



## NOTICE OF INTENT FOR PUBLIC DISPLAY

Minemakers Australia Pty Ltd

# Wonarah Phosphate Project

March 2009

CR 9014\_3\_v3



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Project director	Tara Halliday		
Project manager	Rebecca Powlett		
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**Coffey Natural Systems Pty Ltd** ABN 61 005 041 878  
Unit 8, 21 Parap Road Parap NT 0820 Australia  
T (+61) (8) 8901 1200 F (+61) (8) 8901 1299  
coffey.com

## Contents

<b>1.</b>	<b>INTRODUCTION</b>	<b>1-1</b>
1.1	Overview	1-1
1.2	Project Area and Land Tenure	1-1
1.3	Proponent Details	1-4
1.3.1	Name and Address of Proponent	1-4
1.3.2	Name and Address of Lead Environmental Consultant	1-4
1.4	Purpose of this Notice of Intent	1-4
1.5	Report Structure	1-6
<b>2.</b>	<b>PROJECT DESCRIPTION</b>	<b>2-1</b>
2.1	Project Overview	2-1
2.2	Project Components	2-1
2.3	Mining Process	2-3
2.4	Mining Schedule	2-7
2.5	Treatment Process	2-8
2.6	Water Management	2-8
2.6.1	Surface Water Management	2-8
2.6.2	Water Use	2-8
2.6.3	Borefield	2-8
2.7	Transport Infrastructure	2-9
2.7.1	Access Road	2-9
2.7.2	Haul Roads and Other Site Roads	2-9
2.7.3	Aerodrome	2-10
2.8	Ore Storage and Transport to Market	2-10
2.9	Other Mine Infrastructure	2-10
2.9.1	Administration and Maintenance Areas	2-10
2.9.2	Power Station	2-11
2.9.3	Explosives Magazine	2-11
2.9.4	Accommodation Village	2-11
2.9.5	Sewage Treatment Facility	2-11
2.10	Waste Management	2-12
2.11	Workforce	2-12
2.12	Timing	2-12
2.13	Rehabilitation and Mine Closure	2-14
<b>3.</b>	<b>ENVIRONMENTAL PERMITTING</b>	<b>3-1</b>
3.1	Commonwealth Legislation	3-1
3.1.1	Environment Protection and Biodiversity Conservation Act	3-1
3.1.2	Native Title Act and Aboriginal Land Rights (Northern Territory) Act 1976	3-1
3.2	Northern Territory Legislation	3-2
3.2.1	Mining Act and Mining Management Act	3-3
3.2.2	Environmental Assessment Act	3-3
3.2.3	Water Act	3-3
3.2.4	Other Relevant Legislation	3-4

<b>4.</b>	<b>EXISTING ENVIRONMENT</b>	<b>4-1</b>
4.1	Climate	4-1
4.2	Greenhouse Gas	4-1
4.3	Air Quality	4-2
4.4	Land Resources	4-2
4.4.1	Landform, Topography and Drainage	4-2
4.4.2	Geology	4-3
4.4.3	Soils and Land Systems	4-4
4.5	Land Use	4-4
4.6	Flora and Fauna	4-4
4.6.1	Flora	4-6
4.6.2	Fauna	4-7
4.7	Groundwater	4-14
4.7.1	General	4-14
4.7.2	Groundwater Users	4-16
4.8	Socio-economic Environment	4-17
4.8.1	Northern Territory and Darwin Profile	4-17
4.8.2	Tennant Creek and the Barkly Tablelands	4-19
4.9	Cultural Heritage and Archaeological Sites	4-20
4.10	Noise	4-20
4.11	Radiation	4-20
<b>5.</b>	<b>POTENTIAL IMPACTS AND PROPOSED MANAGEMENT MEASURES</b>	<b>5-1</b>
5.1	Greenhouse Gas and Climate Change	5-1
5.1.1	Potential Impacts	5-1
5.1.2	Mitigation and Management Measures	5-1
5.2	Air Quality	5-2
5.2.1	Potential Impacts	5-2
5.2.2	Mitigation and Management Measures	5-2
5.3	Land Resources and Use	5-3
5.3.1	Potential Impacts	5-3
5.3.2	Mitigation and Management Measures	5-3
5.4	Flora	5-3
5.4.1	Potential Impacts	5-3
5.4.2	Mitigation and Management Measures	5-4
5.5	Fauna	5-5
5.5.1	Potential Impacts	5-5
5.5.2	Mitigation and Management Measures	5-6
5.6	Groundwater	5-7
5.6.1	Potential Impacts	5-7
5.6.2	Mitigation and Management Measures	5-7
5.7	Downstream Impact to Surface Waters	5-7
5.7.1	Potential Impacts	5-7
5.7.2	Mitigation and Management Measures	5-8
5.8	Socio-Economic Environment	5-8
5.8.1	Potential Impacts	5-8
5.8.2	Mitigation and Management Measures	5-9

5.9	Infrastructure and Transport	5-9
5.9.1	Potential Impacts	5-9
5.9.2	Mitigation and Management Measures	5-10
5.10	Cultural Heritage and Archaeological Sites	5-10
5.10.1	Potential Impacts	5-10
5.10.2	Mitigation and Management Measures	5-10
5.11	Noise and Vibration	5-11
5.11.1	Potential Impacts	5-11
5.11.2	Mitigation and Management Measures	5-11
5.12	Visual Amenity	5-11
5.12.1	Potential Impacts	5-11
5.12.2	Mitigation and Management Measures	5-12
5.13	Rehabilitation and Mine Closure	5-12
5.13.1	Potential Impacts	5-12
5.13.2	Mitigation and Management Measures	5-12
<b>6.</b>	<b>ENVIRONMENTAL MANAGEMENT</b>	<b>6-1</b>
6.1	Planning	6-1
6.1.1	Risk Management	6-1
6.1.2	Environmental Management Plan	6-2
6.1.3	Emergency Response Plan	6-2
6.2	Implementation	6-3
6.2.1	Roles and Responsibility	6-3
6.2.2	Communication	6-3
6.3	Checking and Corrective Action	6-4
6.4	Management Review	6-4
6.5	Monitoring	6-4
<b>7.</b>	<b>STAKEHOLDER CONSULTATION</b>	<b>7-1</b>
7.1	Stakeholders	7-1
7.2	Consultation to Date	7-2
7.3	Proposed Stakeholder Consultation	7-3
<b>8.</b>	<b>REFERENCES</b>	<b>8-1</b>

## Figures

1.1	Location of Wonarah phosphate project	1-2
1.2	Land tenure	1-3
2.1	Mine layout	2-4
2.2	Main Zone mine layout	2-5
2.3	Strip mining process	2-6
2.4	Wonarah schedule	2-13

## Tables

1.1	NOI requirements as addressed by this document	1-5
2.1	Wonarah phosphate project inferred resources	2-1
2.2	Project components and approximate footprints	2-2
2.3	Mining schedule	2-7
4.1	Fauna species recorded during June 2008 field survey	4-7
4.2	Listed fauna species with potential to occur in the project area	4-8
4.3	Details of registered bores within 50 km of the project area	4-16
7.1	Stakeholder consultation to date	7-2

## Plates

4.1	Typical Wonarah landscape of open <i>Hakea</i> woodland over <i>Triodia</i>	4-5
4.2	Aerial view of Wonarah historical drill site and access track	4-5
4.3	Post-fire woodland showing spinifex regrowth	4-15
4.4	Minemakers Wonarah weather station	4-15
4.5	Post-fire woodland showing typical sandy soils	4-15
4.6	Post-fire woodland and access track	4-15

## Appendices

A	Section 46 Requirements for the <i>Aboriginal Land Rights (Northern Territory) Act 1976</i>
B	Dust Deposition Monitoring Results
C	Minemakers Wonarah Phosphate Project Baseline Flora and Fauna Report
D	Minemakers Environmental Policy

# 1. INTRODUCTION

## 1.1 Overview

Minemakers Australia Pty Ltd (Minemakers) proposes to develop the Wonarah phosphate project, located approximately 260 km east of Tennant Creek and 960 km southeast of Darwin in the Barkly Tableland of the Northern Territory (Figure 1.1). The Wonarah phosphate project, hereafter referred to as 'the project', involves the mining of two phosphate deposits, known as 'Arruwurra' and 'Main Zone'. The project has an inferred JORC compliant resource estimate of 461 Mt at 18.8% phosphorite ( $P_2O_5$ ) that will be developed over two discrete stages.

Stage 1 involves the mining of the deposits for direct shipping ore. Direct shipping ore is of a quality that requires minimal processing to meet market requirements. Mining during Stage 1 is expected to occur for approximately five years although exploration currently underway may extend this period up to ten years, commencing at a rate of 1.5 Mt/a and increasing to 3.0 Mt/a. Stage 2 of the project involves an expansion of the mining and processing operations to develop the lower grade ore. This stage is expected to commence within about five years from commencement of Stage 1 and to continue producing at a rate of 3 Mt/a for a further 40 years.

This Notice of Intent (NOI) provides formal notification to the Northern Territory Government and other interested parties of Minemakers' intention to develop Stage 1 of the Wonarah phosphate project. Information on Stage 2 of the project has been included where available; however, Stage 2 of the project is still being defined and is outside the scope of this NOI. Stage 2 will be subject to a separate referral and approval process in due course.

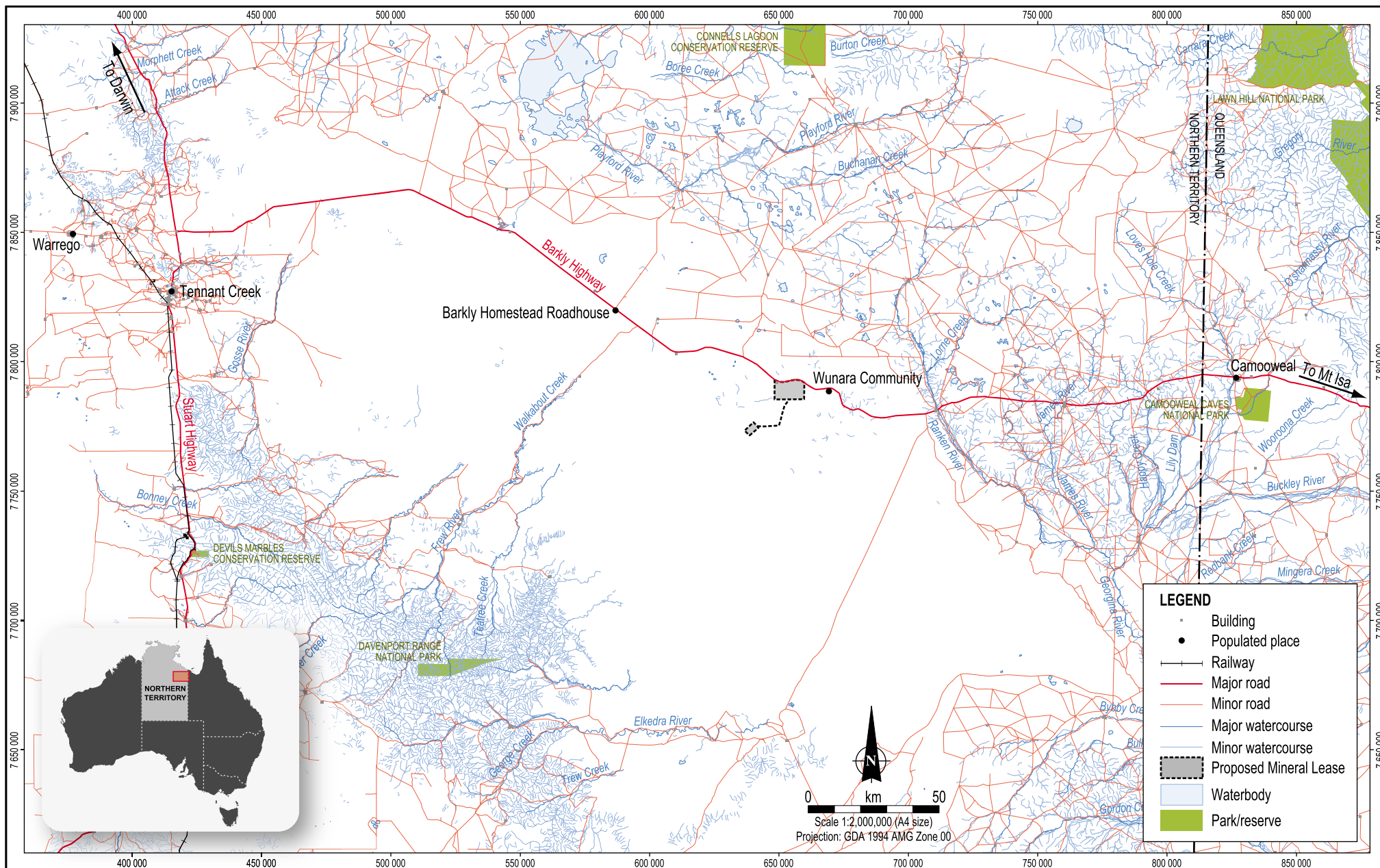
## 1.2 Project Area and Land Tenure

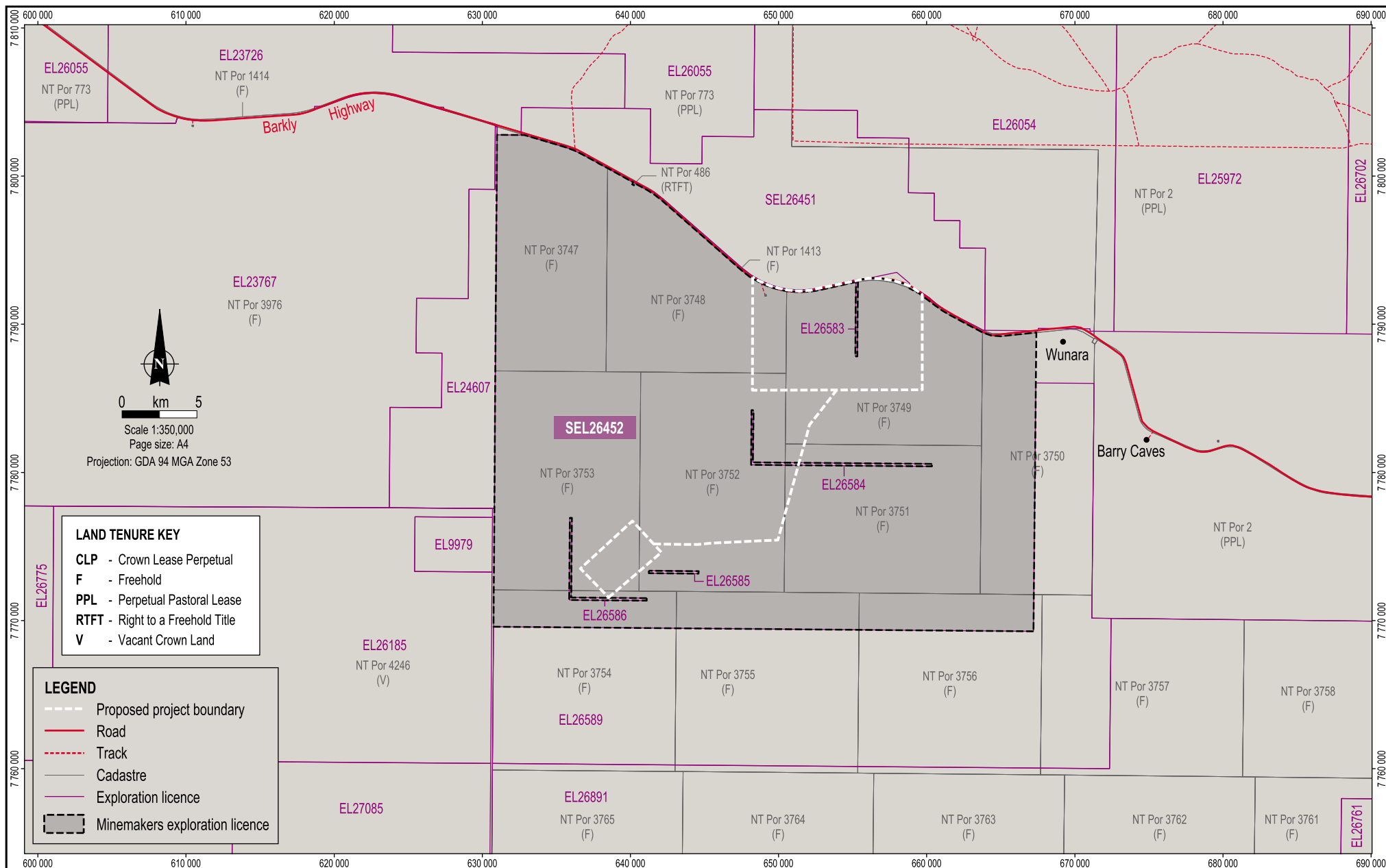
Minemakers is in the process of applying for a Mineral Lease under the Northern Territory *Mining Act*. It is a prerequisite for a Mineral Lease that the applicant holds a Northern Territory Miners Right. Minemakers is the registered holder of Miners Right number 556124. The project area (Figure 1.1) referred to in this NOI reflects the proposed Mineral Lease area.

The project area is located wholly within the Substitute Exploration Licence 26452 which is held by Minemakers (Figure 1.2). The project area also encompasses Exploration Licences EL26583, to EL26586 which are held by Minemakers. This licence was granted by the Minister for Primary Industry, Fisheries and Resources on 9 January 2008 for a renewable term of four years.

The land tenure of the project is Northern Territory enhanced freehold and the project is located wholly within enhanced freehold portions 1413, 3748, 3749 and 3751 to 3754 (Figure 1.2). These land portions are declared as Aboriginal community living areas in accordance with the *Miscellaneous Acts Amendment Act* and are part of the Arruwurru Aboriginal land which is owned by the Arruwurru Aboriginal Corporation.

The Wunara Community is the closest populated area to the project and comprises four houses and associated buildings. The population fluctuates from 2 to 30 people according to the season. The community is located adjacent to the Barkly Highway and is approximately 10 km from the proposed Mineral Lease boundary.





Source:  
Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)  
Exploration leases from DMETIS  
Cadastral from NT DPI  
Imagery from NATMAP

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**Land tenure**

Figure No:  
**1.2**

## **1.3 Proponent Details**

Minemakers is an Australian company and has been listed on the Australian Stock Exchange since October 2006 (ASX code: MAK). The company owns, or has options over, the following mineral projects and prospects, all located within Australia:

- Wonarah phosphate project in the Northern Territory (100% ownership).
- Tasmanian tin and tungsten deposits in northeast Tasmania including Storey's Creek and Aberfoyle (100% ownership).
- Moina polymetallic project (fluorspar, magnetite, tungsten, tin, zinc and other base metals) in northwest Tasmania (option to acquire 80% equity).
- Port Keats salt target in the Northern Territory (100% ownership).
- Fraser iron, iron ore targets in southwest Western Australia (option to purchase 80% ownership).

The company is also exploring for uranium mineralisation in Western Australia and Tasmania.

### **1.3.1 Name and Address of Proponent**

Minemakers Australia Pty Ltd  
Level 2, 34 Colin Street  
West Perth WA 6005

Telephone: (08) 9264 7000  
Fax: (08) 9264 7099

Contact: Neville Bergin, General Manager - Projects Development.

### **1.3.2 Name and Address of Lead Environmental Consultant**

Coffey Natural Systems  
Unit 8, 21 Parap Road  
Darwin NT 0820

Telephone: (08) 8901 1220  
Fax: (08) 8901 1299

Contact: Tara Halliday, Project Director, or Rebecca Powlett, Project Manager.

## **1.4 Purpose of this Notice of Intent**

This NOI relates to Stage 1 of the Wonarah phosphate project. Stage 2 of the project will be referred separately prior to the completion of Stage 1 of the project.

The objectives of this NOI are to:

- Provide formal notification of Minemakers' intention to develop Stage 1 of the Wonarah phosphate project.

- Outline the proposed project, including its potential economic, social and environmental benefits.
- Describe the existing environment and potential environmental impacts of the project.
- Outline high-level management and mitigation measures that are will minimise adverse environmental impacts as a result of the project.
- Provide sufficient information to allow Department of Regional Development, Primary Industry, Fisheries and Resources (RDPIFR) and Northern Territory Department of Natural Resources, Environment, the Arts and Sport (NRETAS) to determine the appropriate level of environmental assessment for the project.

This NOI has been prepared in accordance with the NRETAS Information Guidelines for a Notice of Intent (DNRETA, 2007), as summarised in Table 1.1, and the RDPIFR Environmental Assessment of Mining Proposals Advisory Note (DPIFM, 2006).

**Table 1.1 NOI requirements as addressed by this document**

NOI Requirement	Report Section
Name of proponent and consultant	1.3
Address and contact details of proponent	1.3.1
Location of proposal	1.2
Description of proposal	Chapter 2
Outline of legislative and licensing requirements	Chapter 3
Description of site and related details of existing environment	Chapter 4
Description of marine and land uses in and adjacent to the proposal	4.5
Description of waste management and pollution control on and off site	2.7 and 2.10
Description of existing environment and related environmental aspects	Chapter 4 and 5
Aboriginal and sacred sites clearance	4.9
Description of project timing, staging and decommissioning	2.4
Description of environmental commitments, safeguards and monitoring	Chapter 6
Description of rehabilitation and decommissioning	2.14

Although the provisions of the *Native Title Act 1993* and *Aboriginal Land Rights (Northern Territory) Act 1976* do not apply to the project, at the request of the Central Land Council (CLC), Minemakers has undertaken to ensure that the environmental permitting process of the project meets the requirements of Section 46 of the *Aboriginal Land Rights (Northern Territory) Act*. Appendix A outlines how this NOI and the subsequent environmental impact assessment document will voluntarily address Section 46 requirements.

In parallel with the submission of this NOI, a referral has been lodged to the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) for the project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The referral states that the project is not likely to have a significant impact on any matters of national environmental significance as defined by the EPBC Act and therefore that it should not be considered 'not a controlled action'.

## **1.5 Report Structure**

The NOI comprises eight chapters and a table of contents that outlines figures, tables and plates in relevant chapters. The format of the main report is:

Chapter 1 (this chapter)—introduction, proponent details, project details, project summary, and purpose of the NOI.

Chapter 2—detailed description of the project.

Chapter 3—legislative framework (including Commonwealth and Northern Territory legislation, international conventions and national policies and strategies).

Chapter 4—description of existing environment (generally from a regional perspective).

Chapter 5—identification of potential environmental and social issues.

Chapter 6— environmental management.

Chapter 7— stakeholder consultation.

Chapter 8—references.

Appendices—reports for baseline specialist study investigations completed to date.

## 2. PROJECT DESCRIPTION

### 2.1 Project Overview

The Wonarah phosphate project involves the mining of two phosphate deposits, known as 'Arruwurra' and 'Main Zone'. The project has an inferred JORC compliant resource estimate of 461 Mt at 18.8% phosphorite ( $P_2O_5$ ) that will be developed over two discrete stages (Table 2.1).

**Table 2.1 Wonarah phosphate project inferred resources**

Deposit Description	Tonnage (Mt)	$P_2O_5$ grade (%)
Main Zone:	330	18.9
<i>Comprising:</i>		
- Mudstone phosphorite	(221)	(19.1)
- Chert breccia phosphorite	(91)	(17.2)
- Transitional phosphorite	(18)	(25.3)
Arruwurra	131	18.6
<b>Total</b>	<b>461</b>	<b>18.8</b>

Stage 1 of the Wonarah phosphate project involves the mining of DSO from four open pits, a treatment plant for crushing and screening and associated mine infrastructure. The cut-off grade for direct shipping ore is 28% of phosphorite and the location of open pits reflects the areas of the deposit containing the highest proportion of direct shipping ore. Based on currently defined resources Stage 1 has a mine life of around five years and will produce approximately 12.8 Mt of direct shipping ore, exploration currently underway may extend the mine life up to a total of ten years. The ore will initially be mined at a rate of 1.5 Mt/a, increasing to 3 Mt/a over three years. The phosphate produced at the mine will be transported by road to Tennant Creek and then transported by rail to the Port of Darwin.

The capital costs of the project are estimated to be \$107 M.

Stage 2 of the project is still being defined and is outside the scope of this document. Stage 2 will involve the expansion of the mining and processing operation (within the same proposed Mineral Lease) and will be permitted separately.

The project description in this chapter relates to Stage 1 only, unless direct reference to Stage 2 is made.

### 2.2 Project Components

The major components of the project and their proposed footprints are identified in Table 2.2 and described in detail in the following sections. The proposed project layout and location of related infrastructure is shown in Figures 2.1 and 2.2.

**Table 2.2 Project components and approximate footprints**

<b>Component</b>	<b>Approximate Total Disturbance Area (ha)</b>
Arruwurra Pit	150
Main Zone Pit A	720
Main Zone Pit B	900
Main Zone Pit C	320
Crushing and screening plant and product stockpile	14
Run-of-Mine stockpile	2
Non-direct shipping ore stockpiles (Arruwurra and Main Zone A, B and C)	145
Waste rock storage	200
Temporary ore stockpile	8
Access road	40
Haul roads	140
Aerodrome	40
Borefield	6
Offices	4
Explosives magazines	1
Power station	1
Mining contractors area	2
Accommodation village	10
Sewage treatment facility	3
Putrescible waste landfill	3
<b>Total</b>	<b>2,709</b>

The general principles guiding the location of project infrastructure have been to:

- Centre infrastructure around the Main Zone deposit, which is a larger deposit than Arruwurra and will produce more ore, to minimise overall haulage distances.
- Build on higher ground where possible to avoid inundation of infrastructure by flood waters.
- Utilise natural topography where possible to minimise earthworks and pumping requirements (i.e., make use of gravity).
- Place accommodation up-wind of the open pits and treatment plant to avoid noise and dust becoming a nuisance to the village residents. The prevailing wind direction is from the southeast.
- Minimise disturbance by placing infrastructure, such as temporary stockpiles, haul roads and the treatment plant in areas that will be disturbed by subsequent mining.
- Ensure access to the site is controlled for safety reasons by locating the office near the site entrance.

## 2.3 Mining Process

The Arruwurra and Main Zone deposits will be developed using conventional shallow open pit and strip mining methods which allow for progressive rehabilitation to occur. Four open pits will be mined, one in the Arruwurra deposit (Arruwurra Pit) and three pits in the Main Zone (Main Zone Pit A, B and C) (Figure 2.1). All pits will be operated concurrently to minimise the potential for downtime and allow blending of ore types to achieve optimum blends for market requirements. The final pit design and positioning will depend on the results of a drilling campaign being undertaken in the first half of 2009.

The strip mining process involves the excavation of waste and ore in progressive strips. After the initial strip or cut has been mined, the waste rock for subsequent strips is placed in the void created from the first strip (Figure 2.3). This technique enables areas to be progressively rehabilitated once mining has advanced to the next strip. Contouring of the replaced waste will occur ahead of re-topsoiling and replanting with native species of local provenance.

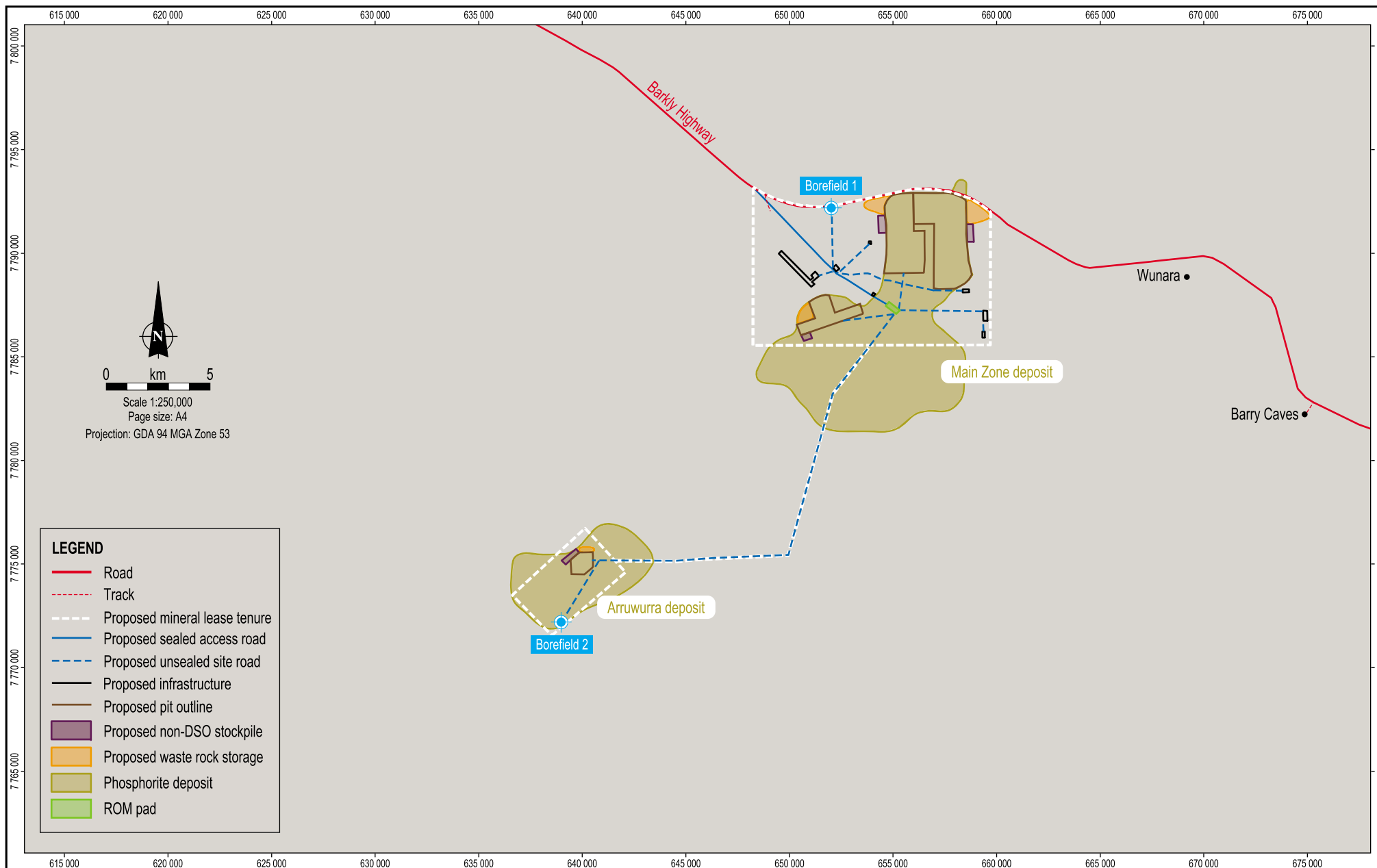
Typically the strip mining process will commence with removal of topsoil from all areas to be disturbed for the initial box cut, including the initial waste rock storage. A slot is opened from the initial wedge shaped box cut and then extended along the full 500 m strike extent of the pit. The initial box cut will be positioned mid-strike of the direct shipping ore grade zone and mining will advance along strike for the full extent of one half of the initial slot before commencing on the other half. The initial pit will have a width of approximately 50 m at the base of the pit.

Waste rock from the initial strip will be stockpiled in a waste rock storage immediately adjacent to the pits. The waste rock storages will be contoured into a low hill with a height above the natural ground level of approximately 15 m and batter slopes of approximately 18°. The waste rock storages will be covered using some stockpiled topsoil, and will be ripped and seeded to promote early regrowth of vegetation.

The development and mining of the Main Zone will be deeper than that of the Arruwurra deposit as the depth to the deposits (i.e., or the amount of waste rock overlying the deposits) varies, as does the thickness of the deposits. The depth to the Arruwurra deposit ranges from 10 to 15 m at its shallowest point to 25 to 30 m at its deepest point. The thickness of the Arruwurra phosphorite deposit ranges from 3 to 5 m. For the Main Zone, the depth to the deposit ranges from 20 m at its shallowest point to 50 to 60 m at its deepest point and the thickness of the phosphorite deposit is around 5 m.

Mining will be undertaken by excavator, face shovel or mobile miner. Blasting may be used to loosen the waste rock ahead of mining. The mined ore will be loaded into haul trucks and transported to a temporary ore stockpile adjacent to each pit. The footprint of each temporary ore stockpile will cover an area of approximately 2 ha. Wherever possible, these stockpiles will be located within the footprint of the final pit and advanced ahead of mining in order to minimise total land disturbance.

During the mining process temporary bunds will be placed at a distance of at least 5 m from the edge of the pits to prevent accidental access to the pit. These bunds will be removed and replaced progressively as the pits advance.



Source:  
Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000).  
Mine plan, proposed mining lease and exclusion zones from Minemakers.  
Imagery from NATMAP.

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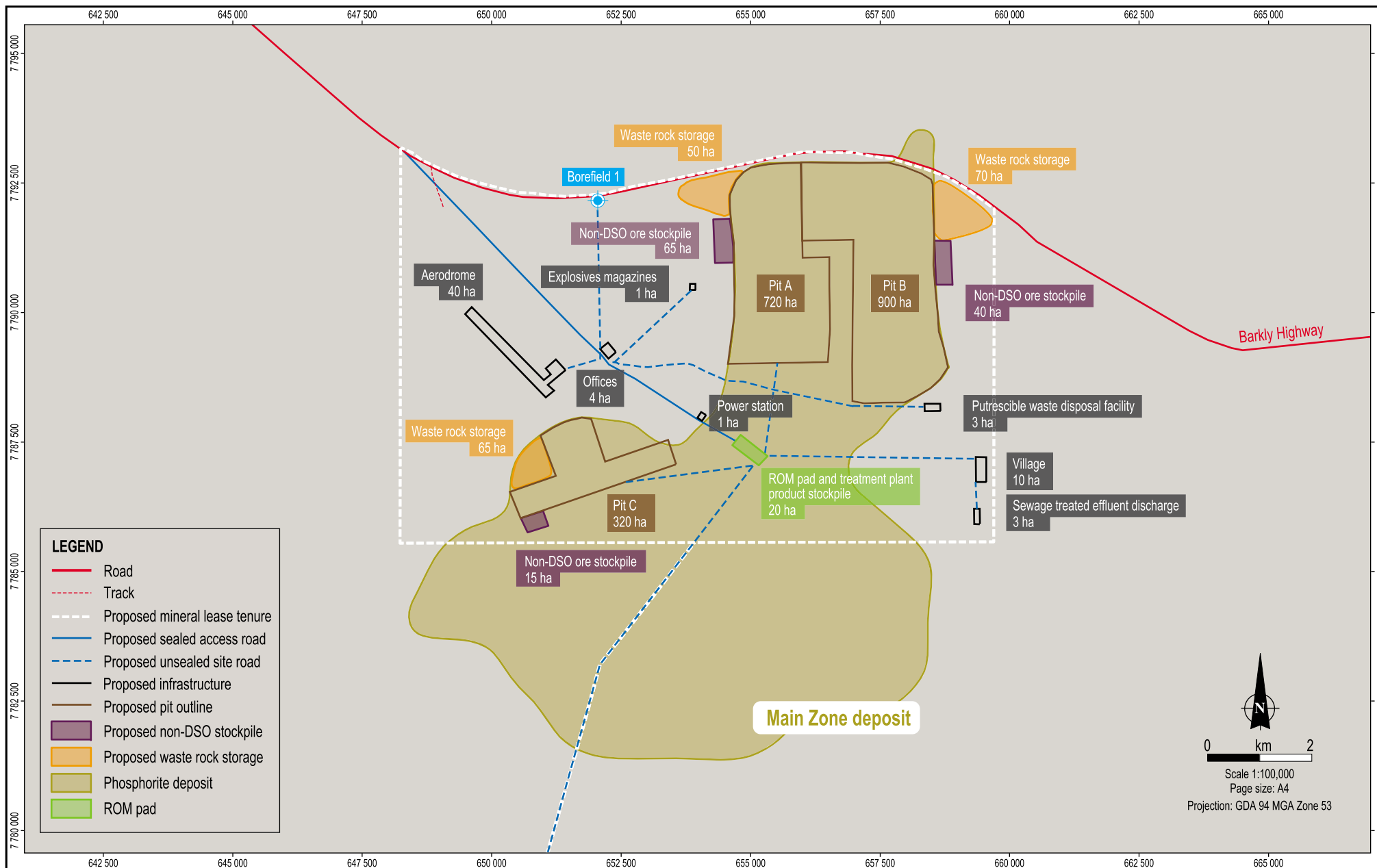
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**Mine layout**

Figure No:  
**2.1**



Source:  
 Roads and tracks from GEODATA 250k (optimum scale 1:250,000).  
 Mine plan, proposed mining lease and exclusion zones from Minemakers.  
 Imagery from NATMAP.

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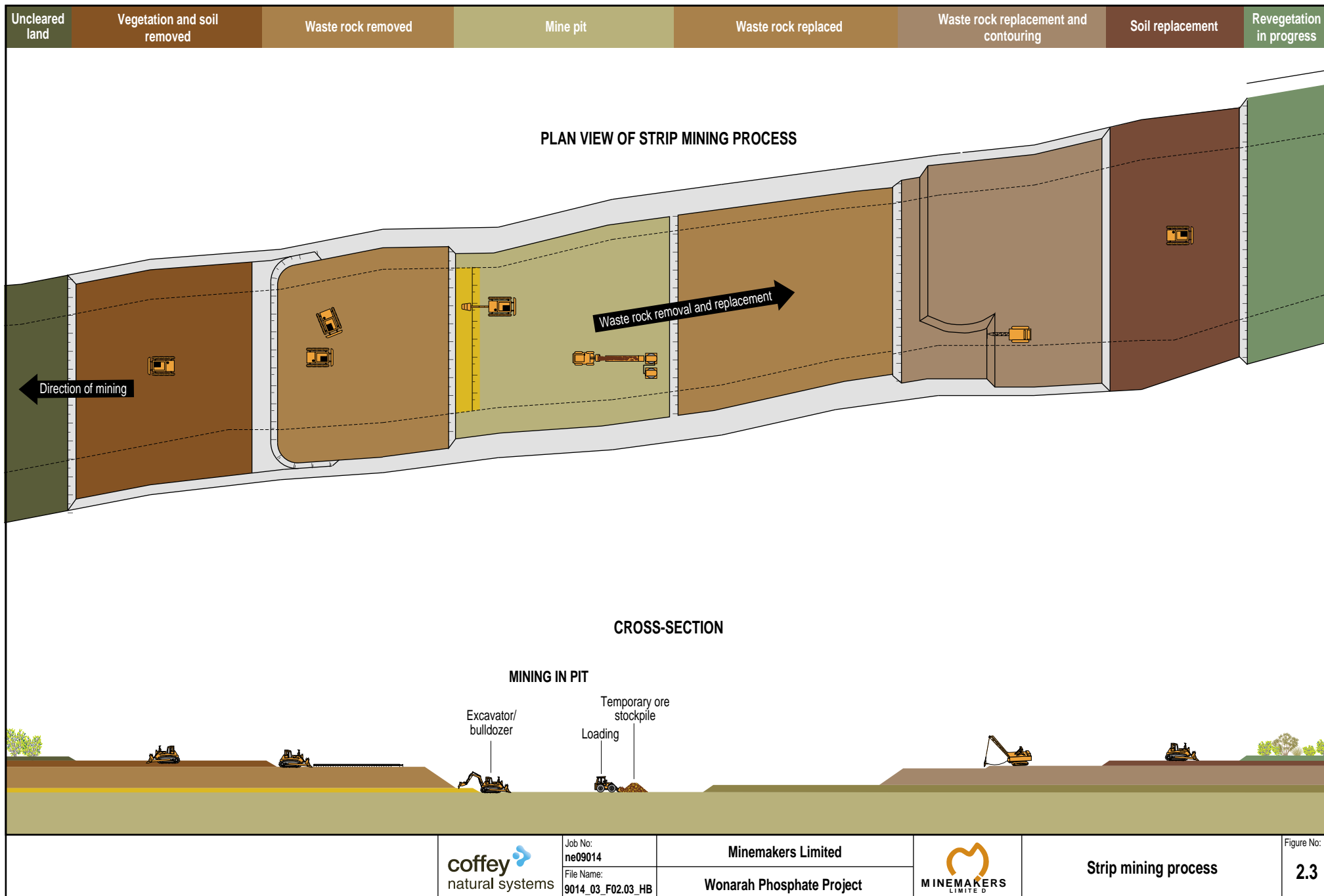
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**Main Zone mine layout**

Figure No:  
**2.2**



The process of waste rock removal, phosphate mining and filling of the void will be repeated until the economic geological limit of the Stage 1 direct shipping ore in the pit is reached. At completion of mining the final void will be left unfilled. Bunds will be formed around the final void at a distance of at least 25 m to prevent accidental access to the edge of the void. A bund will also be formed across the haul road to prevent access.

Mined ore will be transported via haul trucks to the Run-of-Mine (ROM) stockpile adjacent to the crushing and screening plant. This plant is located roughly equidistant from the starting point of each of the three Main Zone pits. The ROM stockpile will be formed on an elevated ROM pad. The ROM pad will have a footprint of 250 x 250 m and be around 15 m above the natural ground level. The ROM stockpile will have sufficient capacity for four weeks of plant feed.

Mining will also generate non-direct shipping ore which will be stockpiled adjacent to each pit for later treatment as part of Stage 2. If Stage 2 does not proceed, the non-direct shipping ore will be shaped into a stable landform, spread with topsoil and revegetated.

## 2.4 Mining Schedule

Mining will commence simultaneously at Arruwurra and Main Zone, with Main Zone Pit C likely to be the first of the three Main Zone pits to be developed. Development of Pits A and B is expected to commence towards the later part of the first year of operation. Thereafter all pits will be mined concurrently to allow blending of ore types to achieve optimum blends for market requirements. The mining sequence will be confirmed at the completion of the feasibility study.

A summary of the proposed mining schedule is shown in Table 2.3. Exploration drilling currently underway has the potential to extend the direct shipping ore resource and may extend the mine life up to a total of ten years.

**Table 2.3 Mining schedule**

Type of Material	Year						Totals (Mt)
	2009	2010	2011	2012	2013	2014	
Arruwurra							
Waste rock (Mt)	2.5	3.3	3.3	3.3	3.3	3.3	19.0
Direct shipping ore (Mt)		0.5	0.5	0.5	0.5	0.5	2.5
Non-direct shipping ore (Mt)		0.3	0.3	0.3	0.3	0.3	1.5
Main Zone							
Waste (Mt)		15.0	27.0	37.5	37.5	37.5	154.5
Direct shipping ore (Mt)		1.0	1.8	2.5	2.5	2.5	10.3
Non-direct shipping ore (Mt)		0.5	0.9	1.3	1.3	1.3	5.3
Total							
Waste (Mt)	2.5	18.3	30.3	40.8	40.8	40.8	173.5
Direct shipping ore (Mt)	0.0	1.5	2.3	3.0	3.0	3.0	12.8
Non-direct shipping ore (Mt)	0.0	0.8	1.2	1.6	1.6	1.6	6.8

## **2.5 Treatment Process**

The ore will be reclaimed from the ROM stockpile by front end loader and fed to the primary crusher where the size will be reduced to 75 mm. The crushed product will be screened on a double deck screen and then fed into the secondary crusher where the ore is crushed to a particle size less than 2 mm. The secondary crusher product will be screened to ensure the product is less than 2 mm in size and any oversized material will be returned to the secondary crusher for further processing.

Infrastructure associated with the crushing and screening plant includes warehouses, phosphate storage areas and truck loading facilities. The total area occupied by the ROM pad, crushing and screening plant and stockpile areas will be approximately 20 ha.

## **2.6 Water Management**

### **2.6.1 Surface Water Management**

The project area is located in a semi-arid climate and there are no significant watercourses present on the site, during heavy rainfall the area is prone to flooding. Watercourses that drain the region are ephemeral and only flow after major rains.

Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease.

Site surface water management will be based on the principle of diverting clean surface water runoff away from disturbed areas, and intercepting runoff from disturbed areas and directing it through sediment control structures prior to discharge to the downstream environment.

### **2.6.2 Water Use**

It is anticipated that water usage will be approximately 4 ML/d for all purposes including dust suppression and potable water for domestic use:

- Dust suppression. Water will be used for dust suppression around the crushing and screening plant and in water carts for dust suppression on haul roads and other site roads.
- Potable water. Potable water will be produced from treating borewater in a reverse osmosis plant. The potable water will be reticulated to the crushing plant, administration offices, contractors' offices and workshops and the accommodation village.

Water storage will comprise a main tank of approximately 20,000 L capacity and a 0.5 ML water pond.

### **2.6.3 Borefield**

Water for the project will be groundwater sourced from borefields. The borefields are likely to be located in the northwest and southwest of the project area. A drilling program will be conducted in the first half of 2009 to determine the optimum locations. Clearing within the borefield will be confined to access tracks to allow the drilling and maintenance of the bores. A total network of approximately 10 km of tracks each of 6 m width will be cleared, totalling 6 ha.

## **2.7 Transport Infrastructure**

During the construction phase of the project, materials required for construction and operation will be transported to the site from either Tennant Creek, Darwin or Mount Isa via a combination of rail and road. Existing transport infrastructure is not required to be upgraded for construction and operation of the project.

### **2.7.1 Access Road**

A sealed access road of approximately 8.5 km length will be constructed from the Barkly Highway to the crushing and screening plant. The disturbance for the road will typically be 35 m wide including shoulders and provision for drainage. The sealed width will be 8 m.

The access road corridor will also host a power line over a distance of 3 km from the power station to the office complex and from the power station to the crushing and screening plant. The corridor will also host water pipelines.

The total cleared width at any part along the route may be up to 35 m to allow for statutory clearances from overhead power lines. A maximum area of disturbance, including borrow pits, is anticipated to be 40 ha.

Construction of the road will require the mining of borrow pits to produce material suitable for road base and formation. Borrow pits will generally be located adjacent to the access road. Each borrow pit will be mined to a depth of approximately 3 m below natural ground surface. Rehabilitation of the borrow pits will comprise battering of slopes to form stable landforms that allow safe ingress and egress and re-spreading of disturbed areas with stripped topsoil.

### **2.7.2 Haul Roads and Other Site Roads**

Approximately 60 km of road network of varying standards will be established to provide access around the site. Roads will provide access to the aerodrome, magazines, borefields, accommodation village and putrescibles waste landfill.

