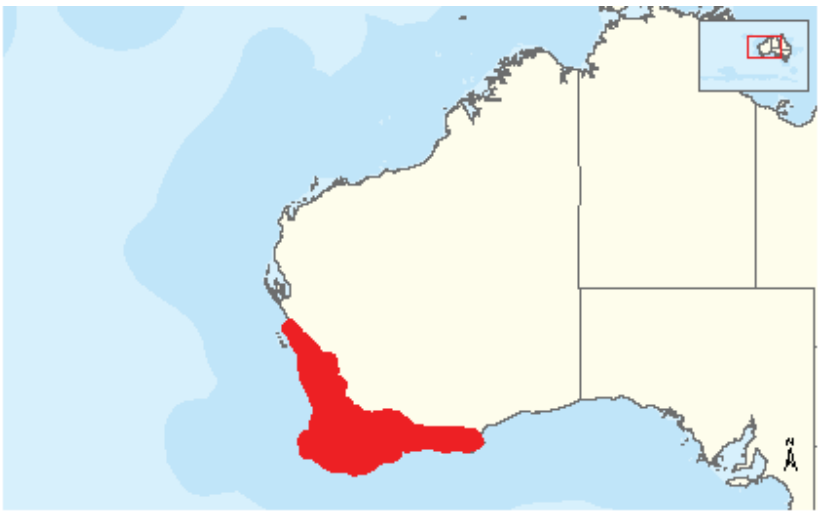


Figure 2 - Distribution of *Calyptorhynchus latirostris*

Habitat and Ecology: Carnaby's Black-Cockatoo has a present population of approximately 11 000 – 60 000 birds (Saunders *et al.* 1985) that is divided into three to five sub-populations (Garnett and Crowley 2000). Its extent of occurrence has contracted approximately 30% since the 1940s (Mawson 1997).

Eucalypt woodlands containing *Eucalyptus salmonophloia* (Salmon Gum) and *E. wandoo* (Wandoo) is the preferential breeding habitat for Carnaby's Cockatoo. However, the availability of suitable nesting hollows, which can take 120 to 150 years to develop (Pittman *et al.* 2007), will influence breeding success together with the availability of nearby foraging grounds (DSEWPC 2011). Foraging habitat generally includes shrub-land or kwongan health-land dominated by *Hakea*, *Banksia* and *Grevillea* species (Morcombe 2003). However, Carnaby's may seasonally forage in marri, exotic pine forests (DSEWPC 2011) or on farmed fruit and nut trees (Pittman *et al*. 2007). The distance between foraging grounds and nesting sites vary, but can be over 12 km as demonstrated in one study by Saunders (Saunders 1980).

Nests are generally more than two metres above ground level, at least 0.1 m deep (DSEWPC 2011) and are mostly lined with wood dust (Johnstone and Storr 1998). The parents live in solitary pairs throughout the breeding season and generally return to the same breeding grounds each year (Higgins 1999).

The loss and fragmentation of habitat, the clearance of health-lands around breeding sites, and the removal of native vegetation corridors are considered principle factors in the decline of the Carnaby's Cockatoo (DSEWPC 2011). Furthermore, the reduced availability of suitable nesting hollows compounded by competition for nesting hollows by other bird species, such as the Galah and Western Corella, and by the European bee are other factors. Other threats include predation by Wedge-tailed Eagles, vehicular trauma and the abandonment of nests following disturbance (DSEWPC 2011).

Carnaby's Cockatoo do not reach breeding age until at least four years of age (Saunders 1982) and can live for 40 – 50 years (DSEWPC 2011). Cale (2003) estimates that the generation time to be 15 years. Hence, threatening processes have a high potential to cause significant declines in populations, and that any recovery of the species will be relatively slow, especially considering those birds that do breed successfully in a season are very unlikely to have more than one fledged offspring.

Recordings from the area and potential impacts: Very small numbers of Carnaby's Cockatoo occur in the region during the breeding season, which occurs from September

to January, suggesting that most are probably migrants returning from the Lake Cronin and Hatters Hill feeding areas (Johnstone, Johnstone and Kirkby 2008).

Three individual Carnaby's Cockatoo were seen flying overhead in the southern area of the proposed haul road during a recent Single Phase Fauna Survey (Biota 2010). Biota (2010) reported that this species had been recorded in past surveys within the Forrestania area.

Targeted surveys were conducted in June and July 2010 to record any Carnaby's Cockatoo present and to determine the number of potential breeding hollows for Carnaby's Cockatoo in the area proposed for the haul road (KLA 2011). While no sightings of Carnaby's were recorded during the surveys, many hollows and potential hollows were recorded. However, the results indicated that only some sections of the proposed haul road route comprise vegetation with attributes that support hollows and potential hollows for Carnaby's Cockatoo and primarily this vegetation is described as "Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland". Single or sparse *E. salmonophloia* in other vegetation groups particularly in the southern section of the proposed haul road route also provide potential habitat for these species. The survey included an area to the west of the proposed haul road to determine if hollows and potential hollows were confined to the area proposed for disturbance or were present elsewhere. Results from this survey indicated that the vegetation outside of the proposed haul road route also supports habitat characteristics favoured by Carnaby's Cockatoo. Thus, vegetation comprising hollows and potential hollows for Carnaby's Cockatoo is not limited to areas within the proposed haul road route. Therefore, the project is unlikely to alter the conservation significance of this species.

2.1.3 *Leipoa ocellata* Malleefowl

Family: Megapodiidae



Plate 3 - *Leipoa ocellata*

EPBC Distribution and Status: The Malleefowl was once broadly distributed across the southern half of the Australian continent, but has undergone significant range reduction and now occupy semi-arid regions of southern Australia where mallee eucalypts form the dominant vegetation (Birds Australia 2011). It is listed as Vulnerable and Migratory (Terrestrial) under the EPBC Act.

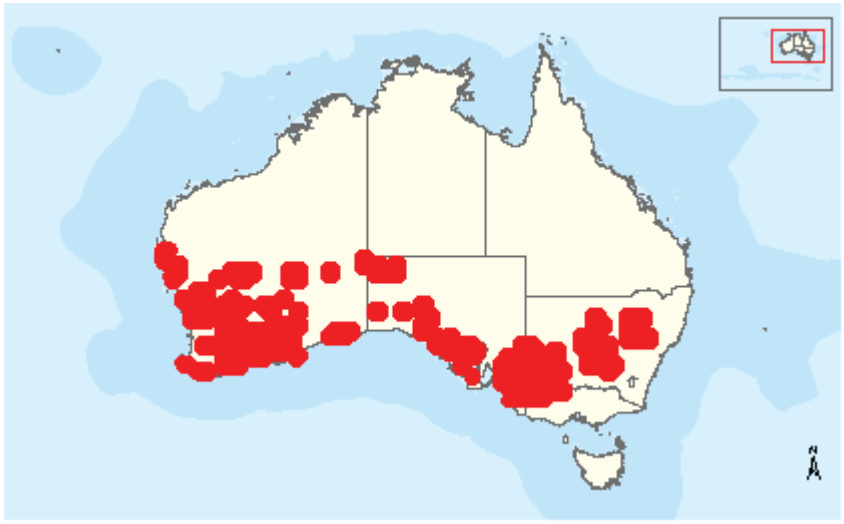


Figure 3 - Distribution of *Leipoa ocellata*

Habitat and Ecology: The Malleefowl is a large, ground-dwelling bird weighing up to 2.5 kg; it is a poor flyer and therefore, rarely flies but rather walks along the ground (DSEWPC 2011). Malleefowl are usually solitary and occupy a home range of between 0.5 and 4.6 km^2 (Benshemesh 1992). Established monogamous breeding pairs usually inhabit a similar area throughout the year, and come together for breeding (Marchant and Higgins 2003; Benshemesh 1992). An estimated lifespan of the Malleefowl is 15 years, with the onset of breeding occurring in three to four-year old captive birds (DSEWPC 2011).

An accurate estimate of the population of Malleefowl is unknown, but it could lie in the vicinity of 100 000 birds (Garnett and Crowley 2000); and it is known to be declining (Benshemesh 2005; Benshemesh 2000; Garnett and Crowley 2000).

Shrublands and low woodlands that are dominated by mallee vegetation are the Malleefowl's preferred habitat, but they may also occur in other plant communities such as eucalypt or native pine woodlands, acacia shrub-lands, and Broombush vegetation (Benshemesh 2005). A dense, discontinuous canopy together with a dense understorey of shrubs, or grasses and herbs, together with abundant leaf litter is ideal (Benshemesh 2005), as it provides shelter from predators and materials for building mounds (Marchant and Higgins 2003).

Suitable soils are sandy or loamy, and the area with a rainfall of between 200 and 450 mm (Priddel and Wheeler 1995). Mounds may consist of sand or soil, and organic matter; and are up to 12 m in diameter and more than one metre high (Marchant and Higgins 2003). A combination of fermentation and solar radiation incubates the eggs (Frith 1956). Food sources include seeds, plant material, invertebrates, lerp, fungi, and tubers; they mostly forage at dawn and dusk (Marchant and Higgins 2003).

Birds generally breed annually (Marchant and Higgins 2003) with the breeding season extending up to 11 months (DSEWPC 2011) beginning with the first eggs being laid in September that may continue through until autumn (Marchant and Higgins 2003). Three to 35 eggs are laid at five to 17-day intervals, and the fully independent chicks emerge 49 to 96 days later (Frith 1959). Fifty to eighty-five percent of eggs hatch (Frith, 1959). However, generally more than 80% of chicks die within the first few weeks from predation and 'metabolic stress' (Priddel and Wheeler 1994).

Significant threats to the conservation of the Malleefowl include clearing (DSEWPC 2011), fragmentation and isolation of populations and fire (Benshemesh 2005). One of the most important threats to the long-term survival of the species is predation (Priddel and

Wheeler 1995), principally by foxes, which can take more than a third of eggs and are responsible for up to 50% of mortality amongst chicks to sub-adult stage (Benshemesh 2005). Raptors may account for a further 30% of chick deaths (Priddel and Wheeler 1995).

Recordings from the area and potential impacts: A Single Phase Fauna Survey identified one recently disused Malleefowl mound in the area proposed for the haul road (Biota 2010).

Recent targeted surveys were conducted in June and July 2010 to record any Malleefowl and Malleefowl mounds in the area proposed for the haul road (KLA 2011). No active Malleefowl mounds were found within the areas surveyed and no signs of Malleefowl presence were recorded. However, three old Malleefowl mounds were identified within the area proposed for disturbance and a fourth 'megamound' was located within 500 m northeast of the northern portion of the proposed haul road. The presence of these mounds indicated that Malleefowl once did use this area. A recent targeted Malleefowl survey within 5 km of the northern section of the current survey area identified eight old, abandoned Malleefowl mounds and only one active mound (753926E 6405992N) (KLA 2010). Given the large home range (up to 4.6 km) of the Malleefowl and the amount of undisturbed vegetation locally, the development of the proposed haul road is not likely to impact on the Malleefowl and its potential mound-building habitat. Thus, the conservation status of this species is not likely to be altered by the proposed disturbance for the haul road.

2.1.4 *Apus pacificus* Fork-tailed Swift

Family: Apodidae



Plate 4 - *Apus pacificus*

EPBC Distribution and Status: The Fork-tailed Swift has a large distribution throughout Australia except for a small central arid section. It is listed as Migratory and Marine under the EPBC Act and is included in the CAMBA, JAMBA and ROKAMBA treaties.

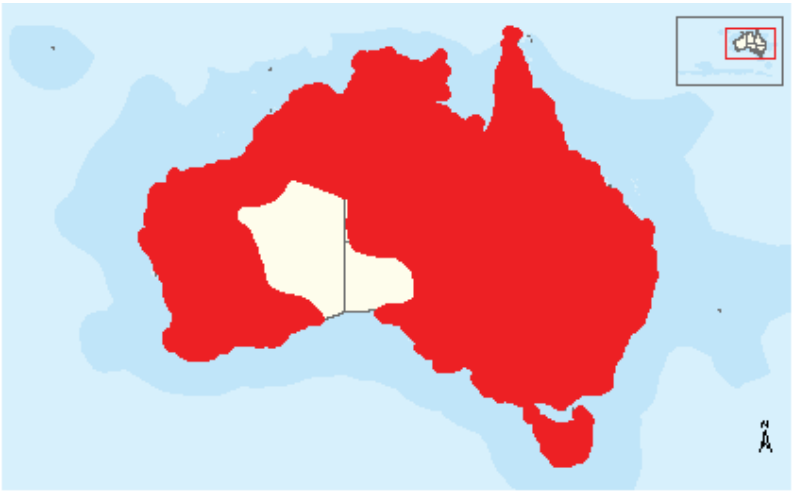


Figure 4 - Distribution of *Apus pacificus*

Habitat and Ecology: The Fork-tailed Swift is a transient of Australia, choosing to breed in mainland Asia, as well as some of the islands off Asia from the Kuril Islands to Formosa. It nests in cliff crevices, or under the eaves of houses, or similar structures. Eggs are laid in June/July and the young leave the nest usually in the first week of August. Migration takes place at the end of August, and the Swift occurs in Australia between September and April. They are often associated with cyclonic storms, near which, they 'hawk' for insects on which they feed (Boehm and Sutherlands 1962).

Recordings from the area and potential impacts: There have been no reported sightings of the Fork-tailed Swift at Forrestania, and no records in surveys conducted at the site (WANL 2009). If the species does frequent the area, any impact is likely to be negligible, as it does not breed within Australia. Furthermore, the Spotted Quoll proposal area presents a very small area in terms of potential habitat.

2.1.5 *Ardea modesta (alba)* Great Egret, White Egret

Family: Ardeidae



Plate 5 - *Ardea modesta (alba)*

EPBC Distribution and Status: The Great Egret has a large distribution throughout Australia except for a small central arid section. It is listed as Migratory and Marine under the EPBC Act and is included in the CAMBA and JAMBA treaties.



Figure 5 - Distribution of *Ardea modesta (alba)*

Habitat and Ecology: The Eastern Great Egret is common throughout much of Australia. It inhabits wetlands, flooded pastures, dams, estuarine mudflats, mangroves and reefs (Morcombe 2003); where they hunt in shallow water feeding on mostly fish, but also insects, crustaceans and amphibians (WANL 2009). They breed in colonies of mixed species (WANL 2009).

Recordings from the area and potential impacts: There have been no reported sightings of the Great Egret at Forrestania, and no records in surveys conducted at the site (WANL 2009). The Forrestania area does not support its preferred habitat as there are no significant permanent or ephemeral freshwater systems in or near the project area, and none capable of providing its primary food source. Therefore, the proposal is not expected to impact upon this species or alter its conservation status.

2.1.6 *Ardea ibis* Cattle Egret

Family: Ardeidae



Plate 6 - *Ardea ibis*

EPBC Distribution and Status: The Cattle Egret has a large distribution throughout Australia except for a small central arid section. The Cattle Egret first arrived in northern Australia in the 1950's, and has since spread to its current distribution, though it is less common in the southern areas (Morcombe 2003). It is listed as Migratory and Marine under the EPBC Act and is included in the CAMBA and JAMBA treaties.



Figure 6 - Distribution of *Ardea ibis*

Habitat and Ecology: The Cattle Egret is mostly seen in small groups to large flocks. They primarily inhabit moist pastures with tall grass, shallow open wetlands and margins and mudflats (Morcombe 2003). The Cattle Egret often nests and roosts in colonies with thousands of other birds. They live on insects and sometimes-on small aquatic animals, and is often seen feeding around the feet of slow moving cattle, or perched on their backs (WANL 2009).

Recordings from the area and potential impacts: There have been no reported sightings of the Great Egret at Forrestania, and no records in surveys conducted at the site (WANL 2009). The Forrestania area does not support its preferred habitat as there are no significant permanent or ephemeral freshwater systems in or near the project area, and there are no livestock in the general area. Therefore, the proposal is not expected to impact upon this species or alter its conservation status.

2.1.7 *Merops ornatus* Rainbow Bee-eater

Family: Meropidae



Plate 7 - *Merops ornatus*

EPBC Distribution and Status: The Rainbow Bee-eater is distributed throughout Australia, excluding Tasmania; eastern Indonesia; and east to Papua New Guinea; the Bismarck Archipelago; and rarely the Solomon Islands. They are vagrants to Palau, south-western Micronesia, Saipan, the northern Mariana Islands, Miyako Island, and the southern Ryuku Islands in Japan (WANL 2009). The Rainbow Bee-eater is listed as Migratory and Marine under the EPBC Act 1999 and is included in the JAMBA treaty.



Figure 7 - Distribution of *Merops ornatus*

Habitat and Ecology: The Rainbow Bee-eater is a medium-sized bird that is usually seen in pairs of small flocks when not migrating (Higgins 1999). While there are no estimates on the population size of the species, it is considered large (DSEWPC 2011).

The Rainbow Bee-eater occurs in a diverse range of habitats. It is most often observed in open forests and woodlands usually dominated by eucalypts (DSEWPC 2011), shrub-lands, and in cleared or semi-cleared habitats that includes farmland and areas of human habitation (Higgins 1999), and often in close proximity to permanent water (DSEWPC 2011). Other types of habitats include heath-land, sedgeland, grassland, vine forest and vine thickets; also coastal sand dune systems, and mangroves in northern Australia (Higgins 1999).

The bird nests in monogamous pairs in small colonies (DSEWPC 2011) with parents sometimes being aided by generally male 'helpers' (Boland 2004). The majority of the global population breed in Australia where the breeding season occurs from August to January (Higgins 1999). The bird nests on flat or sloping ground, in riverbanks, creeks or dams, roadside cuttings, in the walls of gravel pits, gravel mounds or in cliff faces by excavating a chamber at the end of a long burrow (Fry 1984; Higgins 1999; Lill 1993). Two to eight eggs are laid (Lill 1993). The young are continued to be fed, two to four weeks after fledging (Boland 2004).

The population in the south of Australia migrate north between February and April to return to their breeding grounds in September and October (Serventy and Whittell 1976). Birds have a lifespan of up to two years (Higgins 1999).

There is one identified threat to the Rainbow Bee-eater, this being the Cane Toad, as they feed on eggs and nestlings and usurp the nesting burrows that are often located on the banks of water-bodies (DSEWPC 2011). One study by Boland (2004), found that one third of breeding attempts failed due to interference by Cane Toads, and that this potentially could have a significant effect on those populations affected.

Nestlings or eggs may be lost to predation by foxes (Higgins 1999), dingoes, feral dogs (Boland 2004), goannas and monitors (Forshaw and Cooper 1987), brown snakes (Lill 1993), Australian magpies and Brown Goshawks (Ashton 1986; Forshaw and Cooper, 1987); heavy rain; desertion; malnutrition; or by trampling *etc.* (Boland 2004; Lill 1993).

Recordings from the area and potential impacts: Few observations (n = 2) of this species have been recorded from Forrestania during all surveys conducted in the area (Biota 2006, WANL 2009, KLA 2011). Given that Forrestania does not support a permanent

fresh water source, it is unlikely that the Bee-eater would remain in the area to breed. However, it would not be surprising for this species to be seen in the area within its migratory route. Notwithstanding this, it is unlikely that the proposed disturbance will alter the conservation status of the Rainbow Bee-eater.

2.2 Mammals

2.2.1 *Dasyurus geoffroii* Chuditch

Family: Dasyuridae



Plate 8 - *Dasyurus geoffroii*

EPBC Distribution and Status: The Chuditch was formerly present across semi-arid southern Australia from south-west Western Australia to western Queensland and New South Wales. It is now confined to sclerophyll and mallee remnants in south-west Western Australia (Menkhorst and Knight 2004). It is listed as Vulnerable under the EPBC Act.

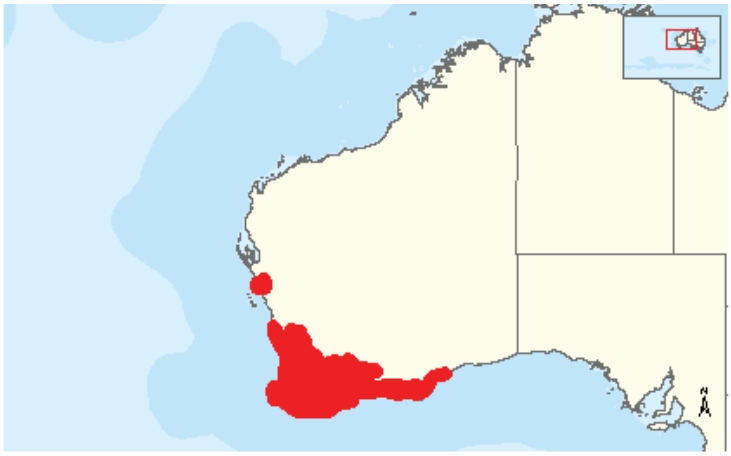


Figure 8 - Distribution of *Dasyurus geoffroii*

Habitat and Ecology: The Chuditch is the largest carnivorous marsupial found in Western Australia. It is solitary, mostly nocturnal and partly arboreal. It is estimated that Chuditch formerly occupied 70% of mainland Australia (DSEWPC 2011). However, in 1994, the Chuditch was estimated to occur in just 5% of its original range (Orell and Morris 1994). The Chuditch has a large home range and occurs at very low densities with males ranging over 15 km^2 and females 3 km^2 to 4 km^2 (Serena and Soderquist 1989). Females tend to be territorial and their 'core areas', defined by den locations, are typically non-overlapping.

Most types of wooded habitats are utilised by the Chuditch within its current distribution; such areas include Eucalypt forest, dry woodland, and mallee shrub-lands (Serena and Soderquist 1988). However, the Chuditch may be able to inhabit dry sclerophyll forests, beaches and deserts as suggested by its previous distribution (Burbridge *et al.* 1988;

Shortridge 1909). Riparian forest has provided the densest populations of Chuditch (DSEWPC 2011), presumably due to the abundance of food in these areas (Orell and Morris 1994).

Suitable dens or refugia for Chuditch include tree hollows, hollow logs, beneath the base of fallen trees or rock crevices. The Chuditch is a generalist predator and includes large invertebrates, supplemented by small mammals, birds and lizards in its diet (Orell and Morris 1994).

The breeding season begins in April with young being born between May and September (Stead-Richardson *et al*. 2001). Young are pouch-bound for their first two months, before being left in the den (Orell and Morris 1994). At five to six-months of age they are weaned (DSEWPC 2011). Weaned females will remain close to the maternal home range. However, males disperse within two weeks of weaning (Soderquist and Serena 2000).

Recordings from the area and potential impacts: Chuditch have been captured in the Forrestania area (Biota 2006a, 2007a) and more recently at the southern end of the proposed haul road (Biota 2010). A fire in the 1990's destroyed many of the large trees and logs (Johnstone, Johnstone, and Kirkby 2008) in the Spotted Quoll area and elsewhere that would act as suitable dens for Chuditch.

Targeted surveys were conducted in June and July 2010 to record any Chuditch present and to determine the number of potential refugia for Chuditch in the area proposed for the haul road (KLA 2011). While no sightings of Chuditch were recorded during the surveys, many refugia were recorded. However, the results indicated that not all sections of the proposed haul road route comprise vegetation with attributes that support refugia for Chuditch. The survey included an area to the west of the proposed haul road to determine if refugia were confined to the area proposed for disturbance or were present elsewhere. Results from this survey indicated that the vegetation outside of the proposed haul road route also supports habitat characteristics favoured by Chuditch. Thus, vegetation comprising refugia for the Chuditch is not limited to areas within the proposed haul road route. Therefore, the proposed disturbance is unlikely to alter the conservation significance of this species.

2.2.2 *Phascogale calura* Red-tailed Phascogale

Family: Dasyuridae



Plate 9 - *Phascogale calura*

EPBC Distribution and Status: Formerly widespread in woodland habitats in inland south and central Australia, the Red-tailed Phascogale is now restricted to remnants of Mature Wandoo or Rock Oak woodland in the south of the Western Australian wheatbelt where the annual rainfall is 300 – 600 mm (Menkhorst and Knight 2004). It is listed as Endangered under the EPBC Act.

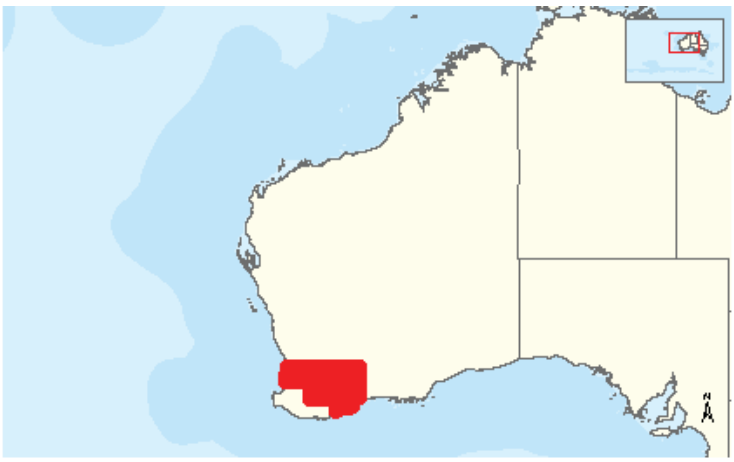


Figure 9 - Distribution of *Phascogale calura*

Habitat and Ecology: The Red-tailed Phascogale is a small, arboreal, carnivorous marsupial (DSEWPC 2011), inhabiting the central and southern Wheatbelt regions of Western Australia with an annual rainfall of 350 – 600 mm (Bradley, 1998). Its preferred habitat includes *Allocasuarina hueglianna* (granite she-oak) woodland associations with hollow-containing eucalypts such as *Eucalyptus wandoo* (Kitchener 1981). However, it has also been found in other woodlands and mallee-scrub (DSEWPC 2011). They prefer an unburnt landscape with continuous canopy with hollows and logs for nesting (DSEWPC 2011).

Recordings from the area and potential impacts: There have been no sightings of the Red-tailed Phascogale, nor have there been any found in site fauna surveys (WANL 2009). However, due to their timid nature, they are not readily seen in their natural environment (DSEWPC 2011). *Allocasuarina huegliana* and *Eucalyptus wandoo* woodland associations that are the preferred habitat of the Red-tailed Phascogale do not occur within the proposed footprint of disturbance. Therefore, the proposed activities associated with the construction and use of the haul road are not likely to impact the conservation status of this species.

2.3 Plants

2.3.1 *Acacia lanuginophylla* Woolly Wattle

Family: Mimosaceae



Plate 10 - *Acacia lanuginophylla*

EPBC Distribution and Status: *Acacia lanuginophylla* is found in the Newdegate-Pingaring area (Brown *et al.* 1998) and near Mt Holland in the south of south-western Western Australia (DSEWPC 2011). It is listed as Endangered under the EPBC Act.

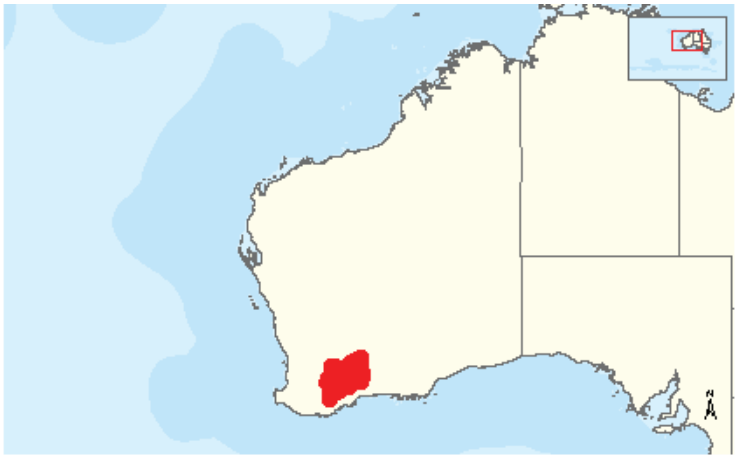


Figure 10 - Distribution of *Acacia lanuginophylla*

Habitat and Ecology: *Acacia lanuginophylla* normally grows in slightly saline grey-white sands over clay and gravelly soils in broad drainage channels (DSEWPC 2011). It occurs in open low scrub of various *Melaleuca* and *Eremophila* species (DSEWPC 2011). The globular golden flower heads are borne variably between June and February, but most commonly from August to October.

Recordings from the area and potential impacts: This species has not been recorded in any of the flora surveys conducted in the Forrestania area (WANL 2009, Botanica Consulting 2011). Therefore, the disturbance proposed for the haul road is unlikely to have any impact on the species or its conservation status.

2.3.2 *Banksia sphaerocarpa* var. *dolichostyla* Ironcaps Banksia

Family: Proteaceae



Plate 11 - *Banksia sphaerocarpa* var. *dolichostyla*

EPBC Distribution and Status: This species occurs just to the east of the cleared southern wheatbelt in south-western WA. It grows between Mt Holland and South Ironcap, east of Hyden, on vacant Crown Land (Mollemans *et al.* 1993; Brown *et al.* 1998). Surveys carried out in 1989/90 showed seven populations totaling over 2,400

plants. By 1994 there were nine populations with a total of about 6,500 plants. It is listed as Endangered under the EPBC Act.

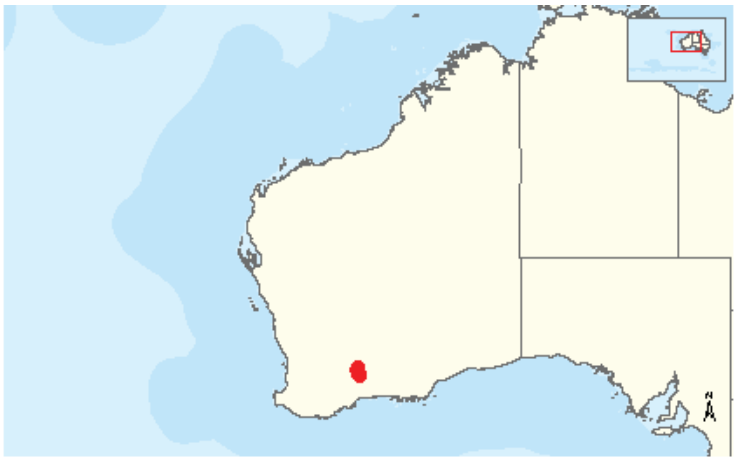


Figure 11 - Distribution of *Banksia sphaerocarpa* var. *dolichostyla*

Habitat and Ecology: The plant is a shrub or small tree that can grow to 4 m by 4 m. It produces spherical-shaped yellow flowers (DSEWPC 2011) from March through to May (George, 1996) that are pollinated by wasps, bees, and ants (Taylor and Hopper 1988).

Banksia sphaerocarpa var. *dolichostyla* prefers iron-capped hills and rises on ironstone soil profiles. It is found in low woodlands or shrub-lands (DSEWPC 2011) with an annual rainfall of approximately 300 mm (George 1996), and is often associated with *Dryandra* and *Allocasuarina* species (Hopper *et al*. 1990). The species is fire tolerant as it possesses a lignotuber (George 1996).

Recordings from the area and potential impacts: The populations that occur closest to the Forrestania tenements include those on the North Ironcap, which comprises more than 100 plants, Forrestania with more than 50 plants, the South Ironcap with more than 1000 plants, and southeast of the South Ironcap that has more than 500 plants.

This species has not been identified in the vicinity of the proposed haul road (Botanica Consulting 2011), which is in support of its preference for ironstone ridges, the closest of which occurs some 12 km to the southeast (WANL 2009). Given that there is no preferred habitat for the species in the area, and it was not recorded in the area, there will be no impact on this species from the proposed disturbance.

2.3.3 *Boronia revoluta* Ironcaps Boronia

Family: Rutaceae

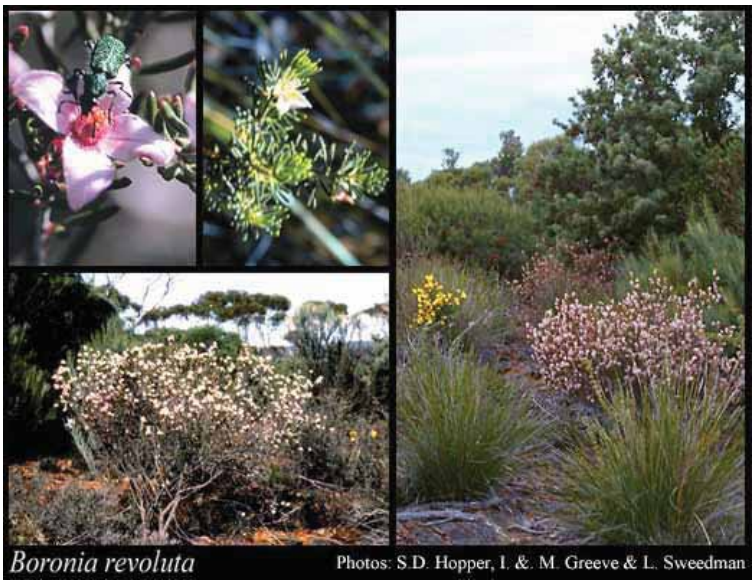


Plate 12 - *Boronia revoluta*

EPBC Distribution and Status: *Boronia revoluta* is restricted to an approximate 40 km range within the South Ironcap-Hatters Hill area that lies northeast of Lake King in Western Australia (Leigh *et al.* 1984). It has been collected from only three locations on ironstone hills within its range as follows; Hatters Hill (approximately 60 plants), South Ironcap (approximately 400-500 plants) and Middle Ironcap where this species has not been found since 1976 (Buehrig 1997, Duretto 1999). It is listed as Endangered under the EPBC Act.

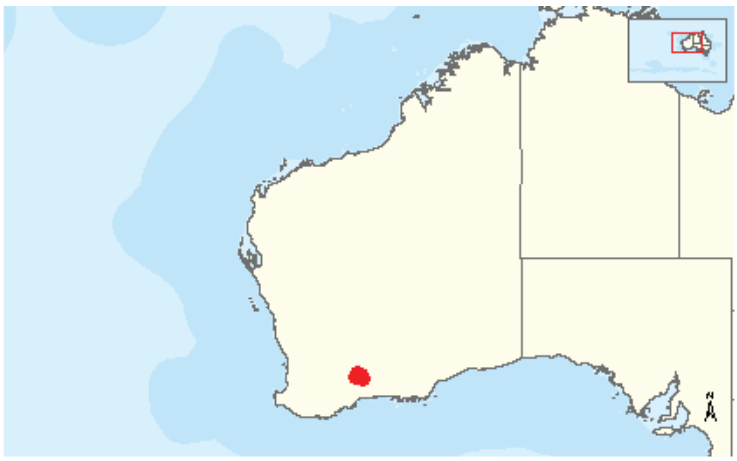


Figure 12 - Distribution of *Boronia revoluta*

Habitat and Ecology: Ironcap Boronia is an erect shrub, 0.5 – 1.5 m in height, with many branches and pale to dark pink flowers from July to October, and producing fruit from September to December (Duretto 1996). This species is most likely to be restricted to ironstone hills growing in cracks in the rocks (WANL 2009).

Recordings from the area and potential impacts: *Boronia revoluta* is known to occur in the Forrestania area (WANL 2009). However, it was not recorded during a comprehensive flora survey of the proposed haul road area. (Botanica Consulting 2011). Therefore, the disturbance proposed for the haul road is unlikely to have any impact on the species or its conservation status.

2.3.4 *Eremophila viscida* Varnish Bush

Family: Myoporaceae



Plate 13 - *Eremophila viscida*

EPBC Distribution and Status: *Eremophila viscida* occurs in the southwest of Western Australia and is generally found in granitic, sandy-loam or red brown clay-loam, and in stony gullies and sand-plains (DEC 2011; Phillimore *et al*. 2003), as well as in association with salt lake systems (Phillimore *et al.* 2003). It is listed as Endangered under the EPBC Act.

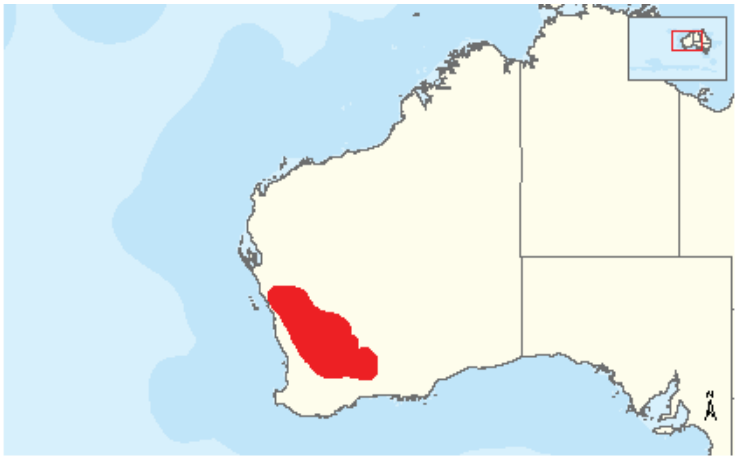


Figure 13 - Distribution of *Eremophila viscida*

Habitat and Ecology: Eremophila viscida is a shrub that is 1.2- 6 m high (Phillimore *et al*. 2003; DEC 2011). Flowers are greyish or reddish, and are strongly veined with purple spots.

All known habitat is considered critical to the survival of the species including translocated populations (Phillimore *et al*. 2003).

Recordings from the area and potential impacts: Eremophila viscida is not known to occur in the Forrestania area and has not been identified in any of the flora surveys conducted in the general area and more specifically in the area proposed for the haul road (WANL 2009, Botanica Consulting 2011). Therefore, there will be no impact on this species from the proposed development of the haul road.

2.3.5 *Eucalyptus steedmanii* Steedman's Gum

Family: Myrtaceae



Plate 14 - *Eucalyptus steedmanii*

EPBC Distribution and Status: Eucalyptus steedmanii is limited to six known populations in an area approximately 80 km east of Hyden, in the Forrestania to North Ironcap areas. It is listed as Vulnerable under the EPBC Act. It is also listed as a Declared Rare Flora (DRF) species pursuant to Subsection 2 of Section 23F of the Wildlife Conservation Act (1950).

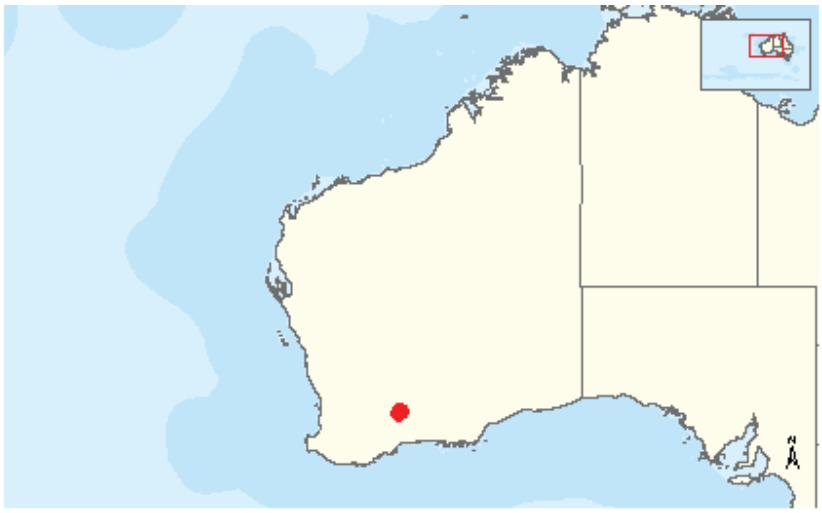


Figure 14 – Distribution of *Eucalyptus steedmanii*

Habitat and Ecology: Eucalyptus steedmanii is a mallet tree, 2-8 m high, with smooth bark, white flowers and distinctive four-sided winged fruit. The flowering period is from January through to March (DEC 2011). They prefer gravely-loam soils over ironstone, sand, and undulating plains (DEC 2011)

Recordings from the area and potential impacts: Eucalyptus steedmanii is known from eight populations within the Forrestania area (Botanica Consulting 2011). While no individuals were identified within the area surveyed for the proposed haul road, one population is located approximately 20 m northeast and 470 m west of the most northern region of the area surveyed (Botanica Consulting 2011).

Fifty metres from any Declared Rare Flora is considered an Environmentally Significant Area under the *Environmental Protection Act 1986*. If WANL is unable to avoid clearing within the 50 m buffer area, a Clearing Permit under Section 51E of this Act will be required.

Proposed management measures to ensure the protection of the populations of *E. steedmanii* in the vicinity of the proposed haul road are incorporated in the Management Plan for this species (Coffey 2009)(Appendix 1).

2.3.6 *Grevillea involucrata* Lake Varley Grevillea

Family: Proteaceae

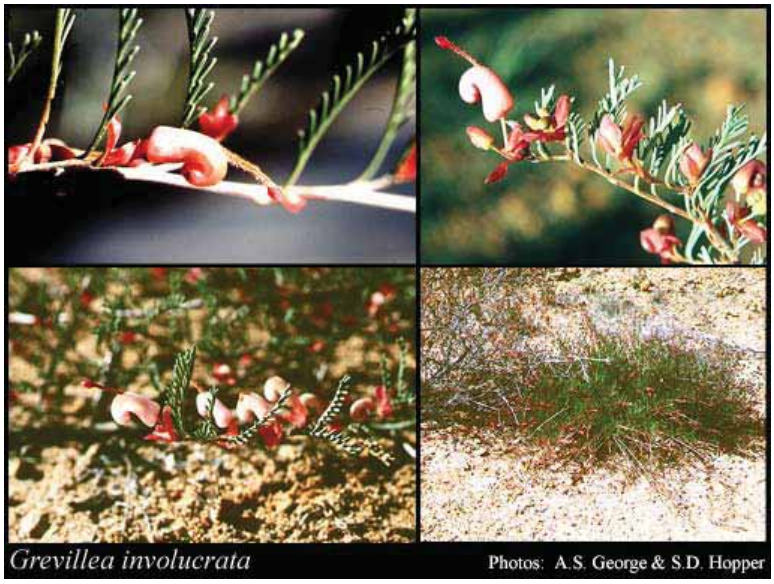


Plate 15 - *Grevillea involucrata*

EPBC Distribution and Status: *Grevillea involucrata* is generally found amongst low to medium trees, or low sclerophyll shrub-land. It occupies lateritic ridges, and prefers rocky or stony soil, or loam or sand (DEC 2011). *Grevillea involucrata* is known to exist between Hyden and Lake Magnet (Durell and Beuhrig, 2001. It is listed as Endangered under the EPBC Act.

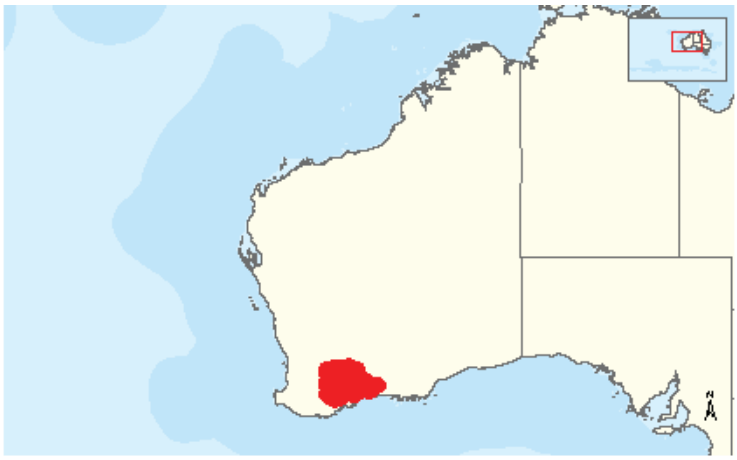


Figure 15 - Distribution of *Grevillea involucrata*

Habitat and Ecology: *Grevillea involucrata* is a small shrub up to 30 cm high with branchlets. Pink irregular flowers can be observed between June to October, and following flowering, ellipsoidal fruit.

Recordings from the area and potential impacts: *Grevillea involucrata* is not known from the proposed haul road area. Further, it has not been identified in any flora surveys undertaken in the area (Botanica Consulting 2011). Therefore, there will be no impact on this species from the proposed development of the haul road.

2.3.7 *Roycea pycnophylloides* Saltmat

Family: Chenopodiaceae



Plate 16 - *Roycea pycnophylloides*

EPBC Distribution and Status: *Roycea pycnophylloides* is isolated to the south-west corner of Western Australia. It is listed as Endangered under the EPBC Act.

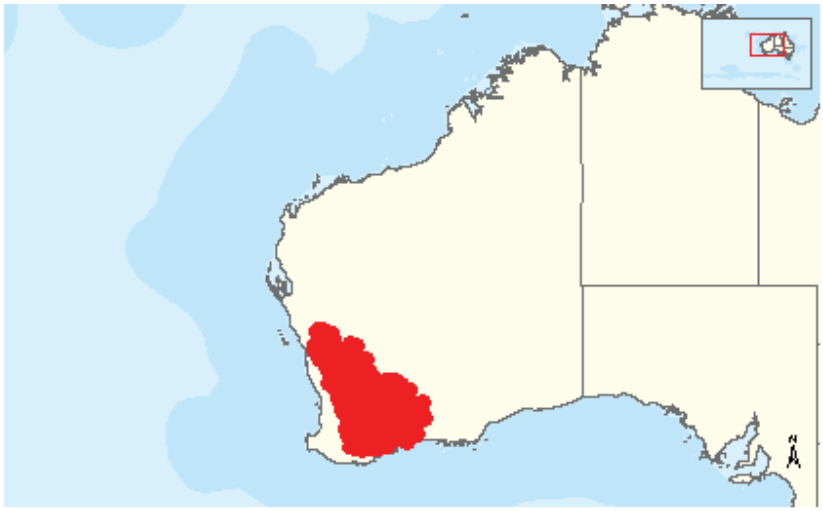


Figure 16 – Distribution of *Roycea pycnophylloides*

Habitat and Ecology: Roycea pycnophylloides is a dense perennial herb, silver in colour and up to 1 m in diameter. It prefers sandy or clayey soils and saline flats and flowers in September (DEC 2011).

Recordings from the area and potential impacts: Roycea pycnophylloides apparently inhabits a narrow range of soil types preferring sandy or clayey soil and saline flats. There are no saline flats in the area proposed for the haul road and this species has not been recorded in any local flora survey (Botanica Consulting 2011). Therefore, there will be no impact on this species from the proposed development of the haul road.

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APPENDIX 1: EUCALYPTUS STEEDMANII MANAGEMENT PLAN

Spotted Quoll/Cosmic Boy Haul Road

Flora and Vegetation Survey

Prepared For:

WESTERN AREAS NL



January 2011
Final Report

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Executive Summary

Botanica Consulting was commissioned by Western Areas NL to conduct a flora and vegetation survey for the Spotted Quoll/Cosmic Boy (SQ/CB) Haul Road area. The survey area was located 30.4 km northeast of Varley, WA, 77.3 km east of Hyden, WA and 9 km southwest of the intersection of the Hyden Norseman Road and the Southern Cross Road. The survey area totalled 412.4 hectares.

No Declared Rare Flora species (DRF), pursuant to Subsection 2 of Section 23F of the Wildlife Conservation Act (1950) and listed by the Department of Environment (Atkins, 2010) were located during the survey. However, Population 2 of the DRF species *Eucalyptus steedmanii* is located approximately 20m north-east and 470m west of the most northern region of the survey area. Four Priority Flora species; *Stenanthemum liberum* (P1)*, Stylidium sejunctum* (P2), *Microcorys* sp. Forrestania (V. English, 2004) (P4) and *Eutaxia acanthoclada* (P3) were recorded in the survey area. Two weed species as defined by Florabase (WAHERB, 2011) were recorded in the survey area. Neither of these plants are classified as Declared Weeds by the Department of Agriculture and Food of Western Australia (DAFWA, 2011).

Eleven vegetation groups and three sub-groups were identified within the survey area: Rehabilitation Area; *Eucalyptus urna* woodland; *E. livida* woodland; *E. salubris* woodland*; E. eremophila* subsp. *eremophila* and *E. cylindrocarpa* Mallee shrubland*;* Mixed Mallee shrubland over *Melaleuca* shrubland; Burnt *E. salmonophloia* woodland over mixed Mallee shrubland (including sub-groups *Melaleuca hamata* thicket and *Melaleuca lanceolata* thicket); *Eucalyptus salmonophloia* woodland, Mixed Mallee and mixed shrub thicket on Banded Ironstone Ridge, Mixed Mallee shrubland (including sub-group *E. horistes* Mallee shrubland) and *E. goniocarpa* shrubland.

These groups were represented by a total of 27 Families, 60 Genera and 141 Species. Twenty seven quadrats were established to further investigate the species composition of the vegetation groups. The data recorded from the quadrat survey was used in a PATN analysis to group quadrats with similar species compositions.

According to the Department of Sustainability, Environment, Water, Population and Communities database (DSEWPC, 2011) none one of the eleven vegetation groups and three sub-groups have national environmental significance as defined by the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. However the *E. salmonophloia* woodland vegetation group located within the far northern region of the survey area has a DRF population located approximately 20m north-east and 470m west. Within a minimum 50m boundary surrounding any DRF plant is considered an Environmentally Sensitive Area. There are no Threatened Ecological Communities (TEC's) as defined by the *EPBC Act 1999* or listed by the DEC recorded within the survey area (DSEWPC, 2011; DEC, 2010b). The survey area is however located within the North Ironcap and the Middle Ironcap Priority Ecological Communities (PEC's) which are listed by the DEC as Priority 3 Ecological Communities (DEC, 2010b).

Based on Keighery (1994), one vegetation group was classed as being ‘degraded’, three were classed as ‘good’ and the remaining seven were classed as having a ‘very good’ health condition. Disturbance was in the form of fire, and clearing for exploration activities.

1 Introduction

1.1 Project Description

Western Areas NL (WSA) commissioned Botanica Consulting (BC) to conduct a flora and vegetation survey for the Spotted Quoll/Cosmic Boy (SQ/CB) Haul Road area. The survey area is a reverse "S" that starts to the west of the Cosmic Boy mine site and continues to the Spotted Quoll area. This survey area was located 30.4 km northeast of Varley, WA, 77.3 km east of Hyden, WA and 9 km southwest of the intersection of the Hyden Norseman Road and the Southern Cross Road. The survey area totalled 412.4 hectares. Figure 1 shows a regional map of the SQ/CB Haul Road survey area and its surroundings. Botanica Consulting conducted this survey from the 30th of November to the 1st of December, 2009. This region was visited in January 2011 to re-assess the vegetation composition of the area and establish more quadrats.

The aim of the survey was to produce a vegetation map and species list for WSA as well as documenting the occurrence of any Threatened Ecological Communities and Declared Rare (DRF) or Priority listed flora species within the survey area.

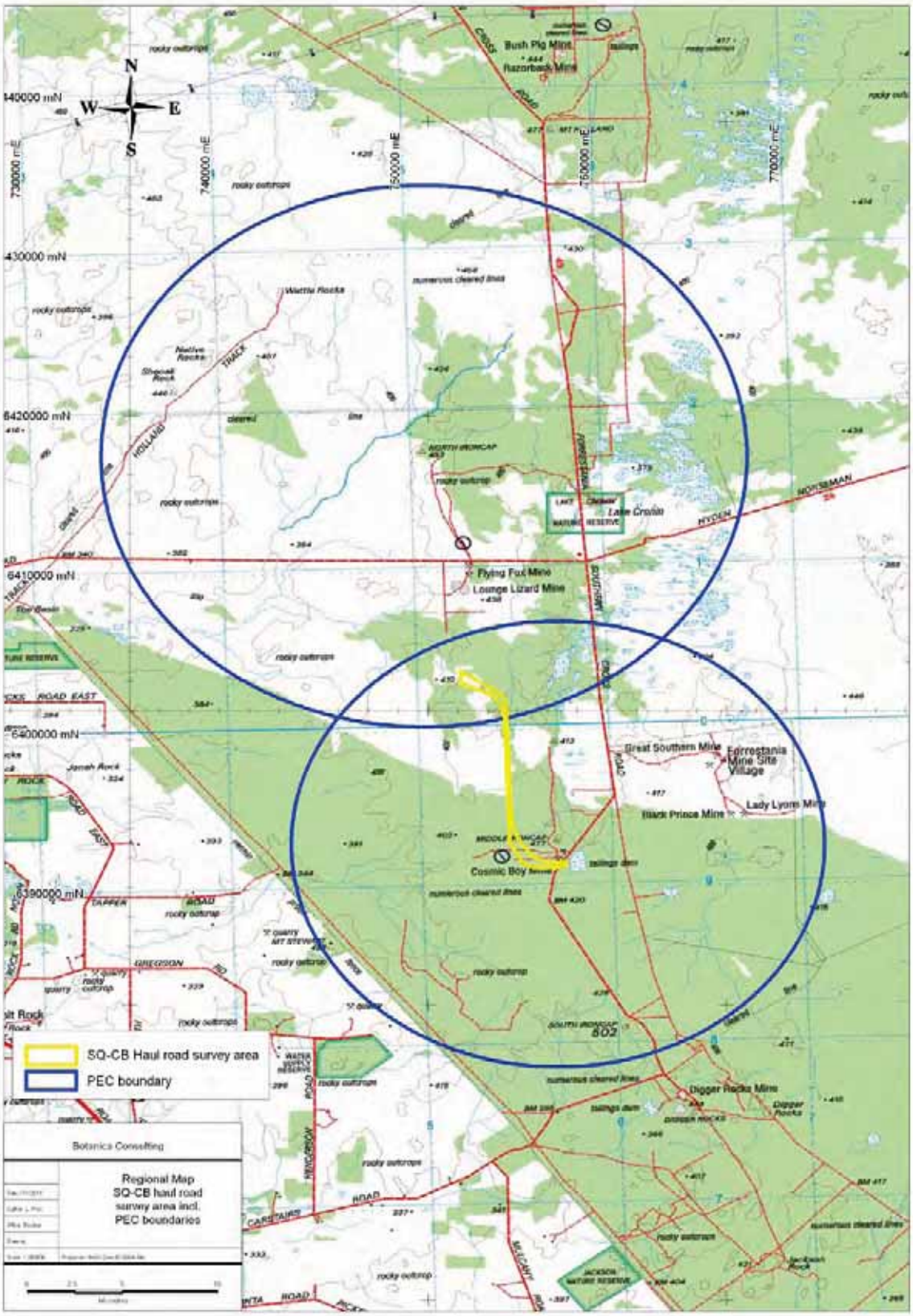


Figure 1: **Regional map of the survey area**

1.2 Previous relevant flora surveys

- **New Morning/Spotted Quoll Flora Survey, 2007**

  Botanica Consulting was commissioned by Western Areas NL to conduct a scoping study into development of a new mine within the New Morning/Spotted Quoll area. The area surveyed included 88.4ha where the mine site will be located, 25.18ha for the proposed pipeline/access routes and 503.1ha proposed for exploration. The area surveyed was 616.7ha and was conducted on the 8th-9th of October and the 8th of November, 2007.

  Six vegetation groups were identified within the survey area; *Eucalyptus* woodland, *Eucalyptus* Mallee Woodland, *Eucalyptus salmonophloia* Woodland, Sand Plain Heath, *Allocasuarina* shrubland and Rocky Outcrop. One Declared Rare Flora, *Eucalyptus steedmanii,* and two Priority Flora species, *Eremophila racemosa* (P4) and *Microcorys* sp. Forrestania (V. English, 2004) (P4), were recorded during the survey.

  The survey area retained no regional environmental significance as defined by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA, 2009). However, approximately 12.35ha of the total survey area lies within the Lake Cronin ESA.

- **Cosmic Boy Flora and Vegetation Survey, October , 2007**

  BC was commissioned by Western Areas NL to conduct a flora and vegetation survey within the Cosmic Boy greater area on the 10th of October, 2007. An area of 109ha was surveyed by two scientists.

  Five vegetation groups were identified in the survey area: Transitional *Eucalyptus* woodland, *Allocasuarina* shrubland, *Melaleuca* Heath, Mallee woodland and Rehabilitation vegetation.

  Five Priority Flora species were located: *Stenanthemum liberum* (P1), *Acacia singula* (P3), *Grevillea insignis* subsp. *elliottii* (P3), *Stylidium sejunctum* (P2) and *Pityrodia* sp. Yilgarn (P3). Four known DEC locations of *Microcorys* sp. Forrestania (V. English, 2004) (P4) were searched for, however none were located. No Declared Rare Flora was found within the survey area.

  Three weed species: *Dimorphotheca ecklonis*, *Mesembryanthemum nodiflorum* and *Daucus carota* were identified. These species are not classified as Declared Weeds by the Department of Agriculture and Food.

- **Flora and Vegetation Survey within the Greater Comic Boy Area, January, 2009**

  Botanica Consulting was commissioned by Western Areas NL to undertake a flora and vegetation survey of approximately 102ha in the Cosmic Boy area on the 30th of September, 2008. Eight vegetation groups were identified in the area surveyed: Transitional *Eucalyptus* woodland, *Allocasuarina* shrubland, *Melaleuca* Heath, Mallee Woodland, Rehabilitation vegetation, *Eucalyptus salmonophloia* Woodland, Heath vegetation and *Eucalyptus livida* woodland. These groups were represented by a total of 31 Families, 68 Genera and 174 Species.

  No Declared Rare Flora species were located during the survey. Five Priority Flora species were located within the survey area: *Stenanthemum liberum* (P1), *Acacia singula* (P3), *Grevillea insignis ssp elliottii* (P3), *Stylidium sejunctum* (P2) and *Pityrodia* sp. Yilgarn (P3). Three weed species, *Dimorphotheca ecklonis*, *Mesembryanthemum nodiflorum and Daucus carota,* were identified. None are classified as a Declared Weed by the Department of Agriculture and Food. None of the eight vegetation groups have regional environmental significance as defined by the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act*. *1999.* There were no Priority Ecological Communities or Threatened Ecological Communities as defined by the DEC found within the survey area.

  Based on Keighery (1994), the Transitional *Eucalyptus* woodland vegetation was classed as 'good' and the vegetation condition of the Rehabilitation vegetation community was classed as having a 'degraded' health condition. The heath condition of the remaining six vegetation groups was 'very good'.

- **Spotted Quoll Exploration Area Flora and Vegetation Survey, May 2009**

  Botanica Consulting was commissioned by Western Areas NL to conduct the Spotted Quoll Flora and Vegetation Survey on the 11th and 12th of May, 2009. This survey provided quadrat data for previous surveys. This survey established 18 quadrats and recorded 28 Families, 62 Genera and 158 species within six vegetation groups.

  None of the six vegetation groups have regional environmental significance as defined by the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. There were also no Priority Ecological Communities or Threatened Ecological Communities as defined by the DEC recorded within the survey area (DEC, 2008). Three of the six vegetation groups contained *Eucalyptus steedmanii, a* Declared Rare Flora species. Two Priority Flora species, *Microcorys* sp. Forrestania V. English, 2004) (P4) and *Eremophila racemosa* (P4) were recorded during the survey.

Areas of the *Eucalyptus salmonophloia* woodland, *Eucalyptus* mallee woodland and *Eucalyptus* woodland were classed as 'degraded' (Keighery, 1994). A majority of the *Eucalyptus* mallee woodland and Sandplain heath located within the survey area were classed as 'very good'. The remaining vegetation groups, *Allocasuarina* shrubland and a Rocky Outcrop, were in a 'good' health condition.

2 Regional Biophysical Environment

2.1 Topography & Soils

The survey area is located within the Southern Cross subregion of the Coolgardie Region (CALM, 2001; IBRA, 2009). The Southern Cross subregion is described as being comprised of gently undulating uplands dissected by broad valleys with bands of low greenstone hills. Valleys within the subregion have Quaternary duplex and gradational soils along with chains of saline lakes. The uplands are the eroded remnants of a lateritic duricrust which yields yellow sand plains, gravely sand plains and laterite breakaways (CALM, 2001).

2.2 Climate

The climate is characterised as being arid non-seasonal to semi-arid Mediterranean. The area receives approximately 250-300mm of rainfall per year (Beard, 1990; CALM, 2001). Rainfall data for the Lake Carmody weather station (#10670) is displayed in Figure 2 (BOM, 2009).

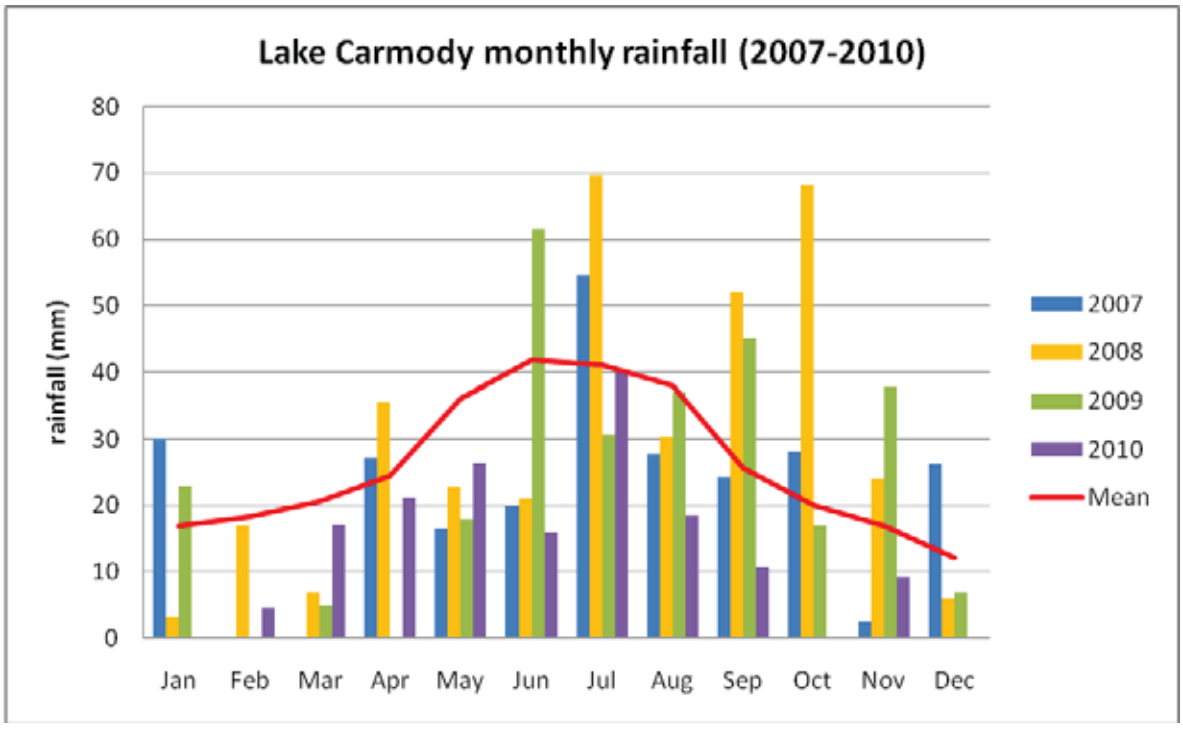


Figure 2: Mean annual rainfall (Jan, 1906-Nov, 2010) and the rainfall amounts from Jan 2007 to Nov 2010 for the Lake Carmody weather station (#10670) (BOM, 2011).

2.3 Pre-European Vegetation Groups

Beard (1990) locates the survey area within Coolgardie Botanical District of the Southwestern Interzone. The typical sequences of vegetation within the Coolgardie Botanical District is eucalypt woodlands becoming open with saltbush/bluebush understorey on calcareous soils, patches of shrub steppe adjoining the Great Victorian Desert and shrub-heath and *Casuarina* thickets on sandplains (Beard, 1990). The Department of Agriculture and Food GIS file (DAF, 2010) places the survey area within Pre-European Beard vegetation associations 511and 1413. These vegetation groups are described by Beeston *et. al.* (2002) in Table 1.

Table 1: Remaining Beard Vegetation Associations within the Southern Cross subregion (Beeston, et. al., 2002)

Beard Vegetation Association	Pre-European extent (ha)	Current Extent (ha)	Remaining (%)	Description
511	464,424.57	435,793.50	93.84	Medium woodland; salmon gum & morrel
1413	953,238.34	933,703.37	97.95	Shrublands; Acacia, Casuarina & Melaleuca thicket

2.4 Land Use

The land uses for the Southern Cross subregion are native pasture grazing (17%), UCL and Crown Reserves (66.74%), dry-land cultivation (2.27%) and conservation reserves (11.53%) (CALM, 2001).

2.5 Survey Objectives

The objectives of this work were to:

1. Compile a broad scale vegetation community flora map and species list of the survey area.
2. Document and map locations of any Declared Rare or Priority listed flora species within the survey area.
3. Identify and map occurrences of any “Declared and Environmental” weeds within the survey area.
4. Provide plot based data as per Guidance Statement 51 (EPA, 2004).

3 Survey Methodology

3.1 Desktop Assessment

Prior to the field survey, the results of the combined search of the Department of Environment and Conservation’s (DEC) Declared Rare and Priority Flora databases (DEC, 2007a), were obtained by Botanica Consulting. The results of this database search are provided in Appendix 1. These significant flora species were examined on the Western Australian Herbarium’s web page (WAHERB, 2011) prior to the survey to familiarise staff with their appearance. Locations of Declared Rare Flora and Priority Flora species revealed in the database search were mapped over the survey area aerial images. Appendix 2 shows a map of the DRF and Priority Flora species resulting from the DEC search (DEC, 2010a). BC visited known locations of Priority Flora within and nearby the survey area.

These locations were visited to sample the species for identification and familiarisation. BC also used known locations of Priority Flora based upon past surveys conducted over portions of the current survey area. Priority Flora and their respective vegetation types were then targeted in the survey area and all areas of occurrence were traversed on foot specifically looking for the threatened flora associated with that vegetation description. Table 2 represents the definitions of Declared Rare and Priority ratings under the *Wildlife Conservation Act (1950)* as extracted from Florabase (WAHERB, 2011).

Table 2: **Definitions of Rare and Priority Flora Species (WAHERB, 2011)**

R: Declared Rare Flora – Extant Taxa 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.
X: Declared Rare flora – Presumed Extinct Taxa 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.
1: Priority One – Poorly known Taxa Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small populations 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 in protected lands. Such taxa are under consideration for declaration as “rare flora”, but are in urgent need of further survey.
2: Priority Two – Poorly Known Taxa Taxa which are known from one of 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.
3: Priority Three – Poorly known Taxa Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally <5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as “rare flora” but are in need of further survey.
4: Priority Four – Rare Taxa 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

3.2 Sampling and Analysis Methods

The survey area was traversed by two people via four wheel drive vehicle and on foot. Vehicles were only used for transportation on existing roads and trails to ensure no damage was done to existing vegetation. If no roads or trails were present, the survey area was travelled on foot. A map of the surveyed area including quadrat locations is provided in Appendix 3.

Prior to field work, aerial photography was inspected and differences in the vegetation assemblages were initially identified. These different vegetation associations were then visited during the survey and used as initial sampling sites. The data from the sites visited were used to create a vegetation map.

At each sample point, the following information was recorded:

- GPS location
- Photograph of vegetation
- Dominant species
- Collection and documentation of unknown plant specimens
- GPS location, photograph and collection of Threatened Flora if encountered

Unknown specimens collected during the survey were identified with the aid of samples housed at the Botanica Consulting Herbarium and the Western Australian Herbarium.

3.3 20m×20m Quadrats

This survey was conducted to provide quadrat data for the area. Twenty seven, 20m x 20m quadrats were established within the survey area with the aim of establishing at least three quadrats per vegetation group to capture the floristic variations of the survey area. If a vegetation group was not large enough to set up three quadrats only as many quadrats that could fit within the group were established. No quadrats were placed in the Rehabilitation Area vegetation group due to past clearing and then re-establishment of native vegetation.

The quadrats were established by inserting four metal pickets in each of the four corners of the 20 x 20m square quadrat. Each side of the quadrat was measured to ensure the accuracy of its established dimensions. After the quadrat had been established the location was recorded by GPS, three photographs of the quadrats were taken and the quadrat data was recorded. The types of data recorded are explained in the paragraph below.

Within each quadrat all vascular plants were recorded. Dominant taxa from the upper, middle and lower stratum were recorded. All unknown taxa from the quadrats were sampled and identified with the use of BC's own reference herbarium and relative taxonomical keys. Data on topographical position, percentage litter, percentage bare ground, percentage surface rock (bedrock and surface deposits), and vegetation structure were collected from each quadrat.

3.4 Data Analysis Tools

Once the survey was completed the data obtained was analysed to generate a vegetation map in MapInfo (Appendix 3). A PATN analysis was also conducted on the data obtained from the quadrats. The PATN analysis was conducted on both the dominant species in each strata of vegetation and on all species present in each quadrat. The PATN analysis classified the quadrats into groupings based upon the similarities in the recorded species composition. The classifications were based upon a Bray-Curtis association matrix using a flexible UPGMA.

3.5 Personnel involved

Jim Williams- Environmental Consultant/Botanist (Diploma of Horticulture)

Eren Reid- Environmental Consultant (BSc- Biological Science)

Lauren Pick- Environmental Consultant (BSc-Conservation Biology)

Evan Anderson-Environmental Consultant (BSc-Forestry, Master of Tropical Env. Mgmt,)

3.6 Flora survey limitations and constraints

It is important to note that there are limitations involved with conducting flora surveys, despite the careful planning that is put into their design. Such limitations that can occur are listed in Table 3 below.

Table 3: **Limitations and constraints associated with the flora and vegetation survey.**

Variable	Impact on Survey outcomes
Access problems	Access was not a problem as the survey was conducted via 4WD and on foot
Experience levels	The BC staff members who conducted the survey were regarded as suitably qualified and experienced. **Coordinating Botanist:** Jim Williams and Eren Reid-Environmental Consultant (BSc) **Field Staff:** Eren Reid-Environmental Consultant (BSc) and Lauren Pick (BSc) **Data Interpretation:** Jim Williams, Eren Reid and Evan Anderson
Timing of survey, weather & season	Fieldwork was completed during the EPA's recommended time period (i.e., Spring) for detecting most ephemeral flora and the majority of species were in flower. In the months preceding the survey, rainfall was normal for the Lake Carmody weather station (Figure 2).
Completeness	In the opinion of BC the survey area was covered sufficiently. BC estimate that approximately 90% of the flora species in the survey area were recorded. This estimation takes into account the timing of the survey and the experience of the botanists undertaking the work. The vegetation groups for this study were based on visual descriptions of locations in the field. The distribution of these vegetation groups outside the study area is not known, however vegetation groups identified were categorized via comparison to vegetation distributions throughout WA given on Australian Natural Resources Atlas (ANRA, 2009). The species *Baeckea crispiflora sens lat* and *Eucalyptus* sp (sterile) could not be properly identified due to a lack of floral evidence.

4 Results

4.1 Summary

The survey area is made up of eleven vegetation groups and three sub-groups. The Rehabilitation Area was classed as 'degraded'. The Burnt *E. salmonophloia* over mixed Mallee, *E. eremophila* subsp. *eremophila* and *E. cylindrocarpa* Mallee shrubland and the *E. urna* woodland were classed as being in a 'good' condition. The remaining seven vegetation groups were classed as having a 'very good' health condition.

During the survey no DRF species were located within the survey area. There is however a population of the DRF species *Eucalyptus steedmanii* (Population 2) which is located within approximately 20m north-east and 470m west of the *E. salmonophloia* woodland located within the most northern region of the survey area. A map showing the location of the DRF population in relation to the vegetation groups of the survey area is provided in Appendix 3. Within a minimum 50m area surrounding each DRF plant is considered an Environmentally Sensitive Area. Four Priority Flora species were recorded within the survey area. There were no Threatened Ecological Communities as defined by the *EPBC Act* or listed by the DEC within the survey area (DSEWPC, 2011; DEC, 2010b). The survey area is however located within the boundary of two Priority Ecological Communities; North Ironcap and Middle Ironcap (PEC3). Two weed species were recorded during the survey (WAHERB, 2011). Neither of these species was listed as a Declared Plant species (DAFWA, 2011).

4.2 Desktop Assessment

The results of the combined search of the Department of Environment and Conservation's (DEC) Declared Rare and Priority Flora databases (DEC, 2010a) revealed many Priority Flora species near and within the area (Appendix 2). Priority species with the potential to occur in the survey area are listed in Table 4 below.

Table 4: **Priority Flora with the potential to occur within the survey area (WAHERB, 2011)**

Species	Priority	Description (WAHERB, 2011)
Acacia asepala	2	
Banksia viscida	3	Gentle lower slope with a SW/W aspect, on yellow sandy loam soils with lateritic gravel.
Boronia revoluta	R	Sand plain in gravelly yellow sand.
Boronia westringioides	2	Undulating plain in yellow sand.
Calamphoreus inflatus	4	Brown-yellow sandy loam.
Eremophila racemosa	4	Depression. Wet and dry seasonally. Light red brown loam.
Eucalyptus steedmanii	R	Tree, 2–8(–12) m high, bark smooth. Fl. white, Jan–Mar. Gravelly loam over ironstone, sand. Low hills, undulating plains.
Eutaxia nanophylla	3	Straggly, rounded shrub, to 0.35 m high. Fl. yellow, orange, red, Oct–Nov. Clayey sand, red clay, stoney clayey loam. Low-lying areas, damp flats, slopes, undulating plains, low stony ridges
Eutaxia rubricarina	3	Straggling shrub, to 0.5 m high. Fl. orange, yellow, brown, Aug–Oct. Gravelly sand, grey to pinkish-white sandy clay, red loam. Flats, slopes, valley floors, road verges
Grevillea insignis subsp. elliottii	3	Erect, bushy, non-lignotuberous shrub, 1–2 m high. Fl. red, pink, cream, white, Oct. Gravelly sand or loam over ironstone. Hilltops or rises.
Lepidosperma ferriculmen	1	Tufted rhizomatous, perennial, herb (sedge), leaves 0.16–0.38 m high, culms and leaves distichous. Fl. Jul. Well-drained orange-red sandy loam with banded ironstone gravel and rocks. Stony slopes.
Microcorys sp. Forrestania	4	Flat site in disturbed soil at the side of the track. Brown loamy clays.
Pityrodia sp. Yilgarn (A.P. Brown 2679)	3	Red-brown clay loam soil with ironstone nodules. Rehabilitation area.
Stenanthemum liberum	1	Dwarf shrub, ca 0.5 m high. Yellow sandy loam over laterite.
Stylidium sejunctum	2	Caespitose perennial, herb, 0.25–0.45 m high, Leaves tufted, linear to narrowly oblanceolate, 10-30 cm long, 0.8-4 mm wide, apex acute to mucronate, margin involute, glabrous to scabrous. Membraneous scale leaves present at base of mature leaves. Scape glandular throughout. Inflorescence paniculate. Fl. white, pink, purple, Sep–Nov. Clayey sand or loam, laterite. Outcrops, upper slopes, breakaways. Mallee and Allocasuarina shrubland.

4.3 Vegetation Groups

Eleven vegetation groups and three sub-groups were identified within the survey area:

1. Rehabilitation Area;
2. *Eucalyptus urna* woodland;
3. *Eucalyptus livida* woodland;
4. *Eucalyptus salubris* woodland;
5. *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee shrubland;
6. Mixed Mallee shrubland over *Melaleuca* shrubland*;*
7. Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland (including two sub-groups; *Melaleuca hamata* thicket and *Melaleuca lanceolata* thicket);
8. *Eucalyptus salmonophloia* woodland;
9. Mixed Mallee and Mixed shrubs on Banded Ironstone ridge;
10. Mixed Mallee shrubland (including *E. horistes* Mallee shrubland sub-group); and
11. *Eucalyptus goniocarpa* shrubland.

These groups were represented by a total of 27 Families, 60 Genera and 141 Species (Appendix 4).

4.4 Rehabilitation Area

4.4.1 Flora

Flora recorded in this vegetation group was represented by 20 Families, 27 Genera and 49 Species.

No quadrats were established in this vegetation group due to disturbance.

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. One Priority Flora species, *Stenanthemum liberum* (P1), was identified in this vegetation group during the survey. Two weed species; *Carduus nutans* and *Salvia verbenaca*, were recorded in this vegetation group (WAHERB, 2011). Neither of these weed species are listed as Declared Plants (DAFWA, 2011).

4.4.2 Vegetation

The flora recorded in this vegetation group was representative of a Rehabilitated Area. The upper storey included *Eucalyptus eremophila* subsp. *eremophila, E. annulata* and *E. pileata.* The mid-storey species included *Melaleuca pauperiflora* subsp. *pauperiflora, Dodonaea stenozyga, Santalum acuminatum, Hakea scoparia* subsp. *scoparia, Hakea multilineata, Grevillea nematophylla* subsp. *nematophylla, Melaleuca lateriflora* subsp. *lateriflora, Allocasuarina campestris, Melaleuca eleuterostachya, Senna artemisioides* subsp. *artemisioides* and *Melaleuca cordata.* The understorey species included *Olearia pimelioides, Phebalium filifolium, Acacia deficiens, Atriplex stipitata, Sclerolaena diacantha, Atriplex vesicaria, Hibbertia pungens, Astroloma serratifolium, Acacia hemiteles, Acacia merrallii, Daviesia benthamii* subsp. *acanthoclada, Goodenia pinifolia, Dodonaea bursariifolia* and *Solanum hoplopetalum.*

The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 5. Appendix 8 displays the chart used to create this Table.

Table 5: Vegetation assemblage for Rehabilitation Area within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Shrub Form	10-30%	*Eucalyptus eremophila* subsp. *eremophila*
Shrubs 1-1.5m	10-30%	*Melaleuca pauperiflora* subsp. *pauperiflora* *Dodonaea stenozyga*
Shrubs 0-0.5m	2-10%	*Phebalium filifolium* *Acacia deficiens*

Extensive broad scale clearing has occurred in this vegetation group within the survey area. The area has been rehabilitated since disturbance and now contains native vegetation.

This vegetation group is best represented by the Other Forest and Woodlands vegetation group according to Australian Natural Resources Atlas (ANRA), which covers 0.1% of the State of Western Australia (ANRA, 2011).



Figure 3: Rehabilitation Area within the survey area

4.5 *Eucalyptus urna* woodland

4.5.1 Flora

Flora recorded in the vegetation group was represented by 10 Families, 14 Genera and 30 Species.