The general site roads will generally be formed to a width of approximately 5 m with an allowance of an additional 15 m of disturbance to allow for shoulders and drainage. The total area potentially disturbed by such roads is approximately 140 ha. The road corridor may also host a water pipeline from the borefield to the treatment plant, which will be laid within the disturbed area of the road.

Haul roads will be established to connect the pits to the ROM stockpile. The longest of these will be from the Arruwurra pit to the plant, a distance of 22.5 km. The main haul roads will be constructed to a standard to allow the haulage of ore in road trains. The haul roads will generally be established at a gradient of 1:9, although short, localised ramps at 1:5 may be used and will have a formed road width of approximately 8 m with a total of up to 25 m being disturbed to allow for shoulders and drainage works. Wherever possible, these haul roads will be formed on areas that will later be disturbed by mining of their respective pits.

Other temporary haul roads may be established from time to time within the pit to provide access for mining and haulage via the shortest haulage route.

Water will be sprayed onto haul roads and unsealed access roads to suppress dust using a water cart. Where practicable and economically viable, proven, environmentally benign surfactants may be used on road surfaces to reduce the water demand for dust suppression.

### **2.7.3 Aerodrome**

An aerodrome will be constructed to the southwest of the office complex. The aerodrome will be orientated approximately southeast to northwest to accommodate the prevailing wind direction. It will be constructed and marked in accordance with the Civil Aviation Regulations for aircraft landing areas. The runway will be 2 km long with a taxiway to an aircraft parking and refuelling area located at least 50 m from the edge of the runway.

Typically, aircraft of 20 to 30 seats will be used for shift changes for workers on a fly-in-fly-out roster. Emergency lighting will be available at the aerodrome to enable the Royal Flying Doctor Service to land and take off at night, should the need arise.

The total cleared area of the aerodrome will be approximately 40 ha.

## **2.8 Ore Storage and Transport to Market**

Phosphate product will be stored on a designated stockpile area prior to transport to Tennant Creek via the Barkly Highway by road trains.

The road trains will either deliver the phosphate to the multi-user hub to be constructed by Global Port Solutions at Tennant Creek (if constructed), or direct to the Adelaide-Darwin rail line at a new siding within the rail reserve north of the town of Tennant Creek.

The phosphate product will be stored under cover in a shed that will cover approximately 1 ha or in overhead silos prior to loading onto rail wagons for transport by train to the Port of Darwin.

Storage at the Port would again be in a covered shed ahead of loading into Panamax or smaller vessels for shipment to markets.

## **2.9 Other Mine Infrastructure**

### **2.9.1 Administration and Maintenance Areas**

An office complex covering approximately 4 ha and comprising site reception, administration, technical services, meeting and training rooms will be located adjacent to the sealed site access road and approximately 3 km to the west of the crushing and screening plant. All traffic entering or leaving the site will have to pass by the offices and this provides a logical location at which to control access to the site.

Located in the same area will be the occupational health and safety, first aid and rescue centre and a maintenance workshop for both mechanical and electrical work with the site store, laydown area and vehicle parking areas.

### **2.9.2 Power Station**

A power station generating approximately 4 MW will be located approximately 900 m from the process plant and 2 km from the office complex.

The power station will be dual fuelled (diesel and gas) with fuel storage located immediately adjacent to the power station. A buffer zone of approximately 50 m surrounding the power station will be cleared to prevent fire risk and to allow access for refilling of fuel storage vessels and for heavy vehicle access for removal and replacement of the power generating units.

The power station will be designed to prevent the emission of sparks from the engine exhausts by fitting each with spark arrestors.

### **2.9.3 Explosives Magazine**

Licensed explosives magazine will be established in accordance with the Northern Territory's *Dangerous Goods Act*. Storage capacity is expected to be of the order of 10 t of explosive and up to 10,000 detonators.

The explosive magazine will be located approximately 2 km northeast of the office complex and access to the magazines will be strictly controlled.

### **2.9.4 Accommodation Village**

An accommodation village covering an area of approximately 10 ha will be constructed to the east of the Main Zone resource approximately 4 km from the crushing and screening plant and 7.5 km from the office.

The village will be sized to accommodate approximately 120 persons, including full time employees and contractors as well as short-term contractors and visitors.

Accommodation will be demountable units that typically comprise three rooms to each 12 m by 3 m unit. All units will have potable water reticulation, an ensuite bathroom and be plumbed into a centralised modular sewage system. Each room will be fitted with air-conditioning, satellite TV, broadband internet and telephone.

The accommodation village will be landscaped and provided with a network of paths to enable easy access. Facilities such as a laundry blocks and a central kitchen and dining room will form part of the accommodation village. The kitchen drains will incorporate grease traps for the collection and removal of grease prior to delivery to the sewage treatment facility.

Water storage tanks of approximately 60,000 L, sufficient to meet normal use and emergency fire fighting needs, will be located at the village. Power will be supplied via overhead powerlines running from the power station and adjacent to the main access road and village access road.

### **2.9.5 Sewage Treatment Facility**

A modular sewage treatment plant will be located approximately 100 m from the village. It will comprise a number of above ground modules to process sewage waste from the village and offices. Suitable systems will likely include both aerobic and anaerobic reactors and clarification systems. Processing capacity will be approximately 10,000 L per day.

The treated and clarified effluent will be discharged via irrigation sprays into a fenced area of approximately 3 ha a further 500 m away. An area of approximately 1 ha within the larger 3 ha discharge area will be set aside for bio-remediation pads for the treatment of soils contaminated by hydrocarbons.

Four pads, each of dimensions of around 20 by 30 m, will be formed for the remediation of soils. Contaminated soil will be spread over the floor of each pad and irrigated with effluent water. The soils will be turned occasionally until hydrocarbon removal is successfully achieved. The remediated soil will then be returned for use in rehabilitation.

Each pad will drain to a centralised sump for settling of solids before discharge by overflow into the adjoining fenced area.

## **2.10 Waste Management**

Putrescible and domestic waste generated by the living areas and offices will be collected and disposed of in a designated waste landfill. The waste landfill will be fenced to prevent wind blown spread of waste and access by animals. Deposited waste will be covered with waste rock weekly.

Wherever practically and economically viable all waste materials will be recycled. Metals such as steel, manganese wear parts, copper wire, etc. will be collected in designated areas prior to removal from site for recycling. Plastic pipe including HDPE, PVC, ABS, will be reused wherever possible. Used tyres will be collected and periodically dispatched to off-site recyclers or a retread facility.

Where inert industrial wastes cannot be practically or economically disposed of off-site they will be co-disposed with the waste being placed in the mining void. Burial will be at least 3 m below final surface. Empty drums will be cleaned and squashed flat by a bulldozer prior to burial.

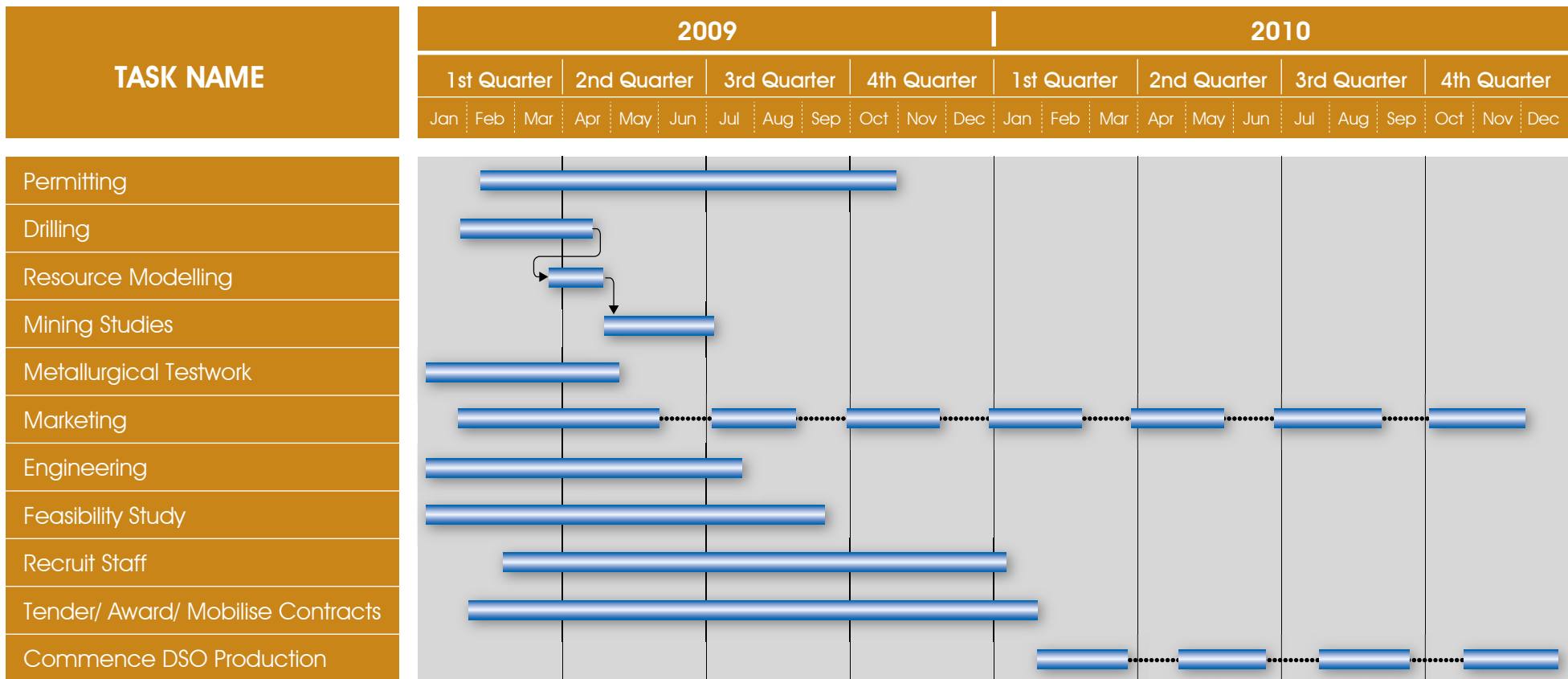
## **2.11 Workforce**

The construction phase of the project is expected to employ 50 to 100 people over a period of approximately 8 months. During operations, the mine will accommodate a fly-in-fly-out workforce of approximately 120 people, including project management, ore treatment staff and contractual mining workforce. A road haulage workforce of approximately 140 drivers and support staff is expected to be based in Tennant Creek.

## **2.12 Timing**

Pending regulatory approvals, construction of the project will commence in September 2009 and take approximately three months. Production is scheduled to commence early in the first quarter of 2010. Subject to agreement with the land owners and relevant regulatory approvals the construction of the access road, village and aerodrome may be commenced earlier.

Once heavy vehicle access is available to the site and sufficient rooms are available for occupation in the accommodation village, the Mining Contractor will set up on-site and establish



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Task

Split task

facilities, including workshop, offices and laydown areas and will commence development of the box cut and initial slot.

This initial phase of mine development at Arruwurra is expected to take 12 weeks, with production of direct shipping ore commencing as soon as one half of the initial slot is fully developed.

Delivery of crushed and screened direct shipping ore product to Tennant Creek will commence immediately upon the commencement of treatment of ore. Stockpiles at the mine site, Tennant Creek and the Port of Darwin will be allowed to accumulate progressively over time, with initial focus on getting product to market in as short a time frame as possible.

The timeframe for completion of the permitting, construction and production of direct shipping ore is shown in Figure 2.4.

## 2.13 Rehabilitation and Mine Closure

Mine closure planning is a continuous process which commences prior to project development. Closure plans will be progressively refined and adapted throughout the life of the mine. This ensures that the planning adapts to further site information that becomes available during construction and operations, and to changes in regulations, stakeholder expectations, technology, knowledge and mine planning.

Mine closure planning will be conducted in consultation with stakeholders to ensure that the final rehabilitation and mine closure objectives incorporate their requirements (e.g., retention of certain infrastructure) and keep them informed of achievement of mine closure criteria.

The mine closure plan will be developed in line with the following objectives:

- Protect human health and safety.
- Reduce the need for long term monitoring and maintenance through design of and construction of landforms that are geotechnically and geochemically stable.
- Develop landforms that are consistent with the surrounding landscape.
- Develop an environmental monitoring and reporting program which is focused towards demonstrating the achievement of closure outcomes.
- Undertake progressive rehabilitation of the site during operations.
- Ensure that the full cost of decommissioning and rehabilitation is understood and that a mechanism for funding exists.
- Ensure that residual risks and liabilities are identified and controlled to an acceptable level.

A key aspect of mine closure will be the progressive rehabilitation of the site during operations, where this will enable rehabilitation techniques to be trialled and refined prior to closure. While rehabilitation and mine closure will continue to be refined during the life of the mine, generally the Mineral Lease will be rehabilitated as follows:

- **Open pits**—will be progressively backfilled with waste rock during mining. The areas will be contoured, topsoil will be spread and they will be revegetated with native species. A final void may remain and bunds will be established to ensure public safety where required.

- **Waste rock storages**—some waste rock storages will remain at the completion of mining and these will be contoured, and spread with topsoil and revegetated with native species.
- **Infrastructure areas**—mine infrastructure not required by the land owners will be removed from site. Once infrastructure has been removed, any areas of contamination will be remediated and the areas will then be ripped, spread with topsoil and revegetated with native species.

Prior to development of any site infrastructure, including the pit voids, the topsoil layer will be stripped. Where possible stripped topsoil will be reused immediately to preserve the seed store and nutrients. When immediate reuse is not possible, topsoil will be stored in stockpiles no higher than 2 m and adjacent to the area of clearance in readiness for reuse in rehabilitation.

## **3. ENVIRONMENTAL PERMITTING**

### **3.1 Commonwealth Legislation**

#### **3.1.1 Environment Protection and Biodiversity Conservation Act**

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), actions that are likely to have a significant impact on a matter of national environmental significance are assessed. The Australian Government Department of Environment, Water, Heritage and the Arts (DEWHA) is responsible for administering the act. Matters that are considered to be of national environmental significance include:

- World Heritage properties
- National Heritage places
- Ramsar wetlands of international significance
- Threatened species and ecological communities
- Migratory species
- Nuclear actions
- Commonwealth marine areas
- Additional matters of national environmental significance ('prescribed actions')

A referral and assessment process has been established to determine the application of the EPBC Act. The first step in this process is referral of the project to the DEWHA. The project is then assessed for the potential for impacts upon matters of national significance, and if this is applicable to establish the significance of these impacts. If it is determined that there will be, or there is likely to be, a significant impact to a matter of national significance the project is declared to be a controlled action.

An EPBC Act referral will be lodged in parallel with the lodging of the NOI. Minemakers considers the project will not have a significant impact to any matters of national significance and will therefore propose that the project should not be a controlled action.

If it is determined that the project is a controlled action, Minemakers proposes that the project be assessed under the EPBC Act by the process agreed to under the bilateral agreement between the Northern Territory and the Australian governments. If the project is not a controlled action, assessment of the project will proceed under the Northern Territory legislative approvals process.

#### **3.1.2 Native Title Act and Aboriginal Land Rights (Northern Territory) Act 1976**

The *Native Title Act 1993* provides legal recognition of the rights and interests of the Aboriginal people over land and water possessed under their traditional laws and customs. The act sets out basic principals regarding native title in Australia and establishes a regulating and governing body, the National Native Title Tribunal.

The *Aboriginal Land Rights (Northern Territory) Act 1976* provides for the granting of a fee simple interest in certain lands (as per Schedule 1 to the Act) to Aboriginal Land Trusts and for the

claiming of unalienated crown land by those groups of Aboriginal people who can prove that they were the traditional owners of such land (ATNS, 2005).

As the underlying land tenure of the project is enhanced freehold, the provisions of the Native Title Act and Aboriginal Land Rights (Northern Territory) Act do not apply to the project. However, Minemakers is working with the Central Land Council (CLC) to ensure that Aboriginal landownership and cultural heritage concerns and issues are addressed.

### **Native Title Act and Aboriginal Land Rights (Northern Territory) Act and the Role of the Central Land Council**

Aboriginal landowners in the project area are represented by the Central Land Council (CLC), one of four councils established as a result of the Aboriginal Land Rights (Northern Territory) Act. The Central Land Council and its northern equivalent, the Northern Land Council, were established on an interim basis in 1973 following a report by Justice Woodward (Woodward, 1973).

In accordance with the Act the functions of each land council are to:

- Ascertain and express the wishes and opinions of Aboriginals living in the area concerning the management of Aboriginal land in that area.
- Protect the interests of traditional Aboriginal owners of land in that area.
- Consult with traditional Aboriginal owners of land in that area concerning proposed uses of the land.

The CLC is also a Representative Body under the Native Title Act.

Land Trusts in the Northern Territory are statutory bodies under the Aboriginal Land Rights (Northern Territory) Act. Land Trusts hold the title to land handed back to the traditional Aboriginal owners under one of the mechanisms outlined in the Act. A Land Trust exercises certain functions in relation to the land held by it as set out in the Act, but cannot exercise those functions except in accordance with a direction given to it by the Land Council for the area in which that land is situated.

## **3.2 Northern Territory Legislation**

The initial environmental permitting of mining activities is regulated in the Northern Territory by both the *Mining Management Act* and the *Environmental Assessment Act*.

A decision on the appropriate permitting route for new mining proposals in the Northern Territory is initiated by the proponent's submission of a NOI (i.e., this document) to the Northern Territory Government through the Minerals and Energy Referral Assessment branch of the RDPIFR. If assessment under the Environmental Assessment Act is thought to be required, the NOI is referred to the Minister for Natural Resources, Environment and Heritage through the NRETAS for determination of the appropriate level of assessment.

Following completion of the assessment and approval process under the Environmental Assessment Act by the Northern Territory Minister for Natural Resources, Environment and Heritage (assisted by the NRETAS Environment, Heritage and the Arts Division (EHA)), RDPIFR proceeds with the approval process under the *Mining Act* and Mining Management Act.

### **3.2.1 Mining Act and Mining Management Act**

The principal legislation for the regulation of mining proposals in the Northern Territory are the Mining Act and the Mining Management Act, both of which are administered by the RDPIFR.

#### **Mining Act**

The Mining Act establishes the framework within which activities to explore for and mine mineral resources can occur. The Act sets out the administrative processes for authorising these activities through the grant of a title.

Prior to any activities taking place on a granted Mineral Lease, an authorisation to carry out mining activities under the Mining Management Act must be obtained.

#### **Mining Management Act**

The objectives of the Mining Management Act are to ensure that the development of mineral resources is in accordance with the best practice health, safety and environmental standards and to protect the environment and health and safety of all persons on mining sites.

Under the Mining Management Act, an application for an authorisation to carry out mining activities must be accompanied by a mine management plan. A mine management plan includes information relating to the description of mining activities, the management system to be implemented for the management of health, safety and environmental aspects, costing of closure activities and particulars of organisational structure. Plans of any existing or proposed mine workings and infrastructure must also be included. The mine management plan is required to be reviewed at intervals specified in the authorisation to carry out mining activities.

### **3.2.2 Environmental Assessment Act**

The Environmental Assessment Act and the Environmental Assessment Administrative Procedures establish the framework for the assessment of potential or anticipated environmental impacts of development, and provide for protection of the environment. The Northern Territory Minister for Natural Resources, Environment and Heritage is responsible for administering the Act. The Minister also determines the appropriate level of assessment for new developments or material changes to existing operations, based on the sensitivity of the local environment, the scale of the proposal and its potential impact upon the environment.

### **3.2.3 Water Act**

The *Water Act* provides for the investigation, allocation, use, control, protection and management of surface water and groundwater resources, as well as the administrative process for licensing these activities. The Act also considers the protection and use of water resources for purposes such as recreational, social and cultural.

Under this Act, mining activities (as defined by the Mining Management Act) or another activity for a purpose ancillary to that mining activity, including the use of water as drinking water, are exempt from a number of provisions in the Water Act. This includes, but is not limited to, the use of surface water and groundwater as well as the construction of works to allow for the use of water.

While this project will not require discharge of waste off the Mineral Lease, if off-lease discharge was anticipated a waste discharge licence would be required for this activity. Waste is defined in the Water Act as any solids, liquids or gas, which, if added to the water, may pollute the water.

### **3.2.4 Other Relevant Legislation**

Other Northern Territory legislation relevant to the project includes the following Acts and their associated amendments and regulations:

- *Aboriginal Land Act.*
- *Bushfires Act.*
- *Control of Roads Act.*
- *Dangerous Goods Act.*
- *Dangerous Goods (Road and Rail Transport) Act.*
- *Environmental Offences and Penalties Act.*
- *Heritage Conservation Act.*
- *Miscellaneous Acts Amendment (Aboriginal Community Living Areas) Act.*
- *Northern Territory Aboriginal Sacred Sites Act.*
- *Planning Act.*
- *Soil Conservation and Land Utilisation Act.*
- *Territory Parks and Wildlife Conservation Act.*
- *Traffic Act.*
- *Waste Management and Pollution Control Act.*
- *Weeds Management Act*

## **4. EXISTING ENVIRONMENT**

### **4.1 Climate**

The project area has a semi-arid climate with the majority of rainfall occurring between November and April. Annual rainfall totals show moderate variability from year to year. The closest continuously operating Bureau of Meteorology weather station, known as Brunette Downs, is located about 145 km northwest of the Wunara Community. The Brunette Downs weather station commenced data collection in 1891. This weather station has recorded the average annual maximum temperature as 33.5°C and an average minimum temperature of 18.7°C.

The highest rainfall is received in January, with an average of 104.3 mm, with the lowest rainfall recorded in August, with an average of 1.4 mm. The annual average rainfall is 412.6 mm, with approximate average evaporation between 2,800 and 3,200 mm per annum. Humidity is generally higher in the mornings than in the afternoons and on average does not exceed 48%. The prevailing wind direction is southeasterly and the average wind speed is around 12 to 13 km/h.

A weather station was installed at the project site in June 2008. The weather station records:

- Rainfall.
- Temperature.
- Humidity.
- Wind speed and direction.
- Solar radiation.

During the first month the weather station recorded dry conditions with no rainfall. Total evaporation was recorded at 339.5 mm. Temperatures recorded were mild with an average of 19.4°C and ranged from a minimum of 8.2°C to a maximum of 31.5°C which are slightly lower than the mean annual temperatures recorded at the Brunette Downs weather station during the same period. Relative humidity averaged 25.8% and peaked at 75.5% which is slightly higher than that which is recorded at the Brunette Downs weather station.

The prevailing wind direction was southeast, similar to that recorded at Brunette Downs weather station, at an average speed of 10 km/h with a maximum gust recorded at 38 km/h. The weather station measures solar radiation in units of power or intensity which is averaged over a period of time. Levels of solar radiation were recorded averaging 426.8 W/m<sup>2</sup> and peaking at 994 W/m<sup>2</sup>. These figures are within the extreme ultraviolet (UV) index range.

### **4.2 Greenhouse Gas**

Activities which emit greenhouse gas within close vicinity of the project are limited. The largest source of anthropogenic greenhouse gas emissions in close vicinity to the project is likely to be methane emitted from pastoral activities. There are no pastoral activities carried out on the project area.

## 4.3 Air Quality

The project area is remote from significant pollution sources such as industry. The existing air quality in the vicinity of the project area is typical of a remote, rural environment with dust the main pollutant. The sources of particulate matter are natural, such as windblown dust from exposed surfaces.

To determine the background atmospheric (dust) conditions of the project area, eight dust deposition gauges have been installed in the project area. The dust monitoring results will be used as a project baseline and will assist with prediction of potential dust-related impacts resulting from the proposed mine.

Dust, which is deposited in the traps, is collected on a monthly basis and sent to an accredited laboratory for analysis. The samples are analysed for:

- Total solids.
- Soluble matter.
- Total insoluble matter.
- Combustible matter.
- Ash content.

Baseline dust monitoring commenced in June 2008 and results to date show that the background dust deposition is relatively high compared to the New South Wales air quality standards<sup>1</sup>, ranging from 0.8 to 4.0 g/m<sup>2</sup>/month and averaging at 2.6 g/m<sup>2</sup>/month (full results are provided in Appendix B). Increased dust levels are not unusual for an arid environment.

## 4.4 Land Resources

### 4.4.1 Landform, Topography and Drainage

The project is located on the plains of the Barkly Tableland, which have very gentle relief. The landscape of the project area has a general low relief, although small bevelled chert/silcrete rocky outcrops are locally common (Plates 4.1 and 4.2).

Watercourses that drain the Barkly Tableland are ephemeral and only flow after major rains (Tickell, 2003). No significant watercourses traverse the project area, with the closest significant watercourse being the ephemeral Ranken River about 50 km to the east of the project area. There are very few permanent waterholes; however, some waterholes are known to retain water for extended periods.

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<sup>1</sup> The Northern Territory does not currently have any air quality criteria; instead the National Environment Protection Measure for Ambient Air Quality (Air NEPM) is adopted. As the Air NEPM does not have criteria for dust deposition, the New South Wales air quality standards have been adopted.

#### **4.4.2 Geology**

##### **Regional Geology**

The project is located within the Georgina Basin, a sedimentary basin containing lower and middle Palaeozoic sediments. The Georgina Basin is subdivided into several sub-basins that primarily reflect the thickness of Cambrian deposition. Within the region of the Wonarah phosphate deposit two sub-basins occur, the Brunette and the Undilla, which are made up of Middle Cambrian sediments and volcanics.

Within these two sub-basins, two geological sequences (the Ordian and the Late Templetonian) have been identified. The Ordian sequence consists of Thornton limestone (dolomitic siltstone) overlying the Peaker Piker volcanics which are weathered basalt and dolerite. The Late Templetonian sequence includes the phosphate bearing Upper Gum Ridge Formation and consists of (from bottom to top of formation) transitional phosphorite overlain by transitional sediments (clay rich mudstone and siltstone, some dolomite and sandstone), then overlain by Chert Breccia Phosphorite, Mudstone Phosphorite and Convolute Mudstone.

##### **Arruwurra Geology**

At the Arruwurra Deposit the phosphate mineralisation occupies a broad northeast to southwest trending shelf that slopes gently to the southwest. The shelf drops away sharply at the western end and along the southeastern edge. Mineralisation outcrops in the northeast before petering out against the basement high to the north.

The basement at Arruwurra is a basalt of the Peaker Piker Volcanics. Thornton Limestone equivalent dolomites and dolostones overlay the basalt along the southeastern and southern margin of the deposit. An abrupt change in lithology and depth to the basalt basement indicates a probable fault which has thrown the deposit side upwards. A karst surface is present on the dolomite.

The Upper Gum Ridge Formation at Arruwurra is different to the Main Zone. The Upper Gum Ridge Formation transition unit is thinner and comprises 1 to 5 m of mudstone, siltstone and phosphorite. The high grade transitional phosphorite does not appear to be well developed at Arruwurra.

##### **Main Zone Geology**

The basalt basement in the Main Zone area is also comprised of the Peaker Piker Volcanics. The top of the basalt is extremely weathered and has a ferruginous and manganiferous duricrust. Some dolomitic rocks of the Thornton Limestone equivalent are present above the basalt at the southeastern extremity of the Main Zone. To the east and the south the carbonate rocks are extensively developed.

The overlying phosphate-bearing Upper Gum Ridge Formation is divided into four main units: basal undifferentiated Transitional Unit sediments, Chert Breccia Phosphorite, Phosphorite Mudstone and Convolute Mudstone.

The Transition Unit is laterally continuous, 4 to 8 m thick and comprised of clay-rich mudstone and siltstone with minor phosphorite, dolomite, sandstone and basal epiclastics. The basal transitional phosphorite is a laterally discontinuous high grade porcellainous phosphorite up to 3 m thick developed throughout the eastern and southern part of the Main Zone.

The Wonarah Beds overlie the Convolute Mudstone and are comprised of mudstone and siltstone with minor chert. The Wonarah Beds thicken towards the east and south away from the basement high that defines the western fringe of the Main Zone. Dolomitic units of the Hangingwall Dolostone, are present east and south of the Main Zone.

The phosphatic units thin out towards the basement high which trends in a northeast to southwest direction towards Arruwurra. To the east and south the phosphatic units, although still present with grade and thickness, are too deep to be of economic interest at this time.

#### **4.4.3 Soils and Land Systems**

Broadscale land systems mapping identifies the of the project area as forming part of the Yelvertoft land system (Stewart *et al.*, 1954 and Perry *et al.*, 1962). The Yelvertoft land system is described as typically undulating terrain with skeletal soils and truncated gravelley lateritic red earths, dominated by *Eucalyptus brevifolia* or *E. dichromophlora* woodlands.

More specifically, soils of the project area have been described as having a surface crust, with slightly more structure at depth. Pye (2008) also noted the soil in the vicinity of the project area could be categorised as light sandy loam (medium sand).

### **4.5 Land Use**

Broadscale land use mapping identifies the project area as having grazing, natural vegetation and traditional indigenous use (Owen and Meakin, 2003). Surrounding pastoral properties are grazed with beef cattle; however, no pastoral activities are currently carried out in the project area. It is understood that there is some hunting and gathering by the local Aboriginal community within the project area.

There is little development in the area, with the closest residents located in the Wunara Community, approximately 10 km east of the northeast corner of the proposed Mineral Lease boundary. This community comprises four houses and some associated buildings. The project area lies within the Arruwurru portions of Aboriginal land (Read, 2007).

### **4.6 Flora and Fauna**

A baseline flora and fauna assessment was completed in August 2008 (see Appendix C) to broadly characterise the habitats and faunal communities present in the project area. The focus of this assessment was to determine whether threatened flora and fauna species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *Territory Parks and Wildlife Conservation Act* (TPWC Act) are present, or likely to be present, within the project area. The significance of the habitats for listed threatened flora and fauna was also determined. Any potentially significant impacts to threatened flora and fauna as a result of the project were also identified.



**Plate 4.1**

Typical Wonarah landscape of open *Hakea* woodland over *Triodia*.



**Plate 4.2**

Aerial view of Wonarah historical drill site and access track.

#### 4.6.1 Flora

A field survey was undertaken during June 2008 as part of the baseline assessment (Appendix C). At the time of the survey, approximately 60% of the project area had recently been burnt, potentially decreasing overall species lists and the ability to locate flora species of conservation significance.

The survey's vegetation transects had 48% bare ground, 23% litter and 29% vegetation. While the vegetation of the project area will naturally have a percentage of bare ground, the high percentage of bare ground at the time of the survey was due to the recent fire. To account for the impact of the recent fire, survey sites were distributed throughout burnt and unburnt sites (where possible) to maximise exposure to undisturbed areas and this, in combination with a drive-over inspection of the project area, allowed identification of habitats of ecological significance. While the area has been subject to disturbance (i.e., disturbance due to fire and minor disturbances due to exploration activities), this is unlikely to have reduced the ability to identify habitats of ecological significance due to the combination of survey techniques adopted and fact that the vegetation of the sand plains, woodlands and rocky rises is relatively common and widespread in the region.

A follow up wet season survey will be undertaken in March 2009.

#### Vegetation Communities

The field survey identified that the main vegetation community of the region is *Eucalyptus opaca* (bloodwood) low open woodland with *Triodia pungens* (soft spinifex) hummock grassland understorey. This particular vegetation community covers extensive areas in the Northern Territory and the project area is considered to constitute a small proportion of this community. On a regional scale the vegetation and landscape of the project area are not considered threatened or significant.

Habitat found within the project area is typical of habitat found within the surrounding Davenport and Murchison Ranges Bioregion. The project area contains several diverse plant communities with a high number of young seedlings, although flora in the area are generally common and widespread.

#### Flora Species

During the field survey 69 flora species were recorded. The dominant species in the project area are: *Atatalya*, *Acacia*, *Grevillea* and *Hakea* spp. over *Aristida* and *Triodia* spp in the sand plains; *Acacia*, *Eucalyptus*, *Hakea* and *Melauleuca* spp. over *Aristida* and *Triodia* spp in the open woodlands; and sparsely distributed *Acacia*, *Eucalyptus* and *Triodia* spp on the rocky rises.

None of the species identified in the field survey are listed under the EPBC Act. One species identified was however listed under the TPWC Act as data deficient (*Distichostemon barklyanus*). No weed species, including weeds species of national concern, were identified in the project area during the field survey, although a number of species are known to occur in the region, including five introduced flora species listed on the Northern Territory Parks and Wildlife flora atlas records:

- Kapok bush (*Aerva javanica*).
- Bellyache bush (*Jatropha gossypifolia*).
- Spiked malvastrum (*Malvastrum americanum*).
- Whorled pigeon grass (*Setaria verticillate*).

- Verano stylo (*Stylosanthes hamata*).

Many other introduced species have the potential to occur, particularly as the project area is in close proximity to a major highway where vehicles act as a major vector for spread of species. Introduced species that are of concern in the bioregion include neem tree (*Azadirachta indica*), buffel grass (*Cenchrus ciliaris*), shedda grass (*Dichanthium annulatum*), olive hymenachne (*Hymenachne amplexicaulis*), leucaena (*Leucaena leucocephala*), mesquite (*Prosopis limensis*), parkinsonia (*Parkinsonia aculeata*), Paddy's lucerne (*Sida rhombifolia*) and noogoora burr (*Xanthium strumarium*).

## Vegetation Health

The vegetation in the project area was showing positive signs of regeneration from the fire, with many *Eucalyptus* and *Triodia* spp. re-sprouting from their bases. In the fire affected areas there will be changes in the vegetation structure and dominance over the next few years, particularly with more rain, and this may increase the number of species visible. Ephemeral areas are likely to be important for both annual and perennial species which are adapted to seasonal inundations.

### 4.6.2 Fauna

The project area is located within the Davenport and Murchison Ranges Bioregion. This bioregion is not known for having a high diversity of mammalian and reptile fauna, although there have been very few surveys undertaken within the bioregion. Avian fauna (particularly water birds) can be rich where large areas of semi permanent water exist. As there are no large drainage channels or drainage basins within the project area or surrounding region, there is not a significant amount of potential habitat for these species in the area, although ephemeral areas may be important in good wet seasons.

During the field survey in June 2008 a total of 17 fauna species were recorded (Table 4.1). Of these, one species was reptile, eight species were birds and eight were mammals. No amphibian species were recorded. Of the species recorded only one species (Australian bustard, *Ardeotis australis*) is listed as vulnerable under the TPWC Act. No species listed under the EPBC Act were recorded.

**Table 4.1 Fauna species recorded during June 2008 field survey**

Group	Species name	Common Name
Bird	<i>Acanthagenys rufogularis</i>	Spiny-cheeked honeyeater
	<i>Ardeotis australis</i>	Australian bustard
	<i>Artamus cinereus</i>	Black-faced woodswallow
	<i>Cinlosoma cinnamomeum</i>	Cinnamon quail thrush
	<i>Epthianura tricolor</i>	Crimson chat
	<i>Falco berigora</i>	Brown falcon
	<i>Falco cenchriodes</i>	Nankeen kestrel
	<i>Rhipidura leucophrys</i>	Willie wagtail
Mammal	<i>Camelus dromedarius</i>	Camel
	<i>Canis lupis</i>	Dingo
	<i>Macropus robustus</i>	Euro
	<i>Macropus rufus</i>	Red kangaroo

Group	Species name	Common Name
	<i>Notomys alexis</i>	Spinifex hopping mouse
	<i>Pseudomys desertor</i>	Desert mouse
	<i>Pseudomys hermannsburgensis</i>	Sandy inland mouse
	<i>Sminthopsis crassicaudata</i>	Fat tailed dunnart
Reptile	<i>Varanus gouldii</i>	Sand goanna

### Threatened Species

Under the EPBC Act, two matters of national environmental significance may be triggered by the project: protected migratory species and threatened species and communities. While no protected migratory species were recorded during the field survey, the DEWHA EPBC Act protected matters search of the project area identified one endangered species, three threatened (vulnerable) species, nine migratory species and eight listed marine bird species with potential to occur in the project area. These species are listed in Table 4.2 and discussed in detail below.

**Table 4.2 Listed fauna species with potential to occur in the project area**

Scientific Name	Common Name	Act Listed Under	Status in Act	Likelihood of Occurrence in Project Area Based on Baseline Flora and Fauna Assessment
<b>Mammals</b>				
<i>Dasycercus cristicauda</i>	Mulgara	EPBC TWPC	V V	Suitable habitat known to occur within the project area. No evidence of species observed.
<i>Macrotis lagotis</i>	Bilby	EPBC TWPC	V V	Suitable habitat known to occur within the project area. No evidence of species observed.
<b>Birds</b>				
<i>Rostratula australis</i>	Australian painted snipe	EPBC TWPC	V, Mw V	Unlikely to occur due to lack of wetland habitat.
<i>Merops ornatus</i>	Rainbow bee-eater	EPBC	Mt, L	Suitable habitat may occur within the project area. Is migratory in summer. Species may occur within the project area.
<i>Ardea alba</i>	Great egret, white egret	EPBC	Mw, Mm, L	Unlikely to occur due to lack of wetland habitat.
<i>Ardea ibis</i>	Cattle egret	EPBC	Mw, Mm, L	Unlikely to occur due to lack of wetland habitat.
<i>Charadrius veredus</i>	Oriental plover, Oriental dotterel	EPBC	Mw, Mm, L	Suitable habitat may occur within the project area. Species may occur within the project area.
<i>Apus pacificus</i>	Fork-tailed swift	EPBC	Mm, L	Unlikely to occur due to lack of forest habitat.
<i>Glareola maldivarum</i>	Oriental pratincole	EPBC	Mw, L	Suitable habitat may occur within the project area. Species may occur within the project area.
<i>Numenius minutus</i>	Little curlew, little whimbrel	EPBC	Mw, L	Suitable habitat may occur within the project area. Species may occur within the project area.

Scientific Name	Common Name	Act Listed Under	Status in Act	Likelihood of Occurrence in Project Area Based on Baseline Flora and Fauna Assessment
<i>Ardeotis australis</i>	Australian bustard	TWPC	V	Known to occur within the project area.
<i>Epthianura crocea</i>	Yellow chat	EPBC TWPC	E E	Unlikely to occur due to lack of suitable habitat.
* Key: L = Listed overfly marine area, Mm = Migratory Marine, Mt = Migratory Terrestrial, Mw = Migratory Wetland, V = Vulnerable, E = Endangered				

### Mulgara (*Dasyercus cristicauda*)

The mulgara is a carnivorous marsupial found within the Northern Territory, with most records of the mulgara from the Simpson Desert and the north of South Australia. The mulgara is primarily nocturnal and will burrow on sand dunes. The principle habitat for mulgara is hummock grasslands of spinifex, especially *Triodia basedowii* and *T. pungens*. They feed on invertebrates, reptiles and small mammals.

Suitable habitat for this species is present within and surrounding the project area. Mulgaras have not been recorded in the project area and there is no evidence (i.e., burrows) of a population being present. There is suitable habitat within the project area. Mulgaras were recorded 40 km west-south-west of the project area in 1993.

The mulgara may be present within suitable habitat in the project area, and could be disturbed during construction and operation activities. However, any impacts to this species, should they occur, are not predicted to be significant given:

- Critical habitat and populations of the mulgara are yet to be investigated but there is no evidence of the species being present within the project area, indicating that significant populations are unlikely to be present. As such it is unlikely that any mining activities will affect a significant habitat or significant population of this species.
- Any habitat disturbed during construction and operation of the project will be minor in the context of the extensive areas of similar suitable habitat across the Barkly Tablelands. Further, the proposed method of strip mining lends itself to progressive rehabilitation of disturbed areas, minimising the period of time between ground disturbance and re-establishment of habitat.
- Predation of the mulgara by foxes and cats and competition pressure by introduced grazers are suspected of significantly impacting on mulgara populations. Foxes, cats and dingoes and rabbits and cattle have been recorded in the project area. This project is unlikely to see the introduction of any further pest species that could potentially impact on mulgara, if present.

### Bilby (*Macrotis lagotis*)

The bilby is found within the central and western parts of the Tanami bioregion, the southern Sturt Plateau bioregion and the northern Great Sandy Desert bioregion of the Northern Territory. The bilby previously occupied a large area of arid and semi-arid Australia; however, the distribution has declined significantly since European settlement and now occupies 20% of its former range.

Habitat of the greater bilby in the Northern Territory is characterised by sandy soils dominated by hummock grasslands covered predominantly by three species of spinifex, *Triodia basedowii*,

*T. pungens* and *T. schinzii*. An overstorey of low shrub cover dominated by *Acacia* and *Melaleuca* species grows over much of this country. Broad-scale surveys of bilbies in the Northern Territory in the 1990s indicated that laterite and drainage line land systems were occupied more frequently than sand plain and dune systems.

It is unlikely that the project will have any significant impacts on the bilby:

- Although no estimate is available for the size of the population of bilbies in the Northern Territory the range of the species is declining and contracting northwards. Bilby have not been recorded in the project area and no evidence of the species was identified during the June 2008 survey. Although bilby have been collected west of the present Barkly Roadhouse on Dalmore Downs station there are very few records in the Barkly Tableland region since 1970. The project area does not cover any critical habitat for the bilby identified in the Bilby Recovery Plan and it is unlikely that an important population falls within the project area. Although there is suitable habitat within the project area, the Bilby Recover Plan (Pavey, 2006) considers the Tanami desert bioregion (west of the Stuart Highway) and the northern Great Sandy Desert bioregion as containing critical habitat and populations of the bilby. The project area does not encompass these regions.
- It is unlikely that the project will in any way adversely affect the availability or quality of habitat to the extent that it will cause a further decline of the bilby. The habitat is not critical and the proposed mining method of strip mining ensures that progressive rehabilitation is carried out. This will enable rehabilitation and re-establishment of suitable habitat within reasonable timeframes.
- The project is unlikely to result in the introduction of invasive species. The major threats to the bilby are predation by foxes, cats and dingoes and competition with rabbits and cattle for food resources. All of these introduced pests are already present in the project area and this project will not introduce any new invasive species harmful to the bilby. All existing feral populations will be controlled through pest management measures.

### **Australian painted snipe (*Rostratula australis*)**

The Australian painted snipe is a wader of around 220 to 250 mm in length and occurs solitarily or in only small parties. The Australian painted snipe have been recorded at Tarrabool Lake on Eva Downs on the Barkly Tablelands and Lake Woods in 1993 (DNRETA, 2006) in the Northern Territory.

The species occur in shallow, vegetated, freshwater swamps, claypans or inundated grassland. The species is nomadic and can inhabit temporary wetlands. There is limited understanding of the population size and trend in the Northern Territory. The major threats to the species are drainage of wetlands and degradation of habitat by cattle. The lack of wetland habitat in the project area makes any impact on this species is unlikely.

### **Rainbow bee-eater (*Merops ornatus*)**

The rainbow bee-eater is a medium-sized bird that is usually seen in pairs or small flocks. The species occurs mainly in open forests and woodlands, shrublands, and in cleared or semi-cleared areas such as farmland. It is usually located in close proximity to permanent water. The rainbow bee-eater is distributed across most arid regions of mainland Australia. In the Northern Territory it is known to occur in Kakadu National Park, Casuarina Coastal Reserve, Fogg Dam Conservation Reserve, Gregory National Park and Nitmiluk (Katherine Gorge) National Park.

The major threat to the rainbow bee-eater is the introduced cane toad (*Bufo marinus*) as it will feed on the rainbow bee-eater eggs and nestlings and the cane toad will also occupy the nesting burrows.

Suitable habitat may occur within the project area and the species may seasonally visit the site during significant wet seasons. However due to a lack of permanent water, populations are likely to be ephemeral and not significantly impacted by this project. The major threat to the rainbow bee-eater, the cane toad, is unlikely to be introduced to -or survive in- the project area because of the lack of available water.

### **Great egret, white egret (*Ardea alba*)**

The great egret or white egret is found across most of the tropical regions of Australia. The species feeds in shallow water and breeds in colonies in trees close to large lakes with reed beds or other extensive wetlands. This species is unlikely to be in the project area due to lack of wetland habitats, and any impact on significant habitat or a population is not likely.

### **Cattle egret (*Ardea ibis*)**

The cattle egret has a distribution from Darwin down the east coast of Australia and southern Western Australia. The preferred habitat of the cattle egret is grasslands, woodlands and wetlands. It also uses pasture land. It is not common in arid areas.

As there are no large drainage channels or drainage basins within the project area or immediate surrounds, the potential habitat for the cattle egret is unlikely. Ephemeral areas may be inhabited by these species in good wet seasons, however these areas are not classified as critical habitat, and any significant impacts on the populations are unlikely.

### **Oriental plover, Oriental dotterel (*Charadrius veredus*)**

The Oriental Plover has been recorded throughout Australia. The species is generally found in open grasslands in arid and semi-arid zones. It can also be found in estuarine or littoral environments, but is less common in these areas. The Oriental Plover may move to lightly-wooded grasslands with the onset of the wet season.

Suitable habitat for the species may occur within the project area, and there is the potential for the species to be present within the project area. However, there is no critical habitat for this species in the project area and breeding does not occur in Australia so impacts on this species are unlikely.

### **Fork tailed swift (*Apus pacificus*)**

Fork tailed swifts are small insectivorous birds that spend the majority of their time in flight. They never voluntarily come to ground as they have small feet which they use to cling to vertical surfaces. This species has a large range, with an estimated global extent of occurrence of 10,000,000 km<sup>2</sup>, breeding from central Siberia eastwards through Asia. It is a rare vagrant in western Europe, but has been recorded as far west as Norway and Great Britain (Birdlife International, 2008). This species is migratory, spending winter in Australia and summer in the northern hemisphere.

Although global populations have yet to be quantified populations of the fork tailed swift are thought to be increasing and they are considered of least concern on the IUCN redlist (IUCN,

2008). Distributed over much of Australia, the project area encompasses only a minor part of available habitat for this species and the project is not expected to make a significant impact on populations.

### **Oriental pratincole (*Glareola maldivarum*)**

Although classed as waders the oriental pratincole generally hunts their insect prey whilst in flight. In non-breeding grounds in Australia, the oriental pratincole usually inhabits open plains, floodplains or short grassland (including farmland or airstrips), often with extensive bare areas. They often occur near terrestrial wetlands, such as billabongs, lakes or creeks, and artificial wetlands such as reservoirs, saltworks and sewage farms, especially around the margins. It also occurs along the coast, inhabiting beaches, mudflats and islands, or around coastal lagoons. This species has a large range, with an estimated global extent of occurrence of 1,000,000-10,000,000 km<sup>2</sup>, extending through the warmer regions of south and east Asia, breeding in northern India and China and wintering in India, Australia and Indonesia (Birdlife International 2008).