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. No Priority Flora species were identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.5.2 Vegetation

The flora recorded in this vegetation group was representative of *Eucalyptus* woodland. The upper storey included *Eucalyptus urna, E. salubris, E. melanoxylon, E. cylindrocarpa* and *E. eremophila* subsp. *eremophila.*

The mid-storey species included *Melaleuca pauperiflora* subsp. *pauperiflora, Grevillea oncogyne, Melaleuca lateriflora* subsp. *lateriflora, Dodonaea stenozyga, Melaleuca cardiophylla, Santalum acuminatum, Daviesia nematophylla* and *Melaleuca adnata.* The understorey species included *Olearia muelleri, Atriplex vesicaria, Acacia erinacea, Gompholobium gompholobioides, Acacia merrallii, Westringia rigida, Grevillea acuaria* and *Eremophila densifolia* subsp. *capitata*.

The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 6.

Table 6: Vegetation assemblage for *Eucalyptus urna* woodland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	10-30%	*Eucalyptus urna*
Shrub 1.5-2m	30-70%	*Melaleuca pauperiflora* subsp. *pauperiflora* *Melaleuca adnata* *Dodonaea stenozyga*
Shrub 0-0.5m	2-10%	*Grevillea acuaria* *Olearia muelleri*

No broad scale clearing has occurred in this vegetation group within the survey area. This vegetation group is best represented by the *Eucalyptus* open woodlands vegetation group according to ANRA, which covers 1.3% of the State of Western Australia (ANRA, 2011).



Figure 4: *Eucalyptus urna* woodland within the survey area.

4.6 *Eucalyptus livida* woodland

4.6.1 Flora

Flora recorded in the vegetation group was represented by 18 Families, 30 Genera and 47 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. Two Priority Flora species; *Stenanthemum liberum* (P1) and *Stylidium sejunctum* (P2) were identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.6.2 Vegetation

The flora recorded in this vegetation group was representative of *Eucalyptus* woodland. The species in the upper storey included *Eucalyptus livida, E. horistes* and *E. eremophila* subsp. *eremophila.* The mid-storey included *Allocasuarina campestris, Melaleuca glaberrima, Allocasuarina helmsii, Melaleuca hamata, Calothamnus quadrifidus, Hakea scoparia* subsp. *scoparia, Acacia enervia* subsp. *enervia, Callitris preissii, Halgania andromedifolia, Melaleuca cordata, Melaleuca laxiflora, Persoonia coriacea* and *Santalum acuminatum.* The understorey species included *Darwinia inconspicua, Boronia inornata* subsp. *inornata, Hibbertia pungens, Baeckea crispiflora, Dodonaea bursariifolia, Phebalium filifolium, Westringia cephalantha* var. *caterva, Lepidosperma brunonianum* and *Acacia sphacelata* subsp, *sphacelata*.

The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 7.

Table 7: Vegetation assemblage for *Eucalyptus livida* woodland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Tree Form	10-30%	*Eucalyptus livida* *Eucalyptus horistes*
Shrub >2m	10-30%	*Allocasuarina campestris*
Shrub 1.5-2m	30-70%	*Melaleuca hamata* *Acacia enervia* subsp. *enervia* *Calothamnus quadrifidus* *Hakea scoparia* subsp. *scoparia* *Halgania andromedifolia*
Shrub 0-0.5m	10-30%	*Darwinia inconspicua* *Hibbertia pungens* *Dodonaea bursariifolia* *Phebalium filifolium* *Lepidosperma brunonianum*

No broad scale clearing has occurred in this vegetation group within the survey area. This vegetation group is best represented by the *Eucalyptus* open woodland vegetation group according to ANRA, which covers 1.3% of the State of Western Australia (ANRA, 2011).



Figure 5: *Eucalyptus livida* woodland area within the survey area.

4.7 *Eucalyptus salubris* woodland

4.7.1 Flora

Flora recorded in the vegetation group was represented by 12 Families, 17 Genera and 27 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. No Priority Flora species were identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.7.2 Vegetation

The flora recorded in this vegetation group was representative of *Eucalyptus salubris* woodland. The upper storey species included *Eucalyptus salubris, E. salmonophloia* and *E. urna.* The mid-storey included *Melaleuca pauperiflora subsp. pauperiflora, Santalum acuminatum, Melaleuca eleuterostachya, Exocarpos aphyllus, Daviesia nematophylla, Hakea corymbosa, Dodonaea stenozyga, Melaleuca lateriflora* subsp. *lateriflora* and *Melaleuca eleuterostachya* .The understorey species included *Acacia merrallii, Olearia muelleri, Wilsonia humilis, Acacia deficiens, Gompholobium gompholobioides, Templetonia sulcata, Acacia intricata* and *Westringia rigida.*

The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 8.

Table 8: Vegetation assemblage for *Eucalyptus salubris* woodland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5m-15m	30-70%	*Eucalyptus salubris* *Eucalyptus salmonophloia*
Shrub 1.5-2m	10-30%	*Melaleuca pauperiflora* subsp. *pauperiflora* *Melaleuca eleuterostachya* *Daviesia nematophylla* *Dodonaea stenozyga*
Shrub 0-0.5m	30-70%	*Acacia merrallii* *Acacia deficiens* *Acacia intricata*

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the *Eucalyptus* Woodland vegetation group according to ANRA, which covers 3.5% of the State of Western Australia (ANRA, 2011).



Figure 6: *Eucalyptus salubris* woodland area within the survey area.

4.8 *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee shrubland

4.8.1 Flora

Flora recorded in the vegetation group was represented by 10 Families, 13 Genera and 35 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. No Priority Flora species were identified in this vegetation group during the survey. The DEC search results (DEC, 2010a) located a known specimen of *Banksia viscida* (P3) (formerly *Dryandra viscida*) in this vegetation group. This specimen was searched for during the survey but was not located. No weed species were recorded in this vegetation group.

4.8.2 Vegetation

The flora recorded in this vegetation group was representative of Mallee shrubland. The upper storey species included *Eucalyptus eremophila* subsp. *eremophila. E. cylindrocarpa, E. urna* and *E. salubris.* The mid-storey species included *Melaleuca urceolaris, Daviesia nematophylla, Melaleuca pauperiflora* subsp. *pauperiflora, Melaleuca pauperiflora* subsp. *fastigiata, Hakea commutata, Melaleuca cardiophylla* and *Exocarpos aphyllus.*

The understorey species included *Acacia intricata, Dodonaea stenozyga, Acacia deficiens, Grevillea acuaria, Boronia inornata* subsp. *inornata*, *Westringia rigida* and *Acacia poliochroa.* The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 9.

Table 9: Vegetation assemblage for *E. eremophila* subsp. *eremophila* and *E. cylindrocarpa* Mallee shrubland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Shrub Form	30-70%	*Eucalyptus eremophila* subsp. *eremophila* *Eucalyptus cylindrocarpa*
Shrub 1.5-2m	70-100%	*Melaleuca urceolaris* *Melaleuca pauperiflora* subsp. *pauperiflora* *Melaleuca pauperiflora* subsp. *fastigiata* *Melaleuca cardiophylla*
Shrub 0.5-1m	10-30%	*Dodonaea stenozyga* *Grevillea acuaria*
Shrub 0-0.5m	2-10%	*Acacia intricata* *Acacia deficiens* *Boronia inornata* subsp. *inornata*

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the Mallee woodlands and shrublands vegetation group according to ANRA, which covers 2% of the State of Western Australia (ANRA, 2011).



Figure 7: *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee shrubland vegetation within the survey area.

4.9 Mixed Mallee shrubland over *Melaleuca* shrubland

4.9.1 Flora

Flora recorded in the vegetation group was represented by 14 Families, 18 Genera and 45 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed.

No Priority Flora species were identified in this vegetation group during the survey. The DEC search results (DEC, 2010a) located a known location of *Microcorys* sp. Forrestania (P4) in this vegetation group. This species was searched for during the survey but was not located. No weed species were recorded in this vegetation group.

4.9.2 Vegetation

The flora recorded in this vegetation group was representative of Mallee shrubland. The species in the upper storey included *Eucalyptus eremophila* subsp. *eremophila, E. calycogona* subsp. *calycogona, E. cylindrocarpa, E. pileata* and *E. urna.* The mid-storey species included *Daviesia benthamii* subsp. *acanthoclada, Melaleuca cardiophylla, Melaleuca lateriflora* subsp. *lateriflora, Melaleuca urceolaris, Melaleuca pauperiflora* subsp. *fastigiata, Melaleuca adnata, Melaleuca pauperiflora subsp. pauperiflora, Daviesia nematophylla* and *Hakea corymbosa.*

The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 10.

Table 10: Vegetation assemblage for Mixed Mallee shrubland over *Melaleuca* shrubland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Shrub Form	30-70%	*Eucalyptus eremophila* subsp. *eremophila* *Eucalyptus cylindrocarpa* *Eucalyptus urna*
Shrub 0.5-1m	70-100%	*Daviesia benthamii* subsp. *acanthoclada* *Melaleuca cardiophylla* *Melaleuca lateriflora* subsp. *lateriflora* *Melaleuca urceolaris* *Melaleuca pauperiflora* subsp. *fastigiata* *Melaleuca adnata* *Melaleuca pauperiflora* subsp. *pauperiflora*
Shrub 0.5-1m	10-30%	*Acacia deficiens* *Acacia intricata* *Hakea corymbosa* *Westringia cephalantha* var. *caterva*

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the Mallee woodlands and shrublands vegetation group according to ANRA, which covers 2% of the State of Western Australia (ANRA, 2011).



Figure 8: Mixed Mallee shrubland over *Melaleuca* shrubland vegetation within the survey area.

4.10 Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee

4.10.1 Flora

Flora recorded in the vegetation group was represented by 12 Families, 16 Genera and 43 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. One Priority Flora species, *Microcorys* sp. Forrestania (P4), was identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.10.2 Vegetation

The flora recorded in this vegetation group was representative of *Eucalyptus* woodland and also included two vegetation sub-groups of *Melaleuca hamata* thicket and *Melaleuca lanceolata* thicket (Figure 10 and 11). The upper storey comprised of *Eucalyptus salmonophloia* in low densities which have been disturbed by fire. The mid-storey included a variety of Mallees including *E. polita, E. cylindrocarpa, E. transcontinentalis, E. urna* and *E. goniocarpa.*

The understorey included *Eremophila drummondii, Templetonia sulcata, Dodonaea stenozyga, Acacia hemiteles, Melaleuca pauperiflora subsp. pauperiflora, Acacia deficiens, Acacia erinacea, Lepidosperma brunonianum, Acacia intricata, Westringia cephalantha* var. caterva, *Acacia merrallii, Grevillea acuaria, Wilsonia humilis* and *Olearia muelleri*. The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 11.

Table 11: Vegetation assemblage for Burnt *E. salmonophloia* woodland over Mixed Mallee within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	2-10%	*Eucalyptus salmonophloia*
Mallee Shrub Form	30-70%	*Eucalyptus polita* *Eucalyptus cylindrocarpa*
Shrub 1.5-2m	10-30%	*Eremophila drummondii* *Templetonia sulcata* *Dodonaea stenozyga* *Acacia hemiteles* *Melaleuca pauperiflora* subsp. *pauperiflora*
Shrub 0-0.5m	30-70%	*Acacia deficiens* *Acacia erinacea* *Acacia intricata* *Acacia merrallii* *Grevillea acuaria* *Wilsonia humilis* *Olearia muelleri*

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the *Eucalyptus* woodlands vegetation group according to ANRA, which covers 3.5% of the State of Western Australia (ANRA, 2011).



Figure 9: Burnt *E. salmonophloia* woodland over Mixed Mallee within the survey area



Figure 10: *Melaleuca hamata* thicket sub-group within the Burnt *E. salmonophloia* woodland over Mixed Mallee



Figure 11: *Melaleuca lanceolata* thicket sub-group within the Burnt *E. salmonophloia* woodland over Mixed Mallee

4.11 *Eucalyptus salmonophloia* woodland

4.11.1 Flora

Flora recorded in the vegetation group was represented by 16 Families, 23 Genera and 38 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. There is however a population of *Eucalyptus steedmanii* (DRF) located approximately 20m north-east and 470m west of this vegetation group within the Northern region of the survey area. One Priority Flora species, *Microcorys* sp. Forrestania (P4), was identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.11.2 Vegetation

The flora recorded in this vegetation group was representative of *Eucalyptus* woodland. The upper storey species included *Eucalyptus salmonophloia, E. urna, E. salubris, E. annulata* and *E. cylindrocarpa.* The mid-storey included *Exocarpos aphyllus, Daviesia nematophylla, Melaleuca pauperiflora* subsp*. pauperiflora, Scaevola spinescens, Melaleuca adnata* and *Dodonaea stenozyga.*

The understorey species included *Coopernookia strophiolata, Eremophila decipiens* subsp. *decipiens, Acacia intricata, Dodonaea bursariifolia, Acacia deficiens, Cryptandra aridicola, Acacia merrallii, Acacia sphacelata* subsp. *sphacelata, Olearia muelleri* and *Grevillea acuaria.*

The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 12.

Table 12: Vegetation assemblage for *Eucalyptus salmonophloia* woodland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5m-15m	10-30%	*Eucalyptus salubris* *Eucalyptus salmonophloia*
Shrub 1.5-2m	10-30%	*Exocarpos aphyllus* *Melaleuca pauperiflora* subsp. *pauperiflora* *Melaleuca adnata*
Shrub 0.5-1m	10-30%	*Acacia merrallii* *Acacia sphacelata* subsp. *sphacelata* *Grevillea acuaria*
Shrub 0-0.5m	10-30%	*Coopernookia strophiolata* *Acacia intricata* *Acacia deficiens* *Wilsonia humilis*

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the *Eucalyptus* open woodland vegetation group according to ANRA, which covers 1.3% of the State of Western Australia (ANRA, 2011).



Figure 12: *Eucalyptus salmonophloia* woodland vegetation within the survey area.

4.12 Mixed Mallee and mixed shrub thicket on Banded Ironstone Ridge

4.12.1 Flora

Flora recorded in the vegetation group was represented by 17 Families, 35 Genera and 62 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. Two Priority Flora species; *Stenanthemum liberum* (P1) and *Stylidium sejunctum* (P2) were identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.12.2 Vegetation

The flora recorded in this vegetation group was representative of Mallee/Mixed shrub thicket. The species in the upper storey included *Eucalyptus eremophila* subsp. *eremophila, E. horistes* and *E. cylindrocarpa.* The mid-storey species included *Allocasuarina corniculata, Banksia cirsioides, Allocasuarina campestris, Calothamnus quadrifidus, Allocasuarina helmsii, Santalum acuminatum, Hakea scoparia* subsp. *scoparia, Callitris preissii, Acacia fragilis, Melaleuca hamata, Hakea multilineata, Daviesia benthamii* subsp. *acanthoclada* and *Melaleuca adnata.* The understorey species included *Hibbertia pungens, Acacia sphacelata subsp. sphacelata, Dodonaea bursariifolia, Phebalium filifolium, Boronia inornata* subsp. *inornata, Thryptomene kochii, Westringia cephalantha* var. *caterva, Goodenia viscida* and *Hibbertia gracilipes.*
The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 13.

Table 13: Vegetation assemblage for Mixed Mallee and Mixed shrub thicket on Banded Ironstone ridge within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Shrub Form	10-30%	*Eucalyptus eremophila* subsp. *eremophila* *Eucalyptus horistes*
Shrub >2m	30-70%	*Banksia cirsioides* *Allocasuarina campestris* *Calothamnus quadrifidus* *Hakea scoparia* subsp. *scoparia* *Melaleuca hamata*
Shrub 0.5-1m	10-30%	*Hibbertia pungens* *Acacia sphacelata* subsp. *sphacelata* *Phebalium filifolium*

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the Heath vegetation group according to ANRA, which covers 0.7% of the State of Western Australia (ANRA, 2011).



Figure 13: Mixed Mallee and Mixed shrub thicket on Banded Ironstone ridge within the survey area.

4.1 Mixed Mallee shrubland

4.1.1 Flora

Flora recorded in the vegetation group was represented by 9 Families, 11 Genera and 21 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. One Priority Flora species; *Eutaxia acanthoclada* (P3) was identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.1.2 Vegetation

The flora recorded in this vegetation group was representative of Mallee shrubland. The species in the upper storey included *Eucalyptus cylindrocarpa, E. gracilis* and some isolated occurrences of burnt *E. salmonophloia* was also evident. The mid-storey species included *Melaleuca pauperiflora* subsp. *fastigiata, Eremophila dichroantha, Melaleuca pauperiflora* subsp. *pauperiflora, Exocarpos aphyllus, Melaleuca thyoides* and *Melaleuca adnata.* The understorey species included *Acacia deficiens, Olearia muelleri, Acacia intricata, Grevillea acuaria, Acacia merrallii, Wilsonia humilis, Acacia hemiteles* and *Eremophila decipiens* subsp. *decipiens.* The

dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 14.

Table 14: Vegetation assemblage for Mixed Mallee shrubland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Shrub Form	30-70%	*Eucalyptus cylindrocarpa* *Eucalyptus gracilis*
Shrub 0.5-1m	10-30%	*Eremophila dichroantha*
Shrub 0-0.5m	30-70%	*Acacia deficiens* *Acacia intricata* *Acacia merrallii* *Grevillea acuaria*

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the Mallee woodlands and shrublands vegetation group according to ANRA, which covers 2% of the State of Western Australia (ANRA, 2011).



Figure 14: Mixed Mallee shrubland vegetation within the survey area.

4.2 *Eucalyptus goniocarpa* shrubland

4.2.1 Flora

Flora recorded in the vegetation group was represented by 7 Families, 9 Genera and 20 Species (Appendix 4).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. One Priority Flora species; *Eutaxia acanthoclada* (P3) was identified in this vegetation group during the survey. No weed species were recorded in this vegetation group.

4.2.2 Vegetation

The flora recorded in this vegetation group was representative of Mallee shrubland. The species in the upper storey included *Eucalyptus goniocarpa, E. transcontinentalis, E. eremophila* subsp. *eremophila, E. salmonophloia* and *E. horistes.* The mid-storey species included *Melaleuca adnata, Melaleuca lateriflora* subsp. *lateriflora, Grevillea huegelii, Persoonia coriacea, Melaleuca adnata, Melaleuca pauperiflora* subsp. *fastigiata, Exocarpos aphyllus, Melaleuca thyoides* and *Melaleuca acuminata.* The understorey species included *Spyridium mucronatum subsp. mucronatum, Olearia muelleri, Acacia merrallii*, *Lepidosperma* sp. A2 Inland Flat and *Cryptandra minutifolia* subsp. *minutifolia.* The dominant species for each stratum of the vegetation group are displayed in the vegetation assemblage according to Muir (1977) in Table 15.

Table 15: Vegetation assemblage for *Eucalyptus goniocarpa* shrubland within the survey area (Muir, 1977)

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Shrub Form	30-70%	*Eucalyptus transcontinentalis* *Eucalyptus goniocarpa*
Shrub 0.5-1m	30-70%	*Melaleuca adnata* *Melaleuca pauperiflora* subsp. *fastigiata* *Exocarpos aphyllus* *Melaleuca thyoides* *Melaleuca acuminata*
Shrub 0-0.5m	10-30%	*Spyridium mucronatum subsp. mucronatum* *Olearia muelleri* *Acacia merrallii*
Hummock Grass	30-70%	*Lepidosperma* sp. A2 Island Flat

No broad scale clearing has occurred in this vegetation group within the survey area.

This vegetation group is best represented by the Mallee woodlands and shrublands vegetation group according to ANRA, which covers 2% of the State of Western Australia (ANRA, 2011).



Figure 15: *Eucalyptus goniocarpa* shrubland vegetation within the survey area.

4.3Vegetation of Conservation Significance

None of the eleven vegetation groups and three sub-groups have national environmental significance as defined by the Commonwealth *Environment Protection* and *Biodiversity Conservation (EPBC) Act 1999* (DSEWPC, 2011). There were no Threatened Ecological Communities or Declared Rare Flora as defined by the *EPBC Act* or listed by the DEC found within the survey area (DSEWPC, 2011; DEC, 2010). There is however a population of the DRF species *Eucalyptus steedmanii* located approximately 20m north-east and 470m west of the *E. salmonophloia* woodland vegetation group, located within the Northern region of the survey area. Within a minimum 50m area of each DRF plant is protected as an ESA. As a result the *E. salmonophloia* woodland vegetation group is considered an ESA (Appendix 3). The survey area also occurs within the boundaries of the North Ironcap and Middle Ironcap vegetation complexes which are listed by the DEC as Priority 3 Ecological Communities.

4.4 Flora of conservation significance

Four Priority Flora species were identified within the survey area:

1. *Stenanthemum liberum* (P1)*;*
2. *Stylidium sejunctum* (P2);
3. *Microcorys* sp. Forrestania (P4); and
4. *Eutaxia acanthoclada* (P3);

One DRF species was identified approximately 20m north-east of the survey area; *Eucalyptus steedmanii.* The GPS coordinates for all Priority Flora identified during the survey are located in Appendix 9 and a map showing the locations of the species is located in Appendix 10.

- ***Stenanthemum liberum* (P1)**

This species is described as a dwarf shrub that reaches 0.5 metres in height. It inhabits sites with yellow sandy loam over laterite (WAHERB, 2011). This species was identified within the Rehabilitated Area, *E. livida* woodland and Mixed shrub thicket on Banded Ironstone Ridge vegetation groups. There are six DEC records of this species between South Ironcap and Diggers Rock.



Figure 16: Images of *Stenanthemum liberum* (P1)

- ***Stylidium sejunctum* (P2)**

This species is a caespitose perennial herb that reaches heights of 0.25–0.45 metres. The 10-30 mm long and 0.8-4 mm wide leaves are tufted, linear to narrowly oblanceolate, apex acute to mucronate, margin involute and glabrous to scabrous. This species has membraneous scale leaves present at base of the mature leaves. The flowers are white, pink and purple and bloom from September through November. It inhabits sites with clayey sand, loam or laterite on outcrops, upper slopes and breakaways (WAHERB, 2011). This species was identified within the *E. livida* woodland and Mixed shrub thicket on Banded Ironstone Ridge vegetation groups. There are 21 DEC records of this species distributed from the North Ironcap to the Lake Grace-Kalgarin Highway within the Forrestania region.



Figure 17: Image of *Stylidium sejunctum* (P2) (WAHERB, 2011).

- ***Microcorys* sp. Forrestania (V. English, 2004) (P4)**

  This species is a prostrate or erect shrub that reaches heights of 0.35-0.4 metres. It had white to purple flowers that bloom from January to April each year. This species inhabits sites with yellow sandy or red/brown clay soils in open woodlands or cleared areas (WAHERB, 2011). This species was identified within the Burnt *E. salmonophloia* woodland over Mixed Mallee and *E. salmonophloia* woodland vegetation groups. There are 33 DEC records of this species which has a distribution from Marvel Loch to Forrestania. This species is abundant within the Forrestania region.



Figure 18: Image of *Microcorys* sp. Forrestania (V. English, 2004)

- ***Eutaxia acanthoclada* (P3)**

  This species is described as a compact, mat-forming, prostrate shrub, which grows up to 0.3 metres high. It produces yellow, orange or red flowers from October to November. It occurs on light brown sandy clay, shallow sandy loam, red clay over banded ironstone or gravel soils. It inhabits gently undulating plains (WAHERB, 2011). This species was identified within the Mixed Mallee shrubland vegetation group. The nearest DEC known location of this species is 8km north-east of where this species was identified within the survey area. This species is distributed from the North Ironcap area through to the Hatters hill area in the south-east of the Forrestania region. There are 13 DEC records of this species.



Figure 19: Image of *Eutaxia acanthoclada* (P3)

- ***Eucalyptus steedmanii* (DRF)**

  Eucalyptus steedmanii is defined as a Rare Flora species pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010). This tree species grows to 2-8 metres in height and is covered by a smooth bark. The white flowers are present from January to March each year. This species inhabits low hills and undulating plains with gravely loams over ironstone and sand sites (WAHERB, 2011). There are eight known populations of this species located within the Forrestania region.

  The species was not located within the survey area however Population 2 of this species occurs approximately 20m north-east and 470m west of the *E. salmonophloia* woodland vegetation group identified within the survey area. Within a 50m area of each DRF plant is protected as an ESA.



Figure 20: Image of *E. steedmanii* (DRF) located near the survey area.

4.5 Vegetation condition

The health condition of the vegetation groups were based on Keighery Health Rating Scale (1994). Appendix 10 displays the definitions of each health class. The Rehabilitation Area was classed as 'degraded'. Degraded health means that the vegetation structure is severely disturbed but has the ability to regenerate to a good condition with intensive management.

The Burnt *E. salmonophloia* over mixed Mallee, *E. eremophila* subsp. *eremophila* and *E. cylindrocarpa* Mallee shrubland and the *E. urna* woodland were classed as being in a 'good' condition. Good health means that the vegetation structure has been impacted with multiple disturbances, including fire and historical track construction, but it retains its basic vegetation structure and the ability to regenerate itself.

The remaining seven vegetation groups were classed as having a 'very good' health condition. A very good health condition means that the vegetation has been altered due to obvious disturbance but has not been impacted to a degree which affects structure or regeneration.

4.6 PATN Analysis on the Quadrats

The analysis was used to determine the similarities or differences between and within delineated vegetation groups. The classifications are based upon a Bray-Curtis association matrix using a flexible UPGMA (Beta Vale -0.1) which standardizes the data enabling the analysis to be completed. Only perennial species were included in the analysis and species reconciliation was completed. Species reconciliation eliminated those sterile species that could not be fully identified from the analysis.

Figure 20 shows the dendrograms for all perennial species PATN data analysis. The quadrats are represented as Q1-Q27. Table 16 lists the vegetation type that each quadrat was located within. The Rehabilitation Area vegetation group was not used in the PATN analysis because it contained no quadrats as it has been heavily disturbed. Quadrats were also not established within the sub-groups.

Table 16: The vegetation groups with corresponding quadrats.

Vegetation Group	Quadrat
Mixed Mallee and Mixed shrub thicket on Banded Ironstone ridge	Q5; Q6; Q7
Eucalyptus salmonophloia woodland	Q15; Q16;Q20
Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee	Q14; Q17; Q18
Mallee shrubland over *Melaleuca* shrubland	Q11; Q13; Q19
Eucalyptus eremophila subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee shrubland	Q2; Q3; Q4
Eucalyptus salubris woodland	Q12
Eucalyptus livida woodland	Q8;Q9;Q10
Eucalyptus urna woodland	Q1; Q21; Q22
Mixed Mallee shrubland	Q23; Q24**
Eucalyptus goniocarpa shrubland	Q25; Q26; Q27
Rehabilitation Area	None*

* no quadrats were established in the Rehabilitation Area because all native vegetation had been previously cleared

** only two quadrats were established as the Mixed Mallee woodland covered a small area (approximately 3ha).

4.6.1 PATN Analysis for All Recorded Species

The dendrogram resulting from the PATN analysis for all recorded species placed the quadrats into ten groupings based upon the similarities in the total species composition within the quadrats (Figure 21). This analysis showed that the *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland, Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee and the Mallee shrubland over *Melaleuca* shrubland vegetation groups have similar species composition. From the analysis three separate vegetation group classifications were formed using quadrats from these three vegetation groups; however the quadrats within each vegetation group were a mix of all three vegetation groups.

All of the *E. salmonophloia* quadrats were placed in different groupings with two of the three placed as their own grouping (Q15 & Q20). The third *E. salmonophloia* quadrat was place with two of the Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee quadrats. This showed that the *Eucalyptus salmonophloia* Woodland vegetation group has high species variability per quadrat.

Because of the high similarity in species compositions throughout most of the *Eucalyptus* and Mallee vegetation groups, the structural and density factors that caused the different vegetation groups to be delineated during the survey were not captured by the analysis.

The three *E. goniocarpa* shrubland quadrats (Q25, Q26 & Q27) were grouped together as an individual group however from all other Eucalypt quadrats. The two mixed Mallee shrubland quadrats (Q23 & Q24) were also grouped together as a separate group.

Two of the three *E. urna* woodland quadrats (Q21 & Q22) were grouped together separately from all other Eucalypt quadrats whereas Q1 of the *E. urna* woodland was grouped with the *E. salubris* woodland quadrat (Q12). Q1 and Q12 are in closer proximity to each other than Q1 is to the other *E. urna* quadrats and despite differences in the dominant upper stratum of each quadrat (i.e *E. urna* and *E. salubris)* it is apparent that the species composition of the lower stratums are quite similar between these two vegetation communities.

The three Mixed Mallee and Mixed shrub thicket on Banded Ironstone ridge quadrats (Q5, Q6 & Q7) were found to be most similar to each other and grouped together however the grouping also included the three *E. livida* woodland quadrats (Q8, Q9 & Q10). These two vegetation groups occurred within close proximity to each other with the *E. livida* woodland surrounding the base and lower slope of the Banded Ironstone Formation. As a result these vegetation groups had a similar species composition as evident from the analysis.

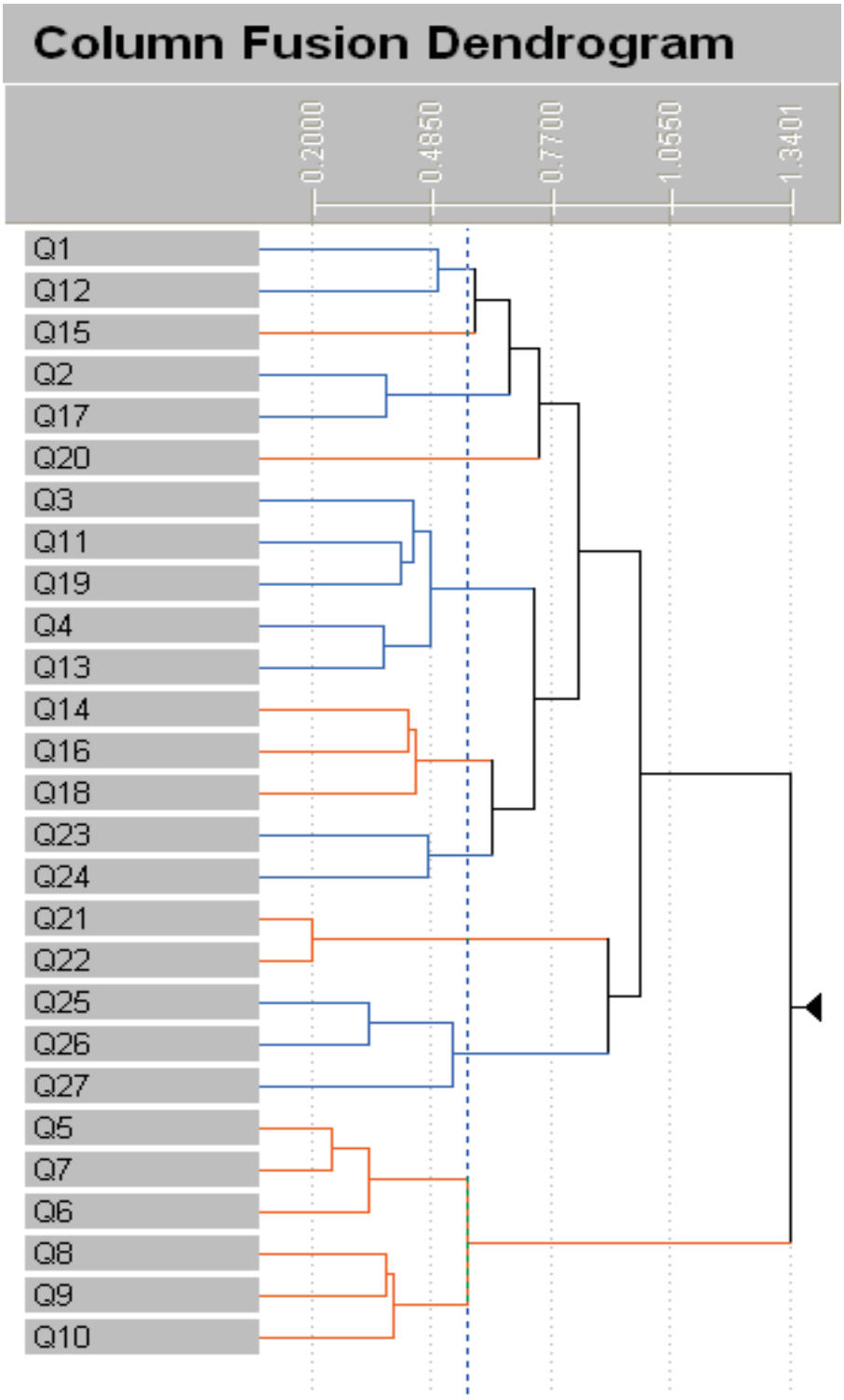


Figure 21: Dendrogram resulting from the PATN analysis on the all recorded species quadrat data (Flexible UPGMA clustering Beta Value -0.1).

4.7 Species accumulation curve

A species accumulation curve was created to display the rate of species accumulation during the quadrat survey. The R^2 value (0.97) suggests that the data "fits" the species accumulation curve shown in Figure 22. The rate of species accumulation for the 27 quadrats in the survey was 3.96 new species per quadrat. According to the equation of the species accumulation curve (located in Figure 22), the rate of species accumulation is estimated to drop to 0.6, 0.35, 0.3 and 0.25 species per quadrat for the next four intervals of 20 quadrats (40, 60, 80 and 100). BC has determined that according to this data a sufficient number of quadrats were established in the survey area.

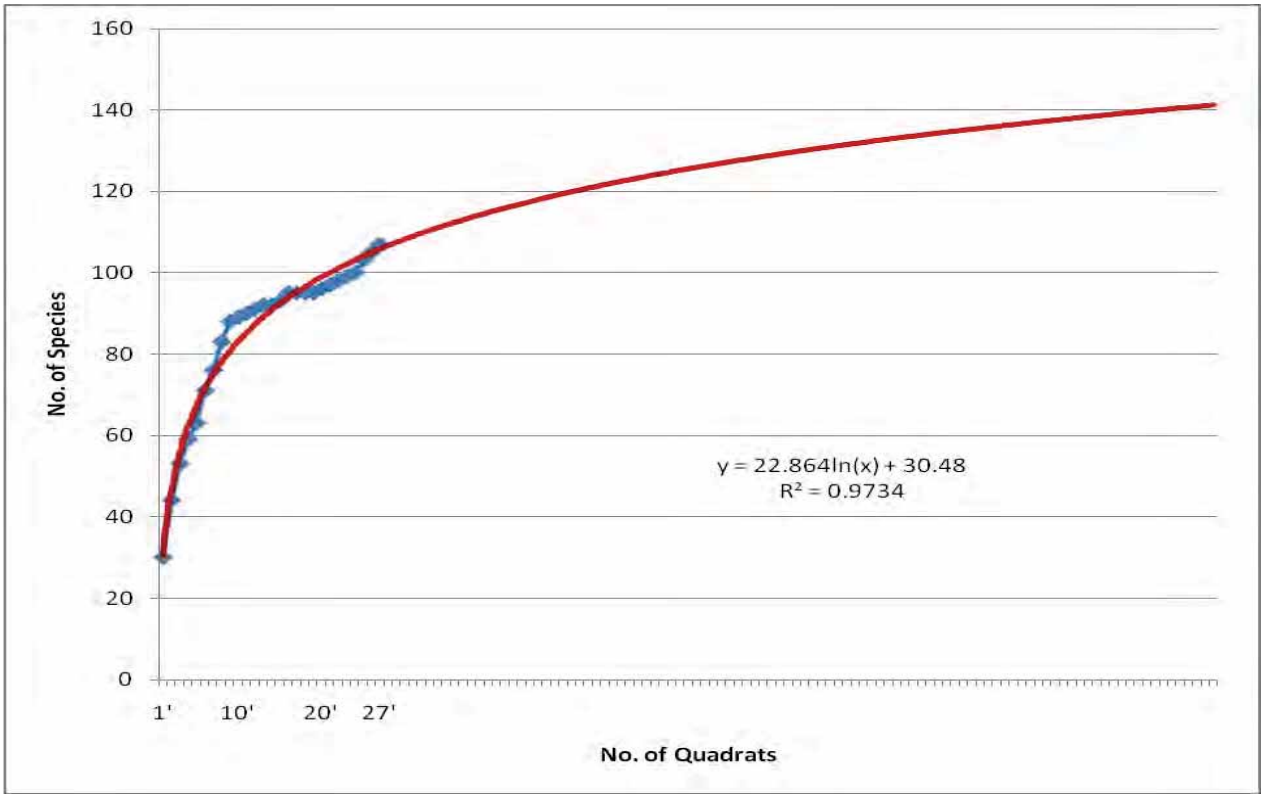


Figure 22: Species accumulation curve for the survey with the accumulation curve (red) and the number of species recorded in the quadrats (blue). The curve is forecast for 100 quadrats.

5 Introduced Plant Species

Two weed species as defined by Florabase (WAHERB, 2011) were identified within the survey area; *Carduus nutans* and *Salvia verbenaca*. Both of these species were only located within the Rehabilitation Area. According to the Department of Agriculture and Food WA database neither of these species are listed on the Declared Plants (DAFWA, 2011).

- ***Carduus nutans* (Nodding thistle)**

This species is described as a rosette-forming, spiny annual or biennial, herbaceous plant. It produces purple, blue or red flowers and commonly inhabits pastures (WAHERB, 2011). No image available.

- ***Salvia verbenaca* (Wild Sage)**

This weed species is a described as a slightly aromatic perennial herb that grows to heights of 0.1–1 metres. It produces blue, pink or purple flowers that appear from July to October each year. It often inhabits disturbed sites such as roadsides (WAHERB, 2011).



Figure 23: Image of *Salvia verbenaca*

6 Relevant Legislation and Compliance with Recognised Standards

6.1 Commonwealth Legislation

Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The aim of this Act is to protect matters of national environmental significance and is used by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) to list threatened species and ecological communities into categories based on the criteria set out in the Act.
The act provides a national environmental assessment and approval system for proposed developments and enforces strict penalties for unauthorised actions that may affect matters of national environmental significance (www.environment.gov.au/epbc/index.html).

None of the eleven vegetation groups and three sub-groups identified contain DRF species *or* Threatened Ecological Communities as defined by the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. The survey area therefore has no national environmental significance under the *EPBC Act 1999.* It is important to note however that the *E. salmonophloia* vegetation group located within the far northern region of the survey area occurs within close proximity (approximately 20m) of Population 2 of the DRF species *Eucalyptus steedmanii.*

6.2 State Legislation

Clearing of Native Vegetation

The *Environmental Protection (Clearing of Native Vegetation) Regulations WA* 2004 dictate that any clearing of native vegetation in Western Australia requires a permit from the Department of Environment and Conservation. Native vegetation includes aquatic and terrestrial vegetation indigenous to Western Australia, and intentionally planted vegetation declared by regulation to be native vegetation, but not vegetation planted in a plantation or planted with commercial intent (*Environmental Protection Act WA-Section 51A, 1986*). The *Environmental Protection Act WA 1986* Section 51A, defines clearing as: “the killing or destruction of; the removal of; the severing or ringbarking of trunks or stems of; or the doing of substantial damage to some or all of the native vegetation in an area, including the flooding of land, the burning of vegetation, the grazing of stock or an act or activity that results in the above”.

Under the *Environmental Protection (Clearing of Native Vegetation) Regulations WA 2004* - Regulation 6 – Environmentally sensitive areas (ESA) are "the area covered by vegetation within 50 m of Rare Flora, to the extent to which the vegetation is continuous with the vegetation in which the Rare Flora is located".

A clearing permit must be obtained prior to any clearing within an area of 50 m surrounding all populations of Declared Rare Flora. The area covered by a TEC is also considered an environmentally sensitive area and therefore non-permitted, unless a clearing permit is granted. Exploration Activities are exempt from requiring clearing permits when undertaken via a Mining Act approval process such as "Programme of Work" provided the area does not occur in an ESA.

Approximately 0.22ha of the *E. salmonophloia* woodland vegetation group located within the far northern region of the survey area is located approximately 20m south-west of a *E. steedmanii* DRF population (Population 2) and is within the 50m boundary of DRF which is considered an ESA.. A clearing permit would be required for any clearing within this 0.22ha area of the vegetation group. No TEC's are located within the survey area.

Wildlife Conservation Act WA 1950

This Act is used by the Western Australian Department of Environment and Conservation (DEC) to list flora taxa as being protected and the level of protection needed for such flora. Flora species are classified as 'Declared Rare Flora' when their populations are geographically restricted or are threatened by local processes. Under this Act all native flora (spermatophytes, pteridophytes, bryophytes and thallophytes) are protected throughout the State. Financial penalties are enforced under this Act if threatened plant species are collected without an appropriate licence.

DEC Priority lists

The DEC lists 'Priority' flora species which are under consideration for declaration as Rare Flora. Species classed as Priority 1-3 are in urgent need of further survey, whereas Priority 4 species only require monitoring every 5-10yrs.

Results of the DEC data base search revealed twelve Priority Flora and two DRF species occurring within a 5 km radius of the survey area (Appendix 2). Four Priority Flora were recorded in the survey area.

The DEC also lists PEC's which identifies those communities that may need monitoring before possible nomination for TEC status. Possible TEC's that do not meet survey criteria or are not adequately defined are added to the PEC list 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 a TEC.

These priority species and communities have no formal legal protection until they are endorsed by the Minister as being DRF and TEC's respectively.

According to the DEC database search (DEC, 2010b) the survey area is located within two DEC listed PEC's known as North Ironcap and Middle Ironcap which form part of the *Ironcap Hills vegetation complex* (P3) (DEC, 2010). Whilst PEC's are not formally protected they are of conservation significance and consultation with the DEC is recommended prior to any clearing within the survey area.

6.3 EPA Position Statements

The EPA develops Position Statements to inform the public about environmental issues facing Western Australia and the plans for the future to ensure protection and ecological sustainability of environmentally important ecosystems. It provides a set of principles to assist the public and decision-makers on their responsibilities for managing land with care. These principles also provide the basis for the EPA to evaluate and report upon achieving environmental and ecological sustainability and the protection of natural resources.

Position Statement No. 2 *Environmental Protection of Native Vegetation in Western Australia* (EPA 2000) outlines EPA policy on the protection of native vegetation in Western Australia, particularly in the agricultural area. It identifies basic elements that the EPA should consider when assessing proposals that impact on biological diversity. These include the following: comparison of all proposal options; avoidance of species and community extinctions; an expectation that implementing the proposal will not take a vegetation type below the "threshold level" of 30%; and that proponents should demonstrate that on- and off-site impacts can be managed.

None of the vegetation associations as classified by Beard located within the survey area are or will fall below the 30% threshold level of current vegetation. The survey area does not contain any TEC's however it does have a DRF located approximately 20m north-east suggesting that clearing within the survey area will not meet the EPA standards outlined in Position statement no. 2.

Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection* outlines that the EPA adopted the definition of Biological Diversity and the Principles as defined in the *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996); that the quality of information and scope of field surveys should meet standards, requirements and protocols as determined and published by the EPA; and the Interim Biogeographic Regionalisation of Australia (IBRA) should be used as the largest unit for EIA decision-making in relation to the conservation of biodiversity. The IBRA has identified 26 bioregions in the State which

are affected by a range of different threatening processes and have varying levels of sensitivity to impact. Terrestrial biological surveys should provide sufficient information to address both biodiversity conservation and ecological function values within the context of proposals and the results of surveys should be publicly available.

The flora survey of the study area was planned and implemented as far as practicable according to the EPA Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004). Also as suggested in the above Position Statement, the Interim Biogeographic Regionalisation of Australia was used in preparing the report to identify the Conservation status of the area and identify the main threats to the biodiversity of plant species in the region.

Position Statement No. 5 *Environmental Protection and Ecological Sustainability of the Rangelands in WA* outlines that the EPA recognize WA rangelands are geologically unique, containing a wealth of diverse native plants and animals. They also provide an important resource for grazing, mining, tourism and conservation and are currently being severely degraded by accelerated soil erosion, increased numbers and distribution of weeds, reduced water quality and the decline and changes to native plant communities. The EPA have developed the following operational objectives for protecting the WA rangelands; 1) protection of biodiversity hot spots by developing reserves, 2) setting rehabilitation and regeneration requirements for landholders, 3) protection of air quality and water resources, 4) effective monitoring of biodiversity, ecological processes and ecological function.

7 Conclusions, Discussions and Recommendations

7.1 Conclusions

The entire SQ/CB Haul Road flora survey area (approximately 412.4ha) revealed eleven vegetation groups and three sub-groups in which a total of 27 Families, 60 Genera and 141 Species were recorded.

No Declared Rare Flora species and four Priority Flora species were recorded within the survey area. There is however a population of the DRF species *Eucalyptus steedmanii* located within close proximity to the *E. salmonophloia* woodland vegetation group located within the northern region of the survey area. As a result this part of the vegetation group is protected as an Environmentally Sensitive Area as it occurs within a 50m area of DRF. The survey area has no national environmental significance as defined by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.* No Threatened Ecological Communities (TEC's) listed by the *EPBC Act 1999* or defined by the DEC are known to occur in the survey area (DSEWPC, 2011; DEC, 2010b). The survey area is however located within the North Ironcap and Middle Ironcap Priority 3 Ecological Communities which form part of the *Ironcap Hills Vegetation Complex.* Two weed species were recorded in the

Rehabilitation Area, neither of which are listed by the Department of Agriculture and Food as Declared Weeds (DAFWA, 2011).

7.2 Recommendations

- Consultation with the DEC is recommended prior to any clearing within the survey area as it occurs within the boundaries of two PEC's. Although PEC's are not formally protected they are of conservation significance and are being considered to be formally protected under the *EPBC Act 1999* as Threatened Ecological Communities.
- Consultation with the DEC is recommended prior to any clearing within the *Eucalyptus salmonophloia* woodland vegetation located within 50m of the DRF in the northern region of the survey area. This part of the vegetation group is considered an ESA as it is located within a 50m area of the DRF species *Eucalyptus steedmanii.* To clear within an ESA a clearing permit required.
- Avoidance of all Priority Flora species identified within this report is recommended.
- If disturbance is unavoidable where Priority Flora have been identified in this report further consultation with the DEC will be required and numbers of priority flora will need to be counted for a permit to destroy application.
- The total number of plants for each Priority Flora species identified within the survey area and in the local area surrounding the survey area (10km radius) needs to be determined in order to submit an application to destroy Priority Flora to the DEC if Priority Flora cannot be avoided.

For the purpose of this vegetation survey, BC submits the following comments for the clearing principals listed below:

(a) **Native vegetation should not be cleared if it comprises a high level of biological diversity.**

This survey revealed diverse flora that are not restricted to the project area and occur across the same and other regions.

(c) **Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.**

No DRF species were recorded within the survey area however a DRF population is located approximately 20m north-east and 470m west of the *E. salmonophloia* woodland vegetation group located in the far northern region of the survey area. Consultation with the DEC is recommended prior to any clearing within this vegetation group. Within a 50m area of each DRF plant is protected as an ESA and requires a clearing permit.

(d) **Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a threatened ecological community (TEC).**

No Threatened Ecological Communities (TEC's) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (DSEWPC, 2011) or by the DEC (2010b) occur in the survey area. The survey area is located within the boundary of two Priority 3 Ecological Communities; North Ironcap and Middle Ironcap. PEC's are not formally protected but are areas of conservation significance being considered for listing and formal protection under the *EPBC Act 1999* as TEC's.

(e) **Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.**

No vegetation considered as a significant remnant of extensively cleared vegetation was recorded in the survey area. None of the Beard pre-European vegetation associations identified within the area are or will be reduced below the 30% threshold.

(f) **Native vegetation should not be cleared if it is growing, in, or in association with, an environment associated with a watercourse or wetland**

No vegetation growing in, or in association with a watercourse or wetland occurs in the survey area.

(h) **Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.**

The southern most boundary of the closest conservation area, the Lake Cronin Nature Reserve, lies 10km to the north of the survey area. The localised nature of disturbance within the survey area will not impact on the conservation values of this reserve. The 10km ESA buffer zone around this Nature Reserve is located approximately 3km north-east of the the survey area.

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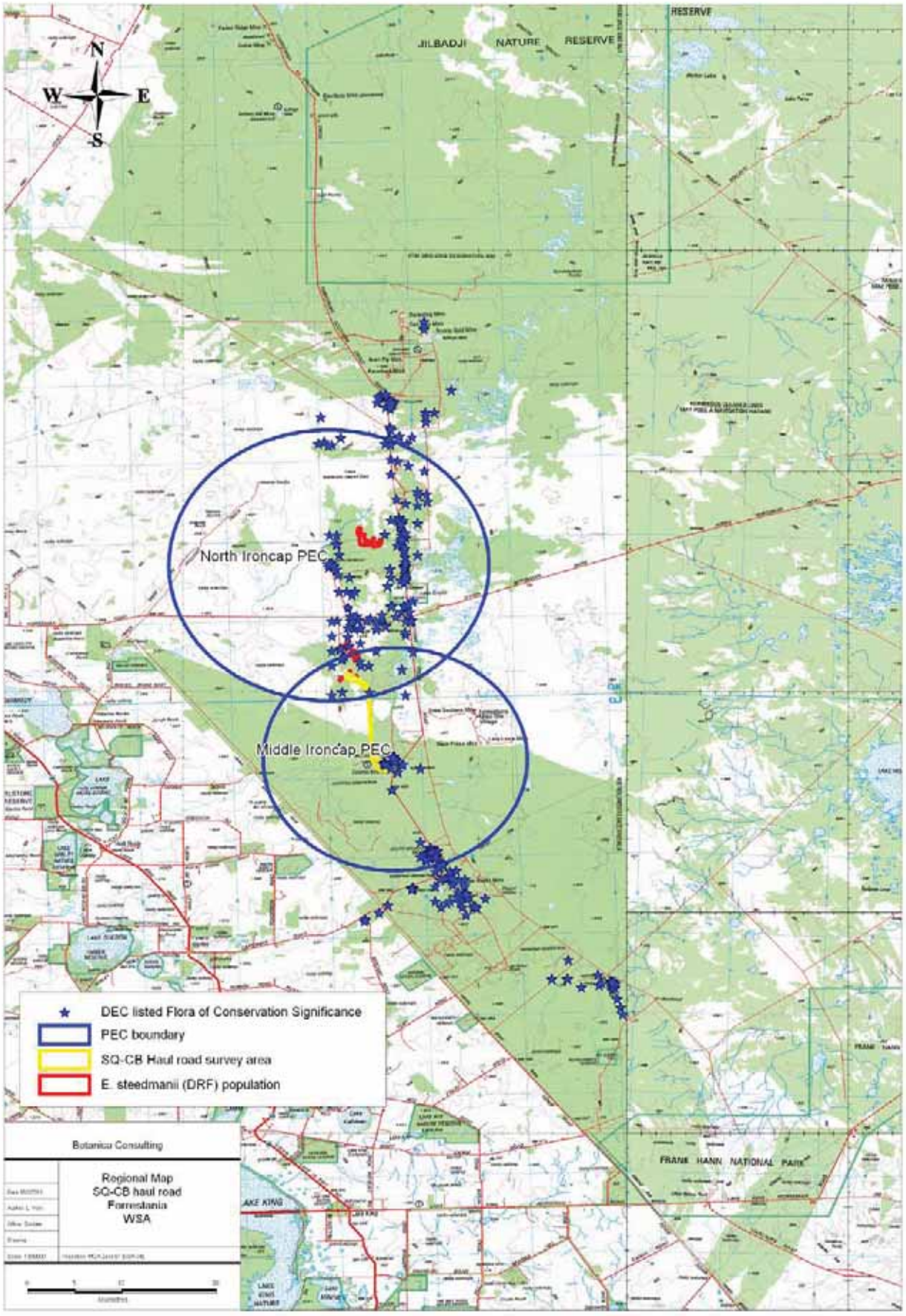
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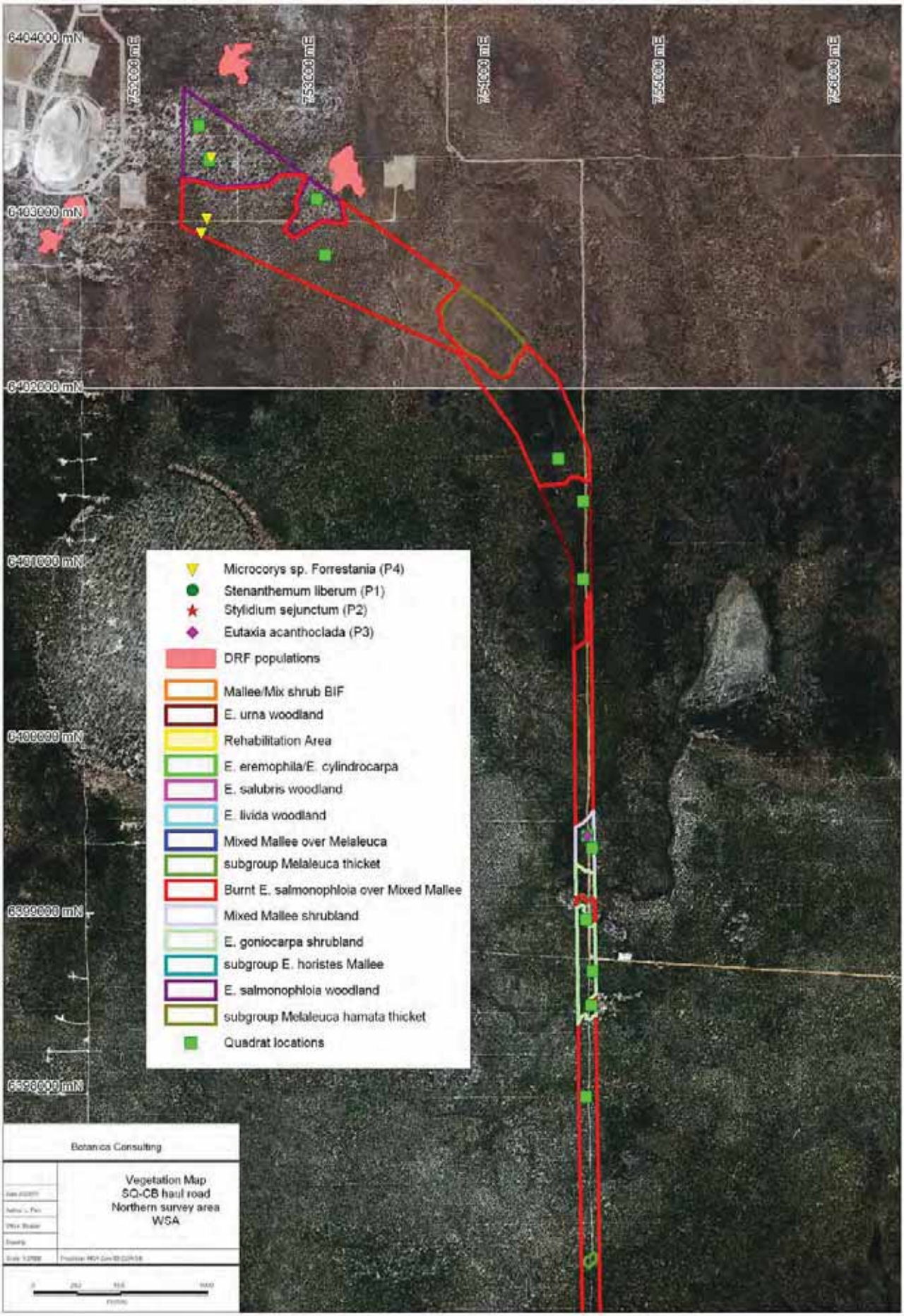
Appendix 1: DEC Database search results for Rare and Priority species within 10km of the survey area (DEC, 2010a)

GENUS	SPECIES	CONS_CODE
Acacia	*asepala*	P2
Baeckea	sp. Parker Range (M. Hislop & F. Hort MH 2968)	P3
Baeckea	sp. Lake Cronin (K.R. Newbey 9191)	P1
Baeckea	sp. North Ironcap (R.J. Cranfield 10580)	P2
Boronia	*revoluta*	R
Boronia	*westringioides*	P2
Calamphoreus	*inflatus*	P4
Comesperma	*calcicola*	P3
Cryptandra	*polyclada* subsp. *polyclada*	P3
Dampiera	*scaevolina*	P1
Daviesia	*elongata* subsp. *implexa*	P3
Dillwynia	*acerosa*	P1
Banksia	*viscida*	P3
Eremophila	*biserrata*	P4
Eremophila	*racemosa*	P4
Eucalyptus	*steedmanii*	R
Eutaxia	*acanthoclada*	P3
Eutaxia	*nanophylla*	P3
Eutaxia	*rubricarina*	P3
Grevillea	*insignis* subsp. *elliottii*	P3
Grevillea	*lullfitzii*	P1
Grevillea	*pilosa* subsp. *redacta*	P3
Lepidosperma	*ferriculmen*	P1
Microcorys	sp. Forrestania (V. English 2004)	P4
Pityrodia	sp. Yilgarn (A.P. Brown 2679)	P3
Stenanthemum	*liberum*	P1
Stylidium	*sejunctum*	P2

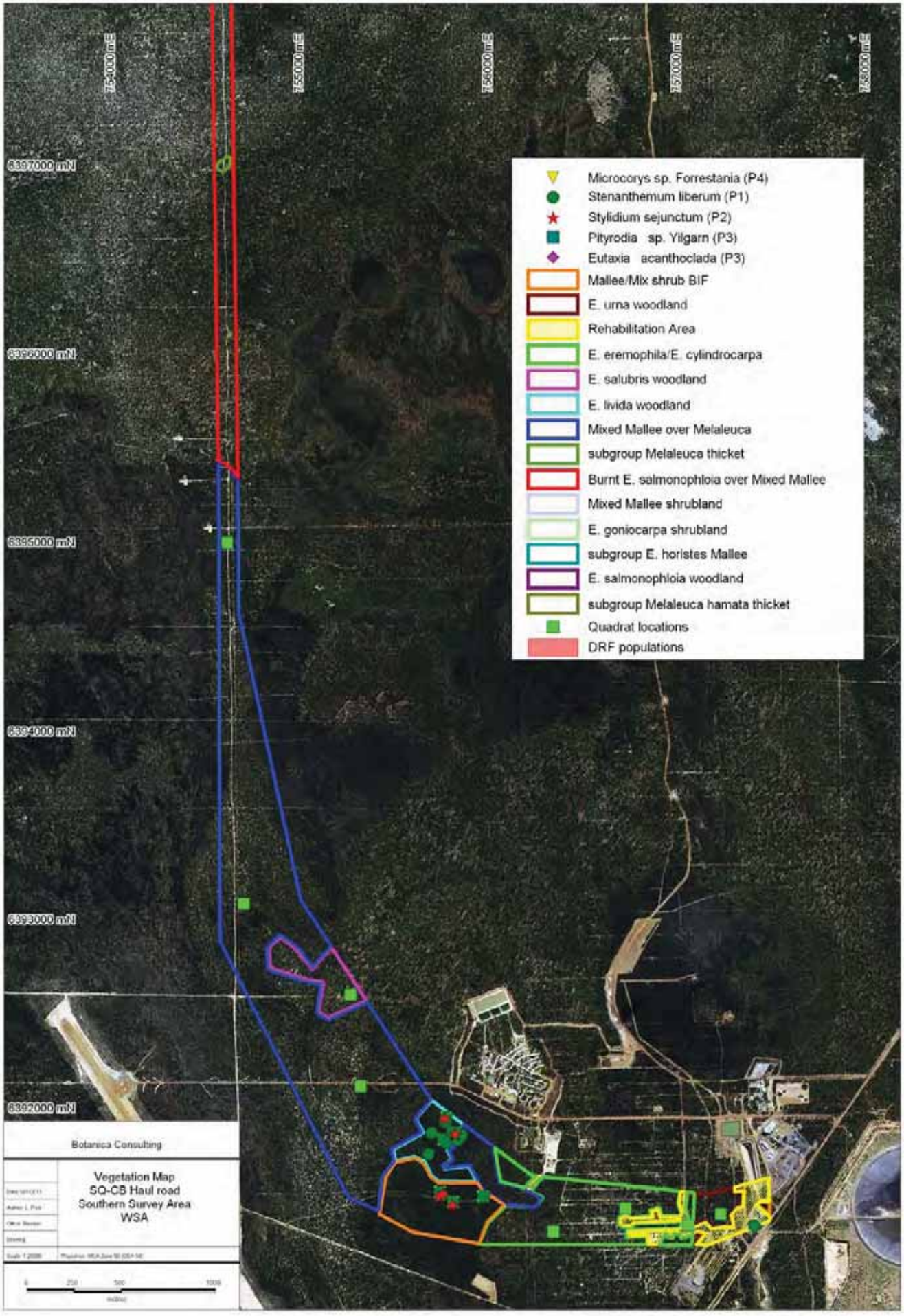
Appendix 2: Regional map of the survey area including DRF populations, PEC boundaries and DEC locations of Flora of Conservation Significance (DEC, 2010a).



Appendix 3a: Vegetation Map (Northern Area) with Quadrat Locations, Priority Flora and DRF populations.



Appendix 3b: Vegetation Map (Southern Area) with Quadrat Locations, Priority Flora and DRF populations.



Appendix 4: Complete Species List per vegetation group

Family	Genus	Species	Rehab Area	*E. urna*	*E. livida*	*E. salubris*	*E. eremophila* and *E. cylindrocarpa*	Mallee over *Melaleuca*	Burnt *E. salmonophloia* over Mixed Mallee	*E. salmon*	Scrub Heath	Mixed Mallee	E. goniocarpa
Aizoaceae	*Disphyma*	*crassifolium* subsp. *clavellatum*								*			
Apiaceae	*Platysace*	*maxwellii*											*
Asparagaceae	*Thysanotus*	*sparteus*								*			
Asteraceae	*Carduus*	*nutans (W)*	*										
Asteraceae	*Erymophyllum*	*ramosum* subsp. *ramosum*								*			
Asteraceae	*Olearia*	*muelleri*		*		*			*	*		*	*
Asteraceae	*Olearia*	*pimeleoides*	*										
Boraginaceae	*Halgania*	*andromedifolia*			*	*							
Casuarinaceae	*Allocasuarina*	*campestris*	*		*						*		
Casuarinaceae	*Allocasuarina*	*corniculata*	*								*		
Casuarinaceae	*Allocasuarina*	*helmsii*			*						*		
Chenopodiaceae	*Atriplex*	*stipitata*	*	*									
Chenopodiaceae	*Atriplex*	*vesicaria*	*	*									
Chenopodiaceae	*Sclerolaena*	*diacantha*	*	*						*			
Chenopodiaceae	*Sclerolaena*	*uniflora*								*		*	
Convolvulaceae	*Wilsonia*	*humilis*				*		*	*	*		*	
Cupressaceae	*Callitris*	*preissii*	*		*						*		
Cyperaceae	*Lepidosperma*	A2 Inland Flat											*
Cyperaceae	*Lepidosperma*	*brunonianum*			*			*	*				
Dilleniaceae	*Hibbertia*	*gracilipes*									*		
Dilleniaceae	*Hibbertia*	*pungens*	*		*						*		
Ericaceae	*Astroloma*	*serratifolium*	*								*		
Ericaceae	*Coleanthera*	*myrtoides*									*		
Ericaceae	*Leucopogon*	*cuneifolius*			*			*			*		
Ericaceae	*Leucopogon*	sp. Wheatbelt			*								
Fabaceae	*Acacia*	*acanthoclada subsp. acanthoclada*	*		*						*		
Fabaceae	*Acacia*	*acuaria*								*			
Fabaceae	*Acacia*	*deficiens*	*			*	*	*	*	*		*	
Fabaceae	*Acacia*	*enervia subsp. enervia*			*		*	*			*		
Fabaceae	*Acacia*	*erinacea*		*		*	*	*	*	*			
Fabaceae	*Acacia*	*fragilis*	*								*		

Family	Genus	Species	Rehab Area	*E. urna*	*E. livida*	*E. salubris*	*E. eremophila* and *E. cylindrocarpa*	Mallee over *Melaleuca*	Burnt *E. salmonophloia* over Mixed Mallee	*E. salmon*	Scrub Heath	Mixed Mallee	E. goniocarpa
Fabaceae	*Acacia*	*hemiteles*	*	*				*	*	*		*	*
Fabaceae	*Acacia*	*intricata*				*	*	*	*	*		*	
Fabaceae	*Acacia*	*leptospermoides* subsp. *leptospermoides*					*						
Fabaceae	*Acacia*	*merrallii*	*	*		*			*	*		*	*
Fabaceae	*Acacia*	*poliochroa*	*	*			*		*				
Fabaceae	*Acacia*	*sphacelata subsp. sphacelata*	*		*			*		*	*		
Fabaceae	*Acacia*	*steedmanii subsp. steedmanii*	*										
Fabaceae	*Acacia*	*sulcata var. platyphylla*	*					*			*		*
Fabaceae	*Acacia*	*uncinella*	*					*			*		
Fabaceae	*Daviesia*	*benthamii subsp. acanthoclona*	*	*	*	*	*	*	*	*	*		
Fabaceae	*Daviesia*	*lancifolia*						*					
Fabaceae	*Daviesia*	*nematophylla*	*	*		*	*	*	*	*	*		
Fabaceae	*Eutaxia*	*acanthoclada* (P3)										*	
Fabaceae	*Gompholobium*	*gompholobioides*		*		*				*			
Fabaceae	*Senna*	*artemisioides subsp. artemisioides*	*										
Fabaceae	*Templetonia*	*sulcata*				*			*	*			
Goodeniaceae	*Coopernookia*	*strophiolata*	*							*			
Goodeniaceae	*Dampiera*	*angulata subsp. Peak Charles*	*										
Goodeniaceae	*Goodenia*	*pinifolia*	*		*				*	*	*		
Goodeniaceae	*Goodenia*	*viscida*									*		
Goodeniaceae	*Scaevola*	*spinescens*				*				*			
Hemerocallidaceae	*Dianella*	*revoluta*								*			
Lamiaceae	*Microcorys*	*sp. Forrestania (P4)*							*	*			
Lamiaceae	*Pityrodia*	*Exserta var. lanata*										*	
Lamiaceae	*Salvia*	*verbenaca (W)*	*										
Lamiaceae	*Westringia*	*cephalantha var. caterva*			*		*	*	*	*	*		

Family	Genus	Species	Rehab Area	*E. urna*	*E. livida*	*E. salubris*	*E. eremophila* and *E. cylindrocarpa*	Mallee over *Melaleuca*	Burnt *E. salmonophloia* over Mixed Mallee	*E. salmon*	Scrub Heath	Mixed Mallee	E. goniocarpa
Lamiaceae	*Westringia*	*rigida*		*		*	*	*	*				
Lauraceae	*Cassytha*	*melantha*	*		*		*	*		*	*		
Myrtaceae	*Baeckea*	*crispiflora sens lat.*			*		*	*			*		
Myrtaceae	*Beaufortia*	*interstans*									*		
Myrtaceae	*Beaufortia*	*schaueri*									*		
Myrtaceae	*Calothamnus*	*quadrifidus*			*						*		
Myrtaceae	*Calytrix*	*sapphirina*			*						*		
Myrtaceae	*Darwinia*	*inconspicua*			*						*		
Myrtaceae	*Eucalyptus*	*annulata*	*							*			
Myrtaceae	*Eucalyptus*	*astringens*							*				
Myrtaceae	*Eucalyptus*	*calycogona* subsp. *calycogona*						*				*	
Myrtaceae	*Eucalyptus*	*cylindrocarpa*		*			*	*	*	*	*	*	
Myrtaceae	*Eucalyptus*	*eremophila*					*		*				*
Myrtaceae	*Eucalyptus*	*eremophila subsp. eremophila*	*	*	*		*	*	*		*		
Myrtaceae	*Eucalyptus*	*?goniocarpa*							*				*
Myrtaceae	*Eucalyptus*	*gracilis*							*			*	
Myrtaceae	*Eucalyptus*	*horistes*			*						*		*
Myrtaceae	*Eucalyptus*	*livida*			*								
Myrtaceae	*Eucalyptus*	*melanoxylon*		*									
Myrtaceae	*Eucalyptus*	*pileata*	*					*	*				
Myrtaceae	*Eucalyptus*	*polita*							*				
Myrtaceae	*Eucalyptus*	*salmonophloia*				*			*	*		*	*
Myrtaceae	*Eucalyptus*	*salubris*		*		*	*		*	*			
Myrtaceae	*Eucalyptus*	sp. (sterile)						*		*			
Myrtaceae	*Eucalyptus*	*transcontinentalis*							*				*
Myrtaceae	*Eucalyptus*	*urna*		*		*	*	*		*			
Myrtaceae	*Eucalyptus*	*aff. yilgarnensis*										*	
Myrtaceae	*Leptospermum*	*erubescens*			*						*		
Myrtaceae	*Leptospermum*	*roei*									*		
Myrtaceae	*Melaleuca*	*acuminata* subsp. *acuminata*				*		*					
Myrtaceae	*Melaleuca*	*adnata*		*		*	*	*	*	*	*	*	*
Myrtaceae	*Melaleuca*	*cardiophylla*		*			*	*		*			
Myrtaceae	*Melaleuca*	*cordata*	*		*		*				*		
Myrtaceae	*Melaleuca*	*cucullata*		*				*	*				

Family	Genus	Species	Rehab Area	*E. urna*	*E. livida*	*E. salubris*	*E. eremophila* and *E. cylindrocarpa*	Mallee over *Melaleuca*	Burnt *E. salmonophloia* over Mixed Mallee	*E. salmon*	Scrub Heath	Mixed Mallee	E. goniocarpa
Myrtaceae	*Melaleuca*	*eleuterostachya*	*			*	*		*				
Myrtaceae	*Melaleuca*	*glaberrima*			*						*		
Myrtaceae	*Melaleuca*	*glaberrima*			*						*		
Myrtaceae	*Melaleuca*	*hamata*			*		*	*	*		*		
Myrtaceae	*Melaleuca*	*lanceolata*							*				
Myrtaceae	*Melaleuca*	*lateriflora subsp. lateriflora*	*	*		*	*	*		*			*
Myrtaceae	*Melaleuca*	*laxiflora*	*		*			*					
Myrtaceae	*Melaleuca*	*pauperiflora subsp. fastigiata*		*	*		*	*	*	*		*	
Myrtaceae	*Melaleuca*	*pauperiflora subsp. pauperiflora*		*								*	
Myrtaceae	*Melaleuca*	*sapientes*	*										
Myrtaceae	*Melaleuca*	*scoparia*			*						*		
Myrtaceae	*Melaleuca*	*thyoides*											*
Myrtaceae	*Melaleuca*	*urceolaris*		*			*	*		*			
Myrtaceae	*Thryptomene*	*kochii*									*		
Myrtaceae	*Verticordia*	*chrysantha*									*		
Myrtaceae	*Verticordia*	*plumosa var. incrassata*			*						*		
Proteaceae	*Banksia*	*cirsioides*									*		
Proteaceae	*Grevillea*	*acuaria*		*		*	*	*	*	*		*	
Proteaceae	*Grevillea*	*huegelii*					*		*	*			*
Proteaceae	*Grevillea*	*nematophylla subsp. nematophylla*	*										
Proteaceae	*Grevillea*	*oligantha*											*
Proteaceae	*Grevillea*	*oncogyne*		*			*	*			*		*
Proteaceae	*Hakea*	*commutata*					*						
Proteaceae	*Hakea*	*corymbosa*				*		*					
Proteaceae	*Hakea*	*erecta*									*		
Proteaceae	*Hakea*	*multilineata*	*		*						*		
Proteaceae	*Hakea*	*scoparia subsp. scoparia*	*		*						*		
Proteaceae	*Isopogon*	*axillaris*			*						*		
Proteaceae	*Isopogon*	*scabriusculus subsp. pubifloris*									*		
Proteaceae	*Persoonia*	*coriacea*	*		*						*		*
Proteaceae	*Persoonia*	*helix*	*		*						*		

Family	Genus	Species	Rehab Area	*E. urna*	*E. livida*	*E. salubris*	*E. eremophila* and *E. cylindrocarpa*	Mallee over *Melaleuca*	Burnt *E. salmonophloia* over Mixed Mallee	*E. salmon*	Scrub Heath	Mixed Mallee	E. goniocarpa
Proteaceae	*Persoonia*	*striata*									*		
Rhamnaceae	*Cryptandra*	*aridicola*							*	*			
Rhamnaceae	*Cryptandra*	*intonsa*								*	*		
Rhamnaceae	*Cryptandra*	*minutifolia subsp. minutifolia*						*	*				*
Rhamnaceae	*Spyridium*	*mucronatum* subsp. *mucronatum*											*
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	*		*						*		
Rutaceae	*Boronia*	*inornata subsp. inornata*			*		*	*		*	*		
Rutaceae	*Microcybe*	*multiflora subsp. multiflora*			*						*		
Rutaceae	*Phebalium*	*filifolium*	*		*						*		
Rutaceae	*Phebalium*	*tuberculosum*			*					*	*		
Santalaceae	*Exocarpos*	*aphyllus*		*	*	*	*	*	*	*	*	*	*
Santalaceae	*Exocarpos*	*sparteus*											*
Santalaceae	*Santalum*	*acuminatum*	*	*	*	*		*		*	*		
Sapindaceae	*Dodonaea*	*bursariifolia*	*		*		*	*	*	*	*		
Sapindaceae	*Dodonaea*	*microzyga var. acrolobata*			*								
Sapindaceae	*Dodonaea*	*stenozyga*	*	*		*	*	*	*	*			
Scrophuliaceae	*Eremophila*	*decipiens subsp. decipiens*							*	*		*	
Scrophuliaceae	*Eremophila*	*densifolia subsp. capitata*	*	*		*			*				
Scrophuliaceae	*Eremophila*	*dichroantha*										*	
Scrophuliaceae	*Eremophila*	*drummondii*					*	*	*				
Solanaceae	*Solanum*	*hoplopetalum*	*										
Stylidiaceae	*Stylidium*	*sejunctum (P2)*			*						*		

W indicates weed species

(P) indicates Priority Species

Appendix 5: Species List per Quadrat

Q1-15

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Acacia acuaria															*
Acacia deficiens			*	*							*	*		*	
Acacia enervia subsp. enervia							*	*			*				
Acacia enervia															
Acacia erinacea												*		*	
Acacia hemiteles															
Acacia intricata			*	*							*	*		*	
Acacia leptospermoides subsp. leptospermoides		*													
Acacia merrallii												*			*
Acacia poliochroa	*														
Acacia sphacelata subsp. *sphacelata*					*	*	*		*		*				*
Acacia sulcata var. *platyphylla*													*		
Acacia sulcata subsp. sulcata															
Adenanthos argyreus															
Allocasuarina campestris						*	*		*	*					
Allocasuarina helmsii						*									
Astroloma serratifolia					*										
Baeckea crispiflora sens lat.			*						*	*			*		
Banksia cirsioides					*	*	*								
Beaufortia interstans					*	*	*								
Beaufortia schaueri					*	*	*								
Boronia inornata subsp. *inornata*				*				*			*				
Callitris preissii					*	*	*								
Calothamnus quadrifidus					*	*	*	*		*					
Calytrix sapphirina						*		*		*					
Cassytha melantha			*	*									*		
Coopernookia strophiolata															
Cryptandra intonsa															
Cryptandra minutifolia subsp. *minutifolia*													*		
Darwinia inconspicua					*	*	*	*	*						
Daviesia benthamii subsp. *acanthoclona*				*			*			*	*		*	*	

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Daviesia nematophylla											*	*			
Dianella revoluta															
Dodonaea bursariifolia		*			*		*	*	*	*					
Dodonaea microzyga var. *acrolobata*									*						
Dodonaea stenozyga	*	*	*	*								*	*		*
Eremophila decipiens subsp. *decipiens*															
Eremophila densifolia subsp. *capitata*												*			
Eremophila dichroantha															
Eremophila drummondii				*									*	*	
Eucalyptus calycogona subsp. *calycogona*													*		
Eucalyptus cylindrocarpa		*	*	*		*					*		*	*	
Eucalyptus eremophila subsp. *eremophila*		*	*	*	*			*	*		*			*	
Eucalyptus ?goniocarpa															
Eucalyptus gracilis															
Eucalyptus horistes					*	*	*	*	*						
Eucalyptus livida								*	*	*					
Eucalyptus melanoxylon															
Eucalyptus pileata														*	
Eucalyptus salmonophloia												*			*
Eucalyptus salubris	*	*										*			*
Eucalyptus transcontinentalis															
Eucalyptus sp. (sterile)															
Eucalyptus urna	*	*		*								*	*		
Eucalyptus aff. yilgarnensis															
Eutaxia acanthoclada (P3)															
Exocarpos aphyllus			*		*		*				*	*		*	*
Exocarpos sparteus								*		*					
Gompholobium gompholobioides	*											*			
Goodenia pinifolia					*		*	*	*						
Grevillea acuaria	*	*		*								*	*	*	*
Grevillea huegelii				*										*	*
Grevillea sp. Sterile															
Grevillea oncogyne				*							*		*		
Hakea commutata															

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Hakea corymbosa											*	*	*		
Hakea multilineata					*	*	*		*	*					
Hakea scoparia subsp. scoparia					*	*	*		*	*					
Halgania andromedifolia								*	*	*					
Hibbertia pungens					*	*	*	*	*	*					
Isopogon axillaris					*	*		*		*					
Isopogon scabriusculus subsp. pubifloris						*									
Lepidosperma sp. sterile															
Lepidosperma sp. A2 Inland Flat										*					
Lepidosperma sp. Maggie Hays (R. Barrett)															
Leptospermum erubescens								*	*						
Leucopogon cuneifolius					*	*									
Leucopogon sp. Wheatbelt								*	*	*					
Melaleuca acuminata subsp. acuminata												*			
Melaleuca adnata	*	*	*	*							*	*	*		
Melaleuca cardiophylla			*								*		*		
Melaleuca cordata					*	*	*								
Melaleuca cucullata															
Melaleuca eleuterostachya			*									*			
Melaleuca glaberrima						*	*	*	*	*					
Melaleuca hamata		*			*	*	*	*	*	*					
Melaleuca lateriflora subsp. *lateriflora*			*	*							*		*		
Melaleuca laxiflora									*	*			*		
Melaleuca pauperiflora subsp. *fastigiata*		*	*										*	*	
Melaleuca pauperiflora subsp. *pauperiflora*	*		*									*			
Melaleuca scoparia					*		*	*							
Melaleuca thyoides															
Melaleuca urceolaris			*	*							*		*		
Microcorys sp. Forrestania (P4)															
Microcybe multiflora subsp. multiflora						*	*	*	*						
Olearia muelleri	*														
Persoonia coriacea					*		*								
Persoonia helix					*		*			*					
Phebalium filifolium						*	*	*	*	*					

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Phebalium tuberculosum					*	*		*							
Santalum acuminatum	*						*		*			*			*
Sclerolaena diacantha															
Sclerolaena uniflora															
Spyridium mucronatum subsp. mucronatum															
Stenanthemum liberum (P1)					*	*	*	*	*	*					
Stylidium sejunctum (P2)						*	*		*						
Templetonia sulcata												*		*	
Thysanotus sparteus															
Verticordia chrysantha						*	*								
Westringia cephalantha var. caterva		*			*		*	*		*					
Westringia rigida												*			
Wilsonia humilis											*	*		*	

(P) indicates Priority Species

Q16-27

Species	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27
Acacia acuaria												
Acacia deficiens	*	*	*						*			
Acacia enervia subsp. enervia												
Acacia enervia									*			
Acacia erinacea		*										
Acacia hemiteles		*			*				*		*	*
Acacia intricata	*			*				*	*			
Acacia leptospermoides subsp. leptospermoides												
Acacia merrallii	*	*	*		*	*	*	*	*	*	*	*
Acacia poliochroa												
Acacia sphacelata subsp. *sphacelata*					*	*						
Acacia sulcata var. *platyphylla*												
Acacia sulcata subsp. sulcata										*		*
Adenanthos argyreus												*
Allocasuarina campestris												

Species	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27
Allocasuarina helmsii												
Astroloma serratifolia												
Baeckea crispiflora sens lat.												
Banksia cirsioides												
Beaufortia interstans												
Beaufortia schaueri												
Boronia inornata subsp. *inornata*												
Callitris preissii												
Calothamnus quadrifidus												
Calytrix sapphirina												
Cassytha melantha												
Coopernookia strophiolata	*											
Cryptandra intonsa											*	
Cryptandra minutifolia subsp. *minutifolia*		*										
Darwinia inconspicua												
Daviesia benthamii subsp. *acanthoclona*				*								
Daviesia nematophylla						*	*					
Dianella revoluta	*									*	*	
Dodonaea bursariifolia		*										
Dodonaea microzyga var. *acrolobata*												
Dodonaea stenozyga		*										
Eremophila decipiens subsp. *decipiens*			*						*			
Eremophila densifolia subsp. *capitata*												
Eremophila dichroantha								*	*			
Eremophila drummondii			*									
Eucalyptus calycogona subsp. *calycogona*									*			
Eucalyptus cylindrocarpa	*	*	*	*				*	*			
Eucalyptus eremophila subsp. *eremophila*	*	*	*	*								
Eucalyptus ?goniocarpa										*	*	*
Eucalyptus gracilis			*									
Eucalyptus horistes												
Eucalyptus livida												
Eucalyptus melanoxylon						*						
Eucalyptus pileata			*	*								

Species	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27
Eucalyptus salmonophloia	*				*							
Eucalyptus salubris		*			*							
Eucalyptus transcontinentalis										*		*
Eucalyptus sp. (sterile)	*							*				
Eucalyptus urna				*		*	*					
Eucalyptus aff. yilgarnensis									*			
Eutaxia acanthoclada (P3)									*			
Exocarpos aphyllus	*	*	*	*					*		*	*
Exocarpos sparteus												
Gompholobium gompholobioides	*											
Goodenia pinifolia												
Grevillea acuaria	*	*	*					*	*			
Grevillea huegelii				*						*	*	
Grevillea sp. Sterile										*		
Grevillea oncogyne				*								
Hakea commutata											*	
Hakea corymbosa				*								
Hakea multilineata												
Hakea scoparia subsp. scoparia												
Halgania andromedifolia												
Hibbertia pungens												
Isopogon axillaris												
Isopogon scabriusculus subsp. pubifloris												
Lepidosperma sp. sterile										*		
Lepidosperma sp. A2 Inland Flat												
Lepidosperma sp. Maggie Hays (R. Barrett)												*
Leptospermum erubescens												
Leucopogon cuneifolius												
Leucopogon sp. Wheatbelt												
Melaleuca acuminata subsp. acuminata												*
Melaleuca adnata		*	*	*	*			*	*	*	*	*
Melaleuca cardiophylla				*								
Melaleuca cordata												
Melaleuca cucullata			*									

Species	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27
Melaleuca eleuterostachya		*										
Melaleuca glaberrima												
Melaleuca hamata		*										*
Melaleuca lateriflora subsp. lateriflora				*				*		*	*	
Melaleuca laxiflora												
Melaleuca pauperiflora subsp. fastigiata		*		*		*	*		*		*	
Melaleuca pauperiflora subsp. pauperiflora	*		*	*	*	*	*	*				*
Melaleuca scoparia												
Melaleuca thyoides							*		*	*	*	*
Melaleuca urceolaris												
Microcorys sp. Forrestania (P4)					*							
Microcybe multiflora subsp. multiflora												
Olearia muelleri		*	*								*	
Persoonia coriacea												
Persoonia helix												
Phebalium filifolium												
Phebalium tuberculosum												
Santalum acuminatum												
Sclerolaena diacantha					*							
Sclerolaena uniflora					*							
Spyridium mucronatum subsp. mucronatum										*	*	
Stenanthemum liberum (P1)												
Stylidium sejunctum (P2)												
Templetonia sulcata	*											
Thysanotus sparteus					*							
Verticordia chrysantha												
Westringia cephalantha var. caterva		*		*								
Westringia rigida		*		*		*	*					
Wilsonia humilis	*	*	*		*							

(P) indicates Priority Species

Appendix 6: Co-ordinates of the quadrats established in the survey area.