The oriental pratincole has a large global population estimated to be 2.5 million individuals in 2004 and is not approaching the thresholds for the population decline criterion of the IUCN Red List (i.e. declining more than 30% in ten years or three generations), and is evaluated as least concern (IUCN, 2008). Distributed over much of northern Australia the project is not likely to impact significantly on habitat suitable for this species.

### **Little curlew, little whimbrel (*Numenius minutus*)**

The little curlew is widespread in the north of Australia and scattered elsewhere. It is an irregular visitor to New Zealand and Tasmania. The species may gather in large flocks on coastal and inland grasslands and black soil plains in northern Australia, where near swamps and flooded areas.

Suitable habitat may occur within the project area. However, as there are no large drainage channels or drainage basins within the project area or immediate surrounds, the potential habitat is limited. More suitable habitat is within 20 km of the site to the north and over 10 km to the west. This area supports rich areas of Mitchell grass with fertile black soils and areas of seasonal ponds with fringing marginal vegetation. The project is on the edge of the little curlew distribution and is not considered to be critical habitat or population. A significant impact on this species is unlikely.

### **Australian bustard (*Ardeotis australis*)**

The Australian bustard is widespread but is generally scarce in the Northern Territory (DNRETA, 2006). Within the Northern Territory, it is more common in the Barkly Tableland, Daly River region, the Victoria River District and the Tanami Desert.

Typical habitat of the Australian bustard includes grasslands, low shrublands and grassy woodlands. The Australian bustard has had a widespread decline in numbers which has been attributed to a combination of factors including predation, altered fire regimes, hunting disturbance, habitat alteration, pesticides and grazing (DNRETA, 2006).

While the species is relatively scarce in the Northern Territory, it is known to occur within the project area. Numbers of the species are likely to fluctuate depending on seasons, and due to the highly mobile nature of the species, small, localised disturbance is not likely to affect its status.

### **Yellow chat (*Epthianura crocea*)**

The yellow chat is a localised species of bird which inhabits vegetation bordering wetlands in scattered sites in tropical, arid and semi-arid zones of Australia (Higgins *et. al.*, 2001). It is an endemic species to Australia where three sub-species have been described (Simpson and Day, 2004, Higgins *et. al.*, 2001):

- *E.c. crocea* – of western and northwestern Queensland and eastern parts of the Northern Territory including the Barkly Tablelands.
- *E.c. tunneyi* – of the northern parts of the Northern Territory.
- *E.c. macgregori* – of the central coast of Queensland.

The sub-species which is known to occur within 20 km of the proposed Wonarah phosphate mine site is *E.c. crocea*, the most widespread of the sub-species.

Higgins *et. al.* (2001) reports that the yellow chat's distribution is as follows:

Endemic to Australia.

NT in Top End, recorded at scattered sites between Darwin and Oenpelli, including floodplains of S. and E Alligator Rs. A few records farther S, e.g. at Timber Ck and Delamere. Widespread on Barkly Tableland, from Brunette Downs SE to Burrumurra. Vagrant farther S, where recorded at Alice Springs, at Plenty R. Salt Ls, n. Simpson Desert and Andado Stn, undated.

The proposed Wonarah phosphate mine site is on the Barkly Tablelands in central eastern Northern Territory, an area within the yellow chat's known distribution.

According to Higgins *et. al.* (2001), yellow chat:

Mainly inhabit low vegetation round ephemeral wetlands, especially floodplains, swamps and bore drains, and sometimes also vegetated dams, saltlakes, claypans, lagoons, sewage ponds or reservoirs; sometimes occur among sparse reeds. Sometimes occur in saltmarsh or samphire *Halosarcia* near swamps, or in dry areas away from wetlands, in habitats dominated by chenopods, such as bluebush *Maireana*, saltbush *Atriplex* and *Bassia*. Occasionally occur in grasslands dominated by mitchell grass *Astrebla* with patches of chenopods, or sometimes lignum, sedges or scattered acacias, such as Gidgee or Georgina Gidgee *Acacia georginae*. At Roebuck Plains, near Broome, nw. WA, observed on saline grasslands dominated by *Sporobolus virginicus* and sparse samphire flats. Very occasionally recorded in open Coolibah woodlands with scattered bluebush.

Records of this species from the Barkly Tablelands have been from dams and seasonally wet ponds within Mitchell grasslands. The area proposed for the Wonarah phosphate mine lies well to the south (over 10 km) of the black soils where Mitchell grass dominates and has no habitat suitable for yellow chats. The habitat of the project area is dominated by sand plains and open woodlands as described in Section 4.6.1.

Coffey Natural Systems personnel visited the site in May 2008. One of the surveyors is an experienced ecologist and ornithologist familiar with yellow chats from sites in Western Australia and the Northern Territory. The project area was traversed extensively and observations of soil types and vegetation confirmed that there were no areas of permanent or seasonal wetlands and no habitat suitable of supporting yellow chats (Plates 4.3 to 4.6). However, areas within 20 km to the north and west (over 10 km from the project area) were found to be dramatically different from

this area, supporting rich areas of Mitchell grass with fertile black soils and areas of seasonal ponds with fringing marginal vegetation.

Whilst yellow chats have been recorded from the Barkly Tablelands, there is no suitable habitat for them to be resident on this site or to use this site seasonally. It is possible that an occasional bird may disperse through this area whilst moving locally (yellow chats are known to be nomadic according to weather / habitat conditions). However, disturbance by the mine would have no significant effects on this species. Also, the sub species present is not listed under the EPBC Act and the two listed subspecies, *E.c. tunneyi* and *E.c. macgregori*, are not in the proximity of the project area and not likely to be affected by the project.

## **Introduced Fauna**

Foxes and cats are a common pest within the Davenport and Murchison Ranges Bioregion and are considered a major threat to the small to medium sized mammals (DEWHA, 2007). Horses and donkeys are also common within the bioregion. In the more arid parts of the bioregion, camels are known to be spreading from their desert range. During the field survey, camels (*Camelus dromedarius*) and dingoes (*Canis lupis*) were recorded within the project area.

## **4.7 Groundwater**

### **4.7.1 General**

The project occurs within the central portion of the Georgina Basin. The Georgina Basin is a large sedimentary basin covering most of the central-eastern Northern Territory and extends into western Queensland (RDPIFR, 2006). A number of water resource studies have been undertaken within the Georgina Basin to identify suitable groundwater resources for domestic and agricultural use.

Within the central portion of the Georgina Basin, Read (2007) investigated the groundwater resource for potential horticultural development, which included the Arruwurru Aboriginal land. This investigation identified that the Arruwurru area has variable bore yields ranging from 0 to 9 L/s. This investigation did not penetrate the aquifer more than 30 m and the existing bores were not tested for the aquifer's potential (Read, 2007). Groundwater quality ranged from 515 to 2,010 mg/L total dissolved solids (TDS).

Bores in the Wakaya area generally have TDS ranging from 850 to 1,030 mg/L. However, bores in this area have been proven to be capable of yielding 20 L/s with under 1,000 mg/L TDS (Read, 2007).

Water supply bores drilled in the past 40 years along the Barkly Highway demonstrate the existence of an extensive karst aquifer north of the project area, likely to be the Thornton Limestone. The aquifer has highly variable airlift yields between 0.2 and 6 L/s. Exploration drilling in 2001 and recent exploration drilling in the project area have confirmed the extent of the Thornton Limestone to the east and southeast. Occurrences of Thornton Limestone at the proposed mine site and elevation contours of its surface were derived from exploration borehole logs and logs of water supply bores.



**Plate 4.3** Post-fire woodland showing spinifex regrowth.



**Plate 4.4** Minemakers Wonarah weather station.



**Plate 4.5** Post-fire woodland showing typical sandy soils.



**Plate 4.6** Post-fire woodland and access track.

Almost all of the exploration bores drilled into the Thornton Limestone intercepted only the top of the limestone and gave minimal information regarding its thickness. At the fringe of a ridge formed by the Peaker Piker Volcanics below the proposed pits, the Thornton Limestone is only a few metres thick but is expected to increase in thickness further to the centre of the basin.

Although many of the water supply bore logs indicated the occurrences of karst cavities no information is available on the total effective porosity of the Thornton karst aquifer, groundwater resources and sustainable yields. Hair (2007) describes the Thornton Limestone further in the east of the Georgina Basin as a productive aquifer.

With total dissolved solids in the range of 500 to 3,000 mg/L the groundwater from the Thornton karst aquifer is considered to be of good to moderate quality.

## 4.7.2 Groundwater Users

A search of the NRETAS groundwater database was conducted to locate registered bores within 50 km of the mine lease and available bore logs, pumping test data, standing water level data and groundwater chemistry data was reviewed. Twenty-seven bores were identified within 50 km of the project area. Registered bore locations and associated available data are shown in Table 4.3.

**Table 4.3 Details of registered bores within 50 km of the project area**

RN Number	Coordinates (MGA94 Zone 53)		Standing Water Level (m BGL)	Airlift Yield (L/s)	Total Dissolved Solids (mg/L)	Water Use	Geology
	Easting	Northing					
RN000045	676,299	7,782,355	N/A	0.3	1,280	Unknown	N/A
RN000206	683,300	7,778,327	47.6	2	N/A	Unknown	N/A
RN000301	641,726	7,798,919	N/A	N/A	N/A	Unknown	N/A
RN000370	646,126	7,794,869	N/A	N/A	N/A	Unknown	N/A
RN001778	640,212	7,799,448	53.9	0.68	1,133	Unknown	Limestone
RN002489	695,126	7,784,169	73.1	N/A	N/A	Unknown	N/A
RN005957	663,122	7,809,332	64	1.86	2,520	Potable supply	Siltstone/sandstone
RN008266	671,374	7,788,987	91.4	0.5	1,280	Unknown	Dolomite
RN016244	696,483	7,779,281	78	2.5	570	Stock supply	Limestone
RN016621	675,126	7,768,369	N/A	N/A	N/A	Unknown	Limestone
RN016622	674,526	7,768,369	N/A	N/A	N/A	Unknown	Limestone
RN016623	674,526	7,769,169	N/A	N/A	N/A	Unknown	Limestone
RN016624	675,126	7,772,769	N/A	N/A	N/A	Unknown	N/A
RN020675	672,257	7,788,498	100	3.79	940	Unknown	Dolomite
RN020997	648,937	7,792,271	Inflow @ 97	0.4	N/A	Unknown	Chert/Shale
RN020998	646,026	7,794,669	Inflow @ 79	0.25	N/A	Unknown	Chert/Shale
RN021238	653,526	7,792,769	63	0.38	N/A	Unknown	Limestone/ Chert
RN021239	652,227	7,795,886	N/A	N/A	N/A	Unknown	Basalt
RN023353	675,126	7,776,969	N/A	N/A	N/A	Unknown	Limestone

**Table 4.3 Details of registered bores within 50 km of the project area**

RN Number	Coordinates (MGA94 Zone 53)		Standing Water Level (m BGL)	Airlift Yield (L/s)	Total Dissolved Solids (mg/L)	Water Use	Geology
	Easting	Northing					
RN023355	675,126	7,773,169	N/A	N/A	N/A	Unknown	N/A
RN025868	669,476	7,788,967	94.3	1.2	677	Unknown	Dolomite
RN026472	654,267	7,812,522	66	2	N/A	Potable supply	Limestone
RN026500	655,626	7,809,419	N/A	N/A	N/A	Potable supply	Dolomite
RN028297	673,191	7,805,807	N/A	2	N/A	Unknown	N/A
RN033241	674,517	7,818,177	60.2	2	N/A	Potable supply	Limestone
RN033464	665,477	7,817,488	72	1.5	N/A	Potable supply	Limestone
RN034997	636,296	7,806,158	N/A	N/A	N/A	Unknown	Basalt

## 4.8 Socio-economic Environment

Information contained in the following socio-economic profiles has been sourced from the Australian Bureau of Statistics 2006 census data. The recent changes in the economic situation and its impacts on mining industry in the Northern Territory will have had an influence of the current Northern Territory statistics.

### 4.8.1 Northern Territory and Darwin Profile

The Northern Territory is the most sparsely populated state or territory in Australia and includes many small Aboriginal communities. The population density of the Northern Territory is around 0.1 people per square kilometre. In contrast, the remoteness and often harsh environmental conditions give residents of the Northern Territory, known as 'Territorians', a sense of community often showcased at the many community festivals held in the Territory's remote communities through the year. Its make-up comes from a mix of both ancient and contemporary culture.

The Northern Territory's economy is based on tourism, largely for Kakadu National Park and Uluru (Ayers Rock), mining and defence. In 2008 the average weekly wages in the Northern Territory were slightly lower than the national average, with the percentage increase of average weekly wages also slightly lower than the national percentage increase.

### Population

The Northern Territory has a total population of 192,898 centred around Darwin (population 120,900), Palmerston (27,185), Alice Springs (26,486) and the far north-west mainland. It covers an area of more than 1,352,176 km<sup>2</sup>.

The Northern Territory's population is the youngest in Australia having the largest proportion under 15 years of age and the smallest proportion aged 65 and over. The median age of residents is 30 years, almost six years younger than the national median age.

Almost 28% of the Northern Territory population comprises Aboriginal and Torres Strait Islander people, compared with 2.3% in the whole of Australia. In Darwin the indigenous population is 10% of the total population. Nearly half of the Northern Territory is owned by Aboriginal people or held in a tenure which provides Aboriginal people with secure rights of use (Strakosch *et. al.*, 2006).

## **Employment and Wages**

Unemployment in the Territory at the 2006 census was 4.4%. In Darwin, unemployment was lower (3.5%) with government administration (7.7%), defence (7.3%) and school education (5.4%) being the dominant employment industries.

The Northern Territory recorded the largest percentage increase (4.8%) in the employment rate of anywhere in Australia between 2006 and 2007. More than 5,000 jobs were created in the 12 months to 30 June 2007.

The average weekly full time adult earnings (AWE) in November 2008 was \$1,162.60 (seasonally adjusted), compared to the national AWE of \$1,215.70 (Northern Territory Treasury, 2009). During the November quarter of 2008 the AWE for the Northern Territory increased by 0.8% compared to the national increase of 1.4%.

## **Economy**

The ABS estimates that the Northern Territory Gross State Product (GSP) rose from \$12,693 million in 2005/06 to \$13,405 million in 2006/07, an increase of 6%. This is higher than the increase in the Australian Gross Domestic Product (GDP) for the same period, which was 3%. GDP per capita for the Northern Territory (\$63,548) was also 33% higher than GDP per capita for Australia (\$47,954).

The mining industry is a major contributor to the Northern Territory economy, with a total value of \$3,942 million in 2006/07, up 42% from the previous year (\$2,775 million). Taxes and mining royalties accounted for \$47 million of Territory Government revenue in 2007/08.

The Territory's expenditure on mineral exploration in 2006/07 was \$92.2 million, representing an increase of 23% from the previous year (\$74.7 million in 2005/06).

An additional \$2.4 million will be provided over three years from 2008 for government-industry partnerships to increase mineral exploration in the Northern Territory. This is on top of the \$12 million provided in the 2007 budget.

According to figures released by the Northern Territory Treasury, there are approximately 5,000 people employed in mining, oil and gas in the Territory (Northern Territory Government, 2006).

According to the Northern Territory Government in its 2008 budget released in May 2008, Access Economics has forecast the Territory's economic growth to be at 7% next financial year, the highest in Australia. The growth forecasts are driven by strong growth in exports from the mining and manufacturing industries.

## **Services**

Darwin is the capital city of the Northern Territory and has a broad range of social, commercial and professional services available.

#### **4.8.2 Tennant Creek and the Barkly Tablelands**

The Barkly Tablelands region covers a large area of the central eastern Northern Territory. The major service centre for the region is the town of Tennant Creek. The region is sparsely populated with the major sources of income for the region generated from grazing. Pastoral production within the Barkly Tablelands region accounts for 39% of the Northern Territory cattle industry. Other sources of income include mining and tourism.

##### **Population**

The Barkly Tablelands region covers an area of 283,648 km<sup>2</sup>, with Tennant Creek covering 42.2 km<sup>2</sup>. Tennant Creek has a total population of 3,332 and a regional population approximately 5,840. The Aboriginal and Torres Strait Islander people comprise 56% of the total population of Tennant Creek.

The Barkly Tablelands is a sparsely populated region of the Northern Territory. The population density of Tennant Creek is around 79 people per square kilometre.

##### **Employment and Wages**

Unemployment in Tennant Creek at the 2006 census was 10% and a similar unemployment rate exists throughout the non-urban areas of the Barkly Tablelands. Employment in Tennant Creek is dominated by public servants (approximately 25%), with only 8% employment in both the retail trade and accommodation and service industries.

Those who were working in the Barkly Tablelands in 2001 were earning, on average, \$638 per week. Tennant Creek residents earned a higher share of the region's average wages and salaries.

##### **Economy**

Agricultural production is the major source of economic income for the region, totalling \$91.2 million in 2003 to 2004. The mining industry is also a major contributor to the regional economy with a total value of \$12.8 million in 2003 to 2004. Tourism directly contributed \$27 million to the regional economy during this time period.

##### **Services**

Tennant Creek is the major centre for the region and has a range of social, commercial and professional services available. Residents within the region may elect to travel to Darwin to access services, such as specialist medical services, hospitals and some commercial and professional services which are not available in the smaller townships such as Tennant Creek.

## **4.9 Cultural Heritage and Archaeological Sites**

Sites of Indigenous and non-Indigenous cultural or archaeological significance have the potential to occur within the project area. Indigenous cultural heritage and archaeological sites may include surface scatters, art sites, myth related sites, stone quarries and stone arrangements. The CLC have identified a number of cultural exclusion zones within the current Exploration Licence. These cultural exclusion zones have been determined by the CLC based upon their cultural significance to Indigenous people and may include sacred sites, mythological areas and areas containing a high density of archaeological sites. All activities within and access to these cultural exclusion zones is restricted.

There is no infrastructure or activities related to the proposed project within these cultural exclusion zones. No cultural exclusion zones are contained within the proposed Mineral Lease.

Non-indigenous historical sites may include areas relating to past exploration, pastoral, transport and mining activities. Although other than past exploration, no evidence of historical pastoral, transport or mining activities has been noted.

## **4.10 Noise**

Existing noise levels in the project area and surrounds are considered to be typical of a remote, rural area, with low ambient levels. Noise measurements have not been undertaken; however, most of the noise present is caused by natural sounds (birds and wind).

## **4.11 Radiation**

Elevated radiation levels are sometimes associated with phosphate rock deposits.

A suite of uranium assays have been undertaken on the lithologies of the deposit and routine radiometric logging has been undertaken, on a per metre basis, of every sample drilled. The results show that radiation levels are uniformly low for sediments in general and particularly so for sedimentary phosphates or phosphorites. Uranium is present at background levels only, usually 10 ppm or less, which is typical for normal weathered and leached sedimentary rocks. No radiometric values logged have deviated from the normal range.

## **5. POTENTIAL IMPACTS AND PROPOSED MANAGEMENT MEASURES**

This chapter outlines the potential impacts associated with the project and the proposed mitigation and management measures that will be used to address these impacts. The potential impacts have been identified based on knowledge of the existing environment, our project description and our experience with similar operations elsewhere.

As part of the environmental assessment process for the project a detailed environmental impact assessment will be undertaken for the project and presented to stakeholders as a public environment report or an environmental impact statement. During this process refinement of and further detail on the potential impacts and associated risks and mitigation and management measures will be provided. Minemakers places the highest value on being a responsible operator, and is committed to minimising the impact of its operations on the environment.

### **5.1 Greenhouse Gas and Climate Change**

#### **5.1.1 Potential Impacts**

The construction and operation of the project will increase the greenhouse gas emissions for the region. Of the main greenhouse gases, carbon dioxide (CO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O) are the most significant in relation to the project since they are the main products that result from the combustion of diesel when powering earthmoving equipment and when generating electrical energy. Both of these activities will occur during the project, although the proponent will endeavour to use cleaner sources of energy, such as gas, where practicable.

#### **5.1.2 Mitigation and Management Measures**

Best practice environmental measures for reducing greenhouse gas emissions will be employed during the construction and operations phases and include:

- Developing and applying policies and procedures for energy efficient mine operation.
- Minimising haul distances to minimise diesel consumption.
- Monitoring energy consumption (e.g., diesel and electricity) and calculating greenhouse gas emissions.
- Where practicable, establishing measurable improvement targets (e.g., participation in revegetation programs) for greenhouse gas emission.
- Considering the use of alternate fuels (e.g., compressed natural gas or aquadiesel) and technologies, including investigating solar energy.
- Considering the use of efficient siting and design of power-efficient lighting.
- Ensuring that vehicles (company-owned and contractors) are well maintained and correctly sized to maximise their fuel efficiency and minimise emissions.
- Reporting greenhouse gas emissions in accordance with the Territory Greenhouse Gas Inventory (Department of Climate Change, 2008).

## **5.2 Air Quality**

### **5.2.1 Potential Impacts**

The main potential air quality issue that will result from construction and operation of the project is the increase in dust levels with consequent adverse impacts on human health, vegetation and amenity. The main sources of dust will include:

- Drilling and blasting of ore and waste rock if required.
- Loading and unloading of ore and waste rock.
- Hauling of waste rock and ore on the project area.
- Crushing and screening of ore.
- General vehicle movements over unsealed roads.
- Wind erosion from exposed surfaces (e.g., topsoil stockpiles and waste rock storage).

The potential impacts of dust to flora are discussed in Section 5.4.1 below.

Emissions of combustion products such as carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and particulate matter from fuel combustion of fixed on-site sources (i.e., plant equipment and machinery) and vehicles will occur and also have the potential for minor adverse impacts to local air quality.

Some phosphate mines have the potential to generate odour. The exploration and testing carried out on the deposit to date has indicated that this deposit does not generate odour.

### **5.2.2 Mitigation and Management Measures**

It is likely that the location of mine infrastructure at least 12 km from the closest sensitive receptor (the Wunara community) will ensure that any increase in dust levels, and consequent adverse impacts on human health and amenity, will be sufficiently mitigated within the Mineral Lease. However, should environmental impact assessment identify this buffer is insufficient, management measures to reduce or avoid impacts associated with reduction in air quality will include:

- Using water or dust suppressants on trafficked areas (i.e., internal haul roads), exposed surfaces and similar to reduce emissions.
- Maintaining roads to minimise the build up of fine particles that are susceptible to wind erosion.
- Regular cleaning of vehicles to prevent debris falling onto roads and creating a source of dust.
- Using speed limits on roads used by mine traffic.
- Using signage and markings to ensure traffic is kept to designated roadways.
- Designing and scheduling blasting to minimise dust emissions (i.e., schedule blasting when conditions are suitable).
- Prompt clean up of spills.
- Minimising the extent of exposed areas susceptible to wind erosion.
- Where practical, limiting high dust-generating activities during adverse wind conditions or instead increasing the frequency of road watering.

- Transport of product in covered trucks where practicable.
- Progressively rehabilitating disturbed areas once they are no longer required for mining.
- Establishing a complaints register that records the frequency of occurrence, intensity, duration, offensiveness and location of public complaints regarding dust.

## **5.3 Land Resources and Use**

### **5.3.1 Potential Impacts**

The project has limited potential to reduce the land available for pastoral activities in the region as extensive pastoral land remains within the region. While the project area will be rehabilitated, there will be some areas, such as the final voids, which will be permanently unavailable for pastoral activities. These areas will not restrict any future pastoral use of the remaining project area. Removal of vegetation within the Mineral Lease may result in some topsoil and subsoil erosion, with subsequent impacts on the future uses of affected land.

Soil contamination may occur during project activities from chemical or fuel spills, product spills, and dust emissions. Soil contamination may reduce pasture quality, inhibit revegetation and limit suitable future land uses.

### **5.3.2 Mitigation and Management Measures**

Management measures to reduce or avoid impacts associated with changes to land resources and use include:

- Using appropriate transport, storage and handling methods for fuels, lubricants and other chemicals.
- Using spill response procedures when required.
- Ensuring construction material brought to site is clean (i.e., free of weeds, hydrocarbons, metals).
- Ensuring site personnel have a high level of operator training and diligence.
- Assessing soils prior to mine closure for contamination and undertaking appropriate remediation measures where necessary.
- Restricting vegetation clearing to the project footprint, undertaking progressive rehabilitation, utilising erosion controls (e.g., drains, brush matting) where appropriate and controlling surface water runoff.

## **5.4 Flora**

### **5.4.1 Potential Impacts**

The project has the potential to impact upon individual species of flora and the vegetation communities within the project area. These potential issues are discussed below. Another flora survey will be completed in March 2009 which will further define the flora of the project area and will assist in refining potential impacts.

## Loss of Vegetation

Approximately 2,709 ha of land will be disturbed due to mine infrastructure. The clearing of vegetation will remove individual plants from the broader regional population. This has the potential to impact on the distribution, dispersal and genetic diversity of populations of species in the region. However, as noted in Section 4.6.1 the vegetation of the project area is typical of the region and is not considered to be regionally significant. The removal of vegetation also has the potential to fragment and reduce the area of habitat available for fauna species dependent on it for resources.

## Introduction of Weeds

Project-related vehicles and equipment (especially earth-moving equipment) have the potential to introduce and/or spread weed species within and around the project site.

Increases in weed density and distribution have the potential to further reduce the available local habitat for fauna species that are dependent on specific vegetation communities. An increase in the presence of woody weeds also has the potential to increase the fuel load and in turn increase the intensity of fires.

## Reduced Conditions Favourable for Plant Growth

Vegetation clearing, vehicle movements and day-to-day operational activities will generate dust. This has the potential to reduce conditions favourable for plant growth (e.g., reduction in photosynthesis and respiration due to an accumulation of dust on plant surfaces or damage to plants from reactive dust particles) with subsequent reduced plant health.

Ground compaction, soil or water contamination and physical damage to vegetation in the Mineral Lease area may also reduce the ability of plants to become established, and limit the potential for regeneration and revegetation of disturbed areas.

Mine infrastructure may alter the runoff and drainage characteristics of the Mineral Lease area and have adverse effects on downstream vegetation. This may promote weed invasion, reduce plant health and degrade habitat for existing vegetation.

### 5.4.2 Mitigation and Management Measures

Management measures to reduce or avoid impacts associated with loss of vegetation, introduction of weeds and reduced conditions favourable for plant growth include:

- Revegetating backfilled areas of the pits.
- Managing weeds in the Mineral Lease and in particular in remnant *Eucalyptus opaca* woodland and *Triodia pungens* grassland.
- Avoiding areas with vegetation communities of conservation significance.
- Erecting flagging tape to mark 'no-go' zones to ensure areas to be protected are clearly defined, identified and avoided and that clearing and ground disturbance is only occur within designated areas.
- Ensuring the development and implementation of vegetation clearance protocols (including an internal clearance procedure) and assessing performance against them.

- Progressively rehabilitating disturbed areas and avoiding unnecessary future disturbance of these areas.
- Implementing methods to monitor and maintain progressively rehabilitated and revegetated areas.
- Ensuring that vehicles and project equipment arrive on site free of vegetative matter, seeds and mud.
- Implementing targeted weed control measures for any observed significant increase in the distribution or density of existing weeds, or new populations of weeds.
- Regularly monitoring areas with a high potential for, or susceptibility to, weed invasion, such as along roadsides, recently cleared areas and permanently wet areas such as the banks of the water storage facilities and drains, particularly following rainfall events.
- Controlling or preventing weed infestations in topsoil stockpiles to minimise the likelihood of weed introduction or increased distribution during respreading of topsoil.
- Progressive rehabilitation of disturbed areas to reduce the potential for weed species to become established.

Progressive rehabilitation will enable rehabilitation to be continually monitored, refined and adapted throughout the life of the mine.

## **5.5 Fauna**

### **5.5.1 Potential Impacts**

The project has the potential to impact upon individual species of fauna within the project area. These potential issues are discussed below. Another fauna survey will be completed in March 2009 which will further define the fauna of the project area and will assist in refining potential impacts.

#### **Habitat Loss and Fragmentation**

Vegetation clearing will potentially fragment habitat in the local area, with possible consequences including increased inter- and intra-specific competition for resources due to reduced foraging areas, increased hunting pressure from prey species due to a reduction in habitat providing cover, and the isolation of breeding populations. There is also the potential for loss of individual animals during the clearing of vegetation.

#### **Reduced Species Abundance**

Species abundance can be measured by the density and diversity of species present (i.e., the number of individual animals in an area and the total number of species present in that area). There is potential for species abundance to be reduced as a result of:

- **Noise and Vibration.** Project construction and operations will create noise and vibration emissions, typically generated by vehicle traffic, excavations, blasting and ore processing.
- **Increased Light at Night.** Project construction and operation will result in increased light levels in an otherwise dark area that provides habitat for fauna. This light emission may result

in some species being displaced from habitat near to project infrastructure in the Mineral Lease.

- **Surface Water Contamination.** Waterbodies established as part of the project (e.g., sediment ponds) may attract waterbirds. There is the potential for adverse impacts to visiting waterbirds if these waterbodies are contaminated.

### Significant Impacts to Threatened Species

Two mammals and 10 bird species potentially present in the project area are listed for their conservation significance. Ground disturbance (including mining) and vegetation clearing, in particular the clearing of high-quality *Eucalyptus opaca* woodland and *Triodia pungens* grassland, may reduce the abundance of threatened animal species in the Mineral Lease. This may result in impacts to resident threatened species due to a lack of other suitable habitat surrounding the area.

### Increase in Abundance of Introduced Fauna

Three introduced vertebrate fauna have been recorded in the area, foxes (*Vulpes vulpes*), cats (*Felis catus*) and camels (*Camelus dromedarius*). Both foxes and cats are common pests throughout the area (DEWHA, 2007). The presence of rubbish and artificial water sources associated with the project has the potential to increase feral animal populations. The presence of roads assist the movement of some introduced prey species such as the cat and fox.

Introduced grazers such as the rabbit have the potential to degrade revegetation areas through grazing of seedlings. These species can also attract raptors to the area which can result in an increase in predation of local endemic species such as small birds, reptiles and mammals.

## 5.5.2 Mitigation and Management Measures

Management measures to reduce or avoid impacts associated with habitat loss and fragmentation, reduced species abundance, impacts to threatened species, and increase in introduced fauna include:

- Minimising the potential for water to pool in areas where it is applied as a dust suppressant (e.g., along unsealed haul roads) to reduce the attraction for animals.
- Ensuring that waste management procedures are diligently followed to deter pest animals.
- Minimising the area of vegetation clearance in *Eucalyptus opaca* woodland and *Triodia pungens* grassland.
- Consolidating areas of vegetation to be cleared for access tracks and infrastructure pathways so that large blocks of habitat, rather than small fragments, are preserved.
- Rehabilitating cleared land both progressively during the life of the project and following project completion.
- Regularly monitoring areas with a high potential for, or susceptibility to, increases in abundance of introduced species (e.g., administration and crushing and screening plant facilities, water sources, waste storage areas and around water sources).

## **5.6 Groundwater**

### **5.6.1 Potential Impacts**

The potential impacts to groundwater relate to:

- Groundwater extraction. Groundwater will be used to provide water for the construction and operation of the project. Groundwater extraction may adversely impact regional groundwater resources and affect existing operating bores.
- Groundwater contamination. Contaminates have the potential to enter groundwater aquifers from spills or seepage from waste rock storages and final voids. Geochemical characterisation of the waste rock is currently being completed; however, initial results indicate that potentially acid forming material is not present in the waste rock and orebody.

A groundwater exploration drilling program commenced in February 2009 to further define the groundwater resource in the vicinity of the project and inform the impact assessment.

### **5.6.2 Mitigation and Management Measures**

Management measures to reduce or avoid impacts associated with reduction in groundwater quality and quantity include:

- Operating bores at sustainable extraction rates.
- Undertaking monitoring to establish the baseline water level in wells located on properties directly adjacent to the Mineral Lease.
- Replacing or deepening existing wells if they are substantially affected (based on the establishment of sustainable levels) by dewatering activities, or provide alternative water sources for affected users.
- Appropriate drainage and construction of waste rock storage areas.
- Appropriate bunding and management of wastes and chemicals.
- Monitoring of groundwater quality.

## **5.7 Downstream Impact to Surface Waters**

### **5.7.1 Potential Impacts**

Waste rock and ore stockpiled on site may release metals and salts into the surrounding environment. The leaching of surface waters through the waste rock storages can acidify surface and ground waters (acid rock drainage) and mobilise metal components. Geochemical characterisation of the waste rock is currently being completed; however, initial results indicate that potentially acid forming material is not present in the waste rock and orebody.

Sources of potentially contaminated water in the project area may include:

- Dust suppression water.
- Stormwater runoff from disturbed areas and stockpiles.
- Pit water.

### **5.7.2 Mitigation and Management Measures**

Further geochemical testwork will be undertaken to confirm that the waste rock and ore do not contain potentially acid forming material. However, if geochemistry demonstrates that the material is potentially acid forming or has potential to leach other contaminants management measures to reduce or avoid impacts will include the implementation of waste rock management plan which includes details on the selective placement of potentially reactive waste rock materials.

Other mitigation and management measures are described in Section 2.6.1 and including constructing sediment basins and bunds for surface water collection and treatment.

## **5.8 Socio-Economic Environment**

### **5.8.1 Potential Impacts**

A mining project of this scale will have positive and negative social and economic impacts on its local and peripheral communities. The influx of workers associated with construction and operation of the project has the potential to place pressure on the limited resources within the region and change settlement patterns and demography. The new workforce also has the potential to alter the structure of the local Wunara community.

The development of the project, however, provides an opportunity to contribute significantly to the regional economy. Local employment and business opportunities will be created both directly and indirectly as a result of the project. There is also potential for economic benefits as a result of the project for the indigenous groups.

There are a number of potential socio-economic issues that might emerge during construction and operations which would require a thorough impact assessment. These potential issues are discussed below.

#### **Impacts on Population**

The development of resources projects in remote locations can impact the composition of local and peripheral communities and impact social cohesion. Such impacts will depend on the size of the required workforces and details of the fly-in-fly-out arrangements.

#### **Restriction of Existing and Future Land Use**

Resource development has the potential to impact on existing and future land uses and users. The project has the potential to restrict the use of land for traditional activities such as hunting and gathering. However, Minemakers will continue to work with the CLC to ensure that traditional owners and indigenous groups can continue to utilise land for traditional activities with minimal disruption.

#### **Community Services**

The increase in population in the region, both permanent residents of Tennant Creek and the fly-in-fly-out workforce has the potential to impact on the existing community services (health, education, emergency services).

## **Increased Demand for Housing and Accommodation**

The nature, extent, quality and availability of housing and accommodation in the region is limited. While an accommodation village will be constructed for the fly-in-fly-out workforce, there is likely to be an increase in demand for housing (particularly in Tennant Creek) for people employed by businesses associated with the mine (e.g., transport companies).

## **Economic Growth and Employment in the Region**

Development of the project will create direct and indirect economic benefits in the local Wunara community, peripheral communities and the Northern Territory as a whole. The project will have flow on employment benefits into the community with additional workforce requirements in sectors such as retail, community services and hospitality.

The workforce needs of the project will vary during different stages of the project. The skills required of the workforce, the existing skill base and experience within local and peripheral communities, and the presence or absence of skill development and training programs will influence the extent to which these communities can benefit from the increased employment opportunities arising from the project. Indirect employment benefits will vary dependent on the nature of the resources operation and employment practices.

### **5.8.2 Mitigation and Management Measures**

Management measures to reduce or avoid impacts with associated increased use of infrastructure disturbance or destruction of cultural heritage and archaeological sites include:

- Consultation with relevant government agencies and local registered training organisations to discuss training and skill requirements.
- Preferentially source people, goods and services from within the local region and the Northern Territory.
- Develop the project as quickly as possible.
- Seek premium prices for the sale of mine products.
- Place a high emphasis on stakeholder consultation to foster and maintain good relationships and continue to consult with the community through all phases of the project cycle, including:
  - Planning.
  - Construction.
  - Operations.
  - Closure.
- Invest in training and education programs for employees and potential employees.

## **5.9 Infrastructure and Transport**

### **5.9.1 Potential Impacts**

The project has the potential to impact upon existing infrastructure (such as the Barkly Highway) and users. There will be potential increases to local and regional traffic volumes and traffic type during both construction and operations.

### **5.9.2 Mitigation and Management Measures**

All appropriate laws and regulations associated with the use of public roads and other infrastructure will be abided by. Management measures to reduce or avoid any impacts will include:

- Ensuring the traffic load is within the capacity of the existing road network and will not cause any disturbance to it.
- Selecting a transport route in consultation with the appropriate authorities and the Tennant Creek community that considers the impacts to road traffic, safety and condition of existing infrastructure.
- Provision of measures such as escort vehicles and appropriate signage for heavy haulage of construction and mining equipment to site.
- Construction of temporary diversion roads for local traffic (if required).

## **5.10 Cultural Heritage and Archaeological Sites**

### **5.10.1 Potential Impacts**

Sites of indigenous and non-indigenous cultural or archaeological significance may occur within the project area and the project has the potential to disturb or destroy these sites during construction and operation should they exist. The impact of disturbance or destruction of these sites will be dependent upon the significance of the sites should they exist.

### **5.10.2 Mitigation and Management Measures**

Minemakers carries out its exploration activities in accordance with a Mining Management Plan approved by RDPIFR. The Central Land Council (CLC) and traditional owners will be consulted regarding management of any sites potentially affected by the project. The CLC have issued sacred site clearance certificates C2008-008, issued 26 March 2008, and C2008-087, issued 18 November 2008, and amendments issued 20 November 2008 and 26 November 2008 and has identified exclusion zones where exploration and mining cannot occur. All activities are undertaken in accordance with these certificates and agreements.

Other management measures to reduce or avoid impacts with associated disturbance or destruction of cultural heritage and archaeological sites include:

- Incorporating indigenous site and object recognition training into the site inductions, ensuring employees and contractors are aware of their legislative obligations.
- Requiring clearance/disturbance forms to be completed for any ground disturbance within the Mineral Lease.
- Establishing a specific protocol to be followed in the event that a suspected indigenous site, object or burial is discovered.

## **5.11 Noise and Vibration**

### **5.11.1 Potential Impacts**

Noise and vibration from construction and operation of the project have the potential to disrupt surrounding residents. However, the nearest residents are approximately 12 km away. In general terms, noise nuisance is determined by the increment above background noise, with attenuation by distance, weather conditions, and local topography. Conversely, nuisance caused by vibration is determined by the increment above human comfort and personal amenity limits with attenuation by distance, depth and ground type.

The main sources of noise and/or vibration emissions are activities at the mine site during construction and operations and project-related noise from traffic on local roads. Specific noise or vibration sources include:

- Vehicles (including reversing alarms).
- Machinery (e.g., drills, loaders, haul trucks, excavators and other ancillary equipment).
- Treatment plant (e.g., crushing and screening).
- Blasting operations (if required).

Disturbance due to noise generated during the construction period may be higher than during operations.

### **5.11.2 Mitigation and Management Measures**

It is likely that 10 km buffer from the Mineral Lease to the closest sensitive receptor (the Wunara community) will ensure that any increase in potential noise and vibration impacts will be sufficiently mitigated within the Mineral Lease. However, should environmental impact assessment identify this buffer is insufficient, management measures to reduce or avoid impacts associated with increases in noise and vibration include:

- Ensuring mine infrastructure has appropriate separation distances from sensitive receptors.
- Servicing all plant, machinery and vehicles regularly.
- Undertaking noise monitoring to ensure compliance with relevant noise criteria.
- Selecting and positioning site buildings, access roads, equipment and plant in a way that minimises acoustic disturbance in the locality.
- Installing standard noise abatement devices (e.g., mufflers) on machinery and vehicles.
- Establishing a complaints register and responding to complaints as appropriate, e.g., undertaking monitoring of noise levels if complaints received.

## **5.12 Visual Amenity**

### **5.12.1 Potential Impacts**

The project has the potential to decrease visual amenity in the area. The impact to existing visual amenity will vary with viewer sensitivity (i.e., the degree to which change is perceived or experienced by an individual), the viewer's distance from the Mineral Lease (i.e., local, sub-

regional or regional) and the phase of the mine cycle (i.e., construction, operation or closure). Given the proximity to the Barkly Highway potential impacts to visual amenity include:

- Permanent changes to landforms within the Mineral Lease.
- Vegetation removal, altering existing landscape and allowing views of the project components.
- Presence of additional vehicles and project machinery, haulage routes of trucks along local roadways.

### **5.12.2 Mitigation and Management Measures**

The region is sparsely populated and the impact to visual amenity is not anticipated to be significant. Mitigation and management measures will include:

- Consideration of the colours of the surrounding landscape when selecting exterior paint colours for buildings.
- Maintaining a high standard of housekeeping at the site.
- Progressive rehabilitation of areas.
- Rehabilitation and decommissioning of site at mine closure (see Section 5.13).

## **5.13 Rehabilitation and Mine Closure**

### **5.13.1 Potential Impacts**

Final land use and landform options will need to be considered so that rehabilitation measures and mine closure requirements can be defined. Project landforms will need to be designed to take into account storm events, the topography of the surrounding landscape and the geochemical nature of the materials. During mine planning, preliminary final land use objectives for completed mine areas and conceptual mine closure and rehabilitation plan will be developed. During the life of the mine the conceptual mine closure and rehabilitation plan will be further refined through trials of rehabilitated landforms and through consultation with stakeholders.

Aspects of the final landform that may have ongoing impacts to the surrounding environment include the:

- Open pits – final void water quality may have the potential to contaminate groundwater resources through seepage into the aquifer.
- Waste rock storages may have the capacity to generate acid rock drainage and or metals and salts into the surrounding environment.

### **5.13.2 Mitigation and Management Measures**

Progressive rehabilitation of disturbed areas within the Mineral Lease will minimise the potential impacts of mine closure and allows the rehabilitation success to be reviewed and improvements to be incorporated as required. Mine closure and rehabilitation planning will be completed during the preparation of the environmental impact assessment. The mine closure and rehabilitation plan will be an active document throughout the life of the mine and will therefore continue to evolve

throughout the life of the mine. The plan will also incorporate results from stakeholder consultation.

Management measures for potentially acid forming materials are described in Section 5.6 and 5.7 and will be implemented if geochemical testwork indicates potential risks. Additional management measures for long term void water quality in the open pits are unlikely to be required as:

- The depth of the final void will not intercept the groundwater table in the area.
- Any temporary ponding associated with occasional seasonal heavy rainfall will either soak through the bottom of the pit towards the groundwater table or will be subject to rapid evaporation in the light of the high temperatures during the wet season.

## **6. ENVIRONMENTAL MANAGEMENT**

Minemakers regards sound environmental management and protection as an integral part of its business and of playing its part in the community, and is committed to excellence in this area of activity. This commitment is reflected in the company's environmental policy (Appendix D).

Minemakers aims to minimise environmental impacts at every stage of work, from planning, exploration, development, mining, production and through to decommissioning. Prior to the commencement of mining, an environmental management system, procedures and standards will be implemented to ensure:

- High operating standards in all aspects of activities to minimise environmental impact and prevent environmental harm.
- Communication and consultation with all stakeholders.
- Employee awareness of sound environmental practice as part of day-to-day activities.
- Continuous improvement through measurement of environmental performance.
- Regular audits and review of policies, systems and procedures.
- Compliance with applicable legislation.

Key elements of the environmental management systems are:

- Commitment.
- Planning.
- Implementation.
- Checking and corrective action.
- Management review.

### **6.1 Planning**

#### **6.1.1 Risk Management**

It is necessary to anticipate, prevent and mitigate environmental risks and impacts to protect the environment, a project risk assessment will be undertaken in order to:

- Anticipate, prevent and mitigate environmental risks and impacts.
- Minimise loss in all areas of the organisation.
- Improve the quality of decision-making within the organisation.

#### **Job Risk Analysis**

Job risk analysis will be used as a tool to identify and record risks associated with specific work activities. A job risk analysis requires personnel to examine the task they are about to undertake and:

- Break the job into separate, defined steps.
- For each step, identify the potential hazards that could occur with that step.

- For each potential hazard, list the method to be followed to prevent the hazard causing an injury, loss, damage or environmental incident.

### **6.1.2 Environmental Management Plan**

A risk-based environmental management plan (EMP) will be developed for the project to:

- Document project commitments and impact mitigation requirements.
- Document conditions of approval resulting from the environmental approval process.
- Provide the basis for the development of environmental guidelines and work procedures to be prepared by the construction contractor.

The EMP will be based on the environmental and social impact and management measures outlined in Chapter 5 of this report and within the environmental impact statement and will be monitored and evaluated against key environmental performance standards to ensure environmental compliance. The EMP will include individual plans that address:

- Water.
- Air quality.
- Noise and vibration.
- Traffic.
- Waste.
- Hazardous materials.
- Flora and fauna.
- Archaeology and heritage.
- Erosion control.
- Rehabilitation.

### **6.1.3 Emergency Response Plan**

An emergency response plan will be developed that establishes specific actions to manage significant events such as fires, car accidents, chemical or oil spills or product spillage.

All incidents, both minor and major, will be recorded in an incident register that will form part of the environmental management system documentation. In the event of a major incident the procedure will be to:

- Ensure that the area is safe.
- Take immediate action to contain the incident.
- Report emergencies to the relevant emergency service.
- Notify the relevant regulatory authority.
- Remediate the site.
- Investigate and prepare a report detailing the findings of the environmental incident investigation.
- Review environmental management procedures.

The project will have an emergency response team that is trained to respond to emergencies, lead evacuations and administer first aid.

## **6.2 Implementation**

### **6.2.1 Roles and Responsibility**

All Minemakers and contractor personnel are responsible for the environmental performance of their activities and complying with the relevant environmental management procedures.

The mine manager will be responsible for ensuring that sufficient resources are available for all project activities to be undertaken in full compliance with statutory regulations and are consistent with any internal policies.

The mine manager will be assisted by an environmental manager who will ensure that the environmental management system is implemented uniformly, and is revised and maintained as required. The environmental manager will also implement the environmental management plan, induction procedures and appropriate training and ensure that contractors fulfil their contractual obligations.