	GDA 94		
Quadrat	**Zone**	**Easting**	**Northing**
Q1	50H	757203	6391463
Q2	50H	757033	6391402
Q3	50H	756698	6391494
Q4	50H	756318	6391369
Q5	50H	755945	6391558
Q6	50H	755784	6391527
Q7	50H	755716	6391580
Q8	50H	755748	6391976
Q9	50H	755797	6391900
Q10	50H	755734	6391858
Q11	50H	755294	6392140
Q12	50H	755242	6392627
Q13	50H	754675	6393110
Q14	50H	753053	6402784
Q15	50H	752334	6403527
Q16	50H	753008	6403108
Q17	50H	754388	6401619
Q18	50H	754547	6397968
Q19	50H	754589	6395025
Q20	50H	752395	6403330
Q21	50H	754530	6401376
Q22	50H	754530	6400932
Q23	50H	754582	6399393
Q24	50H	754554	6399462
Q25	50H	754547	6398981
Q26	50H	754583	6398686
Q27	50H	754577	6398491

Appendix 7: Quadrat Data Sheets

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 30/11/09	**Botanist:** ER & LP	
Location: SQ Haul Road	**Quadrat:** Q1	
Quadrat size: 20mX20m		
WP: 102	**Vegetation group: *Eucalyptus urna* woodland**	
Photo number: 20-22		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/1**		
Soil (profile/field texture/soil surface): D/CL/F		
%Cover leaf litter: 95		
%Cover bare ground (including rock and litter): 40		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: S**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: V**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus urna	*Melaleuca pauperiflora* subsp. *pauperiflora* *Melaleuca adnata* *Dodonaea stenozyga*	*Grevillea acuaria* *Olearia muelleri*

ALL SPECIES
Eucalyptus urna
Melaleuca pauperiflora subsp. *pauperiflora*
Melaleuca adnata
Dodonaea stenozyga
Grevillea acuaria
Olearia muelleri
Eucalyptus salubris
Santalum acuminatum
Gompholobium gompholobioides
Acacia poliochroa

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 30/11/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** 2	
Quadrat size: 20mX20m		
WP: 106	**Vegetation group:** ***E. eremophila sub. sp eremophila and E. cylindrocarpa*** **Mallee shrubland**	
Photo number: 26-28		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 1/0**		
Soil (profile/field texture/soil surface): D/CL/F		
%Cover leaf litter: 95		
%Cover bare ground: 20		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 3**
Crown cover %: S	**Crown cover %: S**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus eremophila subsp. *eremophila* *Eucalyptus cylindrocarpa*	*Melaleuca pauperiflora* subsp. *fastigiata* *Melaleuca hamata*	*Dodonaea stenozyga* *Grevillea acuaria*

ALL SPECIES
Eucalyptus eremophila subsp. *eremophila*
Eucalyptus cylindrocarpa
Melaleuca pauperiflora subsp. *fastigiata*
Melaleuca hamata
Dodonaea stenozyga
Grevillea acuaria
Eucalyptus urna
Eucalyptus salubris
Dodonaea bursariifolia
Melaleuca adnata
Westringia cephalantha var. *caterva*
Acacia leptospermoides subsp. *leptospermoides*

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 30/11/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q3	
Quadrat size: 20mX20m		
WP: 109	**Vegetation group: *E. eremophila sub. sp eremophila and E. cylindrocarpa* Mallee shrubland**	
Photo number: 31-33		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/F		
%Cover leaf litter: 85		
%Cover bare ground: 10		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 1**
Crown cover %: M	**Crown cover %: D**	**Crown cover %: V**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus eremophila subsp. *eremophila* *Eucalyptus cylindrocarpa*	*Melaleuca urceolaris* *Melaleuca pauperiflora* subsp. *pauperiflora* *Melaleuca pauperiflora* subsp. *fastigiata* *Melaleuca cardiophylla*	*Acacia intricata* *Acacia deficiens*

ALL SPECIES
Eucalyptus eremophila subsp. *eremophila*
Eucalyptus cylindrocarpa
Melaleuca urceolaris
Melaleuca pauperiflora subsp. *pauperiflora*
Melaleuca pauperiflora subsp. *fastigiata*
Melaleuca cardiophylla
Acacia intricata
Acacia deficiens
Exocarpos aphyllus
Dodonaea stenozyga
Melaleuca adnata
Cassytha melantha
Baeckea crispiflora sens lat
Melaleuca lateriflora subsp. *lateriflora*
Melaleuca eleuterostachya

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 30/11/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q4	
Quadrat size: 20mX20m		
WP: 111	**Vegetation group: *E. eremophila sub. sp eremophila and E. cylindrocarpa* Mallee shrubland**	
Photo number: 34-36		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/C		
%Cover leaf litter: 80		
%Cover bare ground: 20		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 2**
Crown cover %: M	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus cylindrocarpa *Eucalyptus eremophila* subsp. *eremophila*	*Melaleuca urceolaris* *Melaleuca adnata* *Melaleuca lateriflora* subsp. *lateriflora*	*Acacia intricata* *Boronia inornata* subsp. *inornata*

ALL SPECIES
Eucalyptus cylindrocarpa
Eucalyptus eremophila subsp. *eremophila*
Melaleuca urceolaris
Melaleuca adnata
Melaleuca lateriflora subsp. *lateriflora*
Acacia intricata
Boronia inornata ssp. inornata subsp. *inornata*
Eremophila drummondii
Cassytha melantha
Grevillea huegelii
Grevillea acuaria
Acacia deficiens
Eucalyptus urna
Dodonaea stenozyga
Grevillea oncogyne
Daviesia benthamii subsp. *acanthoclada*

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 30/11/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q5	
Quadrat size: 20mX20m		
WP: 114	**Vegetation group: Mixed Mallee & Mixed shrub thicket on BIF**	
Photo number: 40-42		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 4/2/R **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): G/CL/L		
%Cover leaf litter: 85		
%Cover bare ground: 5		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: Z**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 3**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus eremophila subsp. *eremophila* *Eucalyptus horistes*	*Banksia cirsioides* *Hakea scoparia* subsp. *scoparia* *Melaleuca hamata*	*Hibbertia pungens* *Acacia sphacelata* subsp. *sphacelata*

ALL SPECIES
Eucalyptus eremophila subsp. *eremophila*
Eucalyptus horistes
Banksia cirsioides
Hakea scoparia subsp. *scoparia*
Melaleuca hamata
Hibbertia pungens
Acacia sphacelata subsp. *sphacelata*
Exocarpos aphyllus
Darwinia inconspicua
Hakea multilineata
Phebalium tuberculosum
Calothamnus quadrifidus
Astroloma serratifolia
Isopogon axillaris
Callitris preissii
Beaufortia schaueri
Melaleuca cordata
Leucopogon cuneifolius
Melaleuca scoparia
Dodonaea bursariifolia
Beaufortia interstans
Goodenia pinifolia
Stenanthemum liberum (P1)
Persoonia helix
Persoonia coriacea
Westringia cephalantha var. *caterva*

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** 6	
Quadrat size: 20mX20m		
WP: 115	**Vegetation group: Mixed Mallee & Mixed shrub thicket on BIF**	
Photo number: 43-45		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 5/2/RT **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): G/SCL/L		
%Cover leaf litter: 85		
%Cover bare ground: 15		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: Z**	**Growth form: Z**
Height: 5	**Height: 4**	**Height: 3**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus cylindrocarpa	*Allocasuarina campestris* *Hakea scoparia* subsp. *scoparia* *Calothamnus quadrifidus* *Melaleuca hamata*	*Phebalium filifolium* *Hibbertia pungens*
ALL SPECIES		
Eucalyptus cylindrocarpa		
Allocasuarina campestris		
Hakea scoparia subsp. *scoparia*		
Calothamnus quadrifidus		
Melaleuca hamata		
Phebalium filifolium		
Hibbertia pungens		
Allocasuarina helmsii		
Stylidium sejunctum (P2)		
Phebalium tuberculosum		
Melaleuca glaberrima		
Darwinia inconspicua		
Beaufortia schaueri		
Beaufortia interstans		
Eucalyptus horistes		
Verticordia chrysantha		
Calytrix sapphirina		
Melaleuca cordata		
Banksia cirsioides		
Callitris preissii		
Isopogon axillaris		
Leucopogon cuneifolius		
Stenanthemum liberum (P1)		
Hakea multilineata		
Microcybe multiflora subsp. *multiflora*		
Acacia sphacelata subsp. *sphacelata*		
Isopogon scabriusculus subsp. *pubifloris*		

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q7	
Quadrat size: 20mX20m		
WP: 116	**Vegetation group: Mixed Mallee & Mixed shrub thicket on BIF**	
Photo number: 47-49		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 4/2/R **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): G/SCL/F		
%Cover leaf litter: 80		
%Cover bare ground: 10		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: Z**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 3**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus horistes *Allocasuarina campestris*	*Melaleuca scoparia* *Hakea scoparia* subsp. *scoparia* *Melaleuca hamata* *Banksia cirsioides* *Calothamnus quadrifidus*	*Phebalium filifolium* *Hibbertia pungens* *Acacia sphacelata* subsp. *sphacelata*

ALL SPECIES
Eucalyptus horistes
Allocasuarina campestris
Melaleuca scoparia
Hakea scoparia subsp. *scoparia*
Melaleuca hamata
Banksia cirsioides
Calothamnus quadrifidus
Phebalium filifolium
Hibbertia pungens
Acacia sphacelata subsp. *sphacelata*
Stenanthemum liberum (P1)
Darwinia inconspicua
Beaufortia schaueri
Callitris preissii
Melaleuca cordata
Dodonaea bursariifolia
Persoonia helix
Microcybe multiflora subsp. *multiflora*
Melaleuca glaberrima
Santalum acuminatum
Verticordia chrysantha
Persoonia coriacea
Exocarpos aphyllus
Hakea multilineata
Westringia cephalantha var. *caterva*
Beaufortia interstans
Stylidium sejunctum (P2)
Acacia enervia subsp. *enervia*
Daviesia benthamii subsp. *acanthoclada*
Goodenia pinifolia

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q8	
Quadrat size: 20mX20m		
WP: 118	**Vegetation group: *Eucalyptus livida* woodland**	
Photo number: 50-52		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SL/L		
%Cover leaf litter: 85		
%Cover bare ground: 25		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus livida *Eucalyptus horistes*	*Melaleuca hamata* *Acacia enervia* subsp. *enervia* *Calothamnus quadrifidus*	*Darwinia inconspicua* *Hibbertia pungens*
ALL SPECIES		
Eucalyptus livida		
Eucalyptus horistes		
Melaleuca hamata		
Acacia enervia subsp. *enervia*		
Calothamnus quadrifidus		
Darwinia inconspicua		
Hibbertia pungens		
Isopogon axillaris		
Calytrix sapphirina		
Stenanthemum liberum (P1)		
Dodonaea bursariifolia		
Goodenia pinifolia		
Phebalium tuberculosum		
Phebalium filifolium		
Westringia cephalantha var. *caterva*		
Melaleuca scoparia		
Leucopogon sp. Wheatbelt		
Microcybe multiflora subsp. *multiflora*		
Leptospermum erubescens		
Boronia inornata subsp. *inornata*		
Melaleuca glaberrima		
Eucalyptus eremophila subsp. *eremophila*		
Halgania andromedifolia		
Exocarpos sparteus		

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q9	
Quadrat size: 20mX20m		
WP: 119	**Vegetation group: *Eucalyptus livida* woodland**	
Photo number: 53-55		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/LS/L		
%Cover leaf litter: 90		
%Cover bare ground: 20		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: Z**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus livida *Eucalyptus horistes*	*Melaleuca hamata* *Allocasuarina campestris* *Hakea scoparia* subsp. *scoparia* *Halgania andromedifolia*	*Hibbertia pungens* *Dodonaea bursariifolia*
ALL SPECIES		
Eucalyptus livida		
Eucalyptus horistes		
Melaleuca hamata		
Allocasuarina campestris		
Hakea scoparia subsp. *scoparia*		
Halgania andromedifolia		
Hibbertia pungens		
Dodonaea bursariifolia		
Acacia sphacelata subsp. *sphacelata*		
Melaleuca laxiflora		
Leptospermum erubescens		
Stenanthemum liberum (P1)		
Dodonaea microzyga var. *acrolobata*		
Darwinia inconspicua		
Baeckea crispiflora sens lat		
Leucopogon sp. Wheatbelt		
Eucalyptus eremophila subsp. *eremophila*		
Microcybe multiflora subsp. *multiflora*		
Hakea multilineata		
Dodonaea bursariifolia		
Stylidium sejunctum (P2)		
Melaleuca glaberrima		
Phebalium filifolium		
Santalum acuminatum		
Goodenia pinifolia		

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q10	
Quadrat size: 20mX20m		
WP: 120	**Vegetation group: *Eucalyptus livida* woodland**	
Photo number: 56-58		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SL/L		
%Cover leaf litter: 95		
%Cover bare ground: 30		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y/S	**Growth form: Z**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus livida *Allocasuarina campestris*	*Melaleuca hamata* *Halgania andromedifolia* *Hakea scoparia* subsp. *scoparia*	*Phebalium filifolium* *Hibbertia pungens* *Lepidosperma brunonianum*

ALL SPECIES
Eucalyptus livida
Allocasuarina campestris
Melaleuca hamata
Halgania andromedifolia
Hakea scoparia subsp. *scoparia*
Phebalium filifolium
Hibbertia pungens
Lepidosperma sp. A2 Inland Flat
Stenanthemum liberum (P1)
Dodonaea bursariifolia
Melaleuca glaberrima
Hakea multilineata
Isopogon axillaris
Melaleuca laxiflora
Baeckea crispiflora sens lat
Westringia cephalantha var. *caterva*
Persoonia helix
Dodonaea bursariifolia
Leucopogon sp. Wheatbelt
Calytrix sapphirina
Calothamnus quadrifidus
Exocarpos sparteus
Daviesia benthamii subsp. *acanthoclada*

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q11	
Quadrat size: 20mX20m		
WP: 121	**Vegetation group: Mixed Mallee shrubland over Melaleuca shrubland**	
Photo number: 59-61		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SL/S		
%Cover leaf litter: 60		
%Cover bare ground: 15		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 5	**Height: 3**	**Height: 2**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus eremophila subsp. *eremophila* *Eucalyptus cylindrocarpa*	*Daviesia benthamii* subsp. *acanthoclada* *Melaleuca cardiophylla* *Melaleuca lateriflora* subsp. *lateriflora* *Melaleuca urceolaris*	*Acacia deficiens* *Acacia intricata*

ALL SPECIES
Eucalyptus eremophila subsp. *eremophila*
Eucalyptus cylindrocarpa
Daviesia benthamii subsp. *acanthoclada*
Melaleuca cardiophylla
Melaleuca lateriflora subsp. *lateriflora*
Melaleuca urceolaris
Acacia deficiens
Acacia intricata
Hakea corymbosa
Daviesia nematophylla
Wilsonia humilis
Boronia inornata subsp. *inornata*
Grevillea oncogyne
Exocarpos aphyllus
Melaleuca adnata
Acacia sphacelata subsp. *sphacelata*
Acacia enervia subsp. *enervia*

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q12	
Quadrat size: 20mX20m		
WP: 122	**Vegetation group: *Eucalyptus salubris* woodland**	
Photo number: 68-70		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 3/3/A **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/F		
%Cover leaf litter: 90		
%Cover bare ground: 40		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: S**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: M**	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salubris *Eucalyptus salmonophloia*	*Melaleuca eleuterostachya* *Melaleuca pauperiflora* subsp. *pauperiflora* *Daviesia nematophylla* *Dodonaea stenozyga*	*Acacia merrallii* *Acacia deficiens* *Acacia intricata*

ALL SPECIES
Eucalyptus salubris
Eucalyptus salmonophloia
Melaleuca eleuterostachya
Melaleuca pauperiflora subsp. *pauperiflora*
Daviesia nematophylla
Dodonaea stenozyga
Acacia merrallii
Acacia deficiens
Acacia intricata
Santalum acuminatum
Templetonia sulcata
Acacia erinacea
Hakea corymbosa
Wilsonia humilis
Gompholobium gompholobioides
Eremophila densifolia subsp. *capitata*
Eucalyptus urna
Westringia rigida
Grevillea acuaria
Melaleuca acuminata subsp. *acuminata*
Exocarpos aphyllus
Melaleuca adnata

Project Name: Spotted Quoll to Cosmic Boy Haul rd	
Date: 1/12/09	**Botanist:** ER & LP
Location: SQ HR	**Quadrat:** Q13
Quadrat size: 20mX20m	
WP: 128	**Vegetation group: Mixed mallee shrubland over *Melaleuca* shrubland**
Photo number: 72-74	
Landform: F/PLA	
Land surface/disturbance: 0	
Coarse fragments on the surface (abundance/size/shape): 1/2/U **Rock outcrop (abundance/runoff): 0/0**	
Soil (profile/field texture/soil surface): D/SCL/H	
%Cover leaf litter: 70	
%Cover bare ground: 25	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: Y**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 3**
Crown cover %: S	**Crown cover %: S**	**Crown cover %: D**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus urna	*Eucalyptus calycogona* subsp. *calycogona* *Eucalyptus cylindrocarpa*	*Melaleuca lateriflora* subsp. *lateriflora* *Melaleuca cardiophylla* *Daviesia benthamii* subsp. *acanthoclada* *Melaleuca pauperiflora* subsp. *fastigiata* *Melaleuca adnata* *Melaleuca urceolaris*

ALL SPECIES
Eucalyptus urna
Eucalyptus calycogona subsp. *calycogona*
Eucalyptus cylindrocarpa
Melaleuca lateriflora subsp. *lateriflora*
Melaleuca cardiophylla
Daviesia benthamii subsp. *acanthoclada*
Melaleuca pauperiflora subsp. *fastigiata*
Melaleuca adnata
Melaleuca urceolaris
Hakea corymbosa
Baeckea crispiflora sens lat
Dodonaea stenozyga
Grevillea oncogyne
Acacia sulcata var. *platyphylla*
Cryptandra minutifolia subsp. *minutifolia*
Melaleuca laxiflora
Eremophila drummondii
Grevillea acuaria
Cassytha melantha

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q14	
Quadrat size: 20mX20m		
WP: 130	**Vegetation group: Burnt *E. salmonophloia* woodland over Mixed Mallee**	
Photo number: 75-77		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/F		
%Cover leaf litter: 50		
%Cover bare ground: 45		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: Y**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 2**
Crown cover %: V	**Crown cover %: M**	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Eucalyptus polita* *Templetonia cylindrocarpa*	*Acacia deficiens* *Acacia intricata* *Grevillea acuaria* *Eremophila drummondii* *Templetonia sulcata*

ALL SPECIES
Eucalyptus polita
Eucalyptus salmonophloia
Eucalyptus cylindrocarpa
Eremophila drummondii
Templetonia sulcata
Acacia deficiens
Acacia intricata
Grevillea acuaria
Wilsonia humilis
Daviesia benthamii subsp. *acanthoclada*
Exocarpos aphyllus
Melaleuca pauperiflora subsp. *fastigiata*
Acacia erinacea
Grevillea huegelii
Eucalyptus pileata

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q15	
Quadrat size: 20mX20m		
WP: 131	**Vegetation group: *Eucalyptus salmonophloia* woodland**	
Photo number: 78-80		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 2/2/U **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/F		
%Cover leaf litter: 40		
%Cover bare ground: 45		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: S**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 3**
Crown cover %: S	**Crown cover %: S**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia *Eucalyptus salubris*	*Acacia merrallii* *Exocarpos aphyllus*	*Acacia sphacelata* subsp. *sphacelata* *Grevillea acuaria*

ALL SPECIES
Eucalyptus salmonophloia
Eucalyptus salubris
Acacia merrallii
Exocarpos aphyllus
Acacia sphacelata subsp. *sphacelata*
Grevillea acuaria
Dodonaea stenozyga
Santalum acuminatum
Grevillea huegelii
Acacia acuaria

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q16	
Quadrat size: 20mX20m		
WP: 132	**Vegetation group: *Eucalyptus salmonophloia* woodland**	
Photo number: 83-85		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 2/2/U **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/F		
%Cover leaf litter: 50		
%Cover bare ground: 55		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: S**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: S**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Eucalyptus* sp. (sterile) *Melaleuca pauperiflora* subsp. *pauperiflora* *Exocarpos aphyllus* *Acacia merrallii*	*Acacia intricata* *Acacia deficiens* *Coopernookia strophiolata* *Grevillea acuaria*

ALL SPECIES
Eucalyptus salmonophloia
Eucalyptus sp. (sterile)
Melaleuca pauperiflora subsp. *pauperiflora*
Exocarpos aphyllus
Acacia merrallii
Acacia intricata
Acacia deficiens
Coopernookia strophiolata
Grevillea acuaria
Wilsonia humilis
Gompholobium gompholobioides
Eucalyptus cylindrocarpa
Dianella revoluta
Templetonia sulcata

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q17	
Quadrat size: 20mX20m		
WP: 133	**Vegetation group: Burnt *E. salmonophloia* woodland over Mixed Mallee**	
Photo number: 96-98		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 1/2/S **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/F		
%Cover leaf litter: 60		
%Cover bare ground: 30		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: Y**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 2**
Crown cover %: V	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Eucalyptus polita* *Eucalyptus cylindrocarpa*	*Acacia erinacea* *Grevillea acuaria* *Acacia merrallii* *Dodonaea stenozyga* *Acacia hemiteles*

ALL SPECIES
Eucalyptus polita
Eucalyptus salmonophloia
Eucalyptus cylindrocarpa
Dodonaea stenozyga
Acacia hemiteles
Acacia erinacea
Grevillea acuaria
Acacia merrallii
Eucalyptus salubris
Westringia rigida
Westringia cephalantha var. *caterva*
Olearia muelleri
Dodonaea bursariifolia
Melaleuca pauperiflora subsp. *fastigiata*
Exocarpos aphyllus
Wilsonia humilis
Cryptandra minutifolia subsp. *minutifolia*
Melaleuca adnata
Acacia deficiens
Melaleuca eleuterostachya
Melaleuca hamata

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q18	
Quadrat size: 20mX20m		
WP: 134	**Vegetation group: Burnt *E. salmonophloia* woodland over Mixed Mallee**	
Photo number: 99-101		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/CL/F		
%Cover leaf litter: 85		
%Cover bare ground: 40		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: Y**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 2,3**
Crown cover %: V	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Eucalyptus cylindrocarpa* *Eucalyptus polita*	*Acacia merrallii* *Olearia muelleri* *Acacia deficiens* *Grevillea acuaria* *Eremophila drummondii* *Melaleuca pauperiflora* subsp. *pauperiflora*

ALL SPECIES
Eucalyptus salmonophloia
Eucalyptus polita
Eucalyptus cylindrocarpa
Eremophila drummondii
Melaleuca pauperiflora subsp. *pauperiflora*
Acacia merrallii
Olearia muelleri
Acacia deficiens
Grevillea acuaria
Eucalyptus gracilis
Eucalyptus pileata
Wilsonia humilis
Melaleuca cucullata
Eremophila decipiens subsp. *decipiens*
Melaleuca adnata
Exocarpos aphyllus

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 1/12/09	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q19	
Quadrat size: 20mX20m		
WP: 136	**Vegetation group: Mixed Mallee shrubland over *Melaleuca* shrubland**	
Photo number: 102-104		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**		
Soil (profile/field texture/soil surface): D/SCL/F		
%Cover leaf litter: 40		
%Cover bare ground: 25		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 5	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: D**	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus eremophila subsp. *eremophila* *Eucalyptus cylindrocarpa* *Eucalyptus urna*	*Melaleuca cardiophylla* *Melaleuca pauperiflora* subsp. *pauperiflora* *Daviesia benthamii* subsp. *acanthoclada*	*Hakea corymbosa* *Westringia cephalantha* var. *caterva*

ALL SPECIES
Eucalyptus eremophila subsp. *eremophila*
Eucalyptus cylindrocarpa
Eucalyptus urna
Melaleuca cardiophylla
Melaleuca pauperiflora subsp. *pauperiflora*
Daviesia benthamii subsp. *acanthoclada*
Hakea corymbosa
Westringia cephalantha var. *caterva*
Exocarpos aphyllus
Grevillea oncogyne
Melaleuca adnata
Westringia rigida
Melaleuca pauperiflora subsp. *fastigiata*
Acacia intricata
Melaleuca lateriflora subsp. *lateriflora*
Eucalyptus pileata
Grevillea huegelii

Project Name: Spotted Quoll to Cosmic Boy Haul rd	
Date: 1/12/09	**Botanist:** ER & LP
Location: SQ HR	**Quadrat:** Q20
Quadrat size: 20mX20m	
WP:	**Vegetation group:** ***Eucalyptus salmonophloia*** **woodland**
Photo number:	
Landform: F/PLA	
Land surface/disturbance: 0	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0/0**	
Soil (profile/field texture/soil surface): U/SL/C	
%Cover leaf litter: 45	
%Cover bare ground: 50	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: T	**Growth form: S**	**Growth form: S**
Height: 6	**Height: 4**	**Height: 2**
Crown cover %: S	**Crown cover %: S**	**Crown cover %: V**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia *Eucalyptus salubris*	*Acacia merrallii* *Melaleuca adnata*	*Wilsonia humilis* *Acacia hemiteles* *Acacia sphacelata* subsp. *sphacelata*

ALL SPECIES
Eucalyptus salmonophloia
Eucalyptus salubris
Acacia merrallii
Melaleuca adnata
Wilsonia humilis
Acacia hemiteles
Acacia sphacelata subsp. *sphacelata*
Thysanotus sparteus
Sclerolaena diacantha
Sclerolaena uniflora
Microcorys sp. Forrestania (P4)
Melaleuca pauperiflora subsp. *pauperiflora*

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 11/01/11	**Botanist:** JW & LP	
Location: SQ HR	**Quadrat:** Q21	
Quadrat size: 20mX20m		
WP: 709	**Vegetation group: *Eucalyptus urna* woodland**	
Photo number: 33 - 35		
Landform: L/HSL		
Land surface/disturbance: 2		
Coarse fragments on the surface (abundance/size/shape): Nil **Rock outcrop (abundance/runoff):** 0/2		
Soil (profile/field texture/soil surface): U/CL/G		
%Cover leaf litter: 90		
%Cover bare ground: 20		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 4	**Height: 2**	**Height: 1**
Crown cover %: M	**Crown cover %: M**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus urna *Eucalyptus melanoxylon*	*Daviesia nematophylla*	*Westringia rigida*
ALL SPECIES		
Eucalyptus urna		
Eucalyptus melanoxylon		
Daviesia nematophylla		
Westringia rigida		
Acacia merrallii		
Acacia sphacelata subsp. *sphacelata*		
Melaleuca pauperiflora subsp. *fastigiata*		
Melaleuca pauperiflora subsp. *pauperiflora*		

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 11/01/11	**Botanist:** JW & LP	
Location: SQ HR	**Quadrat:** Q22	
Quadrat size: 20mX20m		
WP: WP710	**Vegetation group: *Eucalyptus urna* woodland**	
Photo number: Pic 36- 38		
Landform: L/HSL		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): **Rock outcrop (abundance/runoff):** 0/2		
Soil (profile/field texture/soil surface): U/CL/G		
%Cover leaf litter: 80		
%Cover bare ground: 10		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form:** S	**Growth form:** S
Height: 4	**Height: 4**	**Height:** 2
Crown cover %: M	**Crown cover %:** M	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus urna	*Melaleuca pauperiflora* subsp. *fastigiata* *Melaleuca pauperiflora* subsp. *pauperiflora*	*Acacia merrallii* *Daviesia nematophylla*

ALL SPECIES
Eucalyptus urna
Melaleuca pauperiflora subsp. *fastigiata*
Melaleuca pauperiflora subsp. *pauperiflora*
Melaleuca thyoides
Acacia merrallii
Daviesia nematophylla
Westringia rigida

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 11/01/11	**Botanist:** JW & LP	
Location: SQ HR	**Quadrat:** Q23	
Quadrat size: 20mX20m		
WP: 711	**Vegetation group:** Mixed Mallee shrubland	
Photo number: Pics 39 -41		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0 - 1		
Soil (profile/field texture/soil surface): U/SL/H yellow white		
%Cover leaf litter: 40%		
%Cover bare ground: 30%		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: Shrub**
Height: 4	**Height: 3**	**Height: 2**
Crown cover %: M	**Crown cover %:** S	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus cylindrocarpa	*Eremophila dichroantha*	*Acacia deficiens* *Acacia intricata*

ALL SPECIES
Eucalyptus cylindrocarpa
Eremophila dichroantha
Acacia intricata
Grevillea acuaria
Acacia merrallii
Melaleuca lateriflora
Melaleuca pauperiflora subsp. *pauperiflora*
Melaleuca adnata
Eucalyptus sp. sterile

Project Name: Spotted Quoll to Cosmic Boy Haul rd		
Date: 11/01/11	**Botanist:** ER & LP	
Location: SQ HR	**Quadrat:** Q24	
Quadrat size: 20mX20m		
WP: 712	**Vegetation group:** Mixed Mallee shrubland	
Photo number: pic 42 - 44		
Landform: F/PLA		
Land surface/disturbance: 0		
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0/1		
Soil (profile/field texture/soil surface): U/ Cl / H yellow - light brown		
%Cover leaf litter: 60%		
%Cover bare ground: 20%		
Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form:** S	**Growth form:** S
Height: 4	**Height:** 3	**Height:** 2
Crown cover %: M	**Crown cover %: M**	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus cylindrocarpa	*Eremophila dichroantha*	*Grevillea acuaria* *Acacia merrallii* *Acacia intricata*

ALL SPECIES
Eucalyptus cylindrocarpa
Eremophila dichroantha
Grevillea acuaria
Acacia merrallii
Acacia intricata
Melaleuca thyoides
Exocarpos aphyllus
Acacia enervia
Eremophila decipiens
Acacia deficiens
Melaleuca adnata
Melaleuca pauperiflora subsp. *fastigiata*
Acacia hemiteles
Eutaxia acanthoclada (P3)
Eucalyptus calycogona subsp. *calycogona*
Eucalyptus aff. *yilgarnensis*

Project Name: Spotted Quoll to Cosmic Boy Haul rd	
Date: 11/01/11	**Botanist:** JW & LP
Location: SQ HR	**Quadrat:** Q25
Quadrat size: 20mX20m	
WP: WP713	**Vegetation group:** *Eucalyptus goniocarpa* shrubland
Photo number: Pic 45 - 47	
Landform: F/PLA	
Land surface/disturbance: 0	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff): 0**/1	
Soil (profile/field texture/soil surface): U/CL (no colour)	
%Cover leaf litter: 90%	
%Cover bare ground: 60%	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 4	**Height: 3**	**Height: 1**
Crown cover %: M	**Crown cover %: M**	**Crown cover %: M**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus goniocarpa	*Melaleuca thyoides* *Melaleuca adnata*	*Spyridium mucronatum subsp. mucronatum*

ALL SPECIES
Eucalyptus goniocarpa
Melaleuca thyoides
Melaleuca adnata
Spyridium mucronatum subsp. mucronatum
Acacia sulcata var. *platyphylla*
Grevillea sp. sterile
Melaleuca lateriflora
Lepidosperma sp. sterile
Dianella revoluta
Eucalyptus transcontinentalis
Acacia merrallii
Grevillea huegelii

Project Name: Spotted Quoll to Cosmic Boy Haul rd	
Date: 11/01/11	**Botanist:** JW & LP
Location: SQ HR	**Quadrat:** Q26
Quadrat size: 20mX20m	
WP: 714	**Vegetation group:** *Eucalyptus goniocarpa* shrubland
Photo number: 48 - 50	
Landform: F/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0 / 1	
Soil (profile/field texture/soil surface): U /SL? C yellow white	
%Cover leaf litter: 70%	
%Cover bare ground: 10%	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 4	**Height: 2**	**Height: 2**
Crown cover %: M	**Crown cover %: S**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus goniocarpa	*Melaleuca pauperiflora* subsp. *fastigiata* *Exocarpos aphyllus*	*Spyridium mucronatum subsp. mucronatum* *Olearia muelleri*

ALL SPECIES
Eucalyptus goniocarpa
Melaleuca pauperiflora subsp. *fastigiata*
Exocarpos aphyllus
Spyridium mucronatum subsp. mucronatum
Olearia muelleri
Cryptandra intonsa
Grevillea huegelii
Hakea commutata
Dianella revoluta
Acacia merrallii
Melaleuca acuminata
Acacia hemiteles
Melaleuca thyoides
Melaleuca lateriflora

Project Name: Spotted Quoll to Cosmic Boy Haul rd	
Date: 11/01/11	**Botanist:** ER & LP
Location: SQ HR	**Quadrat:** Q27
Quadrat size: 20mX20m	
WP: 715	**Vegetation group:** *Eucalyptus goniocarpa* shrubland
Photo number: Pic 51 - 53	
Landform: F/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 1	
Soil (profile/field texture/soil surface): U/SL/C	
%Cover leaf litter: 50%	
%Cover bare ground: 70%	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Y	**Growth form: S**	**Growth form: S**
Height: 4	**Height: 3**	**Height: 2**
Crown cover %: M	**Crown cover %: S**	**Crown cover %: S**
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus goniocarpa	*Melaleuca acuminata*	*Acacia merrallii*

ALL SPECIES
Acacia merrallii
Melaleuca acuminata
Eucalyptus goniocarpa
Eucalyptus transcontinentalis
Acacia sulcata var. platyphylla
Melaleuca pauperiflora subsp. *pauperiflora*
Melaleuca thyoides
Adenanthos argyreus
Acacia hemiteles
Lepidosperma sp. Maggie Hays (R. Barrett)
Exocarpos aphyllus
Melaleuca hamata
Melaleuca adnata

Appendix 8: Muir Life Form/Height Class (Muir, 1977).

LIFE FORM/HEIGHT CLASS	CANOPY COVER			
	DENSE 70% -100%	**MID DENSE 30% - 70%**	**SPARSE 10% -30%**	**VERY SPARSE 2% - 10%**
Trees > 30m Trees 15 – 30m Trees 5 – 15m Trees < 5m	Dense Tall Forest Dense Forest Dense Low Forest A Dense Low Forest B	Tall Forest Forest Low Forest A Low Forest B	Tall Woodland Woodland Low woodland A Low Woodland B	Open Tall Woodland Open Woodland Open Low Woodland A Open Low Woodland B
Mallee Tree Form Mallee Shrub Form	Dense Tree Mallee Dense Shrub Mallee	Tree Mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee
Shrubs > 2m Shrubs 1.5 – 2m Shrubs 1 – 1.5m Shrubs 0.5 – 1m Shrubs 0 – 0.5m	Dense Thicket Dense Heath A Dense Heath B Dense Low Heath C Dense Low Heath D	Thicket Heath A Heath B Low Heath C Low Heath D	Scrub Low Scrub A Low Scrub B Dwarf Scrub C Dwarf Scrub D	Open Scrub Open Low Scrub A Open Low Scrub B Open Dwarf Scrub C Open Dwarf Scrub D
Mat Plants Hummock Grass Bunch grass >0.5m Bunch grass < 0.5m Herbaceous spp.	Dense Mat Plants Dense Hummock Grass Dense Tall Grass Dense Low Grass Dense Herbs	Mat Plants Mid-dense Hummock Grass Tall Grass Low Gras Herbs	Open Mat Plants Hummock Grass Open Tall Grass Open Low Grass Open Herbs	Very Open Mat Plants Open Hummock Grass Very Open Tall Grass Very Open Low Grass Very Open Herbs
Sedges > 0.5m Sedges < 0.5m	Dense Tall Sedges Dense Low Sedges	Tall Sedges Low Sedges	Open Tall Sedges Open Low Sedges	Very Open Tall Sedges Very Open Low Sedges
Ferns Mosses, liverworts	Dense ferns Dense Mosses	Ferns Mosses	Open Ferns Open Mosses	Very Open Ferns Very Open Mosses

Appendix 9: Coordinates of Priority Flora species located during the survey.

			GDA 94			
Family	**Genus**	**Species**	**Zone**	**Easting**	**Northing**	**Population Size**
Fabaceae	*Eutaxia*	*acanthoclada (P3)*	50H	754554	6399462	10
Lamiaceae	*Microcorys*	sp. Forrestania (P4)	50H	752349	6402908	1
Lamiaceae	*Microcorys*	sp. Forrestania (P4)	50H	752381	6402991	1
Lamiaceae	*Microcorys*	sp. Forrestania (P4)	50H	752406	6403339	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755656	6391781	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755672	6391893	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755750	6391842	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755808	6391857	40
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755831	6391882	200
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755745	6391950	27
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755782	6391902	11
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755727	6391565	4
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	757382	6391401	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755945	6391558	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755784	6391527	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755716	6391580	100
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755748	6391976	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755797	6391900	1
Rhamnaceae	*Stenanthemum*	*liberum (P1)*	50H	755734	6391858	12
Stylidiaceae	*Stylidium*	*sejunctum (P2)*	50H	755782	6391511	1
Stylidiaceae	*Stylidium*	*sejunctum (P2)*	50H	755712	6391557	1
Stylidiaceae	*Stylidium*	*sejunctum (P2)*	50H	755798	6391888	1
Stylidiaceae	*Stylidium*	*sejunctum (P2)*	50H	755740	6391973	2
Stylidiaceae	*Stylidium*	*sejunctum (P2)*	50H	755735	6391573	1

Appendix 10: Health Class Definitions (Keighery, 1994).

Health Rating	Health Description	Definition
6	Pristine	No obvious signs of disturbance
5	Excellent	Vegetation intact despite disturbance affect, weeds are non-aggressive individual species
4	Very Good	Vegetation altered due to obvious signs of disturbance
3	Good	Structure affected, multiple disturbances. Retains basic structure, has ability to regenerate
2	Degraded	Structure severely disturbed. Can regeneration to good condition, but requires intensive management
1	Completely Degraded	Completely bare no native species

Appendix 11: Quadrat photographs (separate file)

Biota Environmental Sciences

Spotted Quoll Haul Road Single Phase Fauna Survey







Prepared for Western Areas NL

May 2010

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Spotted Quoll Haul Road: Single Phase Fauna Survey

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1.0 Summary

1.1 Background

Western Areas NL is evaluating the development of the Spotted Quoll Haul Road, east of Hyden. The proposed haul road construction will involve clearing and removal of vegetation, with the proposed disturbance area at Spotted Quoll currently estimated at approximately 140 ha.

Biota Environmental Sciences (Biota) was commissioned to complete a single-phase fauna survey of a 411 ha area encompassing the proposed haul road corridor.

The scope of this study was to:

- undertake a Level 2 fauna survey consistent with relevant Environmental Protection Authority (EPA) Guidance Statements;
- identify the fauna habitats present in the study area;
- document the vertebrate and short-range endemic (SRE) invertebrate fauna assemblages within the habitats of the study area using established sampling techniques;
- identify habitats and fauna species of particular conservation significance (particularly Schedule and Priority listed fauna, as well as potential SRE taxa); and
- provide a generic assessment of the potential impacts that the proposed development may have on the fauna habitats and assemblages occurring in the study area.

1.2 Methodology

A baseline fauna survey of the Spotted Quoll Haul Road study area was conducted from November 30th to December 9th, 2009. The survey included:

- trapping at 12 locations within defined habitats; this comprised varying combinations of pit, Elliott and cage traps, for a total of 1,218 trap nights;
- avifauna censuses (40 minutes duration) at the systematic trapping grids, along with recording of opportunistic observations;
- bat sampling using harp traps and Anabat echolocation call recorders;
- various other non-systematic survey activities for vertebrate fauna; and
- targeted searches for potential SRE invertebrate species.

1.3 Results

1.3.1 Overview

The survey recorded a total of 76 vertebrate fauna species, comprising 21 herpetofauna species, 38 bird species and 17 species of mammal (including four introduced species).

The 21 herpetofauna comprised one gecko from the Gekkonidae family, three geckos from the Diplodactylidae family, one gecko from the Carphodactylidae family, two legless lizards (Pygopodidae), seven skinks (Scincidae), three dragons (Agamidae), one monitor (Varanidae), one blind snake (Typhlopidae), and two front-fanged snakes (Elapidae). No frogs were recorded.

The 38 bird species comprised 11 non-passerine species and 27 passerine species from 20 families.

Eleven non-volant mammal species (seven native and four introduced) were recorded: these comprised three species from the Dasyuridae family (carnivorous marsupials), one species from the Macropodidae family (the Western Grey Kangaroo), one species from the Burramyidae family (the Western Pygmy Possum), three species of Muridae (rodents), one species from the Leporidae family (the Rabbit), one species of the Canidae family (Dingo) and one species of the Felidae family (Cat). Six volant mammal species (bats) were present in the study area based on recorded echolocation calls: these comprised four vespertilionids (evening bats) and two molossids (freetail bats).

1.3.2 Fauna of Conservation Significance

No herpetofauna of listed conservation significance and no reptile species endemic to the region were recorded.

Individuals of four bird species of conservation significance were observed, and a fifth species of conservation significance was recorded from signs:

- three individuals of the Schedule 1 Carnaby's Cockatoo (*Calyptorhynchus latirostris*) were recorded flying over site SQH04;
- an apparently inactive mound of the Malleefowl (*Leipoa ocellata;* Schedule 1) was recorded in the vicinity of site SQH05;
- the Priority 4 Shy Groundwren (*Hylacola cauta whitlocki*) was recorded on 10 occasions at sites SQH03, SQH05, SQH06 and SQH07;
- the Priority 4 White-browed Babbler (*Pomatostomus superciliosus*) was recorded on one occasion at site SQH05 and four occasions at site SQH06; and
- the Priority 4 Crested Bellbird (*Oreoica gutturalis gutturalis*) was recorded on three separate occasions at sites SQH04 and FR26 and opportunistically within the study area.

The Schedule 1 Western Quoll (*Dasyurus geoffroii*) was the only mammal of conservation significance recorded during the Spotted Quoll Haul Road survey.

Three of the species of conservation significance area also listed under the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. Carnaby's Cockatoo is listed 'Endangered', while the Malleefowl and Western Quoll are both considered 'Vulnerable'. A further 13 vertebrate species of listed conservation significance may potentially occur in the study area.

Nine potential SRE taxa (eight mygalomorph spiders and one pseudoscorpion) were recorded. The conservation significance of these species has not been established.

1.4 Recommendations

Based on the nature of the proposed Spotted Quoll Haul Road project, the following management recommendations apply:

1. Western Areas NL should minimise vegetation clearing wherever practicable, thereby reducing the loss of fauna habitat. Potential nesting hollows for Carnaby's Black-Cockatoos and Western Rosellas should be retained.

2. Vehicle speed along the haul road should be limited to minimise the chance for road kill of fauna, particularly Malleefowl. Site inductions and signs should highlight the potential presence of rare fauna in the locality.

3. The risk of predation (by cats and foxes) and habitat degradation (by rabbits) should be reduced by continued implementation of a feral animal-control baiting programme (specifically targeting foxes, cats and rabbits, as outlined in Benshemesh (2000)), throughout Western Areas' operations.

4. Trapping and baiting was first undertaken in December 2006. Following assessment of the outcome of the initial program it was determined that baiting and trapping on an annual basis would provide adequate control of feral animals at the target sites. In addition, Western Areas NL, where possible will help to maintain the existing wild dog control program currently undertaken in the area by the Department of Agriculture and the Department of Environment and Conservation.

5. Fire threats should be reduced by implementing a Fire Management Plan for all Western Areas' operations, with a focus on minimising the spread of large fires and promoting patchier burns if fire does occur, as outlined in Benshemesh (2000).

6. Given the records of species listed as Threatened fauna under the EPBC Act 1999, Western Areas should consider its obligations to refer the proposed action of constructing the haul road to the Department of the Environment, Water, Heritage and the Arts (DEWHA), to determine if this represents a Controlled Action under that act.

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2.0 Introduction

2.1 Project Background

Western Areas NL is evaluating the development of a haul road that will run from the Spotted Quoll mine south to Cosmic Boy; a distance of approximately 12 km. To assist with the Environmental Impact Assessment (EIA) of the haul road project, Biota was commissioned to undertake a fauna survey of the Spotted Quoll Haul Road corridor. The haul road footprint is estimated to be approximately 140 ha, however as the exact route has not yet been determined, the study area encompassed approximately 411 ha.

2.2 Study Objectives and Scope

2.2.1 Scope

The scope of this study was to:

- undertake a Level 2 fauna survey consistent with relevant EPA Guidance Statements;
- identify the fauna habitats present in the study area;
- document the vertebrate and SRE invertebrate fauna assemblages within the habitats of the study area using established sampling techniques;
- identify habitats and fauna species of particular conservation significance (particularly Schedule and Priority listed fauna, as well as potential SRE taxa); and
- provide a generic assessment of the potential impacts that the proposed development may have on the fauna habitats and assemblages occurring in the study area.

The fauna survey was planned and implemented in accordance with:

- EPA Position Statement No. 3: "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002);
- EPA Guidance Statement No. 56: "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004); and
- EPA Guidance Statement No. 20: "Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia" (EPA 2009).

2.2.2 Purpose of this Report

This report documents the methods, results and key findings of a fauna survey of the area encompassing the proposed Spotted Quoll Haul Road. It provides an assessment of the fauna assemblages and species recorded. This document reports on the baseline fauna survey work in the area, examines potential conservation issues and presents management recommendations. Its intended use is as a supporting document for the EIA of the project. Both the survey and report are subject to specific limitations that are discussed in more detail in Section 3.3.

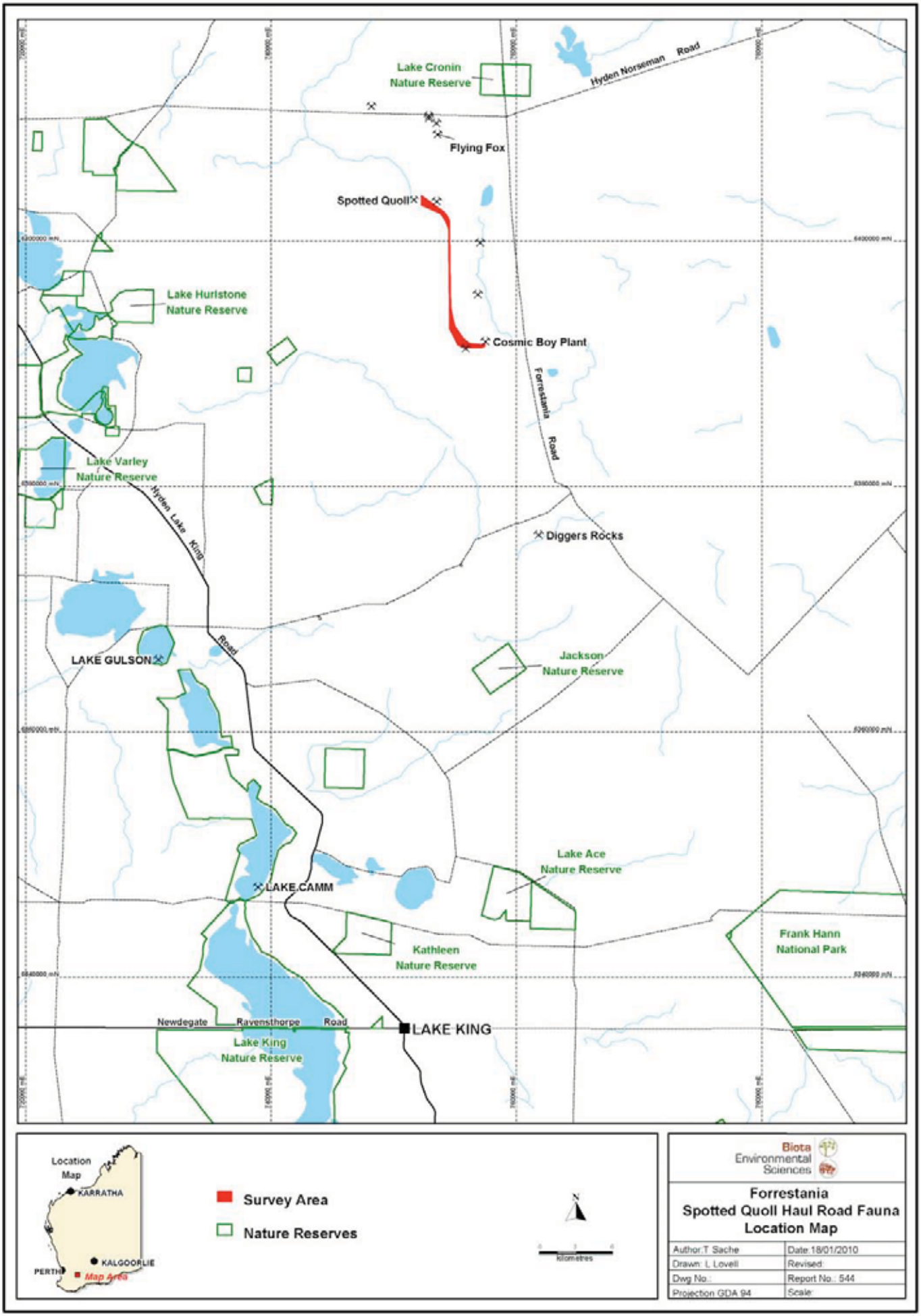


Figure 2.1: Location of the Spotted Quoll Haul Road survey area.

3.0 Survey Methodology

3.1 Desktop Review

3.1.1 Database Searches

Three databases were searched to indicate fauna of significance potentially occurring within the Spotted Quoll Haul Road study area:

1. the Department of Environment and Conservation (DEC) Threatened Fauna Database (Appendix 1);
2. the NatureMap database (http://NatureMap.dec.wa.gov.au; Appendix 2); NatureMap is a joint project of the DEC and the WA Museum, and presents the most comprehensive source of information on the distribution of Western Australia's flora and fauna; and
3. the Federal *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters database (Appendix 3).

The bounding coordinates for these searches were 32.1765°S, 119.2917°E and 32.8907°S, 120.1269°E, with the area comprising a 40 km buffer around the haul road.

3.1.2 Literature Review

Biota has previously conducted a number of fauna surveys in the Forrestania area, and the following reports provided the main contextual fauna data for the current project:

- Forrestania Fauna Survey – Fauna and Faunal Assemblages Report (Biota 2006a);
- Forrestania Fauna Monitoring – Interim Summary Report (Biota 2006b);
- Forrestania Water Disposal Pipeline Survey – Fauna and Faunal Assemblages Report (Biota 2006c);
- Forrestania Monitoring Survey, Flying Fox Phases III and IV (Biota 2007a);
- Diggers South Fauna Survey – Phase I (Biota 2007b);
- Interim Results of Forrestania Mygalomorph Studies (Biota 2008a); and
- Forrestania Targeted Malleefowl Survey (Biota 2009).

Other published reports reviewed for the current study comprised mainly the regional studies of bioregional data (Beecham and Danks 2001; Section 4.1), geology (Geological Survey of Western Australia 1984; Section 4.3), and Beard's vegetation mapping (Beard 1981; Section 4.4).

3.2 Fauna Sampling

3.2.1 Survey Timing and Weather

The Spotted Quoll Haul Road survey was conducted over a 10-day period from November 30th to December 9th, 2009. Data from the nearest meteorological station at Hyden indicate that maximum temperatures ranged from 26.0°C to 41.0°C, while minimum temperatures ranged from 7.0°C to 15.5°C (Table 3.1). Only 1.2 mm of rain was recorded at Hyden during the survey (Table 3.1).

A total of 235.6 mm of rain fell in Hyden during the six months leading up to the survey in 2009 (i.e. from June to November), compared to an expected rainfall of 207.1 mm for this period (based on long term averages at Hyden; see Figure 3.1 and Figure 3.2). This indicates that the Spotted Quoll Haul Road survey was conducted following a period of near average rainfall.

Table 3.1: **Daily meteorological observations at Hyden over the current (Phase I) fauna survey of the Spotted Quoll Haul Road** (data provided by the WA Bureau of Meteorology).

Date	30/11	1/12	2/12	3/12	4/12	5/12	6/12	7/12	8/12	9/12	Mean / Total
Maximum Temperature (°C)	34.5	30.5	26.5	29.8	36.1	41.0	34.6	26.0	29.0	28.2	**31.6**
Minimum Temperature (°C)	12.6	12.0	14.6	10.5	11.8	15.5	15.0	15.2	7.0	10.4	**12.5**
Rainfall (mm)	0	0	0	0	0	0	1.2	0	0	1.2	**1.2**

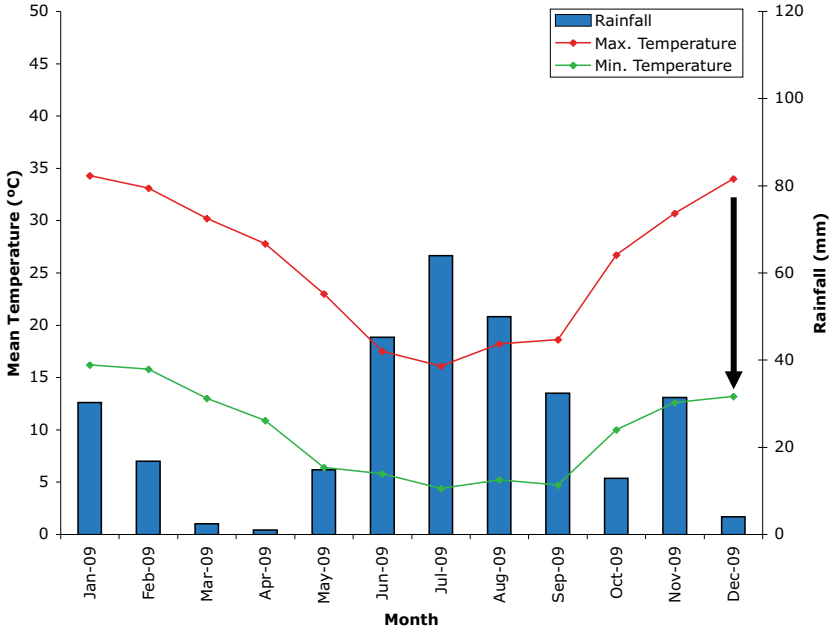


Figure 3.1: **Climatological summary for Hyden using data for 2009** (data provided by the WA Bureau of Meteorology; arrow indicates survey timing).

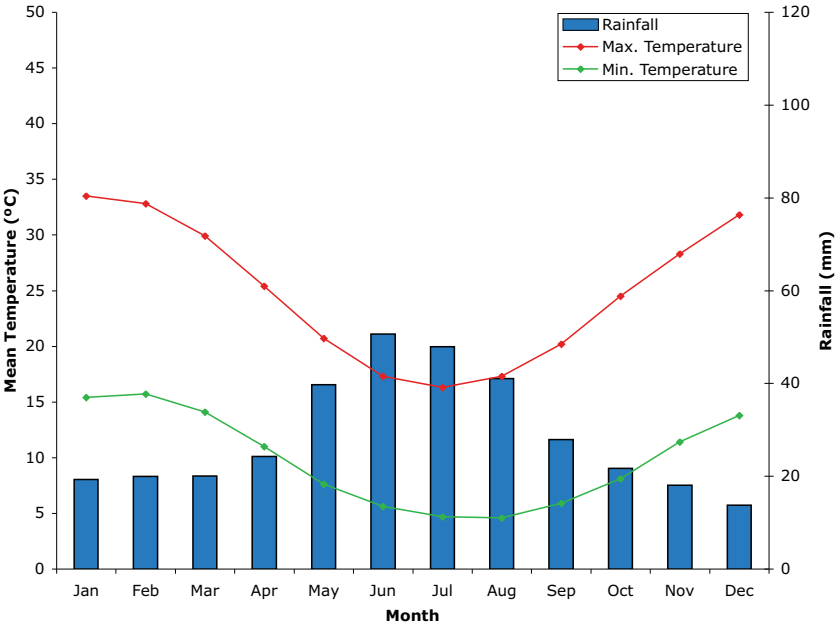


Figure 3.2: **Long-term climatological summary for Hyden 1970 to 2009** (data provided by the WA Bureau of Meteorology).

3.2.2 Survey Team

The vertebrate fauna sampling for the field survey component was conducted under "Licence to Take Fauna for Scientific Purposes" No. SF7178 issued to Mr Dan Kamien (Appendix 4). The fauna

survey team comprised Mr Dan Kamien, Mr Timothy Sachse, Mr Michael Greenham and Mr David Keirle (all of Biota).

Analysis of bat call recordings was completed by Mr Bob Bullen (Bat Call WA). Invertebrate identifications were undertaken by Mr Dan Kamien (Biota), and Dr Volker Framenau (WA Museum). Geographical Information System (GIS) analyses and maps presented in this report were prepared by Mr Luke Lovell (Biota).

3.2.3 Sampling Site Selection, Location and Design

The sampling approach for this study consisted of a combination of systematic fauna sampling, along with targeted searches within habitats deemed suitable for Threatened vertebrate fauna or SRE species (see Sections 3.2.6 and 3.2.7).

The systematic censusing component consisted of 12 trapping grids, each located within a defined habitat (**Table 3.2** and Figure 4.1).

The majority of the trapping grids (nine of the 12) consisted of a single row of six pitfall traps (alternating 20 litre buckets, and 150 mm diameter x 600 mm high PVC tubes), spaced at approximately 10 m intervals and connected with a single 60 m length of 300 mm high flywire fence. These sites also included six medium-sized Elliott box traps, placed parallel to the pit traps at approximately 10 m intervals. Finally, a single cage trap was set at the start of each of the nine pit trapping lines (see Figure 3.3)

Two additional trapping grids consisted of 18 or 19 large-sized Elliott box traps spaced at approximately 10 m intervals. The final trapping grid consisted of 20 cage traps placed at approximately 25 m intervals. All Elliott and cage traps were baited with universal bait (peanut butter and oats). A summary of the total trapping effort is provided in **Table 3.2**.

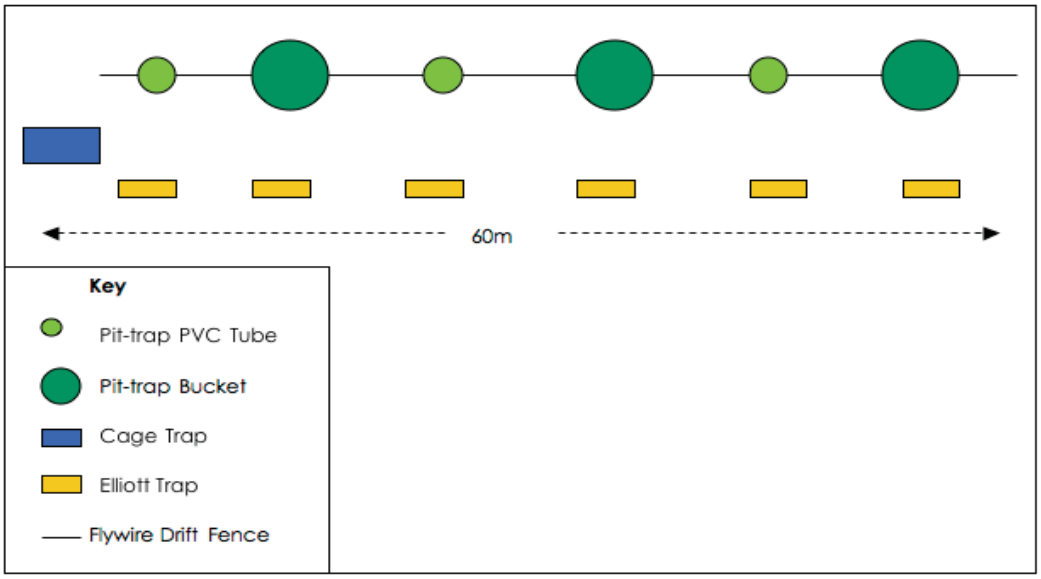


Figure 3.3: Indicative layout of typical trapping design.

Table 3.2: Trapping sites location and effort (datum WGS84).

Site	Easting (mE)	Northing (mN)	Date Opened	Date Closed	Nights Open	Trap Type	No. of Traps	Total Effort (trap nights)
SQH01	752570	6403441	2/12/09	9/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
SQH02	752995	6402961	2/12/09	9/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
SQH03	754594	6396874	1/12/09	8/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
SQH04	754594	6394342	1/12/09	8/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
SQH05	756085	6391545	1/12/09	8/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
SQH06	756756	6391341	2/12/09	9/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
SQH07	755184	6392646	2/12/09	9/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
SQH08E	752615	6403324	2/12/09	9/12/09	7	Elliott trap (large)	18	126
SQH09E	754601	6395037	2/12/09	9/12/09	7	Elliott trap (large)	19	133
SQH10C	754743	6392624	2/12/09	9/12/09	7	Cage trap	20	140
FR25	754560	6401137	1/12/09	8/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
FR26	754576	6398991	1/12/09	8/12/09	7	Pit trap Elliott trap Cage trap	6 6 1	42 42 7
						Total Pit Trap Effort		378
						Total Elliott Trap Effort		637
						Total Cage Trap Effort		203

3.2.4 Avifauna Sampling

Sampling of avifauna in the study area was carried out using a combination of techniques including:

- unbounded area searches (40 minutes duration) conducted at all systematic trapping grids; and
- opportunistic observations of birds recorded while driving through the study area.

Eighteen avifauna censuses were completed across nine trapping sites, with each site censused twice (Table 3.3). Individual censuses were confined to discrete habitat types, typically corresponding to vegetation types. Censuses were conducted between 6:00 am and 10:00 am. A total of 12 hours was dedicated to systematic avifauna censusing during the survey.

Table 3.3: Time and date of systematic avifauna censuses undertaken at each fauna site.

Site	3/12	4/12	5/12	6/12	7/12	8/12	Total Minutes
SQH01		6:34am – 7:14am			7:14am – 7:54am		80
SQH02		7:22am – 8:02am			6:29am – 7:09am		80
SQH03			7:25am – 8:05am			7:06am – 7:46am	80
SQH04			6:17am – 6:57am			6:18am – 6:58am	80
SQH05	6:40am – 7:20am			7:27am – 8:07am			80
SQH06	7:41am – 8:21am			6:10am – 6:50am			80
SQH07	8:45am – 9:25am				8:50am – 9:30am		80
FR25		8:06am – 8:46am			8:24am – 9:04am		80
FR26			8:29am – 9:09am			8:18am – 8:58am	80
						Total	**720**

3.2.5 Bat Sampling

Bat sampling was conducted within the study area using both direct capture methods via harp traps, and recording of echolocation calls (Table 3.4, Figure 4.1, Plate 3.1 to Plate 3.4). Bat echolocation calls were recorded using Anabat SD1 bat detector units, which detect and record ultrasonic echolocation calls emitted during bat flight. The calls were stored on a compact flash card after being processed by an Anabat CF ZCAIM. Calls were visualised on Analook 3.3f software.

Continuous recordings were made at two sites (SQHbat01 and SQHbat04) using an Anabat SD1 bat detector in conjunction with a LS-10 Professional PCM Recorder (Olympus, Japan). COOL EDIT 2000 was used to display each "continuous call" sequence for identification. Details of calls were analysed by Mr Bob Bullen (Bat Call WA) in a manner recommended by the Australasian Bat Society (ABS 2006) in conjunction with available reference data (Bullen and McKenzie 2002, McKenzie and Bullen 2003 and 2009).

In both methods, only sequences containing good quality search phase calls were considered for identification.

Table 3.4: Anabat recorder and Harp trap locations and effort (map datum WGS84).

Site	Easting (mE)	Northing (mN)	Habitat	Sampling	Date Started	Date Ended	Sampling Effort (Nights)
SQHbat01	752579	6403424	Salmon Gum woodland	Anabat + continuous recording	2/11/09	7/12/09	5
SQHbat02	754474	6401634	Mallee tall open scrub	Harp trap Anabat	3/12/09 3/12/09	8/12/09 5/12/09	5 2
SQHbat03	756756	6391355	Mallee low open woodland	Anabat	5/12/09	8/12/09	3
SQHbat04	755181	6392646	Salmon Gum open woodland over mallee low woodland	Anabat + continuous recording	7/12/09	8/12/09	1
						Total Anabat Effort	**11**
						Total Harp Trap Effort	**5**



Plate 3.1: SQHbat01.



Plate 3.2: Harp trap at SQHbat02.



Plate 3.3: SQHbat03.



Plate 3.4: SQHbat04.

3.2.6 Non-Systematic Sampling of Vertebrate Fauna

A range of non-systematic fauna survey activities was undertaken by the survey team to supplement the systematic trapping data and to investigate additional habitats identified during the course of the survey. These activities included:

- habitat specific searches for Schedule and Priority listed fauna species;
- searching (including head-torching) of microhabitats for reptile, frog and small mammal species;
- recording and identification of secondary signs (where possible) including tracks, scats and diggings;
- identification of road kills and other animal remains; and
- nocturnal road spotting and head torching.

3.2.7 Short-Range Endemic Invertebrates

Specific invertebrate groups were targeted using both systematic and non-systematic collection techniques during the survey. Invertebrate groups targeted during the survey were those considered most likely to potentially support SRE taxa, including:

- Mygalomorphae (trapdoor spiders);
- Diplopoda (millipedes);
- Pulmonata (land and aquatic snails); and
- Pseudoscorpionida (pseudoscorpions).

Trapdoor spiders were specifically targeted by searching for burrows and excavating them with the aim of collecting and preserving individuals in 70% ethanol. One leg was removed and placed in 100% ethanol for future molecular studies. Millipedes were searched for under leaf litter, bark and logs. Aestivating snails were targeted by digging in drainage gullies and under vegetation. Pseudoscorpions were searched for under rocks and bark.

Targeted searches for SRE taxa were conducted in the vicinity (a 200 m radius) of nine of the systematic survey sites (see Table 3.5 and Figure 4.1), with additional sampling effort through the pit trapping (principally in respect of mygalomorph spiders and millipedes). In total, 27 person hours were dedicated to SRE searches. SRE sampling was not conducted outside the Spotted Quoll Haul Road project boundary, as extensive SRE searches have been conducted during past surveys (Biota 2006a, 2006b, 2006c, 2007a, 2007b and 2008a; see Section 6.3).

Identification of Mygalomorph spiders was conducted by Dr. Volker Framenau of the WA Museum. This was carried out in conjunction with the molecular analysis of spiders from the Spotted Quoll Haul Road survey, with these being referenced against spiders collected elsewhere in the Forrestania area and the broader region (Appendix 5; Section 6.3).

Identification of pseudoscorpions was conducted by Dr. Mark Harvey of the WA Museum.

Table 3.5: Location and duration of dedicated SRE searches.

Site	People	Search Effort (minutes)	Total Effort (person minutes)
SQH01	2	90	180
SQH02	2	60	120
SQH03	2	90	180
SQH04	2	90	180
SQH05	2	90	180
SQH06	2	120	240
SQH07	2	90	180
FR25	2	90	180
FR26	2	90	180
			1,620

3.3 Survey Limitations

The following limitations should be recognised:

- The Spotted Quoll Haul Road survey represents a single phase of sampling only.
- Not all sections of the study area were equally ground-truthed or sampled for fauna. Parts of the study area were inaccessible by vehicle, hence regular checking of fauna traps in these areas would not have been possible. However, systematic fauna sampling (the primary component of the study) was completed on the basis of trapping grid installation in habitats considered to be representative of the range of units present within the development area.
- Terrestrial invertebrate sampling was targeted at a small number of specific groups that are known to potentially harbour SRE taxa (EPA 2009).

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4.0 Regional Context of the Study Area

4.1 IBRA Bioregions

The Interim Biogeographic Regionalisation of Australia (IBRA) recognises 85 bioregions (Environment Australia 2000). The Spotted Quoll Haul Road study area is located within the Mallee biogeographic region, defined by Environment Australia (2000) as:

> *"the area between Lake Hope, Forrestania and Mount Holland, which comprises Salmon Gum and Morrel woodlands on greenstone, with smaller areas of mallee and Acacia / Casuarina thicket on sandplains. The south-eastern part of the Yilgarn Craton is gently undulating, with partially occluded drainage. Mainly mallee over myrtaceous-proteaceous heaths on duplex (sand over clay) soils. Melaleuca shrublands characterise alluvia, and Tecticornia low shrublands occur on saline alluvium. A mosaic of mixed eucalypt woodlands and mallee occur on calcareous earth plains and sandplains overlying Eocene limestone strata in the east. Semi-arid (Dry) Warm Mediterranean. Extensively cleared for agriculture".*

The Mallee bioregion is divided into two subregions:

1. Eastern Mallee; and
2. Western Mallee.

Beecham and Danks (2001) place the Spotted Quoll Haul Road study area in the MAL2 (Western Mallee) biological subregion. The total area of the MAL2 subregion is 4,763,963 ha and is described as follows:

> *"Main surface-types comprise clays and silts underlain by Kankar, exposed granite, sandplains and laterite pavements. Salt lake systems on a granite basement. Occluded drainage system. Mallee communities occur on a variety of surfaces; Eucalyptus woodlands occur mainly on fine-textured soils, with scrub-heath on sands and laterite. The climate is warm Mediterranean and annual rainfall is 250-500mm"* (Beecham and Danks 2001).

4.2 Land Systems (Rangelands)

Land System (Rangelands) mapping has not been prepared for the locality including the current study area. Future surveys to be carried out by Department of Agriculture Western Australia are pending.

4.3 Geology

The Spotted Quoll Haul Road study area encompasses five major geological types according to Geological Survey of Western Australia, 1984 (Table 4.1 and Figure 4.1).

Table 4.1: Geological units occurring within the Spotted Quoll Haul Road study area (Geological Survey of Western Australia 1:250,000 scale map, 1984).