### **6.2.2 Communication**

#### **Inductions**

Following appointment, each employee and contractor will undergo a formal site induction to ensure that they have the appropriate knowledge concerning health, safety, environment and community relation procedures. The induction will address areas such as:

- Background to project approval.
- Legislative obligations of both individual and company.
- Minemakers environmental policy.
- Key environmental issues at the site.
- Outline of the environmental management plan and obligations.
- Structure of the environment and community relations sections.
- Site environmental management policies and procedures.
- Site safety and occupational health policies, procedures and employee obligations.
- Hazard and incident reporting and management.
- Emergency services and procedures.
- Site security.
- Employment policies and conditions of employment.

#### **Ongoing Community Consultation**

The community consultation program will be ongoing and will continue through the life of the project to ensure due consideration of all project-related opportunities and concerns.

### **6.3 Checking and Corrective Action**

Regular inspections of construction and operations activities will be conducted to ensure that environmental management plans are correctly implemented. The frequency of inspection will depend on the potential risk associated with the activity.

Internal audits will be conducted to ensure the environmental management system is correctly implemented and management plans are effective in managing the potential environmental impacts of the project. A program of undertaking audits will also be implemented with the likely timing being:

An auditable record system will be established and maintained that will include the following documentation:

- Mineral lease conditions.
- Mine Management Plan.
- Environmental management plans.
- Monitoring results.
- Environmental monitoring reports.
- Audit reports.
- Incident register.
- Complaints register.
- Risk register.

### **6.4 Management Review**

Any environmental procedures found to be deficient as a result of an audit or investigation after an environmental incident will be revised and the environmental management plan updated to reflect the new procedures.

### **6.5 Monitoring**

A comprehensive monitoring and reporting program for the project will be implemented. The primary objectives of the environmental and social monitoring program are to:

- Provide information that will determine the adequacy of environmental and social management practices and allow improved practices and procedures to be developed.
- Detect and measure trends or environmental/social changes, and enable analysis of their causes.
- Confirm environmental and social impacts of particular activities and identify unforeseen effects and the need for additional management measures.

The proposed monitoring program will include monitoring of:

- General mine operations.
- Discharges and emissions from the mine site.
- Potential environmental impacts associated with the project.
- Potential social impacts associated with the project.

## 7. STAKEHOLDER CONSULTATION

The adopted approach to community consultation and stakeholder engagement is based on the timely and accurate provision of information to stakeholders and the fair facilitation of views, concerns and aspirations. Consultation and engagement programs will be tailored to the needs of the project and its stakeholders, and identified early in the planning process through a stakeholder identification and prioritisation exercise.

Consultation and engagement strategies will be in accordance with best practice standards for community consultation and stakeholder engagement and ensure that the process is open and transparent for all stakeholders.

A stakeholder consultation and engagement plan will be specifically developed for the environmental impact assessment process. The will document the approach to stakeholder consultation, including how feedback will be obtained and considered. The strategy will outline the specific objectives, methods and activities required to deliver the stakeholder consultation and engagement strategy.

The plan will document the:

- Objectives of the stakeholder consultation and engagement and the commitments to consultation.
- Community engagement techniques and activities that will be used to facilitate consultation, and the timing of these activities.
- Mechanisms available to the community to express their views and feedback on the project proposal and the systems and processes that will be established to record, understand and respond to community issues, and incorporate feedback into project planning.
- Complaints and issues resolution process to record community grievances and through which the project proponent responds to community concerns.
- Process through which the community will be informed about consultation outcomes and the way in which feedback has, or has not, been incorporated into project planning.

The effectiveness of the stakeholder consultation and engagement strategy will be reviewed throughout the environmental impact assessment process.

### 7.1 Stakeholders

Stakeholders are parties with an interest in the project who can potentially influence, or are influenced by, its development. Stakeholders relevant to the project include:

- i) The 'local' community (people associated with the immediate area and who are directly affected by project-related activities), which comprises residents of the Wunara community, pastoralists on surrounding properties and the CLC.
- ii) 'Peripheral' communities (communities that are proximal to the project area and may or may not be affected by the project in some way, e.g., through increased employment opportunities), which comprise the township of Tennant Creek.

- iii) 'Other' communities (communities that are distant from the project area and that may still be affected by the project in some way). These include Darwin and Mt Isa (the localities from which most products, services and people will be sourced) and Camooweal.
- iv) Territory and State government and agencies (e.g., NRETAS, RDPIFR, NT Worksafe, NT Emergency Service, Darwin Port Corporation and relevant ministers and members of parliament).
- v) Australian Government, including DEWHA (concerning EPBC Act matters).
- vi) Special interest groups (e.g., Country Women Association, Barkly Tourism).
- vii) Media (regional, state and national).
- viii) General public (particularly within the Northern Territory).
- ix) Minemakers (e.g., board, employees and shareholders).
- x) Contractors/suppliers (including infrastructure providers) to Minemakers.
- xi) Financiers (e.g., brokers, bankers and investors) and their advisors.
- xii) Australian stock exchange.
- xiii) Mining industry (e.g., other mineral explorers or producers in the area, the Northern Territory Resources Council and the Minerals Council of Australia).

## 7.2 Consultation to Date

Consultation to date has been widespread and has included politicians, government agencies and the CLC (in relation to landowner issues). Table 7.1 outlines the consultation that has been undertaken to date.

**Table 7.1 Stakeholder consultation to date**

Stakeholder	Nature of Interest	Consultations Undertaken
Arruwurra Aboriginal Corporation (ACC) (stakeholder group i)	Environmental and cultural heritage impact AAC community employment and training. Royalty payments.	All consultations have been conducted through the CLC as the representative of the landowners. When invited to do so a company representative has provide an 'on country' briefing at meetings arranged and managed by the CLC.
Local station owners (stakeholder group i)	Impact on regional labour pool.	Whilst there has been some contact with individual local station owners, the specific impacts of the project, especially with regard to the draw on the local pool of labour has not yet been discussed.
Julalikari Council and Remote Employment Services (RES) (stakeholder group iii)	Indigenous employment and training	Meeting with representatives of the council and RES to discuss the project and potential job and training opportunities.

**Table 7.1 Stakeholder consultation to date**

<b>Stakeholder</b>	<b>Nature of Interest</b>	<b>Consultations Undertaken</b>
Northern Territory government (stakeholder group iv)	Job creation. Economic development. Training. Royalty revenue.	Meeting with Chief Minister and other Ministers and heads of departments detailed below. Regular meetings/ consultations with Chief Minister Office. Meeting with the Treasurer, Minister for Regional Development and the Member for Barkly to discuss the project and its implications for the NT.
RDPIFR (stakeholder group iv)	Resource project development.	Meetings with department officials on a number of occasions to discuss project status and permitting process.
NRETAS (stakeholder group iv)	Environmental impact assessment.	Meeting with a department official to discuss project status and permitting process.
Port of Darwin (stakeholder group iv)	Export of bulk phosphate rock through the port.	Meetings with various representatives of the Port to discuss requirements for storage and wharf capacity.
NT Roads within the Department of Planning and Infrastructure (stakeholder group iv)	Road condition/ road safety Barkly Highway.	Meeting with a department representative in Darwin to discuss the project and any road or traffic issues. Meeting with two local representatives in Tennant Creek to discuss the road aspects of the project.
Department of Planning and Infrastructure (stakeholder group iv)	Regional planning and development.	Meeting with two department representatives in Tennant Creek to discuss the project.
Department of Local Government and Housing (stakeholder group iv)	Local government and housing.	Meeting with department representative in Tennant Creek to discuss the project.
FreightLink (stakeholder group x)	Adelaide – Darwin Rail owner.	Meetings with various representatives of FreightLink to discuss the project's rail freight requirements.
NT Resources Council (stakeholder group xiii)	Resource industry promotion. Economic development. Employment. Training.	Minemakers has joined the NT Resources Council and become a member of the Management Committee.

## 7.3 Proposed Stakeholder Consultation

The level of stakeholder consultation will be increased during the preparation of the feasibility study and the preparation of the public environment report or environmental impact assessment. Public consultation with the residents of Tennant Creek and the Wunara Community will occur over the coming months.

Consultation with the landowners will continue through the CLC who act as their agent. This will likely involve 'on country' briefings of the landowners by Minemakers personnel at meetings to be convened and managed by the CLC.

Consultation will be via a range of different techniques including:

- 'On country' meetings with landowners and CLC.
- Community meetings in Tennant Creek.
- Newsletters to stakeholders.
- Site open days.

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# Appendix A

**Section 46 Requirements for the *Aboriginal Land Rights (Northern Territory) Act 1976***



### Section 46 Requirements for the *Aboriginal Land Rights (Northern Territory) Act 1976*

Section 46 of the Act sets out the information required to be provided to the Land Council and traditional Aboriginal owners in order to grant a mining interest on Aboriginal land, as well as the process by which the mining interest will be granted. The following table only summarises the information required to be provided to the Land Council and traditional Aboriginal owners and identifies the Minemakers documents that contain or will contain this information.

Summary of subsection of the Act	Information required	Statutory approval document containing the information	Extent of compliance with the requirements
1(a) Comprehensive proposal in relation to the mining works that are proposed to be carried out on the land.	Anticipated mine life	Notice of Intent, Section 1.2	Full compliance, however, details may change as project planning progresses. Will be updated in the Public Environmental Report or Environmental Impact Statement accordingly.
	Production capacity and scale of operation	Notice of Intent, Section 1.2	
	Proposed mining techniques	Notice of Intent, Section 2.1	
	Infrastructure requirements	Notice of Intent, Sections 2.5 and 2.6	
	Proposed vehicular access to and within the mineral lease	Notice of Intent, Section 2.5	
	Details on other proposed mineral lease access requirements	Notice of Intent, Section 2.5	
	Anticipated construction and operational workforce	Notice of Intent, Section 2.9	
	Potential social impacts	Public Environmental Report /Environmental Impact Statement	Not in compliance at this stage of project approvals.
	Water, timber and other requirements to be obtained from the affected land	Notice of Intent, Section 2.6.6, Chapter 4	Partial compliance. Requirements may change as project planning progresses. Will be updated in the Public Environmental Report or Environmental Impact Statement accordingly.
	Potential impacts within and outside the mineral lease	Notice of Intent, Chapter 5	Partial compliance. Further detailed investigation will be undertaken to determine the extent and severity. Will be updated in the Public Environmental Report or Environmental Impact Statement accordingly.

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Summary of subsection of the Act	Information required	Statutory approval document containing the information	Extent of compliance with the requirements
1(a) Comprehensive proposal in relation to the mining works that are proposed to be carried out on the land.	Proposed impact avoidance, mitigation and management measures	Notice of Intent, Chapter 5	Partial compliance. Will be updated in the Public Environmental Report or Environmental Impact Statement.
	Rehabilitation measures	Notice of Intent, Section 2.11	Partial compliance. Partial compliance. Will be expanded in the Public Environmental Report or Environmental Impact Statement.
	Terms and conditions relating to payments	Public Environmental Report /Environmental Impact Statement	Partial compliance. Indicative terms have been agreed to in the Exploration Agreement and these will form the basis of the Mining Agreement.
1(b) Miner's representatives	Name, position and qualifications of representatives, not exceeding three persons	Notice of Intent, Section 1.3.1	Full compliance.
2. Provision of section 46 statement to the Minister	All information in relation to the requirements is to be provided to the Minister	Notice of Intent	Partial compliance. The Notice of Intent will be provided to the Minister. Further documentation will also be provided as the project progresses through the approvals process.
4. Land Council will not agree to terms and conditions unless there has been consultation and the terms and conditions are reasonable	Details of consultation with the traditional owners of the land concerning the terms and conditions of mining interest.	Notice of Intent, Chapter 6	Partial compliance. Consultation will continue throughout the approvals process. Details of when all consultation with traditional owners and the Central Land Council will be outlined in the Public Environmental Report/Environmental Impact Statement.
	Details of consultation with any other Aboriginal community or group that might be affected by the grant of the mining interest.	Notice of Intent, Chapter 6	Partial compliance. Consultation will continue throughout the approvals process. Further details will be provided in the Public Environmental Report or Environmental Impact Statement.

# Appendix B

## **Dust Deposition Monitoring Results**



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**Attachment B**  
**Wonarah Project Dust Deposition Monitoring Results**

Site Code	Location			Month of collection			
	Northings	Eastings	Elevation (m)	Jun-08	Jul-08	Aug-08	Sep to Nov-08
WonDD1	653,957	7,788,847	293	3.0	3.0	1.7	1.3
WonDD2	657,010	7,786,757	289	4.0	2.9	2.0	3.4
WonDD3	649,497	7,786,544	285	3.0	3.0	0.8	3.1
WonDD4	651,992	7,789,470	289	3.4	3.3	1.6	2.4
AWDD1	637,222	7,775,069	269	3.4	3.5	1.7	2.5
AWDD2	638,524	7,772,379	250	3.9	4.0	4.0	2.3
AWDD3	641,214	7,775,310	251	3.3	2.7	1.2	2.5
AWDD4	652,027	7,775.432	252	3.1	3.3	1.9	1.1

Note: Dust collection was combined for the months of September, October and November, the results in the table are averaged over this period.



# Appendix C

**Minemakers Wonarah Phosphate Project Baseline Flora and Fauna Report**





## Minemakers Wonarah Phosphate Project



### Baseline Flora and Fauna Report



Prepared for  
Coffey Natural Systems



By  
Tom Newsome and Dr Bill Low  
Low Ecological Service P/L  
P.O Box 3130  
Alice Springs 0871  
August 2008



## Executive Summary

### Overview

Minemakers Limited is currently in the pre-feasibility stage of their Wonarah Phosphate Project. Low Ecological Services P/L was commissioned to broadly characterise the ecology of the area, to identify threatened flora and fauna present, or likely to be present in the project area, and highlight the potential for the project to have significant impacts on these species.

Existing data sets were used for a desktop rapid landscape analysis to determine, in a regional context, landforms, geology, drainage systems, vegetation communities or habitats, and compile flora and fauna species list for the project area. A follow up landscape, flora and fauna survey was also undertaken in the project area by Low Ecological Services between the 18<sup>th</sup> and 22<sup>nd</sup> June 2008.

### Regional Context

The project area lies on the edge of the Tanami Bioregion, but falls in the Davenport and Murchison Ranges Bioregion. The project area overlies the Wonarah beds site, which is classified as significant on a bioregional scale as determined by the NRETA Parks and Conservation Masterplan. The project area is dominated by Yelvertoft land system (Stewart *et al.* 1954) with minor Wonarah land system (Perry *et al.* 1962, Stewart *et al.* 1954).

### Existing data

A search of the NT Parks and Wildlife Flora Atlas for the project area and surrounding region did not identify any flora species of conservation significance under the EPBC Act. However, fourteen species were listed under the TPWC Act or by White *et al.* (2000) as significant at a NT or National level. Four of these species occur within the project area, two of which are listed as significant at a national level (*Sporobolus latzii* and *Bonamia alatisemina*) by White *et al.* (2000). No flora species of conservation significance were identified by a protected matters report generated by the Department of Environment Water Heritage and the Arts (DEWHA) web site in the project area and surrounding region.

A search of the NT Parks and Wildlife Fauna Atlas for the project area and surrounding region identified three species of conservation significance under the EPBC Act and TPWC Act, and eight species listed solely under the TPWC Act. Three of these species were located within the project area (Australian bustard, *Ardeotis australis*, woma, *Aspidites ramsayi*, and long-haired rat, *Rattus villosissimus*). Two threatened (vulnerable) fauna species (mulgara, *Dasycercus cristicauda*, and Australian painted snipe, *Rostratula australis*), ten migratory fauna species and eight listed marine species were identified by a protected matters report (DEWHA) as potential for the project area and surrounding region. No endangered or critically endangered species were listed.

### *On site Investigations*

The project area is dominated by sand plains with *Atatallya*, *Acacia*, *Grevillea*, and *Hakea* spp. over *Aristida*, and *Triodia*; open woodlands with *Acacia*, *Eucalyptus*, *Hakea* and *Melauleuca* spp. over *Acacia* shrubs and *Triodia* spp; and rocky rises with sparse *Acacia*, *Eucalyptus*, and *Triodia* spp. Approximately 60% of the project area was burnt prior to this survey, and this was reflected in the vegetation transects, which, on average, had 48 % bare ground and 23 % litter. No flora species identified during on-site investigations were listed under the EPBC Act, and only one species (*Distichostemon barklyanus*) was listed as data deficient under the TPWC Act as a taxon with a geographic range exceeding 100 km and with the potential to belong to a conservation category (White *et al.* 2000). No weed species were identified during on-site investigations, although a number of species are known to occur in the region

Fauna of the area do not exhibit any special features, although Australian bustard, (*Ardeotis australis*) a species of conservation significance (TPWC Act) was identified during on site investigations. Habitat in the project area, particularly the acacia shrublands and hummock grasslands are, however, suitable for bilby (*Macrotis lagotis*) and mulgara (*Dasymercus cristicauda*) and both of these species have been recorded within the surrounding region. There is also potential habitat, in the open woodlands to the south-west of the project area, for spectacled hare wallaby (*Lagorchestes conspicillatus*) and northern nailtail wallabies (*Onychogalea unguifera*), although no sign of these species was observed during on-site investigations.

Within the surrounding region over 90 bird species have been recorded and many of these species are likely to occur within the project area. Sand plain habitats are likely to support the greatest bird diversity owing to the micro-topographic diversity and density of habitat, as well as the range of food resources due to the variable phenology of plant species that occur from ridge to flood out. Ephemeral areas are also likely to be important habitats during wet seasons for many migratory species. In general though, species listed are not especially uncommon or rare in a regional sense. Most present and potential species are wide-ranging.

The onsite investigation was conducted during poor conditions following a summer with very little monsoonal rain, a particularly cold and windy period with 60 % of the country burnt and wind blown sand rapidly covering any sign of animal presence or movement. Thus a repeat survey under better conditions is warranted. However, landscape, flora and fauna results gained during the survey provide a reasonable indication of the bioregional value of the site.

### *Impacts of the Operation*

The proposed operations will not have a significant impact on flora and fauna at a National, or Bioregional scale and the status of species of conservation significance that occur or could occur within the project area will not be affected by the proposed operations. There will be loss of flora and fauna on a local scale and a variety of management strategies are described herein to minimise these impacts.

The most important of these are:

- Additional surveys should be undertaken in the warmer part of the dry season and in the wet season to establish more representative baseline data;
- The survey should replicate the methods described herein, but also include Aboriginal tracking for terrestrial fauna and a survey for any potential bat populations;
- On-going monitoring will be required throughout the operation and rehabilitation phase of the project. In particular, track surveys for fauna species of conservation significance should be conducted immediately before mining operations commence, so identified threatened species can be translocated or harassed to move them out of the open cut pit or infrastructure sites.
- Critical habitats, such as the ephemeral lakes land unit and areas subject to inundation, should be preserved where possible;
- Induction sessions which include information on significant flora and fauna present or likely to be present, and how to identify them and minimise impact should be given to all workers; and,
- Best practice environmental principles should be adhered to at all times.

## Contents

<b>1.</b>	<b>Introduction.....</b>	<b>1</b>
<b>2.</b>	<b>Scope of Works.....</b>	<b>1</b>
2.1.	Study Objectives.....	1
2.2.	Study Tasks.....	1
2.3.	Field Surveys.....	1
2.4.	Reporting.....	2
<b>3.</b>	<b>Methods.....</b>	<b>2</b>
3.1.	Summary of Terminology .....	2
3.2.	Existing data .....	2
3.3.	Field Surveys.....	2
3.3.1	Establishing Familiarity with the Site and Landscape .....	3
3.3.2	Survey.....	3
<b>4.</b>	<b>Regional Context .....</b>	<b>4</b>
4.1.	Climate.....	4
4.2.	Bioregion.....	5
4.3.	Landforms Physiography and Geology .....	5
4.4.	Land Systems .....	5
4.5.	Soils .....	6
4.6.	Flora.....	6
4.7.	Fauna.....	7
<b>5.</b>	<b>Site Description and Existing Environment.....</b>	<b>8</b>
5.1.	Survey Overview and Limitations .....	8
5.2.	Site Description Summaries - Flora.....	9
5.3.	Site Description Summaries - Fauna.....	9
5.4.	Site Description Summaries – Flora Map.....	10
<b>6.</b>	<b>Impact Assessment .....</b>	<b>11</b>
6.1.	Legislative Context .....	11
6.2.	Potential Impacts of the Proposed Operation:.....	12
6.3.	Potential Impacts of the Proposed Operation: National Level.....	12
6.4.	Potential Impacts of the Proposed Operation: Bioregional Level.....	13
6.5.	Potential Impacts of the Proposed Operation: Local Level .....	14
<b>7.</b>	<b>Management Recommendations.....</b>	<b>16</b>
7.1.	Management of Significant Species .....	16
7.2.	Management of Introduced Species.....	18
7.3.	Rehabilitation .....	19
7.4.	Recommended locations for Mining Components.....	20
7.5.	Erosion and Watercourse Management.....	20
7.6.	Fire Management .....	22
7.7.	Vegetation Removal and Revegetation.....	23
7.8.	Future Environmental Monitoring .....	24
<b>8.</b>	<b>Scope Requirements .....</b>	<b>25</b>
<b>9.</b>	<b>References .....</b>	<b>26</b>

<b>10.</b>	<b>Appendices: Plates, Figures and Tables .....</b>	<b>28</b>
10.1.	Appendix One: Location of Minemakers Wonarah prospect in relation to Alice Springs and Tennant Creek, Northern Territory. ....	28
10.2.	Appendix Two: Minemakers Wonarah prospect zones over Landsat 5 image. ....	29
10.3.	Appendix Three: Location of survey sites (s) selected by Low Ecological Services P/L over Landsat 5 image. TS refers to sites where trapping was undertaken. ....	30
10.4.	Appendix Four: Location of Wonarah prospect in relation to watercourse areas and sites of significance as determined by the Northern Territory Government Department of Natural Resources Environment and the Arts Parks and Conservation Masterplan over Landsat 5 image. ....	31
10.5.	Appendix Five: Land Systems of the Wonarah Prospect. Modified after Perry et al. (1962) and Stewart et al. (1954). ....	32
10.6.	Appendix Six: Classification of soils in the Wonarah Prospect and surrounding region (50 km) (Bureau of Rural Sciences 1991). ....	33
10.7.	Appendix Seven: ARC/INFO coverage's for the 1:1,000,000 NT vegetation map (Conservation Commission of the NT, 1991) in the Wonarah Prospect and surrounding region (50 km)..	34
10.8.	Appendix Eight: Matters of Environmental Significance (Department of Environment Water Heritage and the Arts): Species of Conservation Significance listed under the Environmental Protection and Biodiversity Conservation Act (1999), (EPBC) and Territory Parks and Wildlife Conservation Act (2000) (TPWC), that occur or could possibly occur within a 50 km radius of the Wonarah Prospect. Note the category "migratory" includes terrestrial, migratory marine and migratory wetland species. ....	35
10.9.	Appendix Nine: Northern Territory Parks and Wildlife Flora Atlas record sites and their status within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. Note that some sites have multiple species records so this figure should be used as a guide only. A key to conservation codes is provided in Appendix Ten. ....	36
10.10.	Appendix Ten: Flora species list for the Wonarah prospect and surrounding region based on the Northern Territory Parks and Wildlife flora atlas records (existing data) and status under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes (SSOBS) defined by White et al. (2000). ....	37
10.11.	Appendix Eleven: Northern Territory Parks and Wildlife Flora Atlas locations of conservation significance as defined by White et al. (2000) or Territory Parks and Wildlife Conservation Act (2000) within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. A key to conservation codes and species status is provided in Appendix Ten and Twelve respectively. ....	46
10.12.	Appendix Twelve: Northern Territory Parks and Wildlife Flora Atlas records of conservation significance as defined by White et al. (2000) (SSOBS) or Territory Parks and Wildlife Conservation Act (2000) (TPWC) within the Wonarah prospect and surrounding region (50km). A key to conservation codes is provided in Appendix Ten. ....	47
10.13.	Appendix Thirteen: Northern Territory Parks and Wildlife Fauna Atlas records and their status within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. Note that some sites have multiple species records so this figure should be used as a guide only. A key to conservation codes is provided in Appendix Fourteen. ....	48
10.14.	Appendix Fourteen: Fauna Species List for the Wonarah prospect and surrounding region based on the Northern Territory Parks and Wildlife Fauna Atlas records (existing data) and status under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC). ....	49
10.15.	Appendix Fifteen: Northern Territory Parks and Wildlife Fauna Atlas records of conservation significance (Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and/or Territory Parks and Wildlife Conservation Act (2000) (TPWC)) within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. A key to conservation codes and species status is provided in Appendix Fourteen and Sixteen respectively. ....	53
10.16.	Appendix Sixteen: Northern Territory Parks and Wildlife Fauna Atlas records of conservation significance as defined by the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and Territory Parks and Wildlife Conservation Act (2000) (TPWC) within the Wonarah prospect and surrounding region (50km). A key to conservation codes is provided in Appendix Fourteen. ....	54

10.17.	Appendix Seventeen: Site Description Summaries: Trap Site 1 .....	55
10.18.	Appendix Eighteen: Site Description Summaries: Trap Site 2 .....	57
10.19.	Appendix Nineteen: Site Description Summaries: Trap Site 3.....	59
10.20.	Appendix Twenty: Site Description Summaries: Trap Site 4.....	61
10.21.	Appendix Twenty-One: Site Description Summaries: Trap Site 5.....	63
10.22.	Appendix Twenty-Two: Site Description Summaries: Site 6 .....	65
10.23.	Appendix Twenty-Three: Site Description Summaries: Site 7 .....	67
10.24.	Appendix Twenty-Four: Site Description Summaries: Site 8 .....	69
10.25.	Appendix Twenty-Five: Flora recorded during on site investigations within the Wonarah prospect. Status is given under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes defined by White et al. (2000). See Appendix Ten for Conservation Code descriptions. ....	71
10.26.	Appendix Twenty-Six: Fauna recorded during on site investigations within the Wonarah prospect. Status is given under the under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), and the Territory Parks and Wildlife Conservation Act (2000) (TPWC). See Appendix Fourteen for Conservation Code descriptions.....	73
10.27.	Appendix Twenty-Seven: Species identified within Land Units of the Wonarah Prospect (See Appendix Twenty Eight) based on NT Parks and Wildlife Flora Atlas and Surveys herein. Status is given under the under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes defined by White et al. (2000). See Appendix Ten for Conservation Code descriptions. ....	74
10.28.	Appendix Twenty-Eight: Detailed Land System Map of the Wonarah Prospect based on regolith and satellite interpretation and limited ground truthing. ....	79
10.29.	Appendix Twenty-Nine: Rio Tinto's procedure for protecting <i>Sporobolus latzii</i> on the Wonarah tenements. ....	80

## **1. Introduction**

Minemakers Limited (Minemakers) is currently in the pre-feasibility stage of their Wonarah Phosphate Project, located in the Barkly Tableland region of the Northern Territory (NT) (Appendix 1). Two main prospects have been identified within the project area, the Main Zone (Wonarah Prospect) and Aruwurra Prospect, (Appendix 2). Low Ecological Services P/L (LES) was commissioned to broadly characterise the ecology of the area (habitats and faunal communities present), to identify threatened flora and fauna present, or likely to be present in the project area, and highlight the potential for the project to have significant impacts on these species.

## **2. Scope of Works**

The following scope of works was provided to LES.

### **2.1. Study Objectives**

- To broadly characterise the ecology of the area (habitats and faunal communities present);
- To determine whether threatened flora and fauna species listed under the *Environment Protection and Biodiversity Act 2000* (EPBC Act) or *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act) are present, or likely to be present, in the two project areas;
- To determine the significance of the habitat in these areas for listed threatened flora and fauna species;
- To determine the potential for significant impacts to threatened flora and fauna species as a result of the project; and
- To recommend management and mitigation measures specific to any threatened species at risk from the project.

### **2.2. Study Tasks**

The initial desktop survey will include:

- A land system description; and,
- Identification of flora and fauna species expected to be present in the project areas based on data from LES and Northern Territory and Commonwealth government databases.

### **2.3. Field Surveys**

Flora and fauna surveys within the project areas will:

- Identify fauna collected, directly observed or indirectly observed;
- Identify the major vegetation structural types, plant species and, particularly, vulnerable bushland resources for threatened fauna species, or local stakeholders, that will be affected by the project;

- Enable the preparation of a database for vegetation structure and/or floristic composition in the project areas; and,
- Record the locations of any observations of threatened flora or fauna species using a GPS.

## **2.4. Reporting**

A brief study report (suitable as a stand alone document) will be prepared. This report will include:

- A description of the ecology of the area (habitats and faunal communities present), including a list of species identified during the field visit;
- A list of all threatened flora and fauna present and likely to be present in the project areas, including GPS coordinates of recorded locations for these species;
- Classifications of these species in terms of their conservation significance at a local, regional, territory and national level;
- A vegetation map of the project area, including identification of any critical habitat types;
- A summary of the potential for significant impacts to listed threatened flora and fauna species and habitats as a result of the project; and
- A summary of recommended management and mitigation measures to minimise the potential for significant impacts to threatened species identified as present or potentially present.

## **3. Methods**

### **3.1. Summary of Terminology**

For the purposes of this report, the project area refers to the area contained within the boundaries of SEL 26451, SEL 26452, EL24607 and EL9979 (Appendix Two). The surrounding region is classified as the area contained within a 50 km radius of the centre of the project area. The two main prospects refer to the “Main Zone” and “Arruwurra” prospects.

### **3.2. Existing data**

Existing data formed the basis of a rapid landscape analysis to determine, at a regional scale: landforms, geology, drainage systems, vegetation communities or habitats, and associated flora and fauna. Existing fauna and herbarium flora data were used to compile species lists of the project area and surrounding region. In order to account for changes in declared species of conservation significance listed under the EPBC Act and TPWC Act, a protected matters report was generated from the Department of Environment Water Heritage and the Arts (DEWHA) web site for the project area and surrounding region.

### **3.3. Field Surveys**

A landscape, flora and fauna survey of the project area was undertaken by LES between the 18<sup>th</sup> and 22<sup>nd</sup> June 2008. The survey was based on biodiversity sampling methods established by the

Department of Natural Resources Environment and The Arts (NRETA) for Central Australia, but modified slightly to suit the scope of works and landscape characteristics, and to take advantage of the expertise within LES.

The survey consisted of:

- Establishing familiarity with the site and landscape to determine appropriate sites for flora and fauna surveys;
- Elliott and Pit fall trapping for three nights at four selected sites;
- Intensive tracking surveys at eight selected sites;
- General flora surveys of the entire project area;
- Intensive flora surveys, including vegetation transects, at eight selected sites;
- Site descriptions (including landscape variables) at eight selected sites;
- Rapid landscape assessment and site description of the entire project area; and
- Searches for habitats of ecological significance.

### **3.3.1 Establishing Familiarity with the Site and Landscape**

Following discussions about the site with supervisory geological exploration staff, a drive over the project area was undertaken to determine appropriate sites for flora and fauna surveys and to develop familiarity with the landscape. The aim of the process was to maximise exposure to different habitat zones and land units within the two main prospects and the project area. Five sites were selected in the two main prospects and three additional sites were selected throughout the project area. A description of survey methods undertaken in each site is provided below.

### **3.3.2 Survey**

A site description was completed for each site and included a summary of all data collected. Photographs were taken of each site, as well as more broadly, to provide examples of the habitat types in the area and features of note.

Vegetation description, fauna tracking and fauna trapping were undertaken at sites one to five, and the vegetation description and fauna tracking were undertaken at an additional three sites within the project area to maximise exposure to different habitat zones and land units (Appendix Three). Elliott trapping (one line with 25 traps placed 10 m to 15 m apart) was conducted over three nights and represented a total of 75 trap nights (one Elliott trap open for one night = one trap night) at each of the trap sites. Trap lines were positioned to maximise exposure to different habitat zones and land units. Traps were baited with a mixture of oats and peanut butter. A minimum of two pit fall traps each consisting of a 25 L bucket with a 10 m drift fence, were placed 100 m apart along each of the Elliott trap lines. All traps were placed under potential shade when available, checked each morning and left open during the cool days.

The vegetation sampling consisted of recording all plant species within an approximate 200 m x 200 m area at each site. A 200 m transect was also established and consisted of recording all plant species at 1 m intervals. Where multiple layers occurred, plants were classified into upper and lower layers with height classes of 1=1-10 cm, 2=10-25 cm, 3=25-50 cm, 4=50-100 cm, 5=100-200cm, and 6=200+ cm. Bare ground was categorised as bare soil/clay/sand and/or crusting. Litter was categorised as dead or loose plant material, and rocks were categorised as rock cover. Voucher specimens were collected when identification was uncertain, and were identified by Des Nelson (local botanist) with reference to the NT Herbarium. Vegetation characteristics were recorded to indicate species composition and cover, dominance and vegetation structure at each site. Percentage cover of dominant species was also estimated at each site. Dominant vegetation was categorised into four structural layers: (1) Emergent tree layer; (2) Upper shrub layer; (3) Lower shrub layer; and (4) Ground layer.

Fauna tracking was undertaken at all sites, although high winds during the survey period cleared tracks in sandy soils and the results are likely to be an underestimate of species occurrence and frequency. The fauna tracking consisted of a walk-over survey for 25 mins at each site within an approximate 200 m x 200 m area. The 200 m vegetation transect was also utilised for fauna tracking and consisted of recording all tracks within each 1 m interval if present. Tracks and sign of fauna were also recorded opportunistically throughout the project area.

Bird surveys were undertaken at each site for approximately 25 mins in the morning and/or afternoon, and all species seen or heard throughout the project area were recorded.

Landscape analysis is a rapid assessment technique aimed at determining landforms, geology, drainage systems, vegetation communities or habitats, and associated fauna. Landscape patterns were determined from existing data and were refined using available aerial photographs, satellite imagery, and GIS layers (Digital Elevation Model (DEM), Digital Terrain Model (DTM) contours, and spot heights). These data were used to assess habitats of ecological significance, erosion potential and construction considerations for all sites.

Track and waypoint data were collected using a *Garmin GPS 76C Mapper* and were mapped in ArcMap (Version 9.2).

## **4. Regional Context**

### **4.1. Climate**

The climate of the area is described by Slatyer and Christian (1954) as semi-arid and monsoonal with nearly all the rain being received between November and April. Climatic conditions are indicated by those described for Wonarah Weather Station (Bureau of Meteorology 2008). Mean annual rainfall is

about 317 mm with a range of 300 mm to 460 mm. Temperatures are high throughout the year and average monthly maximum temperatures may reach 39 °C just before the onset of the wet season, minimum temperatures may reach 10 °C in the dry season. The strongly seasonal character of rainfall results in wet humid conditions for three to six months of the year and progressively drier conditions through to winter and spring when water stress can be quite severe. Potential evaporation rate is about 3000 mm/year. Conditions in the region in June 2008 were relatively warm, although at the time of our survey conditions were cool, and an intense high pressure system created strong winds. Further, the Barkly region was experiencing a severe deficiency of rainfall verging on the lowest on record for the 12 months preceding the survey, and the majority of the project area was burnt (Bureau of Meteorology 2008).

#### **4.2. Bioregion**

The project area lies on the edge of the Tanami Bioregion, but falls within the Davenport and Murchison Ranges Bioregion which is described by Purdie *et al.* (2008) as being “dominated by rugged rocky hills of folded volcanics, sandstone, siltstone and conglomerates. Soils are generally shallow lithosols, however deep fine-grained alluvial soils occur in the valleys and surrounding plains. Vegetation communities are dominated by spinifex (*Triodia* spp.), hummock grassland and low eucalypt and acacia open woodland”. The project area overlies the Wonarah beds site, which is classified as significant on a bioregional scale as determined by the NRETA Parks and Conservation Masterplan (Appendix Four). White *et al.* (2000) describe the Wonarah beds as low rises of chert chalcedony, tertiary travertine, silicified coquinite and limestone, and outcrops of Cambrian dolomite framed in a sandplain. The beds occur over a very large area and values of this site may not be unique and may extend over a much larger region. The distinctive undulating feature is unique to the Wakaya desert and contains the only known collection site of *Sporobolus latzii* and is a type location for *Acacia drepanocarpa subsp. latifolia*. Another important feature of the bioregion is the relative diversity of aquatic and semi-aquatic plants associated with the large number of permanent or semi-permanent waterholes within the ranges. No ecosystems in this bioregion have been formally listed as threatened.

#### **4.3. Landforms Physiography and Geology**

The physiography of the project area has been described by Noakes and Traves (1954). The area is noted for general low relief of the landscape although small bevelled chert/silcrete rocky outcrops are locally common. Surface flow in the area is relatively disorganised, with no significant water courses present. More detailed geological information is available as a result of the considerable mineral exploration work in the region by Minemakers Limited and its predecessors over the last 45 years.

#### **4.4. Land Systems**

Land systems of the surrounding region and project area have been mapped and described by Stewart *et al.* (1954) (Barkly Region) and Perry *et al.* (1962) (Southern NT). The project area falls on the edge

of these two studies, and, for the purpose of this report, land systems boundaries have been modified slightly and combined where appropriate (Appendix Five). The project area is dominated by Yelvertoft land system (Stewart *et al.* 1954) with minor Wonarah land system (Perry *et al.* 1962 and Stewart *et al.* 1954).

Stewart *et al.* (1954) describes the Yelvertoft land system as undulating, with mostly skeletal soils and truncated gravelley lateritic red earths; *Eucalyptus brevifolia* or *E. dichromophlora* woodlands. The Wonarah land system is described as gently undulating with lateritic red earths and *Eucalyptus brevifolia* woodland or *Eucalyptus. spp* (low mallees) – *Acacia spp.* shrubland. Perry *et al.* (1962) described the Wonarah land system as gently undulating plains with stonier higher parts and broad lowlands, relief mainly up to 30 ft; red clayey sands and red earths, partly lateritic; soft spinifex with sparse shrubs and low trees.

#### **4.5. Soils**

The soils in the project area fall within soil classes By4 and My80 (Appendix Six) (Bureau of Rural Sciences 1991). By4 is described as encompassing: undulating ridge and slope terrain on lateritized sediments; some rock outcrops: chief soils seem to be shallow sands usually containing large amounts of mixed and variable gravels (K-Uc1.4) or ironstone gravels (KS-Uc1.4), and also (Uc1.4) soils with some gravels on ridges and upper slopes generally. Associated are shallow to deep varieties of (Uc1.23), (K-Uc1.23), (Gn2.12), and (K-Gn2.12) soils on mid and lower slopes. Small areas of other soils are likely. My80 is described as encompassing: Gently undulating plains slightly elevated above the adjoining cracking clay plains; some narrow ridges and hills with rock outcrop; some shallow depressions: chief soils on the long gentle slopes and low rises are neutral red earths (Gn2.12) with a variable content and surface scatter of ironstone gravels. Associated are some (Uc5.21 and Uc5.22) soils on slopes and in depressions; loamy (Gn2) soils such as (Gn2.12) and (Gn2.21) marginal to the cracking clay plains; and some shallow gravelly and stony (Uc) soils on ridges and hills. Small areas of units BA13, BY4, and My82 are included.

#### **4.6. Flora**

ARC/INFO coverage for the 1:1,000,000 NT vegetation map based on Wilson *et al.* (1991) indicates that the vegetation in the project area falls within Class 42 L1H3, which is described as encompassing *Eucalyptus opaca*, (bloodwood) low open-woodland with *Triodia pungens* (soft spinifex) hummock grassland understorey. L1 refers to structural formulae (lifeform and height) of trees <10m tall with a density (projective foliage coverage) of 1-9%. H3 refers to structural formulae (lifeform and height) of hummock grassland with a density (projective foliage coverage) of 30-69% (Appendix Seven). Vegetation associations in the area are likely to be strongly related to soil types with distribution limited mainly by water availability which is affected by the summer wet and winter dry periods.

Within the Wonarah beds site, White *et al.* (2000) identify three taxa of Australian significance (*Bonamia alatisemina*, *Rothia indica subsp australis* and *Sporobolus latzii*) seven taxa of NT significance (*Distichostemon barklyanus*, *Heliotropium balli*, *Heliotropium pulvinum*, *Naja marina*, *Triumfetta centralis*, *Triumfetta deserticola*) one taxa of southern NT significance (*Grevillea dryandra subs. dryandra*) and four taxa of bioregional significance (*Eragrostis olida*, *Exocarpus sparteus*, *Isoetes muelleri*, and *Tephrosia stuartii*).

A protected matters report generated from the DEWHA web site within the project area and surrounding region identified no flora species of conservation significance (Appendix Eight). A search of the NT Parks and Wildlife Flora Atlas identified 746 records with 346 species within the surrounding region (Appendix Nine and Ten). None of these species were listed under the EPBC Act for conservation significance, although fourteen species were listed under the TPWC Act as data deficient and/or by White *et al.* (2000) as significant at a NT or National level (Appendix Eleven and Twelve). Four of these species occur within the project area, two of which are listed as significant at a national level (White *et al.* 2000) (*Sporobolus latzii*, 1K, and *Bonamia alatisemina* 3K) (Appendix Eleven and Twelve).

Five introduced flora species (*Aerva javanica*, *Jatropha gossypifolia*, *Malvastrum americanum*, *Setaria verticillate* and *Stylosanthes hamata*) were identified by the NT Parks and Wildlife Flora Atlas within the surrounding region and some of these could potentially occur in the project area. Many other introduced species have the potential to occur, particularly as the project area is in close proximity to a major highway where vehicles become a major vector for spread. Introduced species that are of concern in the bioregion also include *Azadirachta indica*, *Cenchrus ciliaris*, *Dichanthium annulatum*, *Hymenachne amplexicaulis*, *Leucaena leucocephala*, *Prosopis limensis*, *Parkinsonia aculeata*, *Sida rhombifolia* and *Xanthium strumarium*.

#### **4.7. Fauna**

The Davenport Murchison Range Bioregion region is not renowned for its high diversity of mammalian and reptile fauna, although there have been very few extensive surveys undertaken. As with other central Australian bioregions, the mammalian fauna has suffered substantial losses. Of 36 mammal species recorded, 9 have become extinct, 3 have declined and 24 remain stable. Connors. *et. al.*, (1996) listed 394 vertebrate species from the Davenport and Murchison Ranges Bioregion combined with the far larger Tanami bioregion. Avian fauna (particularly water birds) can be rich where large areas of semi permanent water exist. An unconfirmed sighting of a night parrot (*Pezoporus occidentalis*) was recorded in 1970 along the Barkly Highway (Low 1985). Bilby (*Macrotis lagotis*) have been collected west of the present Barkly Roadhouse on Dalmore Downs station, and habitat in the surrounding region is suitable for the spectacled hare wallaby (*Lagorchestes conspicillatus*) and northern nailtail wallabies (*Onychogalea unguifera*). Burrowing bettongs (*Bettongia lesueur*) were once

widespread throughout the area, but are now extinct on the mainland. One of the distinctive features of the Davenport and Murchison Ranges Bioregion is that it may contain core range area for the central pebble-mound mouse (*Pseudomys johnsoni*). The regionally extinct species include the central rock-rat (*Zyzomys pedunculatus*), which has persisted in rocky ranges south of the project area near Alice Springs.

A search of the NT Parks and Wildlife Fauna Atlas identified 693 records of 163 species within the surrounding region (Appendix Thirteen and Fourteen). Three of these species were listed for conservation significance under the EPBC Act and TPWC Act, and eight species were listed solely under the TPWC Act (Appendix Fifteen and Sixteen). Three of these species were located within the project area (Australian bustard, *Ardeotis australis*, woma, *Apsidites ramsayi*, and long-haired rat, *Rattus villosissimus*). Species listed under the EPBC Act that occur within the surrounding region include mulgara, bilby, *Macrotis lagotis*, and yellow chat, *Epthianura crocea*. The yellow chat is listed as vulnerable under the EPBC Act, and as endangered/lower concern under the TPWC Act, although it is the northern sub species (Alligator River, *Epthianura crocea tunneyi*) that is listed as endangered. The yellow chat (southern form) has been recorded 20 km north east of the project area.

A protected matters report (generated from the DEWHA web site) for the project area and surrounding region identified two threatened (vulnerable) species (mulgara, *Dasycercus cristicauda*, and Australian painted snipe, *Rostratula australi*) ten migratory species and eight listed marine bird species (Appendix Eight). No endangered or critically endangered species were listed.

## **5. Site Description and Existing Environment**

### **5.1. Survey Overview and Limitations**

A flora, fauna and landscape survey of the project area was undertaken by LES between the 18<sup>th</sup> and 22<sup>nd</sup> June 2008. Weather during the survey period was relatively cool, and a high-pressure system created strong winds each day. Cool temperatures decreased reptile and mammal activity and strong winds severely limited fauna tracking. Further, the project area has recently been burnt, decreasing overall species lists and the ability to locate flora species of conservation significance. To account for this, survey sites were distributed throughout burnt and unburnt sites (where possible) to maximise exposure to undisturbed areas and this, in combination with a drive over inspection of the project area, allowed identification of habitats of ecological significance. However, prior to the commencement of any works, additional fauna surveys are recommended especially towards the end of the year when conditions are warmer. This will ensure baseline data is collected during different seasons.

## 5.2. Site Description Summaries - Flora

Site description summaries, including dominant flora species identified at each site, are provided in Appendices Seventeen – Twenty-Four. A full list of flora (including conservation status) identified during on-site investigations is provided in Appendix Twenty-Five. The project area is dominated by sand plains with *Atatlya*, *Acacia*, *Grevillea*, and *Hakea* spp. over *Aristida* and *Triodia*; open woodlands with *Acacia*, *Eucalyptus*, *Hakea* and *Melauleuca* spp. over *Acacia* shrubs and *Triodia* spp; and rocky rises with sparse *Acacia*, *Eucalyptus*, and *Triodia* spp. Approximately 60% of the project area was burnt prior to this survey, and this was reflected in the vegetation transects which, on average, had 48% bare ground and 23% litter. The vegetation is showing good signs of regeneration with many *Eucalyptus* and *Triodia* spp. re-sprouting from their bases. Although the area has been subject to disturbance (fire), this is unlikely to have reduced the ability to identify habitats of ecological significance, and the vegetation of the sand plains, woodlands and rocky rises is relatively common and widespread. There will however be changes in the vegetation structure and dominance over the next few years, particularly with more rain, and this may increase the identification of significantly more species. Ephemeral areas are likely to be important for both annual and perennial species which are adapted to seasonal inundations.

None of the species identified during on-site investigations were listed under the EPBC Act, and only one species (*Distichostemon barklyanus*) was listed as data deficient under the TPWC Act and as a taxa with a geographic range exceeding 100 km with the potential to belong to a conservation category by White *et al.* (2000) (Appendix Twenty Five). No weed species were identified during on-site investigations, although a number of species are known to occur in the region (Appendix Ten).

## 5.3. Site Description Summaries - Fauna

Site description summaries, including species identified at each site are provided in Appendices Seventeen – Twenty-Four. A full list of fauna identified during on-site investigations is provided in Appendix Twenty-Six. In general, the area does not exhibit any special features although one species (Australian bustard, *Ardeotis australis*) of conservation significance (TPWC Act) was identified.

### Birds

Eight birds were recorded during on site investigations (Appendix Twenty-Six) including one bird species of conservation significance, the Australian bustard (*Ardeotis australis*). Within the surrounding region over 90 bird species have been recorded in habitats similar to those in the project area and many of these species are likely to occur within the project area. Sand plain habitats are likely to support the greatest bird diversity owing to the micro-topographic diversity and density of habitat, as well as a range of food resources due to the variable phenology of plant species that occur from ridge to flood out. Ephemeral areas are also likely to be important habitats during wet seasons for many

migratory species. In general though, species listed are not especially uncommon or rare in a regional sense. Most present and potential species are wide-ranging.

#### *Mammals*

Eight mammals were recorded during on-site investigations (Appendix Twenty-Six). Trap captures were relatively low over three nights and ranged from 5 individuals (Trap Site 4 and 5) to 21 individuals (Trap Site 3). Highest trap captures were recorded in Trap Site 3, which was not recently burnt. Unburnt areas are likely to act as refuges for some species, although there was an abundance of seeds available for small mammals to collect in some of the burnt sites. Weather during the survey was relatively cold and this may have reduced small mammal activity, although all sites had some trapping success. None of the species recorded was listed under the TPWC Act or EPBC Act for conservation significance. However, habitats in the project area, particularly the acacia shrublands and hummock grasslands are suitable for bilby (*Macrotis lagotis*) and mulgara (*Dasycercus cristicauda*) and both of these species have been recorded within the surrounding region (Appendix Fifteen). Further, there is potential habitat in the open woodlands to the south-west of the project area for spectacled hare wallaby (*Lagorchestes conspicillatus*) and northern naitail wallabies (*Onychogalea unguifera*), of which the former has been recorded within a 50 km radius. No sign of any of these species was observed during on-site investigations.

#### *Amphibian and Reptiles*

No amphibian species were recorded during on-site investigations (Appendix Twenty-Six). Very low numbers of reptiles were recorded, with only one species (sand goanna, *Varanus gouldii*) identified and very few identifiable tracks found. However, weather during the survey was likely to be too cold for high reptile activity, and high winds also limited the ability to identify tracks on the ground. Low activity may also be attributed to site characteristics e.g. recently burnt, although there was not a significant difference between reptiles seen or trapped in burnt and unburnt sites, suggesting that weather may be the primary factor. Within the surrounding region, 50 reptile species have been recorded, and habitat is suitable within the project area for many of these species.

### **5.4. Site Description Summaries – Flora Map**

Descriptions of land units and a map of the project area are provided in Appendix Twenty Seven and Twenty Eight respectively. Land units have long been used as classification units (Perry *et al.* 1962) and have been suggested by many authors as surrogates for diversity (Ferrier and Watson 1997, Oliver 1998, Smart *et al.* 2000). Land units were therefore considered the appropriate level at which to commence stratification of the landscape and as an alternative to a vegetation map. Existing land system mapping for the project area and surrounding region is described by Perry *et al.* (1962) and Stewart *et al.* (1954) although not at a sufficient scale to distinguish between land units within the project area. An alternative system was regolith (defined as the mantle of material that overlies

bedrock) mapping which describes 12 units within the project area (derived from Rio Tinto). Low *et al.* (2001) showed that regolith units could be re-interpreted in a systematic way to provide meaningful inferred land units. Following the procedure employed by Holmes and Low (2000), Low *et al.* (2003a, 2003b) and Moon and Low (2006, 2007) regoliths with similar geology, soils and landform were grouped into inferred land units resulting in the formation of 11 land units over the study area. This was extended spatially using standard GIS procedures. Ground truthing of these land units was beyond the scope of works, although recommended if future surveys are undertaken. Vegetation for each unit was derived using the NT Flora Atlas sites. More specific vegetation sampling is recommended.

## **6. Impact Assessment**

### **6.1. Legislative Context**

The proposed operations will be subject to the following legislation and land clearing guidelines

Key Legislation:

- Environmental Assessment Act 1982;
- Territory Parks and Wildlife Conservation Act 2000;
- Weeds Management Act 2001;
- Environment Protection and Biodiversity Conservation Act 1999;
- Environmental Offences and Penalties Act 1996;
- Soil Conservation and Land Utilization Act 2001 of the Northern Territory;
- Heritage Conservation Act 2000;
- Meteorites Act 2000;
- Northern Territory Weed Management Act;
- Environmental Assessment Act 1982;
- Environmental Offences and Penalties Act;
- Environment Protection (National Pollutant Inventory) Objective;
- Litter Act;
- Water Act; and,
- National Environment Protection Council (Northern Territory) Act.

Land Clearing Guidelines:

- Northern Territory Planning Scheme – Land Clearing Guidelines 2006 (Technical Report No 27/2006)

Other:

- Minimum Construction Requirements for Water Bores in Australia

## **6.2. Potential Impacts of the Proposed Operation:**

The extent to which the proposed operations will affect the environment will vary greatly depending on the size of the operation. In order to determine whether this will affect the environment at a national level, criteria from the EPBC Act are reviewed. In order to determine whether this will affect the environment at a bioregional level, criteria for identifying important habitats (Neave *et al.* 2006) are reviewed. In order to determine whether this will affect the environment at a local level, data provided herein is reviewed.

## **6.3. Potential Impacts of the Proposed Operation: National Level**

The EPBC Act (revised 2005) came into force in July 2000. Since the inception of the Act, any proposed project that will have a significant impact on a matter of national environmental significance must be referred for approval by the federal Minister for the Environment.

There are six areas in which a project may have an impact of national environmental significance. These include:

- Impact on World Heritage properties;
- Impact on Ramsar wetlands of international importance;
- Impact on listed threatened species and communities;
- Impact on migratory species protected under international agreements;
- Nuclear actions, and;
- Impacts on the Commonwealth marine environment.

Of these six areas only two, protected migratory species and threatened species and communities, were potentially of interest to the current project.

No protected migratory species have been identified within the project area or surrounding region, though eight species are listed by DEWHA in the EPBC Act as potentially occurring in the area (Appendix Eight). As there are no large drainage channels or drainage basins within project area or surrounding region there is not a significant amount of potential habitat for these species in the area, although ephemeral areas may be important in good seasons. Hence, migratory avifaunas are only likely to appear during significant wet seasons when rainfall is large enough to cause local flood events.

No threatened ecological communities or flora have been identified within the project area, although three threatened fauna species (yellow chat, *Epthianura crocea*, mulgara *Dasycercus cristicauda* and bilby *Macrotis lagotis*) have been identified within the surrounding region. Whilst we cannot rule out that these species could occur within the project area, on-site investigations indicate that significant or major

populations are unlikely, and in particular there is more appropriate habitat for the yellow chat in the cracking clay and swamp depressions to the north-east, where it has been previously recorded.

#### **6.4. Potential Impacts of the Proposed Operation: Bioregional Level**

Neave *et al.* (2006) identify a number of criteria for identifying important habitats within the Finke and Burt Plains Bioregions and each of these is discussed with reference to the current and previous surveys conducted within the project area and surrounding region.

Criteria for identifying important habitats include:

1. Habitat with high species richness, that supports a high abundance of native species, and/or is structurally complex. These attributes may relate to the: number of vegetation types and the degree of contrast between them; availability of shelter sites (e.g. nesting sites, ground litter and logs, rock crevices) and water and food resources (e.g. presence of nectar producing shrubs); and/or • topographic / geological complexity creating a range of micro-habitats.

Assessment:

The project area and surrounding region do not fully meet the characteristics of this criterion. The main vegetation community of the project area is described as *Eucalyptus opaca*, (bloodwood) low open-woodland with *Triodia pungens* (soft spinifex) hummock grassland understorey (Wilson *et al.* 1991). This particular vegetation community covers hundreds of square kilometres in the Northern Territory (Wilson *et al.* 1991), and the project area constitutes a small proportion of this community. On a regional scale the vegetation and landscape of the project area is not considered threatened or significant. This is highlighted by the relatively low number of flora and fauna species of conservation significance identified by existing data sets and on-site investigations, and the relatively low number of survey sites with multiple height classes.

2. Habitat supporting species of high conservation value (e.g. threatened species, endemic species, poorly reserved species and/or rare species).

Assessment:

The project area and surrounding region do not fully meet the characteristics of this criterion. On site investigations within the project area did not identify any fauna species of conservation significance that would solely rely on that habitat. However, habitat in the project area and/or surrounding region supports a small number of flora and fauna species of conservation significance. In particular this includes flora species *Bonamia alatisemina* and *Sporobolus latzii* and fauna species Australian bustard (*Ardeotis australis*), yellow chat, (*Epthianura crocea*), mulgara (*Dasycercus cristicauda*), and bilby (*Macrotis lagotis*).

3. Habitat that is of good quality (i.e. its compositional and structural integrity and ecological processes have not been undermined). The level of habitat integrity is influenced by:

- The presence/absence (or low cover abundance) of environmental weeds, especially Buffel Grass and Couch Grass, both of which are known to outcompete native plant taxa and alter habitat parameters for native fauna;
- The presence/absence (or low abundance) of introduced animal species;
- The presence/absence of an appropriate fire regime (inappropriate regimes are known to impact on species composition and canopy condition);
- Degree of isolation from infrastructure such as roads and waterpoints (reduced risk of weed invasion and over-grazing); and,
- The state of the hydrological regime (altered regimes may lead to changes in site species composition).

Assessment:

The project area and surrounding region do not fully meet the characteristics of this criterion. Whilst no weed species were identified during on site investigations, several are known to occur in the surrounding region. The project area is also in close proximity to infrastructure (major highway), and introduced species were recorded (albeit at low numbers).

4. Habitat that is poorly reserved elsewhere.

Assessment:

The project area and surrounding region do not fully meet the characteristics of this criterion. Although the closest reserve is the Davenport Ranges, habitat found within the project area is characteristic of typical habitat found within the surrounding bioregion. The area does contain several diverse plant communities with a high number of young seedlings, although flora and fauna in the area are generally common and widespread.

#### **6.5. Potential Impacts of the Proposed Operation: Local Level**

Vegetation communities in the project area are dominated by common *Aristida*, *Atatlya*, *Acacia*, *Grevillea*, *Hakea*, *Melaleuca* and *Triodia* species and the proposed operations will result in localised loss of habitat for these species and local alteration of landscape. However on-site investigations did not identify any species of high conservation value under the TPWC Act/EPBC Act and most of the plants and associated vegetation communities are common in the region. However, 14 flora species listed as significant by White *et al.* (2001), or as data deficient under the TPWC Act, have been recorded within the surrounding region and six of these were found in the project area. Further, ephemeral areas, and also run-on and run-off areas, are likely to be important for both annual and perennial species. The proposed operations may result in disturbance to these areas, although a

number of management strategies can be adopted to minimise disturbance. These are outlined in sections to follow.

Vegetation clearing for the proposed operation will result in localised habitat loss for the fauna living in the impacted area, particularly those in the area of the pit, tailings facility (if required), campsite and access roads. Mining will also indirectly impact on the local fauna through increased noise, vibration, dust, lights, roads, increased human activity and possible alteration of the natural drainage patterns. Although these disturbances will reduce populations in the affected parts of the project area, most species are common and widespread throughout their range and their status is unlikely to be altered. However, there are some species of conservation significance that may be adversely affected by the mining operation.

Only one fauna species of conservation significance (Australian bustard, *Ardeotis australis*) was identified during on-site investigation in the project area, although there are a number species of conservation significance that have been previously identified within the project area and/or surrounding region. Those species that have a conservation status at or above vulnerable (TPWC Act/EPBC Act) are discussed below.

The Australian bustard (*Ardeotis australis*) is listed as vulnerable under the TPWC Act and is known to occur in the project area. Distribution of the bustard is widespread, though they are generally not common in the north and tend to occur in loose aggregations (Woinarski *et al.* 2007). Numbers are likely to fluctuate depending on seasons, and due to the highly mobile nature of the species, small, localised disturbance is not likely to affect its status. Habitat alteration on a much larger scale than this project is likely to be a threatening process.

The yellow chat, (*Epthianura crocea*) is listed as Endangered/Lower Concern under the NT Parks and Wildlife Fauna Atlas and as Vulnerable under the EPBC Act, although it is the northern subspecies *E. tunneyi* that is of particular concern. This species has not been recorded south of about Katherine and is restricted to a small geographic area encompassing floodplains from the Adelaide River to the East Alligator River (Woinarski *et al.* 2007). *Epthianura crocea* occur across northern Australia, typically in chenopod shrublands and grasslands around water sources. The more common sub species has been recorded about 20 km north-east of the project area, in cracking clay country with swamp depressions, a habitat not found within the project area. The status of yellow chats on a local scale is therefore not likely to be affected by the proposed operations.

The bilby (*Macrotis lagotis*) is listed as vulnerable under the TPWC Act and EPBC Act. Bilbies have not been recorded in the project area and no bilby sign was identified during on site investigations.

However, bilbies have been recorded 40 km south-west of the project area (in 1994), and habitat is suitable within the project area for bilbies to occur, although there are very few records post 1970 in the Barkly area. Woinarski *et al.* (2007) describes the suitable habitat as sandy soils dominated by hummock grasslands covered predominantly by spinifex and an overstorey of low shrub cover dominated by *Acacia* and *Melaleuca*. The sandy landscape also often comprises rocky outcrops, lateritic rises and low-lying drainage depressions. As there was no sign of bilbies in the project area, it is unlikely that the status of this species will be affected on a local scale. On going monitoring should occur to identify any potential populations.

The mulgara (*Dasycercus cristicauda*) is listed as vulnerable under the TPWC Act. Mulgaras have not been recorded in the project area and no sign of mulgaras was identified during on-site investigations. However, mulgaras have been recorded 40 km west-south-west of the project area in 1993, and habitat is suitable within the project area for mulgaras to occur. Masters *et al.* (2003) describe the principle habitat for mulgara as hummock grasslands of spinifex, especially *Triodia basedowii* and *T. pungens*. Although there was no sign of mulgara recorded, the survey was limited in its ability to detect smaller mammals due to high winds. Additional surveys may therefore be warranted, and this is discussed in the management recommendations.

## **7. Management Recommendations**

One of the aims of an environmental survey is to identify features of the landscape and biota that should be considered in the project development in order to avoid or minimise potential adverse impacts and optimize rehabilitation. The aim of rehabilitation is to return the landforms and wildlife to a stable condition, as near as possible to their original state. Rehabilitation needs to be an integral part of the mining plan and be applied progressively throughout the mine development. The following are guidelines for site planning and management.

### **7.1. Management of Significant Species**

Species of conservation significance that have been identified in the project area and/or surrounding region include flora species *Bonamia alatisemina* and *Sporobolus latzii* and fauna species, Australian bustard (*Ardeotis australis*) yellow chat, (*Epthianura crocea*), mulgara (*Dasycercus cristicauda*), and bilby (*Macrotis lagotis*).

White *et al.* (2000) note that the Wonarah Beds Site is of bioregional significance and there is the potential for a number of species of conservation significance to occur in this area. Land unit mapping derived herein suggest that *Sporobolus latzii* has been identified within the ephemeral lakes land system, the largest of which occurs to the north of the Arruwurra prospect. This area is currently within an exclusion zone which will prevent any major works, so it is unlikely that there will be any significant

impacts in this area. However there is potential for *Sporobolus latzii* to occur in other low lying drainage depressions and areas subject to prolonged water inundation. The lower areas of the alluvial (low lying) sand plain and shallow sand plain land units would be typical areas where this could occur. The survey described herein was conducted after a fairly mild wet season, so these areas could not be identified. In the future though, if work is being conducted during or after a normal wet season, areas that retain water can be marked for future reference. In the absence of this, contours at 5 m intervals and detailed digital elevation models can be analysed to determine lower lying areas within the project area, so that, where possible works can be restricted or impacts minimised. Rio Tino prepared a procedure for protecting *Sporobolus latzii* on the Wonarah tenements, and this should be adhered to (see Appendix Twenty Nine).

*Bonamia alatisemina* was identified within the calcareous plain land unit, although due to the data deficient status of this species distribution little can be extrapolated with respect to its occurrence throughout the project area. Management should therefore aim to prepare a procedure for protecting *Bonamia alatisemina* on the Wonarah tenements, and this should be adhered to. A general induction manual for all species listed in Appendix 12 should also be prepared so that all workers are aware of the key flora species of conservation significance.

The Australian bustard (*Ardeotis australis*) is listed as vulnerable under the TPWC Act and is known to occur in the project area. As this species is widespread it would not likely be impacted by the proposed operation, and no specific management procedures will be required. However, vehicle speed should be restricted on unsealed roads within the project area to reduce the chance of road kills.

Habitat in the project area is not likely to be suitable for yellow chat, (*Epthianura crocea*), although on going bird monitoring should occur throughout the project and at different seasons, particularly around any areas with water.

Mulgara (*Dasycercus cristicauda*), and bilby (*Macrotis lagotis*) were not identified during on-site investigations, although weather conditions may have restricted the ability to trap the former. Therefore a program of monitoring is provided in Section 7.8, which will help to identify mulgara. On going monitoring will be required to monitor if bilby inhabit the area, and as a start, a walk-over survey of all areas should be conducted prior to the commencement of any work. Sightings should be reported to the consultant or Parks and Wildlife Service of the Northern Territory. Induction manuals for all personnel working on site can also be prepared to help identify sign for bilby and any other species of conservation significance, including spectacled hare wallaby (*Lagorchestes conspicillatus*) and northern nailtail wallabies (*Onychogalea unguifera*).

As for other notable species, short surveys of a few days duration are unlikely to detect all species, rare or otherwise, within the large project area. If species are found during development of the mine, development plans may need to be reviewed so impact on these species can be considered and minimised if necessary. Observations of species of plants or animals of unknown identity should be reported to the consultant or Parks and Wildlife Service of the Northern Territory. If possible, reports should be accompanied with a detailed description, including location and if possible a photo.

Dingoes were recorded throughout the project area, and, although they are likely to be at low numbers several management strategies can be introduced to minimise access to food and water resources which will, in turn, reduce the chance of animal and human welfare incidents. In particular these include:

- Undertaking inductions for all workers on site about not feeding or interacting with dingoes;
- Separating food from normal waste and burning in a separate location;
- Installing predator-proof fencing around all food waste areas;
- Installing dingo proof bins;
- Maintaining clean work and camp sites;
- Minimising access to artificial water sources; and
- Monitoring dingo movements and behaviour.

## **7.2. Management of Introduced Species**

Introduced and feral species already existing within the project area and surrounding region are listed in Appendix 15. Management practices should minimise the potential for spreading or increasing introduced species. Control of weed and feral species will minimise disturbance to the local environment and greatly assist rehabilitation programs.

Weeds: Mining development will lead to increased disturbance and potential for the introduction and spread of weed species. A program for weed identification and control should be implemented. Control of existing weed species prior to mine activity, particularly in areas used by mine vehicles, will reduce weed spread. Potential invading weed species are listed in Section 4.6. The presence and spread of these species should be reported to the district Weeds Officer (Dept of Infrastructure, Planning and Environment (DIPE)). The area should be examined by a weeds officer annually. Identification pictures and description of expected weed species should be provided to staff as a part of the mine site induction so they can easily distinguish between natives and weedy plants and avoid spreading seeds from weeds.

Machinery brought into the lease areas should be “washed down” before use on-site. Topsoil from weed-infested areas should not be used in revegetation work. Any weeds establishing in rehabilitation areas should be immediately eradicated before they set seed. Monitoring of weed spread by periodic mapping at the beginning of the wet season is advisable. Preventative and control measures for weed spread should be developed in consultation with DIPE or a qualified weeds officer. Any landscaping within the project area should only use local native species.

Feral animals: mining operations have the potential to significantly increase the feral animal populations in the area. Feral cats and rodents may be attracted to exposed rubbish dumps and artificial water resources. Rubbish tips should be covered and fenced to avoid attracting these animals. Control of feral animals by fencing out stock may be necessary to prevent damage to sites undergoing rehabilitation. Access to artificial resources, that may attract other feral animals, such as camels and donkeys, should be minimised so that the mine does not aid in population increases. Efforts to control these species should be considered when developing a feral animal control program as part of the mine management plan.

### **7.3. Rehabilitation**

The land use of the mine site following decommissioning will influence the program of rehabilitation. At present there are no rehabilitation requirements dictated by future land use (i.e. more open cut pits, tourism etc.) therefore rehabilitation should aim to restore the land to as near its original condition as possible.

In general, basic rehabilitation practices require that:

- The site be maintained and left in a stable and safe condition;
- Natural drainage and soil erosion control are maintained or reinstated;
- Residue of toxic hazards are removed from the site and action is taken to ensure there is no contamination of the surrounding environment;
- The reshaped land and created landforms are compatible with the adjacent landscape; and,
- The project area is revegetated to the point where a self-sustaining community exists, comprising native species (flora and fauna) typical of the surrounding country.

Rehabilitation should be progressive so disturbed areas are stabilized before erosion develops. This will minimise the impact on the local environment and maximize the extent of rehabilitation completed during the operation period. The rehabilitation program needs to combine the application of standard methods with monitoring and research in order to customize techniques.

In the first year of the projects operation the rehabilitation program should be initiated with conservation of top soil, control of existing erosion, removal of existing weeds and revegetation of disturbed areas surplus to operational requirements. In addition, all drill holes should be capped as they are a hazard to local fauna. This practice is currently being adhered too.

Basic rehabilitation and management methods for disturbed sites are discussed in more detail in sections 7.4 to 7.8.

All facilities and equipment should be removed after mining ceases. Any concrete foundation should be buried or removed. All sites of disturbance need to be rehabilitated. The location of mining infrastructure is unknown at this point; however, land formations likely to remain after mining is completed may include an open cut pit and waste rock dump. Monitoring and maintenance of the rehabilitated mine site will need to be continued after decommissioning to ensure rehabilitation has achieved a self-sustaining environment acceptable to Department of Primary Industries Fisheries and Mines (DPIFM).

#### **7.4. Recommended locations for Mining Components**

Mining infrastructure should be constructed in a way to minimise impact on the environment, avoid excessive clearing of vegetation, minimise erosion potential and minimise visual impact. Mining components such as stockpiles, waste dumps, offices and accommodation should preferably be located in land units that are common within the project area. The area chosen should have the lowest potential for erosion and impact on natural drainage when compared to other land units in the local area. Where practical, existing areas of disturbance should be used before pristine country is cleared to make room for the mining components.

Haul road placement will be largely influenced by location of the mining infrastructure. The area covered by roads should be kept to a minimum. Roads should be planned carefully to avoid disturbing natural drainage, areas of thick vegetation cover and dividing habitat such as granite outlier hills. Where possible, existing roads should be used and modified to ensure they are suitable for frequent usage and to minimise erosion.

Any waste rock dump should be designed to blend into the landscape in areas with low erosion potential and where vegetation communities are common and widespread. If possible though, the pit should be backfilled when sufficient volume of phosphate has been removed.

#### **7.5. Erosion and Watercourse Management**

Erosion control and conservation of natural drainage require attention in the design, construction and operation of the mine. Appropriate management of surface runoff and sediment load from disturbed areas should minimise erosion potential and minimise siltation of watercourses. Drainage lines are

environmentally sensitive, species rich and provide refuge for much of the fauna through the dry season. Minimal disturbance to the natural drainage will result in minimal disturbance to the local environment, provide buffer areas for the local wildlife and reduce costs in drainage management, erosion control and rehabilitation.

Erosion potential can be reduced by careful planning, avoiding drainage areas, minimising areas of disturbance, vegetation rehabilitation and drainage control. New and existing areas of land disturbance, particularly with steep gradient, will require drainage control to reduce erosion potential and siltation of watercourses. Although there are no major watercourses in the project area, drainage control entails constructing new drainage systems in order to direct water flow away from disturbed soils, and protection of existing drainage from pollution by suspended sediment (ERA 1993). In constructing waterways the drainage system of the whole region needs to be considered in the planning process i.e. management needs to alleviate both regional and local problems (Law 1992). Changing the natural water flow of the area should be minimised. Design and construction of any structures required to control water drainage will require consultation with relevant engineers and DIPE.

Water diversion structures should be built to divert runoff from disturbed areas. They need to be constructed to withstand maximum rainfall events (1 in 500 years). Where possible, water should be diverted back into original drainage once all suspended solids have been removed (Law 1992). The manmade drainage systems should be constructed with a broad flat base, avoiding high velocity and thus erosion of the drain itself (Gratridge and Low 1996). Water should be directed to sediment traps before release into the natural drainage system. Trapped water should be released into the natural drainage lines at appropriate points where impact will be minimal (Law 1992). Release points may need to be rock-lined and energy dissipaters designed to reduce water velocity (Law 1992).

Haul road and access tracks can funnel water and often cause gully or rill erosion problems (Law 1992). Where possible, roads/tracks should avoid watercourses, steep sided slopes and permanently wet or boggy areas. Design and construction of roads should follow specific recommendations for earthworks involving removal of vegetation and topsoil. Windrows should be avoided during the construction of roads, and structures for dissipating, or control of, runoff should be provided. On steep slopes roads are best designed to cope with water erosion if they follow topography and are cut into the side of the slope with an out-sloping camber. Water discharge can be controlled by providing table and catch drains which are diverted into a sediment trap prior to release into natural drainage.

Waste dumps are prone to water erosion and their design needs to incorporate water drainage control to provide a stable surface for revegetation. The relief of new landforms should not exceed 18° and the current trend is to reduce the slope to less than 10° so that topsoil will not easily move downslope. Rock

cladding of sloping surfaces using overburden material, 150 mm or greater, will provide some resistance to erosion. Rock materials that are likely to produce acids should not be selected for the rock cladding. Ultimately, revegetation of disturbed soils is the best way to control water erosion. Revegetation is best achieved by using top soil scalped from the footprint for the open cut pit, waste dump, road or permanent infrastructure and placing it over the surface of the waste dump before contour furrowing of the surface. If areas do not revegetate naturally, local seeds or rootstock produced from local seed can be planted using appropriate top soil or fertilizer, to revegetate the site.

## **7.6. Fire Management**

Fire is an inevitable and common environmental feature of the desert country south of the Barkly. The approach of “letting nature take its course” is an unreasonable option (Preece *et al.* 1989). This ignores the fact that humans have been influencing fire regimes for at least 40,000 years (Preece *et al.* 1989). Australian ecosystems and species are adapted to a dynamic fire regime but rehabilitating areas need to be protected from fire to assist revegetation.

Fire intensity, frequency and timing are important factors influencing ecological communities. Excessive burning (i.e. greater than once a year) in open woodlands may result in reduced complexity of flora and predominance of grasses in the understorey. Mott and Andrew (1985) determined that a number of perennial grasses such as *Sorghum plumosum*, *Heteropogon contortus* and *Themeda australis* prefer biennial burns. Active management can regulate and moderate wildfires so they have an acceptable impact on the environment (Preece *et al.* 1989). The establishment of a local fire management control program will ensure containment of wildfires.

Fire will not normally be a part of the project management plan; however, hazard reduction may be necessary when fuel load increases within the operational areas. Patch burning is the preferred method of reducing fire hazard. This method of fire management results in small fires which flora and fauna have a better chance of surviving. In addition to reducing the risk of intense or large-scale fire, a mosaic pattern of burning will produce a diverse range of habitats and hence maintain local biotic diversity (Preece *et al.* 1989).

Hazard reduction burning should be conducted annually or biannually at the beginning of the dry season (March to May). At this time the vegetation is less flammable and the soils are moist, which will favour the survival of stressed trees. Areas of severe erosion should be protected from burning, as removal of vegetation and intense heat will reduce soil stability and accelerate erosion. Appropriate permits are required from the Bush Fire Council.

### **7.7. Vegetation Removal and Revegetation**

To minimise clearing of vegetation, mining operations should attempt to use existing disturbed areas and roads where possible. Clearing of vegetation should be minimal and should be avoided in the ephemeral land systems and areas subject to inundation. Areas to be cleared should be clearly marked with flagging tape prior to any works. Vegetation clearing should be progressive, and conducted in stages as cleared areas are required, rather than initially clearing the complete footprint. This will avoid superfluous clearing, reduce erosion potential, retain seed sources for rehabilitation and allow local fauna to adapt to loss of habitat. Vegetation removed can be used for minor constructions such as ponding and sediment banks. Trees and shrubs could be stockpiled within waste dumps or placed on top to assist rehabilitation and create habitat for microfauna. This option is preferred to burning and results in less nutrient loss from the environment.

In areas targeted for earthworks the topsoil (top 100 mm), including groundcover plants, and subsoil (to about 300 mm) should be stripped and separately stockpiled for use in rehabilitation programs. Stripping and other earthworks should be performed during the dry season when chances of runoff erosion and destruction of soil structure is minimal. It is best to double-strip the topsoils by removing and separately storing the top 100 mm of the soil, which contains the significant proportion of the seed bank, nutrients and microfauna. Immediate use of topsoil on areas awaiting rehabilitation is the most productive option, because soil components such as microorganisms, seeds and organic matter will deteriorate during storage. If stockpiling of the soils is necessary, stockpiles should be stored away from drainage areas to reduce erosion and loss of useful soil material. Topsoil should be stored in low mounds, preferably less than 2 m high, to allow the seed bank to germinate. Stockpiles should be allowed to revegetate to protect against erosion and sustain microbe populations, which are essential to maintaining nutrient composition.

Progressive revegetation should begin as early as possible in the mining operation, so the area will end up as a mosaic of various regrowth stages of local vegetation types.

Revegetation of waste dumps will entail laying 5 to 10 cm of stripped topsoil (preferably less than 4 months old) over the waste rock, followed by contour furrowing or ripping. This will allow infiltration of rainfall, mixing of waste rock and topsoil and loosen the soil surface for sowing or planting of tube stock if the latter are required. Ripping should be carried out prior to the wet season (i.e. in October - November).

If seeds or seedlings are to be planted, only native local species should be used in revegetation and care needs to be taken to exclude weed species. Early in mine development plant revegetation trials should be established to determine if natural vegetation will be adequate for rehabilitation purposes.

These studies should be associated with mineralogical studies of the weathering products of the exposed waste rocks to gain an understanding of the soils forming on the waste dumps and to ensure that acid soils and leachate do not develop.

#### **7.8. Future Environmental Monitoring**

Due to unfortunate weather conditions during the surveys described herein, additional surveys will be required to identify species of conservation significance and to provide baseline monitoring data. Ongoing monitoring will also be required throughout the operation and rehabilitation phase of the project.

The additional surveys should be undertaken in the warmer part of the dry season and in the wet season. The surveys should replicate the methods described herein, and, if possible, extend to areas that were not previously surveyed. However, the survey should also include tracking by experienced traditional owners to aid in the process of identifying areas of ecological significance. Fauna sampling should also be extended to include bats using harp trapping and an anabat recorder. Unfortunately this was not possible for the initial survey due to equipment availability and high winds.

The vegetation mapping undertaken for this report was based on limited ground truthing, and if additional surveys are undertaken then a random selection of points should be allocated across the project area to determine how well the mapping related to on-ground features. Modifications can then be made where appropriate.

A program of environmental monitoring will enable ongoing assessment of the effects of mining in the project area and the success of rehabilitation will indicate remedial action if required. Environmental monitoring should pursue three main objectives:

- 1) Establish the pre-development environment to provide a basis for identifying potential impacts and associated remedial action, and to provide baseline for comparison with future conditions.
- 2) Monitor the projects, environmental impacts and identify unforeseen impacts.
- 3) Assess environmental management strategies and compliance with regulatory permits and licenses.

Collection of baseline data has been initiated with the surveys described herein, and this, in combination with the additional surveys outlined above, will provide an extensive data set. It is preferred and encouraged that surveys of the local fauna need to be conducted in both the wet and dry seasons in order to attain a representative list of species for the project area.

Concentrations of any weed species present on the project area should be mapped prior to major disturbance to avoid using weed-infested soils in revegetation programs and to monitor the effect of development on weed abundance.

Specific environmental aspects that require monitoring during the mining operations will depend on baseline data and final plans for placement of mine infrastructure. In general, ongoing monitoring programs will be required to assess impact and management issues concerning:

- Surface and ground waters
- Disturbed catchment areas
- Processed waters
- Relative abundance of introduced species (flora and fauna)
- Wildfire control
- Dust deposition
- Weathering products of mine waste (i.e. acid drainage)
- Revegetation and rehabilitation techniques

This summary of recommendations gives a broad overview of the impacts and standard requirements for mine establishment at Wonarah. Once the project details have been assembled, the environmental assessment should be extended to address specific environmental matters and management/monitoring strategies.

## **8. Scope Requirements**

We have answered the requirements of the scope as follows:

- Provided a description of the ecology of the area (habitats and faunal communities present), including a list of species identified during the field visit;
- Provided a list of all threatened flora and fauna present and likely to be present in the project areas, including GPS coordinates of recorded locations for these species;
- Provided classifications of these species in terms of their conservation significance at a local, regional, territory and national level;
- Provided a vegetation map (in the form of a land unit map) of the project area, and identified critical land units within the body of text;
- Provided a summary of the potential for significant impacts to listed threatened flora and fauna species and habitats as a result of the project; and
- Provided a summary of recommended management and mitigation measures to minimise the potential for significant impacts to threatened species identified as present or potentially present.

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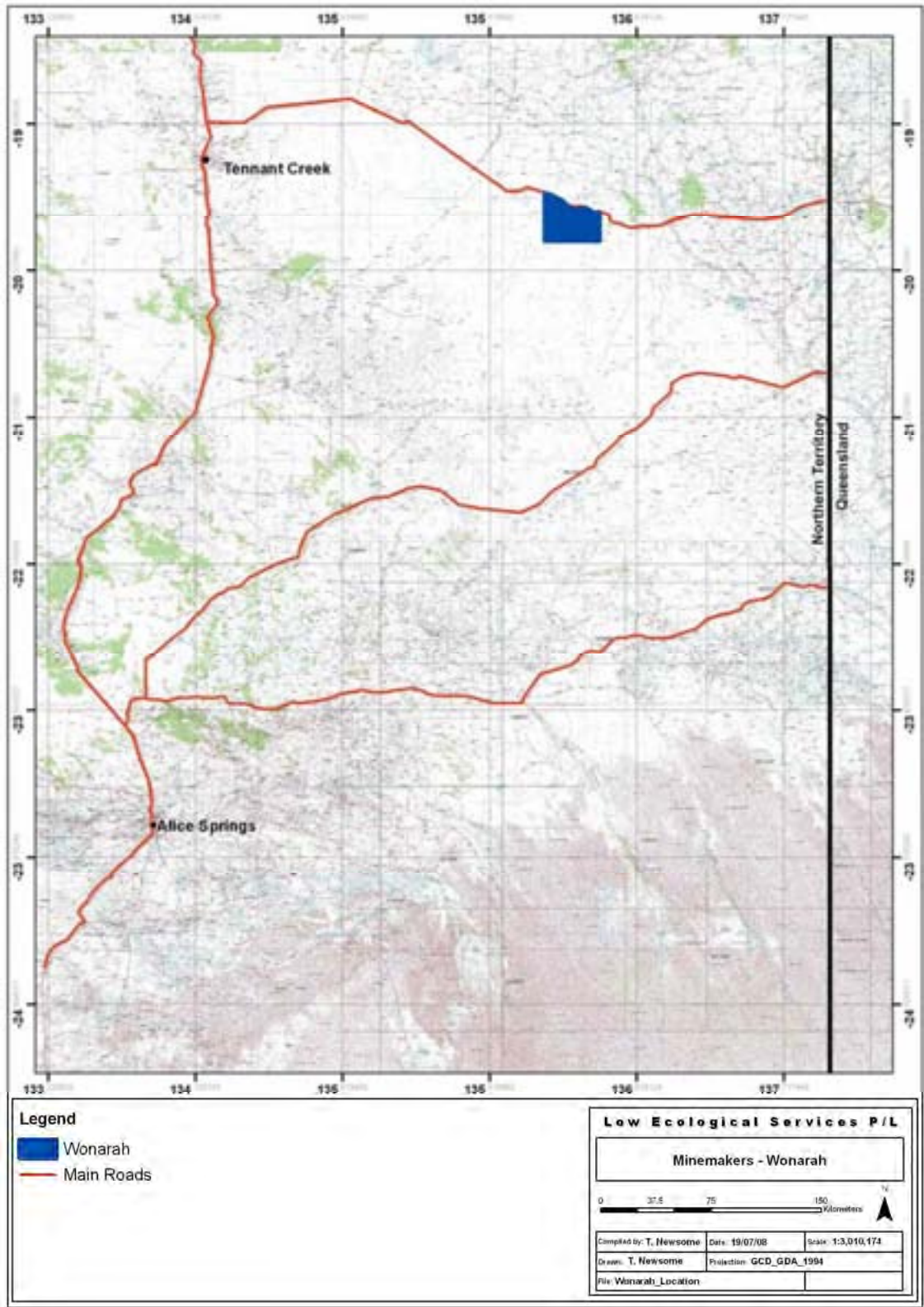
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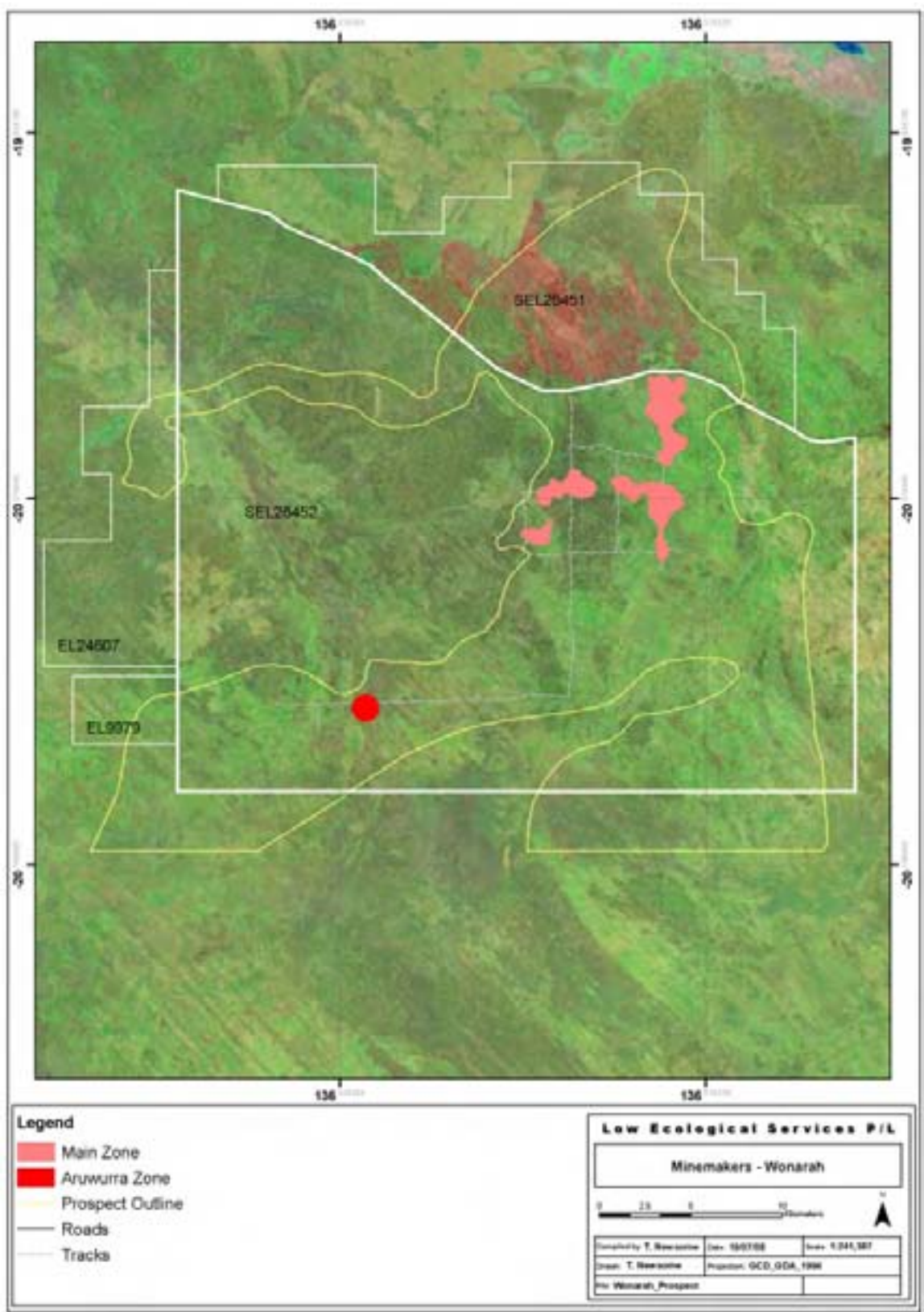
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10. Appendices: Plates, Figures and Tables

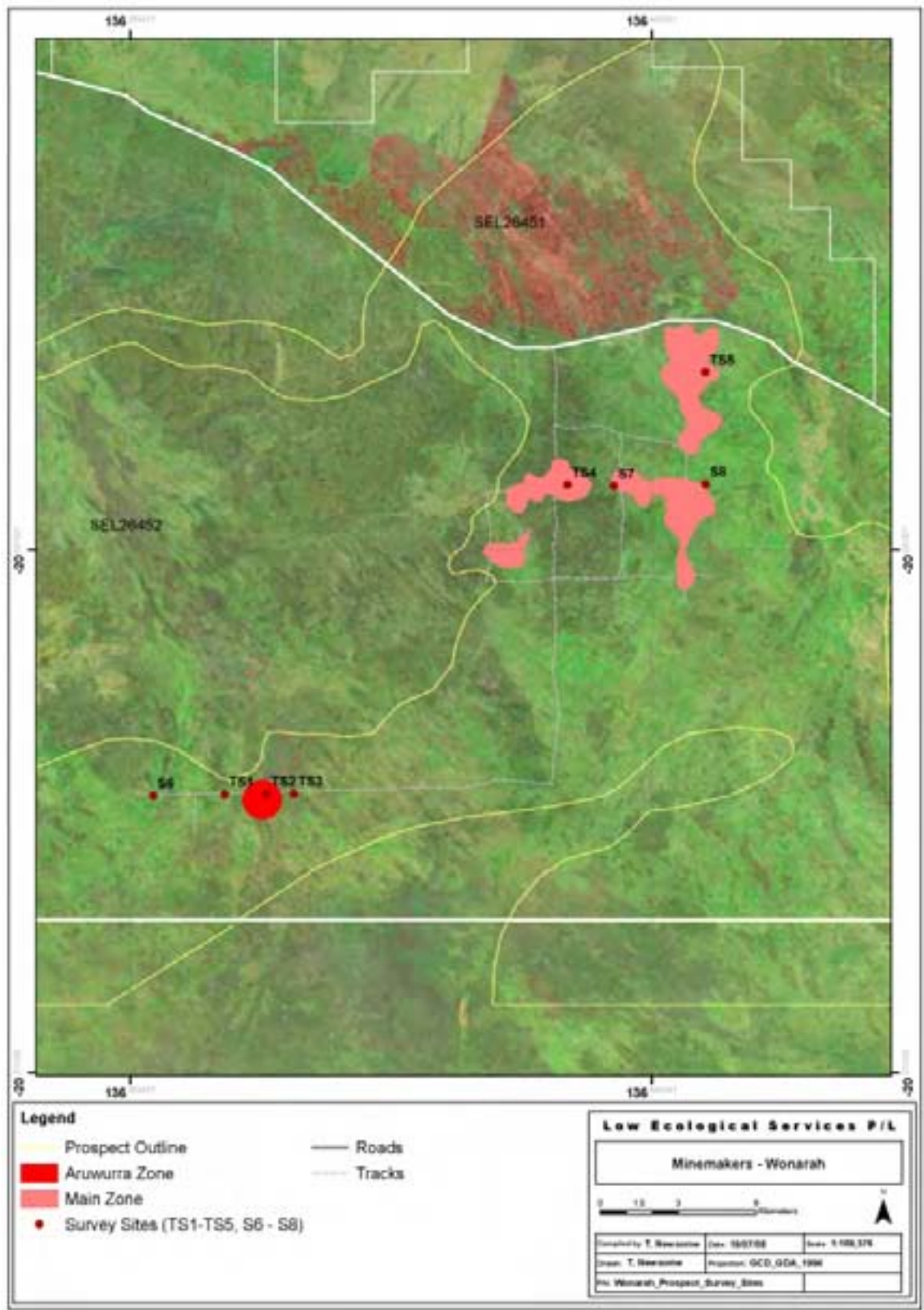
10.1. Appendix One: Location of Minemakers Wonarah prospect in relation to Alice Springs and Tennant Creek, Northern Territory.