Unit	Geological Description	Extent in Study Area (ha)
Aab	Fine- and medium-grained mafic amphibolite and metabasalt	52
Aue	Talc (-carbonate-tremolite) schist	1
Czg	Remnant sandplain - yellow and white sand containing locally abundant limonite pebbles: derived from Czl (Laterite-limonite cemented duricrust over deeply weathered bedrock)	37
Czl	Laterite-limonite cemented duricrust overlying deeply weathered bedrock; minor silcrete	42
Qe	Colluvium and eluvium - red-brown clay and silt derived from mafic amphibolite	279

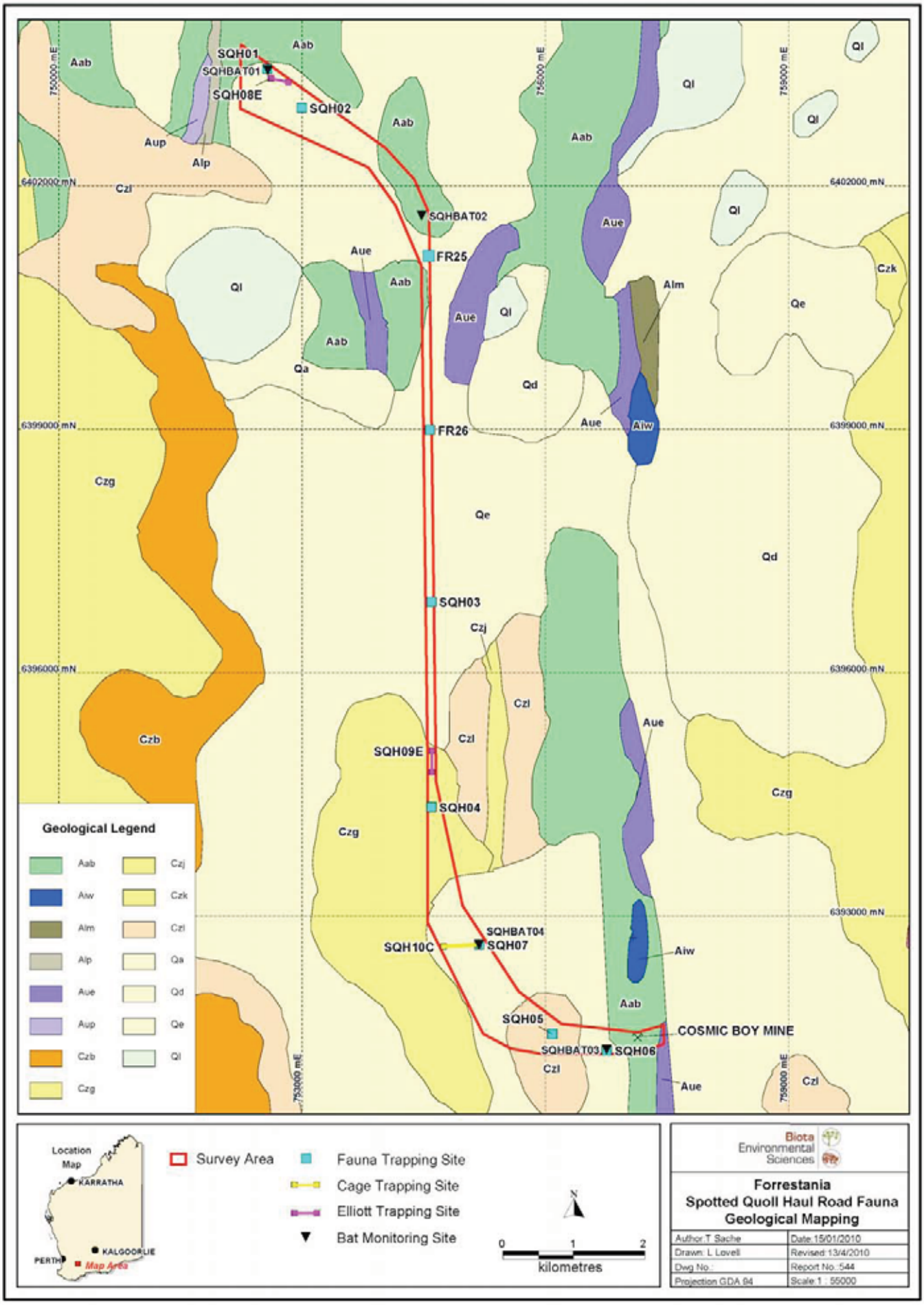


Figure 4.1: Geological map overlain with fauna sampling sites in the Spotted Quoll Haul Road study area.

4.4 Vegetation Mapping

The Forrestania Tableland straddles an ancient watershed dividing the Swan-Avon Basin from the palaeodrainage heading east (Beard 1981). The Forrestania System is developed on a greenstone belt, and comprises a variety of communities that are controlled by the underlying geology in a mosaic form (Beard 1981). The greenstones weather to form a flat tract of country with a heavy soil supporting eucalypt woodland broken by numerous salt small salt lakes. There are also granites and quartzites that form siliceous soils, accounting for areas of mallee, thicket and scrub-heath within the mosaic. The sclerophyll woodlands are dominated by two major tree species, Salmon Gum (*Eucalyptus salmonophloia*) and Morrel (*E. longicornis*).

Beard mapped the vegetation of the Southwest of WA at various resolutions; the Swan region was mapped at a scale of 1:1,000,000 (Beard 1981). The Spotted Quoll Haul Road study area intersects two vegetation units according to Beard (1981):

- The majority of the study area comprises "Forrestania 511": Salmon Gum and Morrel woodland. This mapping unit occupies 164,071 ha in the region, occurring broadly over a range of 110 km north-south by 50 km east-west.
- The southernmost end of the study area intersects a stand of "Forrestania 1413": *Acacia, Allocasuarina* and *Melaleuca* thicket. This mapping unit is less well represented in the region, occurring in several isolated stands occupying 9,622 ha in total, over a range of 90 km north-south by less than 10 km east-west.

4.5 Conservation Reserves in the Locality

There are three formally gazetted conservation reserves in the vicinity of the Spotted Quoll Haul Road study area:

- Lake Cronin Nature Reserve (1,016 ha) is located approximately 10 km to the northeast;
- Jackson Nature Reserve (910 ha) is located approximately 25 km south; and
- Lake Hurlstone Nature Reserve (4,756 ha) is located approximately 25 km west.

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5.0 Survey Results

5.1 Fauna Habitats

The study area comprised a range of habitat units, distinguished on the basis of differences in substrate and vegetation (Table 5.1; Plate 5.1 to Plate 5.12).

Table 5.1: Habitat descriptions for each trapping site.

Site	Broad Habitat	Vegetation Description	Soil Texture
***Eucalyptus salmonophloia* (Salmon Gum) woodland**			
SQH01	Woodland on plain	*Eucalyptus salmonophloia* open woodland over *Acacia* spp. tall open shrubland	Clay
SQH08E	Woodland on plain	*Eucalyptus salmonophloia* scattered trees over *Eucalyptus* sp. scattered low mallee over *Acacia* spp. shrubland	Clay
***Eucalyptus salubris* woodland**			
SQH07	Woodland on plain	*Eucalyptus salmonophloia* open woodland over *Eucalyptus salubris* low woodland, over *Melaleuca* spp. open shrubland and mixed scattered shrubs	Clay
***Eucalyptus salmonophloia* (Salmon Gum) woodland over regenerating *Eucalyptus* sp.**			
FR25	Woodland (regenerating) on plain	*Eucalyptus* sp. dead scattered trees over *Eucalyptus* sp. open forest of regenerating saplings, over *Melaleuca* spp. open shrubland	Clay
***Eucalyptus eremophila* mallee woodland over *Melaleuca* spp.**			
SQH06	Mallee on plain	*Eucalyptus* sp. mallee low open woodland over *Melaleuca* spp. open heath	Clay
***Eucalyptus eremophila* mallee woodland**			
SQH02	Mallee on plain	*Eucalyptus eremophila* low open mallee woodland over mixed open shrubland	Clay
SQH03	Mallee on plain	*Eucalyptus eremophila* tall mallee shrubland over mixed species shrubland	Clay
FR26	Mallee on plain	*Eucalyptus eremophila* tall open mallee shrubland, over *Acacia* sp. open shrubland, over low open perennial shrubland and sedges	Sand
***Eucalyptus* spp. mallee woodland over *Melaleuca* spp. heath**			
SQH04	Mallee on plain	*Eucalyptus* sp. mallee low open woodland over *Melaleuca* spp. open heath	Clay
SQH09E	Mallee on plain	*Eucalyptus* sp. mallee low open woodland over *Melaleuca* spp. open heath	Clay
SQH10C	Mallee on plain	*Eucalyptus* sp. mallee low open woodland over *Melaleuca* spp. open heath mixed *Acacia* spp and Melaleuca spp open heath	Clay
***Melaleuca* spp. shrubland and heath**			
SQH05	Tall scrub on plain	*Hakea* sp. and *Melaleuca* sp. tall open scrub over *Melaleuca* spp. open heath	Loamy Clay



Plate 5.1 SQH01.



Plate 5.2: SQH02.



Plate 5.3: SQH03.



Plate 5.4: SQH04.



Plate 5.5: SQH05.



Plate 5.6: SQH06.



Plate 5.7: SQH07.



Plate 5.8: SQH08E.



Plate 5.9: SQH09E.



Plate 5.10: SQH10C.



Plate 5.11: FR25.



Plate 5.12: FR26.

5.2 Overview of Vertebrate Fauna of the Study Area

A total of 76 vertebrate species was recorded from the Spotted Quoll Haul Road survey, half of which were birds (Table 5.2).

Table 5.2: Number of vertebrate species recorded during the Spotted Quoll Haul Road survey.

Fauna Group	Total
Reptiles	21
Avifauna	38
Native non-volant mammals	7
Native volant mammals (bats)	6
Introduced mammals	4
Total	**76**

5.3 Herpetofauna

5.3.1 The Assemblage

The single-phase survey yielded a total of 21 reptiles from the study area (Table 5.3), which represents only 35% of all herpetofauna (reptiles and frogs) recorded from the locality based on recent surveys and WA Museum records (Appendix 2). This total comprised one gecko from the Gekkonidae family, three geckos from the Diplodactylidae family, one gecko from the Carphodactylidae family (Plate 5.13), two legless lizards (Pygopodidae), seven skinks (Scincidae), three dragons (Agamidae; see for example Plate 5.14), one monitor (Varanidae), one blind snake (Typhlopidae), and two front-fanged snakes (Elapidae). No frogs were recorded.

By far the most common herpetofauna species was the Clawless Gecko (*Crenadactylus ocellatus ocellatus*), with 40 individuals captured, accounting for 28% of the herpetofauna records (Table 5.3). This species was recorded from all of the major habitat types within the study area. Also relatively common were the geckos *Diplodactylus granariensis* (16 individuals) and *Lucasium maini* (13 individuals), the legless lizard *Delma fraseri* (12 individuals), and the skink *Morethia obscura* (13 individuals) (Table 5.3).

Site SQH07 (*Eucalyptus salubris* woodland) exhibited the highest herpetofauna diversity within the study area, comprising nine species, representing 43% of the herpetofauna species recorded in the study area. However, it should be noted that in general, there appeared to be no relationship between habitat type and the species richness of herpetofauna within the study area.

The most diverse herpetofauna family was the Scincidae, comprising seven species, representing 33% of all herpetofauna species recorded.



Plate 5.13: Barking Gecko (*Nephrurus milii*).



Plate 5.14: Dwarf Bearded Dragon (*Pogona minor*).

5.3.2 Regional Endemism and Restricted Taxa

No herpetofauna species endemic to the Mallee bioregion were recorded during the Spotted Quoll Haul Road survey. However, the Lake Cronin snake (*Paraplocephalus atriceps*) is known solely from the vicinity of Lake Cronin and has the potential to occur with the Spotted Quoll Haul Road study area (see Appendix 2).

5.3.3 Herpetofauna of Conservation Significance

No herpetofauna of conservation significance were recorded during the Spotted Quoll Haul Road fauna survey. However, the Priority 4 Carpet Python (*Morelia spilota* subsp. *imbricata*) and the Priority 3 Lake Cronin Snake (*Paraplocephalus atriceps*) are known to occur in the broader locality (see Section 6.2).

Table 5.3: Herpetofauna recorded within the Spotted Quoll Haul Road study area.

Family Species name	**FR 25**	**FR 26**	**SQH 01**	**SQH 02**	**SQH 03**	**SQH 04**	**SQH 05**	**SQH 06**	**SQH 07**	**SQH 08E**	**SQH 09E**	**SQH 10C**	**Opp†**	**Total**
Gekkonidae														
Gehyra variegata	–	–	–	3	–	–	–	–	–	–	–	–	–	3
Diplodactylidae														
Crenadactylus ocellatus ocellatus	17	–	6	4	9	–	1	1	2	–	–	–	–	40
Diplodactylus granariensis granariensis	–	–	1	1	4	2	2	3	3	–	–	–	–	16
Lucasium maini	–	–	1	7	1	–	–	2	–	–	–	–	2	13
Carphodactylidae														
Nephrurus milii	–	–	–	–	–	–	1	–	–	–	–	–	–	1
Pygopodidae														
Delma fraseri fraseri	–	1	6	–	–	1	–	3	1	–	–	–	–	12
Lialis burtonis	–	–	2	–	1	–	–	–	–	–	–	–	–	3
Scincidae														
Ctenotus schomburgkii	–	–	–	1	2	–	–	2	3	–	–	–	–	8
Hemiergis initialis brookeri	–	–	–	–	–	–	–	1	–	–	–	–	–	1
Lerista distinguenda	1	–	1	–	–	–	–	1	4	–	–	–	–	7
Lerista picturata	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Morethia obscura	–	1	–	3	2	1	1	–	5	–	–	–	–	13
Tiliqua rugosa	–	–	–	–	–	–	–	–	–	4	–	–	–	4
Cryptoblepharus buchananii	–	–	–	–	2	–	–	–	3	–	–	–	–	5
Agamidae														
Ctenophorus cristatus	–	–	–	–	–	–	–	–	2	–	1	–	–	3
Ctenophorus maculatus griseus	1	2	–	–	–	–	1	1	–	–	–	–	–	5
Pogona minor minor	–	1	–	–	1	–	–	–	–	–	–	–	–	2
Varanidae														
Varanus gouldii	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Typhlopidae														
Ramphotyphlops australis	–	–	–	–	–	1	–	–	–	–	–	–	–	1
Elapidae														
Pseudonaja affinis	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Simoselaps bertholdi	–	–	–	–	–	–	–	–	1	–	–	–	–	1
Number of Individuals	**19**	**6**	**17**	**19**	**22**	**5**	**6**	**14**	**24**	**4**	**1**	**0**	**4**	**141**
Number of species	**3**	**5**	**6**	**6**	**8**	**4**	**5**	**8**	**9**	**1**	**1**	**0**	**3**	**21**

† Opp refers to non-systematic opportunistic records.

5.4 Avifauna

5.4.1 The Assemblage

Thirty-eight bird species were recorded from the Spotted Quoll Haul Road study area, comprising 11 non-passerine species and 27 passerine species from 20 families (Table 5.4). This represents 44% of all avifauna recorded in the area based on recent surveys and WA Museum records (Appendix 2).

The Elegant Parrot (*Neophema elegans*) was the most abundant species in the study area, with 32 records representing almost 13% of recorded avifauna. The most speciose family of birds was the Meliphagidae (Honeyeaters), with seven recorded species.

Although SQH05 (*Melaleuca* shrubland and heath) had the highest avifauna richness (16 species) of any of the individual sites, it was the *Eucalyptus* mallee woodland over *Melaleuca* heath habitat that exhibited the highest overall avifauna richness (25 species, accounting for 67% of the species recorded during the survey). This is believed to be due to the high degree of stratification and dense undergrowth within the latter habitat, which would provide a range of niches accommodating a variety of bird species.

5.4.2 Regional Endemism and Restricted Taxa

No avifauna species endemic to the Mallee bioregion were recorded during the Spotted Quoll Haul Road survey.

5.4.3 Avifauna of Conservation Significance

Avifauna of conservation significance recorded during the Spotted Quoll Haul Road fauna survey included the:

- Schedule 1 Carnaby's Cockatoo (*Calyptorhynchus latirostris*);
- Priority 4 Shy Heathwren (*Hylacola cauta whitlocki*);
- Priority 4 White-browed Babbler (*Pomatostomus superciliosus*); and
- Priority 4 Crested Bellbird (*Oreoica gutturalis gutturalis*).

A Malleefowl (*Leipoa ocellata*) mound was also recorded in the vicinity of site SQH05 in *Melaleuca* spp. shrubland and heath habitat (756157 mE, 6391568 mN; Plate 5.15). The mound appeared to be active approximately one year prior, but at the time of the survey was inactive.



Plate 5.15: Inactive Malleefowl mound at 756157 mE, 6391568 mN.

Table 5.4: Avifauna recorded within the Spotted Quoll Haul Road study area.

Family Species name	**Common Name**	**FR 25**	**FR 26**	**SQH 01**	**SQH 02**	**SQH 03**	**SQH 04**	**SQH 05**	**SQH 06**	**SQH 07**	**Opp†**	**Total**
Casuariidae												
Dromaius novaehollandiae	Emu	–	–	–	–	–	1	–	–	–	–	**1**
Megapodiidae												
Leipoa ocellata	Malleefowl							M				**1**
Columbidae												
Phaps chalcoptera	Common Bronzewing	–	–	2	–	–	–	–	–	1	–	**3**
Accipitridae												
Aquila audax	Wedge-tailed Eagle	–	1	–	–	–	–	–	–	–	–	**1**
Calyptorhynchus latirostris	Carnaby's Cockatoo	–	–	–	–	–	3	–	–	–	–	**3**
Turnicidae												
Turnix velox	Little Button-quail	–	3	–	–	–	–	–	–	–	–	**3**
Psittacidae												
Neophema elegans	Elegant Parrot	–	–	–	–	9	–	3	18	2	–	**32**
Polytelis anthopeplus	Regent Parrot	–	–	–	–	–	11	–	–	–	–	**11**
Psephotus varius	Mulga Parrot	–	–	–	–	–	1	1	–	–	–	**2**
Barnardius zonarius	Australian Ringneck	–	–	–	–	–	–	–	2	–	–	**2**
Cuculidae												
Cacomantis pallidus	Pallid Cuckoo	–	1	–	–	–	–	–	–	–	–	**1**
Maluridae												
Malurus pulcherrimus	Blue-breasted Fairy-wren	3	–	–	–	–	–	3	4	–	–	**10**
Acanthizidae												
Acanthiza apicalis	Inland Thornbill	5	4	6	–	2	2	1	4	2	–	**26**
Hylacola cauta	Shy Heathwren	–	–	–	–	2	–	1	1	6	–	**10**
Smicrornis brevirostris	Weebill	1	2	2	4	–	–	1	2	11	–	**23**
Pardalotidae												
Pardalotus punctatus	Spotted Pardalote	–	1	–	–	–	–	–	–	–	–	**1**
Meliphagidae												
Anthochaera carunculata	Red Wattlebird	1	4	–	–	2	2	2	–	–	–	**11**
Lichenostomus leucotis	White-eared Honeyeater	8	–	1	4	1	–	2	3	3	–	**22**
Lichmera indistincta	Brown Honeyeater	–	4	–	–	2	12	3	1	–	–	**22**
Lichenostomus virescens	Singing Honeyeater	–	–	–	–	–	1	1	–	1	–	**3**
Lichenostomus ornatus	Yellow-plumed Honeyeater	–	–	1	–	–	–	–	1	1	–	**3**
Melithreptus brevirostris	Brown-headed Honeyeater	–	–	–	–	–	–	–	–	1	–	**1**
Purnella albifrons	White-fronted Honeyeater	–	–	–	–	–	1	–	–	–	–	**1**
Pomatostomidae												
Pomatostomus superciliosus	White-browed Babbler	–	–	–	–	–	–	1	4	–	–	**5**
Campephagidae												
Coracina novaehollandiae	Black-faced Cuckoo-shrike	–	–	–	–	–	–	1	–	–	–	**1**
Pachycephalidae												

Family Species name	**Common Name**	**FR 25**	**FR 26**	**SQH 01**	**SQH 02**	**SQH 03**	**SQH 04**	**SQH 05**	**SQH 06**	**SQH 07**	**Opp†**	**Total**
Colluricincla harmonica	Grey Shrike-thrush	–	1	–	–	2	3	2	1	1	–	**10**
Oreoica gutturalis	Crested Bellbird	–	1	–	–	–	1	–	–	–	1	**3**
Pachycephala pectoralis	Golden Whistler	–	–	1	–	–	–	1	–	–	–	**2**
Pachycephala rufiventris	Rufous Whistler	–	–	–	–	–	–	–	2	–	–	**2**
Artamidae												
Cracticus torquatus	Grey Butcherbird	3	–	–	–	1	–	–	–	–	–	**4**
Strepera versicolor	Grey Currawong	–	–	1	5	–	–	6	3	–	–	**15**
Dicruridae												
Grallina cyanoleuca	Magpie-lark	–	–	–	–	–	1	–	–	–	–	**1**
Corvidae												
Corvus coronoides	Australian Raven	–	–	–	–	–	–	3	2	–	–	**5**
Petroicidae												
Drymodes brunneopygia	Southern Scrub-robin	–	–	–	–	2	–	–	–	–	–	**2**
Eopsaltria griseogularis	Western Yellow Robin	–	–	–	–	–	–	–	–	2	–	**2**
Microeca fascinans	Jacky Winter	–	–	–	–	–	1	–	–	–	–	**1**
Petroica goodenovii	Red-capped Robin	–	–	–	–	–	–	–	–	1	–	**1**
Motacillidae												
Anthus novaeseelandiae	Australasian Pipit	–	–	2	–	–	1	–	–	–	–	**3**
Number of individuals		**21**	**22**	**16**	**13**	**23**	**41**	**32**	**48**	**32**	**1**	**250**
Number of species		**6**	**10**	**8**	**3**	**9**	**14**	**17**	**14**	**12**	**1**	**38**

† Opp refers to non-systematic opportunistic records.
M = malleefowl mound.
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5.5 Non-Volant Mammals

5.5.1 The Assemblage

Eleven non-volant mammal species (seven native and four introduced) were recorded from the study area (Table 5.5). These comprised three species from the Dasyuridae family (carnivorous marsupials), one species from the Macropodidae family (the Western Grey Kangaroo), one species from the Burramyidae family (the Western Pygmy Possum; Plate 5.16), three species of Muridae (rodents), one species from the Leporidae family (the Rabbit), one species of the Canidae family (the Dingo) and one species of the Felidae family (the Cat).

The most commonly recorded mammal species was the introduced House Mouse (*Mus musculus*), which was captured on 16 occasions and comprised 28% of the non-volant mammals recorded during the survey. The non-volant mammals recorded during this survey represent 58% of all non-volant mammals recorded in the locality based on recent surveys and WA Museum records (Appendix 2).



Plate 5.16: Western Pygmy Possum (*Cercartetus concinnus*).

5.5.2 Regional Endemism and Restricted Taxa

No mammals endemic to the Mallee bioregion were recorded during the Spotted Quoll Haul Road survey.

5.5.3 Mammals of Conservation Significance

The Schedule 1 Western Quoll (*Dasyurus geoffroii*) was the only mammal of conservation significance recorded during the Spotted Quoll Haul Road survey (see Section 6.2.1).

Table 5.5: Mammals recorded within the Spotted Quoll Haul Road study area.

Family Species name	**Common name**	**FR 25**	**FR 26**	**SQH 01**	**SQH 02**	**SQH 03**	**SQH 04**	**SQH 05**	**SQH 06**	**SQH 07**	**SQH 08E**	**SQH 10C**	**Opp†**	**Total**
Dasyuridae														
Dasyurus geoffroii	Western Quoll	–	–	–	–	–	–	–	–	–	–	2	–	**2**
Sminthopsis gilberti	Gilbert's Dunnart	–	–	–	–	1	1	1	2	5	–	–	–	**10**
Sminthopsis granulipes	White-tailed Dunnart	–	4	–	–	–	–	–	–	–	–	–	–	**4**
Macropodidae														
Macropus fuliginosus	Western Grey Kangaroo	1	–	–	–	–	–	1	–	–	–	–	–	**2**
Burramyidae														
Cercartetus concinnus	Western Pygmy Possum	–	–	–	5	1	–	2	–	2	–	–	–	**10**
Muridae														
*Mus musculus**	House Mouse	2	1	–	7	1	1	–	4	–	–	–	–	**16**
Notomys mitchellii	Mitchell's Hopping Mouse	–	5	–	–	–	–	1	–	–	–	–	1	**7**
Pseudomys albocinereus	Ash-grey Mouse	–	–	1	–	2	–	–	–	–	–	–	–	**3**
Leporidae														
*Oryctolagus cuniculus**	European Rabbit	–	–	–	–	–	1	–	–	–	–	–	–	**1**
Canidae														
*Vulpes vulpes**	Red Fox	–	–	–	1	–	–	–	–	–	–	–	–	**1**
Felidae														
*Felis catus**	House Cat	–	–	–	–	–	–	–	–	–	–	1	–	**1**
Number of individuals		**3**	**10**	**1**	**13**	**5**	**3**	**5**	**6**	**7**	**0**	**3**	**1**	**57**
Number of species		**2**	**3**	**1**	**3**	**4**	**3**	**4**	**2**	**2**	**0**	**2**	**1**	**11**

† Opp refers to non-systematic opportunistic records.
* Refers to introduced (non-native) species.

5.6 Volant Mammals (Bats)

Six bat species were recorded within the study area, comprising four vespertilionids (evening bats) and two molossids (freetail bats) (Table 5.6 and Appendix 6). This represents all six bat species recorded in the locality based on other recent surveys and WA Museum records (Appendix 2).

It should be noted that during the Spotted Quoll Haul Road survey, harp trapping within the study area did not result in the direct capture of bats: the documented species were therefore based solely on recorded call sequences.

Table 5.6: Bats recorded within the Spotted Quoll Haul Road study area.

Family Species name	**SQHbat01**	**SQHbat02**	**SQHbat03**	**SQHbat04**
Vespertilionidae				
Chalinolobus gouldii	√	√	√	√
Chalinolobus morio	√	√	√	–
Nyctophilus geoffroyi	√	√	√	–
Vespadelus regulus	√	√	√	√
Molossidae				
Mormopterous sp. 4	√	√	√	–
Tadarida australis	√	√	√	–
Number of Species	**6**	**6**	**6**	**2**

5.7 SRE Invertebrates

Taxonomic groups of invertebrates with naturally small distributions are described as SREs and are in part characterised by poor dispersal capabilities, confinement to disjunct habitats and low fecundity (Harvey 2002, Ponder and Colgan 2002). Given the importance of short-range endemism to the conservation of biodiversity, the assessment of such invertebrate taxa is a potentially important component of impact assessment.

A total of nine potential short-range endemic invertebrate species were recorded from within the Spotted Quoll Haul Road study area, including eight mygalomorph spiders (Section 5.7.1) and one pseudoscorpion species (Section 5.7.2).

5.7.1 Mygalomorph Spiders

Based on molecular investigation (Helix Molecular Solutions 2010; Appendix 5), it is evident that eight species of mygalomorph spiders were recorded from the Spotted Quoll Haul Road study area (Table 5.7). These comprised six species of the genus *Aname* or *Chenistonia* (yet to be determined; family Nemesiidae; examples of five of the species are presented in Plate 5.17 to Plate 5.21), one species of *Aganippe* (family Idiopidae; Plate 5.22), and one species of *Eucyrtops* (family Idiopidae; Plate 5.23).

Table 5.7: Mygalomorph spiders recorded within the Spotted Quoll Haul Road study area.

Family Species name	**FR 25**	**FR 26**	**SQH 01**	**SQH 02**	**SQH 03**	**SQH 04**	**SQH 05**	**SQH 06**	**SQH 07**	**SQH 8E**	**Opp.†**	**Total**
Nemesiidae	–											
Aname/Chenistonia Lineage K	–	–	–	–	–	1	–	–	–	–	–	**1**
Aname/Chenistonia Lineage L	–	1	–	–	–	–	–	–	–	–	–	**1**
Aname/Chenistonia Lineage M	–	–	–	–	1	–	–	–	–	–	–	**1**
Aname/Chenistonia Lineage N	–	–	–	1	–	–	–	–	–	–	–	**1**
Aname/Chenistonia Lineage O	–	1	–	–	–	–	–	–	–	–	–	**1**
Aname/Chenistonia Lineage P	1	1	–	–	–	–	–	–	–	–	–	**2**
Idiopidae												
Aganippe sp.	–	–	2	1	–	–	–	3	–	1	1	**8**
Eucyrtops sp.	–	–	1	1	1	–	–	–	2	–	–	**5**
Number of Individuals	**1**	**3**	**3**	**3**	**2**	**1**	**0**	**3**	**2**	**1**	**1**	**20**
Number of Species	**1**	**2**	**3**	**3**	**3**	**0**	**2**	**1**	**1**	**1**	**1**	**8**

† Opp refers to non-systematic opportunistic records.



Plate 5.17: *Aname/Chenistonia* Lineage L.



Plate 5.18: *Aname/Chenistonia* Lineage M.



Plate 5.19: *Aname/Chenistonia* Lineage N.



Plate 5.20: *Aname/Chenistonia* Lineage O.



Plate 5.21: ***Aname/Chenistonia* Lineage P.**



Plate 5.22: ***Aganippe* sp.**



Plate 5.23: ***Eucyrtops* sp.**

5.7.2 Psuedoscorpions

Two individuals of a single pseudoscorpion species were recorded from the Spotted Quoll Haul Road study area, which were identified as a species of *Haplochernes* (family Chernetidae) by Dr Mark Harvey of the WA Museum (Plate 5.24). Specimens were collected under bark on Salmon Gum (*Eucalyptus salmonophloia*) trees.



Plate 5.24: ***Haplochernes* sp.**

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6.0 Conservation Significance

6.1 Threatened Fauna Statutory Framework

Native fauna species that are rare, threatened with extinction, or have high conservation value are specially protected by law under the Western Australian *Wildlife Conservation Act 1950-1979* (Section 6.1.1). In addition, many of these species are listed under the Federal *EPBC Act 1999* (Section 6.1.2).

6.1.1 *Wildlife Conservation Act 1950-1979*

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 2010* recognises four distinct schedules of taxa:

Schedule 1 Taxa that are rare or likely to become extinct and are declared to be fauna in need of special protection;

Schedule 2 Taxa that are presumed to be extinct and are declared to be fauna in need of special protection;

Schedule 3 birds that are subject to an agreement between the government of Australia and the governments of Japan, China and the Republic of Korea relating to the protection of migratory birds, are declared to be fauna that is in need of special protection; and

Schedule 4 Taxa that are in need of special protection, otherwise than for the reasons mentioned in paragraphs (1), (2) and (3).

In addition to the above classification, fauna are also classified under five different Priority codes:

Priority One **Taxa with few, poorly known populations on threatened lands.**
Taxa that are known from a few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Two **Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands.**
Taxa that are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Three **Taxa with several, poorly known populations, some on conservation lands.**
Taxa that are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Four **Taxa in need of monitoring.**
Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.

Priority Five **Taxa in need of monitoring.**
Taxa that are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

6.1.2 *EPBC Act 1999*

Fauna species of national conservation significance are listed under the *EPBC Act 1999*, and may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent'. Migratory wader species are also protected under the *EPBC Act 1999*. The national List of Migratory Species consists of those species listed under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

6.2 Schedule and Priority Fauna

Six vertebrate species of conservation significance were recorded within the Spotted Quoll Haul Road study area:

- the Schedule 1 Carnaby's Cockatoo (*Calyptorhynchus latirostris*): three individuals were recorded flying over site SQH04;
- the Schedule 1 Malleefowl (*Leipoa ocellata*): a single inactive (possibly active in 2008) nesting mound was recorded close to SQH05 at 756157 mE, 6391668 mN;
- the Schedule 1 Western Quoll (*Dasyurus geoffroii*): two individuals were recorded in cage traps at site SQH10C;
- the Priority 4 Shy Groundwren (*Hylacola cauta whitlocki*): recorded on 10 occasions at sites SQH03, SQH05, SQH06 and SQH07;
- the Priority 4 Crested Bellbird (*Oreoica gutturalis gutturalis*): recorded on three separate occasions at sites SQH04 and FR26 and opportunistically within the study area; and
- the Priority 4 White-browed Babbler (*Pomatostomus superciliosus ashbyi*): recorded on one occasion at site SQH05 and four occasions at site SQH06.

Based on known fauna distributions and habitat preferences, a total of 21 Schedule, Priority or Migratory species may potentially occur within the study area (Table 6.1; Appendices 1, 2 and 3).

Table 6.1: Fauna of conservation significance occurring or potentially occurring within the Spotted Quoll Haul Road study area.

Species Name	Common Name	Conservation Significance	
		State Level	Federal level
Calyptorhynchus latirostris *†Δ	Carnaby's Black-Cockatoo	Schedule 1 Endangered	Endangered
Phascogale calura	Red-tailed Phascogale	Schedule 1 Endangered	Endangered
Dasyurus geoffroii *†Δ	Western Quoll (Chuditch)	Schedule 1 Vulnerable	Vulnerable
Pseudomys shortridgei	Heath Mouse	Schedule 1 Vulnerable	Vulnerable
Leipoa ocellata *†Δ	Malleefowl	Schedule 1 Vulnerable	Vulnerable
Platycercus icterotis zanthogenys †Δ	Western Rosella	Schedule 1 Vulnerable	–
Falco peregrinus †Δ	Peregrine Falcon	Schedule 4	–
Morelia spilota imbricata Δ	Carpet Python	Schedule 4	–
Paroplocephalus atriceps †Δ	Lake Cronin Snake	Priority 3	–
Ardeotis australis Δ	Australian Bustard	Priority 4	–
Hylacola cauta whitlocki *†Δ	Shy Groundwren	Priority 4	–
Calamanthus campestris montanellus †	Rufous Fieldwren	Priority 4	–
Falcunculus frontatus leucogaster	Western Shrike-tit	Priority 4	–
Oreoica gutturalis gutturalis *†Δ	Crested Bellbird	Priority 4	–
Pomatostomus superciliosus ashbyi *†Δ	White-browed Babbler	Priority 4	–
Macropus irma †Δ	Western Brush Wallaby	Priority 4	–
Pseudomys occidentalis Δ	Western Mouse	Priority 4	–
Acanthiza iredalei iredalai	Slender-billed Thornbill	–	Vulnerable
Apus pacificus	Fork-tailed Swift	Schedule 3	Migratory
Merops ornatus †	Rainbow Bee-eater	Schedule 3	Migratory
Ardea modesta	Eastern Great Egret	Schedule 3	Migratory
Ardea Ibis	Cattle Egret	Schedule 3	Migratory

* Denotes species recorded in the Spotted Quoll Haul Road study area during this survey.

† Denotes species recorded in the area during other surveys by Biota.

Δ Denotes species recorded in DEC's threatened and priority fauna database and the NatureMap database (see Appendix 1 and Appendix 2).

The species of listed conservation significance recorded from the study area, and others with the potential to occur, are discussed individually in the following sections.

6.2.1 Schedule One Species

- **Short-billed (Carnaby's) Black-Cockatoo – *Calyptorhynchus latirostris*:** Endangered under the State *Wildlife Conservation Act 1950-1979* and Endangered under the Federal *EPBC Act 1999*.

  Distribution: This species has declined since the 1940s, primarily due to widespread clearing of semiarid sandplains. It remains endemic to the southwest of Western Australia from Kalbarri to Esperance. Lake Cronin marks the easternmost distribution of this species in the locality of the current study area (Johnstone and Storr 1998).

  Ecology: Carnaby's Black-Cockatoo is a post-nuptial nomad, tending to move coastward after breeding (Johnstone and Storr 1998). It is considered uncommon to common within most of its range, but scarce and patchily distributed in the driest parts of its range. Salmon Gum comprises its principal nest tree species within the Wheatbelt.

  Likelihood of Occurrence: Three individuals were recorded flying overhead at site SQH04 during the current survey. This species was also recorded on past surveys at Forrestania (Biota 2006c, 2007a, 2007b and 2008b). Carnaby's Black-Cockatoo is also listed for the general region on the Birds Australia Atlas Database (Barrett et al. 2003) and the WA Museum

NatureMap. It is probably widespread throughout the study area on an occasional basis, primarily in woodland but also occurring in mallee. Breeding in the area would likely be confined to woodland, where large trees provide hollows of a suitable size (Biota 2008b).

Potential Impacts: The conservation status of this species is unlikely to be affected by development of the proposed haul road, however the potential exists to impact individuals if large trees containing nesting hollows are destroyed. In regards to the proposed Spotted Quoll Haul Road, this would include predominantly *Eucalyptus salmonophloia* (Salmon Gum).

- **Red-tailed Phascogale – *Phascogale calura*:**
  Endangered under the *Wildlife Conservation Act 1950-1979* and Endangered under the *EPBC Act 1999*.

  Distribution: Formerly widespread in woodland habitats in inland south and central Australia, this species is now restricted to mature remnant wandoo habitat in the southwestern Wheatbelt (Menkhorst and Knight 2001).

  Ecology: Red-tailed Phascogales are arboreal, often moving to the ground to feed. They are opportunistic feeders, eating invertebrates, small birds and small mammals. Males die shortly after the mating period in July. This species occurs in eucalypt woodlands but is most abundant where Rock Oak (*Allocasuarina huegeliana*) grows over a shrub layer on rocky substrates (Strahan 1995, Menkhorst and Knight 2001).

  Likelihood of Occurrence: Although not recorded during the current survey, the Red-tailed Phascogale is listed as occurring in the general area on the *EPBC Act 1999* Protected Matters report (Appendix 3) and is very cryptic. If present, this species is probably confined to the eucalypt woodlands.

  Potential Impacts: The conservation status of this species is unlikely to be affected by the proposed Spotted Quoll Haul Road.

- **Western Quoll / Chuditch – *Dasyurus geoffroii*:**
  Vulnerable under the *Wildlife Conservation Act 1950-1979* and Vulnerable under the *EPBC Act 1999*.

  Distribution: The Chuditch was formerly present across semi-arid southern Australia from southwest Western Australia to Western Queensland and New South Wales. It is now confined to sclerophyll and mallee remnants in southwest Western Australia (Menkhorst and Knight 2001).

  Ecology: This species is solitary and mostly nocturnal, and creates dens in burrows or hollow logs. It is a generalist predator, mating in April to July (Menkhorst and Knight 2001).

  Likelihood of Occurrence: One adult female and one sub-adult female were captured in cage traps at site SQH10C. This species is also recorded for the area on the WA Museum NatureMap and DEC Threatened Fauna Database. The Chuditch has a large home range and only occurs at very low densities; it is likely to utilise all habitats within the study area.

  Potential Impacts: The conservation status of this species is unlikely to be affected by the proposed haul road, however potential impacts to individuals may arise from habitat loss, and increased predation and competition from foxes and cats.

- **Heath Mouse – *Pseudomys shortridgei:***
  Vulnerable under the *Wildlife Conservation Act 1950-1979* and Vulnerable under the *EPBC Act 1999*.

  Distribution: The Heath Mouse occurs in widely separated populations. The Western Australian populations occur in the Ravensthorpe Range, Fitzgerald River National Park, and Dragon Rocks and Lake Magenta Nature Reserves.

  Ecology: The Heath Mouse is known to occupy variable habitats, preferring stands of scrub mallee and mixed scrub with *Banksia* on loamy soils. The species feeds on flowers, seeds, berries, grass stems and fungi (Strahan 1995, Menkhorst and Knight 2001).

Likelihood of Occurrence: The Heath Mouse was not recorded during the Spotted Quoll Haul Road fauna survey. This species has only been recorded as far north as Dragon Rocks Nature Reserve, about 60 km southwest of the study area (Menkhorst and Knight 2001), and is unlikely to occur in the study area. However, the complete distribution of this species is not well known in Western Australia and the study area does contain suitable habitat.

Potential Impacts: The conservation status of this species is unlikely to be affected by the proposed Spotted Quoll Haul Road, should it occur.

- **Malleefowl – *Leipoa ocellata*:**
  Vulnerable under the *Wildlife Conservation Act 1950-1979* and Vulnerable under the *EPBC Act 1999*.

  Distribution: The Malleefowl was once broadly distributed across the southern half of the Australian continent, but has undergone significant range reduction over several decades. It is now restricted to the southwest of Western Australia and southern areas of South Australia and New South Wales.

  Ecology: Considered uncommon and sedentary, the species typically has a large home range in woodlands or shrublands that have a deep layer of leaf litter, which the species uses to build nesting mounds. Mounds are up to 5 metres in diameter and 1.5 metres in height. Breeding occurs from September to April, with chicks emerging seven weeks after hatching.

  Likelihood of Occurrence: A recently disused nesting mound was recorded close to site SQH05 at 756157 mE, 6391568 mN. It is likely that this mound was used during the 2008/2009 breeding season. There are other records of active and inactive Malleefowl nesting mounds in the vicinity of the Spotted Quoll mine site and in the broader Forrestania locality (Biota 2009). This species is listed for the general region on the Birds Australia Atlas Database (Barrett et al. 2003), the WA Museum NatureMap and DEC Threatened Fauna Database.

  Potential Impacts: The conservation status of this species is unlikely to be affected by the construction and operation of the proposed Spotted Quoll Haul Road. However vegetation clearing has the potential to destroy nest mounds. Furthermore, increased traffic associated with the haul road could increase the risk of mortality of Malleefowl through collision with vehicles.

- **Western Rosella – *Platycercus icterotis xanthogenys:***
  Vulnerable under the *Wildlife Conservation Act 1950-1979*.

  Distribution: Endemic to Western Australia, this species occurs in the semi-arid southern interior.

  Ecology: Habitat and food sources consist mainly of *Eucalyptus* spp. and *Casuarina* spp. woodlands and scrub including Salmon Gum (Johnstone and Storr 1998). This species nests in tree hollows, with favoured nesting trees including Wandoo, Marri, Flooded Gum, York Gum and Salmon Gum. Nesting hollows are small, often a dry sprout leading into a green limb (Johnstone and Storr 1998).

  Likelihood of Occurrence: Although not observed during the Spotted Quoll Haul Road survey, the Western Rosella has been recorded during previous surveys in the vicinity (Biota 2006a, 2006c, 2007a and 2007b). This species is also recorded from the general region on the Birds Australia Atlas Database (Barrett et al. 2003) and the WA Museum NatureMap (Appendix 2). The subspecies is probably widespread in the area in woodland and, to a lesser extent, mallee; it is likely that the locality supports a significant population.

  Potential Impacts: Given the relatively small scale of proposed clearing and the breeding requirement of small tree hollows, the impact of the haul road on the Western Rosella is likely to be negligible. The conservation status of this species is therefore unlikely to be altered by the proposed haul road.

6.2.2 Schedule Four Species

- **Peregrine Falcon – *Falco peregrinus*:**
  Other Specially Protected Fauna under the *Wildlife Conservation Act 1950-1979*.

  Distribution: The Peregrine Falcon has an almost cosmopolitan distribution. The only subspecies in Australia (*F. p. macropus*) is widespread throughout Australia and Tasmania (Marchant and Higgins 1993). The Australian population has been estimated at 3,000 to 5,000 pairs (Cade 1982).

  Ecology: This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country. The availability of prey is apparently more important than habitat in determining its distribution. Home ranges are probably defended year round and are variable in size, though not typically less than 480 ha (Marchant and Higgins 1993). This species generally nests on cliffs (81% of nests Australia-wide), but also on stick nests (11%) and in tree hollows (8%). Breeding typically occurs from August to November (Johnstone and Storr 1998). Food comprises almost exclusively birds such as pigeons, parrots and passerines, which are captured in flight (Johnstone and Storr 1998). Mammals such as possums and rabbits have been recorded as rare prey items (Marchant and Higgins 1993).

  Likelihood of Occurrence: This species was not recorded during the Spotted Quoll Haul Road survey, however it is known to occur in the vicinity (Biota 2006c and 2007a; Appendix 2). The species is also listed for the general region on the Birds Australia Atlas Database (Barrett et al. 2003), the WA Museum NatureMap and DEC Threatened Fauna Database (Appendix 1 and Appendix 2). Home ranges of this species are large (Marchant and Higgins 1993), and the species probably occurs periodically in all habitats throughout the study area at low densities.

  Potential Impacts: In general, loss of potential nesting and foraging habitat comprise the main potential impacts. However, given the mobility of this species, its conservation status is unlikely to be affected by the construction of the Spotted Quoll Haul Road even if it occurs within the haul road footprint.

6.2.3 Priority Species

- **Lake Cronin Snake – *Paroplocephalus atriceps***
  Priority 3 under the *Wildlife Conservation Act 1950-1979*.

  Distribution: The Lake Cronin Snake has a restricted distribution, being confined to the vicinity of Lake Cronin and nearby Peak Elenora (Wilson and Swan 2008).

  Likelihood of Occurrence: This species was not captured during the Spotted Quoll Haul Road survey, however it has been recorded previously in the vicinity (Biota 2007b, Appendix 2).

  Potential Impacts: Given the relatively small scale of the proposed haul road project, it is very unlikely that the conservation status of this species would be altered by the proposed development.

- **Carpet Python – *Morelia spilota imbricata*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979*.

  Distribution: This subspecies inhabits temperate climatic areas with winter rains and dry summers; it occurs in southwest Western Australia (Cogger 1992).

  Ecology: The diet of the Carpet Python includes a variety of terrestrial invertebrates (lizards, birds and mammals). Females have a single ovulation in late spring to early summer, laying 14 to 35 eggs.

  Likelihood of Occurrence: No Carpet Pythons were captured during the current survey, however this species was recorded near the Flying Fox mine during the site inspection in 2005. NatureMap records also exist in the vicinity of the proposed haul road (Appendix 2). The lack of records during the fauna survey probably reflects the low densities at which this species occurs, combined with its cryptic behaviour. The species would be expected to occur at a low density in most, if not all, habitats within the study area.

Potential Impacts: Loss of habitat from land clearing has negatively impacted this subspecies, while the role of predation by feral predators (foxes and cats) remains unknown. Construction of the proposed haul road has the potential to impact individual carpet pythons, however the overall conservation status of this species is unlikely to be altered by the proposed development.

- **Australian Bustard – *Ardeotis australis*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979* and classified as Near-Threatened by Garnett and Crowley (2000).

  Distribution: The Australian Bustard occurs over much of Western Australia, with the exception of the more heavily wooded southern portions of the state (Johnstone and Storr 1998). Its wider distribution includes eastern Australia and New Guinea.

  Ecology: This species prefers open or lightly wooded grassland, including *Triodia* spp. sand plains (Johnstone and Storr 1998), and is considered scarce to common depending on season and habitat. It has an omnivorous diet and occurs in a relatively broad range of habitats, but appears to have some preference for grasshoppers and is often attracted to recently burnt areas (Marchant and Higgins 1993). Bustards breed from March to September and the eggs are laid on bare, preferably stony, ground (Johnstone and Storr 1998). The species tends to be nomadic, moving between good foraging areas such as mulga flats after heavy rainfall (Johnstone and Storr 1998).

  Likelihood of Occurrence: The Australian Bustard was not sighted during the current survey, but has been recorded in the locality according to the NatureMap database; it is likely to occur within the Spotted Quoll Haul Road study area. This species typically inhabits low shrublands and grasslands, and is particularly attracted to burnt areas (Marchant and Higgins 1993). In the study area, it probably occurs in heaths and open areas with a sparse understorey.

  Potential Impacts: Given its distribution and mobility, the conservation status of this species would not be affected by construction of the proposed Spotted Quoll Haul Road.

- **Shy Groundwren – *Hylacola cauta whitlocki*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979* and classified as Near-Threatened by Garnett and Crowley (2000).

  Distribution: This species is restricted to the semi-arid interior of southwest Western Australia.

  Ecology: The Shy Groundwren inhabits shrublands, including the understorey of eucalypt woodlands and scrubs (Johnstone and Storr 2004). This species feeds predominantly on insects and breeds from July to October.

  Likelihood of Occurrence: The Shy Groundwren was recorded on 10 occasions at sites SQH03, SQH05, SQH06, SQH07. This species was also recorded during previous surveys at Forrestania (Biota 2006a, 2006c, 2007a and 2007b), and is recorded for the general region in the Birds Australia Atlas Database (Barrett et al. 2003).

  Potential Impacts: The conservation status of this species would not be affected by the construction of the Spotted Quoll Haul Road.

- **Rufous Fieldwren – *Calamanthus campestris montanellus*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979* and classified as Near-Threatened by Garnett and Crowley (2000).

  Distribution: The Rufous Fieldwren occurs in low shrublands of the southern semiarid zone and also up the arid west coast to the North West Cape (Johnstone and Storr 2004).

  Ecology: This subspecies typically inhabits saltbush, samphire and heaths (Higgins and Peter 2002). It is common near the west and south coasts, and forages in low vegetation, with the diet consisting predominantly of insects.

  Likelihood of Occurrence: Although not recorded during the Spotted Quoll Haul Road survey, this species has been recorded elsewhere at Forrestania (Biota 2007a, Appendix 2). It is also

listed for the general region in the Birds Australia Database (Barrett et al. 2003) and the WA Museum NatureMap.

Potential Impacts: The conservation status of this species is unlikely to be affected by the construction of the proposed haul road.

- **Western Shrike-tit – *Falcunculus frontatus leucogaster*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979* and classified as Near-Threatened by Garnett and Crowley (2000).

  Distribution: The Western Shrike-tit occurs mainly in the southern subhumid and semiarid interior of southwest Western Australia.

  Ecology: This species inhabits woodlands, scrubs and more open forests of *Eucalyptus* species including Salmon Gum (Johnstone and Storr 2004, Higgins and Peter 2002). This subspecies is generally scarce or rare, but can be locally common. It has a mainly insectivorous diet.

  Likelihood of Occurrence: Although not recorded during this survey, the Western Shrike-tit is listed for the general region in the Birds Australia Atlas Database (Barrett et al. 2003). The species typically occurs in eucalypt woodland (Higgins and Peter 2002), hence it could occur in these habitats in the study area. It may also occur occasionally in stands of Gimlet (*Eucalyptus salubris*).

  Potential Impacts: The conservation status of this species is unlikely to be affected by the proposed Spotted Quoll Haul Road development.

- **Crested Bellbird – *Oreoica gutturalis gutturalis*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979* and classified as Near-Threatened by Garnett and Crowley (2000).

  Distribution: This species is distributed across the greater part of Western Australia excluding the wettest regions.

  Ecology: The Crested Bellbird inhabits most types of scrub and thicket. It is moderately common in the arid zone, but scarce and patchily distributed in wetter country (Johnstone and Storr 2004). This is a mainly insectivorous species.

  Likelihood of Occurrence: This species was recorded on three occasions during the Spotted Quoll Haul Road survey. It has also been recorded elsewhere in the vicinity (Biota 2006a, 2006c and 2007a), and is listed for the area on the Birds Australia Atlas Database (Barrett et al. 2003). As this subspecies inhabits woodland, mallee and *Acacia* shrublands (Higgins and Peter 2002), it is probably widespread throughout the study area at low densities.

  Potential Impacts: The conservation status of this species is unlikely to be affected by the construction of the proposed haul road.

- **White-browed Babbler (Western Wheatbelt) – *Pomatostomus superciliosus ashbyi*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979*.

  Distribution: This species occurs mainly in the arid and semiarid zones south of the Tropic of Capricorn.

  Ecology: The White-browed Babbler prefers to inhabit the edges of most types of thicket and scrub (Johnstone and Storr 2004), and is mainly insectivorous. The taxon is in decline due to extensive habitat clearing for agriculture, however it persists in large patches of continuous older-aged habitat that surround the Wheatbelt.

  Likelihood of Occurrence: Five individuals were recorded during the Spotted Quoll Haul Road survey, and this species was also observed nearby during previous studies (Biota 2006a, 2007a and 2007b). It is recorded for the locality on the WA Museum NatureMap, DEC Threatened Fauna Database (Appendix 2) and the Birds Australia Atlas Database (Barrett et al. 2003). This subspecies is typically found in *Eucalyptus* forests and woodlands, mallee and tree-lined inland watercourses.

Potential Impacts: The conservation significance of this subspecies is unlikely to be affected by development of the proposed Spotted Quoll Haul Road.

- **Western Brush Wallaby – *Macropus irma*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979*.

  Distribution: The Western Brush Wallaby is distributed across the southwest of Western Australia, from north of Kalbarri to Cape Arid (Strahan 1995).

  Ecology: This species inhabits predominantly open forest or woodland, but is also found in mallee and heath habitat. The Western Brush Wallaby is a grazer.

  Likelihood of Occurrence: The Western Brush Wallaby was not recorded during the recent Spotted Quoll Haul Road survey, however it has been directly observed during previous surveys in the area (Biota 2006a, 2006c, 2007a and 2007b). *M. irma* is also recorded for the area on the WA Museum NatureMap and DEC Threatened Fauna Database (Appendix 1 and Appendix 2). This species is typically recorded in open woodlands with grassy understorey for foraging and thickets of shrubs for resting (Strahan 1995, Menkhorst and Knight 2001).

  Potential Impacts: A decline in numbers of the Western Brush Wallaby since the 1970s has been attributed to increased fox numbers and predation. The conservation status of this species would not be affected by the construction of the proposed haul road.

- **Western Mouse – *Pseudomys occidentalis*:**
  Priority 4 under the *Wildlife Conservation Act 1950-1979*.

  Distribution: The Western Mouse was formerly distributed in a narrow band across southwest Western Australia and the Nullarbor Plain. The species is now confined to the Ravensthorpe Range, Fitzgerald River National Park and small reserves in the southern Wheatbelt (Menkhorst and Knight 2001).

  Ecology: This species inhabits shrublands on loam soils, and all occupied areas are characterised by an extremely dense shrub layer between 0.5 and 2.5 m in height (Strahan 1995, Menkhorst and Knight 2001). Its diet includes fibrous plant material and invertebrates. Young are born from mid to late spring.

  Likelihood of Occurrence: This species was not recorded during the Spotted Quoll Haul Road fauna survey, however it is recorded for the region on the WA Museum NatureMap and DEC Threatened Fauna Database (Appendix 2). This species has the potential to occur in the study area, although its preferred core habitat is not present.

  Potential Impacts: Habitat destruction and altered fire regimes that remove old growth habitat constitute the main threatening processes for this species. However, the conservation status of this species is unlikely to be affected by the proposed haul road construction, given the relatively small scale of the project.

- **Slender-billed Thornbill – *Acanthiza iredalei iredalai***
  Vulnerable under the Federal *EPBC Act 1999*.

  Distribution: In the southern arid zone the Slender-billed Thornbill has a disjunct distribution and is not known to occur within 200km of the Forrestania (Johnston and Storr 2004, and NatureMap Database).

  Ecology: The Slender-billed Thornbill usually occurs in chenopod shrublands that are dominated by samphires or Bluebush *Maireana sedifolia* and Saltbush Atriplex spp. (Johnston and Storr 2004).

  Likelihood of Occurrence: Given the known distribution and habitat preferences, this species is unlikely to occur within the study area.

  Potential Impacts: The proposed Spotted Quoll Haul Road is unlikely to impact individual Slender-billed Thornbills and will not affect the conservation significance of this species.

6.2.4 Migratory Species

The Fork-tailed Swift (*Apus pacificus*), Rainbow Bee-eater (*Merops ornatus*), Eastern Great Egret (*Ardea Modesta),* and Cattle Egret (*Ardea ibis*) are listed as migratory species under the *EPBC Act 1999*. In addition, the Fork-tailed Swift, Eastern Great Egret and Cattle Egret are listed under the China-Australia Migratory Bird Agreement (CAMBA) and the Japan-Australia Migratory Bird Agreement (JAMBA), while the Rainbow Bee-eater is listed under JAMBA.

The Fork-tailed Swift was not recorded during the survey (or past surveys conducted by Biota) and is not listed for the general region on any of the avifauna databases. However, the occurrence of this species is extremely patchy on both a temporal and spatial basis; it would probably occur in the study area at irregular intervals, and would be likely over all habitats.

Similarly, the Eastern Great Egret and Cattle Egret were not recorded during the survey. The Eastern Great Egret preferred habitat comprises shallow fresh water such as river pools, lakes, large dams and sewage ponds (Johnstone and Storr 1998). Although such habitats may be found in the vicinity, none are present in the study area itself.

The Cattle Egret is a casual visitor to most of Western Australia, preferring well-watered areas such as damp pastures and wetlands (Johnstone and Storr 1998), again habitats that are not represented within the study area.

The Rainbow Bee-eater was not recorded during the current survey, however it has been recorded during earlier survey phases within the Flying Fox study area (Biota 2006a and 2006c). This species is also listed for the general region on the Birds Australia Atlas Database (Barrett et al. 2003). It forages on aerial insects and nests in burrows in the ground (Higgins 1999). It probably occurs in most habitats in the study area that provide suitable soil for nesting and a tall stratum of vegetation for perching.

Given the mobility of these species, there would be no alteration to their conservation status following implementation of the proposed haul road development.

6.3 Invertebrate Short Range Endemics

Nine potential SRE taxa (eight mygalmorph spiders and one pseudoscorpion; see Section 5.7) were recorded within the Spotted Quoll Haul Road study area. Of these, three taxa were also recorded outside of the study area boundary at other locations in the vicinity of the proposed Spotted Quoll Haul Road and/or in the broader Forrestania area (*Aganippe* sp., *Eucyrtops* sp. and *Haplochernes* sp.; Table 6.2). As a result construction of proposed haul road is unlikely to impact the conservation significance of these taxa.

It should be noted that although a number of specimens of the mygalomorph family Nemesiidae were recorded in previous surveys (Biota 2007a, 2007b), molecular analysis of these specimens has not yet been conducted and as a result it remains undetermined whether the Nemesiidae taxa recorded with the Spotted Quoll Haul Road study area are also represented outside this study area.

However, it is unlikely that the Nemisiidae species recorded during the survey are localised solely to the area that will be cleared during construction of the proposed haul road. The narrow and relatively small nature of the proposed haul road (approximately 140 ha comprising 34% of the study area), in conjunction with the occurrence of representative habitat outside the Spotted Quoll Haul Road study area (Biota 2006a, 2006b, 2006c, 2007a and 2007b) indicates that there is a high likelihood that the populations of Nemesiidae species recorded will not be impacted by the proposed haul road.

Table 6.2: Potential SRE invertebrates recorded with the Spotted Quoll Haul Road study area.

Order / Infraorder Family	**Species**	**Recorded during the Spotted Quoll Haul Road survey**		**Recorded during unrelated surveys**
		inside study area	**outside study area**	**outside study area**
Mygalomorphae				
Nemesiidae	*Aname/Chenistonia* Lineage K	Yes	No	Undetermined
Nemesiidae	*Aname/Chenistonia* Lineage L	Yes	No	Undetermined
Nemesiidae	*Aname/Chenistonia* Lineage M	Yes	No	Undetermined
Nemesiidae	*Aname/Chenistonia* Lineage N	Yes	No	Undetermined
Nemesiidae	*Aname/Chenistonia* Lineage O	Yes	No	Undetermined
Nemesiidae	*Aname/Chenistonia* Lineage P	Yes	No	Undetermined
Idiopidae	*Aganippe* sp.	Yes	No	Wider Forrestania region and Mt. Jackson[1]
Idiopidae	*Eucyrtops* sp.	Yes	No	Wider Forrestania region[1]
Pseudoscorpionida				
Chernetidae	*Haplochernes* sp.	Yes	No	Flying Fox[2] Digger Rocks[3]

1 = Report on molecular systematics of the Mygalomorph spiders from Forrestania (Helix Molecular Solutions 2010);
2 = Forrestania Monitoring Survey, Flying Fox Phases III and IV (Biota 2007a);
3 = Diggers South Fauna Survey - Phase I (Biota 2007b).

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7.0 Potential Impacts and Management

7.1 Generic Impacts and Management

The generic impacts that are typically associated with habitat clearing are outlined below. These include:

1. Fauna habitat disturbance and modification resulting directly from habitat clearing; and
2. Indirect fauna habitat disturbance and modification including changes to noise levels, weed introduction or spread, and feral animal spread.

7.1.1 Direct Loss of Habitat

It is considered unlikely that the development of the proposed Spotted Quoll Haul Road will affect the conservation status of the Schedule 1 taxa (see Section 6.2) occurring or potentially occurring in the study area. This is indicated by the narrow and relatively small nature of the proposed haul road (approximately 140 ha), in conjunction with the occurrence of representative habitat outside the Spotted Quoll Haul Road study area (Biota 2006a, 2006b, 2006c, 2007a and 2007b). That is, schedule 1 species potentially impacted by the haul road construction also occur outside the impact area in relatively large numbers.

7.1.2 Direct Loss of Individual Fauna

It is inevitable that there will be some localised loss of fauna due to direct mortality arising from habitat clearing. Ongoing impacts may also arise from more frequent vehicle movements, haulage movements and machinery operation. It is unlikely that the loss of individuals associated with such direct mortalities would be significant enough to affect the overall conservation status of any of the species recorded from the study area.

We have not fully established the distribution of all potential SRE taxa recorded from the study area to determine whether impacts may be significant (specifically mygalomorph spiders of the family Nemesiidae). However, studies indicate that the habitat type in which mygalomorph spiders occur is widespread (Biota 2006a, 2006b, 2006c, 2007a and 2007b; see Section 6.3).

Despite this, in relation to both habitat loss and direct loss of fauna, it should be noted that cumulative effects of a variety of disturbances in the region may impact negatively on some species (eg. mining proposals, road construction and maintenance, wildfires, increased road usage, and feral animals).

7.1.3 Noise

Noise from road construction may impact on fauna. However, we did not record any particularly sensitive habitats or communities within the study area that may be at particular risk (eg. there were no recorded significant bat roosts or breeding populations of birds).

7.1.4 Weed Spread

Ground disturbance associated with construction of the proposed haul road in addition to vehicular traffic provides an opportunity for the infiltration and spread of weeds. The consequences of weed infiltration on the biodiversity of fauna are not well documented, however precautions should be taken to prevent the introduction or spread of weeds.

7.1.5 Feral Animal Spread

Ground disturbance and construction of roads or tracks offer opportunities for the spread of

feral animals that use these disturbances as pathways for travel. Feral animals may be predators or competitors of native fauna, and their spread should be kept to a minimum. Western Areas NL has implemented a feral animal control program at Forrestania since 2006.

7.2 Recommendations

Based on the nature of the proposed Spotted Quoll Haul Road project, the following management recommendations apply:

7. Western Areas NL should minimise vegetation clearing wherever practicable, thereby reducing the loss of fauna habitat. Potential nesting hollows for Carnaby's Black-Cockatoos and Western Rosellas should be retained.

8. Vehicle speed along the haul road should be limited to minimise the chance for road kill of fauna, particularly Malleefowl. Site inductions and signs should highlight the potential presence of rare fauna in the locality.

9. The risk of predation (by cats and foxes) and habitat degradation (by rabbits) should be reduced by continued implementation of a feral animal-control baiting programme (specifically targeting foxes, cats and rabbits, as outlined in Benshemesh (2000)), throughout Western Areas' operations.

10. Trapping and baiting was first undertaken in December 2006. Following assessment of the outcome of the initial program it was determined that baiting and trapping on an annual basis would provide adequate control of feral animals at the target sites. In addition, Western Areas NL, where possible will help to maintain the existing wild dog control program currently undertaken in the area by the Department of Agriculture and the Department of Environment and Conservation.

11. Fire threats should be reduced by implementing a Fire Management Plan for all Western Areas' operations, with a focus on minimising the spread of large fires and promoting patchier burns if fire does occur, as outlined in Benshemesh (2000).

12. Given the records of species listed as Threatened fauna under the EPBC Act 1999, Western Areas should consider its obligations to refer the proposed action of constructing the haul road to the Department of the Environment, Water, Heritage and the Arts (DEWHA), to determine if this represents a Controlled Action under that act.

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Appendix 1

DEC Threatened Fauna Database Search Results

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32.1765 °S 119.2917 °E / 32.8907 °S 120.1269 °E Forrestania study area (plus ~40km buffer) #3010

*	Date	Certainty	Seen	Location Name	Method
Falco peregrinus				**Peregrine Falcon**	*1 records*
This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.					
	1991	1	1	Lake Cronin Nature Reserve	Day sighting
Morelia spilota imbricata				**Carpet Python**	*1 records*
This species occurs in a variety of habitats including forest and heathland. It is often arboreal and preys on birds, other reptiles and small to medium size mammals. This species is listed under both Schedule 4 and Priority 4.					
	2005	1	1	Forrestania	Day sighting
Priority Four: Taxa in need of monitoring					
Macropus irma				**Western Brush Wallaby**	*8 records*
This species occurs in areas of forest and woodland supporting a dense shrub layer.					
	1969	1	3	Lake Varley Nature Reserve	Day sighting
	1998	1	1	Forrestania	Day sighting
	2005	1	1	Forrestania	Day sighting
	2006	1	0	Forrestania	Tracks
	2006	1	0	Forrestania	Tracks
	2006	1	0	Forrestania	Tracks
	2006	1	4	Forrestania	Caught or trapped
	2006	1	1	Forrestania	Caught or trapped
Pseudomys occidentalis				**Western Mouse**	*2 records*
This species occurs most frequently in areas of long-unburnt vegetation on sandy clay or loam with a matrix of gravel. It is known to feed on the seeds of quandong (Santalum acuminatum) and various sedge species.					
		1		Hatter Hill	
	1995	1	1	Dragon Rocks Nature Reserve	Caught or trapped
Ardeotis australis				**Australian Bustard**	*1 records*
This species is uncommon and may occur in open or lightly wooded grasslands.					
	1983	1	4	Hyden/Forrestania	Day sighting
Hylacola cauta whitlocki				**Shy Heathwren (western ssp)**	*10 records*
This species is an uncommon resident in mallee undergrowth.					
	2005	1	4	Forrestania	Day sighting
	2005	1	2	Forrestania	Day sighting
	2005	1	3	Forrestania	Day sighting
	2005	1	2	Forrestania	Day sighting
	2005	1	2	Forrestania	Day sighting
	2006	1	4	Forrestania	Day sighting
	2006	1	6	Forrestania	Day sighting
	2006	1	1	Forrestania	Day sighting
	2006	1	3	Forrestania	Day sighting
	2006	1	1	Forrestania	Caught or trapped

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32.1765 °S 119.2917 °E / 32.8907 °S 120.1269 °E Forrestania study area (plus ~40km buffer) #3010

• Date	Certainty	Seen	Location Name	Method
Oreoica gutturalis gutturalis			**Crested Bellbird (southern)**	*9 records*
This sedentary and solitary species inhabits the drier mallee woodlands and heaths of the southern parts of the State.				
1983	1		Hyden/Forrestania	Day sighting
2005	1	1	Forrestania	Day sighting
2005	1	1	Forrestania	Day sighting
2005	1	1	Forrestania	Day sighting
2005	1	1	Forrestania	Day sighting
2005	1	2	Forrestania	Day sighting
2005	1	1	Forrestania	Day sighting
2006	1	2	Forrestania	Day sighting
2006	1	3	Forrestania	Day sighting
Pomatostomus superciliosus ashbyi			**White-browed Babbler (western wheatbe**	*7 records*
This species of bird lives in eucalypt forests and woodlands, and forages on or near the ground for insects and seeds.				
1982	1		Lake Hurlstone Nature Reserve	Day sighting
1982	1		Tupper Road Nature Reserve	Day sighting
1983	1		Hyden/Forrestania	Day sighting
2005	1	6	Forrestania	Day sighting
2005	1	4	Forrestania	Day sighting
2005	1	6	Forrestania	Day sighting
2006	1	6	Forrestania	Caught or trapped
Morelia spilota imbricata			**Carpet Python**	*1 records*
This species occurs in a variety of habitats including forest and heathland. It is often arboreal and preys on birds, other reptiles and small to medium size mammals. This species is listed under both Schedule 4 and Priority 4.				
2005	1	1	Forrestania	Day sighting

- Information relating to any records provided for listed species:-
  Date: date of recorded observation
  Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
  Seen: Number of individuals observed.
  Location Name: Name of reserve or nearest locality where observation was made
  Method: Method or type of observation

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Threatened and Priority Fauna Database Page 1 of 3

32.1765 °S 119.2917 °E / 32.8907 °S 120.1269 °E Forrestania study area (plus ~40km buffer) #3010

* Date	Certainty	Seen	Location Name	Method
Schedule 1 - Fauna that is rare or is likely to become extinct				
Dasyurus geoffroii		**Chuditch**		*3 records*
This carnivorous marsupial occupies large home ranges, is highly mobile and appears able to utilise bush remnants and corridors.				
2005	1	1	Forrestania	Caught or trapped
2009	1	1	Hyden	Dead
2009	1	1	Hyden/Forrestania	Caught or trapped
Leipoa ocellata		**Malleefowl**		*5 records*
This species was once widely distributed across southern Australia. It prefers woodland or shrubland with an abundant litter layer that provides essential material for the construction of its nest mound.				
1995	1	16	Varley/Mount Sheridan	Day sighting
1996	1	1	Un-named Nature Reserve	Day sighting
2006	1	0	Forrestania	Definite signs
2006	1	1	Forrestania	Day sighting
2006	1	1	Forrestania	Caught or trapped
Calyptorhynchus latirostris		**Carnaby's Black-Cockatoo**		*8 records*
This species moves around seasonally in flocks to feeding areas in proteaceous scrubs and heaths and eucalypt woodlands as well as pine plantations. Breeding occurs in winter/spring, mainly in the eastern forests and wheatbelt where they can find mature hollow-bearing trees to nest in.				
1938	1		MUNGLINUP	Day Sighting
1979	1		FORRESTANIA	
1981	1		FORRESTANIA	
1983	1	2	FORRESTANIA	Day Sighting
2005	1	6	Forrestania	Day sighting
2006	1	20	Forrestania	Caught or trapped
2006	1	4	Forrestania	Caught or trapped
2006	1	3	Forrestania	Caught or trapped
Platycercus icterotis xanthogenys		**Western Rosella (inland ssp)**		*11 records*
This subspecies of the Western Rosella occurs in eucalypt and casuarina woodlands and scrubs, especially of Salmon Gum and tall mallees.				
1969	1	1	Lake Varley Nature Reserve	Day sighting
1983	1		Varley/Forrestania	Day sighting
1991	1	2	Lake Cronin Nature Reserve	Day sighting
1991	1	3	Lake Cronin Nature Reserve	Day sighting
2005	1	1	Forrestania	Day sighting
2005	1	7	Forrestania	Day sighting
2005	1	1	Forrestania	Day sighting
2006	1	4	Forrestania	Day sighting
2006	1	2	Forrestania	Caught or trapped
2006	1	1	Forrestania	Caught or trapped
2007	1	2	Lake Cronin Nature Reserve	Day sighting
Schedule 4 - Other specially protected fauna				

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Appendix 2

Western Australian Museum NatureMap Search: Comparison with Spotted Quoll Haul Road Fauna and Previous Surveys in the Vicinity

Comparison of herpetofauna recorded during the Spotted Quoll haul road, Flying Fox Phase I &II, Flying Fox Phase III & IV, Forrestania Water Disposal Pipeline, Diggers South surveys and herpetofauna collected by the Western Australian Museum (WAM) in a 40km radius buffer from 32°32' 10" S; 119°42' 40" E.

Herpetofauna- Total species = 60

Family *Species name*	Spotted Quoll haul road (single phase)	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline (single phase)	Diggers South (single phase)	WAM
Hylidae						
Litoria cyclorhyncha						X
Myobatrachidae						
Crinia pseudinsignifera			X			X
Heleioporus albopunctatus					X	X
Limnodynastes dorsalis						X
Neobatrachus albipes						X
Neobatrachus kunapalari						X
Neobatrachus pelobatoides						X
Neobatrachus sutor						X
Neobatrachus sp.						
Pseudophryne guentheri						X
Pseudophryne occidentalis			X	X		X
Gekkonidae				X		
Gehyra variegata	X	X	X	X		X
Diplodactylidae						
Crenadactylus ocellatus	X	X	X		X	X
Diplodactylus granariensis	X	X	X	X	X	X
Diplodactylus pulcher		X			X	X
Lucasium maini	X	X	X	X	X	X
Strophurus spinigerus			X	X		X
Oedura reticulata		X			X	X
Carphodactylidae						
Nephrurus milii	X				X	X
Pygopodidae				X		
Delma australis		X			X	X
Delma fraseri	X	X			X	X
Lialis burtonis	X	X		X		X
Pygopus lepidopodus		X				X
Scincidae						
Cryptoblepharus buchananii	X	X	X		X	X
Cyclodomorphus melanops subsp. *Elongatus*						X
Ctenotus atlas						X
Ctenotus impar		X			X	X
Ctenotus schomburgkii	X	X	X		X	X
Egernia inornata						X
Egernia richardi		X			X	X
Egernia multiscutata			X			X
Hemiergis initialis	X	X		X	X	X
Heniergis peronii						X

Family *Species name*	Spotted Quoll haul road (single phase)	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline (single phase)	Diggers South (single phase)	WAM
Lerista distinguenda	X				X	X
Lerista dorsalis			X	X		
Lerista picturata	X	X				X
Menetia greyii					X	X
Morethia butleri						X
Morethia obscura	X	X	X	X	X	X
Tiliqua occipitalis			X	X	X	X
Tiliqua rugosa	X	X	X		X	
Agamidae						
Ctenophorus cristatus	X	X	X		X	X
Cteophotus ornatus						X
Ctenophorus maculatus	X	X	X		X	X
Ctenophorus salinarum						X
Moloch horridus		X		X		X
Pogona minor	X	X	X			X
Rankinia adelaidensis		X		X		
Varanidae						
Varanus gouldii	X		X		X	X
Varanus rosenbergi					X	
Typhlopidae						
Ramphotyphlops australis	X	X	X			X
Pythonidae						X
Morelia spilota subsp. *Imbricata* (Priority 4)						X
Elapidae						
Echiopsis curta					X	X
Neelaps bimaculatus						X
Paraplocephalus atriceps (Priority 3)					X	X
Parasuta gouldii		X	X			X
Parasuta nigriceps		X		X		X
Pseudonaja affinis	X	X	X		X	X
Simoselaps bertholdi	X	X			X	X
Total number of species	**21**	**28**	**21**	**15**	**27**	**55**

Avifauna- Total species = 86

Family *Species name*	Common name	Spotted Quoll haul road PI	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline PI	Diggers South PI	WAM
Casuariidae							
Dromaius novaehollandiae	Emu	X	X	X	X	X	
Megapodidae							
Malleefowl (Schedule 1-vulnerable)	*Leipa ocellata*	X			X	X	X
Turnicidae							
Turnix velox	Little Button-quail	X		X			
Anatidae							
Stictonetta naevosa	Freckled Duck						X
Otididae							
Ardeotis australis (Priority 4)	Australian Bustard						X
Scolopacidae							
Calidris acuminata	Sharp-tailed Sandpiper						X
Accipitridae							
Hamirostra isura	Square-tailed Kite		X	X		X	
Accipiter cirrhocephalus	Collared Sparrowhawk		X	X			
Aquila audax	Wedge-tailed Eagle	X	X	X	X		
Aquila morphnoides	Little Eagle					X	
Falconidae			X				
Falco cenchroides	Australian Kestrel		X	X		X	
Falco peregrinus macropus (Schedule 4)	Peregrine Falcon			X	X		X
Falco berigora	Brown Falcon		X	X	X	X	
Columbidae							
Phaps chalcoptera	Common Bronzewing	X	X	X	X		
Phaps elegans	Brush Bronzewing		X	X		X	
Psittacidae							
Glossopsitta porphyrocephala	Purple crowned Lorikeet		X	X	X	X	
Neophema elegans	Elegant Parrot	X	X	X		X	
Platycercus icterotis (Schedule 1-vulnerable)	Western Rosella		X	X	X	X	X
Polytelis anthopeplus	Regent Parrot	X	X	X	X		
Platycercus varius	Mulga Parrot	X					
Platycercus zonarius	Australian Ringneck	X	X	X	X	X	

Family *Species name*	Common name	Spotted Quoll haul road PI	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline PI	Diggers South PI	WAM
Cacatuidae							
Cacatua roseicapilla	Galah		X	X	X		
Calyptorhynchus latirostris (Schedule 1-endangered)	Carnaby's Cockatoo	X	X	X		X	X
Cuculidae							
Cacomantis flabelliformis	Fan-tailed Cuckoo			X	X	X	
Chrysococcyx lucidus	Shining Bronze Cuckoo			X			
Cuculus pallidus	Pallid Cuckoo	X					
Podargidae							
Podargus strigoides	Tawny Frogmouth		X		X		
Aegothelidae							
Aegotheles cristatus	Australian Owlet-Nightjar		X				
Caprimulgidae							
Eurostopodus argus	Spotted Nightjar			X	X		
Meropidae							
Merops ornatus	Rainbow Bee-eater		X		X		
Climacteridae							
Climacteris rufa	Rufous Treecreeper		X			X	
Neositidae							
Daphoenositta chrysoptera	Varied Sittella				X	X	
Maluridae							
Malurus pulcherrimus	Blue-breasted Fairy-wren	X	X	X		X	
Stipiturus malachurus	Southern Emu-Wren		X	X			
Pardalotidae							
Pardalotus punctatus	Spotted Pardalote	X	X		X		
Pardalotus striatus	Striated Pardalote		X		X		
Acanthizidae							
Acanthiza apicalis	Broad-tailed Thornbill	X	X	X	X	X	X
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		X	X	X		
Acanthiza uropygialis	Chestnut-rumped Thornbill			X			
Calamanthus campestris	Rufous Fieldwren			X			X
Gerygone fusca fusca	Western Gerygone			X	X		
Hylacola cauta whitlocki (Priority 4)	Shy Groundwren	X	X	X	X	X	X
Pyrrholaemus brunneus	Redthroat		X	X	X	X	

Family *Species name*	Common name	Spotted Quoll haul road PI	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline PI	Diggers South PI	WAM
Pardalotus punctatus	Spotted Pardalote			X			X
Pardalotus striatus	Striated Pardalote			X		X	
Smicrornis brevirostris	Weebill	X	X	X	X	X	
Meliphagidae							
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		X	X	X		
Anthochaera carunculata	Red Wattlebird	X	X	X	X	X	
Lichenostomus cratitius	Purple-gaped Honeyeater		X	X	X	X	
Lichenostomus leucotis	White-eared Honeyeater	X	X	X	X	X	
Lichmera indistincta	Brown Honeyeater	X	X	X		X	
Lichenostomus virescens	Singing Honeyeater	X	X	X	X		
Lichenostomus plumulus	Grey-fronted Honeyeater			X			
Lichenostomus ornatus	Yellow-plumed Honeyeater	X	X	X	X	X	
Manorina flavigula	Yellow-throated Miner		X				X
Melithreptus brevirostris	Brown-headed Honeyeater	X	X	X	X	X	
Phylidonyris albifrons	White-fronted Honeyeater	X	X	X		X	
Phylidonyris melanops	Tawny-crowned Honeyeater		X	X	X	X	
Phylidonyris nigra gouldii	White-cheeked Honeyeater			X	X	X	
Phylidonyris novaehollandiae	New Holland Honeyeater				X	X	
Cinclosomatidae							
Cinclosoma castanotus	Chestnut Quail-Thrush		X	X	X	X	
Pomatostomidae							
Pomatostomus superciliosus ashbyi (Priority 4)	White-browed Babbler	X	X	X		X	X
Petroicidae							
Drymodes brunneopygia	Southern Scrub-Robin	X	X	X	X		X
Eopsaltria griseogularis	Western Yellow Robin	X	X	X	X		
Microeca fascinans	Jacky Winter	X	X	X			
Petroica cucullata	Hooded Robin			X	X		
Petroica goodenovii	Red-capped Robin	X				X	
Pachycephalidae							
Colluricincla harmonica	Grey Shrike-Thrush	X	X	X	X	X	

Family *Species name*	Common name	Spotted Quoll haul road PI	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline PI	Diggers South PI	WAM
Oreoica gutturalis gutturalis (Priority 4)	Crested Bellbird	X	X	X	X		X
Pachycephala pectoralis	Golden Whistler	X	X	X	X	X	
Pachycephala rufiventris	Rufous Whistler	X					
Dicruridae							
Grallina cyanoleuca	Magpie-lark	X				X	
Rhipidura leucophrys	Willie Wagtail		X	X	X	X	
Rhipidura fuliginosa	Grey Fantail		X				
Campephagidae				X			
Coracina novaehollandiae	Black-faced Cuckoo-Shrike	X	X	X	X	X	
Lalage suerii	White-winged Triller		X				
Artamidae				X			
Artamus cinereus	Black-faced Woodswallow		X	X			
Artamus cyanopterus	Dusky Woodswallow		X		X	X	
Cracticidae				X			
Cracticus nigrogularis	Pied Butcherbird		X	X			
Cracticus torquatus	Grey Butcherbird	X	X	X	X	X	
Gymnorhina tibicen	Australian Magpie		X	X	X		
Strepera versicolor	Grey Currawong	X	X	X	X	X	
Corvidae				X			
Corvus coronoides	Australian Raven	X	X	X	X	X	
Hirundinidae							
Hirundo nigricans	Tree Martin		X		X	X	
Motacillidae							
Anthus australis	Australian Pipit	X				X	
Zosteropidae							
Zosterops lateralis	Silvereye		X		X		X
	Total	**38**	**61**	**65**	**50**	**45**	**16**

Mammals- Total species = 25

Family *Species name*	Common name	Spotted Quoll haul road PI	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline PI	Diggers South PI	WAM
Tachyglossidae							
Tachyglossus aculeatus	Echidna				X	X	X
Dasyuridae							
Dasyurus geoffroii	Western Quoll	X	X	X			X
Ningaui yvonneae	Southern Ningaui						X
Sminthopsis crassicaudata	Fat-tailed Dunnart				X		X
Sminthopsis gilberti	Gilbert's Dunnart	X	X	X		X	X
Sminthopsis granulipes	White-tailed Dunnart	X	X	X	X	X	X
Sminthopsis griseoventer	Grey-bellied Dunnart		X				X
Burramyidae							
Cercartetus concinnus	Western Pygmy Possum	X	X	X	X	X	X
Tarsipedidae							
Tarsipes rostratus	Honey Possum		X	X		X	
Macropodidae							
Macropus fuliginosus	Western Grey Kangaroo	X	X	X	X	X	
Macropus irma	Western Brush Wallaby		X	X	X	X	X
Vespertilionidae							
Chalinolobus gouldii	Gould's Wattled Bat	X	X	X		X	X
Chalinolobus morio	Chocolate Wattled Bat	X	X	X		X	X
Vespadelus regulus	Southern Forest Bat	X	X	X		X	X
Nyctophilus geoffroyi	Lesser Long-eared Bat	X		X			X
Molossidae							
Tadarida australis	White striped Freetail Bat	X	X	X		X	
Mormopterus species 4	South-western Freetail Bat	X	X	X		X	X
Muridae							
*Mus musculus**	House Mouse	X	X	X	X	X	X

Family *Species name*	Common name	Spotted Quoll haul road PI	Flying Fox PI & PII	Flying Fox PIII & PIV	Forrestania Water Disposal pipeline PI	Diggers South PI	WAM
Notomys mitchellii	Mitchell's Hopping Mouse	X	X	X	X		X
Pseudomys albocinereus		X	X			X	X
Pseudomys occidentalis	Western Mouse						X
Canidae							
*Canis lupis**	Dog			X	X		
Vulpes vulpes	Red Fox	X			X		
Felidae							
*Felis catus**	House Cat	X	X	X	X		
Leporidae							
*Oryctolagus cuniculus**	European Rabbit	X	X	X	X		X
	Total	**17**	**18**	**18**	**12**	**14**	**19**

Appendix 3

EPBC Protected Matters Report

Protected Matters Inventory obtained from a search of the EPBC Act Protected Matters Database Search for the a 50km radius buffer surrounding the co-ordinate 32°32'10" S; 119°42'40" E:

Matters of National Environmental Significance			
Scientific Name	**Common Name**	**Status**	**Type of Presence**
Birds			
Acanthiza iredalei iredalei	Slender-billed Thornbill (western)	Vulnerable	Species or species habitat may occur within area
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo	Endangered	Breeding likely to occur within area
Leipoa ocellata	Malleefowl	Vulnerable	Species or species habitat may occur within area
Mammals			
Dasyurus geoffroii	Chuditch, Western Quoll	Vulnerable	Species or species habitat may occur within area
Phascogale calura	Red-tailed Phascogale	Endangered	Species or species habitat likely to occur within area
Migratory Terrestrial Species			
Birds			
Leipoa ocellata	Malleefowl	Migratory	Species or species habitat may occur within area
Merops ornatus	Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species			
Birds			
Ardea modesta	Eastern Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Migratory	Species or species habitat may occur within area
Migratory Marine species			
Birds			
Apus pacificus	Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea modesta	Eastern Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Migratory	Species or species habitat may occur within area

Appendix 4

Licence to Take Fauna for Scientific Purposes

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DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: **Locked Bag 30**
Bentley Delivery Centre WA 6983

PAGE 2
NO. SF007178
PERSON NO. 70754

DATE OF ISSUE	27/11/2009
VALID FROM	30/11/2009
DATE OF EXPIRY	31/12/2009

LICENSING OFFICER

(DAN)

LICENSEE:	MR D KAMIEN
ADDRESS	BIOTA ENVIRONMENTAL SCIENCES P.O. BOX 155 LEEDERVILLE W.A. 6903

WILDLIFE LICENSING

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

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PAGE 1
NO. SF007178
PERSON NO. 70754

RECEIPT NO. AMOUNT
$0.00

WILDLIFE CONSERVATION ACT 1950
REGULATION 17

LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

THE UNDERMENTIONED PERSON MAY TAKE FAUNA FOR RESEARCH OR OTHER SCIENTIFIC PURPOSES AND WHERE AUTHORISED, KEEP IT IN CAPTIVITY, SUBJECT TO THE FOLLOWING AND ATTACHED CONDITIONS, WHICH MAY BE ADDED TO, SUSPENDED OR OTHERWISE VARIED AS CONSIDERED FIT.