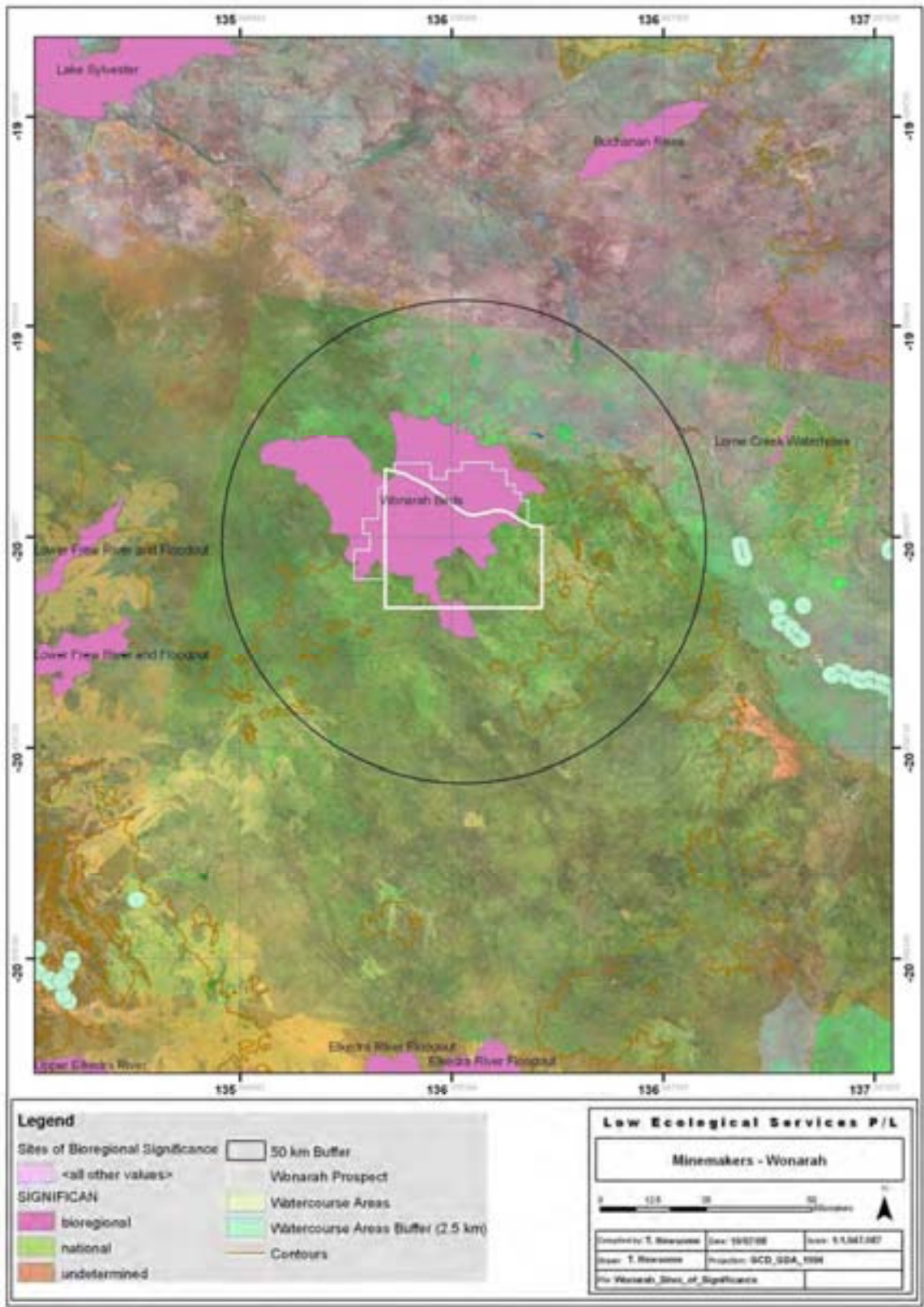
10.2      **Appendix Two:** Minemakers Wonarah prospect zones over Landsat 5 image.



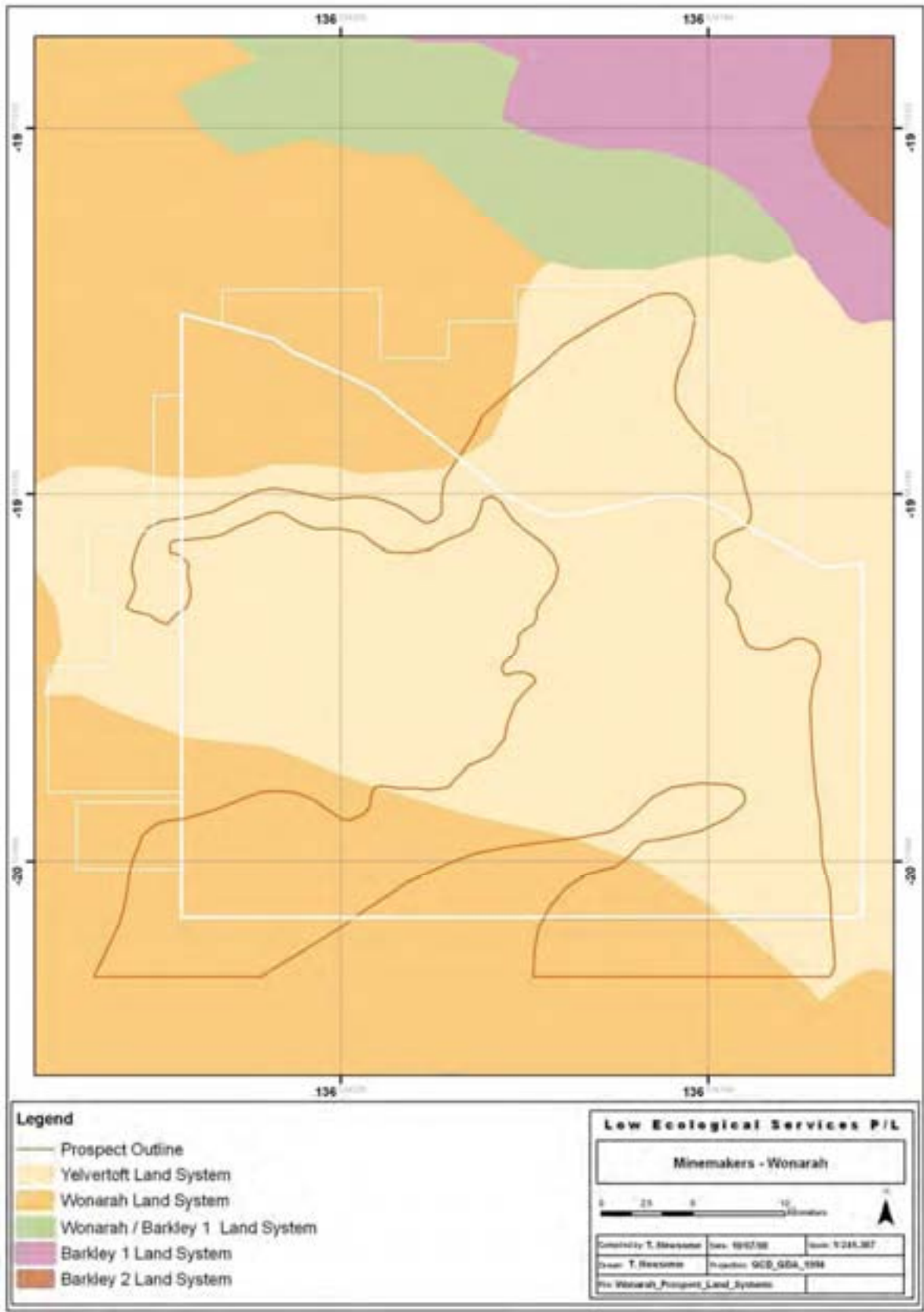
10.3 **Appendix Three:** Location of survey sites (s) selected by Low Ecological Services P/L over Landsat 5 image. TS refers to sites where trapping was undertaken.



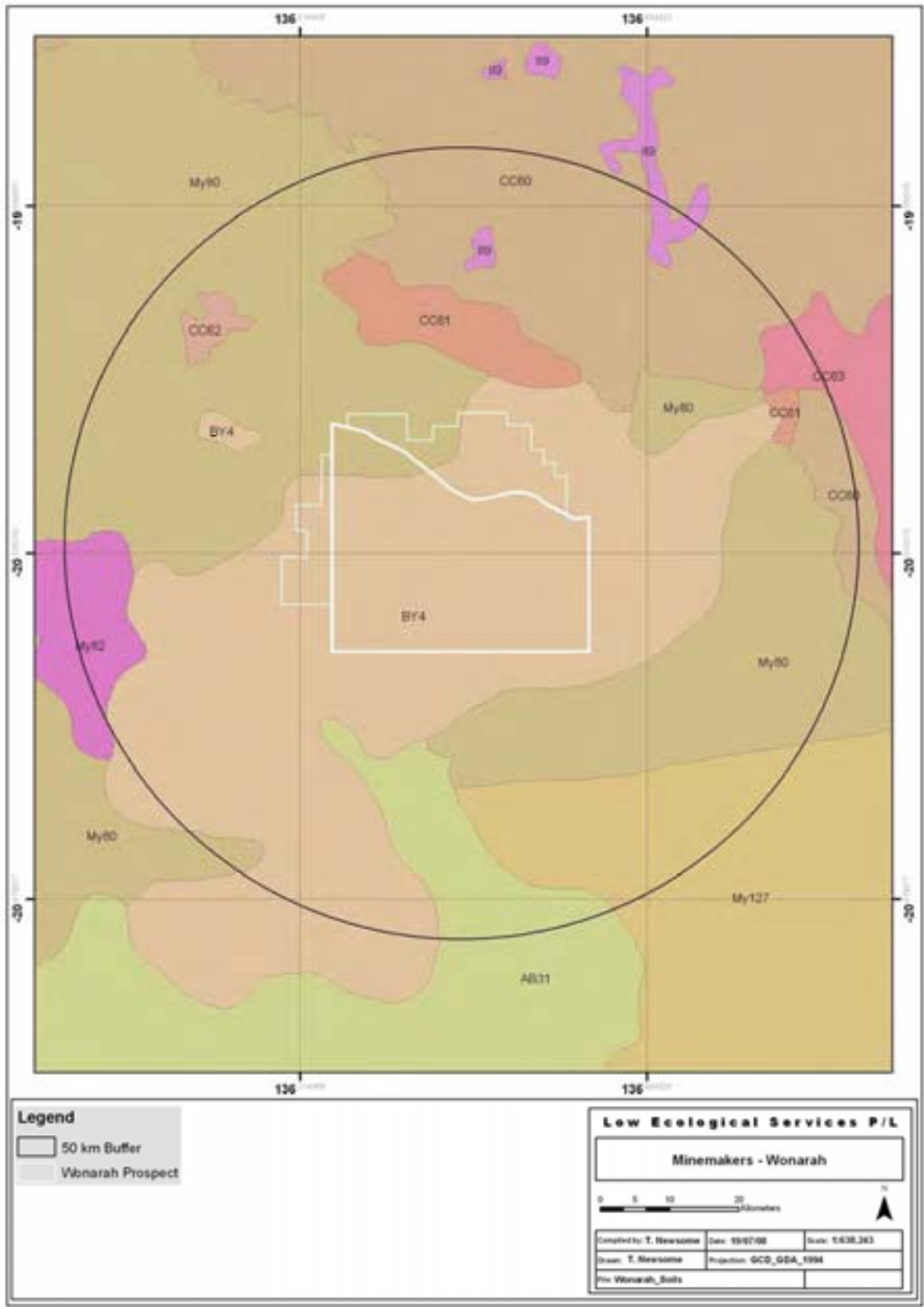
- 10.4. **Appendix Four:** Location of Wonarah prospect in relation to watercourse areas and sites of significance as determined by the Northern Territory Government Department of Natural Resources Environment and the Arts Parks and Conservation Masterplan over Landsat 5 image.



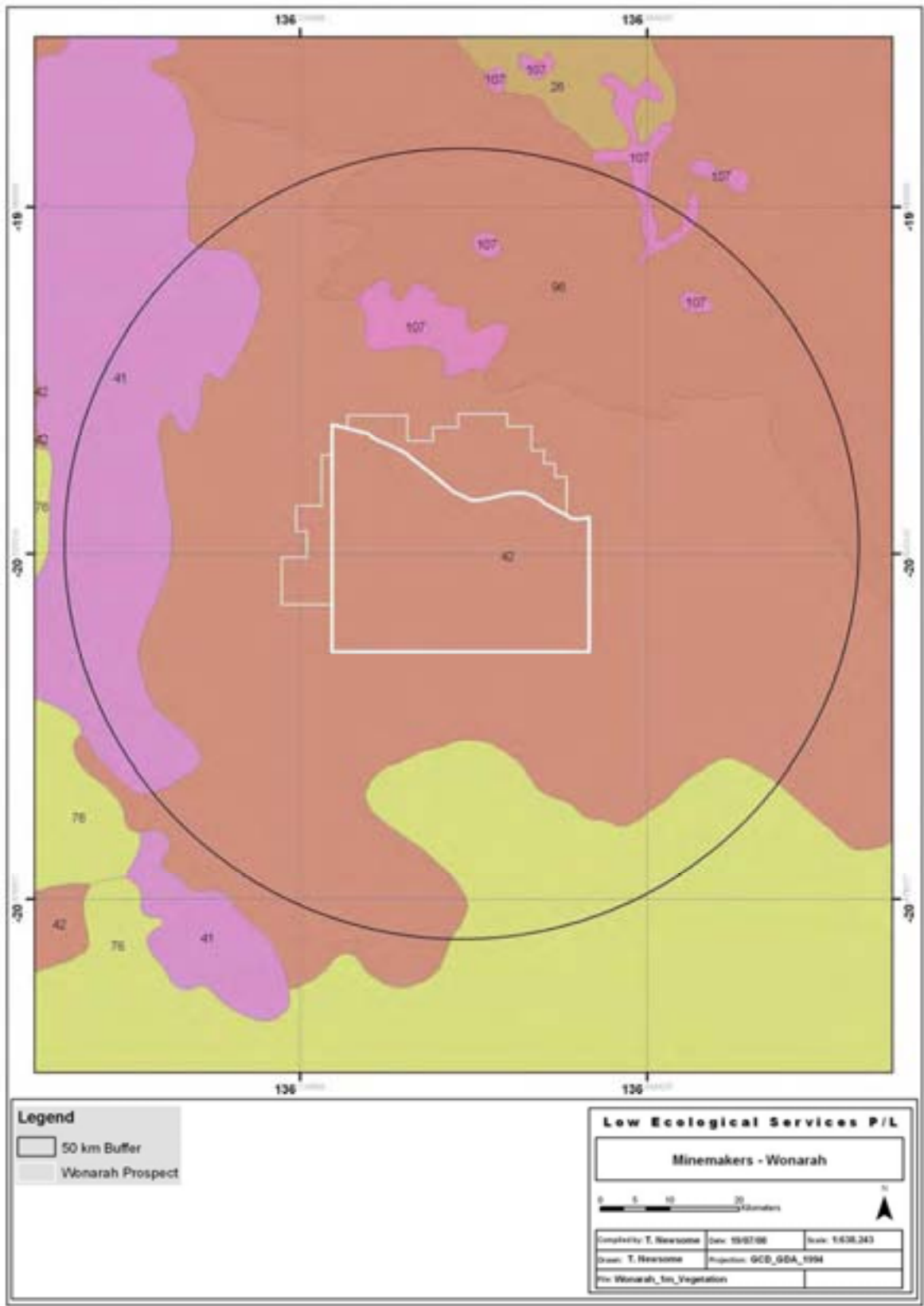
10.5. **Appendix Five:** Land Systems of the Wonarah Prospect. Modified after Perry *et al.* (1962) and Stewart *et al.* (1954).



10.6. **Appendix Six:** Classification of soils in the Wonarah Prospect and surrounding region (50 km) (Bureau of Rural Sciences 1991).



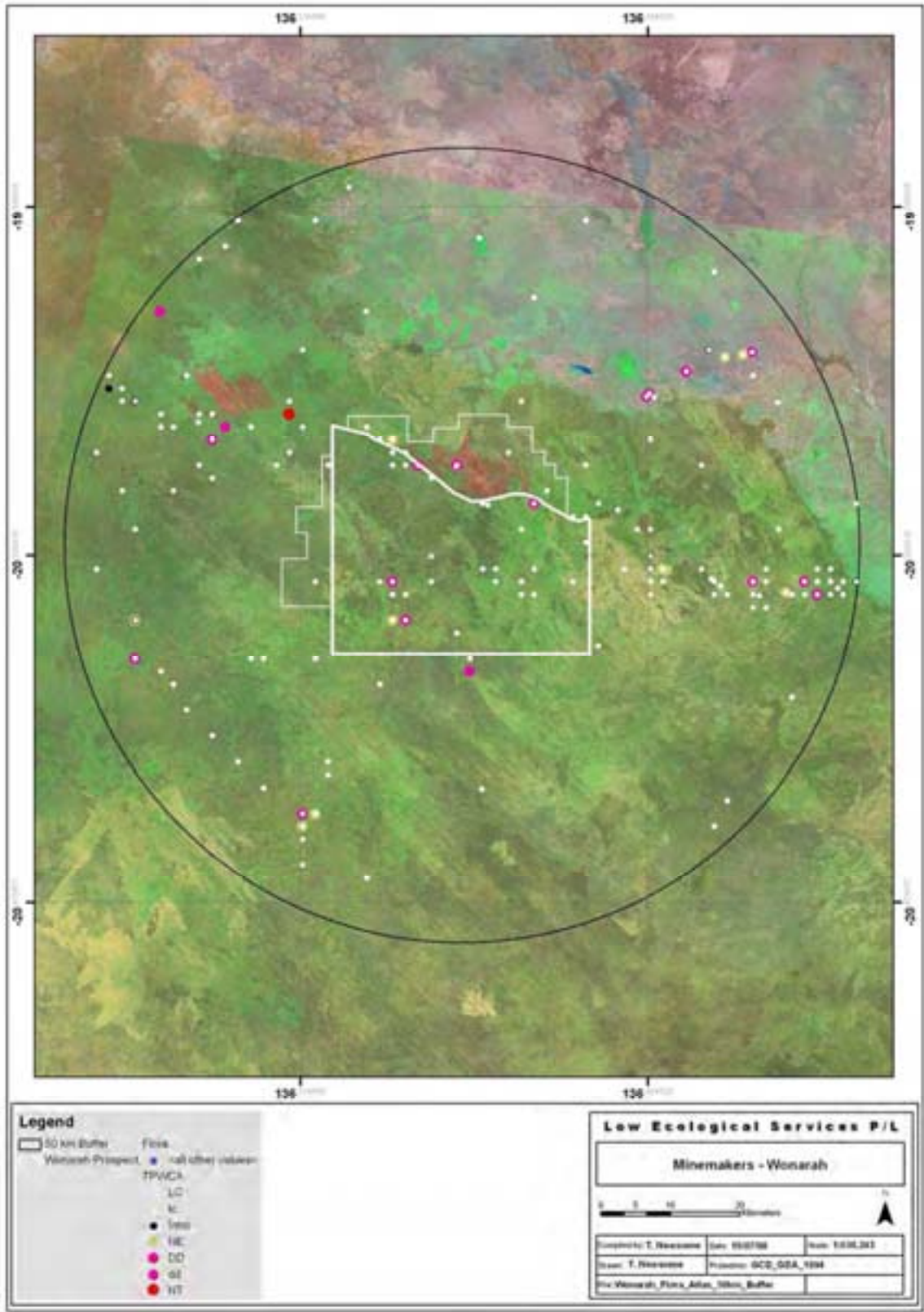
10.7. **Appendix Seven:** ARC/INFO coverage's for the 1:1,000,000 NT vegetation map (Conservation Commission of the NT, 1991) in the Wonarah Prospect and surrounding region (50 km).



- 10.8. **Appendix Eight: Matters of Environmental Significance (Department of Environment Water Heritage and the Arts):** Species of Conservation Significance listed under the *Environmental Protection and Biodiversity Conservation Act* (1999), (EPBC) and *Territory Parks and Wildlife Conservation Act* (2000) (TPWC), that occur or could possibly occur within a 50 km radius of the Wonarah Prospect. Note the category “migratory” includes terrestrial, migratory marine and migratory wetland species.

Species Name and Status	Common Name	Level of Status	Present during the survey / known to occur within 20 km radius	Preferred habitat
<b>VULNERABLE</b>				
<b>Mammals</b>				
<i>Dasycercus cristicauda</i>	mulgara	EPBC TPWC	Not Recorded / known to occur in the region	Arid and semi arid sandy regions particularly mature hummock grasslands
<b>Birds</b>				
<i>Rostratula australis</i>	Australian painted snipe	EPBC	Not Recorded / known to occur in the region	Well vegetated ephemeral areas
<b>MIGRATORY – Species or species habitat may occur within the area</b>				
<b>Birds</b>				
<i>Apus pacificus</i>	fork-tailed swift	EPBC	Not Recorded / not known to occur	Boreal and temperate forests
<i>Ardea alba</i>	great egret, white egret	EPBC	Not Recorded / not known to occur	Wet areas and damp grasslands
<i>Ardea ibis</i>	cattle egret	EPBC	Not Recorded / not known to occur	Grasslands, woodlands and wetlands
<i>Charadrius veredus</i>	oriental plover	EPBC	Not Recorded / not known to occur	Timbered Habitats
<i>Glareola maldivarum</i>	oriental pratincole	EPBC	Not Recorded / not known to occur	Creeklines
<i>Merops ornatus</i>	rainbow bee-eater	EPBC	Not Recorded / not known to occur	Open forests, woodlands and shrublands, and cleared areas, usually near water. Migratory in summer.
<i>Numenius minutus</i>	little curlew, little whimbrel	EPBC	Not Recorded / not known to occur	Dry grasslands and ephemeral areas
<i>Rostratula australis</i>	Australian painted snipe	EPBC	Not Recorded / not known to occur	Well vegetated ephemeral areas

10.9. **Appendix Nine:** Northern Territory Parks and Wildlife Flora Atlas record sites and their status within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. Note that some sites have multiple species records so this figure should be used as a guide only. A key to conservation codes is provided in Appendix Ten.



10.10. **Appendix Ten:** Flora species list for the Wonarah prospect and surrounding region based on the Northern Territory Parks and Wildlife flora atlas records (existing data) and status under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes (SSOBS) defined by White *et al.* (2000).

Where:

LC = lower concern (TPWC);

INTRO = introduced species;

DD = data deficient (TPWC);

NT = near threatened (TPWC);

NE = not evaluated (TPWC).

Codes and classifications (SSOBS) are defined in White *et al.* (2000), where:

1 = Poorly known taxonomic records or taxa known only from the type collection;

3 = Taxa with a geographic range within Australia exceeding 100 km;

C = Indicates that the species occurs with a conservation reserve;

k = These taxa have the potential to belong in a conservation category but there is presently insufficient information;

R = Nationally, these species are rare but not currently considered to be threatened;

r = Within the NT, these species are rare but not currently considered to be threatened; and

- = Indicates that the taxon has been recorded from a reserve but that the population size within the reserve is unknown.

Species Name	Common Name	TPWC	EPBC	SSOBS_level	SSOBS_code
<i>Abelmoschus ficulneus</i>	native rosella	LC			
<i>Abutilon fraseri</i> subsp. <i>fraseri</i>	dwarf lantern-bush	LC			
<i>Abutilon hannii</i>		LC			
<i>Abutilon otocarpum</i>	keeled lantern-bush, desert chinese lantern, desert lantern	LC			
<i>Acacia acradenia</i>		LC			
<i>Acacia adoxa</i> var. <i>adoxo</i>		LC		bioregional	TAN (eastern range limit)
<i>Acacia adsurgens</i>	whipstick wattle, sugar brother	LC			
<i>Acacia ancistrocarpa</i>	fitzroy wattle, pirraru	LC			
<i>Acacia aneura</i>	mulga	LC			
<i>Acacia cambagei</i>	gidgee, stinking wattle	LC			
<i>Acacia chippendalei</i>	chippendales wattle	LC		bioregional	CR (southern range limits)
<i>Acacia cowleana</i>	halls creek wattle	LC			
<i>Acacia drepanocarpa</i> subsp. <i>latifolia</i>		LC			
<i>Acacia elachantha</i>		LC			
<i>Acacia hilliana</i>	flying-saucer bush	LC		bioregional	CR (southern range limit)
<i>Acacia lysiphloia</i>	turpentine, turpentine bush, turpentine wattle	LC		bioregional	GSD (disjunct and southern range limit)
<i>Acacia melleodora</i>	waxy wattle	LC			
<i>Acacia monticola</i>	hill turpentine	LC		bioregional	CR (southern range limit)
<i>Acacia sericophylla</i>	dogwood, wirewood	LC			
<i>Acacia stipuligera</i>	scrub wattle, kurapuka	LC			
<i>Acacia tenuissima</i>	broom wattle, minyana	LC		bioregional	CR (disjunct)
<i>Acacia victoriae</i>	acacia bush, bramble wattle, victoria wattle	LC			
<i>Acacia victoriae</i> subsp. <i>victoriae</i>	acacia bush, bramble wattle, victoria wattle	LC			
<i>Acrachne racemosa</i>		DD		Northern Territory	3k
<i>Aerva javanica</i>	kapok bush, snow bush	INTRO			

<i>Aeschynomene indica</i>	budda pea, kath sola	LC			
<i>Alternanthera angustifolia</i>	narrow-leaf joyweed	NE			
<i>Alternanthera nodiflora</i>	common joyweed	LC			
<i>Alysicarpus muelleri</i>	rough chain-pea	LC			
<i>Amaranthus cochleitepalus</i>		LC			
<i>Amaranthus mitchellii</i>	boggabri	LC			
<i>Ammannia multiflora</i>	jerry jerry	LC			
<i>Amphipogon caricinus</i> var. <i>caricinus</i>	grey-beard grass, long grey-beard grass	LC			
<i>Amyema sanguinea</i> var. <i>sanguinea</i>	blood mistletoe	LC			
<i>Aristida contorta</i>	bunched kerosene grass, mulga grass	LC			
<i>Aristida holathera</i> var. <i>holathera</i>	erect kerosene grass, white grass, arrow grass	LC			
<i>Aristida latifolia</i>	feathertop wiregrass	LC			
<i>Aristida pruinosa</i>	blue wiregrass, gulf feathertop wiregrass	LC			
<i>Astrebula elymoides</i>	hoop mitchell grass, weeping mitchell grass, slender mitchell grass	LC			
<i>Astrebula pectinata</i>	barley mitchell grass	LC			
<i>Bergia ammannioides</i>	water-fire	LC		bioregional	BRT (apparently rare), SSD (disjunct)
<i>Bergia henshallii</i>		LC		bioregional	CHC (eastern range limit)
<i>Bergia trimera</i>	small water-fire	LC			
<i>Blumea tenella</i>		LC			
<i>Boerhavia burbridgeana</i>		LC		bioregional	DAV (apparently rare)
<i>Boerhavia coccinea</i>		LC			
<i>Boerhavia paludosa</i>	black-soil tar vine	LC		bioregional	BRT (disjunct), MAC (disjunct)
<i>Boerhavia repleta</i>		LC			
<i>Bonamia alatisemina</i>		DD		national	3K
<i>Bonamia deserticola</i>	creep weed	LC			
<i>Bonamia media</i> var. <i>media</i>		LC			
<i>Bonamia pannosa</i>		LC			
<i>Brachyachne convergens</i>	spider grass, false couch, annual couch	LC		bioregional	BRT (disjunct), GSD (disjunct)
<i>Cajanus marmoratus</i>		LC			
<i>Calandrinia pumila</i>	tiny purslane, tiny parakeelya	LC			
<i>Calotis porphyroglossa</i>	channel burr-daisy	LC			
<i>Calytrix carinata</i>		LC			
<i>Capparis lasiantha</i>	split-arse-jack, wait-a-whlie, nepine, maypan	LC			
<i>Capparis umbonata</i>	northern wild orange, wild orange, bush orange, native pomegranate	LC		bioregional	MGD (southern range limit)
<i>Carissa lanceolata</i>	conkerberry, conkle berry, kungsberry bush	LC			
<i>Cassytha capillaris</i>	hairless dodder-laurel, snotty gobble	LC			
<i>Centipeda racemosa</i>	erect sneezeweed	LC			
<i>Chamaecrista symonii</i>	dwarf cassia	LC			
<i>Chenopodium auricomum</i>	northern bluebush, swamp bluebush	LC			
<i>Chloris pectinata</i>	comb chloris	LC			
<i>Chrysocephalum apiculatum</i>	small yellow button, common everlasting, yellow buttons	LC			
<i>Cleome viscosa</i>	tickweed, mustard bush	LC			
<i>Clerodendrum floribundum</i>	smooth clerodendrum, smooth spiderbush, lollybrush, lolly bush	NE			

<i>Corchorus aestuans</i>		LC			
<i>Corchorus sidoides</i> subsp. <i>vermicularis</i>	flannel weed	LC			
<i>Corchorus tridens</i>		LC		bioregional	SSD (southern range limit)
<i>Corymbia aparrerinja</i>	ghost gum, white gum, desert white gum	LC			
<i>Corymbia deserticola</i> subsp. <i>mesogeotica</i>	desert bloodwood	LC		bioregional	MGD (eastern range limit), TAN (northern range limit), GSD (western and southern range limits)
<i>Corymbia flavesces</i>		LC			
<i>Corymbia opaca</i>	bloodwood	LC			
<i>Crotalaria crispata</i>		LC			
<i>Crotalaria dissitiflora</i>	grey rattlepod	DD			
<i>Crotalaria dissitiflora</i> subsp. <i>rugosa</i>	grey rattlepod	LC			
<i>Crotalaria medicaginea</i>		LC			
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>		LC			
<i>Crotalaria montana</i>		LC			
<i>Crotalaria novae-hollandiae</i> subsp. <i>lasiophylla</i>	new holland rattlepod	LC			
<i>Croton aridus</i>		LC			
<i>Cucumis melo</i>	bush cucumber, wild cucumber, native cucumber, ulcardo melon	LC			
<i>Cullen cinereum</i>	annual verbine	LC			
<i>Cuscuta victoriana</i>		LC			
<i>Cyperus bifax</i>	downs nutgrass	LC		bioregional	MAC (disjunct)
<i>Cyperus bulbosus</i>	yalka, nutgrass	LC			
<i>Cyperus concinnus</i>	trim sedge	LC			
<i>Cyperus cuspidatus</i>		LC		southern NT	(disjunct & apparently rare)
<i>Cyperus diiformis</i>	variable-leaf sedge, variable flat-sedge, dirty dora	LC			
<i>Cyperus gilesii</i>		LC			
<i>Cyperus iria</i>		LC			
<i>Cyperus victoriensis</i>		LC			
<i>Dactyloctenium radulans</i>	button grass, finger grass, toothbrush grass	LC			
<i>Desmodium campylocaulon</i>	creeping tick-trefoil	LC		bioregional	BRT (disjunct), MAC (disjunct), TAN (disjunct)
<i>Desmodium muelleri</i>		LC		bioregional	CHC (disjunct), TAN (disjunct and apparently rare)
<i>Dichanthium sericeum</i>	silky bluegrass, queensland bluegrass	LC			
<i>Dichanthium sericeum</i> subsp. <i>sericeum</i>	silky bluegrass, queensland bluegrass	LC			
<i>Digitaria brownii</i>	cotton panic grass	LC			
<i>Digitaria coenicola</i>	umbrella grass, finger panic grass	LC			
<i>Digitaria ctenantha</i>	comb finger grass	LC			
<i>Diplatia grandibractea</i>	royal mistletoe	LC		bioregional	SSD (disjunct and apparently rare)
<i>Diplopeltis stuartii</i> var. <i>glandulosa</i>		DD		Northern Territory	3k
<i>Distichostemon barklyanus</i>		DD		Northern Territory	3k
<i>Dodonaea coriacea</i>	hopbush	LC			
<i>Dolichandrone heterophylla</i> s.lat.	dohwa, lemonwood	LC			

<i>Ehretia saligna s.lat.</i>	coonta, false cedar, peachwood, peachbush	NE			
<i>Einadia nutans subsp. eremaea</i>	climbing saltbush	LC			
<i>Eleocharis atropurpurea</i>		LC		bioregional	GSD (disjunct and apparently rare)
<i>Eleocharis pallens</i>	pale spike-rush	LC			
<i>Elytrophorus spicatus</i>	spikegrass	LC			
<i>Enchylaena tomentosa</i>	ruby saltbush, sturts saltbush, plum puddings, berry cottonbush	LC			
<i>Enneapogon cylindricus</i>	jointed nine-awn, limestone oat-grass, jointed bottlewasher	LC			
<i>Enneapogon pallidus</i>	conetop nine-awn, pale bottlewasher	LC			
<i>Enneapogon polyphyllus</i>	woolly oat-grass, oat-grass, leafy nine-awn	LC			
<i>Enneapogon purpurascens</i>	purple nine-awn, purple bottlewasher	LC		bioregional	TAN (southern range limit)
<i>Enteropogon acicularis s.lat.</i>	curly windmill grass, umbrella grass, spider grass	LC			
<i>Eragrostis cumingii</i>	fairy grass, cumings lovegrass	LC			
<i>Eragrostis eriopoda subsp. Red earth (D.J.Nelson 1651)</i>		LC			
<i>Eragrostis eriopoda subsp. Sandy fire-weed (P.K.Latz 12908)</i>		LC			
<i>Eragrostis falcata</i>	sickle lovegrass	LC			
<i>Eragrostis kennedyae</i>	small-flowered lovegrass	LC			
<i>Eragrostis olida</i>		LC		bioregional	DAV (eastern range limit)
<i>Eragrostis setifolia</i>	neverfail, narrow-leaf neverfail	LC			
<i>Eragrostis tenellula</i>	delicate lovegrass	LC			
<i>Eremophila latrobei var. glabra</i>	native fuchsia	LC			
<i>Eremophila longifolia</i>	emu bush, weeping emu bush, long-leaved desert fuchsia	LC			
<i>Eriachne aristidea</i>	three-awn wanderrie	LC			
<i>Eriachne armittii</i>	longawn wanderrie	LC			
<i>Eriachne ciliata</i>	slender wanderrie, wiregrass	LC			
<i>Eriachne melicacea</i>	fire grass	LC		bioregional	DAV (southern range limit)
<i>Eriachne mucronata</i>	mountain wanderrie	LC			
<i>Eriachne obtusa</i>	northern wanderrie, wiregrass	LC			
<i>Eriachne pulchella subsp. pulchella</i>	pretty wanderrie	LC			
<i>Erythrina vespertilio</i>	bean tree, batwing coral tree	LC			
<i>Eucalyptus chlorophylla</i>	green-leaf box	LC			
<i>Eucalyptus coolabah</i>		LC			
<i>Eucalyptus coolabah</i>	coolabah	LC			
<i>Eucalyptus coolabah subsp. arida</i>	coolabah	LC		bioregional	TAN (tentative western range limit)
<i>Eucalyptus odontocarpa</i>	sturt creek mallee	LC		bioregional	GSD (southern range limit)
<i>Eucalyptus pachyphylla</i>	red-bud mallee	LC		bioregional	DAV (northern range limit)
<i>Eucalyptus pruinosa subsp. pruinosa</i>	silver box, silver-leaf box, apple box, smoke tree	LC			
<i>Eucalyptus victrix</i>	smooth-barked coolibah, ghost gum coolibah, gum-	LC		bioregional	MGD (eastern range limit)

	barked coolibah				
<i>Eulalia aurea</i>	silky browntop, sugar grass	LC			
<i>Euphorbia alsiniflora</i>		LC			
<i>Euphorbia drummondii</i>	caustic weed, caustic creeper, mat spurge	LC			
<i>Evolvulus alsinoides</i>	blue periwinkle, tropical speedwell	LC			
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	blue periwinkle, tropical speedwell	LC			
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	blue periwinkle, tropical speedwell	LC			
<i>Exocarpos sparteus</i>	slender cherry, broombush	LC		bioregional	DAV (northern range limit)
<i>Fimbristylis ammobia</i>		LC		bioregional	MGD (eastern range limit)
<i>Fimbristylis dichotoma</i>	eight day grass, common fringe-rush	LC			
<i>Fimbristylis eremophila</i>	desert fringe-rush	LC		bioregional	TAN (eastern range limit)
<i>Fimbristylis microcarya</i>		LC			
<i>Fimbristylis oxystachya</i>	iukarrara	LC			
<i>Flaveria australasica</i>	yellow twin stem, speedy weed	LC			
<i>Gomphrena breviflora</i>		LC			
<i>Gomphrena conica</i> (southern NT populations)		DD			
<i>Gomphrena lanata</i>		LC			
<i>Goodenia armitiana</i>	narrow-leaved goodenia	LC			
<i>Goodenia fascicularis</i>	silky goodenia	LC			
<i>Goodenia heterochila</i>	serrated goodenia	LC			
<i>Goodenia lamprosperma</i>		LC			
<i>Goodenia modesta</i>		LC		bioregional	TAN (northern range limit)
<i>Goodenia ramelii</i>		LC			
<i>Goodenia strangfordii</i>		LC		bioregional	MGD (southern range limit)
<i>Goodenia triodiophila</i>	spinifex goodenia	LC			
<i>Gossypium australe</i>	native cotton, tall desert rose	LC			
<i>Grevillea dryandri</i> subsp. <i>dryandri</i>	dryanders grevillea	LC			
<i>Grevillea juncifolia</i> subsp. <i>juncifolia</i>	desert grevillea, honey grevillea, honeysuckle grevillea	LC			
<i>Grevillea refracta</i>	silver-leaf grevillea	LC			
<i>Grevillea refracta</i> subsp. <i>refracta</i>	silver-leaf grevillea	LC			
<i>Grevillea striata</i>	beefwood	LC			
<i>Grevillea wickhamii</i> subsp. <i>aprica</i>	holly-leaf grevillea	LC		bioregional	CR (southern range limit)
<i>Hakea chordophylla</i>	northern corkwood, bootlace tree, bull hakea, whistling tree	LC			
<i>Hakea macrocarpa</i>	flat-leaved hakea	LC		bioregional	SSD (southern range limit)
<i>Haloragis aspera</i>	rough raspwort	LC			
<i>Haloragis glauca</i> forma <i>glauca</i>		LC			
<i>Haloragis glauca</i> forma <i>glauca</i>	grey raspwort	LC			
<i>Haloragis uncatipila</i>		LC			
<i>Heliotropium ballii</i>		DD		Northern Territory	3k
<i>Heliotropium conocarpum</i>	white heliotrope	DD			
<i>Heliotropium haesum</i>		LC			
<i>Heliotropium ovalifolium</i>		LC			

<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
<i>Heteropogon contortus</i>	bunch speargrass, black speargrass	LC			
<i>Hibiscus leptocladus</i>	variable-leaf hibiscus	LC			
<i>Hibiscus sturtii</i> var. <i>campyloclamys</i>	sturts hibiscus	LC			
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	sturts hibiscus	LC			
<i>Hibiscus sturtii</i> var. <i>platyclamys</i>	sturts hibiscus	LC			
<i>Hibiscus trionum</i> var. <i>vesicarius</i>	bladder ketmia	LC		bioregional	SSD (disjunct and southern range limit), BRT (disjunct)
<i>Hybanthus aurantiacus</i>	orange spade flower	LC			
<i>Indigastrum parviflorum</i>	small-flower indigo	LC			
<i>Indigofera colutea</i>	sticky indigo	LC			
<i>Indigofera ewartiana</i>		LC			
<i>Indigofera linifolia</i>	native indigo	LC			
<i>Indigofera linnaei</i>	birdsville indigo, nine-leaved indigo	LC			
<i>Indigofera trita</i>		LC		bioregional	BRT (disjunct)
<i>Ipomoea coptica</i>		LC			
<i>Ipomoea costata</i>	bush potato, potato vine, desert yam	LC			
<i>Ipomoea lonchophylla</i>	common cowvine	LC		bioregional	BRT (disjunct), SSD (disjunct)
<i>Ipomoea plebeia</i>	bellvine	LC		southern NT	(apparently rare)
<i>Ipomoea polymorpha</i>	silky cowvine	LC			
<i>Iseilema membranaceum</i>	small flinders grass	LC			
<i>Iseilema vaginiflorum</i>	red flinders grass	LC			
<i>Iseilema windersii</i>	scented flinders grass	LC			
<i>Isoetes muelleri</i>	quillwort	LC		bioregional	DAV (disjunct and apparently rare)
<i>Isotropis atropurpurea</i>	poison sage	LC		bioregional	TAN (eastern range limit)
<i>Isotropis winneckeii</i>		LC		bioregional	GSD (western range limit)
<i>Jatropha gossypifolia</i>	cotton-leaf physic nut, bellyache bush	INTRO			
<i>Keraudrenia nephrosperma</i>		LC			
<i>Leptochloa fusca</i> subsp. <i>fusca</i>	small-flowered beetle grass	LC			
<i>Leptosema anomalum</i>		LC		bioregional	TAN (eastern range limit)
<i>Leptosema chambersii</i>	upside-down plant, chambers leptosema	LC		bioregional	DAV (northern and eastern range limits)
<i>Lipocarpha microcephala</i>	button rush	LC			
<i>Lysiana spathulata</i>	flat-leaved mistletoe	LC			
<i>Maireana villosa</i>	silky bluebush	LC			
<i>Malvastrum americanum</i>	malvastrum, spiked malvastrum	INTRO			
<i>Marsilea costulifera</i>	narrow-leaf nardoo	LC		Northern Territory	3k
<i>Marsilea crenata</i>		LC		southern NT	(disjunct)
<i>Marsilea exarata</i>	swayback nardoo, little nardoo	LC			
<i>Melaleuca lasiandra</i>	sandhill tea-tree	LC			
<i>Melaleuca viridiflora</i>	green paperbark, broad-leaved paperbark, large-leaved paperbark	LC			
<i>Melhanian oblongifolia</i>	velvet hibiscus	LC			
<i>Merremia davenportii</i>	white morning glory	LC		bioregional	BRT (southern range limit)
<i>Mirbelia viminalis</i>	yellow broom	LC			
<i>Mukia maderaspatana</i>	head-ache vine	LC			

<i>Najas marina</i>	prickly waternymph, prickly naiad	NT		Northern Territory	3rC-
<i>Najas tenuifolia</i>	waternymph, thin-leaved naiad	LC		southern NT	(disjunct)
<i>Neptunia dimorphantha</i>	sensitive plant, nervous plant	LC			
<i>Oldenlandia argillacea</i>		LC		bioregional	MGD (apparently rare), TAN (apparently rare), BRT (disjunct)
<i>Oldenlandia mitrasacmoides</i>		LC			
<i>Oldenlandia mitrasacmoides</i> subsp. <i>mitrasacmoides</i>		LC		bioregional	BRT (southern range limit)
<i>Operculina aequisejala</i>		LC		bioregional	CHC (southern range limit), TAN (disjunct and apparently rare)
<i>Opuntia elatior</i>		LC			
<i>Panicum decompositum</i>	native millet, native panic, australian millet	LC			
<i>Panicum decompositum</i> var. <i>decompositum</i>	native millet, native panic, australian millet	LC			
<i>Panicum laevinode</i>	pepper grass	LC			
<i>Paraneurachne muelleri</i>	spinifex couch, northern mulga grass	LC			
<i>Paspalidium jubiflorum</i>	warrego summer grass	LC			
<i>Paspalidium rarum</i>	bunch paspalidium	LC			
<i>Paspalidium retiglume</i>		LC		bioregional	MGD (southern range limit)
<i>Peplidium muelleri</i>		LC		bioregional	BRT (apparently rare), MGD (apparently rare), SSD (apparently rare), STP (apparently rare)
<i>Perotis rara</i>	comet grass	LC			
<i>Petalostylis cassioides</i>	butterfly bush, petalostylis	LC			
<i>Phyllanthus exilis</i>		LC			
<i>Phyllanthus maderaspatensis</i> var. <i>angustifolius</i>		LC			
<i>Polycarpaea corymbosa</i>		LC			
<i>Polygala</i> sp. Davenport Range (C.R.Dunlop 6042)		LC		bioregional	BRT (apparently rare), TAN (western range limit)
<i>Polygala</i> sp. Western Tanami (D.E.Albrecht 10660)		NE		Northern Territory	3k
<i>Polygala tepperi</i>		LC		bioregional	DAV (southern range limit)
<i>Portulaca filifolia</i> s.lat.	slender pigweed	LC			
<i>Portulaca oleracea</i>	pigweed, common purslane, munyeroo	LC			
<i>Portulaca</i> sp. Clay soil (S.T.Blake 17854)		LC			
<i>Pseudoraphis spinescens</i>	swamp grass, spiny mudgrass, water couch	LC			
<i>Psydrax ammophila</i>		LC			
<i>Psydrax attenuata</i> var. <i>myrmecophila</i> forma <i>myrmecophila</i>		LC			
<i>Psydrax attenuata</i> var. <i>myrmecophila</i> forma <i>myrmecophila</i>		LC			
<i>Pterocaulon serrulatum</i> var. <i>serrulatum</i>	fruit-salad bush, apple bush	LC			
<i>Ptilotus calostachyus</i>	weeping mulla mulla	LC			
<i>Ptilotus calostachyus</i> var.	weeping mulla mulla	LC			