DIRECTOR GENERAL

CONDITIONS

1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.

2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.

3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.

4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.

5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTORGENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.

6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.

7 **********ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE COMMONWEALTH DEPT OF THE ENVIRONMENT AND WATER RESOURCES, PHONE 02 6274 1900. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.**********

8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.

9 FURTHER CONDITIONS (NUMBERED (TO 9) ARE ATTACHED.

PURPOSE CAPTURE AND RELEASE FAUNA SURVEY USING SMALL CAGE TRAPS, BOX TRAPS, DRY PITFALL TRAPS, HARP TRAPS, HAND FORAGING AND SPOTLIGHTING FOR ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED HAUL ROAD BETWEEN SPOTTED QUOLL MINE AND COSMIC BOY CAMP, FORRESTANIA.

AUTHORISED PERSONS
TIM SACHSE
MICHAEL GREENHAM
DAVID KIERLE

WILDLIFE CONSERVATION REGULATIONS 1970

Regulation 17:- Licence to Take Fauna for Scientific Purposes

FURTHER CONDITIONS (OF LICENCE NUMBER SF007178)

1. The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.

2. Except in the case of approved lethal traps, the licensee shall ensure that measures are taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and inspected at regular intervals throughout each day of their use. At the conclusion of research all markers etc and signs erected by the licensee and all traps shall be removed, all pitfalls shall be refilled or capped and the study area returned to the condition it was in prior to the research/capture program. During any break in research, cage traps should be removed and pitfalls either removed, capped or filled with sand.

3. No collecting is to be undertaken in areas where it would impinge on pre-existing scientific research programs.

4. Any form of colour marking of birds or bats shall only be undertaken in accordance with the requirements of the Australian Bird and Bat Banding Scheme.

5. Any inadvertently captured specimen of fauna which is declared as likely to become extinct, rare or otherwise in need of special protection is to be released immediately at the point of capture. Where such a specimen is injured or deceased, the licensee shall contact Department of Environment and Conservation licensing staff at Kensington (08 9423 2434) for advice on disposal. Records are to be kept of any fauna so captured and details included in the report required under further condition 6 below.

6. Within one month of the expiration of this licence, the holder shall submit an electronic return detailing the locality, site, geocode, date and number of each species captured, sighted or vouchered during the currency of the licence, into the Department of Environment and Conservation Fauna Survey Database (DECFSD). A copy of any paper, report or thesis resulting from the research shall on completion be lodged with the Director General. If a renewal of this licence is required, the licensee shall submit a written progress report for activities undertaken during this licence period prior to the expiry of this licence.

7. Not more than ten specimens of any one protected species shall be taken and removed from any location less than 20km apart. Where exceptional circumstances make it necessary to take large series in order to obtain adequate statistical data the collector will proceed with circumspection and justify their actions to the Director General in advance.

8. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected which represents a significant extension of geographic range shall be donated on request to the Western Australian Museum.

9. To prevent any unnecessary collecting in this State, all specimens and material collected under the authority of this license shall, on request, be loaned to the Western Australian Museum. Also, the unused portion or portions of any specimen collected under the authority of this license shall be offered for donation to the Western Australian Museum or made available to other scientific workers if so required.

Appendix 5

Mygalomorph Spider Molecular Systematics

Helix
Molecular
Solutions

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25 March 2010

Re. Report on the molecular systematics of the mygalomorph spiders from Forestania

Objective

The trapdoor spider fauna in WA is diverse, (Main, 1957; 1982), and many new species continue to be recovered (Schmidt, 2007). Morphological taxonomy can be difficult in this group of spiders, especially when only one sex or adults have the diagnostic characters (Paquin & Hedin, 2004). Furthermore, morphological characters may not always capture true species diversity. In such cases DNA methodologies provide a rapid approach for determining taxonomic status and are increasingly being employed. DNA sequencing also allows a rapid assessment of genetic diversity and methods are readily transferred among taxa.

Twenty specimens of mygalomorph spiders, collected from sites at Forestania over an approximately 50 km transect, were sequenced for variation at the mitochondrial DNA gene cytochrome oxidase subunit 1 (COI). The specimens were identified as belonging to three genera (*Aganippe*, *Aname/Chenistonia*, and *Eucyrtops*) from two families. The specimens were analysed with 74 specimens of mygalomorph from Forestania sequenced previously. For comparison, 19 specimens of mygalomorphs were included from Mt. Jackson, a site approximately 250 km away, including specimens of *Aganippe castellum*, *Aganippe* sp. and *Gaius* sp. The samples were analysed with the aims of (1) estimating the number of taxa present in the Forestania collection, (2) characterising levels of genetic diversity within species, and (3) assessing the relationship of the Forestania material to collections from Mt. Jackson.

Executive summary

- Twenty specimens of mygalomorph spiders from Forestania were sequenced for variation at the Cytochrome Oxidase subunit I (COI) gene. These included specimens assigned by morphology to *Aganippe* and *Eucyrtops* in the family Idiopidae and *Aname/Chenistonia* in the family Nemesiidae
- Ten well-supported, divergent lineages of Idiopidae and six lineages of Nemesiidae were identified
- No haplotypes or lineages were shared between Forestania and Mt. Jackson; each lineage contained specimens from a single site only
- While *Gauis* and *Eucyrtops* formed monophyletic clades (lineages of each genus shared the same most recent common ancestor), *Aganippe* was polyphyletic (the composite lineages had more than one most recent common ancestor)
- Each genus was composed of multiple lineages, separated from other such lineages by between 4.4 and 18.5% sequence divergence in the Idiopidae and between 15.3 and 21.6% in the Nemesiidae
- While large genetic distances between lineages indicate the presence of multiple species, lower distances likely reflect a complex history of isolation between sites within

species arising from behavioural aspects of the spiders' biology such as low dispersal in females.
- Up to seven species of Idiopidae and six species of Nemesiidae may be present in the collections, including *Aganippe castellum*
- This study suggests the need for taxonomic re-evaluation of *Aganippe*

Methods

Twenty specimens of mygalomorph spiders from Forestania were sequenced for variation at the COI gene using primers M200 (GGAGGATTTGGA AATTGATTAGTTCC) and M205 (ACTGTAAATATATGATGAGCTCA; Simon et al. 1994). Seventy-four sequences from a previous study and 19 sequences of mygalomorphs from Mt. Jackson were also included in the analysis. Genetic distances between unique genetic types (haplotypes) were measured using uncorrected p-distances (total percentage of nucleotides different between sequences). To account for polymorphism within lineages, the net genetic diversity of Nei (1987) was calculated to give a 'corrected' distance between lineages. Bayesian analysis was used to construct phylogenetic trees. The robustness of the branching pattern was assessed using posterior probabilities, obtained by running four chains, each of 10^6 cycles. A majority rule consensus tree was constructed after discarding the first 500 ("burn-in") trees. The brushed trapdoor spider *Synothele* from the family Barychelidae and the jumping spider *Phidippus* from the family Salticidae were used as outgroups.

Results

Phylogenetic analysis of Idiopidae

A 542 base-pair (bp) fragment of COI was isolated from the 20 specimens. All 20 specimens had unique haplotypes (unique genetic types). Ten well-supported (posterior probabilities >75% are generally considered to be well-supported), genetically distinct lineages were identified (clusters of similar haplotypes separated by long branch lengths from other such clusters; A-J, Figure 1). Lineages A-C were identified morphologically as *Eucyrtops*, and the grouping was monophyletic and well-supported. Lineages D-H were identified as *Aganippe*, and while each lineage was well supported, the *Aganippe* grouping was not monophyletic, with lineages D and H occurring outside of the group containing lineages E-G. Lineages I and J were identified as *Gaius*, and the grouping was monophyletic and well-supported. While in general, major groupings corresponded to genera, there appeared to be a few instances of mis-identification. Three specimens, identified as *Aganippe* occurred in the clade containing haplotypes of *Eucyrtops* lineage A (T96620, T96621, T96221-2), and three specimens identified as *Aganippe* occurred in *Eucyrtops* lineage B (T77636, T96622, T96664). Lineage G was composed of morphotypes MYG064 and MYG065. *Aganippe* morphotype MYG064 occurred in two lineages (G and H), and MYG065 occurred in three lineages (A, B, G).

Geographic placement of lineages

There was high geographic concordance to the lineages (Figure 1). Six of the lineages (B, C, D, G, H, J) were found only at Forestania and three (E, F, I) were found only at Mt. Jackson.

Divergence within and between major lineages

Aganippe

Haplotypes corresponding to *Aganippe* morphotypes were divided into seven lineages (A, B, D, E, F, G, H; Figure 2). It should be noted that lineages A and B were dominated by *Eucyrtops* morphotypes, and lineage D formed a well-supported grouping with *Eucyrtops* indicating that lineages A, B and D may be *Eucyrtops*. Lineage H was external to the clade containing both *Aganippe* and *Eucyrtops* and is of uncertain taxonomic status. Three lineages therefore, are likely to represent *Aganippe*: E, F and G. Lineage E, corresponding to *A. castellum* from Mt. Jackson, differed from lineages F and G by between 14.2 and 14.4% net sequence divergence (Table 2). Lineages F and G, corresponding to haplotypes from Mt. Jackson and Forestania, respectively, differed from one another by 4.4% net sequence divergence (Table 2). All of the

new specimens of *Aganippe* from Forestania occurred in lineage G. One (M20091203SQH01TS-1) was identified as *A. rhaphiduca*; the remainder were identified as *Aganippe* sp. (Table 1). Average sequence divergence between haplotype pairs within lineages of *Aganippe* ranged from 0.1 to 3.3% sequence divergence (Table 3).

Eucyrtops

There were three well-supported lineages of *Eucyrtops* (A-C; Figure 1, 3). Lineages A-C differed from one another by between 4.9 and 5.9% net sequence divergence (Table 2). The new specimens of *Eucyrtops* occurred in lineage B. All were identified as *Eucyrtops* sp. (Table 1). Lineage D, while containing haplotypes of specimens identified as *Aganippe*, formed a well-supported clade with lineages A-C (Figure 1, Figure 3). Lineage D differed from lineages A-C by between 9.9 and 10.8% net sequence divergence (Table 2). Specimens represented in lineages A-D were all collected at Forestania. Lineage D is sufficiently genetically distinct to suggest it is a distinct species, however, lineages A-C show only low levels of genetic divergence, and are all found at Forestania. Lineages A-C were mapped in order to determine if they were associated with geographic locations within the Forestania tenement. There was a clear association between lineages and location (Figure 4). With one exception, lineages showed restricted geographic distributions that were distinct from the distributions of the other lineages. Only a single individual, a female, from lineage C (T96666) was found in the region where lineage B specimens were collected (Figure 4). Variation between haplotypes within lineages A-C ranged from 1.3 to 1.4% sequence divergence (Table 3).

Gaius

The sequences of *Gaius* formed two well-supported lineages (I, J; Figure 1, 5). The lineages were each associated with a geographical area – lineage I contained haplotypes from Mt. Jackson, and lineage J corresponded to Forestania specimens. The two lineages differed from one another by 13.7% net sequence divergence (Table 2). The majority of specimens in lineage J were identified as MYG063. Average variation between haplotypes within lineages ranged from 0.1 to 0.2% sequence divergence (Table 3).

Phylogenetic analysis of Nemesiidae
Aname/Chenistonia

The *Aname/Chenistonia* sequences formed five well-supported lineages (K-P), and one lineage whose placement was unresolved (K; Figure 6). Only one lineage, P, contained more than one haplotype. The lineages differed from one another by between 15.3 and 21.6% net sequence divergence (Table 2). Three specimens were identified as sp. A and four as sp. B (Table 1). There was no correlation between morphotype and genetic structure; indeed, lineage P contained two haplotypes, differing by 0.7% sequence divergence (Table 3), one that was identified as sp. A , and the other that was identified as sp. B. The specimens were collected from five burrow sites at Forestania. Lineage P contained haplotypes of specimens from two different burrows, FR25 and FR26. Three highly divergent lineages were found at FR26, lineages L, O and P.

Relationship to Mt. Jackson specimens

Some of the Mt. Jackson material showed close relationships to the Forestania specimens. Lineage F from Mt. Jackson formed a well-supported sister group (two lineages that share a most recent common ancestor) to lineage G from Forestania, and the two lineages differed from one another by 4.4% net sequence divergence (Table 2). Likewise, *Gaius* lineages I and J from Mt. Jackson and Forestania respectively, formed a well-supported group. The two lineages differed from one another by 13.7% net sequence divergence (Table 2). *Aganippe castellum* from Mt Jackson was genetically distinct from the Forestania material (13.1-18.9% sequence divergence to the nearest lineage G) but the relationship was not well supported.

Conclusions

The data show the presence of ten distinct evolutionary lineages within the Idiopidae, separated by moderate to large genetic distances (4.4 to 18.5%) that exceed genetic distances

within lineages (0.1 to 4.1%). In addition, there were six lineages within the *Aname/Chenistonia*, separated by between 15.3 and 21.6% sequence divergence. Only one *Aname/Chenistonia* lineage (P) contained more than one haplotype. The haplotypes in lineage P differed by 0.7% sequence divergence. While *Gaius* and *Eucyrtops* form well-supported genetic groups, corroborating their taxonomic status, *Aganippe* shows a more complex pattern which suggests that taxonomic re-evaluation may be merited.

To assess the likely number of species in the current study, the results can be compared to other genetic studies of spiders. An analysis of 29 spider genera from 24 families showed that on average, species differed by 6.5 – 23.1 % sequence divergence at COI (Barrett & Hebert, 2005), and intra-specific variation ranged from 0-7.4% among 37 different spider species. Using the Barrett & Hebert divergences as guidelines, the large genetic distances between some of the lineages of the Forestania and Mt. Jackson material suggest the presence of multiple species within genera, while lower distances likely reflect geographical variation within single species. A summary of the estimated number of species within each genus follows:

Idiopidae

Aganippe: Two species

1. Lineage E (*A. castellum*) found at Mt. Jackson
2. Lineage F-G. Lineages F and G differ by **4.4%** sequence divergence and form a well-supported clade. Hence, the group formed by F-G likely represents geographic variation within a single species, found at Forestania and Mt. Jackson. Lineage F-G is highly genetically distinct from *A. castellum*

Eucyrtops: Two species

1. Lineage A-B-C. The group formed by A-B-C, showing relatively low sequence divergence between lineages (4.9 to 5.9%), likely represents geographic variation within a single species, found at Forestania
2. Lineage D, found at Forestania. Note that this lineage was identified as *Aganippe*, but forms a well-supported clade with lineages A-B-C. The morphology of these specimens should be re-examined.

Gaius: Two species

1. Lineage I, found at Mt. Jackson
2. Lineage J, found at Forestania

The relatively high genetic distance (13.7%) between the two lineages suggests the presence of two species.

Unknown genus: one species

1. Lineage H, found at Forestania. Morphotypes identified as *Aganippe*, but the lineage occurs outside the clade containing both *Aganippe* and *Eucyrtops*.

Nemesiidae

Aname: Six species. The high sequence divergence between lineages (15.3 to 21.6%) suggests that each is a distinct species.

1. Lineage K, found at SQH04, Forestania
2. Lineage L, found at FR26, Forestania
3. Lineage M, found at SQH03, Forestania
4. Lineage N, found at SQH02, Forestania
5. Lineage O, found at FR26, Forestania
6. Lineage P, found at FR25 and FR26, Forestania

The Idiopidae and the Nemesiidae showed different genetic patterns. The genetic data for the Idiopidae suggest a pattern of restricted dispersal among individuals, at large and small spatial scales. At a large spatial scale, lineages F and G form sister lineages of *Aganippe*, differing by 4.4% net sequence divergence, but occurring at Mt. Jackson and Forestania, respectively, sites separated by approximately 250 km. At a smaller scale, *Eucyrtops* shows three well-supported lineages, all of which occur at Forestania over approximately 50 km, yet with only one exception, there is no overlap in the geographical distribution of the lineages. While divergence

between the *Eucyrtops* lineages is relatively low (4.9 to 5.9%) and does not likely represent species-level separation, the distinct lineages, associated with specific locations, are evidence of limited dispersal among populations, even over short distances.

In contrast, *Aname/Chenistonia* lineages are highly divergent over a small spatial scale, with divergences ranging from 15.3 to 21.6% at Forestania. Based on a "molecular clock" for invertebrate sequence change of 2.3 % sequence divergence per million years (Brower 1994), the *Aname/Chenistonia* specimens show millions of years of separation within a single geographical area. One interpretation for this pattern is secondary contact between previously isolated populations. However, the biology of both idiopid and nemesiid spiders is conducive to producing variation at maternally-inherited mitochondrial genes such as COI. Female spiders rarely leave their burrow; it is the males that tend to disperse (Main, 1982). Furthermore, unlike many spider groups, juveniles do not disperse aerially (Main, 1995). These spiders are thus likely to show genetic divergence over small spatial scales, which may not be reflected in morphological variation. The use of nuclear markers would be useful for showing contemporary patterns of gene flow.

The different evolutionary patterns between the Idiopidae and the *Aname/Chenistonia* in this study could be due to factors so far undetermined, such as age differences between the two groups, or different levels of female dispersal.

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Table 1. Specimens used in the current study.

Site Code	Specimen code	Family	Genus	species
SQH01	M20091203SQH01TS-1	Idiopidae	*Aganippe*	*rhaphiduca*
SQH01	M20091203SQH01DK-1	Idiopidae	*Aganippe*	*sp*
OPP	M20091203SQHOPPDK-2	Idiopidae	*Aganippe*	*sp*
SQH06	M20091204SQH06TS-3	Idiopidae	*Aganippe*	*sp*
SQH06	M20091204SQH06TS-1	Idiopidae	*Aganippe*	*sp*
SQH06	M20091204SQH06DK-1	Idiopidae	*Aganippe*	*sp*
SQH02	M20091206SQH02TS-1	Idiopidae	*Aganippe*	*sp*
SQH01	M20091203SQH01TS-2	Idiopidae	*Eucyrtops*	*sp*
SQH02	M20091206SQH02TS-2	Idiopidae	*Eucyrtops*	*sp*
SQH07	M20091207SQH07TS-1	Idiopidae	*Eucyrtops*	*sp*
SQH07	M20091207SQH07TS-2	Idiopidae	*Eucyrtops*	*sp*
SQH03	M20091207SQH03TS-1	Idiopidae	*Eucyrtops*	*sp*
FR25	M20091130FR25TS-1	Nemesiidae	*Aname/Chenistonia?*	sp A
SQH04	M20091205SQH04TS-2	Nemesiidae	*Aname/Chenistonia?*	sp A
FR26	M20091207FR26DK-1	Nemesiidae	*Aname/Chenistonia?*	sp B
FR26	M20091204FR26DK-2	Nemesiidae	*Aname/Chenistonia?*	sp A
SQH03	M20091205SQH03TS-1	Nemesiidae	*Aname/Chenistonia?*	sp B
FR26	M20091205FR26TS-1	Nemesiidae	*Aname/Chenistonia?*	sp B
SQH02	M20091206SQH02DK-1	Nemesiidae	*Aname/Chenistonia?*	sp B
FR26	M20091204FR26DK-1	Nemesiidae	*Aname/Chenistonia?*	sp B

Table 2. Net sequence divergence (uncorrected p-distances) between major lineages of each genus as shown in Figures 1-4. It should be noted that that p distance is a conservative estimate, in that it doesn't account for mutational saturation. Hence these distances should be considered minimum estimates and could in fact be higher.

A. *Aganippe* – all lineages containing morphotypes of *Aganippe*

	A	B	D	E	F	G	H
A	x						
B	0.048	x					
D	0.099	0.109	X				
E	0.136	0.156	0.150	X			
F	0.139	0.147	0.142	0.144	X		
G	0.142	0.145	0.139	0.142	0.044	X	
H	0.168	0.185	0.158	0.184	0.173	0.161	X

B. *Eucyrtops* – all lineages containing morphotypes of *Eucyrtops* plus morphotypes of *Aganippe* that occur in *Eucyrtops* lineages

	A	B	C	D
A	X			
B	0.054	X		
C	0.049	0.059	X	
D	0.104	0.108	0.099	x

C. *Gaius* – all lineages containing morphotypes of *Gaius*

	I	J
I	X	
J	0.137	x

D. *Aname/ Chenistonia* – all lineages containing morphotypes of *Aname/ Chenistonia*

	K	L	M	N	O	P
K	X					
L	0.153	X				
M	0.171	0.192	X			
N	0.159	0.175	0.163	X		
O	0.181	0.180	0.185	0.173	X	
P	0.204	0.192	0.211	0.216	0.206	x

Table 3. Sequence divergence (uncorrected p-distances) between haplotypes within major lineages of each genus as shown in Figures 1-4.

A. *Aganippe*

Lineage	distance
A	0.014
B	0.013
D	0.038
E	0.008
F	0.001
G	0.033
H	0.041

B. *Eucyrtops*

Lineage	distance
A	0.014
B	0.013
C	0.013

C. *Gaius*

Lineage	distance
I	0.002
J	0.001

D. *Aname/ Chenistonia*

Lineage	distance
P	0.007

Figure 1. Bayesian tree for a 542 bp alignment of COI, showing evolutionary relationships among haplotypes of all Idiopidae. Letters refer to the major lineages as described in the text. Numbers on major nodes correspond to posterior probabilities, indicating the proportion of time the arrangement was recovered. Posterior probabilities >0.75 are considered to indicate good support. Posterior probabilities <50% are not shown. Numbers to the right of some haplotypes represent the number of individuals sharing that haplotype. New *Aganippe* haplotypes are highlighted in yellow; new *Eucyrtops* haplotypes are highlighted in turquoise.

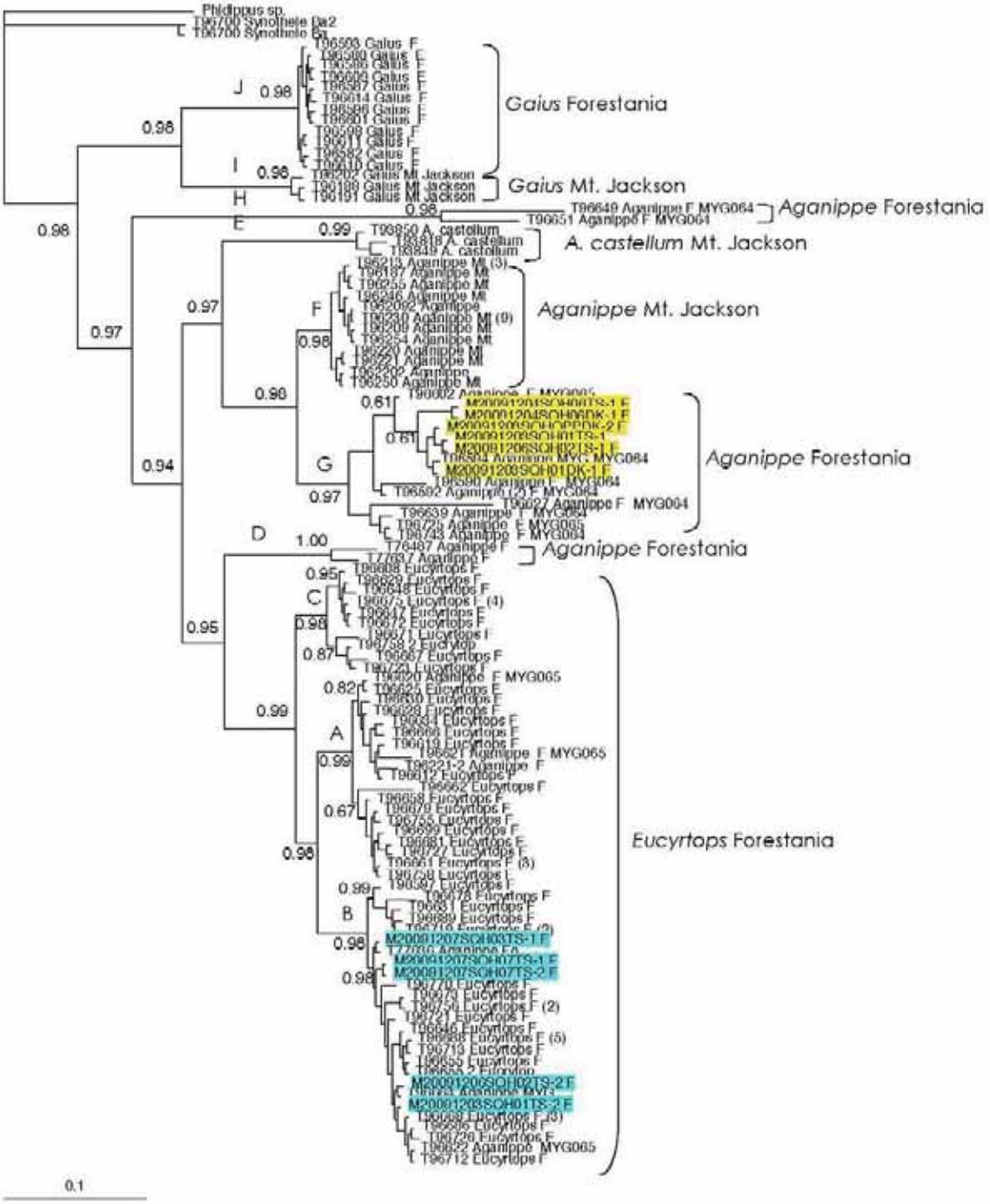


Figure 2. Bayesian tree for a 542 bp alignment of COI, showing evolutionary relationships among haplotypes of *Aganippe* only. Letters refer to the major lineages as described in the text. Numbers on major nodes correspond to posterior probabilities, indicating the proportion of time the arrangement was recovered. Posterior probabilities >0.75 are considered to indicate good support. Posterior probabilities <50% are not shown. New *Aganippe* haplotypes are highlighted in yellow.

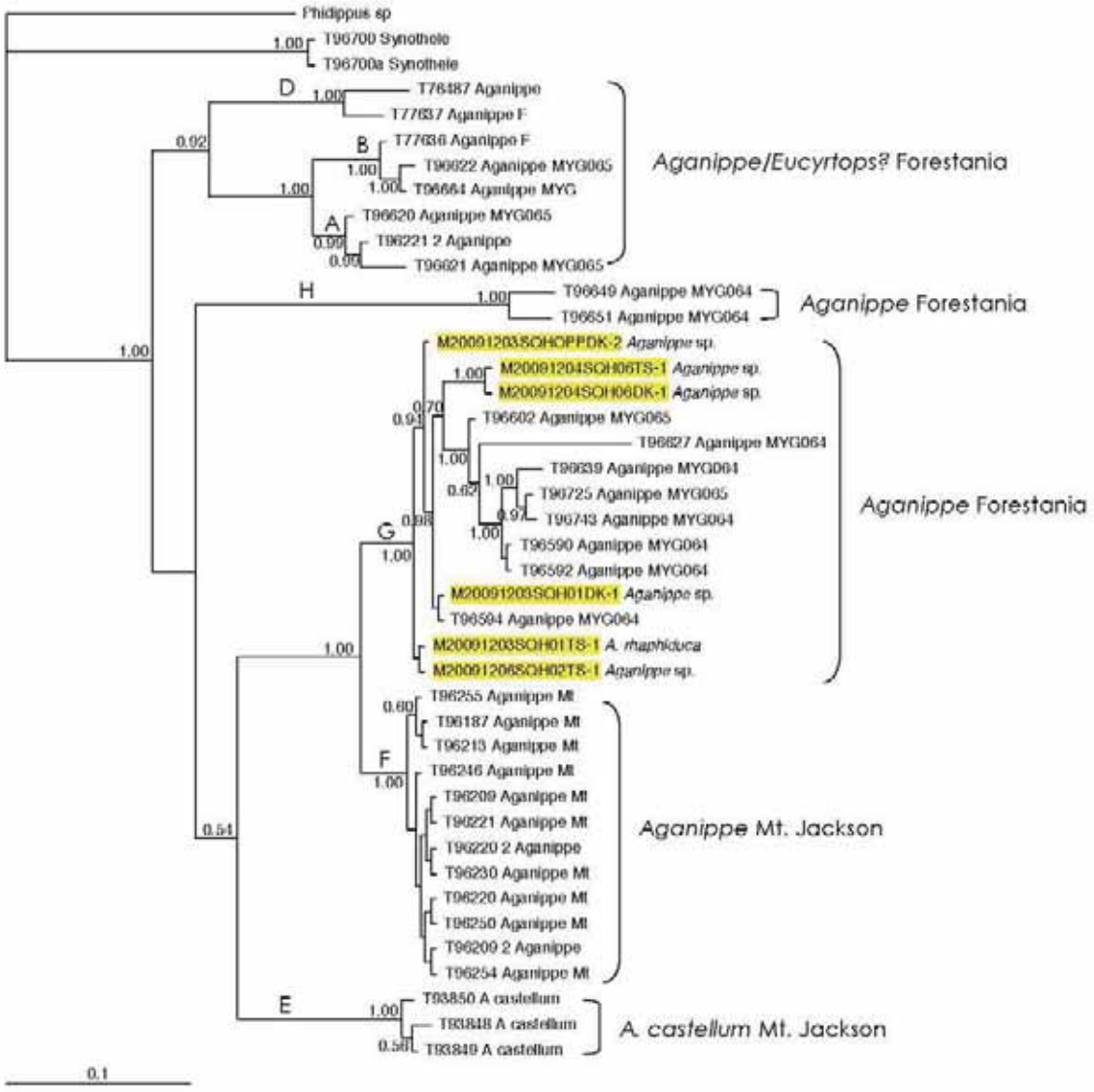


Figure 3. Bayesian tree for a 542 bp alignment of COI, showing evolutionary relationships among haplotypes of *Eucyrtops* only. Letters refer to the major lineages as described in the text. Numbers on major nodes correspond to posterior probabilities, indicating the proportion of time the arrangement was recovered. Posterior probabilities >0.75 are considered to indicate good support. Posterior probabilities <50% are not shown. New *Eucyrtops* haplotypes are highlighted in turquoise.

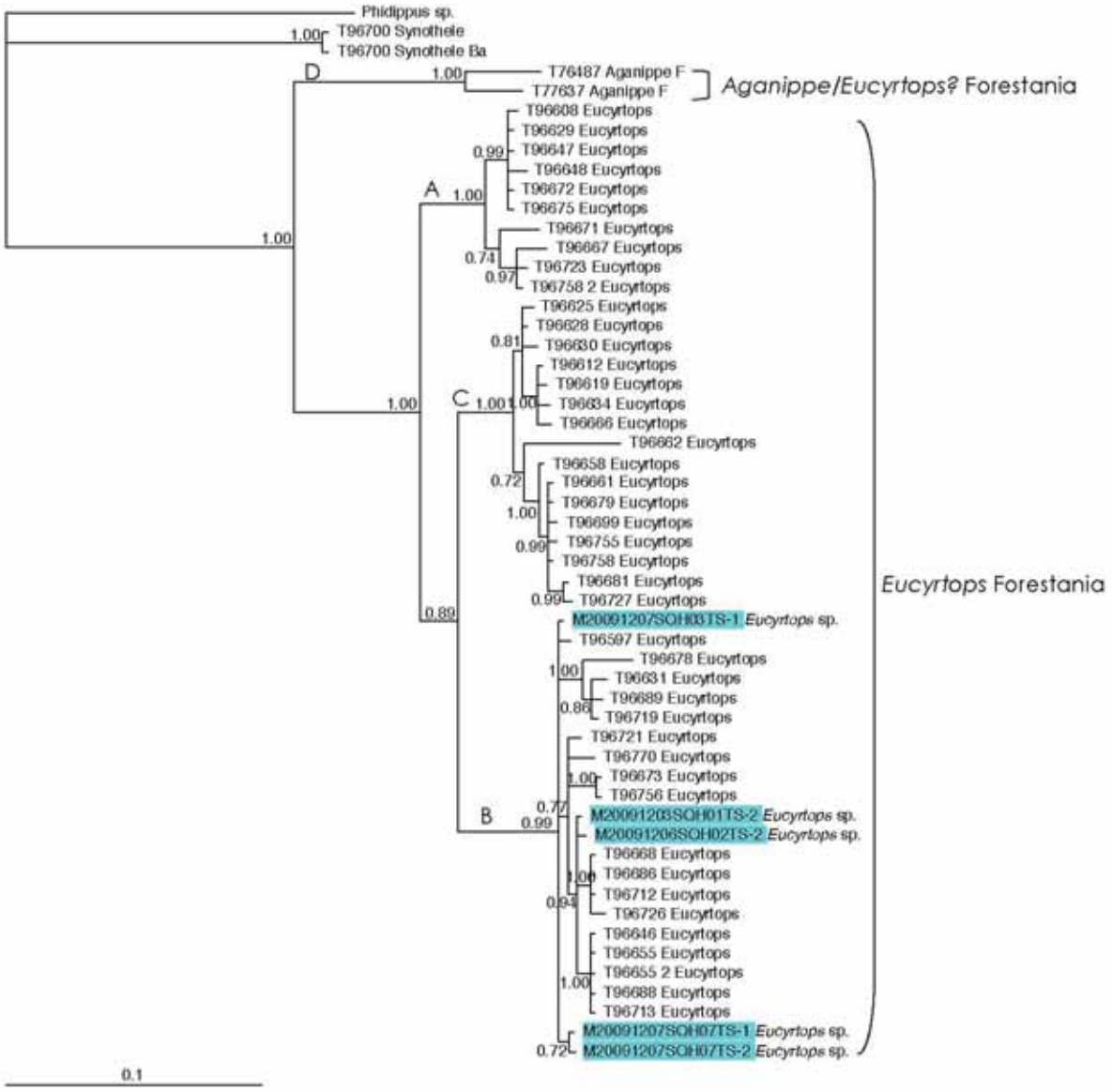


Figure 4. Map of the distribution of *Eucyrtops* lineages A-C.

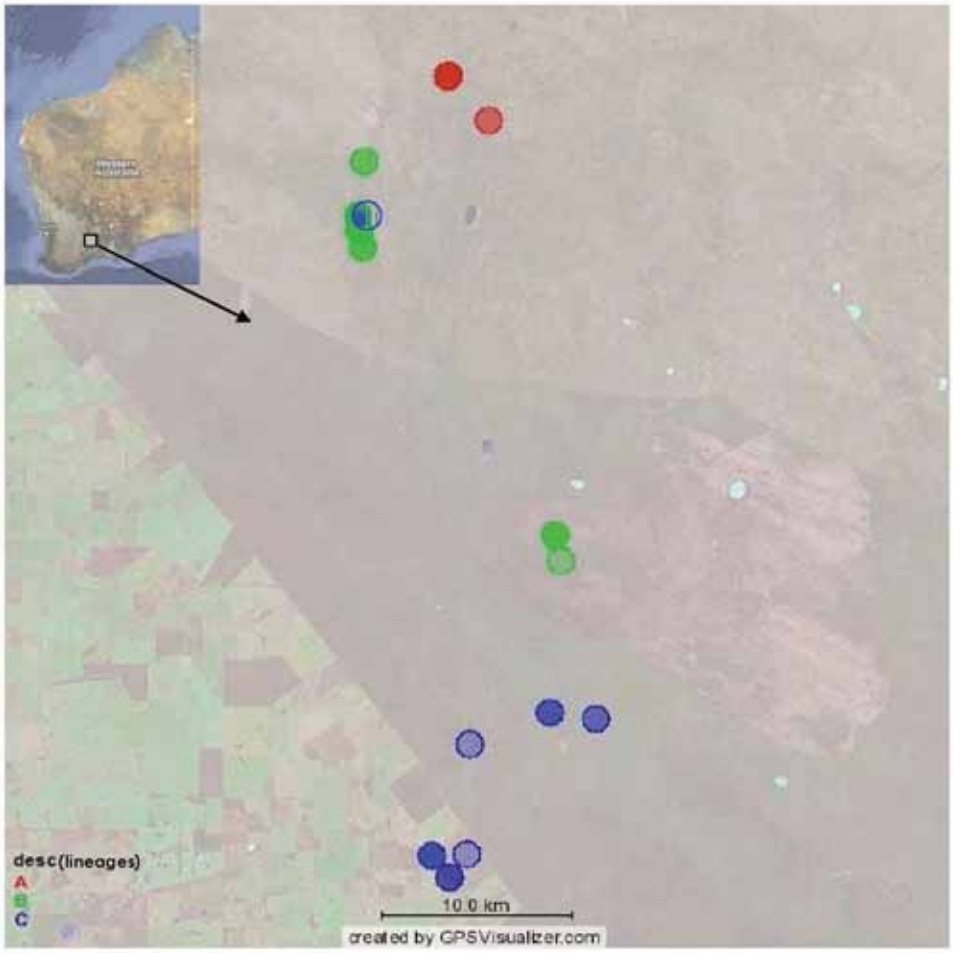


Figure 5. Bayesian tree for a 610 bp alignment of COI, showing evolutionary relationships among haplotypes of *Gaius* only. Letters refer to the major lineages as described in the text. Numbers on major nodes correspond to posterior probabilities, indicating the proportion of time the arrangement was recovered. Posterior probabilities >0.75 are considered to indicate good support. Posterior probabilities <50% are not shown.

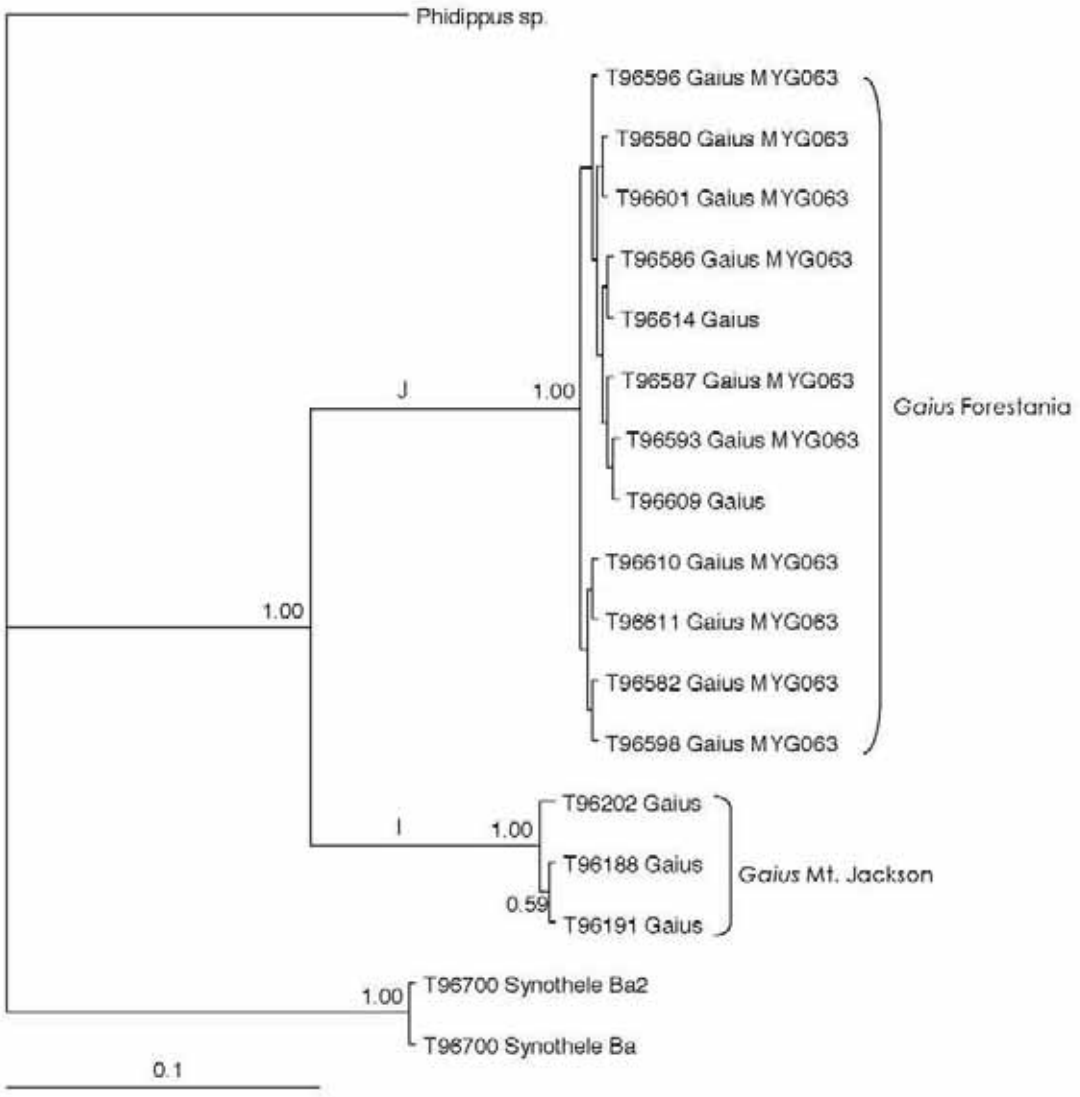
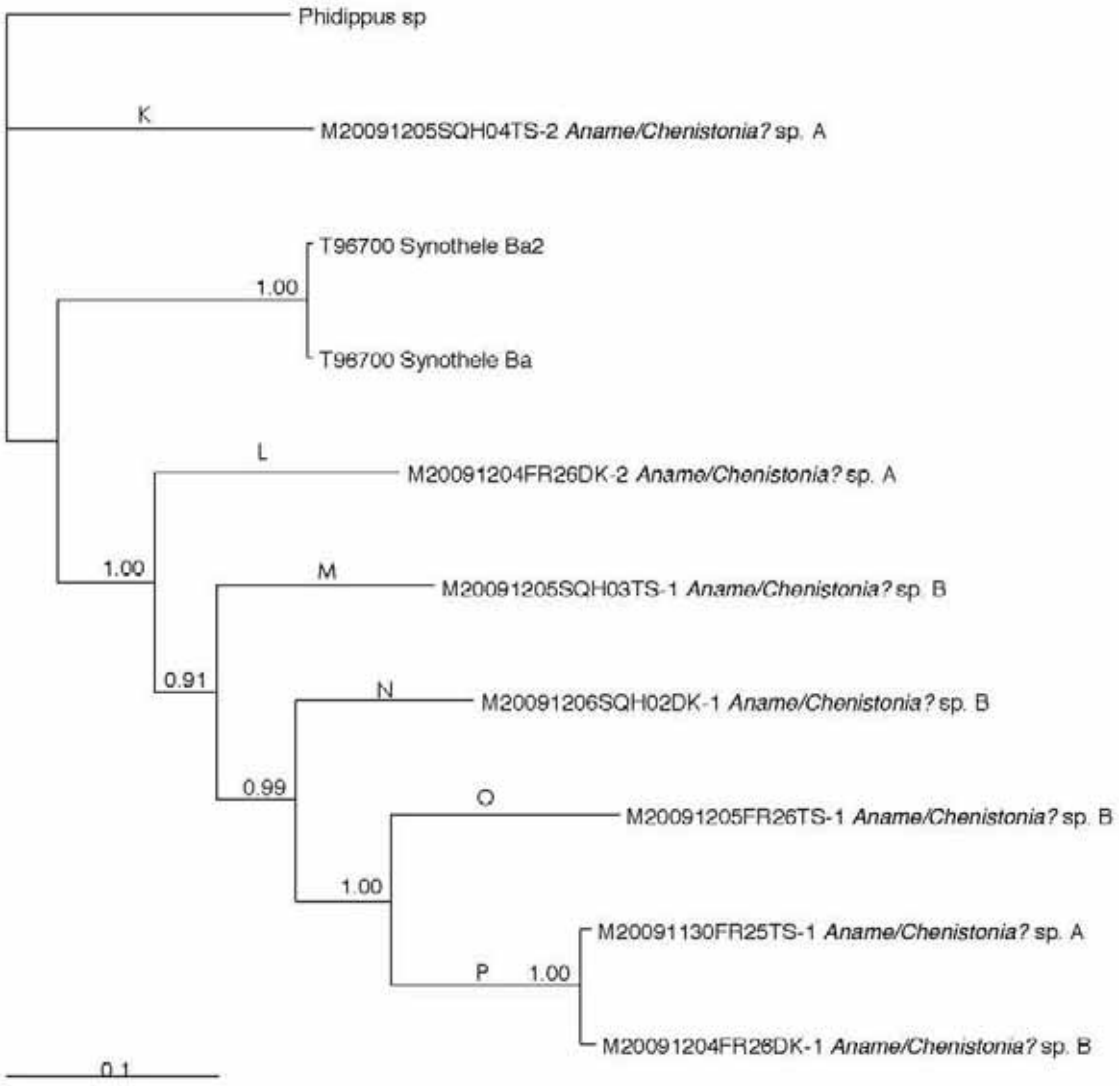


Figure 6. Bayesian tree for a 610 bp alignment of COI, showing evolutionary relationships among haplotypes of *Aname* only. Letters refer to the major lineages as described in the text. Numbers on major nodes correspond to posterior probabilities, indicating the proportion of time the arrangement was recovered. Posterior probabilities >0.75 are considered to indicate good support. Posterior probabilities <50% are not shown.



Appendix 6

Bat Call Identification

Spotted Quoll Haul Road Fauna Survey
Dec 2009

Echolocation Survey of Bat Activity.

Prepared for Biota Environmental Sciences

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Prepared by:
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28 Jan 2010

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Summary

Background

Chiroptera species presence, with an estimate of activity level, is presented for sites on Spotted Quoll Haul Road, near Forrestania, WA. This study area is in the Coolgardie bioregion. Biota Environmental Sciences carried out a systematic echolocation based survey during Dec of 2009. Bat Call WA has reviewed the recordings made and provided species lists for the bats present.

Habitats

Sites for the Chiroptera survey were chosen by Biota. The survey was carried out over six nights between the 2nd and the 7th Dec 2009. Habitats chosen include Salmon gum and mallee woodland over acacia shrublands.

Bat Fauna

A microbat assemblage of six insectivorous species confirmed as present at the study sites in Dec (Table 3). Bat activity level in general was confirmed as "low", see criteria below. This activity level is considered typical of the region away from permanent fresh water sites.

No calls of *Nyctophilus major tor* (recent synonym *N. timoriensis*) (DEC Priority 4 species) were confirmed.

Site specific details are presented in Table 1. Characteristics of the calls recorded are presented in Table 2.

Survey Timing, Moon Phase and Weather

The systematic echolocation survey was conducted between 2nd and 7th of Dec 2009. The survey was conducted in a warm period. Sampling evenings between 2nd and 5th were fine and clear with minimum temperatures between 10 and 15°C overnight. The nights

of the 6th and 7th were warm and humid with storm activity in the vicinity. The moon in this period was full to third quarter.

Survey Team

The bat sampling work was conducted by Dan Kamien of Biota. R. D. Bullen of Bat Call WA completed analysis of echolocation recordings.

Systematic Sampling

The systematic survey consisted of completing 11 overnight bat sound recordings, beginning at twilight, at four locations within the survey area. Refer to Table 1 below for details. Five of the overnight recordings, sites Bat02 and Bat 03, were made with Anabat SD1 unit # 3726 (Titley Electronics, Ballina, NSW) with calls saved on CF cards. Six nights recordings were "continuous", sites Bat01 and Bat 04, and were made using Anabat SD1 detectors, set to divide by 16, in conjunction with a LS-10 Professional PCM Recorder (Olympus, Japan) in addition to the CF card files.

COOL EDIT 2000 (Now available as AUDITION from Adobe Systems Inc.) was used to display each "continuous call" sequence for identification. Only good quality call sequences were used. Details of calls analysed are provided in Table 2 as recommended by Australasian Bat Society (ABS 2006). Reference data for the species identified are available in Bullen and McKenzie 2002, McKenzie and Bullen 2003 and McKenzie and Bullen 2009.

AnalookW 3.3 software was used to visualise the "SD1" CF files.

Bat activity was then characterised as "Low", "Medium" or "High" based on the rate of call sequences recorded.

- Low species activity is referred when a species is recorded with call spacing less often than ten minutes,
- Medium species activity refers to call recordings more often than 10 minutes but less often than two minutes apart for a significant time period followed by sporadic records for the remainder of the session.

- High species activity refers to call recording more often than two minutes apart for significant periods followed by reasonably regular records for the remainder of the session.

Further details of the calls analysed including graphical presentations are available from Bat Call WA on request.

Survey Limitations

All sites surveyed were accessible on foot and the recorders were set at ground level with the microphone pointing approximately 45 deg upward. Bat sound recording was carried out overnight beginning at twilight. Due to a corrupt file, the continuous recordings for Bat01 on the 2nd, 3rd and 4th Dec were lost.

The survey method may be biased against species that are known to forage close to the ground due to the conical shape of the Anabat microphone polar. Species that may be under-represented as a result may include *Nyctophilus geoffroyi* and *N. major tor* that are known to occasionally glean from the ground. Setting the detector at 45O minimises this effect but then provides a directional recording that may reduce overall call numbers from other higher-flying species.

Bat species density is impossible to estimate from echolocation records. Bat activity is therefore substituted as an approximate guide to the relative numbers of each species using the study area.

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Table 1 Site Specific details.

Date (set and recovery dates)	Site	Recording Time	Habitat	Easting	Northing
2 – 7 Dec	SQHBat 01	Unit #3709 recording overnight with LS-10	Open Salmon gum woodland; anabat in open and set at 45°	752579	6403424
3 – 5 Dec	SQHBat 02	Unit #3726 recording overnight	Eucalyptus mallee woodland over Acacia spp. shrubland; anabat in flyway and set at 45°	754474	6401634
5 – 8 Dec	SQHBat 03	Unit #3726 recording overnight	Eucalyptus mallee woodland over Acacia spp. shrubland; anabat in open and set at 45°	756756	6391355
7 – 8 Dec	SQHBat 04	Unit #3709 recording overnight with LS-10	Eucalyptus mallee woodland over Acacia spp. shrubland; anabat in open and set at 45°	755181	6392646

Note – Coordinates are GDA94 Zone 50

Table 2: Summary of Echolocation call characteristics for microbat species present.

Genus species Authority	Common name	Typical F_{peakC} kHz	Ave. Q	Typical Duration msec	Typical Call Shape
Chalinolobus gouldii (Grey 1841)	Gould's wattled bat	32	10	7 - 11	FM
Chalinolobus morio (Grey 1841)	Chocolate wattled bat	50	10	7	FM
Mormopterus species 4 (form sp. 4, population O in Adams et al. 1988)	South-western free-tailed bat	25	10	7 - 14	Shallow FM
Nyctophilus geoffroyi Leach 1821	Lesser long-eared bat	47	2.5	5	Steep FM
Tadarida australis (Grey 1838)	White-striped free-tailed bat	11	7	12 - 23	CF– shallow FM
Vespadelus regulus (Thomas 1906)	Southern forest bat	43	10	4 - 10	FM

Note: FpeakC and Q are defined in McKenzie and Bullen 2003, 2009.

Table 3. Microbat lists obtained presented by site.

Date	Site	Recording system	*Chalinolobus gouldii*	*Chalinolobus morio*	*Mormopterus sp. 4*	*Nyctophilus geoffroyi*	*Tadarida australis*	*Vespadelus regulus*
SQHBat 01	2 Dec	Anabat #3709 SD1 files	Low	Low			Low	Low
	3 Dec	Anabat #3709 SD1 files	Med	Low	Low	Probable	Low	Med
	4 Dec	Anabat #3709 SD1 files	Med	Low	Low	Low	Low	Med
	5 Dec	Anabat #3709 SD1 files	Low					Probable
	5 Dec	Anabat #3709 LS-10 files	Low					
	6 Dec	Anabat #3709 SD1 files						
	6 Dec	Anabat #3709 LS-10 files						

SQHBat 02	3 Dec	Anabat #3726 SD1 files	Low	Low	Low	Low	Low	Low
	4 Dec	Anabat #3726 SD1 files	Low	Low	Low	Low	Low	Low
SQHBat 03	5 Dec	Anabat #3726 SD1 files	Med	Low	Low	Low	Low	Med
	6 Dec	Anabat #3726 SD1 files					Low	
	7 Dec	Anabat #3726 SD1 files						
SQHBat 04	7 Dec	Anabat #3709 SD1 files						
	7 Dec	Anabat #3709 LS-10 files	Low				Low	

Figure 1 Anabat Sites in Study area in relation to local features.



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WESTERN AREAS NL
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FORRESTANIA NICKEL PROJECT

Spotted Quoll – Cosmic Boy Haul Road

TARGETED FAUNA SURVEY

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March 2011

EXECUTIVE SUMMARY

Western Areas NL (WSA) operates the Forrestania Nickel Project (FNP) in the Goldfields of Western Australia. The FNP is located approximately 160 km south of Southern Cross and 80 km east of Hyden in the Shire of Kondinin. Within the FNP, the Spotted Quoll deposit is located approximately 15 km north of WSA's Cosmic Boy Project area. WSA proposes to develop a haul road between the Spotted Quoll operation and Cosmic Boy processing plant.

WSA commissioned Keith Lindbeck and Associates (KLA) to conduct a targeted fauna survey of the following four vertebrate species of conservation significance:

- Chuditch (*Dasyurus geoffroii*),
- Malleefowl (*Leipoa ocellata*),
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and
- Western Rosella (inland spp.) (*Platycercus icterotis xanthogenys*).

Further, WSA commissioned KLA to conduct a targeted Short Range Endemic invertebrate (SRE) survey along the proposed haul road route.

While the proposed haul road will be approximately 20 m wide along its length and will become slightly wider where its route curves in the north and south, the searches were conducted in an area measuring 120 m wide along the length of the proposed haul road and up to 160 m in the northern and southern ends to allow for flexibility in design. Further, in order to determine if the vegetation associations within the area proposed for the haul road comprised critical habitat for the four selected vertebrate species that is not found elsewhere, the vertebrate targeted search was extended to include an area up to 2.5 km west of the proposed haul road that included an area known as Boojum Swamp. Similarly, to determine if habitat within the area proposed for disturbance was unique and supported SRE's that were not supported elsewhere, 'paired' quadrats were established where possible outside of the zone of impact within the same vegetation groups, and equally searched for SRE's.

The surveys were conducted from 1st to 3rd June 2010 and 29th June to 3rd July 2010 to:

- ground truth the vegetation communities along the survey route,
- inspect the fauna habitats along the survey route,
- determine the potential within these habitats for the targeted species to utilise these areas,
- extend these searches outside of the proposed haul road route to determine if the habitats are limited to the survey area or are present elsewhere, and
- identify targeted species present at the time through direct observation and indirect evidence, including potential refugia, hollows, mounds, tracks, scats, feathers and trapdoor spider structures etc.

Results

No sightings of the four vertebrate species of conservation significance were recorded during the survey periods. Within the area surveyed for the proposed haul road, a total of 86 potential Chuditch refugia, three very old Malleefowl mounds, 98 potential Carnaby's Cockatoo breeding hollows and 200 potential Western Rosella breeding hollows were recorded.

Generally, the patterns of potential habitat for at least the Chuditch, Carnaby's Cockatoo and Western Rosella mirror changes in vegetation communities along the route of the proposed haul road

- The majority of the habitat items for the Chuditch, Carnaby's Cockatoo and Western Rosella were located in the vegetation group "Burnt *Eucalyptus salmonophloia*

woodland over mixed Mallee shrubland" along the northern length of the proposed haul road area.

- Potential habitat for Carnaby's Cockatoo and Western Rosella was not recorded in the same vegetation type in the northern 'curved' section as this vegetation was noted to be denser than that further south. Some potential refugia for Chuditch were recorded in this northern area, but the majority of these were earth burrows and 'beds' within dense thickets of Dodder *Cassytha* spp. rather than hollows in stags and logs.

- Potential habitat for all three species was not recorded in other vegetation communities along the southern portion along the length of the proposed haul road.

- While isolated occurrences of potential habitat were recorded for each of the three species at the southern end of the proposed haul road route, these findings suggest that there may be sparse and or scattered Eucalypts in this area.

- For the Malleefowl, only three very old mounds were identified in the southern section of the proposed haul road route in the "Mixed Mallee shrubland over *Melaleuca* shrubland".

- In the area to the west of the proposed haul road route to, within and from Boojum Swamp, 24 possible refugia sites for Chuditch, 68 potential breeding hollows for Carnaby's Cockatoo and 326 potential breeding hollows for Western Rosella were recorded. No Malleefowl mounds were recorded in this area.

These results indicate that only some sections of the proposed haul road route comprise vegetation with attributes that support potential refugia, hollows and potential hollows for Chuditch, Carnaby's Cockatoo and Western Rosella, and that this vegetation is described as "Burnt *Eucalyptus salmonophloia* woodland over mixed Mallee shrubland". Vegetation surveys have not been conducted in areas adjacent to the proposed road route area or in Boojum Swamp. Notwithstanding this, results from these areas indicate that the vegetation outside of the proposed haul road route also supports habitat characteristics favoured by these three species. Thus, vegetation comprising refugia, hollows and potential hollows for Chuditch, Carnaby's Cockatoo and Western Rosella is not limited to areas within the proposed haul road route.

The results also indicate that Malleefowl once used at least the southern portion of the proposed haul road route for mound building but have not done so for many years.

To assess the occurrence of invertebrates, seventeen 10 m x 10 m quadrats were established in representative vegetation groups along the length of the area surveyed for the proposed haul road area with eight quadrats within the proposed area and, where possible, a second quadrat was established in the same vegetation group outside of the proposed haul road route area.

Invertebrates were seen in ten of the 17 quadrats with no invertebrates seen in the remaining seven quadrats.

Three representative spiders were excavated and, together with their burrows and lids, sent to the Western Australian Museum for identification. Mature males are required for identification of mygalomorphs and two of the spiders submitted were females and one a juvenile (*Aganippe* spp.). Using putative identifications based on burrow and trapdoor characteristics, up to 18 *Aganippe "squama"* were recorded in the quadrats with three recorded within the proposed haul road route and 15 recorded outside of the proposed disturbance area. Four *Aganippe rhaphiduca* twig lining race were recorded with one within and three outside of the proposed route. Three *Aganippe "jessupi"* were recorded with one in and two outside of the proposed haul road route. All three did not appear to

be occupied. A total of 25 abandoned burrows and lids were recorded within and outside of the area proposed for disturbance and were unable to be identified to genera or species.

A synopsis of the trapdoor spiders recorded indicates that three putative species were collected in eight of the eleven vegetation groups and sub-groups with none recorded in the "Mixed Mallee shrubland over *Melaleuca* shrubland*"*, in the "Mixed Mallee and Mixed shrubs on Banded Ironstone ridge" or in the "*Melaleuca hamata* thicket" sub-group". Apparently live specimens of all three putative species were recorded both within and outside of the area proposed for disturbance.

The pair-wise quadrat comparison in different vegetation communities established that the spider specimens (based on burrow and trapdoor morphology) are not limited to the proposed area of disturbance but are also present beyond the proposed zone of impact.

Soil samples were collected from 15 of the 17 quadrats. Invertebrates were collected from nine of the soil samples and land snails from 13 samples. Nine pseudoscorpions, one symphylan, one scorpion and 86 land snails were collected from the soil samples and submitted to the Museum for identification. Of the species identified, three Families of pseudoscorpions, namely Atemnids (*Oratemnus* spp.), (unidentified) species of Chernetidae and three Oliipids (*Beierolpium* spp.) were collected both within and outside of the proposed haul road route. All were collected in vegetation groups that are not limited to the local area. While taxonomic analysis is required to determine the conservation status of the adult *Beierolpium* ('sp. 8/4'), it is unlikely that any of the other species identified are short range endemics.

A single Symplylid was collected in the "Burnt *Eucalyptus salmonophloia* woodland over mixed Mallee shrubland" within the proposed impact area. Taxonomic analysis of Symphyla is required to be able to comment on the possible endemicity of this taxa. However, the vegetation complex in which it was found is extensive and not limited to the survey area.

Three families of land snails were recognised: Punctidae, Pupillidae and Bulimulidae. Within the Punctidae, all species most closely resemble *Westralaoma* sp. c.f. *W. expicta* Iredale, 1939. Specimens were collected in a variety of vegetation groups and sub-groups both within and outside of the proposed area of disturbance, and current knowledge indicates that this species shows no evidence of short-range endemism at either the species or the population level.

Pupillid and Bulimulid specimens were collected only from "Mixed Mallee shrubland over *Melaleuca* shrubland", and only from outside of the zone of impact. While the tiny pupillid snail, identified as *Gastrocopta margarethae* Cox, 1868, exhibits extensive geographic ranges, the identification of the Bulimulid (*Bothriembryon* sp.) could not be made beyond that of genus.

In conclusion, the area proposed for the development of a haul road between Spotted Quoll and Cosmic Boy does not represent critical habitat for the Chuditch, Malleefowl, Carnaby's Cockatoo, Western Rosella or any invertebrate species, with vegetation groups supporting these species and their habitats also occurring outside of the proposed zone of impact. It is unlikely that the development of the haul road will alter the conservation status of any of these species.

Recommendations

The following recommendations arise from the findings of the targeted surveys conducted for the proposed haul road between Spotted Quoll and Cosmic Boy:

- No clearing to be conducted during the breeding season of Carnaby's Cockatoo (July to November).
- If clearing is to occur during the breeding season of Carnaby's Cockatoo (July to November), all potential breeding hollows are to be checked by cockatoo specialist prior to clearing. No clearing is to occur until breeding event is completed and hollow has been vacated.
- Avoid all other large trees and stags with hollows where possible;
- Any other clearing be minimised in extent given that the abundance and diversity of species lost will be proportional to the amount of habitat cleared;
- Where possible, the haul road be aligned to existing tracks and other barriers or follow the boundaries of broad-scale intact native vegetation;
- Erect signage to alert drivers of (possible) presence of Chuditch and Malleefowl;
- Enforce appropriate speed restrictions;
- Continue feral animal control strategies;
- All sightings of selected species to be reported to environmental officers;
- All members of the work force on site attend an environmental induction to ensure they are familiar with the value of native vegetation to vertebrate and invertebrate fauna indigenous to Western Australia. This should include awareness of driving restrictions, ensuring that off-road driving is minimised, the importance of fire prevention, and the care of fauna in the event of an accident involving fauna.

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1.0 INTRODUCTION

1.1 BACKGROUND

Western Areas NL (WSA) operates the Forrestania Nickel Project (FNP) in the Goldfields of Western Australia (Figure 1). The FNP is located approximately 160 km south of Southern Cross and 80 km east of Hyden in the Shire of Kondinin. Within the FNP, the Spotted Quoll deposit is located approximately 15 km north of WSA's Cosmic Boy Project area (Figure 2). WSA proposes to develop a haul road between the Spotted Quoll operation and Cosmic Boy processing plant.

A single-phase Level 2 fauna survey of the proposed haul road was conducted in May 2010 (Biota 2010). Following receipt of this information, WSA commissioned Keith Lindbeck and Associates (KLA) to conduct a targeted fauna survey of the following four vertebrate species of conservation significance:

- Chuditch (*Dasyurus geoffroii*),
- Malleefowl (*Leipoa ocellata*),
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and
- Western Rosella (inland spp.) (*Platycercus icterotis xanthogenys*).

In addition, WSA commissioned KLA to conduct a targeted Short Range Endemic invertebrate (SRE) survey along the proposed haul road route.

1.2 SELECTED SPECIES OF CONSERVATION SIGNIFICANCE

Native fauna species that are rare, threatened with extinction, or have high conservation value are specially protected by law under the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* and, within Western Australia, under the Western Australian *Wildlife Conservation Act* (WCA) *1950*. In addition, the Department of Environment and Conservation's (DEC) Threatened and Priority Fauna Database also classifies indigenous fauna under five Priority codes. Appendix A lists the categories used in the assessment of conservation status.

The four vertebrate species of conservation significance subject to the targeted search are listed below, together with their conservation status, distribution and abridged ecology.



Figure 1 - Location of Forrestania Nickel Project

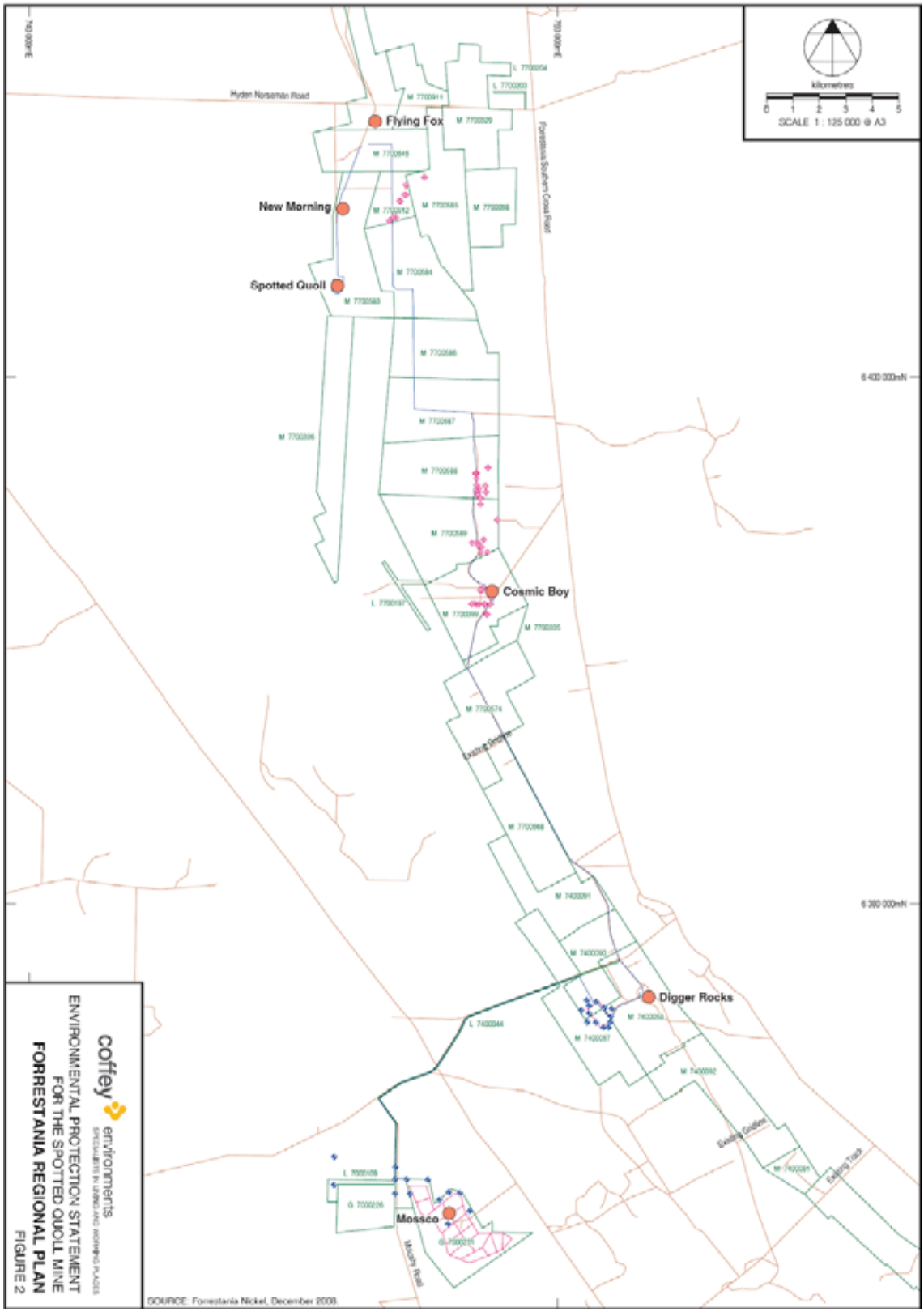


Figure 2 - Forrestania Nickel Project areas

1.2.1 Chuditch

Family: Dasyuridae

Conservation Status: Vulnerable under EPBC Act 1999 and Schedule 1: 'Rare and likely to become extinct' under the WCA 1950.



Plate 1 - Chuditch (*Dasyurus geoffroii*)



Refuge #1Stag



Refuge #2 Hollow log



Refuge #3 Earth burrow under base of fallen tree



Refuge #4 Dodder *Cassytha* sp.

Plate 2 - Potential den sites for the Chuditch

Distribution: The Chuditch was formerly present across semi-arid southern Australia from south-west Western Australia to western Queensland and New South Wales. It is now confined to sclerophyll and mallee remnants in south-west Western Australia (Menkhorst and Knight 2001).

Ecology: The Chuditch is the largest carnivorous marsupial found in Western Australia. It is solitary, mostly nocturnal and partly arboreal. Tree hollows, hollow logs, beneath the base of fallen trees or rock crevices are used as dens. The Chuditch is a generalist predator and mating occurs late April to early July (Menkhorst and Knight 2001).

The Chuditch has a large home range and occurs at very low densities with males ranging over 15 km^2 and females 3 km^2 to 4 km^2 (Serena and Soderquist 1989). Females tend to be territorial and their 'core areas', defined by den locations, are typically non-overlapping.

1.2.2 Malleefowl

Family: Megapodiidae

Conservation Status: Vulnerable under EPBC Act 1999 and Schedule 1: Rare and likely to become extinct under the WCA 1950.



Plate 3 - Adult Malleefowl (*Leipoa ocellata*)



Plate 4 - Active Malleefowl mound

Distribution: The Malleefowl was once broadly distributed across the southern half of the Australian continent, but has undergone significant range reduction and now occupy semi-arid regions of southern Australia where mallee eucalypts form the dominant vegetation (Birds Australia 2010).

Ecology: The Malleefowl is a large, ground-dwelling bird that roosts in trees but rarely flies. The species is omnivorous and typically has a large home range in woodlands or shrublands that have a deep layer of leaf litter which is used in building nesting mounds. Mounds are up to one metre in height and 3m to 5 m in diameter. Breeding occurs from September to April and chicks emerge independently, approximately seven weeks after laying.

1.2.3 Carnaby's Cockatoo

Family: Psittacidae

Conservation Status: Endangered under EPBC Act 1999 and Schedule 1: Rare and likely to become extinct under the WCA 1950.



Plate 5 - Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and potential hollow

Distribution: Carnaby's Cockatoo is endemic to southwest Western Australia, extending from the Murchison River to Esperance, and inland to Corrow, Kellerberrin and Lake Cronin (Johnstone and Storr 1998). Carnaby's Cockatoo is scarce and patchily distributed in the driest parts of its range and in the extreme south-west. It has shown a reduction in its range, particularly in the northern and eastern areas of the wheatbelt, largely because of clearing for agriculture (Cale 2003).

Ecology: Carnaby's Cockatoo occurs in uncleared or remnant areas of eucalypt woodland, principally Salmon Gum *Eucalyptus salmonophloia* or Wandoo *Eucalyptus wandoo*, and shrubland or kwongan heath dominated by *Hakea* and *Banksia* species (Johnstone and Storr 1998).

This Cockatoo nests in hollows of live or dead eucalypts, primarily Salmon Gum and Wandoo. A close association between its woodland nesting habitat and foraging areas is important to the breeding success of the cockatoo (Cale 2003). After the breeding season, Carnaby's Cockatoo moves to higher rainfall coastal areas that feature areas of feeding habitat and accessible water and trees that provide shade in summer.

1.2.4 Western Rosella

Family: Psittacidae

Conservation Status: Schedule 1: Rare and likely to become extinct under the WCA 1950.



Plate 6 - Western Rosella (inland spp.) (*Platycercus icterotis xanthogenys*) and potential hollow

Distribution: The Inland subspecies of Western Rosella *Platycercus icterotis xanthogenys* occurs within the semiarid southern interior of Western Australia. Described as being rare to moderately common, this species prefers wetter areas of the south west (Johnstone and Storr 1998). This species was once distributed throughout the wheatbelt, but numbers have declined significantly since the 1930's as a result of land clearing (Johnstone and Storr 1998).