<i>calostachyus</i>					
<i>Ptilotus clementii</i>	limestone pussycats tails, tassel top	LC			
<i>Ptilotus fusiformis</i>	skeleton plant	LC			
<i>Ptilotus obovatus</i>	smoke bush, silver bush, silver tails	NE			
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	smoke bush, silver bush, silver tails	LC			
<i>Ptilotus polystachyus</i>	long pussy-tails	NE			
<i>Ptilotus polystachyus</i> var. <i>polystachyus</i>	long pussy-tails	LC			
<i>Ptilotus schwartzii</i> var. <i>schwartzii</i> forma <i>schwartzii</i>		LC			
<i>Ptilotus spicatus</i>		NE			
<i>Rhagodia eremaea</i>	tall saltbush	LC			
<i>Rhynchosia minima</i>	native pea, rhynchosia	LC			
<i>Rothia indica</i> subsp. <i>australis</i>		LC		southern NT	(disjunct and apparently rare)
<i>Rutidosis helichrysoides</i> subsp. <i>helichrysoides</i>		LC			
<i>Salsola tragus</i>	buckbush, rolypoly, tumbleweed	LC			
<i>Salsola tragus</i> subsp. <i>tragus</i>	buckbush, rolypoly, tumbleweed	LC			
<i>Santalum lanceolatum</i>	plumbush, wild plum	LC			
<i>Sauropus trachyspermus</i>	slender spurge	LC			
<i>Scaevola glabrata</i>		LC			
<i>Scaevola ovalifolia</i>	bushy fanflower	LC		bioregional	GSD (western range limit)
<i>Scaevola parvifolia</i> subsp. <i>parvifolia</i>	fanflower	LC			
<i>Schoenoplectus dissachanthus</i>		LC			
<i>Schoenoplectus laevis</i>		LC		bioregional	FIN (disjunct and apparently rare)
<i>Sclerolaena bicornis</i> var. <i>bicornis</i>	goathead burr, bassia burr	LC			
<i>Sclerolaena lanicuspis</i>	woolly copper burr	LC			
<i>Sebastiania chamaelea</i>		LC			
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	oval-leaf cassia	LC			
<i>Senna costata</i>		LC			
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>		LC			
<i>Senna notabilis</i>	cockroach bush	LC			
<i>Sesbania chippendalei</i>		LC			
<i>Setaria dielsii</i>	diels pigeon grass	LC			
<i>Setaria verticillata</i>	whorled pigeon grass	INTRO			
<i>Sida cunninghamii</i>		LC			
<i>Sida fibulifera</i>	silver sida, pin sida	LC			
<i>Sida goniocarpa</i>		LC			
<i>Sida platycalyx</i>	lifesaver burr, teddy bears arsehole	LC			
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>	shrub sida	LC			
<i>Sida</i> sp. <i>Wakaya Desert</i> (P.K.Latz 11894)		LC		bioregional	TAN (northern range limit)
<i>Sida spinosa</i>	spiny sida	LC			
<i>Sida trichopoda</i>	high sida, narrow-leaf sida	LC			
<i>Solanum centrale</i>	desert raisin, kampurarrpa	LC			
<i>Solanum chippendalei</i>	bush tomato, ngaru	LC			
<i>Solanum cleistogamum</i>	shy nightshade	LC			
<i>Solanum ellipticum</i> var. <i>Foothills</i> (G.J.Leach 1145)	native tomato, potato bush, potato weed	LC			
<i>Solanum quadriloculatum</i>	wild tomato, tomato bush	LC			

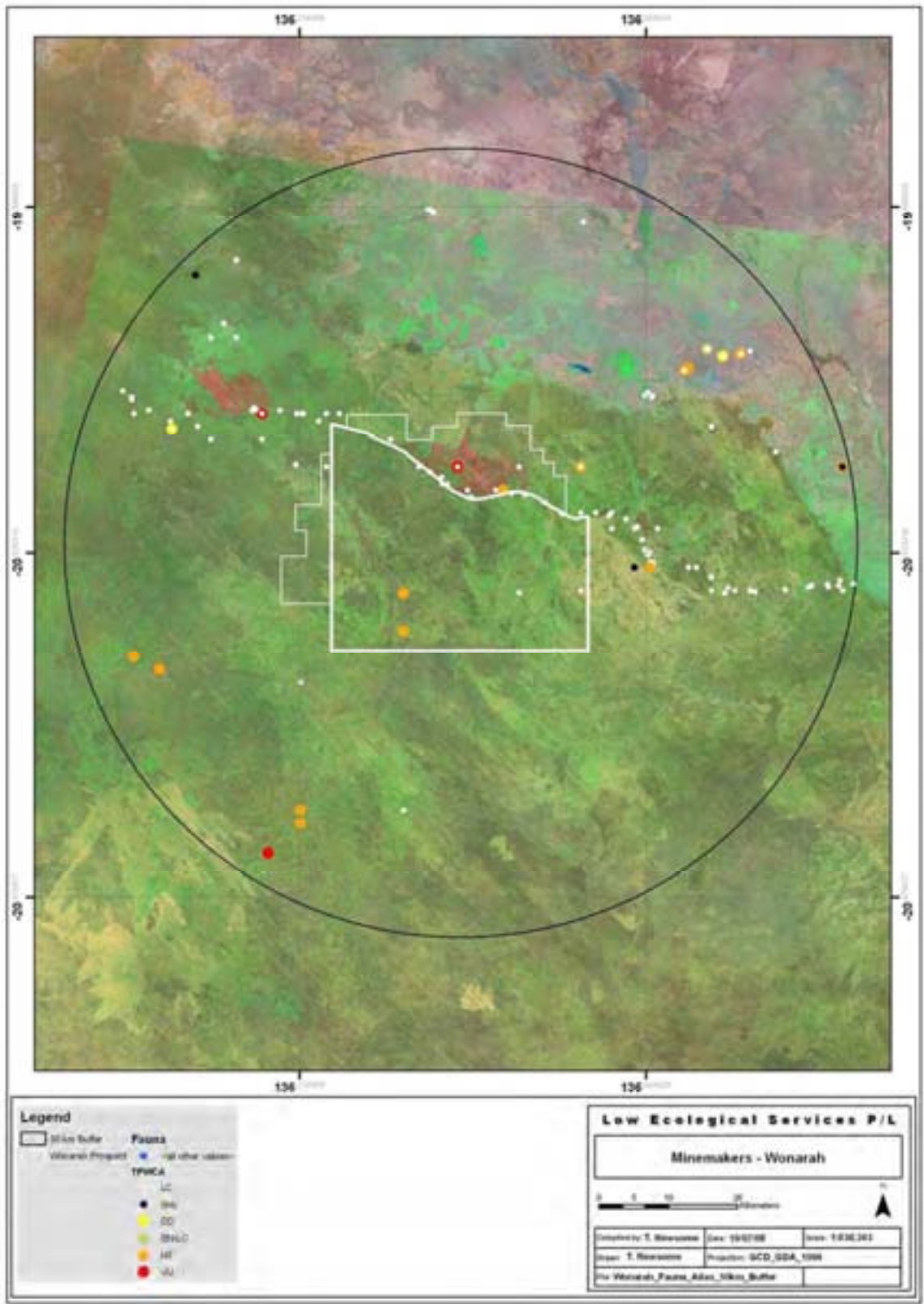
<i>Solanum tumulicola</i>	black-soil wild tomato	LC			
<i>Spathia neurosa</i>	spathe grass	LC			
<i>Spermacoce hillii</i>		LC			
<i>Sporobolus australasicus</i>	australian dropseed	LC			
<i>Sporobolus latzii</i>		DD		national	1K
<i>Sporobolus mitchellii</i>	rat-tail couch, swamp rat-tail grass, short rat-tail grass	LC			
<i>Stackhousia intermedia</i>	wiry stackhousia	LC			
<i>Streptoglossa adscendens</i>		LC			
<i>Streptoglossa macrocephala</i>	large-flowered aromatic daisy	LC			
<i>Streptoglossa odora</i>	aromatic daisy	LC			
<i>Stylosanthes hamata</i>	verano stylo, verano, caribbean stylo, stylo	INTRO			
<i>Swainsona burkei</i>		LC		bioregional	TAN (western range limit)
<i>Synaptantha tillaeacea</i>	synaptantha	DD			
<i>Tephrosia lasiochlaena</i>		LC		bioregional	MAC (southern range limit)
<i>Tephrosia leptoclada</i>		LC			
<i>Tephrosia</i> sp. Barrow Creek (G.M.Chippendale 921)		LC		bioregional	GSD (southern range limit)
<i>Tephrosia</i> sp. Willowra (G.M.Chippendale 4809)		LC			
<i>Tephrosia stuartii</i>		LC		bioregional	DAV (eastern range limit)
<i>Teucrium integrifolium</i>	green germander	LC		bioregional	TAN (disjunct and western range limit)
<i>Themeda triandra</i>	kangaroo grass	LC			
<i>Tragus australianus</i>	small burr-grass, sock grass, tickgrass	LC			
<i>Trianthema pilosa</i>		LC			
<i>Trianthema triquetra</i>	red spinach	LC			
<i>Tribulopsis angustifolia</i>		LC			
<i>Tribulus eichlerianus</i> s.lat.	bindieye	LC			
<i>Trichodesma zeylanicum</i>	cattle bush, camel bush	LC			
<i>Triodia pungens</i>	soft spinifex, gummy spinifex	LC			
<i>Triodia schinzii</i>	feathertop spinifex	LC			
<i>Triumfetta centralis</i>		LC		bioregional	SSD (eastern range limit)
<i>Triumfetta deserticola</i>		DD		Northern Territory	3k
<i>Urochloa piligera</i>	hairy armgrass, hairy summer grass, green summer grass	LC			
<i>Urochloa praetervisa</i>	large armgrass, large summer grass	LC			
<i>Ventilago viminalis</i>	supplejack, vine tree	LC			
<i>Vigna lanceolata</i>	pencil yam, maloga bean, parsnip bean	LC			
<i>Waltheria indica</i>		LC			
<i>Wedelia asperrima</i>	sunflower daisy	LC			
<i>Whiteochloa cymbiformis</i>		LC			
<i>Yakirra australiensis</i> var. <i>australiensis</i>	desert flinders grass	LC			
<i>Zaleya galericulata</i> subsp. <i>galericulata</i>	hogweed	LC			
<i>Zornia albiflora</i>		LC		bioregional	GSD (southern range limit)

- 10.11. **Appendix Eleven:** Northern Territory Parks and Wildlife Flora Atlas locations of conservation significance as defined by White *et al.* (2000) or Territory Parks and Wildlife Conservation Act (2000) within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. A key to conservation codes and species status is provided in Appendix Ten and Twelve respectively.

- 10.12. **Appendix Twelve:** Northern Territory Parks and Wildlife Flora Atlas records of conservation significance as defined by White *et al.* (2000) (SSOBS) or Territory Parks and Wildlife Conservation Act (2000) (TPWC) within the Wonarah prospect and surrounding region (50km). A key to conservation codes is provided in Appendix Ten.

Long	Lat	Species Name	Common Name	TPWC	EPBC	SSOBS_level	SSOBS_code
136.00121	-20.16521752	<i>Acrachne racemosa</i>		DD		Northern Territory	3k
136.35121	-20.11521518	<i>Bonamia alatisemina</i>		DD		National	3K
136.71469	-19.79324	<i>Crotalaria dissitiflora</i>	Grey Rattlepod	DD			
136.78819	-19.77134	<i>Crotalaria dissitiflora</i>	Grey Rattlepod	DD			
136.79999	-19.76834	<i>Crotalaria dissitiflora</i>	Grey Rattlepod	DD			
136.8012	-20.06521217	<i>Diplopeltis stuartii</i> var. <i>glandulosa</i>		DD		Northern Territory	3k
136.43454	-20.18187452	<i>Distichostemon barklyanus</i>		DD		Northern Territory	3k
136.66319	-19.82574	<i>Gomphrena conica</i>		DD			
136.66689	-19.82154	<i>Gomphrena conica</i>		DD			
136.71469	-19.79324	<i>Gomphrena conica</i>		DD			
136.78819	-19.77134	<i>Gomphrena conica</i>		DD			
136.79999	-19.76834	<i>Gomphrena conica</i>		DD			
136.76519	-19.77474	<i>Gomphrena conica</i>		DD			
136.51788	-19.96521424	<i>Heliotropium ballii</i>		DD		Northern Territory	3k
136.71469	-19.79324	<i>Heliotropium conocarpum</i>	White Heliotrope	DD			
136.0333	-19.7167	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.11788	-19.8652171	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.10121	-19.88187719	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.41788	-19.91521499	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.36788	-19.91521533	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.86787	-20.06521171	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.8845	-20.08184158	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.21788	-20.36521579	<i>Heliotropium pulvinum</i>		DD		Northern Territory	3K
136.20121	-19.84854656	<i>Najas marina</i>	Prickly Waternymph, Prickly Naiad	NT		Northern Territory	3rC-
136.6894	-20.0497	<i>Polygala</i> sp. Western Tanami (D.E.Albrecht 10660)		NE		Northern Territory	3k
136.33454	-20.06521536	<i>Sporobolus latzii</i>		DD		National	1K
136.21788	-20.38187577	<i>Synaptantha tillaeacea</i>	Synaptantha	DD			
136.33454	-20.11521529	<i>Triumfetta deserticola</i>		DD		Northern Territory	3k

10.13. **Appendix Thirteen:** Northern Territory Parks and Wildlife Fauna Atlas records and their status within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. Note that some sites have multiple species records so this figure should be used as a guide only. A key to conservation codes is provided in Appendix Fourteen.



10.14. **Appendix Fourteen: Fauna Species List for the Wonarah prospect and surrounding region** based on the Northern Territory Parks and Wildlife Fauna Atlas records (existing data) and status under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC).

Where:

LC = lower concern

DD = data deficient

VU = vulnerable

EN = endangered

NT = near threatened

INT = introduced

NL = near listed

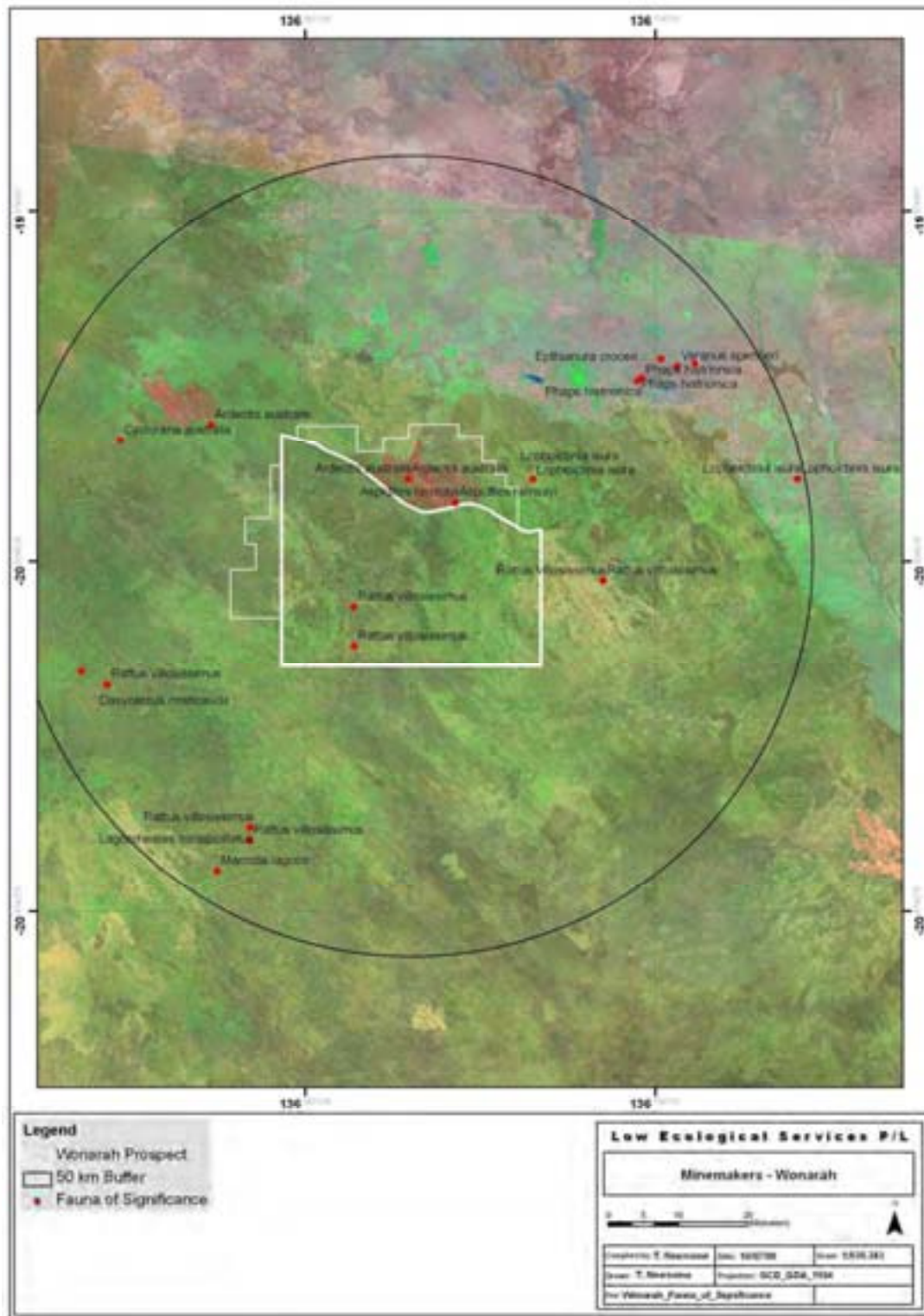
Group	Species Name	TPWC	EPBC	Significant	Exotic	Threatened
Bird	<i>Acanthiza apicalis</i>	LC		0	0	0
Bird	<i>Accipiter cirrhocephalus</i>	LC		0	0	0
Bird	<i>Accipiter fasciatus</i>	LC		0	0	0
Bird	<i>Aegotheles cristatus</i>	LC		0	0	0
Bird	<i>Anas gracilis</i>	LC		0	0	0
Bird	<i>Anhinga melanogaster</i>	LC		0	0	0
Bird	<i>Anthus novaeseelandiae</i>	LC		0	0	0
Bird	<i>Aquila audax</i>	LC		0	0	0
Bird	<i>Ardea alba</i>	LC		1	0	0
Bird	<i>Ardea pacifica</i>	LC		0	0	0
Bird	<i>Ardeotis australis</i>	VU		1	0	1
Bird	<i>Artamus cinereus</i>	LC		0	0	0
Bird	<i>Artamus personatus</i>	LC		0	0	0
Bird	<i>Artamus superciliosus</i>	LC		0	0	0
Bird	<i>Aythya australis</i>	LC		0	0	0
Bird	<i>Cacatua roseicapilla</i>	LC		0	0	0
Bird	<i>Cacatua sanguinea</i>	LC		0	0	0
Bird	<i>Certhionyx niger</i>	LC		0	0	0
Bird	<i>Certhionyx variegatus</i>	LC		0	0	0
Bird	<i>Chalcites basalis</i>	LC		0	0	0
Bird	<i>Chlidonias hybridus</i>	LC		0	0	0
Bird	<i>Cincloramphus cruralis</i>	LC		0	0	0
Bird	<i>Cincloramphus mathewsi</i>	LC		0	0	0
Bird	<i>Circus approximans</i>	LC		0	0	0
Bird	<i>Circus assimilis</i>	LC		0	0	0
Bird	<i>Colluricincla harmonica</i>	LC		0	0	0
Bird	<i>Coracina novaehollandiae</i>	LC		0	0	0
Bird	<i>Corvus bennetti</i>	LC		0	0	0
Bird	<i>Corvus coronoides</i>	LC		0	0	0
Bird	<i>Corvus orru</i>	LC		0	0	0
Bird	<i>Cracticus nigrogularis</i>	LC		0	0	0
Bird	<i>Daphoenositta chrysoptera</i>	LC		0	0	0
Bird	<i>Dendrocygna eytoni</i>	LC		0	0	0
Bird	<i>Dicaeum hirundinaceum</i>	LC		0	0	0
Bird	<i>Elanus axillaris</i>	LC		0	0	0
Bird	<i>Elseyornis melanops</i>	LC		0	0	0
Bird	<i>Emblema pictum</i>	LC		0	0	0

Bird	<i>Epthianura crocea</i>	ENLC	VU\NL	1	0	1
Bird	<i>Epthianura tricolor</i>	LC		0	0	0
Bird	<i>Erythrogonyx cinctus</i>	LC		0	0	0
Bird	<i>Falco berigora</i>	LC		0	0	0
Bird	<i>Falco cenchroides</i>	LC		0	0	0
Bird	<i>Falco longipennis</i>	LC		0	0	0
Bird	<i>Falco peregrinus</i>	LC		0	0	0
Bird	<i>Falco subniger</i>	LC		0	0	0
Bird	<i>Geopelia cuneata</i>	LC		0	0	0
Bird	<i>Geopelia placida</i>	LC		0	0	0
Bird	<i>Grallina cyanoleuca</i>	LC		0	0	0
Bird	<i>Grus rubicunda</i>	LC		0	0	0
Bird	<i>Gymnorhina tibicen</i>	LC		0	0	0
Bird	<i>Haliastur sphenurus</i>	LC		0	0	0
Bird	<i>Hamirostra melanosternon</i>	LC		0	0	0
Bird	<i>Hieraaetus morphnoides</i>	LC		0	0	0
Bird	<i>Himantopus himantopus</i>	LC		0	0	0
Bird	<i>Hirundo ariel</i>	LC		0	0	0
Bird	<i>Hirundo nigricans</i>	LC		0	0	0
Bird	<i>Lalage sueurii</i>	LC		0	0	0
Bird	<i>Lichenostomus keartlandi</i>	LC		0	0	0
Bird	<i>Lichenostomus penicillatus</i>	LC		0	0	0
Bird	<i>Lichenostomus plumulus</i>	LC		0	0	0
Bird	<i>Lichenostomus virescens</i>	LC		0	0	0
Bird	<i>Lichmera indistincta</i>	LC		0	0	0
Bird	<i>Lophoictinia isura</i>	NT		1	0	0
Bird	<i>Malurus lamberti</i>	LC		0	0	0
Bird	<i>Malurus leucopterus</i>	LC		0	0	0
Bird	<i>Malurus melanocephalus</i>	LC		0	0	0
Bird	<i>Manorina flavigula</i>	LC		0	0	0
Bird	<i>Melanodryas cucullata picata/westralensis</i>	LC		0	0	0
Bird	<i>Melithreptus gularis</i>	LC		0	0	0
Bird	<i>Melopsittacus undulatus</i>	LC		0	0	0
Bird	<i>Merops ornatus</i>	LC		1	0	0
Bird	<i>Milvus migrans</i>	LC		0	0	0
Bird	<i>Mirafrja javanica</i>	LC		0	0	0
Bird	<i>Neopsephotus bourkii</i>	LC		0	0	0
Bird	<i>Nymphicus hollandicus</i>	LC		0	0	0
Bird	<i>Ocyphaps lophotes</i>	LC		0	0	0
Bird	<i>Pachycephala rufiventris</i>	LC		0	0	0
Bird	<i>Pardalotus rubricatus</i>	LC		0	0	0
Bird	<i>Passer domesticus</i>	INT		0	1	0
Bird	<i>Pelecanus conspicillatus</i>	LC		0	0	0
Bird	<i>Phalacrocorax melanoleucos</i>	LC		0	0	0
Bird	<i>Phalacrocorax sulcirostris</i>	LC		0	0	0
Bird	<i>Phalacrocorax varius</i>	LC		0	0	0
Bird	<i>Phaps histrionica</i>	NT		1	0	0
Bird	<i>Plegadis falcinellus</i>	LC		1	0	0
Bird	<i>Rhipidura leucophrys</i>	LC		0	0	0
Bird	<i>Smicrornis brevirostris</i>	LC		0	0	0
Bird	<i>Stiltia isabella</i>	LC		0	0	0

Bird	<i>Taeniopygia guttata</i>	LC		0	0	0
Bird	<i>Todiramphus pyrrhopygia</i>	LC		0	0	0
Bird	<i>Tringa nebularia</i>	LC		1	0	0
Bird	<i>Turnix pyrrhorostrax</i>	LC		0	0	0
Bird	<i>Turnix velox</i>	LC		0	0	0
Bird	<i>Vanellus tricolor</i>	LC		0	0	0
Frog	<i>Cyclorana australis</i>	DD		1	0	0
Frog	<i>Notaden nichollsi</i>	LC		0	0	0
Frog	<i>Uperoleia trachyderma</i>	LC		0	0	0
Mammal	<i>Bos taurus</i>	INT		0	1	0
Mammal	<i>Canis lupus</i>	LC		0	1	0
Mammal	<i>Dasyercus cristicauda</i>	VU	VU	1	0	1
Mammal	<i>Lagorchestes conspicillatus</i>	NT		1	0	0
Mammal	<i>Leggadina forresti</i>	LC		0	0	0
Mammal	<i>Macropus rufus</i>	LC		0	0	0
Mammal	<i>Macrotis lagotis</i>	VU	VU	1	0	1
Mammal	<i>Notomys alexis</i>	LC		0	0	0
Mammal	<i>Oryctolagus cuniculus</i>	INT		0	0	0
Mammal	<i>Planigale ingrami</i>	LC		0	0	0
Mammal	<i>Pseudomys desertor</i>	LC		0	0	0
Mammal	<i>Pseudomys hermannsburgensis</i>	LC		0	0	0
Mammal	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	<i>Saccolaimus flaviventris</i>	LC		0	0	0
Mammal	<i>Sminthopsis macroura</i>	LC		0	0	0
Mammal	<i>Sminthopsis youngsoni</i>	LC		0	0	0
Reptile	<i>Antaresia stimsoni</i>	LC		0	0	0
Reptile	<i>Aspidites ramsayi</i>	NT		1	0	0
Reptile	<i>Carlia munda</i>	LC		0	0	0
Reptile	<i>Carlia triacantha</i>	LC		0	0	0
Reptile	<i>Cryptoblepharus plagiocephalus</i>	LC		0	0	0
Reptile	<i>Ctenophorus isolepis</i>	LC		0	0	0
Reptile	<i>Ctenophorus nuchalis</i>	LC		0	0	0
Reptile	<i>Ctenotus grandis</i>	LC		0	0	0
Reptile	<i>Ctenotus greeri</i>	LC		0	0	0
Reptile	<i>Ctenotus helenae</i>	LC		0	0	0
Reptile	<i>Ctenotus joanae</i>	LC		0	0	0
Reptile	<i>Ctenotus leonhardii</i>	LC		0	0	0
Reptile	<i>Ctenotus pantherinus</i>	LC		0	0	0
Reptile	<i>Ctenotus robustus</i>	LC		0	0	0
Reptile	<i>Delma tincta</i>	LC		0	0	0
Reptile	<i>Diplodactylus conspicillatus</i>	LC		0	0	0
Reptile	<i>Diplodactylus stenodactylus</i>	LC		0	0	0
Reptile	<i>Diplodactylus tessellatus</i>	LC		0	0	0
Reptile	<i>Diporiphora lalliae</i>	LC		0	0	0
Reptile	<i>Diporiphora winneckeii</i>	LC		0	0	0
Reptile	<i>Egernia stokesii</i>	LC		0	0	0
Reptile	<i>Eremiascincus richardsonii</i>	LC		0	0	0
Reptile	<i>Gehyra minuta</i>	LC		0	0	0
Reptile	<i>Gehyra montium</i>	LC		0	0	0
Reptile	<i>Gehyra variegata</i>	LC		0	0	0

Reptile	<i>Heteronotia binoei</i>	LC		0	0	0
Reptile	<i>Lerista bipes</i>	LC		0	0	0
Reptile	<i>Lerista xanthura</i>	LC		0	0	0
Reptile	<i>Lophognathus longirostris</i>	LC		0	0	0
Reptile	<i>Menetia greyii</i>	LC		0	0	0
Reptile	<i>Menetia maini</i>	LC		0	0	0
Reptile	<i>Moloch horridus</i>	LC		0	0	0
Reptile	<i>Morethia ruficauda</i>	LC		0	0	0
Reptile	<i>Oedura marmorata</i>	LC		0	0	0
Reptile	<i>Pogona vitticeps</i>	LC		0	0	0
Reptile	<i>Proablepharus kinghorni</i>	LC		0	0	0
Reptile	<i>Pseudechis australis</i>	LC		0	0	0
Reptile	<i>Pseudonaja ingrami</i>	LC		0	0	0
Reptile	<i>Pseudonaja modesta</i>	LC		0	0	0
Reptile	<i>Pseudonaja nuchalis</i>	LC		0	0	0
Reptile	<i>Ramphotyphlops diversus</i>	LC		0	0	0
Reptile	<i>Rhynchoedura ornata</i>	LC		0	0	0
Reptile	<i>Strophurus ciliaris</i>	LC		0	0	0
Reptile	<i>Tiliqua multifasciata</i>	LC		0	0	0
Reptile	<i>Tympanocryptis lineata</i>	LC		0	0	0
Reptile	<i>Varanus acanthurus</i>	LC		0	0	0
Reptile	<i>Varanus gilleni</i>	LC		0	0	0
Reptile	<i>Varanus gouldii</i>	LC		0	0	0
Reptile	<i>Varanus spenceri</i>	DD		1	0	0
Reptile	<i>Varanus tristis</i>	LC		0	0	0

- 10.15. **Appendix Fifteen:** Northern Territory Parks and Wildlife Fauna Atlas records of conservation significance (Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and/or Territory Parks and Wildlife Conservation Act (2000) (TPWC)) within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. A key to conservation codes and species status is provided in Appendix Fourteen and Sixteen respectively.



- 10.16. **Appendix Sixteen:** Northern Territory Parks and Wildlife Fauna Atlas records of conservation significance as defined by the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and Territory Parks and Wildlife Conservation Act (2000) (TPWC) within the Wonarah prospect and surrounding region (50km). A key to conservation codes is provided in Appendix Fourteen.



Group	Long	Lat	Species Name	TPWC	EPBC	Significant	Exotic	Threatened
Bird	136.42	-19.92	<i>Ardeotis australis</i>	VU		1	0	1
Bird	136.1667	-19.85	<i>Ardeotis australis</i>	VU		1	0	1
Bird	136.7442	-19.765	<i>Epthianura crocea</i>	ENLC	VUNL	1	0	1
Bird	136.92	-19.92	<i>Lophoictinia isura</i>	NT		1	0	0
Bird	136.58	-19.92	<i>Lophoictinia isura</i>	NT		1	0	0
Bird	136.7147	-19.7932	<i>Phaps histrionica</i>	NT		1	0	0
Bird	136.7882	-19.7713	<i>Phaps histrionica</i>	NT		1	0	0
Bird	136.7442	-19.765	<i>Phaps histrionica</i>	NT		1	0	0
Bird	136.7199	-19.7896	<i>Phaps histrionica</i>	NT		1	0	0
Frog	136.05	-19.87	<i>Cyclorana australis</i>	DD		1	0	0
Mammal	136.0333	-20.1833	<i>Dasycercus cristicauda</i>	VU	VU	1	0	1
Mammal	136.2167	-20.3667	<i>Lagorchestes conspicillatus</i>	NT		1	0	0
Mammal	136.2167	-20.3667	<i>Lagorchestes conspicillatus</i>	NT		1	0	0
Mammal	136.1746	-20.4223	<i>Macrotis lagotis</i>	VU	VU	1	0	1
Mammal	136.67	-20.05	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136	-20.1667	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136.0333	-20.1833	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136	-20.1667	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136.0333	-20.1833	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136.2167	-20.3667	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136.2167	-20.3833	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136.35	-20.0833	<i>Rattus villosissimus</i>	NT		1	0	0
Mammal	136.35	-20.1333	<i>Rattus villosissimus</i>	NT		1	0	0
Reptile	136.48	-19.95	<i>Aspidites ramsayi</i>	NT		1	0	0
Reptile	136.7652	-19.7747	<i>Varanus spenceri</i>	DD		1	0	0

10.17. **Appendix Seventeen: Site Description Summaries: Trap Site 1**

<b>Site No.:</b> Trap Site 1	<b>Survey:</b> Wonarah Trap Site 1	<b>Quadrat size:</b> 200 x 200
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**Site description & location details:** Aruwurra Prospect – Trap Site 1 (see Appendix Three).  
Alluvial Low Lying Sand Plain / open woodland dominated by *Hakea divaricata* with scattered *Acacia* shrubs

**Photo References:**

<b>Land unit:</b> Alluvial Sand Plain	<b>Run:</b> Off	<b>Topographic position:</b> Flat
<b>Closest Ecotone-</b> 200 m		<b>Road Type in Vicinity:</b> Exploration Track
<b>Perm. Water:</b> 0		<b>Current water:</b> 0
<b>Climate (1-4):</b> 2 = Dry, no plant stress		

<b>Disturbance type-</b>	
<b>Fire impact (0-5):</b> 5	<b>Last fire:</b> This year
<b>Rabbit damage (0-5):</b> 0	<b>Introduced herbivores (0-5):</b> 1 Species - Camel
<b>Weeds (0-5):</b> 0	<b>Weed Species:</b> N/A

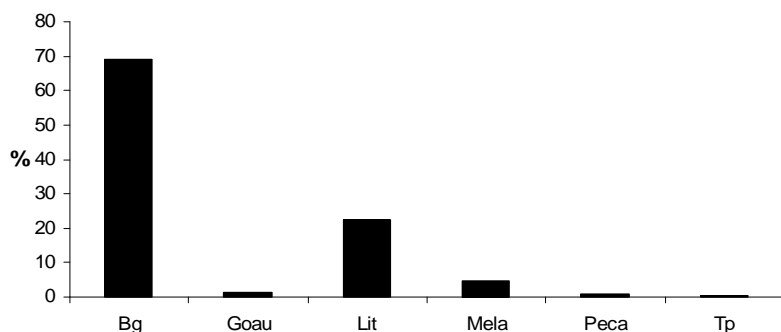
<b>Outcrop:</b> 0 %	<b>Loose Rock/stones:</b> 0 %	<b>Bare soil/sand:</b> 70 % =100%	<b>Bare Ground</b> 70 %	<b>Veg Cover</b> 30 %
<b>Pebbles (&lt;0.6cm):</b> 0 <b>Small stones (0.6-2cm):</b> 0 <b>Stones (2-6cm):</b> 0 <b>Small rocks (6-20cm):</b> 0 <b>Rocks (20-60cm):</b> 0 <b>Big rocks (60cm-2m):</b> 0 <b>Boulders (&gt;2m):</b> 0 <b>Outcrop / slab:</b> 0			<b>Rock Types and Description</b>	

<b>Soil texture:</b> red sand		
<b>Soil depth (cm):</b> 10-40		
<b>Soil crust, termites, log habitat and vegetation strata structure</b>		
<b>Termite mounds (no.):</b> 10	<b>Max. ht. (m):</b> 1	<b>Profile:</b> dome

Number of fallen logs >15cm diameter in the quadrat: 20

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
<b>Emergent tree layer:</b>	<i>Acacia ancistrocarpa</i>	5-8	<10
	<i>Carissa lanceolata</i>	5-8	<10
	<i>Corymbia opaca</i>	5-8	<10
	<i>Eucalyptus leucophloia</i>	5-8	<10
	<i>Hakea macrocarpa</i>	5-8	<10
	<i>Melaleuca lasiandra</i>	4	<10
<b>Upper shrub layer:</b>	<i>Acacia stipuligera</i>	0.2	10-30
	<i>Eucalyptus leucophloia</i>	1	<10
	<i>Melaleuca lasiandra</i>	2	<10
	<i>Petalostylis cassioides</i>	0.5	10-30
<b>Lower shrub layer:</b>	<i>Carissa lanceolata</i>	0.3	<10
	<i>Gossypium australe</i>	0.3	<10
	<i>Melaleuca lasiandra</i> (re-sprouting)	0.4	<10
	<i>Petalostylis cassioides</i>	0.3	<10
<b>Ground layer:</b>	<i>Triodia pungens</i>	0.2	<10


**Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where:** Bg = Bare Ground, Goau = *Gossypium australe*, Lit = Litter, Mela = *Melaleuca lasiandra*, Peca = *Petalostylis cassioides*, and Tp = *Triodia pungens*.



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 11 (5.5 %)

<b>Fauna List</b> <b>Mammals</b> <i>Camelus dromedarius</i> (camel) <i>Notomys alexis</i> (spinifex hopping mouse) <b>Birds</b> <i>Rhipidura leucophrys</i> (willie wag tail)	<b>Evidence</b>  Tracks Tracks, Trapped (6)  Observed
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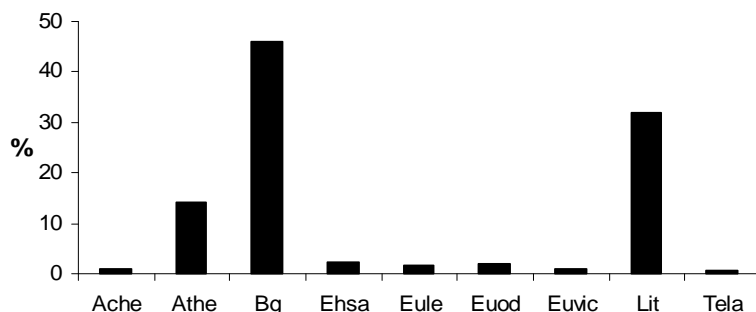
10.18. **Appendix Eighteen: Site Description Summaries: Trap Site 2**

<b>Site No.:</b> Trap Site 2	<b>Survey:</b> Wonarah Trap Site 2	<b>Quadrat size:</b> 200 x 200							
<b>Site description &amp; location details:</b> Aruwurra Prospect – Trap Site 2 (see Appendix Three). Deep Sand Plain / open woodland dominated by <i>Eucalyptus</i> , <i>Atalaya</i> , and <i>Acacia</i> spp.									
<b>Photo References:</b> <div style="display: flex; justify-content: space-around;">   </div>									
<b>Land unit:</b> Deep Sand Plain	<b>Run:</b> On	<b>Topographic position:</b> Flat							
<b>Closest Ecotone-</b> 200 m		<b>Road Type in Vicinity:</b> Exploration Track							
<b>Perm. Water:</b> 0		<b>Current water:</b> 0							
<b>Climate (1-4):</b> 2 = Dry, no plant stress									
<b>Disturbance type-</b>									
<b>Fire impact (0-5):</b> 5		<b>Last fire:</b> This year							
<b>Rabbit damage (0-5):</b> 0		<b>Introduced herbivores (0-5):</b> 1 Species - Camel							
<b>Weeds (0-5):</b> 0		<b>Weed Species:</b> N/A							
<b>Outcrop:</b> _____ % 0 %	<b>Loose Rock/stones:</b> _____ % 0 %	<b>Bare soil/sand:</b> _____ % =100% 65 %	<table border="1"> <tr> <td><b>Bare Ground</b></td> <td><b>Veg Cover</b></td> </tr> <tr> <td>_____ %</td> <td>_____ %</td> </tr> <tr> <td>65 %</td> <td>35 %</td> </tr> </table>	<b>Bare Ground</b>	<b>Veg Cover</b>	_____ %	_____ %	65 %	35 %
<b>Bare Ground</b>	<b>Veg Cover</b>								
_____ %	_____ %								
65 %	35 %								
<b>Pebbles (&lt;0.6cm):</b> 0 <b>Small stones (0.6-2cm):</b> 0 <b>Stones (2-6cm):</b> 0 <b>Small rocks (6-20cm):</b> 0 <b>Rocks (20-60cm):</b> 0 <b>Big rocks (60cm-2m):</b> 0 <b>Boulders (&gt;2m):</b> 0 <b>Outcrop / slab:</b> 0		<b>Rock Types and Description</b>							
<b>Soil texture:</b> red sand									
<b>Soil depth (cm):</b> 10-40									
<b>Soil crust, termites, log habitat and vegetation strata structure</b>									

Termite mounds (no.): 3	Max. ht. (m): 0.2	Profile: dome
Number of fallen logs >15cm diameter in the quadrat: 1		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
<b>Emergent tree layer:</b>	<i>Atalaya hemiglauc</i>	6	<10
	<i>Acacia hemignosta</i>	6	<10
	<i>Acacia sericophylla</i>	5-8	<10
	<i>Eucalyptus odontocarpa</i>	5-8	<10
	<i>Eucalyptus victrix</i>	5-8	<10
	<i>Ventilago viminalis</i>	5-8	<10
<b>Upper shrub layer:</b>	<i>Atalaya hemiglauc</i> (re- sprouting)	1	<10
	<i>Ehretia saligna s.lat.</i>	1	<10
<b>Lower shrub layer:</b>	<i>Eucalyptus leucophloia</i>	0.5	<10
	<i>Tephrosia lasiochlaena</i>	0.5	<10
<b>Ground layer:</b>	<i>Aristida contorta</i>	0.1	<10
	<i>Abutilon otocarpum</i>	0.1	<10
	<i>Astrebla pectinata</i>	0.1	<10
	<i>Gossypium sturtianum</i>	0.1	<10

**Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where:** Ache = *Acacia hemignosta*, Athe = *Atalaya hemiglauc*, Bg = bare ground, Ehsa = *Ehretia saligna s.lat.*, Eule = *Eucalyptus leucophloia*, Euod = *Eucalyptus odontocarpa*, Euvic = *Eucalyptus victrix*, Lit = Litter and Tela = *Tephrosia lasiochlaena*.



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 22 (11 %)

Fauna List	Evidence
<b>Mammals</b>	
<i>Camelus dromedarius</i> (camel)	Tracks
<i>Macropus robustus</i> (euro)	Tracks
<i>Notomys alexis</i> (spinifex hopping mouse)	Tracks, Trapped (6)
<i>Pseudomys hermannsburgensis</i> (sandy inland mouse)	Trapped (3)



10.19. **Appendix Nineteen: Site Description Summaries: Trap Site 3**

<b>Site No.:</b> Trap Site 3	<b>Survey:</b> Wonarah Trap Site 3	<b>Quadrat size:</b> 200 x 200
------------------------------	------------------------------------	--------------------------------

<b>Site description &amp; location details:</b> Aruwurra Prospect – Trap Site 3 (see Appendix Three)	
Shallow Sand Plain / Calcareous Plain / open scattered woodland dominated by <i>Atalaya hemiglauc</i> over <i>Aristida inaequiglumis</i> and <i>Triodia pungens</i> .	

<b>Photo References:</b>	
	

<b>Land unit:</b> Shallow Sand Plain / Calcareous Plain	<b>Run:</b> On	<b>Topographic position:</b> Flat
<b>Closest Ecotone-</b> 200 m		<b>Road Type in Vicinity:</b> Exploration Track
<b>Perm. Water:</b> 0		<b>Current water:</b> 0
<b>Climate (1-4):</b> 2 = Dry, no plant stress		

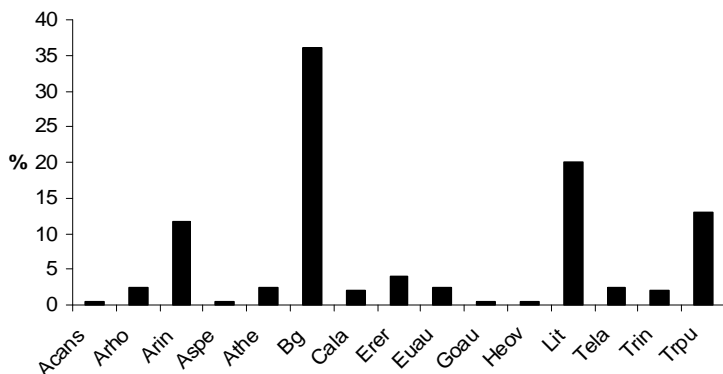
<b>Disturbance type-</b>	
<b>Fire impact (0-5):</b> 1	<b>Last fire:</b> This year
<b>Rabbit damage (0-5):</b> 0	<b>Introduced herbivores (0-5):</b> 1 <b>Species -</b> Camel
<b>Weeds (0-5):</b> 0	<b>Weed Species:</b> N/A



<b>Outcrop:</b> _____ %	<b>Loose Rock/stones:</b> _____ %	<b>Bare soil/sand:</b> _____ % =100%	<b>Bare Ground</b> _____ %	<b>Veg Cover</b> _____ %
<b>Pebbles (&lt;0.6cm):</b> 0 <b>Small stones (0.6-2cm):</b> 0 <b>Stones (2-6cm):</b> >90 % <b>Small rocks (6-20cm):</b> 0 <b>Rocks (20-60cm):</b> 0 <b>Big rocks (60cm-2m):</b> 0 <b>Boulders (&gt;2m):</b> 0 <b>Outcrop / slab:</b> 0			<b>Rock Types and Description</b> <b>Siltstone</b>	

<b>Soil texture:</b> red sand
<b>Soil depth (cm):</b> 10-40
<b>Soil crust, termites, log habitat and vegetation strata structure</b>

Termite mounds (no.): 0		Max. ht. (m): N/A		Profile:																																	
Number of fallen logs >15cm diameter in the quadrat: 4																																					
Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes)																																		
			<10	10-30	30-70	>70																															
Emergent tree layer:	<i>Atalaya hemiglauca</i>	6	<10																																		
Upper shrub layer:	<i>Atalaya hemiglauca</i>	1	<10																																		
Lower shrub layer:	<i>Atalaya hemiglauca</i>	1	<10																																		
Ground layer:	<i>Aristida holathera</i>	0.1	<10																																		
	<i>Aristida inaequiglumis</i>	0.1	<10																																		
	<i>Astrebla pectinata</i>	0.1	10-30																																		
	<i>Triodia pungens</i>	0.1	<10																																		
	<i>Triodia intermedia</i>	0.1	<10																																		
<p><b>Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where:</b> Acans = <i>Acacia ancistrocarpa</i>, Arho = <i>Aristida holathera</i>, Arin = <i>Aristida inaequiglumis</i>, Aspe = <i>Astrebla pectinata</i>, Athe = <i>Atalaya hemiglauca</i>, Bg = bare ground, Cala = <i>Carissa lanceolata</i>, Erer = <i>Eragrostis eriopoda</i>, Euau = <i>Eulalia aurea</i>, Goau = <i>Gossypium australe</i>, Heov = <i>Heliotropium ovalifolium</i>, Lit = Litter, Tela = <i>Tephrosia lasiochlaena</i>, Trin = <i>Triodia intermedia</i>, Trpu = <i>Triodia pungens</i>.</p>  <table><caption>Percentage Ground Cover Data (Estimated from Chart)</caption><thead><tr><th>Species</th><th>% Cover</th></tr></thead><tbody><tr><td>Acans</td><td>0.5</td></tr><tr><td>Arho</td><td>2.5</td></tr><tr><td>Arin</td><td>12.0</td></tr><tr><td>Aspe</td><td>0.5</td></tr><tr><td>Athe</td><td>2.5</td></tr><tr><td>Bg</td><td>36.0</td></tr><tr><td>Cala</td><td>2.0</td></tr><tr><td>Erer</td><td>4.0</td></tr><tr><td>Euau</td><td>2.5</td></tr><tr><td>Goau</td><td>0.5</td></tr><tr><td>Heov</td><td>0.5</td></tr><tr><td>Lit</td><td>20.0</td></tr><tr><td>Tela</td><td>2.5</td></tr><tr><td>Trin</td><td>2.0</td></tr><tr><td>Trpu</td><td>13.0</td></tr></tbody></table>						Species	% Cover	Acans	0.5	Arho	2.5	Arin	12.0	Aspe	0.5	Athe	2.5	Bg	36.0	Cala	2.0	Erer	4.0	Euau	2.5	Goau	0.5	Heov	0.5	Lit	20.0	Tela	2.5	Trin	2.0	Trpu	13.0
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Tela	2.5																																				
Trin	2.0																																				
Trpu	13.0																																				
Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 16 (11 %)																																					
<b>Fauna List</b> <b>Mammals</b> <i>Camelus dromedarius</i> (camel) <i>Canis lupis</i> (dingo) <i>Macropus robustus</i> (euro) <i>Macropus rufus</i> (red kangaroo) <i>Notomys alexis</i> (spinifex hopping mouse) <i>Pseudomys hermannsburgensis</i> (sandy inland mouse) <i>Pseudomys desertor</i> (desert mouse) <i>Sminthopsis crassicaudata</i> (fat tailed dunnart) <b>Reptiles</b> Goanna (unknown)			<b>Evidence</b>  Tracks Tracks Tracks, Scats Tracks Tracks, Trapped (15) Trapped (3) Trapped (2) Trapped (1)  Diggings																																		

10.20. **Appendix Twenty: Site Description Summaries: Trap Site 4**

<b>Site No.:</b> Trap Site 4	<b>Survey:</b> Wonarah Trap Site 4	<b>Quadrat size:</b> 200 x 200					
<b>Site description &amp; location details:</b> Main Zone – Trap Site 4 (see Appendix Three) Alluvial Low Lying Sand Plain with minor Deep Sand Plain and Silcrete Rocky Rises dominated by <i>Acacia stipuligera</i> and <i>Grevillea wichkamii</i> with scattered <i>Eucalyptus victrix</i> over <i>Triodia pungens</i> .							
<b>Photo References:</b> <div style="display: flex; justify-content: space-around;">   </div>							
<b>Land unit:</b> Alluvial Low Lying Sand Plain / Deep Sand Plain / Silcrete Rocky Rise	<b>Run:</b> Off	<b>Topographic position:</b> Flat					
<b>Closest Ecotone-</b> 200 m		<b>Road Type in Vicinity:</b> Exploration Track					
<b>Perm. Water:</b> 0		<b>Current water:</b> 0					
<b>Climate (1-4):</b> 2 = Dry, no plant stress							
<b>Disturbance type-</b>							
<b>Fire impact (0-5):</b> 4		<b>Last fire:</b> This year					
<b>Rabbit damage (0-5):</b> 0		<b>Introduced herbivores (0-5):</b> 0 <b>Species:</b>					
<b>Weeds (0-5):</b> 0		<b>Weed Species:</b> N/A					
<b>Outcrop:</b> _____ 25 _____ %	<b>Loose Rock/stones:</b> _____ 20 _____ %	<b>Bare soil/sand:</b> _____ 65 _____ % =100%	<table border="1"> <tr> <td><b>Bare Ground</b></td> <td><b>Veg Cover</b></td> </tr> <tr> <td>_____ 40 _____ %</td> <td>_____ 60 _____ %</td> </tr> </table>	<b>Bare Ground</b>	<b>Veg Cover</b>	_____ 40 _____ %	_____ 60 _____ %
<b>Bare Ground</b>	<b>Veg Cover</b>						
_____ 40 _____ %	_____ 60 _____ %						
<b>Pebbles (&lt;0.6cm):</b> <b>Small stones (0.6-2cm):</b> <b>Stones (2-6cm):</b> <b>Small rocks (6-20cm):</b> <b>Rocks (20-60cm):</b> <b>Big rocks (60cm-2m):</b> <b>Boulders (&gt;2m):</b> <b>Outcrop / slab:</b>	50-70 % 50-70 % 70-90 % 10-20 % 10-20 % 10-20 % <2 % 0 %	<b>Rock Types and Description</b> Siltstone					
<b>Soil texture:</b> red sand							
<b>Soil depth (cm):</b> 10-40							

Soil crust, termites, log habitat and vegetation strata structure			
Termite mounds (no.): 30		Max. ht. (m): 1	Profile: Dome
Number of fallen logs >15cm diameter in the quadrat: 4			
Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	<i>Atalaya hemiglauca</i>	6	<10
	<i>Eucalyptus victrix</i>	6	<10
Upper shrub layer:	<i>Acacia stipuligera</i>	2	10-30
	<i>Grevillia wichkamii</i>	2	10-30
Lower shrub layer:	<i>Acacia hemignosta</i>	0.3	<10
Ground layer:	<i>Triodia pungens</i>	0.2	<10



Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Ache = *Atalaya hemiglauca*, Bg = bare ground, Euvi = *Eucalyptus victrix*, Grwi = *Grevillea wichkamii*, Lit = Litter, Tp = *Triodia pungens*.