Ecology: The Western Rosella primarily inhabits eucalypt and casuarina woodlands and favours Salmon Gum, Wandoo and tall mallees (Johnstone and Storr 1998). This species nests in tree hollows, with favoured nesting trees including Salmon Gum, Wandoo, Marri (*Corymbia.calophylla*), Flooded Gum (*E. rudis*), York Gum (*E. loxophleba*) and Gimlet (*E. salubris*). Nesting hollows are small and are often in a dry sprout leading from a green limb (Johnstone and Storr 1998).

1.2.5 Short Range Endemic invertebrates

The Environment Protection Authority (EPA) *Guidance for the Assessment of Environmental Factors No 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA 2009) indicate that sheltered mesic environments, mountainous terrains and freshwater habitats often harbour SRE's. SRE's are also noted to be confined to discontinuous habitats.

While the habitat associated with the proposed haul road does not specifically support typical SRE habitat as described above, the current extent of knowledge in relation to SRE's and their habitat encourages searches in other less specific environments.

Invertebrate groups targeted during the survey were those considered most likely to potentially contain SRE taxa including:

- Mygalomorphae (trapdoor spiders);
- Diplopoda (millipedes);
- Pseudoscorpionida (pseudoscorpions); and
- Pulmonata (land snails).

Mygalomorph (trapdoor) spiders belong to one of the focal groups in surveys of short-range endemic taxa (Harvey 2002). Many mygalomorph spiders show low dispersal capabilities, may be restricted to relictual habitats, and have long life cycles with low fecundity. The Western Australian mygalomorph fauna is vast and, despite long-term and ongoing research, remains taxonomically poorly known for many families and genera (Framenau and Harvey 2010).

The best taxonomic features to distinguish mygalomorph spiders are found within the genitalia of males. Females or juveniles may be indistinguishable, although burrow morphology may allow identification to species level in some cases (B.Y. Main *pers. comm.)*

Diplopoda (millipedes): Millipedes are an extremely diverse group of animals, with nine different orders represented in Australia. The most abundant millipede group in Western Australia is the genus *Antichiropus.* This genus is now known to consist of over 100 species, ranging as far north as Cape Range and Barlee Range, and extending onto the Nullarbor Plain and the Eyre Peninsula in South Australia. With the exception of *Antichiropus variabilis*, which inhabits the jarrah forests of south-western WA, all species of the genus are known to be SRE's, and many are known from only a few hundred square kilometres (Harvey 2002).

Pseudoscorpionida (pseudoscorpions): The Western Australian pseudoscorpion fauna is fairly diverse with representatives in 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats.

Pulmonata (land and aquatic snails): The Pulmonata, or "pulmonates," are an informal group of snails and slugs characterized by the ability to breathe air, by virtue of having a pallial lung instead of a gill, or gills. The group includes many land and freshwater families, and several marine families.

1.3 PURPOSE AND SCOPE

The objective of the targeted vertebrate fauna survey was to ground truth the vegetation within the proposed haul road area and determine critical habitat locations for the four vertebrate species of conservation significance, namely the Chuditch, Malleefowl, Carnaby's Cockatoo and Western Rosella.

The objective for the targeted invertebrate survey was to determine potential SRE habitat and, if present, search these areas accordingly. In addition, searches were conducted in representative vegetation associations. Given the limited knowledge currently available for many invertebrate species, particularly short range endemic species, searches were also conducted in representative vegetation associations outside of the proposed footprint of disturbance.

Invertebrate groups targeted during the searches included trapdoor spiders, millipedes, pseudoscorpions and land snails.

The purpose of this report is to document the methodology and results of the targeted vertebrate and invertebrate fauna surveys conducted by KLA in June and July 2010. .

Therefore, the scope of work for the fauna surveys in the area proposed for the haul road was to:

- identify vegetation communities that support critical habitat for the four vertebrate species of conservation significance,
- conduct a targeted search for the Chuditch, Malleefowl, Carnaby's Cockatoo and Western Rosella and their habitats within favoured vegetation communities;
- conduct targeted SRE searches in potential SRE habitat;
- provide an impact risk assessment for selected targeted vertebrate and invertebrate fauna species;
- provide recommendations, including the management of selected fauna of conservation significance and their habitats.

1.4 PREVIOUS RELEVANT FAUNA SURVEYS

1.4.1 Vertebrate survey

A Single Phase Fauna Survey was conducted along the proposed route of the haul road in November and December 2009 (Biota 2010). In relation to the species targeted for this survey:

- one adult female Chuditch and one sub-adult female Chuditch were captured at the southern end of the proposed haul road in a vegetation community described as *Eucalyptus* spp. mallee woodland over *Melaleuca* spp. heath.
- Three individual Carnaby's Cockatoo were seen flying overhead in the southern area of the proposed haul road and Biota (2010) reported that this species had been recorded in past surveys within the Forrestania area.
- While the Western Rosella was not recorded during the Single Phase Fauna Survey, Biota (2010) reported that this species had been recorded previously in the Forrestania area.
- A recently disused Malleefowl nesting mound was also recorded at the southern end of the proposed haul road in *Melaleuca* spp. shrubland and heath vegetation community.

1.4.2 Invertebrate surveys

Biota Environmental Sciences (Biota) has conducted numerous mygalomorph studies in the Forrestania area:

- January and May 2008: 47 sites were surveyed between Flying Fox and Cosmic Boy including eight sites in areas of remnant woodland at Mossco's farm 30 km south. Of the 47 sites, mygalomorphs were identified in 38 sites and collections were made from 37 of the 38 sites. A total of 200 mygalomorph spiders were excavated all of which were female and juveniles and, therefore, were unable to be identified to species level. Tissue (section of leg) collected from these specimens was sent to the University of Western Australia for molecular analysis. Up to five separate morphospecies were identified. However, genetic analysis indicates that perhaps three putative genetic types occur in the area. Results indicate that the Idiopid trapdoor spiders in the FNP area are not restricted to any one specific site (Biota 2008, 2009).

- November and December 2009: A total of nine potential SRE fauna species were collected during the Single Phase Fauna Survey along the proposed haul road between Spotted Quoll and Cosmic Boy (Biota 2010). Eight species of mygalomorph spiders and one pseudoscorpion species were collected. Molecular investigation confirmed six of the eight species of mygalomorphs were of the genus *Aname* or *Chenistonia* (yet to be determined; Family Nemesiidae), one species of *Aganippe* (Family Idiopidae) and one species of *Eucyrtops* (Family Idiopidae).

  Two individuals of the single pseudoscorpion species were identified as a species of *Haplochernes* (Family Chernetidae).

2.0

2.0 BIOPHYSICAL ENVIRONMENT

The area proposed to be cleared comprises a road corridor measuring approximately 20 m in width by 14.6 km in length from the Spotted Quoll project area to the Cosmic Boy processing plant (Figure 3). In order to provide some flexibility in the alignment of the route, a corridor of up to 120 m was searched along the length of the route, with additional areas (~160 m wide) at both the northern and southern ends of the proposed haul road (Figure 3).

2.1 VEGETATION MAPPING

The project area is located within the Coolgardie Botanical District within the Eremaean Province of Western Australia (Beard 1990). This district comprises predominantly scrub-heath on sandplain, with *Acacia-Casuarina* thickets on ironstone gravels, Salmon Gum, Wandoo and York Gum on loams and halophytes on saline soils (Beard 1990).

Botanica Consulting conducted a flora and vegetation survey of the Spotted Quoll – Cosmic Boy haul road encompassing 412.4 ha (Botanica Consulting 2011). Eleven vegetation groups and three sub-groups were identified within the area:

- Rehabilitation area;
- *Eucalyptus urna* Woodland;
- *Eucalyptus livida* Woodland;
- *Eucalyptus salubris* Woodland;
- *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland;
- Mixed Mallee shrubland over *Melaleuca* shrubland*;*
- Burnt *Eucalyptus salmonophloia* woodland over mixed Mallee shrubland; including
    - Sub-group *Melaleuca hamata* thicket and
    - Sub-group *Melaleuca lanceolata* thicket;
- *Eucalyptus salmonophloia* Woodland;
- Mixed Mallee and Mixed shrubs on Banded Ironstone Ridge,
- Mixed Mallee shrubland including
    - Sub-group *E. horistes* Mallee shrubland; and
- *E. goniocarpa* shrubland (Figures 4 and 5).

No Declared Rare Flora (DRF) were recorded within the survey area and four Priority flora species were recorded; *Stenanthemum liberum (*P1), *Stylidium sejunctum* (P2), *Eutaxia acanthoclada* (P3) and *Microcorys* sp. Forrestania (P4). Twenty quadrats were established to further investigate the species composition of the vegetation groups. Two weed species were identified in the area surveyed but neither of these are classified as Declared Plants by the Department of Agriculture and Food of Western Australia (DAFWA 2010). The site is not located within areas designated as Threatened Ecological Communities. However, the survey area is located within buffer zones of the North, Middle and South Ironcap Priority Ecological Communities. These are listed by the DEC as Priority 3 Ecological Communities.

2.2 CRITICAL VEGETATION COMMUNITIES

Aerial mapping of the proposed haul road area was examined in association with vegetation communities delineated by Botanica Consulting (2011) prior to the onsite survey. Initially, it was envisioned that the targeted surveys may be restricted to preferred habitat along the length of the proposed haul road route. However, given the differences in habitat requirements of the four species of conservation significance, in addition to the request to search for SRE's, the entire length of the proposed haul road was searched. Further, it was hypothesized that the habitat was not limited to the proposed haul road route but was extensive within the local area. In order to further determine if the habitat was limited to the proposed haul road route area, an additional area was searched that

extended west of the linear northwest haul road route and included an area known as Boojum Swamp that purportedly supported Salmon Gums and, therefore, preferred habitat for at least Carnaby's Cockatoos (Figure 3). While this additional area was searched for habitat attributes favoured by the four selected vertebrate species, SRE searches were also conducted in representative vegetation associations outside of the area of impact.



Figure 3 - Area surveyed for proposed Haul Road between Spotted Quoll and Cosmic Boy including Boojum Swamp and location of SRE quadrats

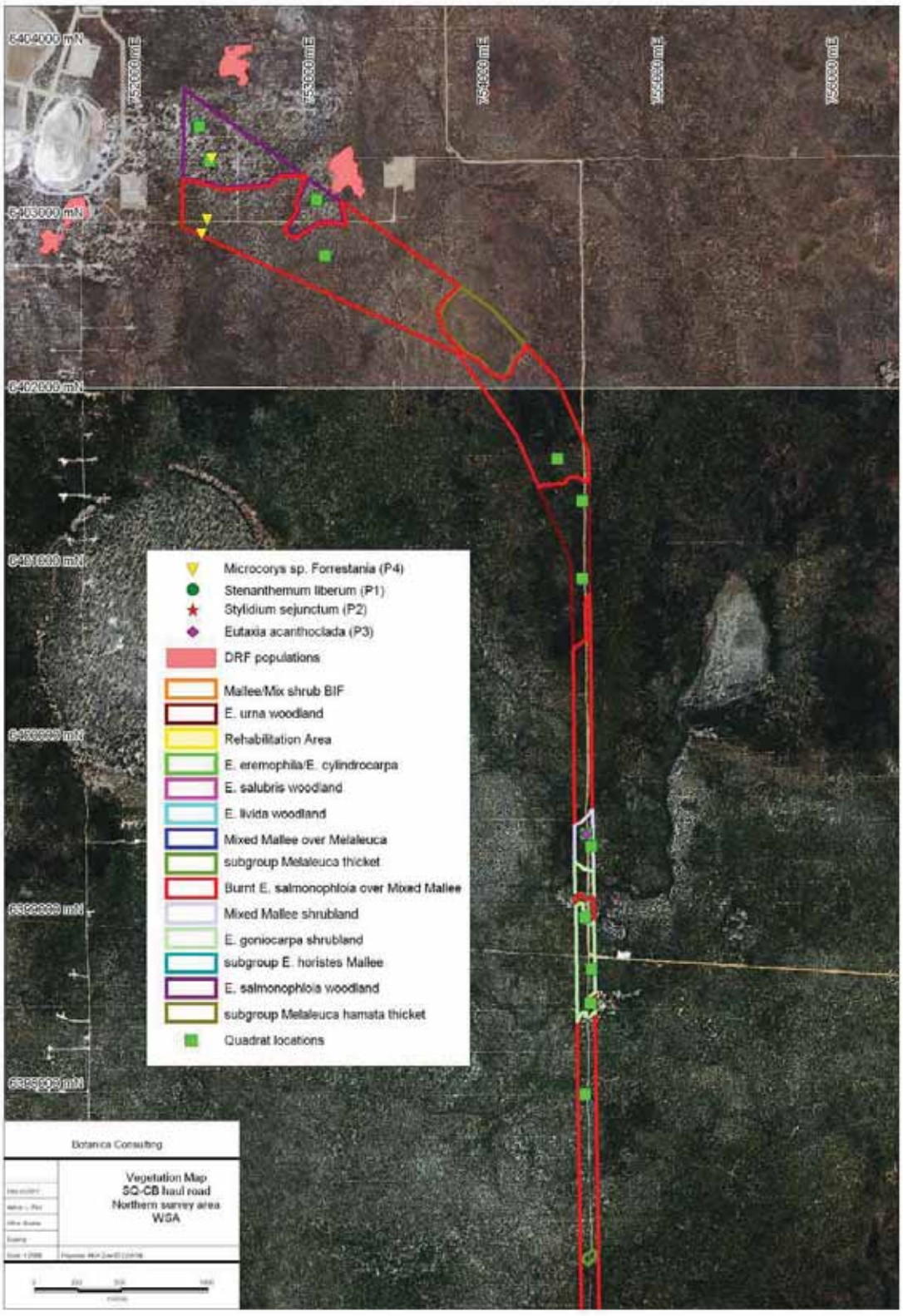


Figure 4 - Vegetation Map of the proposed Haul Road between Spotted Quoll and Cosmic Boy (northern section)
after Botanica Consulting (2011)

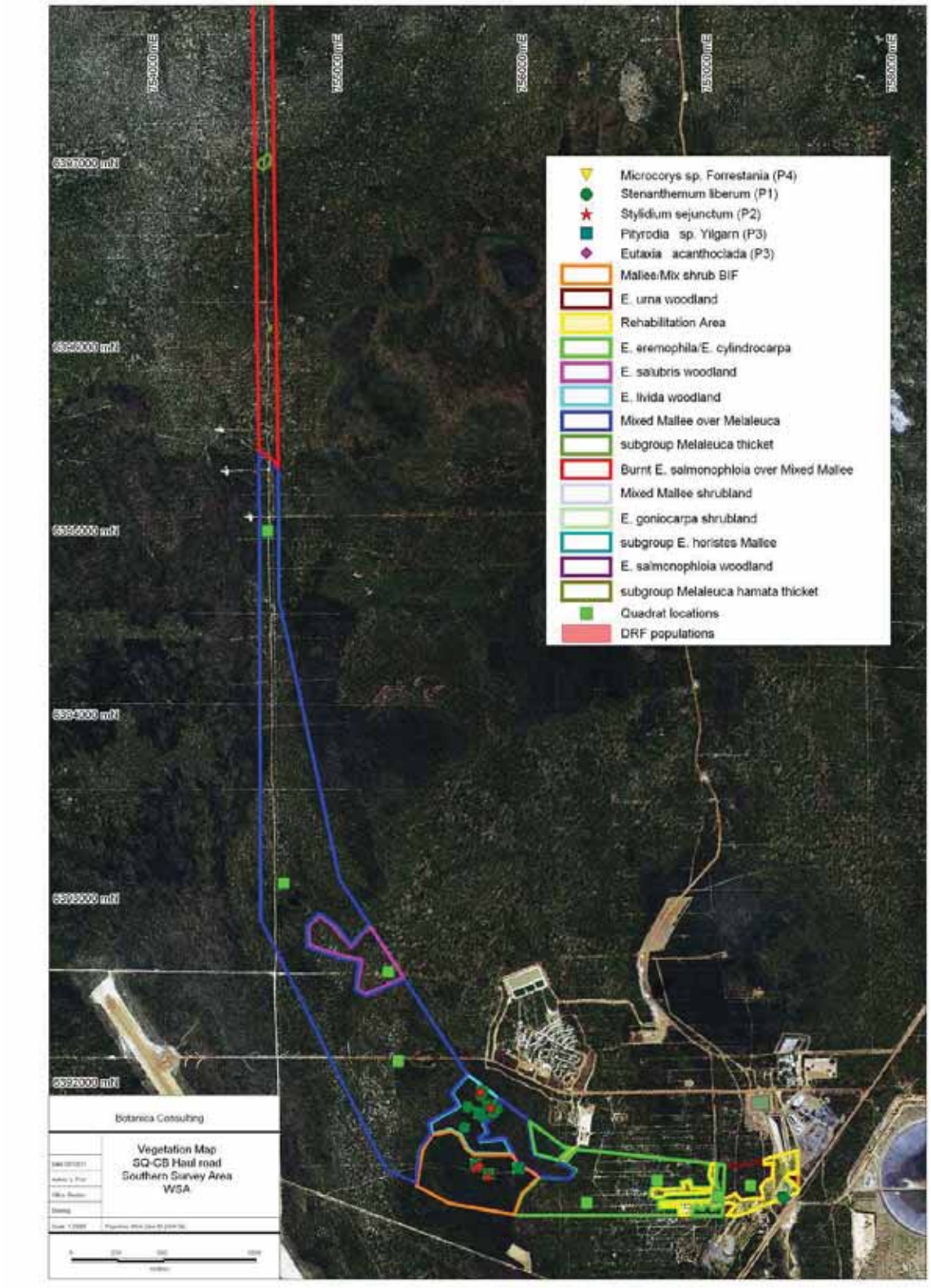


Figure 5 - Vegetation Map of the proposed Haul Road between Spotted Quoll and Cosmic Boy (southern section)
after Botanica Consulting (2011)

3.0 METHODOLOGY

3.1 TARGETED FAUNA SURVEY

The surveys were conducted from 1st to 3rd June 2010 and 29th June to 3rd July 2010 to:

- ground truth the vegetation communities along the survey route,
- inspect the fauna habitats along the survey route,
- determine the potential within these habitats for the targeted species to utilise these areas,
- extend these searches outside of the proposed haul road route to determine if the habitats are limited to the survey or are present elsewhere, and
- identify targeted species present at the time through direct observation and indirect evidence, including dens, hollows, mounds, tracks, scats, feathers and trapdoor spider structures, etc.

3.1.1 Targeted vertebrate fauna species

A line survey approach was adopted that ensured all parts of the proposed route were surveyed. Up to four qualified personnel walked in parallel straight lines. The distance between lines was dictated by the density of the vegetation inasmuch as lines were as close as 5 m to 10 m apart in areas of dense vegetation and others were up to 30 m to 35 m apart in areas of sparse understorey. Two search patterns were used:

- Along the north-south length on the proposed haul road and to, from and within Boojum Swamp, the four personnel walked in parallel lines along the lengths of the routes, and
- at the northern and southern extents of the proposed haul road in areas that broadened out to allow for curve flexibility, the walked route was perpendicular to the proposed haul road route.

In addition to searching for the individual taxa and listening for Carnaby's Cockatoo and Western Rosella calls, specific signs for each species were sought.

For the Chuditch, potential den refugia were recorded and searched where possible. These included stags of trees with usable hollows, hollow areas at the base of fallen trees, hollow logs, in birds' nests, in dense vegetation, burrows and warrens, etc.

Malleefowl mounds were searched for, as well as Malleefowl tracks, scats and feathers.

For Carnaby's Cockatoo, all trees with hollows sufficiently large to accommodate a breeding event or potential hollows were recorded. Hollows were examined for wear around the hollow, chewing, scarring and scratch marks on trunks and branches.

For Western Rosellas, all trees with hollows sufficiently large to accommodate a breeding event or potential hollows were recorded.

Initially, the numbers of potential den refugia for Chuditch and hollows for birds were counted and recorded at odd distances. Thereafter, the numbers of these items were recorded after every 100 m along the lengths walked and GPS locations were taken at these locations.

3.1.2 Targeted invertebrate fauna survey

In accordance with generic advice from the Office of the EPA, 10 m x 10 m quadrats were established in representative landforms and vegetation associations and up to an hour was spent searching for invertebrates in each of these habitats. Searches included under rocks, under bark, under logs, in hollows of logs and in other leaf litter and debris lying on the ground.

Only one of each trapdoor species type was excavated and sent to the Western Australian Museum for identification. Once excavated, the spiders were placed in a freezer for approximately 10 minutes to sedate them. They were then placed in cold 100% Ethanol to narcotise them before the third left leg was removed and placed in a separated vial of 100% ethanol.

While mature males are required to accurately identify mygalomorph species, specialist arachnologist, Dr Barbara York Main of the School of Animal Biology at the University of Western Australia, putatively identifies spider species based on the geographic location of the burrows, the structure of the burrow lid and the presence/absence and architecture of twig lines attached to burrow lids. For the remainder of the spiders, putative identifications were made based on burrow and trapdoor lid characteristics as described by Dr York Main.

In addition to the above searches, a collection of leaf litter and soils was collected from each quadrat and transferred back to Perth for examination. Collections were made from shadowed moist areas, for example, from the south eastern aspect of the bases of tree trunks, etc. Large particles were removed and the remaining collection was examined under a 10X20 Dissecting Microscope. All invertebrate fauna or parts thereof were collected and preserved in accordance with the Western Australian Museum guidelines and sent to appropriate specialists at the Museum for identification.

3.2 PERSONNEL AND REPORTING

The following personnel were involved in the surveys:

- Dr Vi Saffer *BSc (Biol.) Hons (Biol.) PhD (Biol.)*: Senior Zoologist, KLA,
- Mr Hamish Burnett, Field Assistant, TAFE Certificate II Conservation and Land Management, KLA,
- Mr Darren Coulson, Senior Environmental Officer, WSA, FNP and
- Ms Cherie Halfpenny, Environmental Officer, WSA, FNP.
- Mr Keith Lindbeck *BA, WDA, Dip Environ Studies;* Principal, KLA, reviewed the report.

3.3 LICENCE AND PERMITS

A license was not required for the targeted vertebrate survey.

A “LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES” SF007513 was issued by the Department of Environment and Conservation to Dr Vi Saffer to undertake the invertebrate survey (Appendix B). Authorised persons associated with this licence included Hamish Burnett.

3.4 LIMITATIONS

While every attempt was made to survey the entire area, the shrubland vegetation in some areas, particularly in the northern portion of the proposed route, were so dense that there may be some small pockets that were not sighted. It seems reasonable to assume that if the vegetation was that dense, it is unlikely that a Malleefowl would utilise such an area.

Mature males are required for an accurate identification of most mygalomorph spiders. As it was unrealistic to excavate every trap door within each quadrat, representative burrows were excavated and descriptions and digital photographs were taken of other trapdoors to determine the extent of mygalomorph presence within and adjacent to the proposed haul route.

4.0 RESULTS AND DISCUSSION

Approximately 95 person hours were spent traversing the haul road on foot and an additional 10 person hours were spent walking to, within and back from Boojum Swamp.

One hour was spent by two personnel searching for invertebrates and collecting soil at each of 17 invertebrate quadrats.

4.1 FAUNA HABITATS WITHIN THE STUDY AREA

4.1.1 Vegetation groups and vegetation condition within the study areas

Botanica Consulting (2011) identified eleven broad vegetation communities within the survey area, in addition three sub-groups were also recorded. No Declared Rare Flora species or Threatened Ecological Communities were identified in the area surveyed. However, the proposed haul road area is located within the buffer zone of the North, Middle and South Ironcap Priority 3 Ecological Communities. Four Priority flora species, *Stenanthemum liberum (*P1), *Stylidium sejunctum* (P2), *Eutaxia acanthoclada* (P3) and *Microcorys* sp. Forrestania (P4) were recorded along the proposed haul road route. Two weed species were identified in the survey area, neither of which are classified as Declared Plants by the Department of Agriculture and Food of Western Australia (DAFWA 2010).

Disturbance was noted throughout the survey area in the form of historic vegetation clearing for exploration activities and associated tracks and more recent vehicular tracks that traverse many areas. In accordance with Keighery (1994) (Appendix C), the condition of the vegetation overall may be described as 'Very Good'. However, areas away from any disturbance remain in "Excellent' condition and other areas in 'Good' to 'Degraded' condition. No vegetated areas were determined to be in 'Pristine' condition.

4.1.2 Targeted Vertebrate Fauna Survey

The entire length of the proposed haul road route measuring 14.7 km was walked by each of the four personnel spanning approximately 100 m to 130 m in width, equating to approximately 191 ha.

No sightings of the four vertebrate species of conservation significance were recorded during the survey periods. A total of 86 potential Chuditch refugia (Figure 6), three very old Malleefowl mounds (Figure 7), 98 potential Carnaby's Cockatoo breeding hollows (Figure 8) and 200 potential Western Rosella breeding hollows (Figure 9) were recorded within the area surveyed (Appendix D). For the Chuditch, the potential refugia comprised 26 stags, 41 hollow logs and 19 earth burrows including under the bases of fallen trees (Plate 2).

These results suggest that much of the habitat along the central length of the proposed haul road supports a large number of potential refugia and breeding hollows for at least three of the four species of conservation significance, namely the Chuditch, Carnaby's Cockatoo and Western Rosella. Generally, these patterns mirror the changes in vegetation communities along the route (Figures 4 and 5).

Comparisons of Figures 6, 8 and 9 (potential habitat recordings) and vegetation communities (Figures 4 and 5), indicate that habitat characteristics favoured by these three species are well represented primarily in the "Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland" along the length of the proposed haul road. Interestingly, potential habitat for Carnaby's Cockatoo and Western Rosella was not recorded in the same vegetation type in the northern 'curved' section. However, the vegetation in this northern section was noted to be denser than that further south. It was noted however, that

potential refugia for Chuditch were recorded in this northern area, but the majority of these were earth burrows and 'beds' within dense thickets of Dodder *Cassytha* spp. (Plate 2), rather than hollows in stags and logs.

Potential habitat for the Chuditch, Carnaby's Cockatoo and Western Rosella was not recorded in other vegetation communities along the longitudinal portion of the proposed haul road. While few recordings of potential habitat was recorded for each of the three species at the southern end of the proposed haul road route, potential habitat for only the Western Rosella was recorded in the "Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland". Potential habitat for Carnaby's Cockatoo was recorded in "*E. eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland" and in the "Rehabilitation Area", and potential habitat was recorded for the Chuditch in "*E. eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland". These findings suggest that there may be sparse and or scattered Eucalypts in these other vegetation groups in this southern end of the proposed haul road route.



Figure 6 - Location of potential Chuditch refugia



Figure 7 - Location of Malleefowl mounds



Figure 8 - Locations of potential Carnaby's Cockatoo breeding hollows



Figure 9 - Locations of potential Western Rosella breeding hollows

Comparisons of these figures also indicates that potential refugia and hollows are not supported in the "Mixed Mallee shrubland over *Melaleuca* shrubland" which dominates the southern portion of the proposed haul road route.

For the Malleefowl, only three very old mounds were identified in the southern section of the proposed haul road route. Interestingly, all three were recorded in "Mixed Mallee shrubland over *Melaleuca* shrubland" which is not favoured habitat of the other three species.

Although not part of the area of proposed disturbance, an additional Malleefowl mound was located approximately 500 m northeast of the proposed haul road route (753869N 6402938E). This mound had not been used for many years and was exceptionally large (>8 m x 8 m), a characteristic currently being described as a 'megamound'.

An additional 5.4 km were walked to, within and from Boojum Swamp from the proposed haul road. Up to 24 possible refugia sites for Chuditch (Figure 6), 68 potential breeding hollows for Carnaby's Cockatoo (Figure 8) and 326 potential breeding hollows for Western Rosella (Figure 9) were recorded during this leg of the survey (Appendix E). For the Chuditch, the potential refugia comprised 24 stags, 25 hollow logs and 19 earth burrows including under the bases of fallen trees (Plate 2). No Malleefowl mounds were recorded in this area.

These results indicate that only some sections of the proposed haul road route comprise vegetation with attributes that support potential refugia, hollows and potential hollows for Chuditch, Carnaby's Cockatoo and Western Rosella, and primarily this vegetation is described as "Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland". Single or sparse *E. salmonophloia* in other vegetation groups particularly in the southern section of the proposed haul road route also provide potential habitat for these species. Vegetation surveys have not been conducted in areas adjacent to the proposed road route area or in Boojum Swamp. Notwithstanding this, results from these areas indicate that the vegetation outside of the proposed haul road route also supports habitat characteristics favoured by these three species. Thus, vegetation comprising refugia, hollows and potential hollows for Chuditch, Carnaby's Cockatoo and Western Rosella is not limited to areas within the proposed haul road route.

The results also indicate that Malleefowl once used at least the southern portion of the proposed haul road route for mound building but have not done so for many years.

4.1.3 Targeted Invertebrate Fauna Survey

Seventeen 10 m x 10 m quadrats were established in representative vegetation groups along the length of the proposed haul road area (Figure 3 and Table 1). Eight of the quadrats were established within the proposed route of the haul road and, where possible, a second quadrat was established in the same vegetation group outside of the proposed route of the haul road. Only one quadrat was established in "*Eucalyptus salubris* woodland" as this vegetation type did not extend into the proposed route and only one quadrat was established in the small area of "Mixed Mallee and Mixed shrubs on Banded Ironstone ridge" in the southern portion of the proposed route.

Table 1 - Details of invertebrate quadrat search sites along proposed haul road

Quadrat #	GPS location		Vegetation description*	Location in relation to area surveyed for proposed haul road	Invertebrates collected	
	Northings	Eastings			Foraging	Soil sample
1	752360	6403316	*Eucalyptus salmonophloia* Woodland	IN	+	# +
2	752258	6403241	*Eucalyptus salmonophloia* Woodland	OUT	+	#
3	753381	6402778	Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland	OUT	+	# +
4	753289	6402698	Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland	IN	+	+
5	753839	6402704	*Melaleuca hamata* thicket	OUT		
6	753727	6402426	*Melaleuca hamata* thicket	IN		# +
7	754602	6399332	Mixed Mallee shrubland over *Melaleuca* shrubland	OUT		
8	754612	6399304	Mixed Mallee shrubland over *Melaleuca* shrubland	OUT	+	#
9	754536	6399292	Mixed Mallee shrubland over *Melaleuca* shrubland	IN	+	# +
10	754430	6398376	Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland	OUT		+
11	754548	6398356	Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland	IN		# +
12	754566	6394863	Mixed Mallee shrubland over *Melaleuca* shrubland	OUT		#
13	754601	6394821	Mixed Mallee shrubland over *Melaleuca* shrubland	IN		# +
14	755162	6392613	*Eucalyptus salubris* Woodland	OUT	+	# +
15	755814	6391604	Mixed Mallee and Mixed shrubs on Banded Ironstone ridge	IN		# +
16	756521	6391400	*Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland	IN	+	# +
17	756503	6391314	*Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland	OUT	+	#

* after Botanica Consulting (2011)
= land snail,
+ = invertebrate

Invertebrates were recorded from ten of the 17 quadrats with no invertebrates found in the remaining seven quadrats after the hour search. Soil samples were collected from 15 of the 17 quadrats with the remaining two not providing sufficient soil and/or decaying litter. Invertebrates were collected from nine of the soil samples and land snails from 13 (Table 1).

4.1.3.1 Quadrat searches

Three representative spiders were excavated and, together with their burrows and lids, sent to the Western Australian Museum for identification.

The results from the Museum (Framenau and Harvey 2010) identified two female *Aganippe* (Idiopidae) species and one juvenile. Framenau and Harvey (2010) report that the genus *Aganippe* is fairly diverse in Western Australia, with some species showing small distributions. They reiterate that mature males are required for accurate identification and assessment of distribution and conservation status.

Using putative identifications based on burrow and trapdoor characteristics, two of the spiders collected and submitted to the Museum were *Aganippe "squama"* (Quadrats 8 and 17) and one *Aganippe rhaphiduca* twig lining race (Quadrat 16) (Table 2). Of the other spiders recorded in the quadrats, up to 18 *Aganippe "squama"* were recorded with three recorded within the proposed haul road route and 15 recorded outside of the proposed disturbance (Table 2). Two of the 15 recorded outside of the area were old and abandoned. Four *Aganippe rhaphiduca* twig lining race were recorded with one within and three outside of the proposed route. Three *Aganippe "jessupi"* were recorded with one in and two outside of the proposed haul road route. All three did not appear to be occupied and a representative, therefore, was not excavated for submission to the Museum. A total of 25 abandoned burrows and lids were recorded within and outside of the area proposed for disturbance and were unable to be identified to genera or species (Table 2).

A synopsis of the trapdoor spiders recorded indicates that three putative species were collected in eight of the eleven vegetation groups and sub-groups with none recorded in the "Mixed Mallee shrubland over *Melaleuca* shrubland*"*, in the "Mixed Mallee and Mixed shrubs on Banded Ironstone ridge" or in the "*Melaleuca hamata* thicket" sub-group. Specimens of all three putative species were recorded both within and outside of the area proposed for disturbance.

These results indicate that of the vegetation groups (or sub-groups) that support mygalomorph spiders, none of the areas within the proposed the haul road are sufficiently different or unique inasmuch as they support spiders that are not found elsewhere.

Table 2 - Putative identifications of spiders recorded during the targeted invertebrate survey within and outside of the proposed haul road route

Quadrat #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Relative location	IN	OUT	OUT	IN	OUT	IN	OUT	OUT	IN	OUT	IN	OUT	IN	OUT	IN	IN	OUT
Aganippe "squama"																	
collected	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
recorded	1	3 new	2	1	-	-	-	2	1	-	-	-	-	3	-	-	3
	-	2 old	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aganippe rhaphiduca twig lining race																	
collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
recorded	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	1	-
Aganippe "jessupi	-	-	1 new	1 old	-	-	-	1	-	-	-	-	-	-	-	-	-
	-	-	2 old	v	-	-	-	-	-	-	-	-	-	-	-	-	-
borrow hole (unidentified species)	4	3	-	-	-	-	-	-	-	-	1	-	-	7	-	-	1
lid (unidentified species)	1	1	3	1	-	-	-	-	-	-	-	-	-	1	-	1	1

4.1.3.2 Litter and soil samples

Examination of the litter and soil samples resulted in the collection of nine pseudoscorpions, one symphylan, one scorpion (Table 3) and 86 land snails (Table 4).

Species from three families of pseudoscorpions were collected, namely Atemnidae, Chernetidae and Olpiidae (Table 3). Atemnids are frequently found under bark of trees in Western Australia, but the systematics of the group, in particular of the genus *Oratemnus*, is uncertain and the taxonomy of individual species unclear. However, based upon current evidence, it seems that most species will eventually be found to be widely distributed (Framenau and Harvey 2010). For this reason, the *Oratemnus* specimens collected during the survey at Forrestania are not likely to represent a short-range endemic species. Members of this species were collected from both within and outside of the area proposed for disturbance with one in "*Eucalyptus salmonophloia* Woodland", two in "Burnt *Eucalyptus salmonophloia* woodland over mixed Mallee shrubland" and one in "Mixed Mallee shrubland over *Melaleuca* shrubland".

Chernetidae are the most diverse of all pseudoscorpion families with 113 named genera and 652 named species worldwide. The Australian fauna is quite extensive, with 37 described species (Harvey 2009). Chernetid pseudoscorpions are generally found under bark of trees and it is unlikely that the three specimens collected during the targeted survey include any short-range endemic species. The Chernitids were collected from both within and outside of the proposed haul road route and in three different vegetation groups namely "Mixed Mallee shrubland over *Melaleuca* shrubland*", "Eucalyptus salubris* Woodland" and "*Eucalyptus eremophila* subsp. *eremophila* and *Eucalpytus cylindrocarpa* Mallee Woodland".

Within the Olpiidae, a single specimen of *Beierolpium* 'sp. 8/4' and two unidentified juvenile *Beierolpium* were identified (Framenau and Harvey 2010). *Beierolpium* 'sp. 8/4' and one of the juveniles were collected in "Burnt *Eucalyptus salmonophloia* woodland over mixed Mallee shrubland" and the remaining juvenile was collected in "Mixed Mallee shrubland over *Melaleuca* shrubland". While *Beierolpium* 'sp. 8/4' was collected outside of the proposed route, the two juveniles were collected inside of the area of proposed disturbance. The systematic status of members of this genus has not been fully assessed. As such it was not possible to establish the identity of these species and a complete taxonomic revision of the genus *Beierolpium* in Western Australia is necessary to confirm their conservation status.

One Symplylid was collected in the "Burnt *Eucalyptus salmonophloia* woodland over mixed Mallee shrubland" within the proposed haul road route. Framenau and Harvey (2010) report that Symphyla remain taxonomically poorly known and it is currently impossible to determine if the single symphylid specimen collected represents a short-range endemic species. However, the vegetation complex in which it was found is extensive and not limited to the survey area. No identification was provided for the scorpion.

A total of 86 land snails or parts thereof were collected from 13 of the 17 quadrats. All specimens belonged to the terrestrial pulmonate families: Punctidae, Pupillidae and Bulimulidae and all were identified as being indigenous to Western Australia (Table 4) (Slack-Smith and Whisson 2010).

Within the Punctidae, the tiny specimens collected at all 13 quadrats most closely resemble the species *Westralaoma* sp. c.f. *W. expicta* Iredale,1939 (Slack-Smith and Whisson 2010). This species was collected in quadrats located in six vegetation groups and one sub-groups within the proposed haul road area and was collected in quadrats that were located both within the proposed haul road route and outside of the area of disturbance.

Punctids are generally not well known mainly because of their small to minute size. Collecting methods used in the past were unsuitable for detecting such tiny organisms and there has been a lack of research publications pertinent to this group since Iredale's

descriptions of some new species within the Western Australian snail fauna in 1939. Notwithstanding this, current knowledge indicates that this species shows no evidence of short-range endemism at either the species or, indeed, the population level (Slack-Smith and Whisson 2010).

Table 3 - Invertebrates collected during the targeted invertebrate survey within and outside of the proposed haul road route

Quadrat #	Relative location	Family	Species
1	IN	Artemnidae	*Oratemnus* sp.
3	OUT	Artemnidae	*Oratemnus* sp.
4	OUT	Artemnidae	*Oratemnus* sp.
	OUT	Olpiidae	*Beierolpium* 'sp. 8/4'
8	IN	Artemnidae	*Oratemnus* sp.
	IN	Olpiidae	*Beierolpium* 'indet.'
	IN	Symphyla	'indet.'
10	IN	Olpiidae	*Beierolpium* 'indet.'
13	OUT	Chernetidae	'indet.'
14	IN	Chernetidae	'indet.'
16	IN	Chernetidae	indet.

Table 4 - Land snail species collected during the targeted invertebrate survey within and outside of the proposed haul road route

Site #	Relative location	Family	Species
1	IN	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
2	OUT	Pupillidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
3	OUT	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
6	IN	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
8	OUT	Pupillidae	*Gastrocopta margaretae* (Cox, 1868)
		Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
		Pupillidae	*Gastrocopta margaretae* (Cox, 1868)
		Pupillidae	*Gastrocopta* sp. (very young juveniles)
		Bulimulidae	*Bothriembryon* sp. (very young juveniles)
		Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
9	IN	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
11	IN	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
12	OUT	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
13	IN	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
		Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
14	OUT	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
15	IN	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
16	IN	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939
17	OUT	Punctidae	*Westralaoma* sp. cf. *W. expicta* Iredale, 1939

Pupillid and Bulimulid specimens were collected only from Quadrat 8 ("Mixed Mallee shrubland over *Melaleuca* shrubland"). The tiny pupillid snail was identified as *Gastrocopta margarethae (*Cox, 1868) which, together with all recognized species within this genus, exhibits extensive geographic ranges (Slack-Smith and Whisson 2010).

The genus of the one juvenile and broken shell pieces of the bulimulid species collected in Quadrat 8 was identified as *Bothriembryon* spp. However, species identification was not possible. While they most resemble some specimens from the area between the southwest part of Lake Johnston and the northeast part of Lake Hope, they are less like specimens from just north of that area or specimens found to the north of FNP area (Slack-Smith and Whisson 2010). Slack-Smith and Whisson (2010) suggest that the geographic range of *Bothriembryon* tends to be more confined for rock-dwelling species than that for sand plain dwellers. Given that there no rocky habitats with the proposed haul road route, and that the only specimens collected were from outside of the proposed haul road route, the proposed disturbance is not likely to alter the conservation status of this species.

5.0 DISCUSSION AND RECOMMENDATIONS

No sightings of the selected vertebrate species were recorded during the surveys. However, the results established that there are many potential refugia and hollows for Chuditch, Carnaby's Cockatoo and Western Rosella within the area proposed for disturbance and particularly in "Burnt *Eucalyptus salmonophloia* woodland over mixed Mallee shrubland".

The results also indicated that these habitat characteristics are not generally supported by "Mixed Mallee shrubland over *Melaleuca* shrubland" which occurs predominantly in the southern half of the proposed haul road route. While vegetation surveys have not been conducted beyond the proposed area of disturbance, the habitat surveyed between the proposed haul road and Boojum Swamp and within the Boojum Swamp area also provides many potential refugia and hollows. This clearly demonstrates that the habitat favoured by the Chuditch, Carnaby's Cockatoo and Western Rosella is not limited to the area proposed for development and is found elsewhere.

A recent vertebrate survey (Biota 2010) captured two Chuditch in the southern portion of the proposed area in the "Mallee woodland over *Melaleuca*", indicating that Chuditch utilise the area. However, given that Chuditch occur at low densities and have large home ranges (over 15 km^2 for males and 4 km^2 for females) and considering the number of potential refugia available locally, the narrow linear area proposed for development is not likely to significantly impact habitat availability for this species. Similarly, given the low populations of Carnaby's Cockatoo and Western Rosellas observed and recorded generally in the area, and the number of hollow and potential hollows available, the opportunities for hollow selection for these species certainly does not appear to be limited.

Avian specialist R. Johnstone of the Western Australia Museum has advised that while preferred habitat for Carnaby's Cockatoo within the survey area must be considered, the threatened classification of the Western Rosella refers to their presence and habitat in the fragmented vegetation in the wheatbelt, and not the contiguous vegetation present in the Forrestania area.

No active Malleefowl mounds were found within the areas surveyed and no signs of Malleefowl presence were recorded. However, three old Malleefowl mounds were identified within the area proposed for disturbance and a fourth 'megamound' was located within 500 m northeast of the northern portion of the proposed haul road. The presence of these mounds indicated that Malleefowl once did use this area. A recent targeted Malleefowl survey within 5 km of the northern section of the current survey area identified eight old, abandoned Malleefowl mounds and only one active mound (753926E 6405992N) (KLA 2010). Given the large home range (up to 4.6 km) of the Malleefowl and the amount of undisturbed vegetation locally, the development of the proposed haul road is not likely to impact on the Malleefowl and its potential mound-building habitat.

For the invertebrates, the intent of this targeted survey was to determine if the habitat proposed for disturbance was sufficiently different inasmuch as any species recorded within the area are not found elsewhere. Paired quadrats were established within and outside of the area proposed for disturbance in representative vegetation groups where possible. Invertebrates were recorded in more than half (56%) of the quadrats. Using putative identifications based on burrow and trapdoor morphology, three species of mygalomorphs were recorded in eight of the eleven vegetation groups and sub-groups both within and outside of the area proposed for disturbance. This clearly indicates that the habitat within the proposed haul road route is not sufficiently different to an extent that these species of spiders are not found outside of the proposed zone of impact. It is also noted that vegetation groups identified within the area are not limited locally but occur more broadly in the region (Botanica Consulting 2011).

Previous targeted mygalomorph surveys in the Forrestania area including the Spotted Quoll area, determined that Idiopid trapdoor spiders are not restricted to any one specific site (Biota 2008, 2009).

Nine pseudoscorpions, one symphylan, one scorpion and 86 land snails were collected from soil samples and decaying leaf litter and were submitted to the Museum for identification. Of the species identified, three Families of pseudoscorpions were listed: Atemnids (*Oratemnus* spp.), (unidentified) species of Chernetidae and three Oliipids (*Beierolpium* spp.) were collected both within and outside of the proposed haul road route. All were collected in vegetation groups that are not limited to the local area (Botanica Consulting 2011). While taxonomic analysis is required to determine the conservation status of the adult *Beierolpium* ('sp. 8/4'), it is unlikely that any of the other species are short range endemics (Framenau and Harvey 2010).

A single Symplylid was collected within the proposed impact area. However, the vegetation complex in which it was found is extensive and not limited to the survey area. Taxonomic analysis of Symphyla is required to comment on the possible endemicity of this taxa.

Three families of land snails were recognised: Punctidae, Pupillidae and Bulimulidae. Within the Punctidae, all species most closely resemble *Westralaoma* sp. c.f. *W. expicta* Iredale, 1939. Specimens were collected in a variety of vegetation groups both within and outside of the proposed area of disturbance, and current knowledge indicates that this species shows no evidence of short-range endemism at either the species or the population level (Slack-Smith and Whisson 2010).

Pupillid and Bulimulid specimens were collected only from "*Eucalyptus salmonophloia* Woodland" and "Mixed Mallee shrubland over *Melaleuca* shrubland" and only from outside of the area of proposed disturbance. While the tiny pupillid snail, identified as *Gastrocopta margarethae* Cox, 1868, exhibits extensive geographic ranges, the identification of the Bulimulid (*Bothriembryon* sp.) could not be made beyond that of genus (Slack-Smith and Whisson 2010). It is noted that the vegetation complexes that support these species are not limited to the survey area.

In conclusion, vegetation complexes and fauna habitat are not limited to the proposed haul road route and extend beyond the zone of impact. Given the narrow linearity of the area proposed for disturbance, the development of a haul road between Spotted Quoll and Cosmic Boy is unlikely to have a significant impact on the habitat potential for the Chuditch, Malleefowl, Carnaby's Cockatoo, Western Rosella or any invertebrate species and is unlikely to alter the conservation status of any of these species.

The EPA objective for terrestrial fauna is to maintain the abundance, species diversity and geographical distribution of terrestrial vertebrate and invertebrate fauna and protect specially protected (Threatened) fauna consistent with the provisions of the WCA 1950.

The following recommendations arise from the findings of the targeted surveys conducted for the proposed haul road between Spotted Quoll and Cosmic Boy:

- No clearing to be conducted during the breeding season of Carnaby's Cockatoo (July to November).
- If clearing is to occur during the breeding season of Carnaby's Cockatoo (July to November), all potential breeding hollows are to be checked by cockatoo specialists prior to clearing. If a breeding event is recorded, no clearing is to occur until the breeding event is completed and hollow has been vacated.
- Avoid all other large trees and stags with hollows where possible;
- Any other clearing be minimised in extent given that the abundance and diversity of species lost will be proportional to the amount of habitat cleared;

- Where possible, the haul road be aligned to existing tracks and other barriers or follow the boundaries of broad-scale intact native vegetation;
- Erect signage to alert drivers of (possible) presence of Chuditch and Malleefowl;
- Enforce appropriate speed restrictions;
- Continue feral animal control strategies;
- All sightings of selected species to be reported to environmental officers;
- All members of the work force on site attend an environmental induction to ensure they are familiar with the value of native vegetation to vertebrate and invertebrate fauna indigenous to Western Australia. This should include awareness of driving restrictions, ensuring that off-road driving is minimised, the importance of fire prevention, and the care of fauna in the event of an accident involving fauna.

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APPENDIX A
Categories used in the assessment of conservation status

IUCN categories (based on review by Mace and Stuart 1994) as used for the Environmental Protection and Biodiversity Conservation (EPBC) Act 1999 and the WA *Wildlife Conservation Act 1950*.

Extinct. Taxa not definitely located in the wild during the past 50 years.

Extinct in the Wild. Taxa known to survive only in captivity.

Critically Endangered. Taxa facing an extremely high risk of extinction in the wild in the immediate future.

Endangered. Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable. Taxa facing a high risk of extinction in the wild in the medium-term future.

Near Threatened. Taxa that risk becoming Vulnerable in the wild.

Conservation Dependent. Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Data Deficient (Insufficiently known). Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Least Concern. Taxa that are not Threatened.

Schedules used in the WA *Wildlife Conservation Act 1950*.

Schedule 1. Rare and Likely to become Extinct.

Schedule 2. Extinct.

Schedule 3. Migratory species listed under international treaties.

Schedule 4. Other Specially Protected Fauna.

Department of Environment and Conservation Priority Species

(species not listed under the Conservation Act, but for which there is some concern)

Priority 1. Taxa with few, poorly known population on threatened lands.

Priority 2. Taxa with few, poorly known populations on threatened lands, or taxa with several, poorly known populations not on conservation lands.

Priority 3. Taxa with several, poorly known populations, some on conservation lands.

Priority 4. Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

Priority 5. Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

JAMBA The agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment. Australian Treaty Series 1981 No 6.

CAMBA The agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment. Australian Treaty Series 1988 No 22.

ROKAMBA The agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds and their Environment. Australian Treaty Series 2007 ATS 24.

APPENDIX B
Licence to Take Fauna for Scientific Purposes

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: Locked Bag 30
Bentley Delivery Centre WA 6983

PAGE NO. 2
SF007513
PERSON NO. 78973

DATE OF ISSUE	29/06/2010
VALID FROM	29/06/2010
DATE OF EXPIRY	03/07/2010

LICENSING OFFICER

(VI)

LICENSEE:	DR V SAFFER
ADDRESS	SENIOR BIOLOGIST KEITH LINDBECK & ASSOCIATES P.O. BOX 144 BULLCREEK W.A. 6149

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: Locked Bag 30
Bentley Delivery Centre WA 6983

PAGE NO. 1
SF007513
PERSON NO. 78973

RECEIPT NO. AMOUNT
$0.00

WILDLIFE CONSERVATION ACT 1950
REGULATION 17

LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

THE UNDERMENTIONED PERSON MAY TAKE FAUNA FOR RESEARCH OR OTHER SCIENTIFIC PURPOSES AND WHERE AUTHORISED, KEEP IT IN CAPTIVITY, SUBJECT TO THE FOLLOWING AND ATTACHED CONDITIONS, WHICH MAY BE ADDED TO, SUSPENDED OR OTHERWISE VARIED AS CONSIDERED FIT.

DIRECTOR GENERAL

CONDITIONS

1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.

2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.

3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.

4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.

5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR BE HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTOR GENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.

6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.

7 **********ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE COMMONWEALTH DEPT OF THE ENVIRONMENT AND WATER RESOURCES, PHONE 02 6274 1900. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.**********

8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.

9 FURTHER CONDITIONS (NUMBERED TO) ARE ATTACHED.

PURPOSE COLLECT INVERTEBRATES, TARGETING SHORT RANGE ENDEMICS, USING HAND FORAGING, BARK AND LEAF LITTER SAMPLING AND BURROW EXCAVATION, FOR ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED HAUL ROAD BETWEEN SPOTTED QUOLL AND FLYING FOX PROJECT AREAS, FORRESTANIA NICKEL PROJECT (YILGARN).

AUTHORISED PERSONS HAMISH BURNETT

APPENDIX C
Keighery, B.J. (1994) Vegetation Condition Scales

Pristine (1). Pristine or nearly so, no obvious signs of disturbance.

Excellent (2). Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.

Very Good (3). Vegetation structure altered, obvious signs of disturbance.
For example, disturbance to vegetation structure caused by repeating fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Good (4). Vegetation structure significantly altered by very obvious signs of multiple disturbance.
Retains basic vegetation structure or ability to regenerate it.
For example, disturbance to vegetation structure caused by frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded (5). Basic vegetation structure severely impacted by disturbance.
Scope for regeneration but not to a state approaching good condition without intensive management.
For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded (6). The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.
These areas are often described as 'parkland cleared' with the flora compromising weed or crop species with isolated trees or shrubs.

APPENDIX D
Location of all recording points along the survey route of the proposed haul road

Easting	Northing	Date	Carnaby's Cockatoo	Western Rosella	Chuditch		
					Stag	Hollow Log	Under base
752269	6403286	2-Jun-10	0	0	0	0	1
752587	6403202	2-Jun-10	0	0	0	0	1
752820	6403017	2-Jun-10	0	0	1	0	0
752837	6403004	2-Jun-10	0	0	0	0	1
753151	6402872	2-Jun-10	0	0	0	0	0
753423	6402655	2-Jun-10	0	0	1	0	0
753321	6402631	2-Jun-10	0	0	0	0	0
753473	6402591	2-Jun-10	0	0	0	0	0
753564	6402583	2-Jun-10	0	0	0	0	1
753645	6402472	2-Jun-10	0	0	0	0	0
753797	6402361	2-Jun-10	0	0	0	0	0
753999	6402254	2-Jun-10	0	0	0	0	0
754037	6402198	2-Jun-10	0	0	0	0	0
754078	6402183	2-Jun-10	0	0	0	0	0
754143	6402173	2-Jun-10	0	0	0	0	1
754159	6402108	2-Jun-10	0	0	0	0	1
754120	6402103	2-Jun-10	0	0	0	1	0
754318	6401842	2-Jun-10	0	0	0	0	0
754322	6401778	2-Jun-10	0	1	0	0	0
754366	6401726	2-Jun-10	0	0	1	0	1
754388	6401698	2-Jun-10	0	1	3	1	0
754450	6401542	2-Jun-10	0	0	0	1	0
754451	6401481	2-Jun-10	3	5	4	0	0
754492	6401397	2-Jun-10	1	1	0	6	0
754479	6401354	3-Jun-10	0	0	2	0	0
754512	6401302	3-Jun-10	1	0	1	8	0
754482	6401268	3-Jun-10	0	0	0	3	0
754520	6401048	3-Jun-10	0	5	4	1	3
754494	6400931	3-Jun-10	0	0	0	0	0
754500	6400930	3-Jun-10	0	0	0	0	0
754507	6400613	3-Jun-10	1	10	0	0	4
754505	6400414	3-Jun-10	6	14	2	0	0
754496	6400257	3-Jun-10	5	6	0	0	0
754514	6400035	3-Jun-10	5	4	0	2	0
754508	6399915	3-Jun-10	0	0	0	0	0
754506	6399632	3-Jun-10	7	10	0	0	0
754508	6399251	3-Jun-10	0	5	0	0	0
754524	6398766	3-Jun-10	0	0	0	0	0
754529	6398483	3-Jun-10	0	0	0	0	0

Easting	Northing	Date	Carnaby's Cockatoo	Western Rosella	Chuditch		
					Stag	Hollow Log	Under base
754524	6398042	3-Jun-10	4	11	0	1	0
754534	6397864	3-Jun-10	6	13	0	2	3
754530	6397754	3-Jun-10	0	0	0	0	0
754525	6397654	3-Jun-10	2	0	0	0	0
754534	6397556	3-Jun-10	0	2	0	0	0
754532	6397458	3-Jun-10	0	0	0	0	0
754523	6397363	3-Jun-10	1	2	0	0	0
754537	6397249	3-Jun-10	0	5	0	0	0
754530	6397140	3-Jun-10	5	16	0	1	0
754541	6397038	3-Jun-10	2	7	0	0	0
754543	6396930	3-Jun-10	2	1	0	0	1
754545	6396889	3-Jun-10	0	0	0	0	0
754563	6396869	3-Jun-10	0	0	0	0	0
754542	6396817	3-Jun-10	0	3	0	1	0
754534	6396732	3-Jun-10	6	6	0	3	0
754546	6396633	3-Jun-10	0	5	0	3	0
754557	6396503	3-Jun-10	0	4	0	1	0
754554	6396400	3-Jun-10	1	2	0	0	0
754584	6396223	1-Jul-10	3	7	0	0	0
754586	6396113	1-Jul-10	2	1	1	1	0
754586	6395999	1-Jul-10	2	3	1	0	0
754602	6395899	1-Jul-10	7	8	2	0	0
754582	6395773	1-Jul-10	1	12	1	0	0
754590	6395670	1-Jul-10	4	7	0	1	0
754595	6395496	1-Jul-10	2	12	2	2	0
754601	6395360	1-Jul-10	1	5	0	0	1
754600	6395256	1-Jul-10	0	4	0	0	0
754602	6395154	1-Jul-10	0	0	0	0	0
754595	6395058	1-Jul-10	0	0	0	0	0
754595	6394959	1-Jul-10	0	0	0	0	0
754609	6394853	1-Jul-10	0	0	0	0	0
754602	6394761	1-Jul-10	0	0	0	0	0
754604	6394662	1-Jul-10	0	0	0	0	0
754601	6394560	1-Jul-10	0	0	0	0	0
754606	6394420	1-Jul-10	0	0	0	0	0
754605	6394256	1-Jul-10	0	0	0	0	0
754605	6394153	1-Jul-10	0	0	0	0	0
754605	6394051	1-Jul-10	0	0	0	0	0
754602	6393954	1-Jul-10	0	0	0	0	0
754610	6393854	1-Jul-10	0	0	0	0	0

Easting	Northing	Date	Carnaby's Cockatoo	Western Rosella	Chuditch		
					Stag	Hollow Log	Under base
754610	6393756	1-Jul-10	0	0	0	0	0
754624	6393658	1-Jul-10	0	0	0	0	0
754628	6393580	1-Jul-10	0	0	0	0	0
754625	6393481	1-Jul-10	0	0	0	0	0
754625	6393381	1-Jul-10	0	0	0	0	0
754635	6393279	1-Jul-10	0	0	0	0	0
754636	6393181	1-Jul-10	0	0	0	0	0
754658	6393018	1-Jul-10	0	0	0	0	0
754677	6392983	1-Jul-10	0	0	0	0	0
754711	6392884	1-Jul-10	0	0	0	0	0
754740	6392792	1-Jul-10	0	0	0	0	0
754756	6392688	1-Jul-10	0	0	0	0	0
754816	6392611	1-Jul-10	0	0	0	0	0
754805	6392597	1-Jul-10	0	0	0	0	0
754844	6392512	1-Jul-10	0	0	0	0	0
754976	6392411	1-Jul-10	0	0	0	0	0
755048	6392341	1-Jul-10	0	0	0	0	0
754948	6392281	1-Jul-10	0	0	0	0	0
755138	6392253	1-Jul-10	0	0	0	0	0
755216	6392165	1-Jul-10	0	0	0	0	0
755085	6392164	1-Jul-10	0	0	0	0	0
757316	6391515	1-Jun-10	1	1	0	0	0
756970	6391513	1-Jun-10	0	0	0	0	0
756659	6391512	3-Jun-10	0	0	0	0	0
756311	6391491	3-Jun-10	0	0	0	0	0
756807	6391482	1-Jun-10	0	0	0	0	0
756484	6391474	3-Jun-10	0	0	0	0	0
756823	6391472	1-Jun-10	0	0	0	0	0
756330	6391471	3-Jun-10	0	0	0	0	0
757160	6391432	1-Jun-10	0	1	0	0	0
756433	6391427	3-Jun-10	17	0	0	2	0
756292	6391414	3-Jun-10	0	0	0	0	0
757217	6391403	1-Jun-10	0	0	0	0	0
756991	6391397	1-Jun-10	0	0	0	0	0

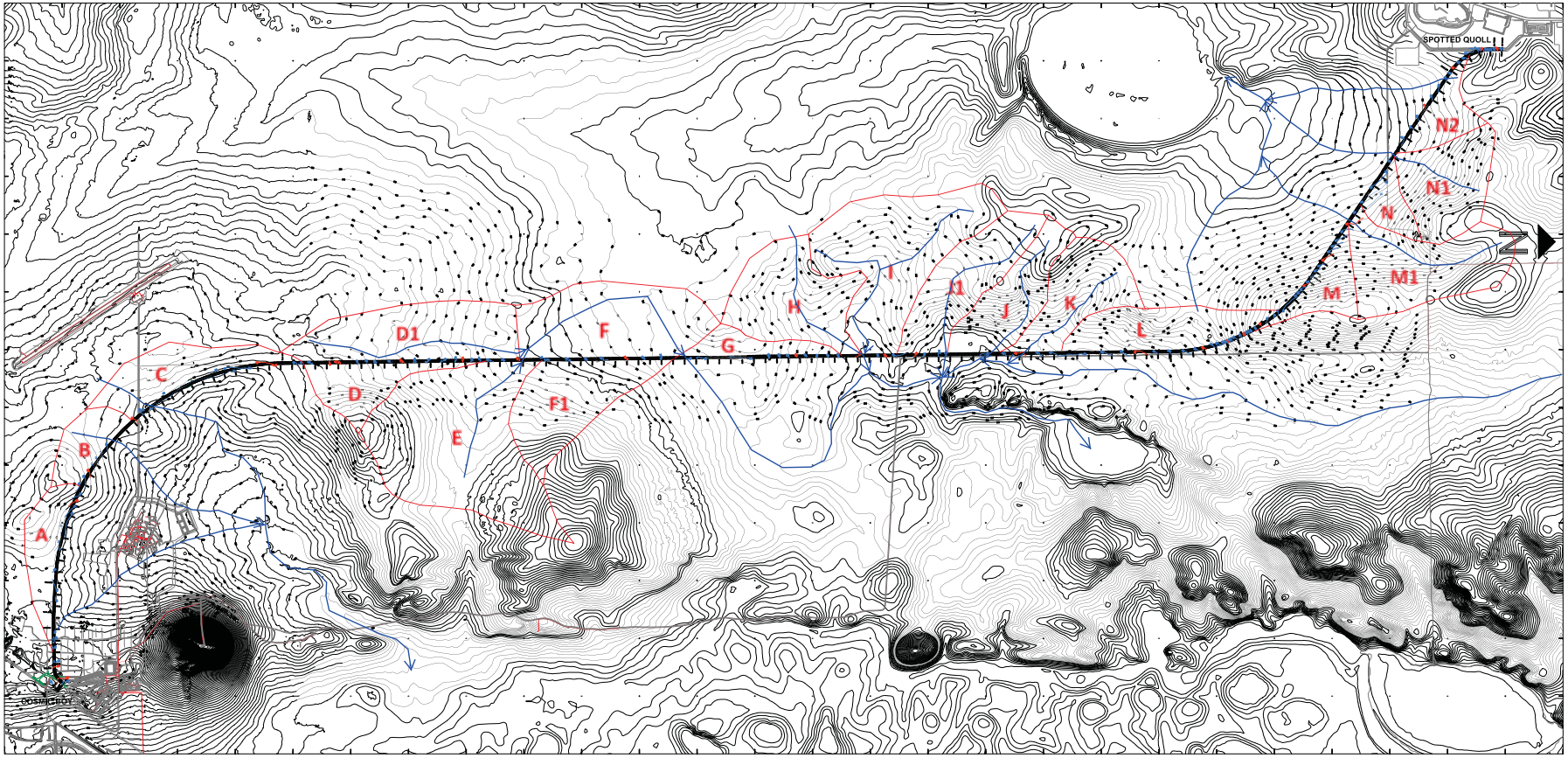
APPENDIX E
Location of all recording points to, within and from Boojum Swamp

Easting	Northing	Date	Carnaby's Cockatoo	Western Rosella	Chuditch		
					Stag	Hollow Log	Under base
754511	6400706	2-Jul-10	0	0	0	0	0
754408	6400712	2-Jul-10	0	1	0	0	0
754307	6400722	2-Jul-10	0	5	0	0	0
754215	6400748	2-Jul-10	0	11	0	0	2
754108	6400753	2-Jul-10	3	15	0	2	0
754007	6400756	2-Jul-10	4	15	0	1	0
753910	6400754	2-Jul-10	0	11	0	0	0
753810	6400737	2-Jul-10	3	24	1	0	0
753707	6400725	2-Jul-10	3	6	0	1	0
753602	6400734	2-Jul-10	0	0	0	0	0
753512	6400748	2-Jul-10	0	0	0	0	0
753452	6400750	2-Jul-10	0	0	0	0	0
753351	6400744	2-Jul-10	0	0	0	0	0
753239	6400741	2-Jul-10	2	2	0	0	0
753148	6400742	2-Jul-10	4	9	1	0	0
753045	6400738	2-Jul-10	1	9	1	0	0
752948	6400729	2-Jul-10	1	6	0	0	0
752828	6400710	2-Jul-10	1	10	0	1	0
752758	6400712	2-Jul-10	3	9	0	0	0
752644	6400712	2-Jul-10	1	1	0	0	2
752544	6400727	2-Jul-10	0	5	0	0	0
752432	6400732	2-Jul-10	0	0	0	0	0
752350	6400734	2-Jul-10	1	8	0	1	1
752251	6400744	2-Jul-10	0	9	0	0	3
752142	6400755	2-Jul-10	3	2	0	0	4
752058	6400781	2-Jul-10	3	8	2	1	1
751961	6400776	2-Jul-10	2	14	0	2	1
751958	6400830	2-Jul-10	3	10	1	1	0
752001	6400974	2-Jul-10	1	7	0	2	0
751977	6401129	2-Jul-10	2	4	1	6	1
752078	6401151	2-Jul-10	1	2	2	3	0
752185	6401151	2-Jul-10	1	4	1	1	0
752280	6401140	2-Jul-10	3	9	2	0	0
752383	6401138	2-Jul-10	0	3	0	0	1
752483	6401117	2-Jul-10	0	6	1	2	0
752582	6401127	2-Jul-10	0	8	0	0	1
752754	6401127	2-Jul-10	1	3	1	1	0
752855	6401122	2-Jul-10	1	2	0	0	0
752954	6401127	2-Jul-10	0	5	1	0	0

Easting	Northing	Date	Carnaby's Cockatoo	Western Rosella	Chuditch		
					Stag	Hollow Log	Under base
753055	6401117	2-Jul-10	5	3	2	0	0
753154	6401122	2-Jul-10	1	2	0	0	0
753257	6401124	2-Jul-10	0	1	0	0	0
753362	6401115	2-Jul-10	1	4	1	0	0
753459	6401105	2-Jul-10	1	3	1	0	0
753554	6401114	2-Jul-10	0	6	1	0	0
753659	6401111	2-Jul-10	1	4	0	0	0
753775	6401126	2-Jul-10	2	10	1	0	0
753818	6401129	2-Jul-10	2	6	0	0	0
753915	6401127	2-Jul-10	2	13	3	0	0
754024	6401118	2-Jul-10	2	14	0	0	0
754145	6401107	2-Jul-10	1	12	0	0	0
754220	6401111	2-Jul-10	0	3	0	0	1
754329	6401102	2-Jul-10	1	0	0	0	0
754417	6401102	2-Jul-10	0	2	0	0	1

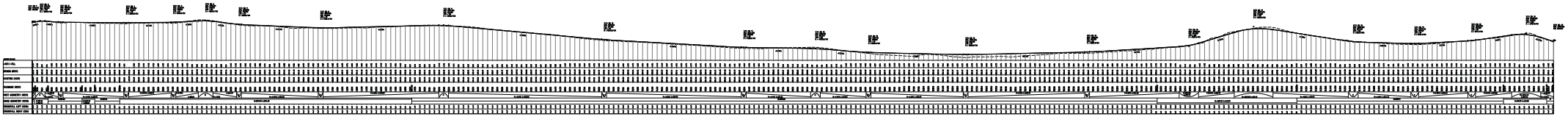
APPENDIX I

SPOTTED QUOLL TO COSMIC BOY HAUL ROAD CATCHMENT AND DRAINAGE PLAN



LEGEND

SURVEY CONTOUR
SURVEY CONTOUR
PHOTOGRAMETRY CONTOUR



SPOTTED QUOLL TO COSMIC BOY HAUL ROAD

SKETCH ONLY

BG&E CONSULTING ENGINEERS

PROJECT: SPOTTED QUOLL TO COSMIC BOY HAUL ROAD

TITLE: PLAN / PROFILE

PROJECT No. P09377 | DATE 06.08.2010 | SCALE 1:10000 | SKETCH No. P09377-SKC-003 | REV. A

B – Additional Information – Offset and Mitigation Strategy

Keith Lindbeck and Associates
Environmental Management Consultants
ABN 36 150 274 469





FORRESTANIA NICKEL PROJECT

SPOTTED QUOLL – COSMIC BOY HAUL ROAD

ENVIRONMENTAL OFFSET PROPOSAL

Prepared for: ***Western Areas NL***

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1 INTRODUCTION

1.1 BACKGROUND

The Western Areas NL (WANL) Forrestania project area has been the target of exploration companies since the 1960's nickel boom. Outokumpu Mining Australia Pty Limited operated the Forrestania Nickel Project during the period 1992 to 1999, during which time they mined and processed on site a total of approximately 3.8 million tonnes of ore at 1.9% Ni from the Flying Fox, Cosmic Boy and Digger Rocks deposits.

Outokumpu produced the first nickel concentrates from the Forrestania Nickel Project in November 1992. At this point in time all ore came from the Digger Rocks open pit. In 1994, both Flying Fox and Cosmic Boy underground came into production and were operated until 1999. Outokumpu then sold the operation to WANL and the nickel process plant was dismantled and relocated to Outokumpu's Black Swan Operation north of Kalgoorlie.

WANL are currently mining the Flying Fox underground mine (M77/582 and M77/545) and the Spotted Quoll Open Pit (M77/583). WANL also operate a processing plant and Tailings Storage Facility (TSF) at Cosmic Boy and have commenced development of the Diggers South mining project at Digger Rocks (M74/58, M74/57 and M74/90).

In April 2011, WANL will commence development of the Spotted Quoll underground mine. Currently ore is being hauled by truck, via a mix of public and "on-lease" roads to be processed at WANL's Cosmic Boy nickel concentrator. The number of loaded cycles on these roads has increased significantly over the past 24 months and will continue to do so as all three mines reach maximum production levels. A risk assessment of the use of haulage trucks on public gazetted roads was undertaken during 2010, the preferred option to minimise the risks associated with haulage on the public roads was to build a private haul road on WANL owned tenements.

WANL propose to construct a haul road from Spotted Quoll to the Cosmic Boy processing plant which will remove haul trucks from public roads. The proposed haul road allows for haulage to be completed on-lease and utilizes a "fit-for purpose design" to allow high axle loads and up to quad configuration.

The project was referred to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) on the 21 June 2011. On the 19 July 2011, the DSEWPAC determined that the proposal was a Controlled Action to be assessed under the bilateral agreement between the Commonwealth (*Environment Protection and Bioduiversity Conservation Act 1999* (EPBC Act)) and the State of Western Australia due to the potential impacts to Carnaby's Black Cocoatoo (*Calyptorhynchus latirostris*) habitat.

1.2 PURPOSE OF THE DOCUMENT

This document provides further details on the WANL offset package and details the implementation mechanism considered as part of developing the offsets package.

The objective of the proposal is to facilitate a net environmental benefit for the bioregion and the community through the establishment of suitable offsets for unavoidable key residual impact through the establishment of collaborative working relationships with Conservation Groups, Conservation Agencies and other interested Stakeholders.

1.3 COMMONWEALTH APPROACH AND GUIDANCE ON ENVIRONMENTAL OFFSETS

The *EPBC Act* was developed to:

Provide for the protection of the environment, especially those aspects of the environment that are matters of 'national environmental significance' (NES).

To promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.

To promote the conservation of biodiversity.

To enable the assessment of environmental impacts of developments on land under Federal tenure (this, and other requirements of the *EPBC Act*, is not relevant to WANL activities).

The Australian Government defines environmental offsets as '*actions taken outside a development site that compensate for the impacts of that development - including direct, indirect or consequential impacts*'. Environmental offsets provide an opportunity to achieve long-term conservation outcomes whilst providing a management option for proponents seeking to undertake development(s) which will have residual environmental impacts, after avoidance and mitigation options have been employed. Environmental offsets are not intended to make proposals with unacceptable impacts acceptable. Environmental offsets provide compensation for those impacts which cannot be adequately reduced through avoidance and mitigation. They should be distinguished from 'mitigation', which refers to the range of actions that can be undertaken to reduce the level of impacts of a development (typically undertaken on-site).

The Commonwealth has defined eight principles for the use of offsets under the EPBC Act::

1. Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted.
2. A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents.
3. Environmental offsets should deliver a real conservation outcome.
4. Environmental offsets should be developed as a package of actions which may include both direct and indirect offsets.
5. Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'.
6. Environmental offsets should be located within the same general area as the development activity.
7. Environmental offsets should be delivered in a timely manner and be long lasting.
8. Environmental offsets should be enforceable, monitored and audited.

As defined in the draft 'EPBC Act Environmental Offsets Policy' (DSEWPC, 2011) suitable offsets must:

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed development.
2. Be efficient, effective, transparent, proportionate, scientifically robust and reasonable.

3. Be built around direct offsets but may include indirect offsets.
4. Be of a size and scale proportionate to the impacts being offset.
5. Be in proportion to the level of statutory protection that applies to the affected species or community.
6. Effectively manage the reisk of the offset not succeeding.
7. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

1.4 HEIRACHY OF CONTROL AND MITIGATION

Management actions for the Project have been guided by EPA principles and hierarchy based on the following:

Avoidance – avoid areas of conservation significance.

Minimise – limit impact area to only that required.

Rectify – progressively rehabilitate as opportunities are presented.

Reduce – monitor to ensure effectiveness.

Offset – any significant residual impacts which remain.

2 EXISTING ENVIRONMENT

2.1 VEGETATION

The haul road is located within the Coolgardie Botanical District of the Southwestern Interzone. This region is characterised by Eucalypt woodlands, open with saltbush/bluebush understorey on calcareous soils, patches of shrub steppe adjoining the Great Victorian Desert and shrub-heath and *Casuarina* thickets on sandplains (Beard 1990).

Botanica Consulting (BC) undertook a vegetation and flora survey of the proposed haul route from 30 November to 1 December 2009. The region was visited in January 2011 to re-assess the vegetation composition of the area and establish more quadrats.

Eleven vegetation groups and three sub-groups were identified within the survey area (BC 2011) (Figures 1 and 2):

1. Rehabilitation Area;
2. *Eucalyptus urna* woodland;
3. *Eucalyptus livida* woodland;
4. *Eucalyptus salubris* woodland;
5. *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee shrubland;
6. Mixed Mallee shrubland over *Melaleuca* shrubland*;*
7. Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland (including two sub-groups; *Melaleuca hamata* thicket and *Melaleuca lanceolata* thicket);
8. *Eucalyptus salmonophloia* woodland;
9. Mixed Mallee and Mixed shrubs on Banded Ironstone ridge;
10. Mixed Mallee shrubland (including *E. horistes* Mallee shrubland sub-group); and
11. *Eucalyptus goniocarpa* shrubland (BC 2011).

2.2 VEGETATION CONDITION

The condition of vegetation in the survey area was assessed by BC (2011) using the condition rating scale of Keighery (1994). Keighery's condition rating scale ranges from Pristine (where vegetation exhibits no visible signs of disturbance) to Completely Degraded (where vegetation structure is no longer intact and without native plant species). The vegetation condition along the proposed haul road ranges from "Degraded" to "Very Good" with the overall condition rating determined to be "Very Good" (BC 2011).

2.3 REMNANT VEGETATION

The vegetation within the survey area comprise Beard Vegetation Associations 511 'Medium woodland; Salmon Gum and Morrel' and 1413 'Shrublands '*Acacia, Casuarina* and *Melaleuca* thicket (Table 1) (DEC 2009).

Greater than 70% of the original pre-european extent of these vegetation associations remains with 17-19% represented in DEC managed lands.

Table 1: Haul Road Beard Vegetation Associations

Beard Vegetation Association	Current Extent (ha)	Pre-European extent (ha)	Remaining (%)	Current extent in DEC managed lands (%)
511 Medium woodland; Salmon Gum and Morrel	499,599.71	700,409.58	71.33	19.35
1413 Shrublands; *Acacia*, *Casuarina* and *Melaleuca* thicket	1,252,585.65	1,679,916.99	74.56	17.28

2.4 TERRESTRIAL FAUNA

Fauna surveys have been completed by Biota Environmental Science (Biota) between 2006 and 2009 in the Forrestania region.

Most recently, a single-phase Level 2 fauna survey of the proposed haul road was conducted from 30 November – 9 December 2009 (Biota 2010). The survey involved the establishment of 12 trapping sites, avifauna censusing, bat sampling and targeted searches for potential Short Range Endemic (SRE) species.

The survey recorded a total of 76 vertebrate fauna species, comprising 21 herpetofauna species, 38 bird species and 17 species of mammal (including four introduced species) (Biota 2010).

Based on the results of the database searches (DEC Threatened and Priority Fauna, the WA Museum Fauna base and the *EPBC Act 1999* Protected Matters) 18 fauna species of conservation significance could potentially occur at the project (Table 2).

Table 2: List of Fauna of Conservation Significance potentially occurring

Species Name	Common Name	Conservation Status	
		State Level	Federal Level
Platycercus icterotis xanthogenys	Western Rosella	Schedule 1	-
Calyptorhynchus latirostris	Carnaby's Cockatoo	Schedule 1, Endangered	Endangered
Dasyurus geoffroii	Chuditch	Schedule 1, Vulnerable	Vulnerable
Leipoa ocellata	Malleefowl	Schedule 1, Vulnerable	Vulnerable/Migratory
Acanthiza iredalei iredalai	Slender-billed Thornbill	-	Vulnerable
Phascogale calura	Red-tailed Phascogale	-	Endangered
Falco peregrinus	Peregrine Falcon	Schedule 4	-
Morelia spilota subsp. imbricata	Carpet Python	Schedule 4, Priority 4	-
Ardeotis australia	Australian Bustard	Priority 4	-
Hylasola cauta whitlocki	Shy Groundwren	Priority 4	-
Oreoica gutturalis gutturalis	Crested Bellbird	Priority 4	-
Pomatostomus superciliosis ashbyi	White-browed Babbler	Priority 4	-
Macropus irma	Western Brush Wallaby	Priority 4	-
Pseudomys occidentalis	Western Mouse	Priority 4	-
Merops ornatus	Rainbow Bee-eater	-	Migratory
Apus pacificus	Fork-tailed Swift	-	Migratory
Ardea alba	Great Egret, White Egret	-	Migratory
Ardea ibis	Cattle Egret	-	Migratory

Of these, records/evidence of six of the species was identified during the survey:

- Three individuals of the Schedule 1 Carnaby's Cockatoo (*Calyptorhynchus latirostris*) were recorded flying over the area.
- One inactive mound of the Malleefowl (*Leipoa ocellata;* Schedule 1) was recorded.
- The Priority 4 Shy Groundwren (*Hylacola cauta whitlocki*) was recorded on 10 occasions.
- The Priority 4 White-browed Babbler (*Pomatostomus superciliosus*) was recorded on five occasions.
- The Priority 4 Crested Bellbird (*Oreoica gutturalis gutturalis*) was recorded on three separate occasions at three sites and opportunistically within the study area.
- The Schedule 1 Western Quoll (*Dasyurus geoffroii*) was recorded.

Based on the results of the fauna survey, WANL commissioned Keith Lindbeck and Associates (KLA) to conduct a targeted fauna survey of the proposed haul road for the following four species of conservation significance and their habitats:

- Chuditch (*Dasyurus geoffroii)*;
- Malleefowl (*Leipoa ocellata);*
- Carnaby's Cockatoo (*Calyptorhynchus latirostris);* and
- Western Rosella (inland spp.) (*Platycercus icterotis xanthogenys).*

No sightings of the four vertebrate species of conservation significance were recorded during the survey periods. Within the area surveyed for the proposed haul road (and nearby Boojum swamp), a total of 86 potential Chuditch refugia, three very old Malleefowl mounds, 98 potential Carnaby's Cockatoo breeding hollows (refer to Section 2.5 for further detail) and 200 potential Western Rosella breeding hollows were recorded (KLA 2011).

2.5 CARNABY'S COCKATOO

The targeted fauna survey undertaken by KLA (2011) recorded 98 potential Carnaby's Cockatoo breeding hollows.

The survey was conducted in an area measuring 120 m wide along the length of the proposed haul road and up to 160 m in the northern and southern ends to allow for flexibility in design. Further, in order to determine if the vegetation associations within the area proposed for the haul road comprised critical habitat for the four selected vertebrate species that is not found elsewhere, the targeted search was extended to include an area up to 2.5 km west of the proposed haul road that included an area known as Boojum Swamp.

Thus, all of the 98 potential hollows recorded are not located specifically within the proposed disturbance area for the haul road (Figure 3).

Further detailed assessment of the number of potential Caranby's Cockatoo breeding hollows to be impacted by the proposed haul road has been undertaken since the original referral and is provided in Section 3.0.

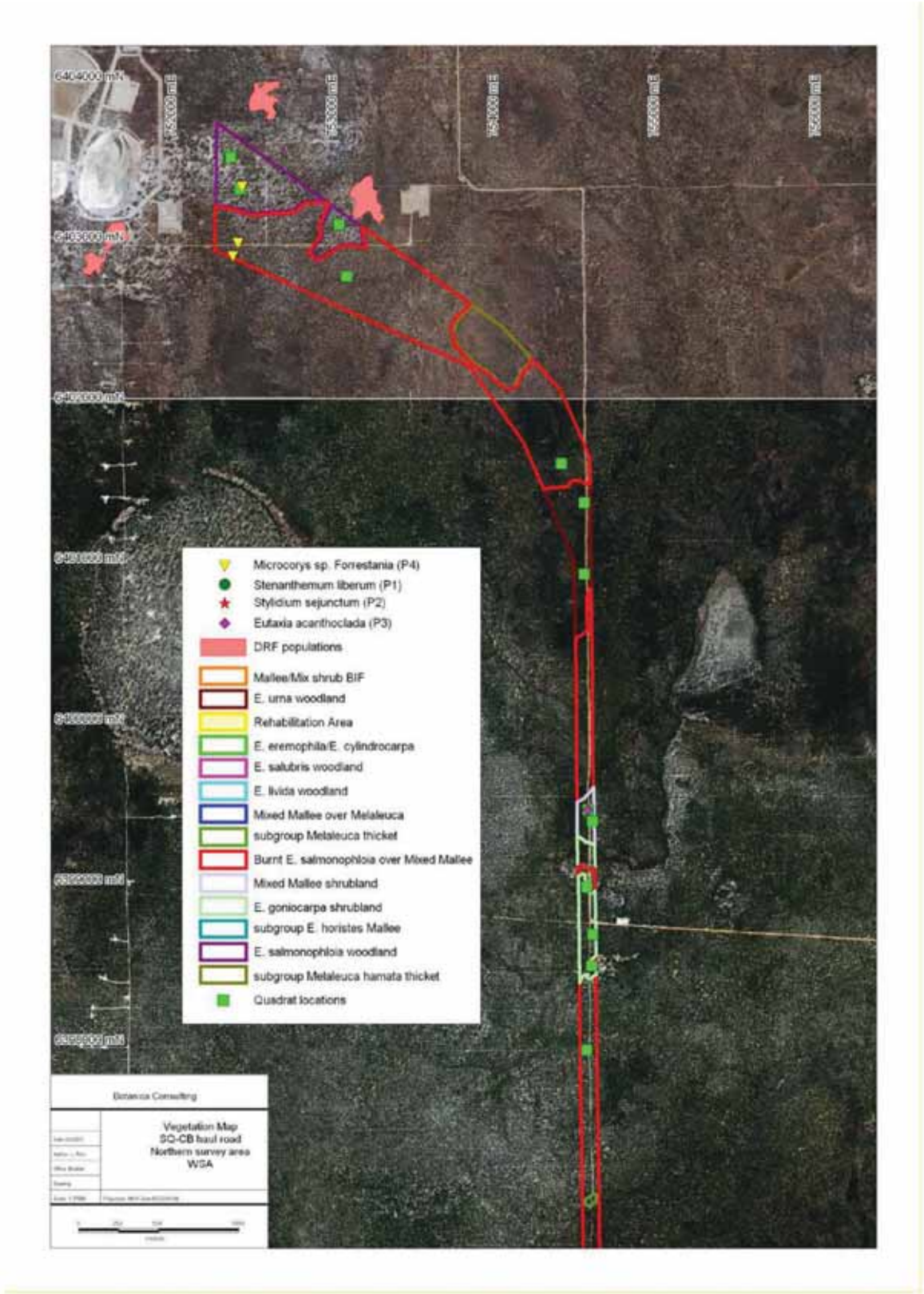


Figure 1 - Vegetation groups identified during survey

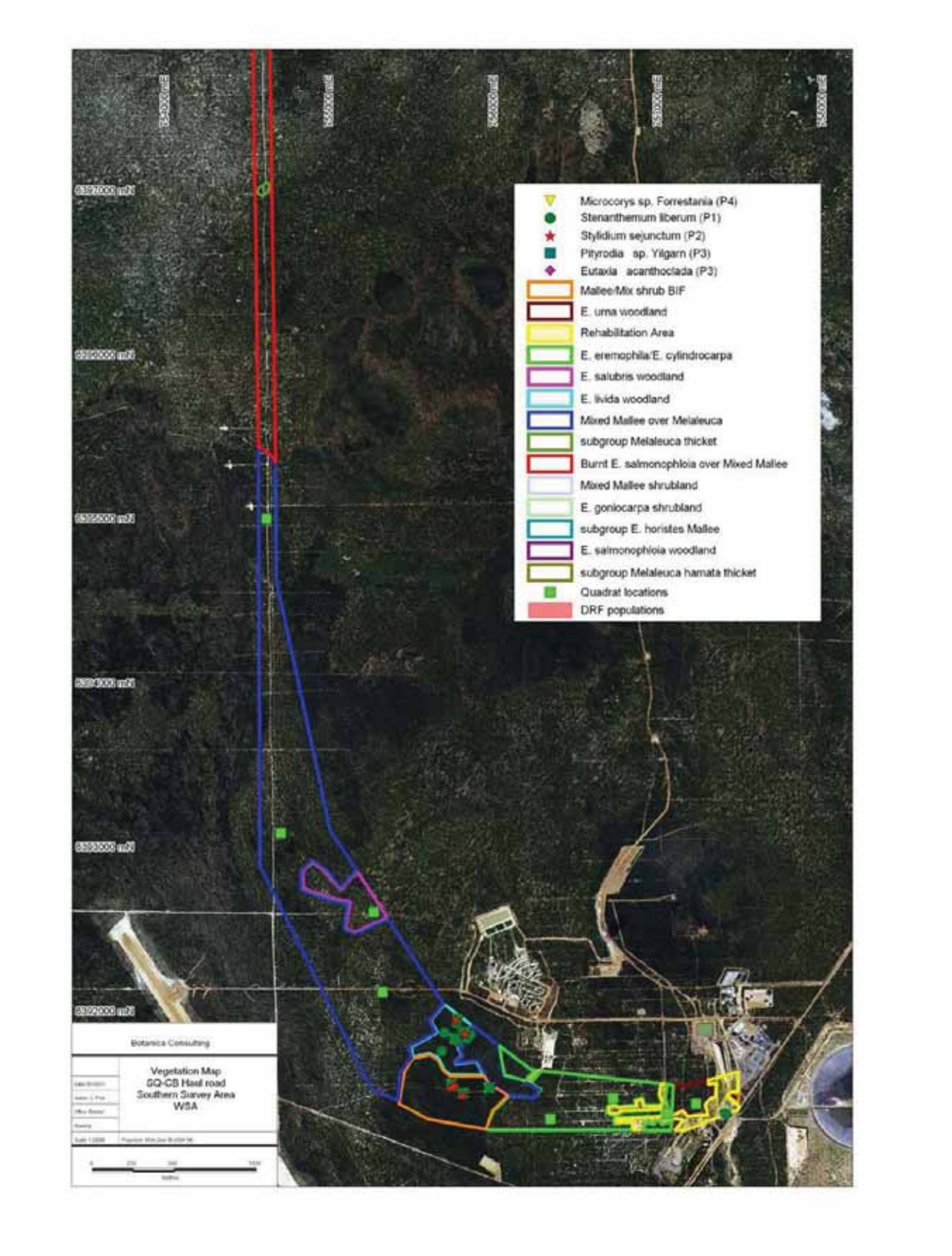


Figure 2 - Vegetation map of southern section of haul road

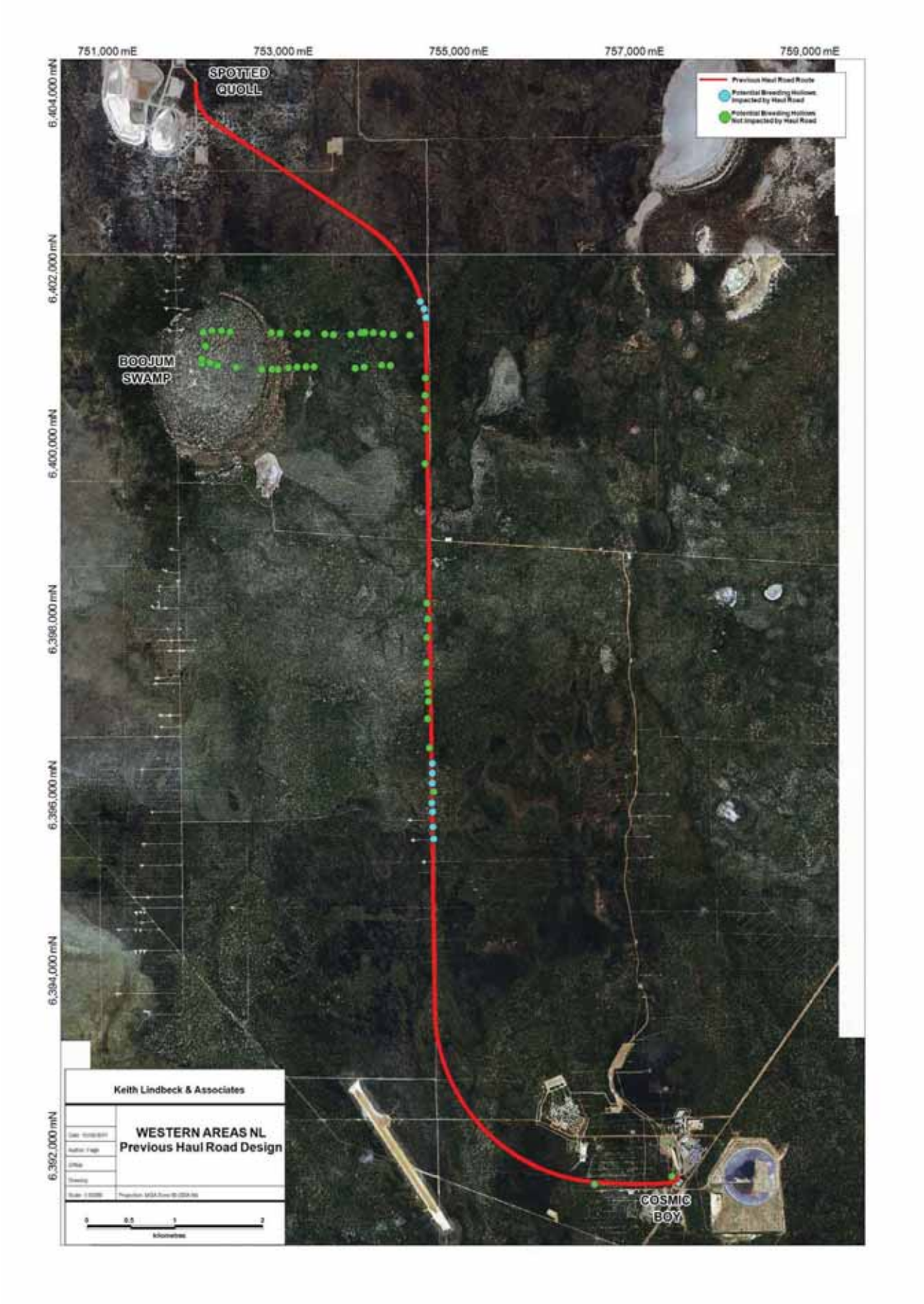


Figure 3 - Potential Carnaby's Cockatoo breeding hollows recorded during the survey

3 REVISED PROPOSED IMPACTS

3.1 DISTURANCEA AREA

Revisions of the proposed disturbance associated with the haul road have been undertaken since the original referral. As a result of safety improvements to bends in the haul road, the disturbance area associated with the haul road is 43.32 ha of which clearing of 40.74 ha of native vegetation is required (Table 3).

This represents an increase of 2.1 ha of clearing from that presented in the original referral.

Table 3 - Revised disturbance areas for proposed haul road

Tenement	TOTAL Haul Rd Area (ha)	Topsoil s/p (ha)	Vegetation s/p (ha)	Gravel pit (ha)	Total disturbance (ha)	Total clearing (ha)
M77/399	6.43	0.56	0.03	0.00	7.02	6.99
M77/583	5.77	0.52	0.03	0.00	6.32	6.24
M77/584	0.50	0.02	0.00	2.96	3.48	3.48
M77/586	6.22	0.30	0.03	0.03	6.58	6.20
M77/587	5.28	0.60	0.03	0.00	5.91	5.18
M77/588	4.58	0.30	0.03	0.00	4.91	4.28
M77/589	8.47	0.60	0.03	0.00	9.10	8.37
TOTAL	**37.25**	**2.90**	**0.18**	**2.99**	**43.32**	**40.74**

* - takes into account existing cleared track on proposed haul route

s/p - stockpile

3.2 BREEDING HABITAT

3.2.1 Local Impact

Further detailed assessment of the impact of the proposed haul road on potential Carnaby's breeding habitat has been undertaken since the original referral.

Results from the targeted survey indicated that, of the eleven vegetation groups and three sub-groups identified, four vegetation groups contain potential habitat for Carnaby's Black Cockatoo:

- Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland.
- *Eucalyptus urna* woodland.
- *E. eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland (boundary).
- Mixed mallee over *Melaleuc*a (boundary).

Assessment of the detailed records of hollows recorded during the KLA survey has been further quantified and Figure 4 presents the areas of potential Carnaby's Cockato breeding habitat as identified during the survey.

Details previously provided by WSA to the DSPEWC regarding the disturbance to each vegetation group has been further quantified and is presented in Table 3.

The proposed haul road will impact a maximum of 6.45 ha of potential breeding habitat, within which 23 potential breeding hollows are located (Table 4).

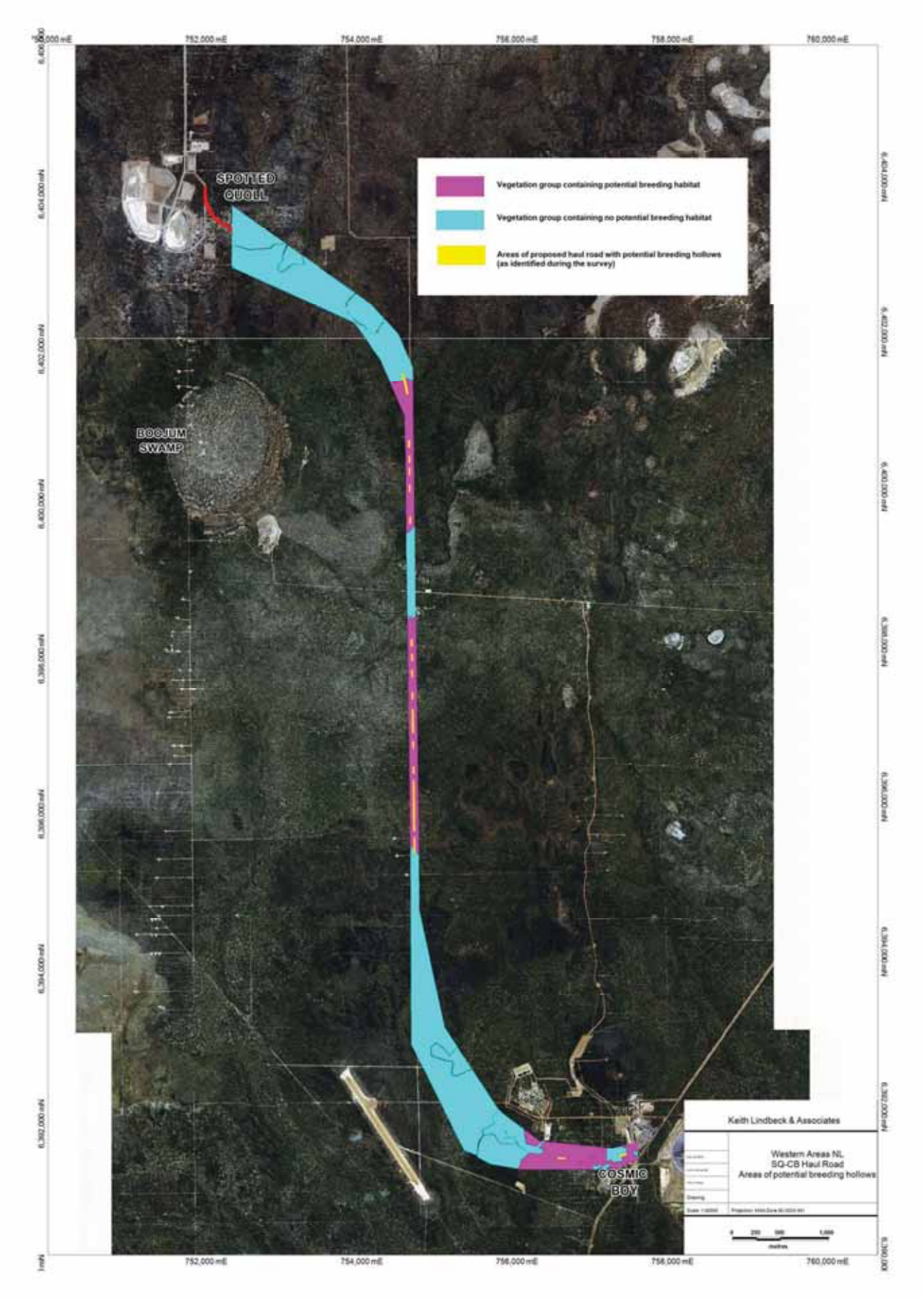


Figure 4 - Potential breeding habitat identified in the proposed haul road area

Table 4 - Area of potential breeding hollows in the proposed haul road area

Vegetation group	Total area surveyed (ha)	Total area to be cleared (ha)	% of each veg group to be cleared	Total area of Carnaby's breeding habitat to be cleared (ha)	% Carnaby's breeding habitat to be cleared of total clearing for haul road (ha)	Proportion of Carnaby's hollows within disturbance area
E. salmonphila woodland	25.29	1.05	4.15	0	Nil	Nil
Burnt *E. salmonphila* woodland over mixed mallee	135.57	13.42	9.90	4.55	11.17	16.34
Sub-group *Melaleuca hamata* thicket	13.33	4.59	34.43	Nil	Nil	Nil
E. urna woodland	17.72	3.24	18.28	1.30	3.19	5.42
Mixed Mallee shrubland	2.95	0.55	18.64	Nil	Nil	Nil
E. goniocarpa shrubland	7.49	1.53	20.43	Nil	Nil	0
Sub-group *E. horistes* Mallee	0.06	0.05	83.33	Nil	Nil	0
Sub-group *Melaleuca* thicket	0.38	0.12	31.58	Nil	Nil	0
Mallee/Mix shrub BIF	18.24	1.61	8.83	Nil	Nil	0
E. livida woodland	8.55	0.55	6.43	Nil	Nil	0
E. eremophila/E. cylindrocarpa	30.66	2.73	8.90	0.30	0.74	0.29
Rehabilitation Area	9.04	1.20	13.27	Nil	Nil	0
Mixed Mallee over *Melaleuca*	131.91	10.10	7.66	0.3001	0.74	0.30
E. salubris woodland	8.63	Nil	Nil	Nil	Nil	Nil
TOTAL	**409.82**	**40.74**		**6.45**		**23**

3.2.2 Regional Impact

The Spotted Quoll to Cosmic Boy haul road is located on the far eastern boundary of Carnaby's Black Cockatoo breeding range (Figure 5). The haul road will not impact or restrict the current distribution of Carnaby's Black Cockatoo.

The haul road is located in the Great Western Woodlands. The Great Western Woodlands is the largest Mediterranean-climate woodland left in southern Australia which encompasses over 16 million hectares (Figure 6). The proposed disturbance area will impact 0.0006% of the Great Western Woodland area.

Vegetation within the survey area dominantly comprised of Beard Vegetation Associations 511 'Medium woodland; Salmon Gum and Morrel' (DEC 2009). In Western Australia, greater than 70% of the original pre-European extent of these vegetation associations remains with 19% represented in DEC managed lands.

The haul road is located within the Coolgardie 2 (Southern Cross) IBRA subregion which covers over 6 million hectares. In this subregion, Vegetation Association 511 represents 435,790. Over 93% of the original pre-European extent remains for Vegetation Association 511 with over 19% within DEC Managed Lands.

Vegetation Associations 486, 936 and 941 is dominantly comprised of Salmon Gums (potential Carnaby's breeding habitat) and surround the haul road route (Figure 7). These vegetation associations are also well represented in the Coolgardie 2 (Southern Cross) IBRA sub-region (Table 5). The area to be cleared for the haul road represents 0.002% of the total area of these four vegetation associations below.

The proposed haul road location is a linear area of disturbance surrounded by large areas of continuous native vegetation of a similar type and is not an isolated remnant vegetation.

Table 5 - Beard vegetation associations

Vegetation Association	Description	Pre-European Extent (ha)	Current Extent (ha)	% Remaining	% Current Extent in All DEC Managed Lands
511	Medium woodland; Salmon Gum and Morrel	464,423	435,793	93.84	19.33
486	Medium woodland; salmon gum & red mallee / Shrublands; mallee scrub Eucalyptus eremophila	115.02	115.02	100	0
936	Medium woodland; salmon gum	275,894	275,893	100	0.8
941	Medium woodland; salmon gum & Morrel / Shrublands; mallee scrub, redwood	10,822	10,822	100	0

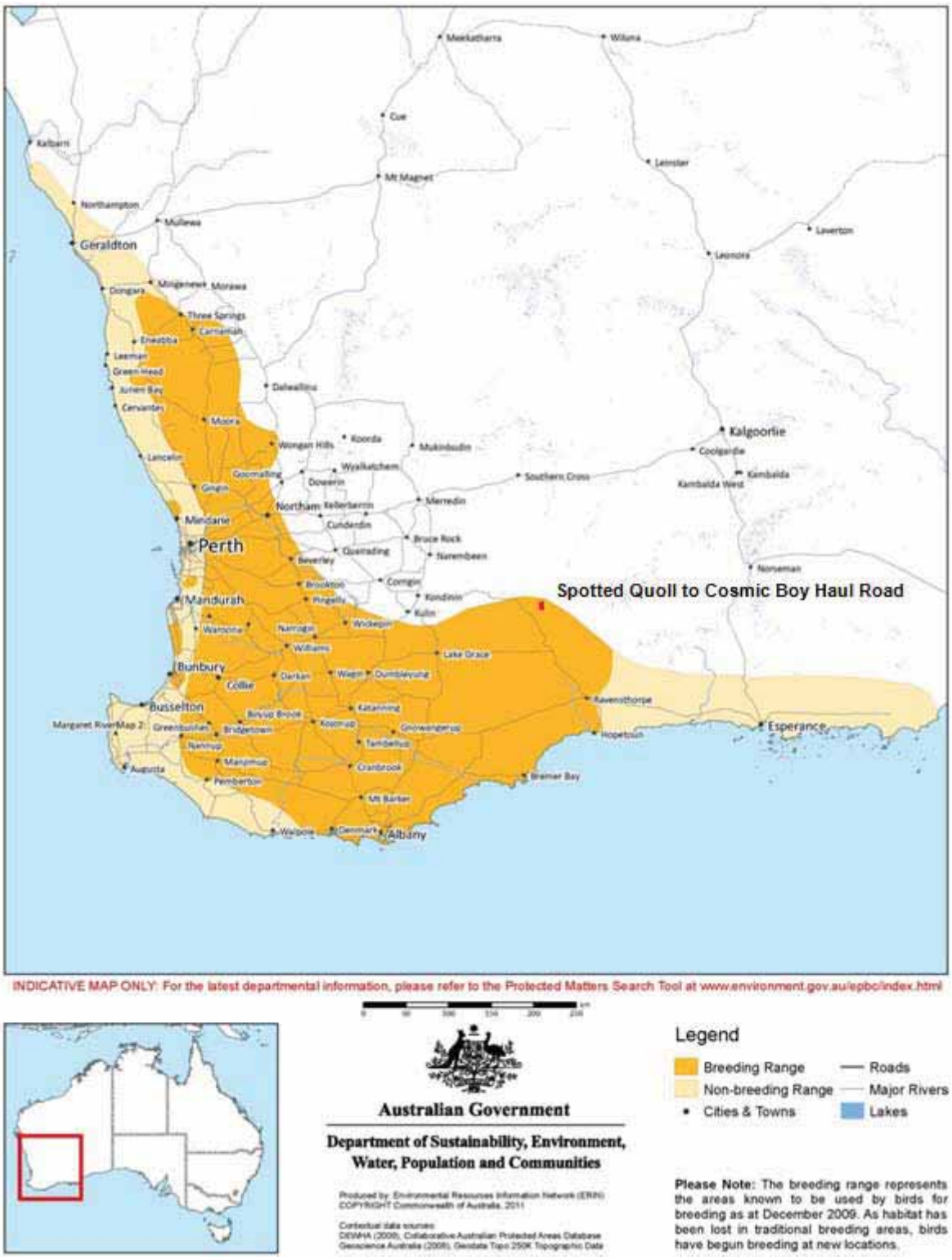


Figure 5 - Distribution of Carnaby's Cockatoo

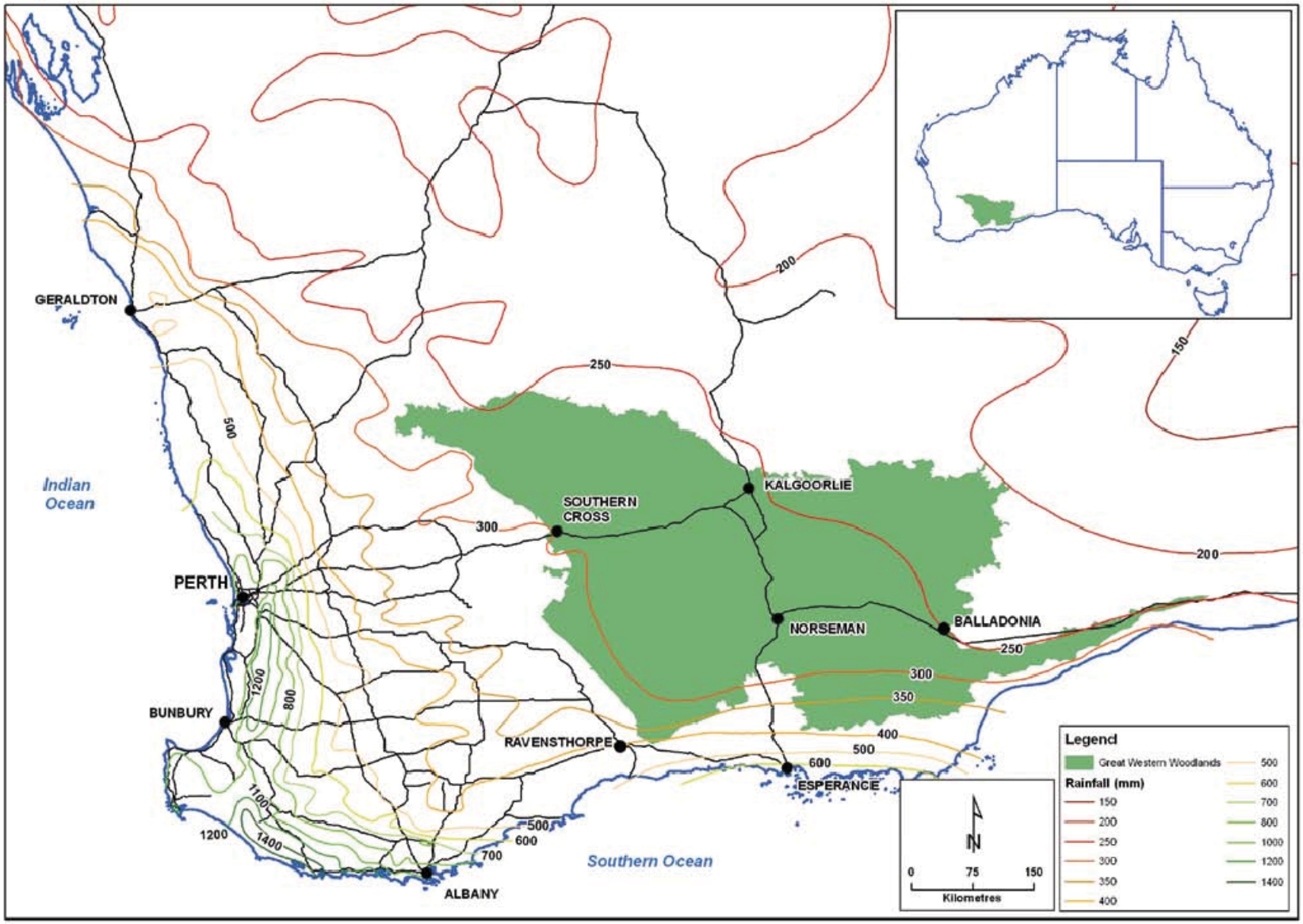


Figure 6 - Great Western Woodlands

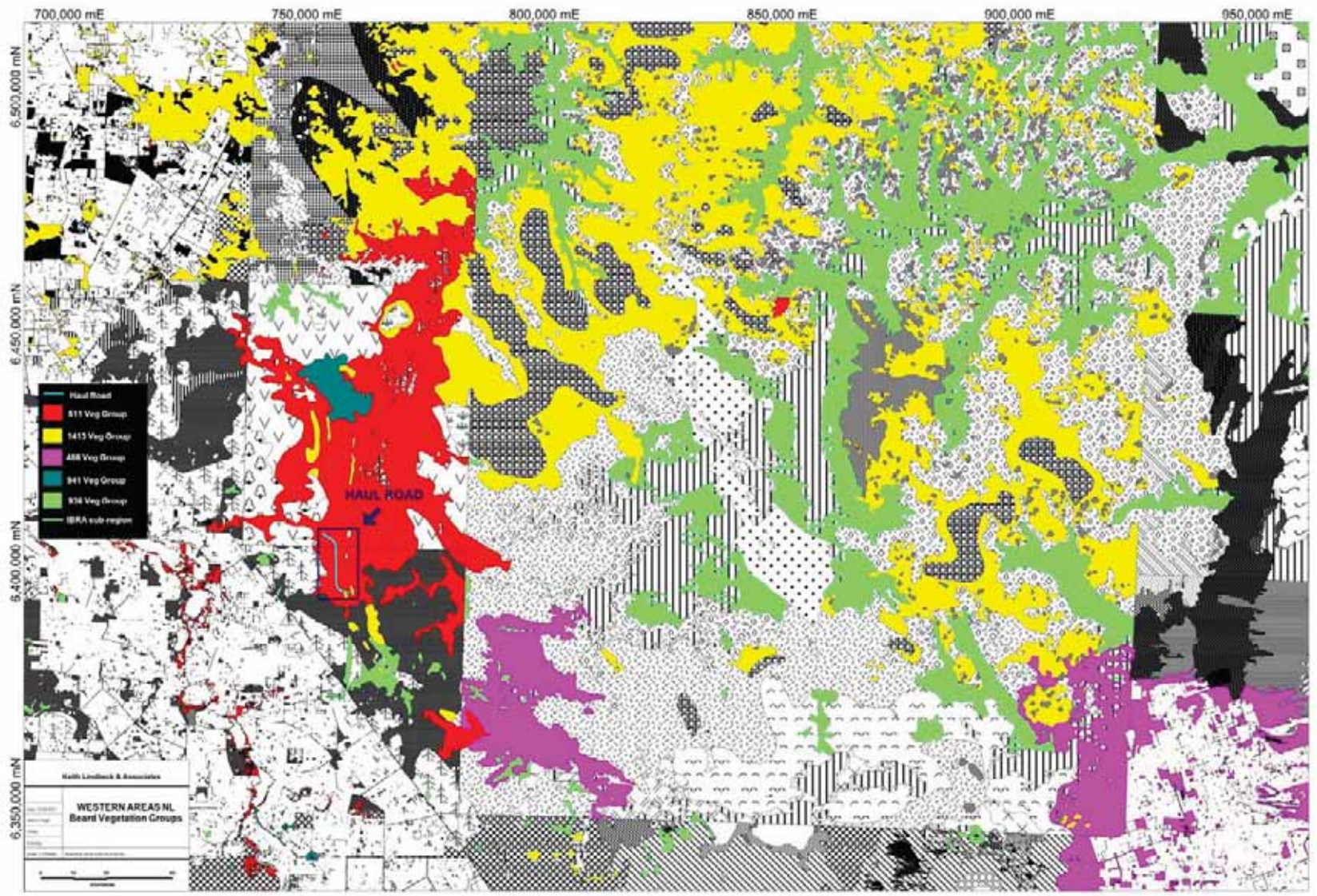


Figure 7 - Beard vegetation associations

3.3 FORAGING HABITAT

3.3.1 Local Impact

During the flora and vegetation survey eleven vegetation groups and three sub-groups were identified within the survey area:

1. Rehabilitation area;
2. Eucalyptus urna Woodland;
3. Eucalyptus livida Woodland;
4. Eucalyptus salubris Woodland;
5. Eucalyptus eremophila subsp. eremophila and Eucalyptus cylindrocarpa Mallee Woodland;
6. Mixed Mallee shrubland over Melaleuca shrubland;
7. Burnt Eucalyptus salmonophloia woodland over mixed Mallee shrubland; including
    a. Sub-group Melaleuca hamata thicket and
    b. Sub-group Melaleuca lanceolata thicket;
8. Eucalyptus salmonophloia Woodland;
9. Mixed Mallee and Mixed shrubs on Banded Ironstone Ridge,
10. Mixed Mallee shrubland including
    a. Sub-group E. horistes Mallee shrubland; and
11. E. goniocarpa shrubland.

The WA Department of Environment and Conservation (DEC) has developed a list of plant species which Carnaby's Black Cockatoos utilise for roosting, nesting and feeding (DEC 2011). In total, there are 139 plant species which the Carnaby Black Cockatoo could potentially utilise in the South West of Western Australia. Each species has been ranked, from High to Low, to prioritise the plant species that are utilised most frequently (Appendix 1).

Of the 139 plant species on the DEC's list, six foraging species were recorded during the vegetation and flora survey (Table 6). These foraging species represent 3.4% of the total 174 speces recorded in the flora survey. Of the 11 vegetation groups and three sub-groups identified only two of the six species (*E. salmonophloia,* and *Hakea scoparia subsp. scoparia*) are listed as dominant species within only four of the vegetation groups.

The proposed haul road alignment is therefore not considred to have any significant local impact on foraging habitat for Carnaby's Black Cockatoo.

Table 6 - List of foraging species recorded on the proposed haul road

Priority	Genus	Species	VEGETATION GROUP										
			1	2	3	4	5	6	7*	8	9*	10	11
MEDIUM	*Callitris*	*preissii*	X		X						X		
HIGH**	*Eucalyptus*	*salmonophloia*				X			X	X		X	X
MEDIUM	*Hakea*	*commutata*					X						
MEDIUM	*Hakea*	*multilineata*	X		X						X		
MEDIUM	*Hakea*	*scoparia subsp. scoparia*	X		X						X		
MEDIUM	*Isopogon*	*scabriusculus subsp. pubifloris*									X		

*Vegetation groups 7 and 9 include subgroups
** Priority ranking is for use of the species – which includes nesting

Table 7 - Vegetation containing foraging species on the proposed haul road

Vegetation group	Total area surveyed (ha)	Area surveyed containing foraging species (ha)	Total area to be cleared (ha)
E. salmonphila woodland	25.29	25.29	1.05
Burnt *E. salmonphila* woodland over mixed mallee	135.57	135.57	13.42
Sub-group *Melaleuca hamata* thicket	13.33	13.33	4.59
E. urna woodland	17.72	Nil	3.24
Mixed Mallee shrubland	2.95	2.95	0.55
E. goniocarpa shrubland	7.49	7.49	1.53
Sub-group *E. horistes* Mallee	0.06	0.06	0.05
Sub-group *Melaleuca* thicket	0.38	0.38	0.12
Mallee/Mix shrub BIF	18.24	18.24	1.61
E. livida woodland	8.55	8.55	0.55
E. eremophila/E. cylindrocarpa	30.66	30.66	2.73
Rehabilitation Area	9.04	9.04	1.20
Mixed Mallee over *Melaleuca*	131.91	Nil	10.10
E. salubris woodland	8.63	8.63	Nil
TOTAL	**409.82**	**260.20**	**40.74**

3.3.2 Regional Impact

There are extensive vegetated areas surrounding the haul road that provide foraging habitat for Carnaby's Black Cockatoo. The Coolgardie 2 (Southern Cross) IBRA subregion covers 6,010,800 ha with over 96% of vegetation remaining (5,808,059 ha).

Figure 8 shows the DEC Managed Lands surrounding the haul road. Jilbadji Nature Reserve is located 50 km north of the haul road and alone encompasses over 208,000 ha. The 27.40 ha

of vegetation containing foraging species proposed to be cleared for the haul road represents 0.013% of the total area of Jilbadgi Nature Reserve.

The proposed haul road will not restrict the availability of foraging habitat which is widespread in the surrounding vegetation and region.



Figure 8 - DEC managed land surrounding the haul road

4 POTENTIAL KEY FACTORS AND AVOIDANCE MEASURES

4.1 OVERVIEW

The WANL Forrestania Project has developed an Environmental Management Plan (EMP). The EMP details the local environmental conditions and impacts of the project and sets out the procedures required to mitigate the environmental impacts and includes emergency response procedures, and incident reporting and responses. The EMP is currently being updated to include the Spotted Quoll to Cosmic Boy haul road.

Table 8 provides the key environmental factors and potential impacts identified and assessed for the Project proposal.

Table 8: Key Environmental Factors and Potential Impacts for the development of the haul road

Key Environmental Factor	Potential Impacts Identified
Lake Cronin ESA	Reduction of conservation values (i.e. vegetation, flora, fauna, hydrology) of the reserve due to ore haulage operations.
Vegetation	Disturbance to ground surface can initiate vegetation fragmentation and/or land degradation if control mechanisms are not implemented.
Flora	Removal or impact to Priority flora species and removal of or reduction in health of DRF (*Eucalyptus steedmanii)*
Weeds	Introduction of weed species as a result of clearing activities as well as machinery and vehicle movements.
Terrestrial Fauna	Direct or indirect impacts leading to a loss or reduction of significant terrestrial fauna species or habitat. Direct loss of potential Carnaby's Cockatoo breeding habitat and foraging habitat
Surface water	Alter surface drainage lines
Erosion	Soil erosion and subsequent sedimentation and loss of vegetation along the proposed haul road.
Dust	Generation of dust from haulage operations and vehicle movement leading to a loss or reduction of vegetation, habitat and human health in the environment.
Noise and Vibration	Truck haulage operations generating excessive noise or vibration leading to loss of lifestyle quality to the rural landholders and the community in the existing human environment.
Gaseous emissions	Increased greenhouse gas emissions.
Rehabilitation and closure	Cessation of mining with an inability to rehabilitate impacting the long-term post mining environment and land use.

4.2 AVOIDANCE MEASURES

WANL have undertaken extensive investigations into the existing environment of the Forrestania Nickel Project, including comprehensive flora and fauna surveys of the proposed Spotted Quoll-Cosmic Boy Haul Road. In addition, a targeted survey was undertaken for four species of conservation significance and their habitat along the route of the proposed haul road. These species included the Chuditch, Malleefowl, Carnaby's Cockatoo and Western Rosella, the latter of which is listed under the *Wildlife Conservation Act 1950* as a Schedule 1 species: Rare and likely to become extinct.

WANL is committed to mitigation plans and measures to reduce or minimise any impact on the environment and all threatened species and their habitat that may possibly be affected by the construction of the haul road and associated disturbances.

5 KEY RESIDUAL IMPACTS

5.1 OVERVIEW

WANL have adopted the hierarchy of controls during the project development to avoid, reduce, and rectify impacts to assets of environmental significance. In accordance with State and Commonwealth guidance documents, WANL is only considering residual impacts associated with key environmental factors.

WANL acknowledge that all the key environmental factors cannot be effectively managed or mitigated without the use of offsets due to the potential impacts to the protected and threatened Carnaby Black Cockatoo habitats.

Table 9 provides an assessment of the key environmental factors and residual impacts as considered in the selection for a possible environmental offset.

Table 10 provides the key mitigation measures for the key environmental factors identified. Detailed mitigation measures to reduce the potential impact to Carnaby's Cockatoo is presented in Section 6.0.

Table 9: Summary of Key Environmental Factors and Residual Impacts

Key Environmental Factor	Mitigation Discussion to Estimate Residual Impacts	Estimated Residual Impact	Environmental Offset Required
Vegetation	The haul road will result in a maximum of 43.32 ha of disturbance. Of this approximately 40.74 ha of clearing of native vegetation is required.	40.74 ha of native vegetation will be cleared and rehabilitated on closure	No – residual impact is not significant
Flora	Four species of Priority flora were recorded on the haul road. The construction of the haul road will require the removal of: • One individual plant of *Stenanthemum liberum* (P1). • 10 individual plants of *Eutaxia acanthoclada* (P3). • Three individual plants of *Microcorys* sp. Forrestania (P4). No DRF will be directly impacted by the development of the haul road. The closest population of DRF, *E. steedmanii*, is located approximately 250 m from the proposed haul road. Monitoring of this population is currently undertaken by WANL.	Nil	No – residual impact is not significant. Advice sought from DEC.
Fauna	Clearing of potential fauna habitat for the following protected and threatened species: • Carnaby Black Cockatoo - Preferred habitat "*E. eremophila* subsp. *eremophila* and *Eucalyptus cylindrocarpa* Mallee Woodland" and "Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland" representing an estimated 23 potential breeding hollows.	6.45 ha of potential Carnaby Cockatoo habitat will be cleared for the construction of the haul road.	Yes – residual impact is significant
Invertebrate Terrestrial Fauna	The clearing of invertebrate terrestrial fauna habitat has the potential to effect loss of those species in the area with low mobility. Mitigation measures include the preservation of known preferred habitat and the rehabilitation of habitat per commitments and plans included within the proposal. Species expected to return to restored habitat at the cessation of the proposal.	Nil (direct)	No – residual impact is not significant
Dust	Dust generating activities will cease at the end of the proposal. Dust impacts are therefore related to indirect impacts during operations. Mitigation includes extensive monitoring of these indirect zones of potential impact with various contingency measures identified. Residual impacts within these indirect zones may include health decline of vegetation and priority flora or flight risk to fauna within fringing habitat. Following closure of the mine, it is reasonable to expect the majority of vegetation and flora would recover with fauna returning to the fringing habitat.	Nil (direct) Vegetation indirect impacts cannot be determined	No – residual impact is not significant

Key Environmental Factor	Mitigation Discussion to Estimate Residual Impacts	Estimated Residual Impact	Environmental Offset Required
Noise and Vibration	Noise and vibration generating activities will cease at the end of the proposal. Noise and vibration impacts are therefore related to operating actions which are likley to include flight fright to fauna within fringing habitat. Following closure of the mine, it is reasonable to expect the majority of fauna would return to the fringing habitat.	Nil (direct)	No – residual impact is not significant
Rehabilitation and Closure	The haul road will be rehabilitated at the completion of mining.	Nil (direct). Haul road will be rehabilitated.	No – residual impact is not significant

Table 10: Key Environmental Factors, Mitigation Measures and Management Strategies for the Project

Key Factor	Aspect/Impact	Management Strategies and Mitigation Measures Summary
Vegetation	Clearing Footprint Vegetation Disturbance	• The clearing corridor will be kept to a minimum. • Vegetative material and topsoil will be collected and correctly stockpiled for rehabilitation of the haul road at completion of mining activitiy.. • WANL have clearing procedures which will continue to be and implemented to minimise clearing and ensure it is restricted to only that required. • All staff and contractors will be environmentally inducted and trained on clearing procedures. • WANL Environmental staff will supervise vegetation clearing works. • Driving off the haul road will be prohibited.
Flora	DRF & Priority Species	• Project footprint designed cognisant of known GPS locations of DRF and Priority flora species. • WANL will continue to implementation the DRF Management Plan. • WANL will continue to undertake monitoring of *E. steedmanii* populations closest to the haul road. • Clearing procedures which clearly mark the area to be cleared to avoid over-clearing. • Prior to clearing, native seed will be collected for rehabilitation.
Terrestrial Fauna	Carnaby's Cockatoo	• Implement the Carnaby's Cockatoo Management Plan. • Vehicle speed limit restrictions. • Supervision of clearing activities will be undertaken by the WANL Environmental staff. • Prohibition on bringing pets, firearms, or traps into the Project area. • Prohibition of feeding or sheltering of native animals. • Waste management to minimise attraction of feral animals. • Continued implementation of the Spotted Quoll Fire Management Plan to protect fauna habitat.
Rehabilitation and Closure	N/A	• Undertake decommissioning and closure of the site to statutory requirements and as identified within conceptual closure plan. • Contingency actions identified in the event that decommissioning and rehabilitation performance indicators are not being achieved. • Collect and correctly stockpile vegetative material and topsoil for later use at selected sites. • Only use local native plant species. • Optimise rehabilitation approach through trials. • Outcomes based EFA monitoring commitment for rehabilitation program post closure • Only local native plant species and local provenance seed will be used for rehabilitation. • Topsoil integrity will be managed and preserved during removal and storage.

6 MANAGEMENT STRATEGIES AND MITIGATION MEASURES FOR CARNABY'S COCKATOO

6.1 OVERVIEW

WANL has developed extensive and varied management strategies and mitigation measures for the proposed haul road.

Where avoidance of all potential breeding and foraging habitat was not a valid alternaltive, WANL has developed management strategies and mitigation measures to minimize and reduce the impact of the proposed haul road on the Carnaby's Cockatoo.

Below is a summary of the specific environmental mitigation measures and management strategies adopted to minimise the impact of the project on the Carnaby's Cockatoo.

6.2 KEY MANAGEMENT STRATEGIES AND MITIGATION MEASURES

6.2.1 Prior to and during construction

Identification of potential sensitive sites

Prior to commencement of construction activities, boundaries for clearing for the proposed haul road will be clearly marked with purpose-made signage.

WANL Environmental staff will oversee the proposed clearing activities to ensure that clearing is limited to only that within the defined clearing corridor and avoidance of all potential breeding hollows is avoided wherever possible.

Clearing outside of the breeding season

To ensure no impact to Carnaby's Cockatoo which are nesting in potential hollows located within the proposed area of clearing or surrounds, clearing and disturbance activities associated with the construction of the haul road during the breeding season (i.e. July to November) will be restricted to areas greater than 400 metres from a potential breeding hollow.

Restrict vegetation disturbance

Vegetation disturbance will be minimised by undertaking the following steps:

The clearing corridor will be kept to a minimum.

Clearly mark areas to be cleared prior to clearing commencing so that over-clearing will be avoided.

Limiting clearing of vegetation to the minimum necessary to implement the project. This will be achieved using the existing WANL internal "Permit to Clear" procedures.

Areas of vegetation disturbed temporarily during the construction of the haul road will be rehabilitated as soon after construction as practicable.

No driving off road and no incursions into native vegetation.

Increase onsite awareness

Onsite awareness will be increased to minimise accidental damage to the Carnaby's Cockatoo or their habitat. This will be undertaken through implementation of the following measures:

Environmental induction for all personnel before entering site and/or commencing construction of the haul road.

Regular reminders at presentations, tool box meetings, etc., of the value of remnant vegetation and habitat for species of conservation significance.

Adequate signage erected to alert personnel of the potential for species of conservation significance to occur within the area.

6.2.2 During implementation

Workforce/Site restrictions

WANL's implemented restrictions at the mine site and associated roads to reduce the risk of damaging potential habitat will continue and will include the area of the proposed new haul road. These include:

Restricted vehicular access to established tracks only thus restricting the potential for damage to Carnaby's habitat.

Limited speed limits appropriate to the area and potential fauna habitat. Construction will be undertaken only during daylight hours.

Continuing onsite awareness

Onsite awareness will continue throughout use of the proposed haul road during inductions (required before entering site) aned at presentation and tool box meetings.

Regular maintenance of signage (where required) will continue throughout the use of the haul road.

6.2.3 Completion of haul road operations

At completion of mining operation, the haul road and associated infrastructure will be rehabilitated to native vegetation. WANL are currently updating their Rehabilitation and Closure Plan to include the haul road and the plan will include:

Rehabilitation prescriptions for different vegetation types and soil types to include local native species with seed sourced locally where practicable.

Where practicable direct seeding and/or planting will be undertaken to stabilise surfaces and integrate landforms into the surrounding landscape and ecosystems.

Rehabilitated areas will be constructed to blend in and allow suitable habitat for recolonising fauna.

During and following construction, the areas surrounding the Proposal infrastructure will be actively managed to ensure indirect impacts are minimised and to aid regeneration of vegetation. Such management will include invasive weed monitoring and control, erosion management, and monitoring and adaptive management.

Rehabilitation efforts will focus on providing species known and potentially suitable for breeding and foraging to provide an effective outcome for the recovery of the species habitat types.

7 OFFSET PROPOSAL

7.1 KEY OBJECTIVES

With broader conservation strategies for Carnaby‟s Black-Cockatoo in mind, WANL is proposing conservation offsets for the loss of potential breeding and foraging habitat within the site.

The mitigation strategy is focused on providing local outcomes of greater ecological importance than that proposed for clearing. Accordingly, in order to mitigate the loss of up to 6.45 ha of potential breeding habitat, WANL is seeking to provide direct offsets for impacts to this potential breeding habitat. WANL understands DSEWPAC's current expectation is at a ratio of 10:1, however given the:

- Linear nature of the proposed disturbance for the haul road.
- Extensive breeding and foraging habitat located in the immediate surrounds and the region.

Proposed direct and indirect offset measures proposed (described in the following sections).

WANL believe a lower ratio of 5:1 is more suitable for the project.

The direct and indirect offsets being proposed by WANL are as follows:

Direct offset:

Maintenance, isolation and amendment to title of 70 ha of existing Canaby's Cockatoo habitat on freehold land owned by Western Areas (Lot 1210 on deposited plan 204244). The certificate of title is included as Appendix 4.

Indirect offsets:

- Expansion and continuation of feral animal control program.
- Development of a Carnaby's Cockatoo Conseravation Plan.
- Research to increase local knowledge on Carnaby's Black-Cockatoo.
- Habitat improvement.
- Habitat monitoring.

The key objectives for the haul road offset will be to affect the following conservation outcomes:

- Deliver an environmentally responsible offset with a minimum standard of 'net conservation benefit'.
- Achieve positive and long-term environmental benefits.
- Build on success, appropriate application of science, effective partnership arrangements and effecting real positive change to the environment.

7.2 DIRECT OFFSETS

7.2.1 Proposed Conservation Reserve of Existing Carnaby's Habitat in a Remnant Vegetation Area (RVA)

In 2008, WSA purchased a freehold farm, "*Mossco*", to enable the establishment of evaporation ponds for the disposal of mine water produced from FNP dewatering operations. The placement of the ponds on Mossco reduced significantly the amount of clearing that would have been required to establish similar ponds on WANL owned mining tenements located on Unallocated Crown Land (UCL) closer to FNP operations areas.

Mossco is located approximately 22 km to the south of the proposed haul road alignment. It is located at the very eastern extent of the Western Australian wheatbelt in the Shire of Lake Grace. Figure 9 shows the location of Mossco and the RVA in relation to the FNP.

Mossco contains a significant remnant vegetation area (RVA) dominated by old growth Salmon Gum Woodland (SGW). WANL commissioned an assessment to establish the potential for the RVA at Mossco to contain breeding, roosting and foraging habitat for the Carnaby's Cockatoo and hence for the RVA to fulfil the DSEWPC offset requirements for the haul road proposal.

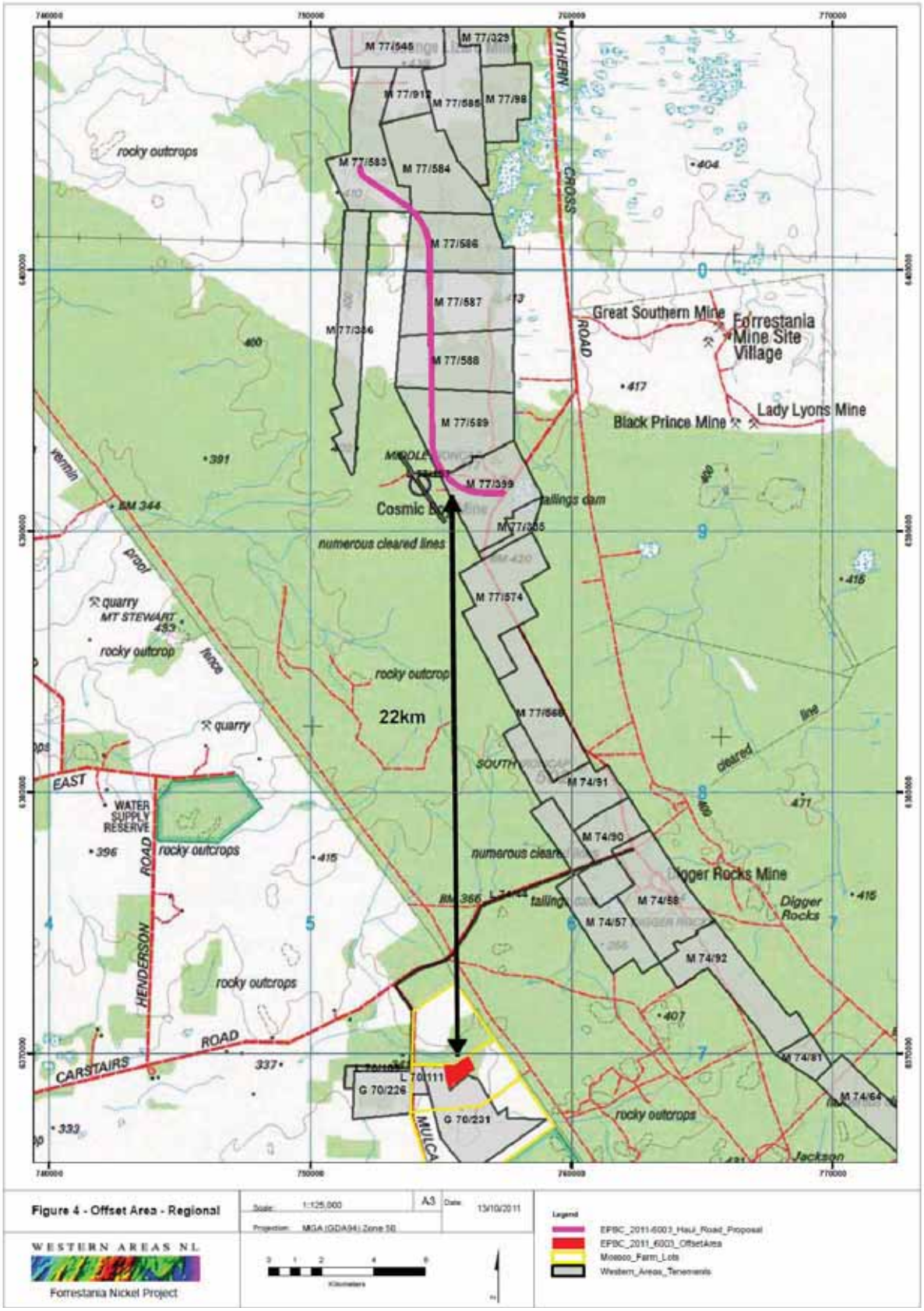


Figure 9 - Location of Mossco and the RVA in relation to the FNP

7.2.1.1 Assessment Methods

Phil Knapton of PEK Enviro was commissioned by WSA to undertake an assessment of the potential for Carnaby's Cockatoo breeding, roosting and foraging habitat to occur within the RVA on Mossco. The criteria used in the assessment were based on those outlined in the recently published DSCWPC 2011 document titled:

"*Environment Protection and Biodiversity Conservation Act 1999 draft referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris; Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii; Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso".*

The criteria are shown in Table 1.

Table 11: Mossco Salmon Gum Woodland potential Carnaby's Cockatoo habitat assessment criteria

Breeding	Roosting	Foraging	Foraging common food items
Any patch of woodland or forest that contains live or dead trees of salmon gum (*E. salmonophloia*), wandoo, tuart, jarrah (*E. marginata*), flooded gum (*E. rudis*), york gum (*E. loxophleba subsp. loxophleba*), karri or marri, with either a diameter at breast height greater than 500 mm, or presence of suitable nest hollow[3].	Generally in or near riparian environments or natural and artificial permanent water sources. Flat-topped yate (*E. occidentalis*), salmon gum, wandoo, marri, karri, blackbutt, tuart, introduced eucalypts (for example blue gum) and introduced pines.	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as Banksia spp. (including *Dryandra* spp.), *Hakea* spp. and *Grevillea* spp. Forages in pine plantations (*Pinus* spp.), Eucalypt woodland and forest that contains foraging species. Also individual trees and small stands of these species.	Seeds, flowers and nectar of native proteaceous plant species (for example, *Banksia* spp., *Hakea* spp., *Dryandra* spp, and *Grevillea* spp) and eucalypts. Also seeds of introduced species including *Pinus* spp., *Erodium* spp., wild radish, canola, almonds and pecan nuts; insects and insect larvae; occasionally flesh and juice of apples and persimmons.

7.2.1.2 Assessment Results

Vegetation and flora

The RVA of interest on Mossco is approximately 105 Ha in size. A brief description of the vegetation and flora occurring within the RVA follows.

Within the RVA, the upper stratum was typically open and comprised almost exclusively of Salmon Gum (*Eucalyptus salmonophloia*) trees. In some areas, Salmon Gum dominated with minimal understorey whilst in other areas Salmon Gum was sparsely distributed with mid storey *Eucalyptus* mallee and *Melaleuca* species dominating.

In the more open areas dominated by a Salmon Gum, the mid stratum was typically comprised of species such as *Daviesia benthamii* subsp. *acanthoclona*, *Eremophila decipiens* subsp. *decipiens*, *Eucalyptus eremophila* subsp. *eremophila*, *Exocarpus sparteus*, *Grevillea huegelii*, *Hakea commutata*, *Hakea newbeyana*, *Melaleuca pauperiflora* subsp.

pauperiflora, Olearia muelleri, *Santalum acuminatum* and *Templetonia sulcata*. The ground stratum was typically dominated by rush species of the Cyperaceae family with grass species from the genus' *Austrostipa* and *Neurachne* also being represented.

In areas where Salmon Gum was more sparsely distributed, Eucalyptus mallee species dominated with *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus calycogona* subsp. *calycogona* strongly represented. Often the Eucalyptus mallee species occurred in combination with Melaleuca species such as *Melaleuca lateriflora, Melaleuca acuminata* subsp. *acuminata* and *Melaleuca adnata*. Other typical species included *Acacia verricula*, *Grevillea huegelii*, *Grevillea oncogyne* and *Hakea cummutata*.

A small area of alluvial sandplain associated with a drainage line also occurred within the RVA and showed a slightly different structure. In this area *Callistemon phoenicius*, *Callitris preisii*, *Hakea newbeyana* and *Leptospermum erubescens* dominated the mid stratum.

Plates showing the vegetation and hollows at the site are included in Appendix 3 (attached).

Breeding Habitat

DSEWPC (2011) state that for a tree to be considered a potential breeding tree for Carnaby's Cockatoo it must have a diameter at breast height (1.3 m above ground) of greater than 500 mm or contain a suitable nesting hollow.

The diameter at breast height for a sample of 50 Salmon Gums trees was taken from within a small section of open SGW within the RVA. The average measurement was ~370 mm however within the sample there were 14 specimens (28%) with a diameter at breast height of greater than or equal to 500 mm. One Salmon Gun specimen showed a diameter at breast height of ~1200 mm (Plate 7).

In addition to many trees showing a diameter at breast height of greater than 50cm, hollows were also present on many. Groom (2010) notes that Carnaby's Cockatoos have been recorded using hollows in Salmon Gum trees which can vary in size between 13 and 32 cm in width (average 21.9) and between 10 and 29 cm in height (average 20.5). Many of the hollows noted in Salmon Gums within the RVA were definitely larger than minimum width of 13 cm and minimum height of 10 cm. Plates 8 - 12 show some examples of typical hollows from the Mossco RVA.

In addition to hollows, many Salmon Gum trees exhibited numerous dead stags. The stags themselves can potentially be used as nesting sites by Carnaby's Cockatoo or when they fall can leave behind an accessible hollow. Plates 13 - 16 show some examples of Salmon Gum stags from the Mossco RVA.

The 70 ha of SGW within the RVA identified as a direct offset contains superior potential breeding habitat to that identified along the proposed haul road route and protection of this area would provide better than 'like for like' offset of the proposed clearing of up to 6.45 ha of potential breeding habitat.

Roosting Habitat

The criteria set out by DSEWPC (2001) state that roosting habitat for Carnaby's Cockatoo is generally in or near riparian environments or natural or artificial permanent water sources. Salmon Gum is included as a preferred roosting tree species.

Shah (2006) notes that drinking forms a normal part of the daily routine for Carnaby's Cockatoos on the Swan Coastal Plain. Dr Hugh Finn in Science Alert (2008) notes that

Carnaby's Cockatoo must drink every day. Hence proximity to water sources would appear to be an important factor in the establishment of roosting (and breeding) sites.

No natural or artificial permanent fresh water sources are known occur within the vicinity of the RVA except for the water captured within farm dams. Given this is the case, farm dams may actually provide an important water source for Carnaby's Cockatoo in the semi-arid eastern wheatbelt. It is possible that proximity to these may be an important factor in choice of roosting (and breeding) sites.

There are numerous farm dams within the vicinity of the RVA and given that the Salmon Gums present in the RVA are old and large it is likely that the RVA area could provide valuable roosting habitat for the Carnaby's Cockatoo.

Foraging Habitat

The vegetation groups that occur within the RVA contain species that are considered to provide foraging habitat for the Carnaby's Cockatoo.

Groom (2011) notes that the genera *Acacia*, *Allocasuarina*, *Banksia*, *Callistemon*, *Callitris*, *Eucalyptus*, *Grevillea*, *Hakea, Isopogon* and *Melaleuca* are all known to contain species that provide value as food sources for the Carnaby's Cockatoo. Representatives of all of these genera with the exception of *Allocasuarina* were recorded within the RVA during this brief assessment.

In addition there are large areas of sandplain (Kwongan) heath occurring in the adjacent UCL areas. Sandplain heath contains many species considered to provide valuable food resources for the Carnaby's Cockatoo. Sandplain heath is located both to the north and to the east of the RVA with the closest area being only 2.5 kms to the north.

A brief assessment was carried out on the species occurring in the sandplain heath area to the north of the Mossco RVA that could provide food resources for Carnaby's Cockatoo. These are listed as follows: *Allocasuarina acutivalvis*, *Banksia elderiana*, *Banksia erythrocephala*, *Banksia violacea*, *Callitris canescens*, *Hakea cygna*, *Hakea platysperma*, *Isopogon scabriusculus* and *Petrophile stricta.*

The results of the assessment of both the Mossco RVA and adjacent sandplain heath areas show that there are likely to be significant food resources available locally for Carnaby's Cockatoo's visiting the area to breed (PEK Enviro, 2011).

Habitat Comparison

The results of a brief assessment of SGW occurring within the RVA on WSA owned Mossco farm show that it contains significant potential breeding, roosting and foraging habitat for the Carnaby's Cockatoo. In addition, water sources in the form of farm dams occur locally and significant areas of sandplain (Kwongan) heath which provide preferred foraging habitat for Carnaby's Cockatoo occur on UCL within 2.5 kms of the RVA.

In the opinion on the author, the habitat values of the SGW within the RVA on Mossco are superior to those of the SGW areas seen along the proposed HR route and significantly exceed the 10:1 "*like for like*" offset requirement of the DSEWPC.

7.2.2 Mechanism of Conservation of Remnant Vegetation Area (RVA)

WANL will liaise with relevant state government authorities to determine the appropriate instrument to protect the conservation values of the identified 70 ha of potential breeding

habitat in perpetuity under either the Transfer of Land Act 1893 or the Soil and Land Conservation Act 1945.

The 70 ha of potential breeding habitat proposed as a direct offset is identified in Figure 10.

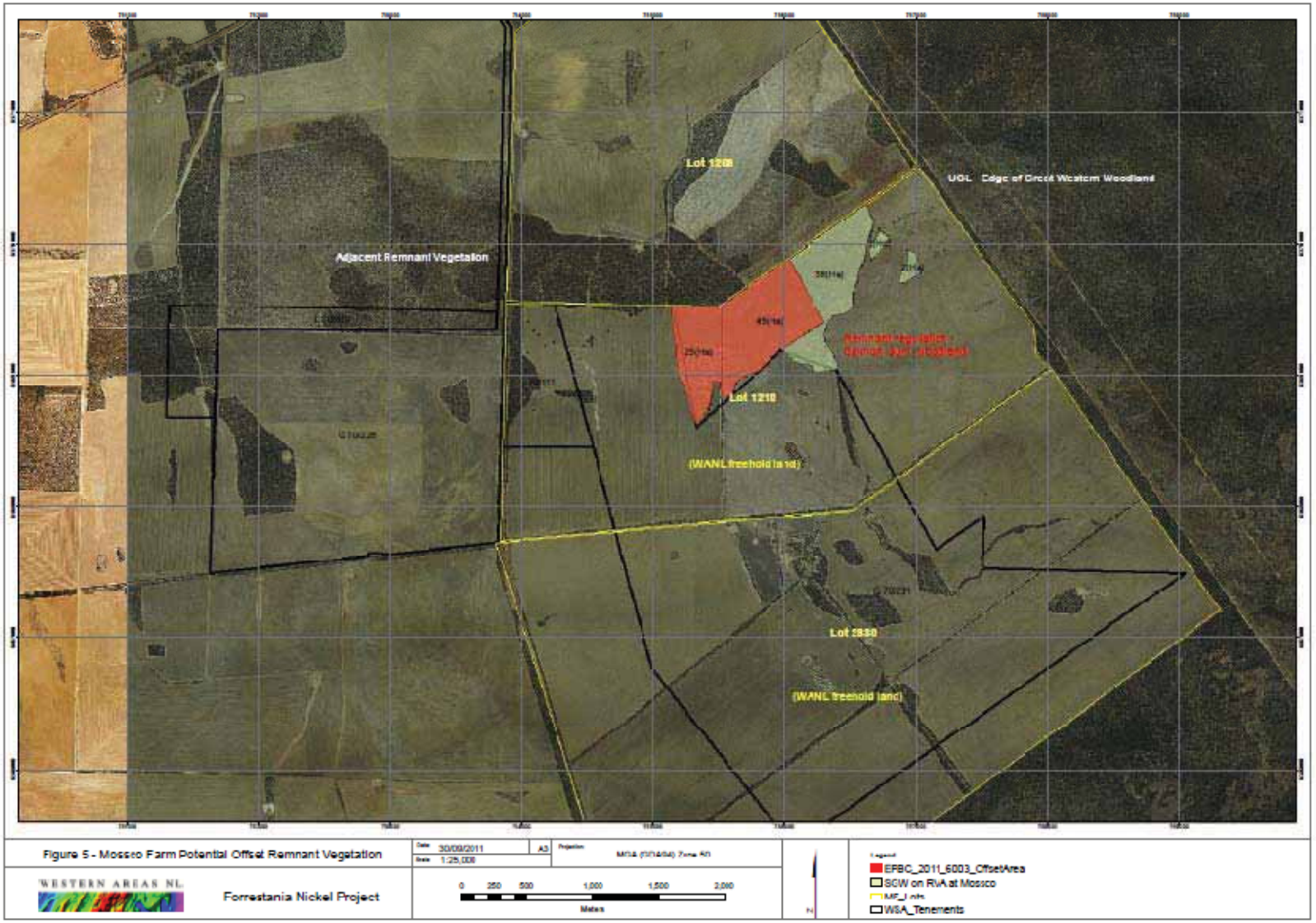


Figure 10 - The 70 ha of potential breeding habitat proposed as a direct offset

7.3 INDIRECT OFFSETS

7.3.1 Carnaby's Cockatoo Management Plan

WANL has commited to the development of a Carnay's Cockatoo Conservation Plan to outline the management measures and strategies to be implemented to minimise the potential impact of the project on the species.

A draft copy of this plan is attached as Appendix 2. Preliminary consultation with Ron Johnstone (WA Museum) with regards to potential conservation strategies has been undertaken and the plan will be further refined based on further liason with Mr Johnstone.

7.3.2 Carnaby's Cockatoo Monitoring Program

WANL has been in liaison with Carnaby's Cockatoo expert Ron Johnstone (WA Museum) regarding a proposed research monitoring program in the Forrestania area. This program would be significant in terms of putting the Carnaby's habitat at Forrestania in context of the broader regional area.

Ron Johnstone's company will be commissioned to undertake a research monitoring program for which WANL propose to provide $20,000 per annum for five years.

Following agreement with DSEWPC, WANL will finalise the terms of this arrangement in further detail.

In accordance with DSEWPC (2011) this indirect offset will improve the knowledge and understanding of Carnaby's Cockatoo by contributing to research.

7.3.3 Feral Animal Control Program

WANL currently undertake feral animal control measures to protect native fauna from completition and predation.

WANL propose to expand the existing annual feral animal trapping and baiting program to include the Spotted Quoll mining leases. The program will aid in keeping predatory feral animal numbers to a minimum, with the aim of reducing predation on native fauna.

WANL commit to sponsorship of conservation of threatened species (Western Shield, Chuditch-zoo) over $165,000 over 6 years.

This will also include sponsorship of the wild dog control program managed by the Eastern Wheatbelt Declared Species Group (a joint group involving members from the Department of Agriculture and Food, the Department of Environment and Conservation, the Shire of Kondinin and other Shires and individuals including local farmers) for the next three years.

In accordance with DSEWPC (2011) this indirect offset will reduce the threat of hunting by feral animals to the species.

7.3.4 Habitat Management

In addition to direct offsets in acquisition, conservation and restoration, WANL proposes a framework for improved management of the offset areas with the management objective to: Create, maintain and improve its natural ecological values.

It is proposed to achieve this through:

Maintaining the existing diversity and abundance of native flora and fauna associated with the area and respective vegetation communities.

The control of noxious weeds within the offset area.

The control of feral animals (described above).

- Introduction of a bushfire management scheme.
- Erosion control activities.
- Inspection, at appropriate time, for invasive weeds and significant environmental weed infestation.
- Implementation of a weed control program.
- Monitoring to assess condition of habitat and effectiveness of measures.
- Contingency actions to implement should monitoring indicate measures are not being effective.

The removal of threatening processes and on-going management activities such as monitoring, maintenance, preparation and implementation of management plans, etc, represent substantial indirect offsets as per DSPEWC (2011).

8 CONSERVATION OUTCOMES

The direct and indirect mitigation components and predicted outcomes of the Offsets Strategy for addressing the on-site clearing of 6.45 ha of potential breeding habitat for Carnaby's Cockatoo are summarised in Table 11.

Table 11 – Summary of conservation outcomes

Element	Description	Area	Offset:Ratio	Conservation Outcome
Direct Offset – breeding habitat				
Maintenance, isolation and title amendment for 70 ha of remnant vegetation currently on freehold land in the agricultural area.	Includes retention of 70 ha of remnant vegetation on project land at Mossco.	70 ha	>10:1	The retention of existing Carnaby's Black-Cockatoo habitat within the Forrestania project area operations which will include enhancement of the local area as an ecological stepping stone/ corridor linkage.
Direct Offset – foraging habitat				
Proposed retention of Carnaby's habitat in adjacent agricultural land currently part of the Forrestania project operations	Includes the proposed retention and title change of 70 ha of remnant vegetationat the project.	70 ha	N/A	The retention of existing Carnaby's Black-Cockatoo habitat within the Forrestania project area operations which will include enhancement of the local area as an ecological stepping stone/ corridor linkage.
Indirect Offset				
Carnaby's Cockatoo Monitoring Program	Research into Carnaby's Black-Cockatoo feeding requirements in region.	N/A	N/A	Increased local and regional knowledge and science relating to Carnaby's in the Forrestania area.
Feral animal control program.	Continuation and expansion of existing baiting and feral animal control program.	N/A	N/A	Reduction in existing threat to the Carnaby's Cockatoo at the project
Habitat Management and monitoring	Improved management and monitoring of all habitat areas retained on-site to create, maintain and improve outcomes.	230 ha	N/A	Improved management and establishment of important areas of vegetation for the Carnaby's Cockatoo.