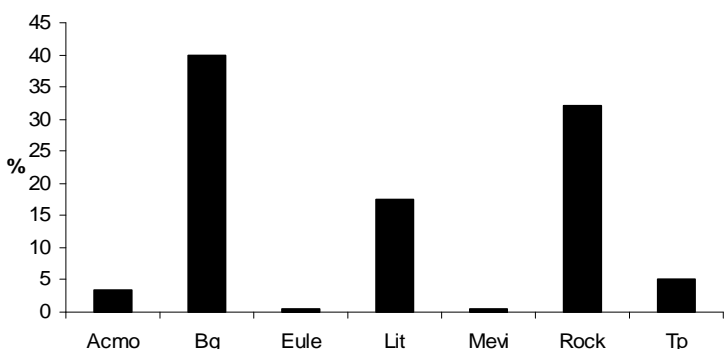
Category	Percentage (%)
Ache	1
Bg	50
Euvi	1
Grwi	2
Lit	30
Tp	15

Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 33 (16.5 %)



<b>Fauna List</b> <b>Mammals</b> <i>Canis lupis</i> (dingo) <i>Felis catus</i> (feral cat) <i>Macropus rufus</i> (red kangaroo) <i>Notomys alexis</i> (spinifex hopping mouse) <i>Vulpes vulpes</i> (fox) <b>Birds</b> <i>Ardeotis australis</i> (australian bustard)	<b>Evidence</b>  Tracks Tracks Tracks, Scats Trapped (5) Tracks
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10.21. **Appendix Twenty-One: Site Description Summaries: Trap Site 5**

<b>Site No.:</b> Trap Site 5	<b>Survey:</b> Wonarah Trap Site 5	<b>Quadrat size:</b> 200 x 200					
<b>Site description &amp; location details:</b> Main Zone – Trap Site 5 (see Appendix Three) Ironstone / Silcrete Rocky Rise with Alluvial Low Lying Sand Plain							
<b>Photo References:</b> <div style="display: flex; justify-content: space-around;">   </div>							
<b>Land unit:</b> Alluvial Low Lying Sand Plain / Silcrete Rocky Rise	<b>Run:</b> On / Off	<b>Topographic position:</b> Flat					
<b>Closest Ecotone-</b> 200 m		<b>Road Type in Vicinity:</b> Exploration Track					
<b>Perm. Water:</b> 0		<b>Current water:</b> 0					
<b>Climate (1-4):</b> 2 = Dry, no plant stress							
<b>Disturbance type-</b>							
<b>Fire impact (0-5):</b> 5		<b>Last fire:</b> This year					
<b>Rabbit damage (0-5):</b> 0		<b>Introduced herbivores (0-5):</b> 0 <b>Species:</b>					
<b>Weeds (0-5):</b> 0		<b>Weed Species:</b> N/A					
<b>Outcrop:</b> _____ 50 _____ %	<b>Loose Rock/stones:</b> _____ 10 _____ %	<b>Bare soil/sand:</b> _____ 40 _____ % =100%	<table border="1"> <thead> <tr> <th>Bare Ground</th> <th>Veg Cover</th> </tr> </thead> <tbody> <tr> <td>_____ 90 _____ %</td> <td>_____ 10 _____ %</td> </tr> </tbody> </table>	Bare Ground	Veg Cover	_____ 90 _____ %	_____ 10 _____ %
Bare Ground	Veg Cover						
_____ 90 _____ %	_____ 10 _____ %						
<b>Pebbles (&lt;0.6cm):</b> <b>Small stones (0.6-2cm):</b> <b>Stones (2-6cm):</b> <b>Small rocks (6-20cm):</b> <b>Rocks (20-60cm):</b> <b>Big rocks (60cm-2m):</b> <b>Boulders (&gt;2m):</b> <b>Outcrop / slab:</b>	0 % 2-10 % 10-20 % 10-20 % 0 % 0 % 0 % 0 %	<b>Rock Types and Description</b> Silcrete Outcrop					
<b>Soil texture:</b> red sand, deep in sand plain							
<b>Soil depth (cm):</b> 10-40							
<b>Soil crust, termites, log habitat and vegetation strata structure</b>							



Termite mounds (no.): 50		Max. ht. (m): 2.5	Profile: Dome																			
Number of fallen logs >15cm diameter in the quadrat: 20																						
Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes)																			
			<10	10-30	30-70	>70																
Emergent tree layer:	<i>Acacia monticola</i>	2	<10																			
	<i>Hakea macrocarpa</i>	2	<10																			
Upper shrub layer:	<i>Acacia monticola</i>	2	<10																			
Lower shrub layer:	<i>Eucalyptus leucophloia</i> (re-sprouting)	0.3	<10																			
Ground layer:	<i>Triodia pungens</i>	0.1	<10																			
<p><b>Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where:</b> Acmo = <i>Acacia monticola</i>, Bg = bare ground, Eule = <i>Eucalyptus leucophloia</i>, Lit = Litter, Mevi = <i>Melaleuca viridiflora</i>, Rock = Rock, Tp = <i>Triodia pungens</i>.</p>  <table><caption>Percentage Ground Cover Data</caption><thead><tr><th>Category</th><th>Percentage (%)</th></tr></thead><tbody><tr><td>Acmo</td><td>3</td></tr><tr><td>Bg</td><td>40</td></tr><tr><td>Eule</td><td>1</td></tr><tr><td>Lit</td><td>18</td></tr><tr><td>Mevi</td><td>1</td></tr><tr><td>Rock</td><td>32</td></tr><tr><td>Tp</td><td>5</td></tr></tbody></table>							Category	Percentage (%)	Acmo	3	Bg	40	Eule	1	Lit	18	Mevi	1	Rock	32	Tp	5
Category	Percentage (%)																					
Acmo	3																					
Bg	40																					
Eule	1																					
Lit	18																					
Mevi	1																					
Rock	32																					
Tp	5																					
Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 10 (5 %)																						
Fauna List		Evidence																				
Mammals																						
<i>Canis lupis</i> (dingo)		Tracks																				
<i>Notomys alexis</i> (spinifex hopping mouse)		Tracks, Trapped (5)																				

10.22. **Appendix Twenty-Two: Site Description Summaries: Site 6**

<b>Site No.:</b> Site 7	<b>Survey:</b> Wonarah Site 6	<b>Quadrat size:</b> 200 x 200	
<b>Site description &amp; location details:</b> End Aruwurra Road – Site 6 (see Appendix Three) Alluvial Low Lying Sand Plain adjacent to lateritic rise with <i>Eucalyptus odontocarpa</i> and <i>Hakea macrocarpa</i> over <i>grevillea</i> spp. and <i>Triodia pungens</i>			
<b>Photo References:</b> <div style="display: flex; justify-content: space-around;">   </div>			
<b>Land unit:</b> Alluvial Low Lying Sand Plain	<b>Run:</b> On / Off	<b>Topographic position:</b> Flat	
<b>Closest Ecotone - 200 m</b>		<b>Road Type in Vicinity:</b> Exploration Track	
<b>Perm. Water:</b> 0		<b>Current water:</b> 0	
<b>Climate (1-4):</b> 2 = Dry, no plant stress			
<b>Disturbance type-</b>			
<b>Fire impact (0-5):</b> 3		<b>Last fire:</b> This year	
<b>Rabbit damage (0-5):</b> 0		<b>Introduced herbivores (0-5):</b> 1 <b>Species:</b> Camel	
<b>Weeds (0-5):</b> 0		<b>Weed Species:</b> N/A	
<b>Outcrop:</b> _____ %	<b>Loose Rock/stones:</b> _____ %	<b>Bare soil/sand:</b> _____ % =100%	<b>Bare Ground</b> _____ % <b>Veg Cover</b> _____ %
<b>Pebbles (&lt;0.6cm):</b> <b>Small stones (0.6-2cm):</b> <b>Stones (2-6cm):</b> <b>Small rocks (6-20cm):</b> <b>Rocks (20-60cm):</b> <b>Big rocks (60cm-2m):</b> <b>Boulders (&gt;2m):</b> <b>Outcrop / slab:</b>	0 % <2 % <2 % <2 % <2 % 2 - 10 % 2 - 10 % 2 - 10 %		<b>Rock Types and Description</b> Silcrete Outcrop
<b>Soil texture:</b> red sand			
<b>Soil depth (cm):</b> 10-40			
<b>Soil crust, termites, log habitat and vegetation strata structure</b>			

Termite mounds (no.): 0		Max. ht. (m): 0		Profile:																							
Number of fallen logs >15cm diameter in the quadrat: 0																											
Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes)																								
			<10	10-30	30-70	>70																					
Emergent tree layer:	<i>Acacia ancistrocarpa</i>	2	<10																								
	<i>Acacia sericophylla</i>	2	<10																								
	<i>Eucalyptus odontocarpa</i>	2	<10																								
	<i>Hakea macrocarpa</i>	2	<10																								
Upper shrub layer:	<i>Grevillea juncifolia</i>	2	<10																								
	<i>Grevillea refracta</i>	2	<10																								
Lower shrub layer:	<i>Acacia hilliana</i>	0.3	<10																								
	<i>Dodonaea coriacea</i>	0.3	<10																								
	<i>Scaevola parvifolia</i>	0.3	<10																								
	<i>Scaevola amblyanthera</i>	0.3	<10																								
Ground layer:	<i>Aristida holothera</i>	0.2	<10																								
	<i>Triodia pungens</i>	0.1	<10																								
<p><b>Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where:</b> Acans = <i>Acacia ancistrocarpa</i>, Achi = <i>Acacia hilliana</i>, Bg = bare ground, Euod = <i>Eucalyptus odontocarpa</i>, Grju = <i>Grevillea juncifolia</i>, Hama = <i>Hakea macrocarpa</i>, Lit = Litter, Mivi = <i>Mirabilia viminalis</i>, Rulo = <i>Rulingia loxophylla</i>, Tp = <i>Triodia pungens</i>.</p> <table><caption>Percentage Ground Cover Data</caption><thead><tr><th>Species/Category</th><th>Percentage (%)</th></tr></thead><tbody><tr><td>Acans</td><td>1</td></tr><tr><td>Achi</td><td>3</td></tr><tr><td>Bg</td><td>38</td></tr><tr><td>Euod</td><td>4</td></tr><tr><td>Grju</td><td>1</td></tr><tr><td>Hama</td><td>1</td></tr><tr><td>Lit</td><td>27</td></tr><tr><td>Mivi</td><td>2</td></tr><tr><td>Rulo</td><td>5</td></tr><tr><td>Tp</td><td>20</td></tr></tbody></table>						Species/Category	Percentage (%)	Acans	1	Achi	3	Bg	38	Euod	4	Grju	1	Hama	1	Lit	27	Mivi	2	Rulo	5	Tp	20
Species/Category	Percentage (%)																										
Acans	1																										
Achi	3																										
Bg	38																										
Euod	4																										
Grju	1																										
Hama	1																										
Lit	27																										
Mivi	2																										
Rulo	5																										
Tp	20																										
Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 25 (12.5 %)																											
Fauna List			Evidence																								
Mammals																											
<i>Canis lupis</i> (dingo)			Tracks																								
<i>Varanus spp.</i>			Tracks																								

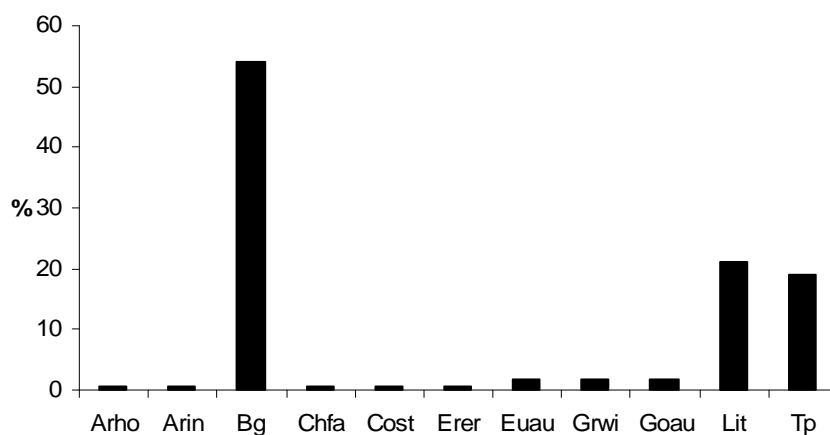
10.23. **Appendix Twenty-Three: Site Description Summaries: Site 7**

<b>Site No.:</b> Site 7	<b>Survey:</b> Wonarah Site 7	<b>Quadrat size:</b> 200 x 200
<b>Site description &amp; location details:</b> Main Prospect – Site 7 (see Appendix Three) Alluvial Low Lying Sand Plain with minor Deep Sand Plain / Open <i>Eucalyptus</i> woodland over <i>Triodia pungens</i>		
<b>Photo References:</b> <div style="display: flex; justify-content: space-around;">   </div>		
<b>Land unit:</b> Alluvial Low Lying Sand Plain / Deep Sand Plain	<b>Run:</b> On	<b>Topographic position:</b> Flat
<b>Closest Ecotone-</b> 200 m		<b>Road Type in Vicinity:</b> Exploration Track
<b>Perm. Water:</b> 0		<b>Current water:</b> 0
<b>Climate (1-4):</b> 2 = Dry, no plant stress		
<b>Disturbance type-</b>		
<b>Fire impact (0-5):</b> 3	<b>Last fire:</b> This year	
<b>Rabbit damage (0-5):</b> 0	<b>Introduced herbivores (0-5):</b> 1 <b>Species:</b> Camel	
<b>Weeds (0-5):</b> 0	<b>Weed Species:</b> N/A	
<b>Outcrop:</b> _____ %	<b>Loose Rock/stones:</b> _____ %	<b>Bare soil/sand:</b> _____ % =100%
<b>Pebbles (&lt;0.6cm):</b> 0 % <b>Small stones (0.6-2cm):</b> 0 % <b>Stones (2-6cm):</b> 0 % <b>Small rocks (6-20cm):</b> 0 % <b>Rocks (20-60cm):</b> 0 % <b>Big rocks (60cm-2m):</b> 0 % <b>Boulders (&gt;2m):</b> 0 % <b>Outcrop / slab:</b> 0 %		<b>Bare Ground</b> _____ % <b>Veg Cover</b> _____ % <b>Rock Types and Description</b>
<b>Soil texture:</b> red sand		
<b>Soil depth (cm):</b> 10-40		
<b>Soil crust, termites, log habitat and vegetation strata structure</b>		

Termite mounds (no.): 50	Max. ht. (m): 1	Profile: Tower
Number of fallen logs >15cm diameter in the quadrat: 0		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	<i>Eucalyptus victrix</i>	> 5	<10
Upper shrub layer:	<i>Grevillea wichkamii</i>	2	<10
Lower shrub layer:	<i>Eucalyptus victrix</i> (re-sprouting)	0.2	0.2
Ground layer:	<i>Eulalia aurea</i>	0.1	<10
	<i>Triodia pungens</i>	0.1	<10



**Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where:** Arho = *Aristida holathera*, Arin = *Aristida inaequiglumis*, Bg = bare ground, Chfa = *Chrysopogon fallax*, Cost = *Sclerolaena costata*, Erer = *Eragrostis eriopoda*, Euau = *Eulalia aurea*, Grwi = *Grevillea wichkamii*, Goau = *Gossypium australe*, Lit = Litter, Tp = *Triodia pungens*.



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 25 (12.5 %)

<b>Fauna List</b> <b>Mammals</b> <i>Canis lupis</i> (dingo) <i>Varanus spp.</i> <b>Birds</b> <i>Ardeotis australis</i> (australian bustard)	<b>Evidence</b>  Tracks Tracks
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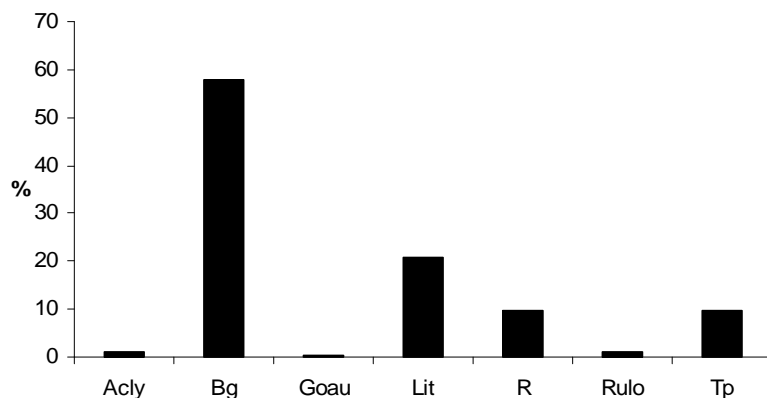
10.24. **Appendix Twenty-Four: Site Description Summaries: Site 8**

<b>Site No.:</b> Site 8	<b>Survey:</b> Wonarah Site 8	<b>Quadrat size:</b> 200 x 200
<b>Site description &amp; location details:</b> Main Prospect – Site 8 (see Appendix Three) Ironstone Rocky Rise / Deep Sand Plain.		
<b>Photo References:</b> <div style="display: flex; justify-content: space-around;">   </div>		
<b>Land unit:</b> Ironstone Rocky Rise / Deep Sand Plain	<b>Run:</b> On	<b>Topographic position:</b> Flat
<b>Closest Ecotone-</b> 200 m		<b>Road Type in Vicinity:</b> Exploration Track
<b>Perm. Water:</b> 0		<b>Current water:</b> 0
<b>Climate (1-4):</b> 2 = Dry, no plant stress		
<b>Disturbance type-</b>		
<b>Fire impact (0-5):</b> 4	<b>Last fire:</b> This year	
<b>Rabbit damage (0-5):</b> 0	<b>Introduced herbivores (0-5):</b> 0 <b>Species:</b>	
<b>Weeds (0-5):</b> 0	<b>Weed Species:</b> N/A	
<b>Outcrop:</b> _____ %	<b>Loose Rock/stones:</b> _____ %	<b>Bare soil/sand:</b> _____ % =100%
<b>Pebbles (&lt;0.6cm):</b> <2 % <b>Small stones (0.6-2cm):</b> 2-10 % <b>Stones (2-6cm):</b> 2-10 % <b>Small rocks (6-20cm):</b> 2- % <b>Rocks (20-60cm):</b> 0 % <b>Big rocks (60cm-2m):</b> 0 % <b>Boulders (&gt;2m):</b> 0 % <b>Outcrop / slab:</b> 0 %		<b>Bare Ground</b> _____ % <b>Veg Cover</b> _____ % <b>Rock Types and Description</b>
<b>Soil texture:</b> red sand		
<b>Soil depth (cm):</b> 10-40		
<b>Soil crust, termites, log habitat and vegetation strata structure</b>		

Termite mounds (no.): 50	Max. ht. (m): 1	Profile: Tower
Number of fallen logs >15cm diameter in the quadrat: 0		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:			
Upper shrub layer:	<i>Acacia lysiphloia</i>	2	<10
Lower shrub layer:			
Ground layer:	<i>Triodia pungens</i>	0.1	<10

**Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where:** Bg = Bare ground, Goau = *Gossypium australe*, Lit = Litter, R = Rock, Rulo = *Rulingia loxophylla*, Tp = *Triodia pungens*.



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 10 (5 %)

<b>Fauna List</b> <b>Mammals</b> <i>Canis lupis</i> (dingo) <b>Birds</b> <i>Ardeotis australis</i> (australian bustard)	<b>Evidence</b>  Tracks Tracks Tracks
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- 10.25. **Appendix Twenty-Five:** Flora recorded during on site investigations within the Wonarah prospect. Status is given under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes defined by White *et al.* (2000). See Appendix Ten for Conservation Code descriptions.

Full Name	Common Name	TPWC	EPBC	SSOBS_level	SSOBS_code
<i>Abutilon otocarpum</i>	Keeled Lantern-bush, Desert Chinese Lantern, Desert Lantern				
<i>Acacia acradenia</i>					
<i>Acacia adsurgens</i>	Whipstick Wattle, Sugar Brother				
<i>Acacia ancistrocarpa</i>	Fitzroy Wattle, Pirraru				
<i>Acacia coriacea</i>					
<i>Acacia hemignosta</i>	Club-leaf Wattle			bioregional	BRT (southern range limit)
<i>Acacia hilliana</i>	Flying-saucer Bush			bioregional	CR (southern range limit)
<i>Acacia lysiphloia</i>	Turpentine, Turpentine Bush, Turpentine Wattle			bioregional	GSD (disjunct and southern range limit)
<i>Acacia melleodora</i>	Waxy Wattle				
<i>Acacia monticola</i>	Hill Turpentine			bioregional	CR (southern range limit)
<i>Acacia sericophylla</i>	Dogwood, Wirewood				
<i>Acacia stipuligera</i>	Scrub Wattle, Kurapuka				
<i>Acacia torulosa</i>	Torulosa Wattle, Deep- gold Wattle				
<i>Aristida contorta</i>	Bunched Kerosene Grass, Mulga Grass				
<i>Aristida holathera</i>	Erect Kerosene Grass, White Grass, Arrow Grass				
<i>Aristida inaequiglumis</i>	Curly Wiregrass, Fire Grass, Unequal Three- awn				
<i>Astrebla pectinata</i>	Barley Mitchell Grass				
<i>Atalaya hemiglauca</i>	Whitewood				
<i>Capparis lasiantha</i>	Split-arse-jack, Wait-a- whlie, Nepine, Maypan				
<i>Capparis umbonata</i>	Northern Wild Orange, Wild Orange, Bush Orange, Native Pomegranate			bioregional	MGD (southern range limit)
<i>Carissa lanceolata</i>	Conkerberry, Conkle Berry, Kungsberry Bush				
<i>Clerodendrum floribundum</i>	Smooth Clerodendrum, Smooth Spiderbush, Lollybrush, Lolly Bush				
<i>Corchorus sidoides</i>	Flannel Weed				
<i>Corymbia opaca</i>	Bloodwood				
<i>Croton aridus</i>				bioregional	TAN (southern range limit)
<i>Cullen pallidum</i>	Woolly Psoralea			bioregional	DAV (apparently rare and disjunct), BRT (apparently rare and disjunct)
<i>Dicrastylis sp.</i>					
<i>Distichostemon barklyanus</i>		dd		Northern Territory	3k
<i>Dodonaea coriacea</i>	Hopbush				
<i>Ehretia saligna s.lat.</i>	Coonta, False Cedar, Peachwood, Peachbush				
<i>Eremophila bignoniiflora</i>	Gooramurra, River Angee, Creek Wilga, Bignonia Emu-bush			bioregional	TAN (apparently rare)
<i>Eriachne obtusa</i>	Northern Wanderrie, Wiregrass				

<i>Eucalyptus gamophylla</i>	Blue Mallee, Twin-leaved Mallee, Blue-leaved Mallee			bioregional	TAN (northern range limit)
<i>Eucalyptus leucophloia</i>	Snappy Gum, Migum				
<i>Eucalyptus leucophloia</i> subsp. <i>euroa</i>	Snappy Gum, Migum				
<i>Eucalyptus odontocarpa</i>	Sturt Creek Mallee			bioregional	GSD (southern range limit)
<i>Eucalyptus pruinosa</i>	Silver Box, Silver-leaf Box, Apple Box, Smoke Tree				
<i>Eucalyptus victrix</i>	Smooth-barked Coolibah, Ghost Gum Coolibah, Gum-barked Coolibah			bioregional	MGD (eastern range limit)
<i>Eulalia aurea</i>	Silky Browntop, Sugar Grass				
<i>Euphorbia drummondii</i>	Caustic Weed, Caustic Creeper, Mat Spurge				
<i>Goodenia azurea</i>	Blue Goodenia				
<i>Gossypium australe</i>	Native Cotton, Tall Desert Rose				
<i>Gossypium sturtianum</i>	Sturts Desert Rose				
<i>Grevillea juncifolia</i>	Desert Grevillea, Honey Grevillea, Honeysuckle Grevillea				
<i>Grevillea refracta</i>	Silver-leaf Grevillea				
<i>Grevillea wickhamii</i>	Holly-leaf Grevillea				
<i>Hakea arborescens</i>	Yellow Hakea				
<i>Hakea lorea</i>	Long-leaf Corkwood, Corkbark Tree				
<i>Hakea macrocarpa</i>	Flat-leaved Hakea			bioregional	SSD (southern range limit)
<i>Heliotropium ovalifolium</i>					
<i>Iseilema vaginiflorum</i>	Red Flinders Grass				
<i>Melaleuca lasiandra</i>	Sandhill Tea-tree				
<i>Melaleuca viridiflora</i>	Green Paperbark, Broad-leaved Paperbark, Large-leaved Paperbark				
<i>Petalostylis cassioides</i>	Butterfly Bush, Petalostylis				
<i>Psydrax latifolia</i>	Native Currant, Orange Bush				
<i>Pterocaulon sphacelatum</i>	Apple Bush, Bush Vicks				
<i>Ptilotus obovatus</i>	Smoke Bush, Silver Bush, Silver Tails				
<i>Rulingia loxophylla</i>	Desert Fire Weed				
<i>Santalum lanceolatum</i>	Plumbush, Wild Plum				
<i>Scaevola amblyanthera</i>					
<i>Scaevola parvifolia</i>	Fanflower				
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>					
<i>Streptoglossa decurrens</i>				bioregional	DAV (disjunct), CHC (disjunct)
<i>Tephrosia lasiochlaena</i>				bioregional	MAC (southern range limit)
<i>Tribulus terrestris</i> s.lat.	Cat-head, Caltrop, Bindieye				
<i>Trichodesma zeylanicum</i>	Cattle Bush, Camel Bush				
<i>Triodia intermedia</i>	Winged Spinifex			bioregional	DAV (disjunct and eastern range limit), BRT (disjunct and southern range limit)
<i>Triodia pungens</i>	Soft Spinifex, Gummy Spinifex				
<i>Ventilago viminalis</i>	Supplejack, Vine Tree				

- 10.26. **Appendix Twenty-Six:** Fauna recorded during on site investigations within the Wonarah prospect. Status is given under the under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), and the Territory Parks and Wildlife Conservation Act (2000) (TPWC). See Appendix Fourteen for Conservation Code descriptions.

Group	Species name	Common Name	TPWC	EPBC	Significant	Exotic	Threatened
Bird	<i>Acanthagenys rufogularis</i>	spiny-cheeked honeyeater	LC		0	0	0
Bird	<i>Ardeotis australis</i>	australian bustard	VU		1	0	1
Bird	<i>Artamus cinereus</i>	black-faced woodswallow	LC		0	0	0
Bird	<i>Cinclosoma cinnamomeum</i>	cinnamon quail thrush	LC		0	0	0
Bird	<i>Epthianura tricolor</i>	crimson chat	LC		0	0	0
Bird	<i>Falco berigora</i>	brown falcon	LC		0	0	0
Bird	<i>Falco cenchriodes</i>	nankeen kestrel	LC		0	0	0
Bird	<i>Rhipidura leucophrys</i>	willie wagtail	LC		0	0	0
Mammal	<i>Camelus dromedarius</i>	camel	INT		0	1	0
Mammal	<i>Canis lupis</i>	dingo	LC		0	1	0
Mammal	<i>Macropus robustus</i>	euro	LC		0	0	0
Mammal	<i>Macropus rufus</i>	red kangaroo	LC		0	0	0
Mammal	<i>Notomys alexis</i>	spinifex hopping mouse	LC		0	0	0
Mammal	<i>Pseudomys desertor</i>	desert mouse	LC		0	0	0
Mammal	<i>Pseudomys hermannsburgensis</i>	sandy inland mouse	LC		0	0	0
Mammal	<i>Sminthopsis crassicaudata</i>	fat tailed dunnart	LC		0	0	0
Reptile	<i>Varanus gouldii</i>	sand goanna	LC		0	0	0

- 10.27. **Appendix Twenty-Seven:** Species identified within Land Units of the Wonarah Prospect (See Appendix Twenty Eight) based on NT Parks and Wildlife Flora Atlas and Surveys herein. Status is given under the under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes defined by White *et al.* (2000). See Appendix Ten for Conservation Code descriptions.

Land Unit	Regolith Unit	Species Name	Common Name	TPWC	EPBC	SSOBS_level	SSOBS_code
Alluvial Low Lying Sand Plain	Active Colluvium / Colluvium over Mudstone	<i>Acacia adoxa</i> var. <i>adoxo</i>		LC		bioregional	TAN (eastern range limit)
		<i>Acacia ancistrocarpa</i>					
		<i>Acacia hemignosta</i>					
		<i>Acacia hilliana</i>	Flying-saucer Bush	LC		bioregional	CR (southern range limit)
		<i>Acacia melleodora</i>	Waxy Wattle	LC			
		<i>Acacia monticola</i>					
		<i>Acacia sericophylla</i>					
		<i>Acacia stipuligera</i>					
		<i>Amphipogon caricinus</i> var. <i>caricinus</i>	Grey-beard Grass, Long Grey-beard Grass	LC			
		<i>Aristida holothera</i>					
		<i>Aristida inaequiglumis</i>					
		<i>Atalaya hemiglauc</i>					
		<i>Bonamia media</i> var. <i>media</i>		LC			
		<i>Carissa lanceolata</i>					
		<i>Chrysopogon fallax</i>	Tickweed, Mustard Bush	LC			
		<i>Clerodendrum floribundum</i>	Smooth Clerodendrum, Smooth Spiderbush, Lollybrush, Lolly Bush	NE			
		<i>Corymbia deserticola</i> subsp. <i>mesogeotica</i>	Desert Bloodwood	LC		bioregional	MGD (eastern range limit), TAN (northern range limit), GSD (western and southern range limits)
		<i>Corymbia opaca</i>	Bloodwood	LC			
		<i>Crotalaria medicaginea</i> var. <i>neglecta</i>					
		<i>Crotalaria novae-hollandiae</i> subsp. <i>lasiophylla</i>	New Holland Rattlepod	LC			
		<i>Cyperus bulbosus</i>	Yalka, Nutgrass	LC			
		<i>Dodonaea coriacea</i>	Hopbush	LC			
		<i>Eragrostis eriopoda</i>					
		<i>Eucalyptus chlorophylla</i>	Green-leaf Box	LC			
		<i>Eucalyptus leucophloia</i>					
		<i>Eucalyptus odontocarpa</i>					
		<i>Eucalyptus victrix</i>					
		<i>Eulalia aurea</i>	Silky Browntop, Sugar Grass	LC			
		<i>Exocarpos sparteus</i>	Slender Cherry, Broombush	LC		bioregional	DAV (northern range limit)
		<i>Fimbristylis oxystachya</i>	lukarrara	LC			
		<i>Gomphrena lanata</i>		LC			
		<i>Goodenia armitiana</i>	Narrow-leaved Goodenia	LC			
		<i>Gossypium australe</i>					
		<i>Grevillea juncifolia</i>	Desert Grevillea, Honey Grevillea,	LC			

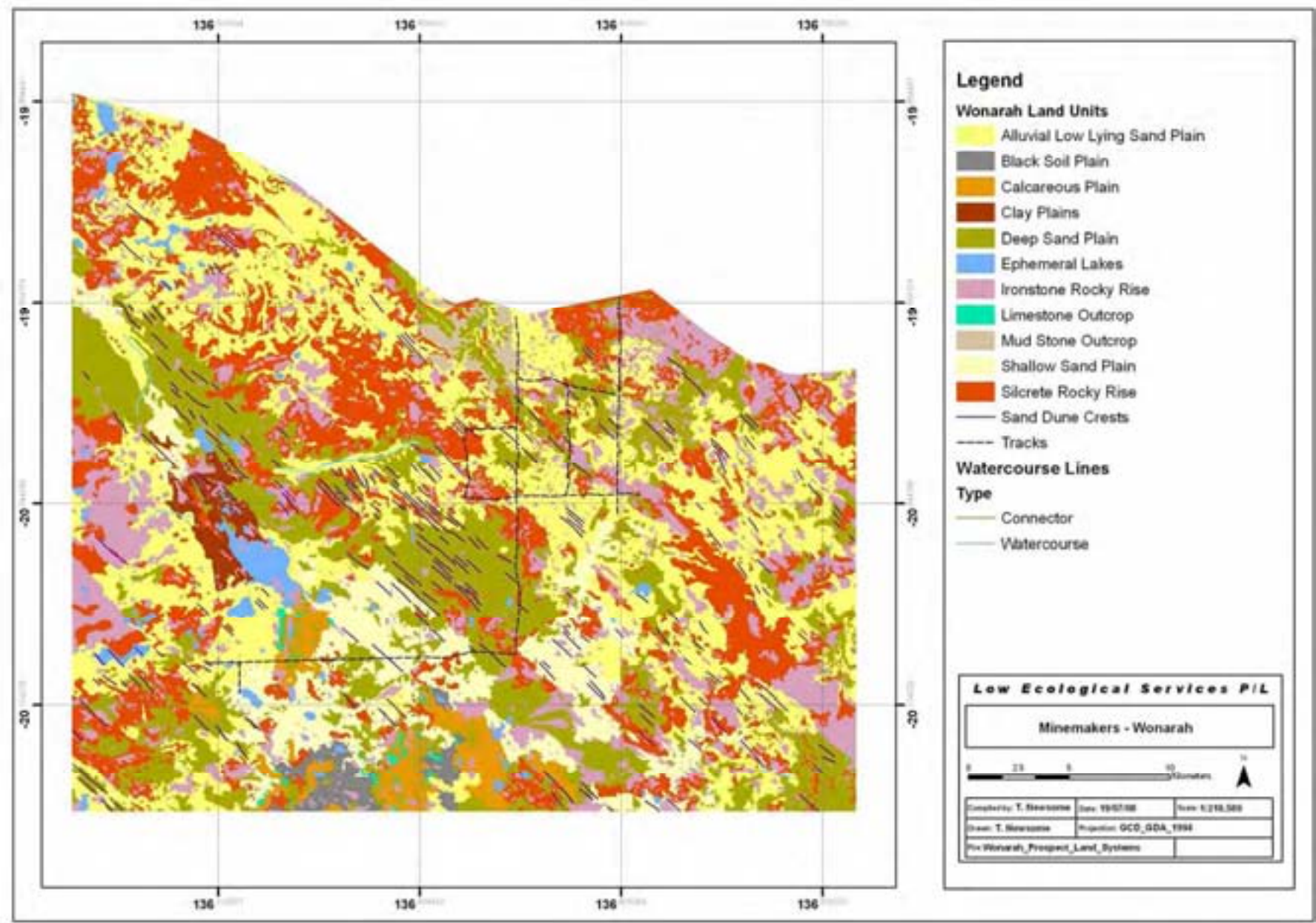




		<i>Leptochloa fusca</i> subsp. <i>fusca</i> <i>Lysiana spathulata</i> <i>Neptunia dimorphantha</i> <i>Rothia indica</i> subsp. <i>australis</i> <i>Sida cunninghamii</i> <i>Solanum tumulicola</i> <i>Sporobolus latzii</i> <i>Streptoglossa adscendens</i> <i>Trianthema triquetra</i>	Small-flowered Beetle Grass Flat-leaved Mistletoe Sensitive Plant, Nervous Plant  Black-soil Wild Tomato  Red Spinach	LC LC LC LC LC DD LC LC		southern NT  national	(disjunct and apparently rare)  1K
Ironstone Rocky Rise	Ferruginous Duricrust	<i>Acacia drepanocarpa</i> subsp. <i>latifolia</i> <i>Acacia lysiphloia</i> <i>Acacia monticola</i> <i>Amyema sanguinea</i> var. <i>sanguinea</i> <i>Eucalyptus leucophloia</i> (re-sprouting) <i>Eucalyptus odontocarpa</i>  <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> <i>Gossypium australe</i> <i>Grevillea refracta</i> subsp. <i>refracta</i> <i>Hakea macrocarpa</i> <i>Haloragis uncatipila</i> <i>Heliotropium ballii</i>  <i>Melaleuca viridiflora</i> <i>Mirbelia viminalis</i> <i>Ptilotus calostachyus</i> var. <i>calostachyus</i> <i>Rulingia loxophylla</i> <i>Spermacoce hillii</i> <i>Themeda triandra</i> <i>Triodia pungens</i> <i>Triumfetta centralis</i>	 Blood Mistletoe  Sturt Creek Mallee  Blue Periwinkle, Tropical Speedwell  Silver-leaf Grevillea   Yellow Broom  Kangaroo Grass	LC  LC LC LC LC DD  LC  LC LC LC LC		bioregional  Northern Territory  bioregional	GSD (southern range limit)  3k  SSD (eastern range limit)
Limestone Outcrop	Oucropping Dolomitic Facies	No Survey Sites Present					
Mudstone Outcrop	Oucropping Hangingwall Mudstone	No Survey Sites Present					
Shallow Sand Plain	Stabilised Aeolian Sand	<i>Acacia ancistrocarpa</i>  <i>Aristida holathera</i>  <i>Aristida inaequiglumis</i> <i>Astrelba pectinata</i> <i>Atalaya hemiglauc</i> <i>Carissa lanceolata</i>  <i>Eragrostis eriopoda</i> <i>Eulalia aurea</i> , <i>Gossypium australe</i>  <i>Heliotropium ovalifolium</i> <i>Tephrosia lasiochlaena</i>  <i>Triodia intermedia</i>	Fitzroy Wattle, Pirraru  Erect Kerosene Grass, White Grass, Arrow Grass Feathertop Wiregrass Barley Mitchell Grass  Conkerberry, Conkle Berry, Kungsberry Bush   Native Cotton, Tall Desert Rose	LC LC LC LC LC LC LC LC LC LC		bioregional	MAC (southern range limit)

		<i>Triodia pungens</i>					
Silcrete Rocky Rise	Silcrete Breccia Duricrust	<i>Acacia lysiphloia</i>	Turpentine, Turpentine Bush, Turpentine Wattle	LC		bioregional	GSD (disjunct and southern range limit) CR (southern range limit)
		<i>Acacia monticola</i>	Hill Turpentine	LC		bioregional	
		<i>Eragrostis eriopoda</i> subsp. <i>Sandy fireweed</i> (P.K.Latz 12908)		LC			
		<i>Eucalyptus leucophloia</i> (re- sprouting)					
		<i>Goodenia strangfordii</i>		LC		bioregional	MGD (southern range limit)
		<i>Grevillea dryandri</i> subsp. <i>dryandri</i>	Dryanders Grevillea	LC			
		<i>Hakea macrocarpa</i>	Flat-leaved Hakea	LC		bioregional	SSD (southern range limit) 3K
		<i>Heliotropium pulvinum</i>		DD		Northern Territory	
		<i>Melaleuca viridiflora</i>	Green Paperbark, Broad-leaved Paperbark, Large- leaved Paperbark	LC			
		<i>Paraneurachne muelleri</i>	Spinifex Couch, Northern Mulga Grass	LC			
		<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>	Weeping Mulla Mulla	LC			
		<i>Senna notabilis</i>	Cockroach Bush	LC			
		<i>Solanum chippendalei</i>	Bush Tomato, Ngaru	LC			
		<i>Triodia pungens</i>	Soft Spinifex, Gummy Spinifex	LC			

10.28. **Appendix Twenty-Eight:** Detailed Land System Map of the Wonarah Prospect based on regolith and satellite interpretation and limited ground truthing.



10.29. **Appendix Twenty-Nine:** Rio Tinto's procedure for protecting *Sporobolus latzii* on the Wonarah tenements.

**Background**

*Sporobolus latzii* is potentially located on RTE-AR Wonarah tenements. The characteristics of this species are:

**Significance**

National 1K

Life Form

Erect perennial grass

**Habitat**

Known to occur in seasonal swamps with clay soils.

**Distribution**

May be endemic to the study region. Known only from a single location in the Wakaya Desert, in the east of the Tanami Bioregion.

**Notes**

Little known about this recently described species. Need to search areas of similar habitat to determine the conservation status of the species.

**Issues**

Due to the poor taxonomic recording of *Sporobolus latzii* the species is classed as having conservation significance. The only collected specimen was on a seasonal swamp clay area in the Wakaya Desert region, on the eastern portion of the Tanami Bioregion. The RTE-AR Wonarah tenement area is located in this region. Therefore, it is important that all RTE-AR activities conducted in this region do not disturb the habitat and communities of *Sporobolus latzii*.

**Field Procedure**

**Habitat Identification**

A ground survey will be conducted with maps to identify the potential habitats where the species are found. This will involve ground truthing the areas, identified on maps, located on the RTE-AR tenements as clay pan seasonal swamps habitat types. These areas will be clearly demarcated and recorded. Monitoring stations will be set up at these sites according to ENVT104 Site Monitoring.

**Field Personnel Induction**

It is fundamental that all personnel in the field are made aware of the situation. All personnel will be:

- Briefed on the conservation significance of *Sporobolus latzii*.
- Provided with a description of the plant
- Made familiar with the designated 'no-go areas' on the tenement



# Appendix D

## **Minemakers Environmental Policy**





## ***ENVIRONMENTAL POLICY***

Minemakers Limited regards sound environmental management and protection as an integral part of its business and of playing its part in the community, and is committed to excellence in this area of activity.

Minemakers aims to minimise environmental impacts at every stage of work, from planning, exploration, development, mining, production and through to decommissioning.

To achieve this goal, the Company will:

- seek to identify, monitor and manage all environmental impacts arising from its operations;
- integrate environmental considerations into project planning and operations;
- develop, implement and enforce a comprehensive Environmental Management System;
- provide information and training to our workforce, contractors, suppliers and customers to provide a greater understanding of environmental issues and responsibilities in relation to our business;
- undertake consultation with appropriate community and government groups to ensure that community interests are addressed;
- comply with applicable laws, regulations and standards;
- monitor performance and provide safeguards and contingency plans for all activities to detect and prevent any potential impacts;
- review the Company's operations in the context of technological advances to seek improvements in production processes, waste management and the efficient use of resources.

As with all areas of its operations, Minemakers will be a responsible corporate citizen in respect to the environment. All employees and contractors are responsible for upholding the Company's standards of environmental management and care.

**ANDREW DRUMMOND**

Managing Director  
27 February 2009