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APPENDIX 1 – LIST OF PLANT SPECIES WHICH CARNABY'S BLACK COCKATOOS UTILISE FOR ROOSTING, NESTING AND FEEDING

Plants Used by Carnaby's Black Cockatoo

Department of Environment and Conservation

List prepared by Christine Groom, Department of Environment and Conservation 15 April 2011

For more information on plant selection or references used to produce this list please visit the Plants for Carnaby's Search Tool webpage at www.dec.wa.gov.au/plantsforcarnabys

Our environment, our future

Species	Used for			Priority for planting for Carnaby's	Growth form	Flower colour	Soil type				Sun exposure	Soil drainage				Origin
	Feeding	Nesting	Roosting				Clayey	Gravelly	Loamy	Sandy		Well drained	Poorly drained	Waterlogged	Salt affected	
Acacia baileyana (Cootamundra wattle)*	■			Low	Tree	Yellow	■		■		○ ◗	■	■	■		Australian native
Acacia pentadenia (Karri Wattle)	■			Low	Tree	Cream			■		○ ◗ ◗	■				WA native
Acacia saligna (Orange Wattle)	■			Low	Tree	Yellow			■	■	○ ◗	■	■			WA native
Agonis flexuosa (Peppermint Tree)	■			Low	Tree	White		■		■	○ ◗ ◗	■	■			WA native
Araucaria heterophylla (Norfolk Island Pine)	■			Low	Tree	Green				■	○ ◗ ◗	■				Exotic to Australia
Banksia ashbyi (Ashby's Banksia)	■			Medium	Tree or Tall shrub	Yellow, Orange				■	○ ◗	■				WA native
Banksia attenuata (Slender Banksia)	■			High	Tree	Yellow			■	■	○ ◗	■				WA native
Banksia baxteri (Baxter's Banksia)	■			Medium	Tall shrub	Yellow	■		■	■	○ ◗	■				WA native
Banksia carlinoides (Pink Dryandra)	■			Medium	Medium or small shrub	White, cream, pink	■		■	■	○ ◗	■				WA native
Banksia coccinea (Scarlet Banksia)	■			Medium	Tree	Red		■	■	■	○ ◗	■				WA native
Banksia dallanneyi (Couch Honeypot Dryandra)	■			Low	Medium or small shrub	Orange, brown			■	■	○	■				WA native
Banksia ericifolia (Heath-leaved Banksia)	■			Medium	Tall shrub	Orange			■	■	○	■				Australian native
Banksia fraseri (Dryandra)	■			Medium	Medium or small shrub	Orange		■		■	○ ◗	■				WA native
Banksia gardneri (Prostrate Banksia)	■			Low	Medium or small shrub	Orange	■	■	■	■	○ ◗	■				WA native
Banksia grandis (Bull Banksia)	■			High	Tree	Yellow		■	■	■	○ ◗	■				WA native
Banksia hookeriana (Hooker's Banksia)	■			Medium	Tall shrub	Orange				■	○ ◗	■				WA native
Banksia ilicifolia (Holly Banksia)	■			High	Tree	Cream				■	○ ◗	■				WA native
Banksia kippistiana (Dryandra)	■			Medium	Medium or small shrub	Yellow		■		■	○ ◗	■				WA native
Banksia leptophylla	■			Low	Medium or small shrub	Yellow				■	○ ◗	■				WA native
Banksia littoralis (Swamp Banksia)	■			High	Tree	Yellow	■	■	■	■	○ ◗	■				WA native
Banksia menziesii (Firewood or Menzie's Banksia)	■			High	Tree	Yellow, pink, red				■	○ ◗	■				WA native
Banksia mucronulata (Swordfish Dryandra)	■			Medium	Medium or small shrub	Yellow	■		■	■	○ ◗	■				WA native
Banksia nivea (Honeypot Dryandra)	■			High	Medium or small shrub	Orange		■		■	○ ◗	■				WA native
Banksia nobilis (Golden Dryandra)	■			Medium	Tall shrub	Orange	■	■	■	■	○	■				WA native
Banksia praemorsa (Cut-leaf Banksia)	■			Medium	Tall shrub	Red, yellow, green				■	○	■				WA native
Banksia prionotes (Acorn Banksia)	■			High	Tree	Orange				■	○	■				WA native

	Used for						Soil type					Soil drainage				
Species	**Feeding**	**Nesting**	**Roosting**	**Priority for planting for Carnaby's**	**Growth form**	**Flower colour**	**Clayey**	**Gravelly**	**Loamy**	**Sandy**	**Sun exposure**	**Well drained**	**Poorly drained**	**Waterlogged**	**Salt affected**	**Origin**
Banksia quercifolia (Oak-leaved Banksia)	■			Medium	Tall shrub	Brown			■	■	○	■				WA native
Banksia sessilis (Parrot Bush)	■			High	Tree	Cream		■		■	○ ◗	■				WA native
Banksia speciosa (Showy Banksia)	■			High	Tree	Yellow	■			■	○ ◗	■				WA native
Banksia squarrosa (Pingle)	■			High	Tall shrub	Yellow	■	■	■	■	○	■				WA native
Banksia tricuspis (Lesueur Banskia or Pine Banksia)	■			Medium	Tree	Orange				■	○ ◗	■				WA native
Banksia undata (Urchin or Cut-leaf Dryandra)	■			High	Tall shrub	Yellow	■	■	■	■	○ ◗	■				WA native
Banksia verticillata (Granite Banksia)	■			Low	Tree	Yellow			■	■	○ ◗	■				WA native
Brassica campestris (Canola, Rape)**	■			Low	Herb	Yellow			■	■	○ ◗ ◗	■				Exotic to Australia
Callistemon viminalis (Captain Cook Bottlebrush)	■			Medium	Tall shrub	Red	■	■	■	■	○	■				Australian native
Callitris sp.	■			Medium	Tree		■		■	■	○	■				WA native
Carya illnoinensis (Pecan)	■			Low	Tree	Yellow			■	■	○ ◗	■				Exotic to Australia
Casuarina cunninghamiana (River Sheoak)*	■			Low	Tree	Red	■	■	■	■	○	■	■	■		Australian native
Citrullus lanatus (Pie or Afghan Melon)*	■			Low	Scrambler, climber or percher	Yellow	■	■	■	■	○	■				Exotic to Australia
Corymbia calophylla (Marri)	■	■	■	High	Tree	Cream	■	■	■	■	○ ◗	■	■			WA native
Corymbia ficifolia (Red Flowering Gum)	■			Medium	Tree	Red		■	■	■	○	■				WA native
Corymbia haematoxylon (Mountain Marri)	■			Medium	Tree	White				■	○	■				WA native
Corymbia maculata (Spotted Gum)			■	Low	Tree	White		■			○	■				Australian native
Darwinia citriodora (Lemon-scented Darwinia)	■			Low	Medium or small shrub	Red, orange, yellow		■			○ ◗	■				WA native
Diospryros sp. (Sweet Persimmon)	■			Low	Tree				■	■	○	■				Exotic to Australia
Eremophila glabra (Tarbush)	■			Low	Tall shrub	Various	■		■	■	○ ◗	■				WA native
Erodium aureum (Corkscrew Grass or Storksbill)*	■			Low	Herb	Pink			■	■	○	■				Exotic to Australia
Erodium botrys (Corkscrew Grass or Storksbill)*	■			Low	Herb	Purple					○	■				Exotic to Australia
Eucalyptus caesia (Silver Princess)	■			Medium	Tree	Pink			■		○	■				WA native
Eucalyptus camaldulensis (River Red Gum)			■	Low	Tree	Cream, yellow	■				○		■	■	■	Australian native
Eucalyptus citriodora (Lemon Scented Gum)	■		■	Medium	Tree	Red		■	■		○	■				Australian native
Eucalyptus diversicolor (Karri)		■		Low	Tree	Cream			■	■	○	■				WA native
Eucalyptus globulus (Tasmaniam Blue Gum)			■	Low	Tree	White	■	■	■		○	■				Australian native
Eucalyptus gomphocephala (Tuart)	■	■	■	High	Tree	White			■	■	○	■				WA native
Eucalyptus grandis (Flooded Gum, Rose Gum)			■	Low	Tree	White, cream	■		■	■	○	■				Australian native
Eucalyptus longicornis (Red Morrell)		■		Low	Tree	White	■		■		○	■				WA native
Eucalyptus loxophleba (York Gum)	■	■		Low	Tree	White		■	■	■	○	■				WA native
Eucalyptus marginata (Jarrah)	■		■	Medium	Tree	White	■	■	■	■	○	■				WA native
Eucalyptus occidentalis (Swamp Yate)		■		Low	Tree	Cream	■		■		○		■	■		WA native
Eucalyptus patens (Blackbutt)	■		■	Medium	Tree	White	■	■	■	■	○	■				WA native
Eucalyptus pleurocarpa (Tallerack)	■			Medium	Tree	White				■	○	■				WA native

Species	Used for			Priority for planting for Carnaby's	Growth form	Flower colour	Soil type				Sun exposure	Soil drainage				Origin
	Feeding	Nesting	Roosting				Clayey	Gravelly	Loamy	Sandy		Well drained	Poorly drained	Waterlogged	Salt affected	
Eucalyptus preissiana (Bell-fruited Mallee)	■			Medium	Tree	Yellow		■	■	■	○	■	■			WA native
Eucalyptus robusta (Swamp Mahogany)	■		■	Medium	Tree	White	■	■	■	■	○	■	■	■	■	Australian native
Eucalyptus rudis (Flooded Gum)			■	Low	Tree	White	■		■	■	○	■				WA native
Eucalyptus salmonophloia (Salmon Gum)	■	■		High	Tree	White	■	■		■	○	■				WA native
Eucalyptus salubris (Gimlet)		■		Medium	Tree	White, cream		■	■	■	○	■				WA native
Eucalyptus todtiana (Coastal Blackbutt or Prickley Bark)	■			Medium	Tree	White				■	○	■				WA native
Eucalyptus wandoo (Wandoo)	■	■	■	High	Tree	White	■	■	■	■	○	■				WA native
Ficus sp. (Fig)	■			Low	Tree		■		■	■	○ ◢ ◢	■				Australian native
Grevillea armigera (Prickly Toothbrushes)	■			Medium	Tall shrub	Green, yellow, black		■		■	○ ◢	■				WA native
Grevillea bipinnatifida (Fuschia Grevillea)	■			Medium	Medium or small shrub	Red	■	■	■	■	○ ◢	■				WA native
Grevillea hookeriana (Red Toothbrushes)	■			Medium	Tall shrub	Red		■	■	■	○	■				WA native
Grevillea hookeriana subsp. apiciloba (Black Toothbrushes)	■			Medium	Medium or small shrub	Black				■	○	■				WA native
Grevillea paniculata (Kerosene Bush)	■			Medium	Tall shrub	White	■	■	■	■	○ ◢	■				WA native
Grevillea paradoxa (Bottlebrush Grevillea)	■			Medium	Medium or small shrub	Cream, pink		■	■	■	○	■				WA native
Grevillea petrophiloides (Pink Poker)	■			Medium	Tall shrub	Pink		■		■	○	■				WA native
Grevillea robusta (Silky Oak)	■			Medium	Tree	Orange	■		■	■	○	■				Australian native
Hakea auriculata	■			Medium	Tall shrub	White		■	■	■	○ ◢	■				WA native
Hakea candolleana	■			Medium	Medium or small shrub	White	■		■	■	○	■				WA native
Hakea circumalata (Coastal Hakea)	■			Medium	Medium or small shrub	White, pink	■	■		■	○ ◢	■				WA native
Hakea commutata	■			Medium	Medium or small shrub		■	■	■	■	○ ◢	■		■		WA native
Hakea conchifolia	■			Medium	Medium or small shrub	White, cream, pink		■	■	■	○	■				WA native
Hakea costata (Ribbed Hakea)	■			Medium	Medium or small shrub	White		■	■	■	○	■				WA native
Hakea cristata (Snail Hakea)	■			Medium	Medium or small shrub	White		■	■		○ ◢	■				WA native
Hakea cucullata (Snail Hakea)	■			Medium	Tall shrub	Pink		■	■	■	○	■				WA native
Hakea cyclocarpa (Ramshorn)	■			Medium	Medium or small shrub	White	■	■	■		○ ◢	■				WA native
Hakea eneabba	■			Medium	Medium or small shrub	Yellow			■	■	○	■				WA native
Hakea erinacea (Hedgehog Hakea)	■			Medium	Medium or small shrub	Cream	■	■	■	■	○ ◢	■				WA native
Hakea falcata (Sickle Hakea)	■			Medium	Tall shrub	White	■	■	■	■	○ ◢		■	■		WA native
Hakea flabellifolia (Fan-leaved Hakea)	■			Medium	Medium or small shrub	Brown		■	■	■	○	■				WA native
Hakea gilbertii	■			Medium	Medium or small shrub	White	■	■	■	■	○	■				WA native
Hakea incrassata (Golfball or Marble Hakea)	■			Medium	Medium or small shrub	Cream		■	■	■	○ ◢	■				WA native
Hakea lasiantha (Woolly Flowered Hakea)	■			Medium	Tall shrub	White		■	■	■	○ ◢	■				WA native
Hakea lasianthoides	■			Medium	Tall shrub	White	■	■	■		◢	■				WA native
Hakea laurina (Pin-cushion hakea)	■			Medium	Tree	Red	■	■		■	○ ◢	■				WA native
Hakea lissocarpha (Honeybush)	■			Medium	Medium or small shrub	White		■	■	■	○ ◢	■				WA native

Species	Used for			Priority for planting for Carnaby's	Growth form	Flower colour	Soil type				Sun exposure			Soil drainage				Origin
	Feeding	Nesting	Roosting				Clayey	Gravelly	Loamy	Sandy	○	◒	●	Well drained	Poorly drained	Waterlogged	Salt affected	
Hakea megalosperma (Lesueur Hakea)	■			Medium	Medium or small shrub	White, cream, pink, red		■		■	○			■				WA native
Hakea multilineata (Grass Leaf Hakea)	■			Medium	Tall shrub	Pink	■	■	■	■	○	◒		■				WA native
Hakea obliqua (Needles and Corks)	■			Medium	Tall shrub	White			■	■	○			■				WA native
Hakea oleifolia (Dungyn or Olive-leaved Hakea)	■			Medium	Tree	White	■	■	■	■	○			■				WA native
Hakea pandanicarpa subsp. crassifolia (Thick-leaved Hakea)	■			Medium	Tall shrub	Cream		■	■	■	○	◒		■				WA native
Hakea polyanthema	■			Medium	Medium or small shrub	White		■	■	■	○			■				WA native
Hakea petiolaris (Sea Urchin Hakea)	■			Medium	Tall to medium shrub	Cream, pink		■	■	■	○	◒		■				WA native
Hakea preissii (Needle Tree)	■			Medium	Tall shrub	Yellow	■	■	■	■	○			■		■	■	WA native
Hakea prostrata (Harsh Hakea)	■			High	Tall to mediumshrub	White	■	■	■	■	○			■				WA native
Hakea psilorrhyncha	■			Medium	Tall shrub	Cream			■	■	○			■				WA native
Hakea ruscifolia (Candle Hakea)	■			Medium	Tall shrub	White		■	■	■	○	◒		■				WA native
Hakea scoparia (Kangaroo Bush)	■			Medium	Tall shrub	Cream	■	■	■	■	○	◒		■				WA native
Hakea smilacifolia	■			Medium	Medium or small shrub	White		■	■	■	○			■				WA native
Hakea spathulata	■			Medium	Medium or small shrub	Red			■	■	○			■				WA native
Hakea stenocarpa (Narrow-fruited Hakea)	■			Medium	Medium or small shrub	White	■	■	■	■	○	◒		■	■			WA native
Hakea sulcata (Furrowed Hakea)	■			Medium	Medium or small shrub	White		■	■	■	○	◒		■		■		WA native
Hakea trifurcata (Two-leaved Hakea)	■			High	Tall shrub	White		■	■	■	○	◒	●	■				WA native
Hakea undulata (Wavy-leaved Hakea)	■			High	Tall shrub	White	■	■	■	■	○	◒		■	■			WA native
Hakea varia (Variable-leaved Hakea)	■			Medium	Tall shrub	White	■	■	■	■	○	◒		■	■	■		WA native
Helianthus annuus (Sunflower)*	■			Low	Herb	Yellow					○			■				Exotic to Australia
Hibiscus sp. (Hibiscus)	■			Low	Tall shrub	Various					○	◒	●	■				Exotic to Australia
Isopogon scabriusculus	■			Medium	Medium or small shrub	Pink		■	■	■	○			■				WA native
Jacaranda mimosifolia (Jacaranda)	■			Low	Tree	Blue, purple			■	■	○	◒		■				Exotic to Australia
Jacksonia furcellata (Grey Stinkwood)	■			Medium	Tall shrub	Orange				■	○	◒		■				WA native
Lambertia inermis (Chittick)	■			Medium	Tree	Red, orange, yellow		■	■	■	○	◒		■				WA native
Lambertia multiflora (Many-flowered Honeysuckle)	■			Medium	Medium or small shrub	Orange, yellow	■	■		■	○			■				WA native
Liquidamber styraciflua (Liquid Amber)	■			Medium	Tree	Green					○	◒		■				Exotic to Australia
Lupinus sp. (Lupin)*	■			Low	Herb	Yellow, blue					○			■				Exotic to Australia
Macadamia integrifolia (Macadamia)	■			Medium	Tree	White		■	■	■	○			■				Australian native
Malus domestica (Apple)	■			Low	Tree	White					○			■				Exotic to Australia
Melaleuca leuropoma	■			Medium	Medium or small shrub	Cream, purple, yellow				■	○			■				WA native
Melia azedarach (Cape Lilac or White Cedar)**	■			Low	Tree	Purple			■	■	○	◒		■				Exotic to Australia
Mesomeleana sp.	■			Medium	Grassy or strappy						○			■				WA native
Protea repens	■			Medium	Tree or medium to small shrub	White, cream, pink		■		■	○	◒		■				Exotic to Australia
Protea 'Pink Ice'	■			Medium	Tree or medium to small shrub	White, cream, pink		■		■	○	◒		■				Exotic to Australia

Species	Used for			Priority for planting for Carnaby's	Growth form	Flower colour	Soil type				Sun exposure	Soil drainage				Origin
	Feeding	Nesting	Roosting				Clayey	Gravelly	Loamy	Sandy		Well drained	Poorly drained	Waterlogged	Salt affected	
Pinus canariensis (Canary Island Pine)	■			Low	Tree	Brown	■	■	■	■	○	■				Exotic to Australia
Pinus caribea (Caribbean Pine)	■			Low	Tree	Brown					○	■				Exotic to Australia
Pinus pinaster (Pinaster or Maritime Pine)**	■		■	Medium	Tree	Brown			■	■	○	■				Exotic to Australia
Pinus radiata (Radiata Pine)**	■		■	Medium	Tree	Brown			■	■	○	■				Exotic to Australia
Prunus amygdalus (Almond Tree)	■			Medium	Tree				■	■	○	■				Exotic to Australia
Raphanus raphanistrum (Wild Radish)*	■			Low	Herb	Various	■	■	■	■	○	■				Exotic to Australia
Tipuana tipu (Tipu or Rosewood Tree)**	■			Low	Tree	Yellow	■	■	■	■	○	■				Exotic to Australia
Xanthorrhoea preissii (Grass Tree)	■			Medium	Grassy or strappy	Cream		■	■	■	○	■				WA native

* Weed

** Potential weed

APPENDIX 2 – DRAFT CARNABY'S COCKATOO CONSERVATION MANAGEMENT PLAN





FORRESTANIA NICKEL PROJECT

SPOTTED QUOLL – COSMIC BOY HAUL ROAD

CARNABY'S BLACK COCKATOO CONSERVATION MANAGEMENT PLAN

Prepared for: *Western Areas NL*

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1.0 INTRODUCTION

1.1 PURPOSE

This Carnaby's Black Cockatoo Management Plan has been prepared to minimise and monitor any impacts on local Carnaby's Black Cockatoo *Calyptorhynchus latirostris* populations arising from the construction of the Spotted Quoll – Cosmic Boy Haul Road which is part of Western Areas NL (WANL) Forrestania Nickel Project (FNP).

The Carnaby's Black Cockatoo Management Plan will be implemented immediately upon approval.

1.2 PROJECT OVERVIEW

WANL are currently mining the Flying Fox underground mine (M77/582 and M77/545) and the Spotted Quoll Open Pit (M77/583). WANL also operate a processing plant and Tailings Storage Facility (TSF) at Cosmic Boy and have commenced development of the Diggers South mining project at Digger Rocks (M74/58, M74/57 and M74/90).

WANL has commenced development of the Spotted Quoll underground mine. Currently ore is being hauled by truck, via a mix of public and "on-lease" roads to be processed at WANL's Cosmic Boy nickel concentrator. The number of loaded cycles on these roads has increased significantly over the past 24 months and will continue to do so as all three mines reach maximum production levels. A risk assessment of the use of haulage trucks on public gazetted roads was undertaken during 2010. The preferred option to minimise the risks associated with haulage on the public roads was to build a private haul road on WANL owned tenements.

The proposed haul road will be approximately 15.8 km in length, 5.7 km of which follows an existing 3 m wide track. Construction of the haul road is planned to commence at the end of 2011 and will take approximately 3 – 4 months to construct.

A maximum of 40.74 ha of vegetation will be cleared for the construction of the haul road.

1.3 ASSESSMENT AND APPROVALS HISTORY

The Spotted Quoll – Cosmic Boy Haul Road Mining Proposal was submitted to the Department of Mines and Petroleum (DMP) on 21 April 2011. The project was then referred to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) under the *Environmental Protection and Biodiversity Conservation* (EPBC) *Act 1999.* On 19 July 2011, DSEWPC assessed the project as a 'controlled action' under the EPBC Act 1999. The assessment is still being reviewed with conditions yet to be determined.

A mitigation and offset strategy is being prepared to compensate for the loss of approximately 6.45 ha of potential breeding habitat and 23 potential breeding hollows of Carnaby's Black Cockatoo in the proposed project area.

2.0 PROJECT BACKGROUND

2.1 LOCATION

The project is situated approximately 160 kilometres south of Southern Cross and 80 kilometres east of Hyden in the Shire of Kondinin. Figure 1 shows the location of the Forrestania project.

2.1.1 Ownership and Land Tenure

The proposed haul road will be constructed on Mining Leases 77/399, 77/589, 77/588, 77/587, 77/586, 77/584 and 77/583 which are 100% owned by WANL. Table 1 shows the current status of mining tenements relating to this project.

Figure 2 shows the tenure of the Spotted Quoll – Cosmic Boy haul road.

Table 1 - Current Status of Mining Leases

TENEMENT	DATE GRANTED	EXPIRY DATE
M77/399	8/11/1989	7/11/2031
M77/589	28/09/1993	27/09/2014
M77/588	28/09/1993	27/09/2014
M77/587	28/09/1993	27/09/2014
M77/586	28/09/1993	27/09/2014
M77/584	28/09/1993	27/09/2014
M77/583	28/09/1993	27/09/2014



Figure 1 - Location of Forrestania Nickel Project

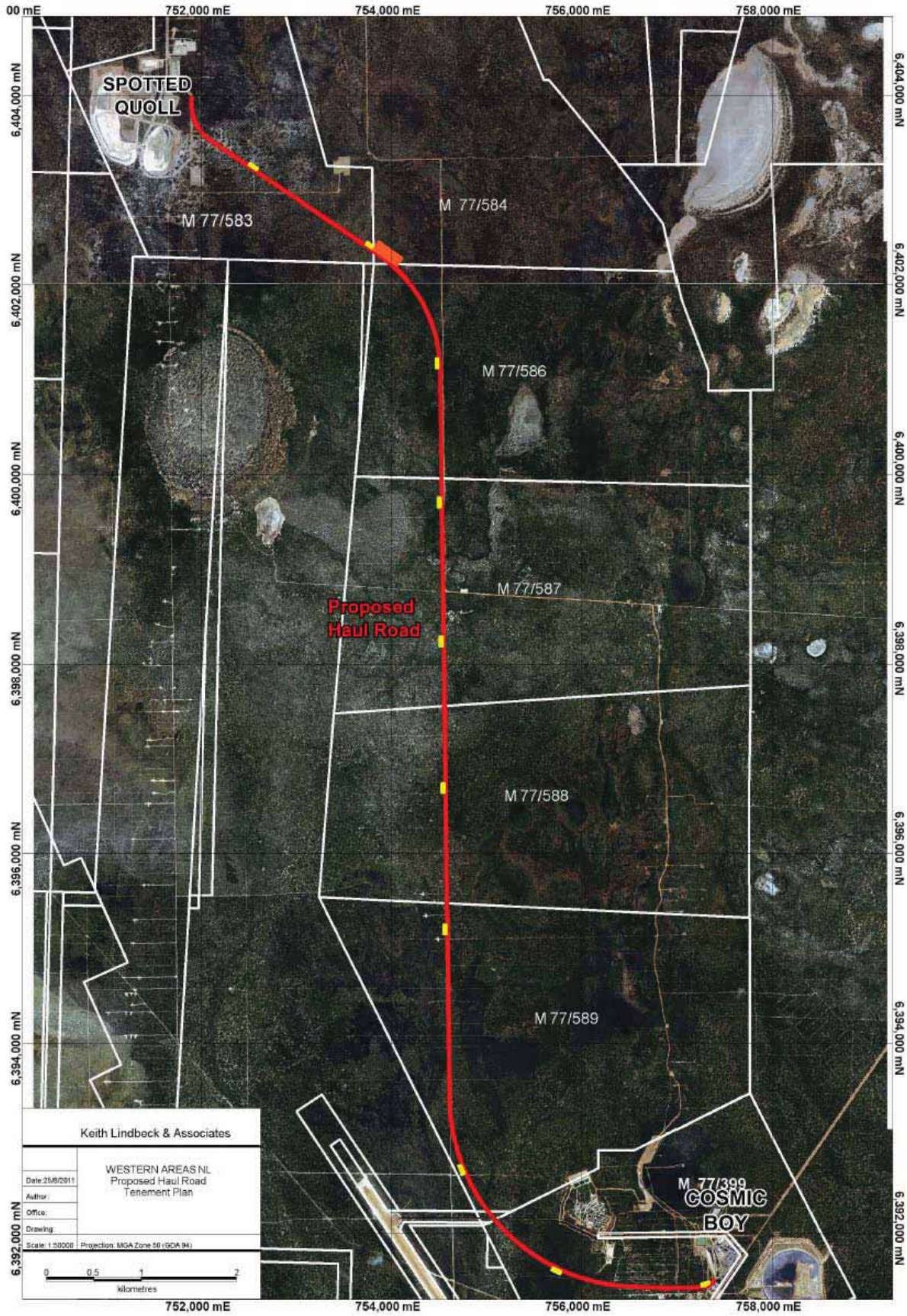


Figure 2 - Tenure of the Spotted Quoll – Cosmic Boy haul road.

2.2 FAUNA SURVEYS

Comprehensive fauna surveys have been conducted for the proposed haul road area. These include:

- A single phase fauna survey conducted by Biota from 30th November to 9th December 2009.
- A targeted Level 2 fauna survey conducted by Keith Lindbeck & Associates in June and July 2010

3.0 THE SPECIES

3.1 DESCRIPTION OF THE SPECIES

Carnaby's black-cockatoo (formerly called the short-billed form of the white-tailed black cockatoo) is a large, black-cockatoo with a white patch on its cheek, white bands on its tail, and a strong curved bill. In males, the bill is black and the eye-ring dark-pink. Females have a light grey bill, grey eye-ring, and the cheek patch is less distinctive (DEC, 2011).



Plate 1 - *Calyptorhynchus latirostris*

3.2 DISTRIBUTION AND GENERAL ECOLOGY

Carnaby's Cockatoo is endemic to southwest Western Australia, extending from the Murchison River to Esperance, and inland to Corrow, Kellerberrin and Lake Cronin (Johnstone and Storr 1998). Carnaby's Cockatoo is scarce and patchily distributed in the driest parts of its range and in the extreme south-west. It has shown a reduction in its range, particularly in the northern and eastern areas of the wheatbelt, largely because of clearing for agriculture (Cale 2003).

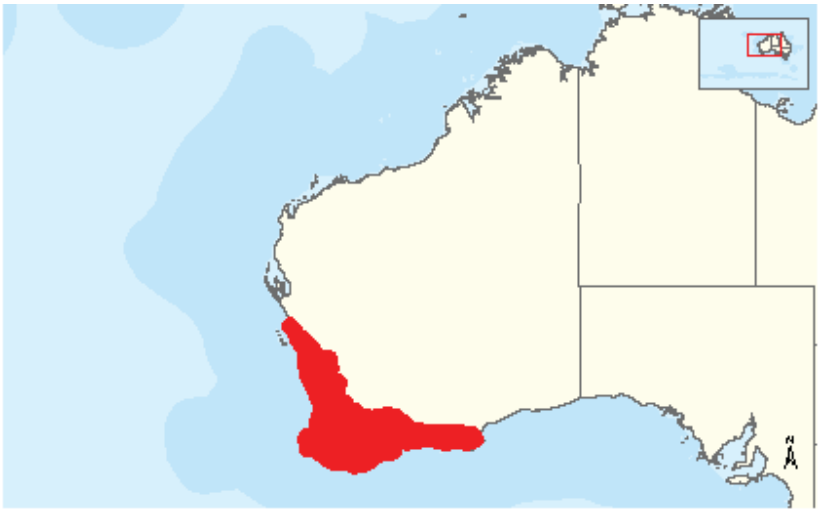


Figure 3 - Distribution of *Calyptorhynchus latirostris*

Carnaby's Black-Cockatoo has a present population of approximately 11,000 – 60,000 birds (Saunders *et al.* 1985) that is divided into three to five sub-populations (Garnett and Crowley 2000). Its extent of occurrence has contracted approximately 30% since the 1940s (Mawson 1997).

Eucalypt woodlands containing *Eucalyptus salmonophloia* (Salmon Gum) and *E. wandoo* (Wandoo) is the preferential breeding habitat for Carnaby's Cockatoo. However, the availability of suitable nesting hollows, which can take 120 to 150 years to develop (Pittman *et al.* 2007), will influence breeding success together with the availability of nearby foraging grounds (DSEWPC 2011). Foraging habitat generally includes shrub-land or kwongan health-land dominated by *Hakea*, *Banksia* and *Grevillea* species (Morcombe 2003). However, Carnaby's may seasonally forage in marri, exotic pine forests (DSEWPC 2011) or on farmed fruit and nut trees (Pittman *et al*. 2007). The distance between foraging grounds and nesting sites vary, but can be over 12 km as demonstrated in one study by Saunders (Saunders 1980).

Nests are generally more than two metres above ground level, at least 0.1 m deep (DSEWPC 2011) and are mostly lined with wood dust (Johnstone and Storr 1998). The parents live in solitary pairs throughout the breeding season and generally return to the same breeding grounds each year (Higgins 1999).

The loss and fragmentation of habitat, the clearance of health-lands around breeding sites, and the removal of native vegetation corridors are considered principle factors in the decline of the Carnaby's Cockatoo (DSEWPC 2011). Furthermore, the reduced availability of suitable nesting hollows compounded by competition for nesting hollows by other bird species, such as the Galah and Western Corella, and by the European bee are other factors. Other threats include predation by Wedge-tailed Eagles, vehicular trauma and the abandonment of nests following disturbance (DSEWPC 2011).

Carnaby's Cockatoo do not reach breeding age until at least four years of age (Saunders 1982) and can live for 40 – 50 years (DSEWPC 2011). Cale (2003) estimates that the generation time to be 15 years. Hence, threatening processes have a high potential to cause significant declines in populations, and that any recovery of the species will be relatively slow, especially considering those birds that do breed successfully in a season are very unlikely to have more than one fledged offspring.

3.3 SPECIES RECORDED IN THE PROJECT AREA

Very small numbers of Carnaby's Cockatoo occur in the region during the breeding season, which occurs from September to January, suggesting that most are probably migrants returning from the Lake Cronin and Hatters Hill feeding areas (Johnstone, Johnstone and Kirkby 2008).

Three individual Carnaby's Cockatoo were seen flying overhead in the southern area of the proposed haul road during a recent Single Phase Fauna Survey (Biota 2010). Biota (2010) reported that this species had been recorded in past surveys within the Forrestania area.

The targeted survey conducted by Keith Lindbeck & Associates did not record any sightings however 23 potential hollows were recorded and these are shown in Figure 4 and Table 2 (KLA, 2011). The survey indicated that only some sections of the proposed haul road route comprise vegetation with attributes that support hollows and potential hollows for Carnaby's Cockatoo and primarily this vegetation is described as "Burnt *Eucalyptus salmonophloia* woodland over Mixed Mallee shrubland". Single or sparse *E. salmonophloia* in other vegetation groups particularly in the southern section of the proposed haul road route also provide potential habitat for these species. The survey included an area to the west of the proposed haul

road to determine if hollows and potential hollows were confined to the area proposed for disturbance or were present elsewhere. Results from this survey indicated that the vegetation outside of the proposed haul road route also supports habitat characteristics favoured by Carnaby's Cockatoo. Thus, vegetation comprising hollows and potential hollows for Carnaby's Cockatoo is not limited to areas within the proposed haul road route. Therefore, the project is unlikely to alter the conservation significance of this species.

3.4 CONSERVATION STATUS

The Carnaby's Black Cockatoo is listed Endangered under EPBC Act 1999 and Schedule 1: Rare and likely to become extinct under the WCA 1950.

Table 2 – Table showing Vegetation Groups and associated Carnaby breeding habitat to be cleared and proportion of hollows within disturbance area

Vegetation group	Total area surveyed (ha)	Total area to be cleared (ha)	% of each veg group to be cleared	Total area of Carnaby's breeding habitat to be cleared (ha)	% Carnaby's breeding habitat to be cleared of total clearing for haul road (ha)	Proportion of Carnaby's hollows within disturbance area
E. salmonphila woodland	25.29	1.05	4.15	0	Nil	Nil
Burnt *E. salmonphila* woodland over mixed mallee	135.57	13.42	9.90	4.55	11.17	16.34
Sub-group *Melaleuca hamata* thicket	13.33	4.59	34.43	Nil	Nil	Nil
E. urna woodland	17.72	3.24	18.28	1.30	3.19	5.42
Mixed Mallee shrubland	2.95	0.55	18.64	Nil	Nil	Nil
E. goniocarpa shrubland	7.49	1.53	20.43	Nil	Nil	0
Sub-group *E. horistes* Mallee	0.06	0.05	83.33	Nil	Nil	0
Sub-group *Melaleuca* thicket	0.38	0.12	31.58	Nil	Nil	0
Mallee/Mix shrub BIF	18.24	1.61	8.83	Nil	Nil	0
E. livida woodland	8.55	0.55	6.43	Nil	Nil	0
E. eremophila/E. cylindrocarpa	30.66	2.73	8.90	0.30	0.74	0.29
Rehabilitation Area	9.04	1.20	13.27	Nil	Nil	0
Mixed Mallee over *Melaleuca*	131.91	10.10	7.66	0.3001	0.74	0.30
E. salubris woodland	8.63	Nil	Nil	Nil	Nil	Nil
TOTAL	**409.82**	**40.74**		**6.45**		**23**

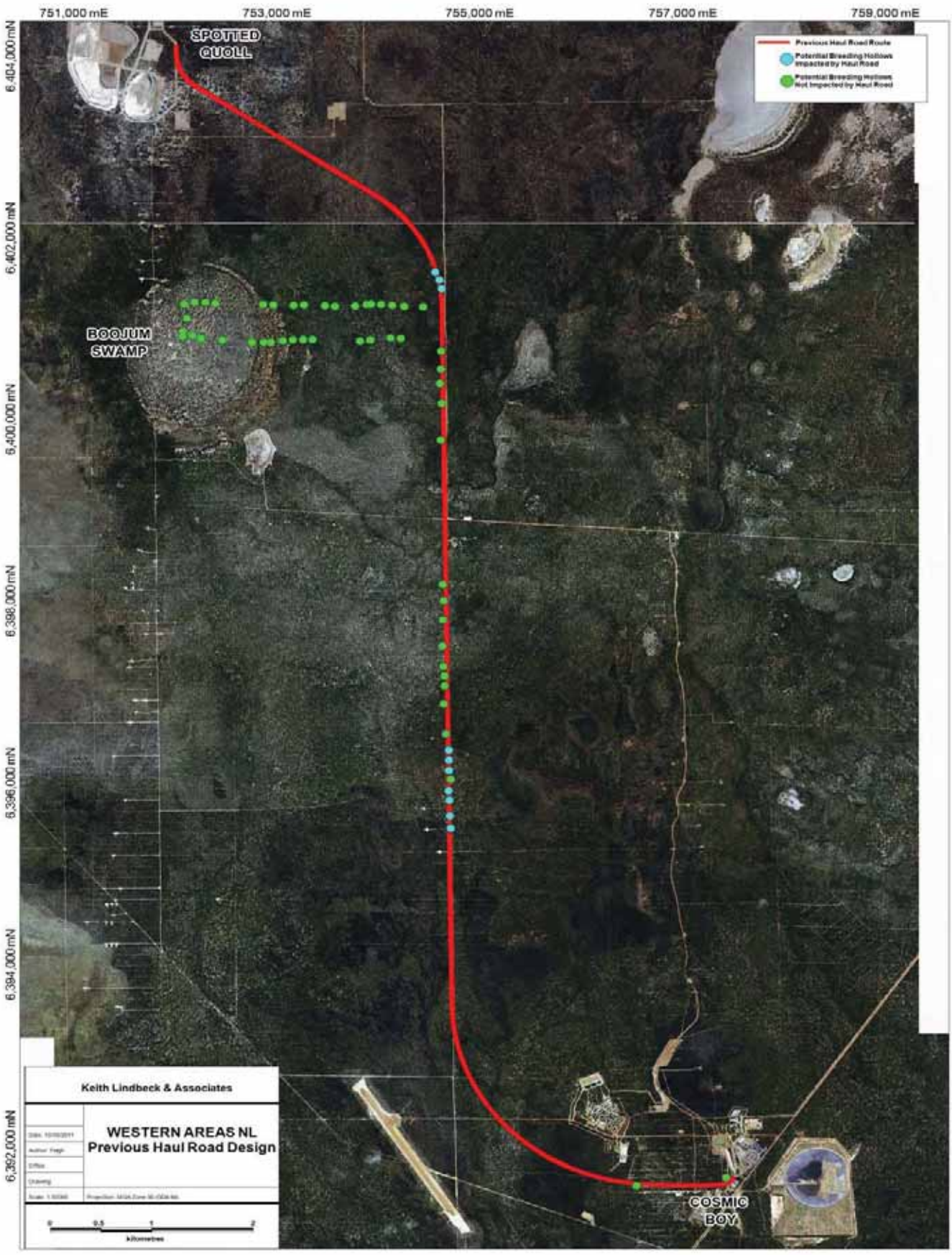


Figure 4 – Areas of proposed haul road with potential breeding hollows

4.0 POTENTIAL IMPACTS AND ON SITE MANAGEMENT

Objective 1: Secure Carnaby's Black Cockatoo Habitat

Action - Identify and retain areas that support *Carnaby's Black Cockatoo* and their habitat and protect them from clearing

Potential Impact

Clearing of native vegetation will cause permanent loss of potential Carnaby's Black Cockatoo habitat and could potentially contribute to impact on populations that may move into the area.

A maximum of 40.74 ha of vegetation will be cleared for the construction of the haul road.

Management Actions

1. All ground disturbance will be in accordance with Forrestania Nickel Project Ground Disturbance Request Procedure (WANL-ENV-PRO-005) whereby sign-off for vegetation clearance must be authorised by the WANL Environmental Manager/Officer.
2. Limiting the clearing footprint to the minimum necessary for the haul road.
3. Prior to clearing commencing, the haul road will be walked by WSA Environmental staff and areas to be cleared will be well-defined to avoid over clearing.
4. WSA environmental staff will create exclusion zones with yellow and black caution flagging tap around breeding hollows and prohibit all staff and contractors from entering this area without permission of the WSA environmental staff.
5. All clearing will be supervised by the Environmental staff.
6. Restricting traffic to established roads and parking areas so as not to disturb vegetation.
7. Induction of employees to ensure disturbance is confined to areas identified clearly in the field.
8. Areas of vegetation disturbed temporarily during the construction of the haul road will be rehabilitated as soon after construction as practicable.
9. Clearing for the project will be restricted during the breeding season to those areas of the haul road outside a 400m zone from any potential breeding hollow.
10. All large trees and stags with hollows will be avoided where possible.

Action - Educate employees and contractors of the importance of conserving Carnaby's Black Cockatoo and their habitat

Potential Impact

Without education and information, the expectation that employees and contractors appreciate the value of Carnaby's Black Cockatoo and their habitat would be unreasonable.

Management Actions

1. All staff and contractors will attend a compulsory environmental induction which will include information on Carnaby's Black Cockatoo, in particular photos and details on breeding hollows and foraging habitat. Information

about the known locations of the species, species management and incidents will be provided to staff and contractors.

Objective 2: Reduce fire threats

Action - Reduce the risk of occurrence of large fires

Potential Impact
Fire ignition and subsequent spread may present a significant threat to Carnaby's habitat. WSA has prepared a Fire Management Plan to address the issues of potential fire risks which might be caused by the proposed operations and accordingly, establish appropriate management and mitigation measures.

Management Actions
1. Firebreaks will be constructed and maintained on the project area in accordance with legislative requirements;
2. Undertake annual fuel-loading assessments on WSA tenements and consider appropriate management options in consultation with DEC and FESA;
3. As required by legislation, the Forrestania Nickel project has an Emergency Response team trained in Emergency Response which includes the outbreak of fire both on the surface and underground. This team will be deployed where required in the event of an out-break of fire;
4. All vehicles will be fitted with two-way radios that can also be used in an emergency situation;
5. Conducting a baseline fire risks study prior to the commencement of the project to determine the background levels of potential fire risks;
6. Public bushfire danger warnings from the Bureau of Meteorology will be used to predict the level of bushfire risk within the Project Area. Appropriate response strategies (for example issue of "hot work" permits may be suspended during periods of extreme fire danger) will be developed accordingly;
7. Fire management monitoring requirements will be reviewed after the initial 12 months of operation and adjusted if necessary;
8. All WSA employees and contractors will be required to report any potential fire risks to the site manager via their supervisor;
9. All records of fire management monitoring kept in accordance with this plan will be summarised in the Annual Environmental Review, which will be submitted to the Department of Mines and Petroleum, and the DEC;

Objective 3: Control feral animals

Action - Reduce the number of feral animals and potential death of Carnaby's Black Cockatoo by predation

Potential Impact
Feral animal control measures need to be implemented to protect the Carnaby's Black Cockatoo from predation.

Management Actions
1. Annual 1080 baiting will occur at strategic locations along the length of the haul road.
2. Food waste will be disposed into local rubbish tips near Cosmic Boy and Spotted Quoll mining areas.

3. Local rubbish tips will be fenced and compacted with soil regularly to limit the availability of edible waste to both feral and native animals.

Objective 4: Monitor Carnaby's Black Cockatoo populations

Action - Establish a monitoring system in the project area

Potential Impact
Baseline knowledge of the local Carnaby's Black Cockatoo population is fundamental to their conservation. Establishing a repeatable monitoring system is the most effective way for collecting scientifically robust data. Ongoing monitoring will also provide valuable information in relation to the effectiveness of predator control.

Management Actions
1. Establish a regular monitoring programme for local populations. Monitoring activities will be undertaken on an annual basis and results will be subject to review following each monitoring event.
2. Develop a recording system for storage of monitoring information and results.
3. The monitoring programme will be undertaken by Mr Ron Johnstone.

Objective 5: Review of Conservation Management Plan

Action - Regularly review status of the Conservation Management Plan by environmentally appropriate people

Justification
The existing Conservation Management Plan must be reviewed and modified on a regular basis in light of monitoring results and progress on management actions.

Management Actions
1. Develop annual reports in accordance with statutory requirements including reports to DSEWPC and DEC.
2. Undertake a review of this Conservation Management Plan after two years (or more frequently where results indicate this is required) and then determine the frequency of review but no less than once every five years.

5.0 MANAGEMENT PROGRAM SUMMARY

Table 3 - Management Program Summary

Management Objective	Action	Timing	Responsibility
Secure Carnaby's Black Cockatoo Habitat	Disturbance will be in accordance with Forrestania Nickel Project Ground Disturbance Request Procedure (WANL-ENV-PRO-005)	During clearance	Environmental Manager
	Limiting the clearing footprint to the minimum necessary for the haul road.	During clearance	Environmental Manager
	Prior to clearing commencing, the haul road will be walked by WSA Environmental staff and areas to be cleared will be well-defined to avoid over clearing.	Prior to clearing	Environmental Manager
	WSA environmental staff will create exclusion zones with yellow and black caution flagging tap around breeding hollows and prohibit all staff and contractors from entering this area without permission of the WSA environmental staff.	Prior to clearing	Environmental Manager
	All clearing will be supervised by the Environmental staff.	During clearing activities	Environmental Manager
	Restricting traffic to established roads and parking areas so as not to disturb vegetation.	Ongoing	Environmental Manager
	Induction of employees to ensure disturbance is confined to areas identified clearly in the field.	Ongoing	Environmental Manager
	Areas of vegetation disturbed temporarily during the construction of the haul road will be rehabilitated as	Ongoing	Environmental Manager

	soon after construction as practicable.		
	Clearing for the project will be restricted during the breeding season to those areas of the haul road outside a 400m zone from any potential breeding hollow.	During clearance	Environmental Manager
	All large trees and stags with hollows will be avoided where possible.	During clearance	Construction personnel
	Site environmental inductions for all employees and contractors to increase awareness of possible Carnaby populations.	Ongoing	Environmental Manager
Reduce the risk of occurrence of large fires	Firebreaks will be constructed and maintained on the project area in accordance with legislative requirements.	Ongoing	Operations Manager
	Undertake annual fuel-loading assessments on WSA tenements and consider appropriate management options in consultation with DEC and FESA.	Annually	Environmental Manager
	The FNP Emergency Response team trained in Emergency Response will be deployed where required in the event of an out-break of fire.	Ongoing	FNP Emergency Response Team
	Vehicles will be fitted with two-way radios that can also be used in an emergency situation.	Ongoing	Operations Manager
	Conducting a baseline fire risks study prior to the commencement of project to determine the background levels of potential fire risks.	Prior to disturbance	Environmental Manager
	Public bushfire danger warnings from	Ongoing	Operations Manager

	the Bureau of Meteorology will be used to predict the level of bushfire risk within the Project Area.		
	Fire management monitoring requirements will be reviewed after the initial 12 months of operation and adjusted if necessary.	Annually	Environmental Manager
	All WSA employees and contractors will be required to report any potential fire risks to the site manager via their supervisor.	Ongoing	All site employees and contractors
	All records of fire management monitoring kept in accordance with this plan will be summarised in the Annual Environmental Review, which will be submitted to the Department of Mines and Petroleum and DEC.	Ongoing	Environmental Manager
Reduce the number of feral animals and potential death of Carnaby's Black Cockatoo by predation	Annual 1080 baiting will occur at strategic locations along the length of the haul road.	Annually	Environmental Manager
	Food waste will be disposed into local rubbish tips near Cosmic Boy and Spotted Quoll mining areas.	Ongoing	All staff and contractors
	Local rubbish tips will be fenced and compacted with soil regularly to limit the availability of edible waste to both feral and native animals.	Ongoing	Operations Manager
Monitor Carnaby's Black Cockatoo populations	Establish a regular monitoring programme for local populations.	2011	Environmental Manager
	Develop a recording system for storage of monitoring information and results.	Ongoing	Environmental Manager

	Monitoring programme to be undertaken by Mr Ron Johnstone	Annually	Mr Ron Johnstone
Regularly review status of the Conservation Management Plan	Develop annual reports in accordance with statutory requirements including reports to DSEWPC and DEC.	Annually	Environmental Manager
	Review Conservation Management Plan	Every two years	Environmental Manager

6.0 PERFORMANCE INDICATORS

The progress of the Conservation Management Plan will be regularly reviewed and modified as necessary in the light of new information, monitoring results and progress on management actions. WSA will review and update the plan two years after implementation depending on results which may indicate that an earlier change in strategy is required. Timing of subsequent reviews will be determined after the initial review but will occur no later than at five year intervals.

WSA's performance will be reviewed against the following indicators:

- Identification and retention of Carnaby's Black Cockatoo habitat;
- Reduction of fire risk due to the construction of the haul road;
- Monitoring (and reporting outcomes) of current and future distribution of Carnaby's Black Cockatoo;
- Workforce awareness of Carnaby's Black Cockatoo conservation measures; and
- No known decline in the viability of local Carnaby's Black Cockatoo populations.

7.0 RESPONSIBILITY

The Environmental Manager will be responsible to ensure that the Carnaby's Black Cockatoo Conservation Management Plan is implemented and reviewed when required.

8.0 DECOMMISSIONING PHASE

Any rehabilitation or decommissioning activity within the Carnaby's Black Cockatoo habitat areas will be undertaken in a manner which is consistent with the Project Closure Plan.

9.0 AUDITING

WSA will conduct compliance audits annually.

10.0 REPORTING

10.1 WSA INTERNAL REPORTING

All employees and contractors will be required to report any issues relating to the conservation of local Carnaby's Black Cockatoo populations to the Site Environmental officer, via their supervisor. Issues include sightings, or other evidence of their presence, for example hollows. Action in response to the report will depend on the nature of the report.

10.2 ENVIRONMENTAL REPORTING

All environmental reporting will be completed in accordance with statutory requirements and submitted to the appropriate authorities when required.

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APPENDIX 3 – CARNABY'S COCKATOO HABITAT ASSESSMENT PROPOSED MOSSCO FARM OFFSET AREA REPORT

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Carnaby's Cockatoo Habitat Assessment
Proposed Mossco Farm Offset Area



Prepared for: WESTERN AREAS NL

October 2011

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1.0 BACKGROUND INFORMATION

1.1 Background

Western Areas NL (WSA) is an Australia based nickel sulphide mineral exploration and development company. Its principal asset is a 100% interest in the Forrestania Nickel Project (FNP) located in the Yilgarn and Phillip's River Mineral Fields of Western Australia.

The FNP is located approximately 450 km east of Perth, 160 km south of Southern Cross, and 80 km east of Hyden, in the Shire of Kondinin (Figure 1).

The FNP area has been the subject of exploration activities since the 1960's nickel boom with Outokumpu Mining Australia Pty Ltd (OMA) mining nickel at a number of project sites located there in the 1990's. OMA undertook decommissioning and rehabilitation of their FNP from 1999 to 2001. WSA acquired the project in early 2002 reopening the Flying Fox mine in late 2004. Works commenced at the Spotted Quoll open pit operations (SQO) in October 2009. The Flying Fox and Spotted Quoll mining operations cover mining tenements M77/582, M77/583 and M77/545.

Ore from both the Flying Fox and Spotted Quoll operations is currently being transported along a haulage route to the Cosmic Boy Concentrator (CBC) where it is processed into a concentrate. The current haulage route includes 6kms of private haul road and approximately 26kms of public road (i.e. sections of the Hyden – Norseman Rd and Southern Cross – Forrestania Rd). Nickel concentrate is then either transported in bulk to the BHP nickel smelter in Kambalda or in sealed containers to the Esperance Port for delivery to buyers in China. The CBC is located on mining tenements M77/399 and M77/335 on the site of the concentrator operated by OMA during the 1990's.

1.2 Project Objective

WSA is proposing as a part of the FNP to establish a privately owned internal haul road (the HR proposal) to link its Flying Fox and Spotted Quoll operations to the Cosmic Boy nickel processing plant site. The HR will reduce the current reliance on the existing public road network (i.e. sections of the Hyden – Norseman Rd and the Southern Cross – Forrestania Rd), which is currently used for haulage of ore. This in turn will reduce safety risks as well as streamline the project making it significantly more efficient. There will also be measurable environmental benefits in that dust lift-off will be reduced due to reduced traffic volumes traversing both the new haul road and the existing public road.

Fauna studies undertaken in 2010 to facilitate the environmental approvals process for the HR proposal have identified that there is likely to be an impact to potential breeding and foraging habitat for the Carnaby's Cockatoo (*Calyptorhynchus latirostris*) associated with clearing along the HR route. Salmon Gum (*Eucalyptus salmonophloia*) woodland (SGW) and in particular the Salmon Gum trees themselves are a preferred breeding and roosting habitat for the Carnaby's Cockatoo if they of the right age and size. In addition flora and vegetation studies undertaken along the proposed HR route found that there were a number of flora species that could act as foraging habitat for the Carnaby's cockatoo including *Allocasuarina*, *Eucalyptus*, *Grevillea*, *Hakea* and *Melaleuca* species.

Carnaby's Cockatoo is listed as *Threatened (T – Schedule1)*, under the Western Australian "*Wildlife Conservation Act 1950*" (WC Act) and as *Endangered* under the Commonwealth "*Environment Protection and Biodiversity Conservation Act 1999*" (EPBC Act). The main threat to this species is the loss of breeding

and foraging habitat due to land clearing for agriculture in the Western Australian wheatbelt. Further significant impact to remaining areas of potential breeding and foraging habitat for this species without careful management could potentially lead to a further escalation of it's conservation status.

The HR proposal was determined by the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (DSEWPC) to be a controlled action due to the potential for impact on an EPBC Act listed Threatened Species. Impact to listed Threatened Species is considered a Matter of National Environmental Significance (MNES) under the EPBC Act. DSEWPC has directed WSA to develop an offset package that will provide for acquisition and protection of "*like for like*" breeding and foraging habitat for the Carnaby's Cockatoo. The DSEWPC have directed WSA to complete this at a 10:1 protection ratio meaning that for every 1 Ha of potential habitat impacted by the proposal, 10 Ha of "*like for like*" habitat must be acquired and/or protected.

It has been determined that approximately 7 Ha of potential breeding and foraging habitat will be impacted by the HR proposal so WSA must acquire and/or protect 70 Ha of "*like for like*" breeding and foraging habitat.

1.3 Report Purpose

In 2008, WSA purchased a freehold farm, "*Mossco*", to enable the establishment of evaporation ponds for the disposal of mine water produced from FNP dewatering operations. The placement of the ponds on Mossco reduced significantly the amount of clearing that would have been required to establish similar ponds on WSA owned mining tenements located on Unallocated Crown Land (UCL) closer to FNP operations areas.

Mossco is located approximately 9 kms to the west of the FNP. It is located at the very eastern extent of the Western Australian wheatbelt in the Shire of Lake Grace.

Mossco contains a significant remnant vegetation area (RVA) dominated by old growth SGW. The purpose of this report is to detail the results of a brief assessment undertaken to establish the potential for the RVA at Mossco to contain breeding, roosting and foraging habitat for the Carnaby's Cockatoo and hence for the RVA to fulfil the DSEWPC offset requirements for the HR proposal.

Figure 2 shows the location of Mossco and the RVA in relation to the FNP.

2.0 ASSESSMENT METHODS

Phil Knapton of PEK Enviro was commissioned by WSA to undertake a brief assessment of the potential for Carnaby's Cockatoo breeding, roosting and foraging habitat to occur within the RVA on Mossco. The criteria used in the assessment were based on those outlined in the recently published DSCWPC 2011 document titled:

"*Environment Protection and Biodiversity Conservation Act 1999 draft referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris; Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii; Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso".*

The criteria are shown in Table 1.

Table 1: Mossco Salmon Gum Woodland potential Carnaby's Cockatoo habitat assessment criteria

Breeding	Roosting	Foraging	Foraging common food items
Any patch of woodland or forest that contains live or dead trees of salmon gum (*E. salmonophloia*), wandoo, tuart, jarrah (*E. marginata*), flooded gum (*E. rudis*), york gum (*E. loxophleba subsp. loxophleba*), karri or marri, with either a diameter at breast height greater than 500 mm, or presence of suitable nest hollow[3].	Generally in or near riparian environments or natural and artificial permanent water sources. Flat-topped yate (*E. occidentalis*), salmon gum, wandoo, marri, karri, blackbutt, tuart, introduced eucalypts (for example blue gum) and introduced pines.	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as Banksia spp. (including *Dryandra* spp.), *Hakea* spp. and *Grevillea* spp. Forages in pine plantations (*Pinus* spp.), Eucalypt woodland and forest that contains foraging species. Also individual trees and small stands of these species.	Seeds, flowers and nectar of native proteaceous plant species (for example, *Banksia* spp., *Hakea* spp., *Dryandra* spp, and *Grevillea* spp) and eucalypts. Also seeds of introduced species including *Pinus* spp., *Erodium* spp., wild radish, canola, almonds and pecan nuts; insects and insect larvae; occasionally flesh and juice of apples and persimmons.

The RVA was traversed by both vehicle and on foot depending on the level of accessibility. An assessment of the RVA was made and compared against the breeding, roosting and foraging habitat criteria.

No assessment was made as to the actual use of the RVA by Carnaby's Cockatoo.

3.0 ASSESSMENT RESULTS

3.1 Vegetation and flora

The RVA of interest on Mossco is approximately 105 Ha in size. A brief description of the vegetation and flora occurring within the RVA follows.

Within the RVA, the upper stratum was typically open and comprised almost exclusively of Salmon Gum (*Eucalyptus salmonophloia*) trees. In some areas, Salmon Gum dominated with minimal understorey whilst in other areas Salmon Gum was sparsely distributed with mid storey *Eucalyptus* mallee and *Melaleuca* species dominating.

In the more open areas dominated by a Salmon Gum (Plates 1 - 3), the mid stratum was typically comprised of species such as *Daviesia benthamii* subsp. *acanthoclona*, *Eremophila decipiens* subsp. *decipiens*, *Eucalyptus eremophila* subsp. *eremophila*, *Exocarpus sparteus*, *Grevillea huegelii*, *Hakea commutata*, *Hakea newbeyana*, *Melaleuca pauperiflora* subsp. *pauperiflora, Olearia muelleri*, *Santalum acuminatum* and *Templetonia sulcata*. The ground stratum was typically dominated by rush species of the Cyperaceae family with grass species from the genus' *Austrostipa* and *Neurachne* also being represented.

In areas where Salmon Gum was more sparsely distributed (Plate 4), Eucalyptus mallee species dominated with *Eucalyptus eremophila* subsp. *eremophila* and *Eucalyptus calycogona* subsp. *calycogona* strongly represented. Often the Eucalyptus mallee species occurred in combination with Melaleuca species such as *Melaleuca lateriflora, Melaleuca acuminata* subsp. *acuminata* and *Melaleuca adnata*. Other typical species included *Acacia verricula*, *Grevillea huegelii*, *Grevillea oncogyne* and *Hakea cummutata*.

A small area of alluvial sandplain associated with a drainage line also occurred within the RVA and showed a slightly different structure (Plate 5 and Plate 6). In this area *Callistemon phoenicius*, *Callitris preisii*, *Hakea newbeyana* and *Leptospermum erubescens* dominated the mid stratum.

Plate 1: Mossco RVA - Salmon Gum woodland



Plate 2: Mossco RVA - Salmon Gum woodland



Plate 3: Mossco RVA - Salmon Gum woodland



Plate 4: Mossco RVA - Salmon Gum woodland



Plate 5: Mossco RVA – *Callistemon phoenicius* on alluvial sandplain area



Plate 6: Mossco RVA – *Callitris preisii* on alluvial sandplain area



3.2 Breeding habitat

DSEWPC (2011) state that for a tree to be considered a potential breeding tree for Carnaby's Cockatoo it must have a diameter at breast height (1.3 m above ground) of greater than 500 mm or contain a suitable nesting hollow.

The diameter at breast height for a sample of 50 Salmon Gums trees was taken from within a small section of open SGW within the RVA. The average measurement was ~370 mm however within the sample there were 14 specimens (28%) with a diameter at breast height of greater than or equal to 500 mm. One Salmon Gun specimen showed a diameter at breast height of ~1200 mm (Plate 7).

Plate 7: Example of a Salmon Gum a diameter at breast height of 1200mm



In addition to many trees showing a diameter at breast height of greater than 50cm, hollows were also present on many. Groom (2010) notes that Carnaby's Cockatoos have been recorded using hollows in Salmon Gum trees which can vary in size between 13 and 32 cm in width (average 21.9) and between 10 and 29 cm in height (average 20.5). Many of the hollows noted in Salmon Gums within the RVA were definitely larger than minimum width of 13 cm and minimum height of 10 cm. Plates 8 - 12 show some examples of typical hollows from the Mossco RVA.

Plate 8: Typical Salmon Gum hollow



Plate 9: Typical Salmon Gum hollow



Plate 10: Typical Salmon Gum hollow



Plate 11: Typical Salmon Gum hollow



Plate 12: Typical Salmon Gum hollow



In addition to hollows, many Salmon Gum trees exhibited numerous dead stags. The stags themselves can potentially be used as nesting sites by Carnaby's Cockatoo or when they fall can leave behind an accessible hollow. Plates 13 - 16 show some examples of Salmon Gum stags from the Mossco RVA.

Plate 13: Typical Salmon Gum stag



Plate 14: Typical Salmon Gum stag



Plate 15: Typical Salmon Gum stag



Plate 16: Typical Salmon Gum stag



3.3 Roosting habitat

The criteria set out by DSEWPC (2001) state that roosting habitat for Carnaby's Cockatoo is generally in or near riparian environments or natural or artificial permanent water sources. Salmon Gum is included as a preferred roosting tree species.

Shah (2006) notes that drinking forms a normal part of the daily routine for Carnaby's Cockatoos on the Swan Coastal Plain. Dr Hugh Finn in Science Alert (2008) notes that Carnaby's Cockatoo must drink every day. Hence proximity to water sources would appear to be an important factor in the establishment of roosting (and breeding) sites.

No natural or artificial permanent fresh water sources are known occur within the vicinity of the RVA except for the water captured within farm dams. Given this is the case, farm dams may actually provide an important water source for Carnaby's Cockatoo in the semi-arid eastern wheatbelt. It is possible that proximity to these may be an important factor in choice of roosting (and breeding) sites.

There are numerous farm dams within the vicinity of the RVA and given that the Salmon Gums present in the RVA are old and large it is likely that the RVA area could provide valuable roosting habitat for the Carnaby's Cockatoo.

3.4 Foraging habitat

The vegetation groups that occur within the RVA contains species that are considered to provide foraging habitat for the Carnaby's Cockatoo.

Groom (2011) notes that the genera *Acacia*, *Allocasuarina*, *Banksia*, *Callistemon*, *Callitris*, *Eucalyptus*, *Grevillea*, *Hakea, Isopogon* and *Melaleuca* are all known to contain species that provide value as food sources for the Carnaby's Cockatoo. Representatives of all of these genera with the exception of *Allocasuarina* were recorded within the RVA during this brief assessment.

In addition there are large areas of sandplain (Kwongan) heath occurring in the adjacent UCL areas. Sandplain heath contains many species considered to provide valuable food resources for the Carnaby's Cockatoo. Sandplain heath is located both to the north and to the east of the RVA with the closest area being only 2.5 kms to the north.

A brief assessment was carried out on the species occurring in the sandplain heath area to the north of the Mossco RVA that could provide food resources for Carnaby's Cockatoo. These are listed as follows: *Allocasuarina acutivalvis*, *Banksia elderiana*, *Banksia erythrocephala*, *Banksia violacea*, *Callitris canescens*, *Hakea cygna*, *Hakea platysperma*, *Isopogon scabriusculus* and *Petrophile stricta.*

The location of the sandplain heath area to the north of the Mossco RVA is shown in Figure 3.

The results of the assessment of both the Mossco RVA and adjacent sandplain heath areas show that there are likely to be significant food resources available locally for Carnaby's Cockatoo's visiting the area to breed.

3.5 Spotted Quoll to Cosmic Boy Haul Road

As a part of the assessment of the Mossco RVA, the SGW areas assessed as having potential to provide breeding habitat for Carnaby's Cockatoo along the proposed HR were visited briefly for comparisons sake.

The majority of the Salmon Gum trees located within clearing zone for the haul road were considered to be less than 500 mm in diameter at breast height, however the area has been burnt and as such there are numerous dead tree remnants and dead stags on live trees which could provide some potential breeding habitat. No hollows similar to the ones shown in Plates 8 - 12 were noted by the author on any of the trees.

Plates 17 – 21 show what the author considers were some of the better areas in terms of potential breeding habitat. There are no permanent fresh water sources within close proximity to the haul road area. The closest is probably Lake Cronin which is an intermittent fresh water lake located approximately 12.5kms to the north of the northern end of the proposed HR. This lake only has water in it following heavy rainfall events and then only for short periods.

SGW occurring adjacent to the proposed HR, appeared to contain many more Salmon Gum trees that were either dead or alive with stags.

Plate 17: Potential breeding habitat along the proposed Spotted Quoll to Cosmic Boy haul road



Plate 18: Potential breeding habitat along the proposed Spotted Quoll to Cosmic Boy haul road



Plate 19: Potential breeding habitat along the proposed Spotted Quoll to Cosmic Boy haul road



Plate 20: Potential breeding habitat along the proposed Spotted Quoll to Cosmic Boy haul road



Plate 21: Potential breeding habitat along the proposed Spotted Quoll to Cosmic Boy haul road



4.0 DISCUSSION AND CONCLUSION

The results of a brief assessment of SGW occurring within the RVA on WSA owned Mossco farm show that it contains significant potential breeding, roosting and foraging habitat for the Carnaby's Cockatoo. In addition, water sources in the form of farm dams occur locally and significant areas of sandplain (Kwongan) heath which provide preferred foraging habitat for Carnaby's Cockatoo occur on UCL within 2.5 kms of the RVA.

In the opinion on the author, the habitat values of the SGW within the RVA on Mossco are superior to those of the SGW areas seen along the proposed HR route and significantly exceed the 10:1 "*like for like*" offset requirement of the DSEWPC.

5.0 REFERENCES

DSEWPC (Department of Sustainability, Environment, Water, Population and Communities). (2011). *Environment Protection and Biodiversity Conservation Act 1999 draft referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris; Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii; Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso.* Commonwealth of Australia, July 2011.

Groom, C. (2010). *An investigation of the placement, use, monitoring and maintenance requirements of artificial hollows for Carnaby's black cockatoo*. Department of Environment and Conservation, Government of Western Australia, August 2010.

Groom, C. (2011). *Plants Used by Carnaby's Black Cockatoo*. Department of Environment and Conservation, Government of Western Australia, 15th April 2011.

Science Alert. (2008). *Gold mines could save cockatoos*. Article published on the Science Alert Australian and New Zealand website, http://www.sciencealert.com.au/news/20082808-17871-2.html , 28 August 2008.

Shah, B. (2006). *Conservation of Carnaby's Black-Cockatoo on the Swan Coastal Plain, Western Australia.* Carnaby's Black-Cockatoo Recovery Project. Birds Australia WA, December 2006.

6.0 FIGURES

Figure 1: FNP location within Western Australia

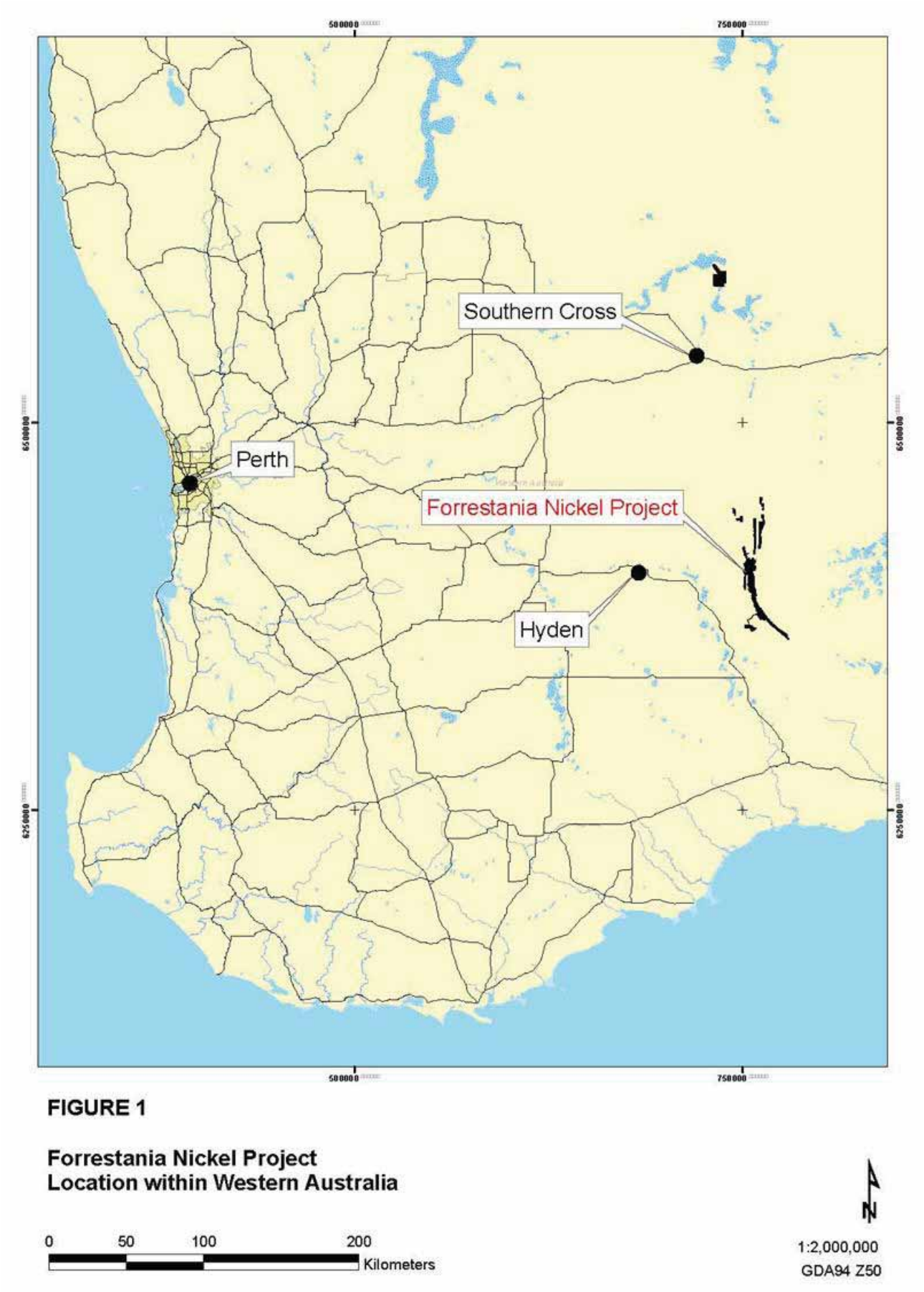


Figure 2: Location of Mossco Farm RVA in relation to FNP

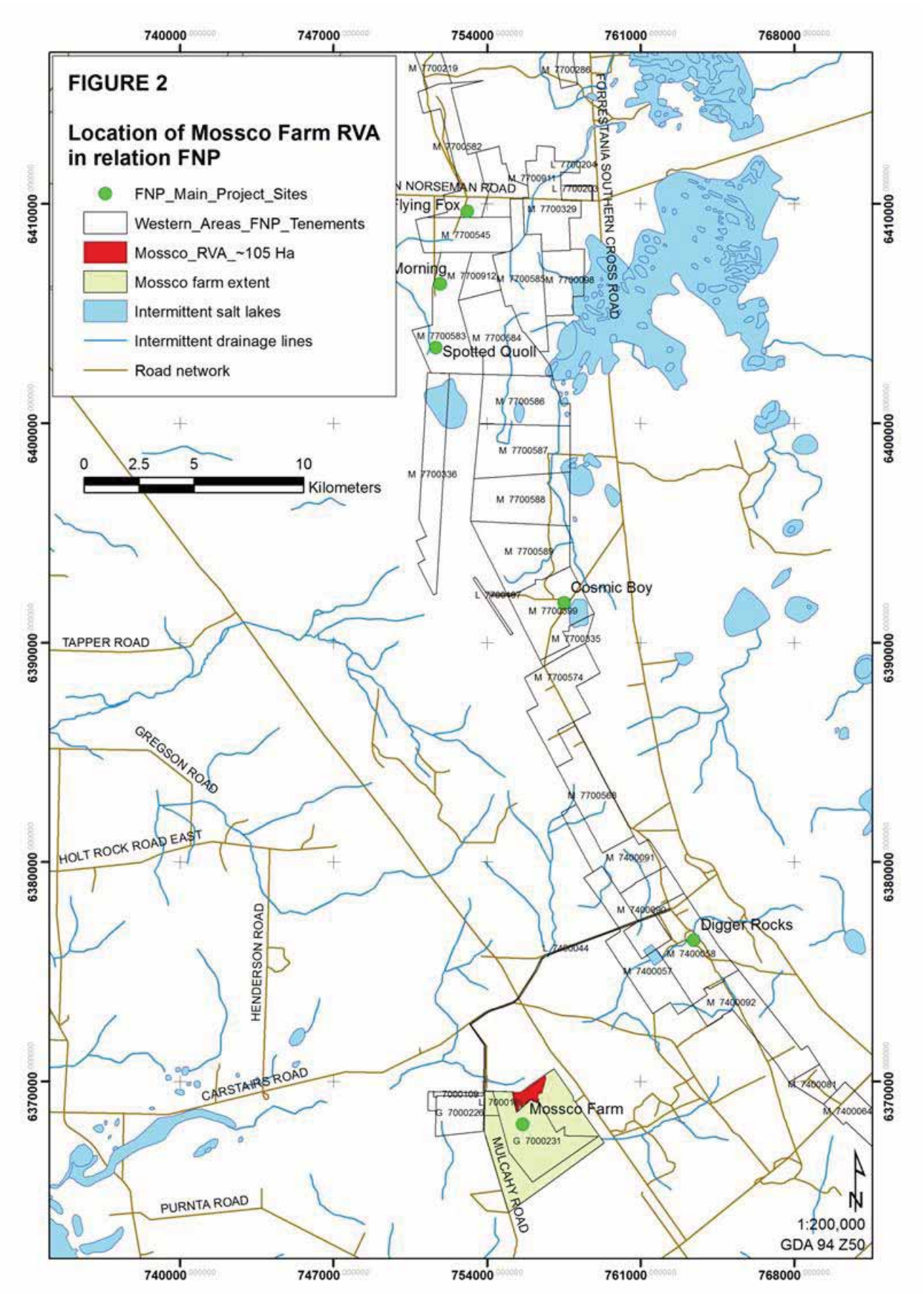
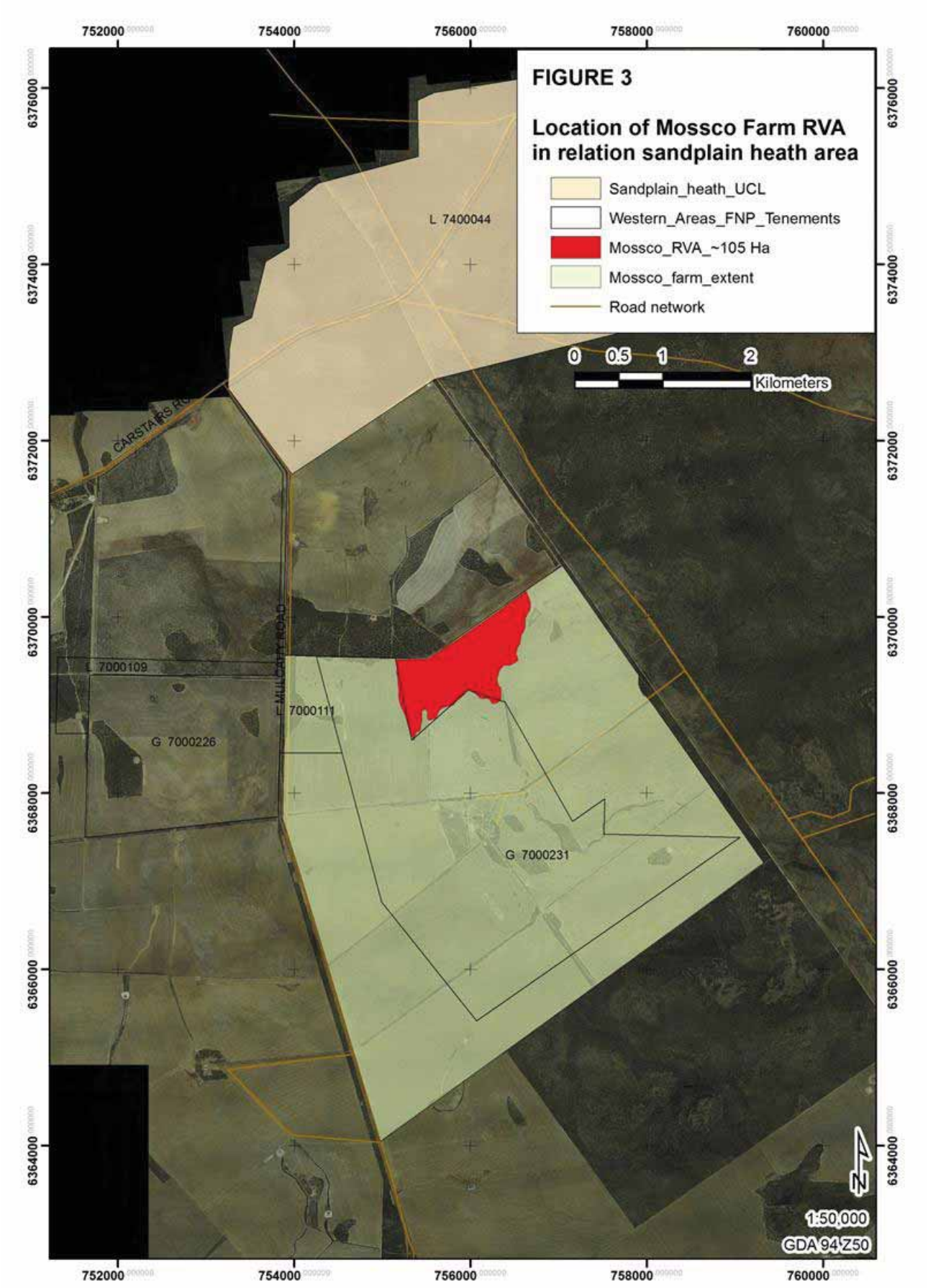


Figure 3: Location of sandplain heath in relation to Mossco RVA



APPENDIX 4 – LOT 1210 ON DEPOSITED PLAN 204244 CERTIFICATE OF TITLE

WESTERN AUSTRALIA

REGISTER NUMBER	
1210/DP204244	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	**9/5/2008**

RECORD OF CERTIFICATE OF TITLE

VOLUME **2689** FOLIO **194**

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 1210 ON DEPOSITED PLAN 204244

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WESTERN AREAS NL OF SUITE 3/LEVEL 1, 11 VENTNOR AVENUE, WEST PERTH
(T K534044) REGISTERED 12 MARCH 2008

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	1793-546 (1210/DP204244).
PREVIOUS TITLE:	1793-546.
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA:	SHIRE OF LAKE GRACE.

NOTE 1:	K553450	LAND PARCEL IDENTIFIER OF ROE LOCATION 1210 CHANGED TO LOT 1210 ON DEPOSITED PLAN 204244 ON 2.4.2008 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE
NOTE 2:		THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Sep 2 15:23:17 2011 JOB 37482218

C - Invitation for Comment

CONSTRUCTION OF A HAUL ROAD BETWEEN THE SPOTTED QUOLL OPEN PIT OPERATION AND THE COSMIC BOY PROCESSING PLANT, FORRESTANIA, WA (EPBC 2011/6003).
INVITATION FOR PUBLIC COMMENT

The following notice is published pursuant to Section 95A (3) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Western Areas NL proposes to construct a haul road between the Spotted Quoll open pit operations and the Cosmic Boy processing plant (EPBC Act Ref: 2011/6003). The proposed haul road is located at the Forrestania Nickel Project, Goldfields, 160km south of Southern Cross and 80km east of Hyden, Western Australia.

The proposed action has been determined to be a controlled action under the EPBC Act. The controlling provisions under Part 3 of the EPBC Act 1999 are: Listed threatened species and communities (Sections 18 and 18A).

The Department of Sustainability, Environment, Water, Population and Communities has advised that the proposal will be assessed by preliminary documentation.

The preliminary documentation for the proposed action, consisting of the original referral documentation and subsequent additional information requested by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities, will be on display from 4 November 2011 to 1 December 2011 at the following locations:

Shire of Kondinin
Gordon Street, Kondinin and 12 McPherson Street, Hyden

Environmental Protection Authority Library
168 St Georges Terrace, Perth

Department of Sustainability, Environment, Water, Population and Communities Library
John Gorton Building
King Edward Terrace
PARKS ACT 2600
The documents can also be viewed or downloaded at
http://www.westernareas.com.au

Persons with special needs (i.e. for whom English is a second language or who has a vision impairment) may contact the designated person below for assistance in accessing the material). Interested persons and organisations are invited to comment in writing on the proposal via:

Post: Darren Coulson
Western Areas NL
PO Box 1891
West Perth WA 6872
Fax: 08 9486 7866
Email: dcoulson@westernareas.com.au
The deadline for submissions is:
5pm (WST) on 1 December 2011.