



November 2005  
CR 836\_8\_v4

# Public Environmental Report

Executive Summary and Main Report

Compass Resources NL, Browns Oxide Project



Compass Resources NL





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**Browns Oxide Project**

**Public Environmental Report**

**Executive Summary and Main Report**



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<b>Version/s:</b>	<b>Distribution:</b>
CR 836_8_v1 August 2005 (Via email)	Compass – 1 copy Enesar – 1 copy
CR 836_8_v2 August 2005 (Via email)	Compass – 1 copy Enesar – 1 copy
CR 836_8_v3 September 2005 (Via email)	OEH – 1 copy DEH – 1 copy (+ 1 hard copy) Compass – 1 copy Enesar – 1 copy
CR 836_8_v4: • Executive Summary and Main Report • Appendices November 2005	OEH – 20 copies (+ 20 CD ROMs) DEH – 3 copies (+ 1 CD ROM) Libraries – 8 copies NLC – 5 copies (+ 1 CD ROM) Coomalie Council – 1 copy (+ 1 CD ROM) Environment Centre – 1 copy (+ 1 CD ROM) Compass – 9 copies (+ 3 CD ROMs) Enesar – 3 copies (+ 3 CD ROMs)

## Guide to the Browns Oxide Project Public Environmental Report

The PER comprises two volumes:

- Executive Summary and Main Report.
- Appendices.

Information on how to view or obtain copies of this documentation and how to make a submission on the PER is provided overleaf.



## **Viewing or Obtaining a Copy of the PER**

This document will be available for public review from the 10 November until the 15 December 2005 at the following locations:

- Northern Territory Library, Parliament House, Corner Bennett and Mitchell streets, Darwin, Northern Territory.
- Darwin Public Library, Civic Centre, Harry Chan Avenue, Darwin, Northern Territory.
- Casuarina Public Library, Bradshaw Terrace, Casuarina, Northern Territory.
- Palmerston Public Library, Civic Plaza, Corner University Avenue and Chung Wah Terrace, Palmerston, Northern Territory.
- Information NT, Palmerston Shopping Centre, Palmerston, Northern Territory.
- Department of Planning and Infrastructure, Cavenagh House, Cavenagh Street, Darwin, Northern Territory.
- Coomalie Community Government Council offices, Batchelor, Northern Territory.
- Batchelor Library, Batchelor, Northern Territory.
- Commonwealth Department of the Environment and Heritage Library, John Gorton Building, King Edward Terrace, Parkes, Australian Capital Territory.

The report can also be examined for the duration of the public review period on the Department of Natural Resources, Environment and the Arts internet site at [www.nreta.nt.gov.au/whatwedo/environment/assessment/register/](http://www.nreta.nt.gov.au/whatwedo/environment/assessment/register/).

The PER is also available either in CD-ROM format (purchase price \$5.00) or hard copy (purchase price \$100.00) on request from:

Compass Resources NL  
Suite 4B, 384 Eastern Valley Way  
Roseville NSW 2069  
Phone: 02 9417 3588  
[admin@compassnl.com.au](mailto:admin@compassnl.com.au)

## **Making a Submission on the PER**

Persons wishing to comment on the PER are invited to make submissions by close of business on 15 December 2005 to:

Ms Denise Montgomery  
Office of Environment and Heritage  
Department of Natural Resources, Environment and the Arts  
GPO Box 1680, DARWIN NT 0801  
[Denise.Montgomery@nt.gov.au](mailto:Denise.Montgomery@nt.gov.au)

Submissions will be treated as public documents unless confidentiality is requested. Copies of all submissions will be forwarded to Compass Resources NL.



# Executive Summary

## 1. Introduction

Compass Resources NL (Compass) is proposing the development of the Browns Oxide Project, located in the Northern Territory approximately 65 km south of Darwin and 7 km northwest of Batchelor (Figure ES1). Compass proposes to utilise open cut mining methods and a conventional hydrometallurgical process to extract approximately 3.9 Mt of oxide ore and produce copper, cobalt and nickel over a four-year period.

The project is located near to, but separate from, former mining areas at Rum Jungle. Background uranium levels in the Browns Oxide deposit are very low<sup>1</sup> and uranium will not be produced as part of the development.

The purpose of this Public Environmental Report (PER) is to describe the project and address the associated environmental and social impacts and management strategies, and to obtain environmental approval under the Northern Territory *Environmental Assessment Act* (EA Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

## 2. Legislative Framework and Approvals

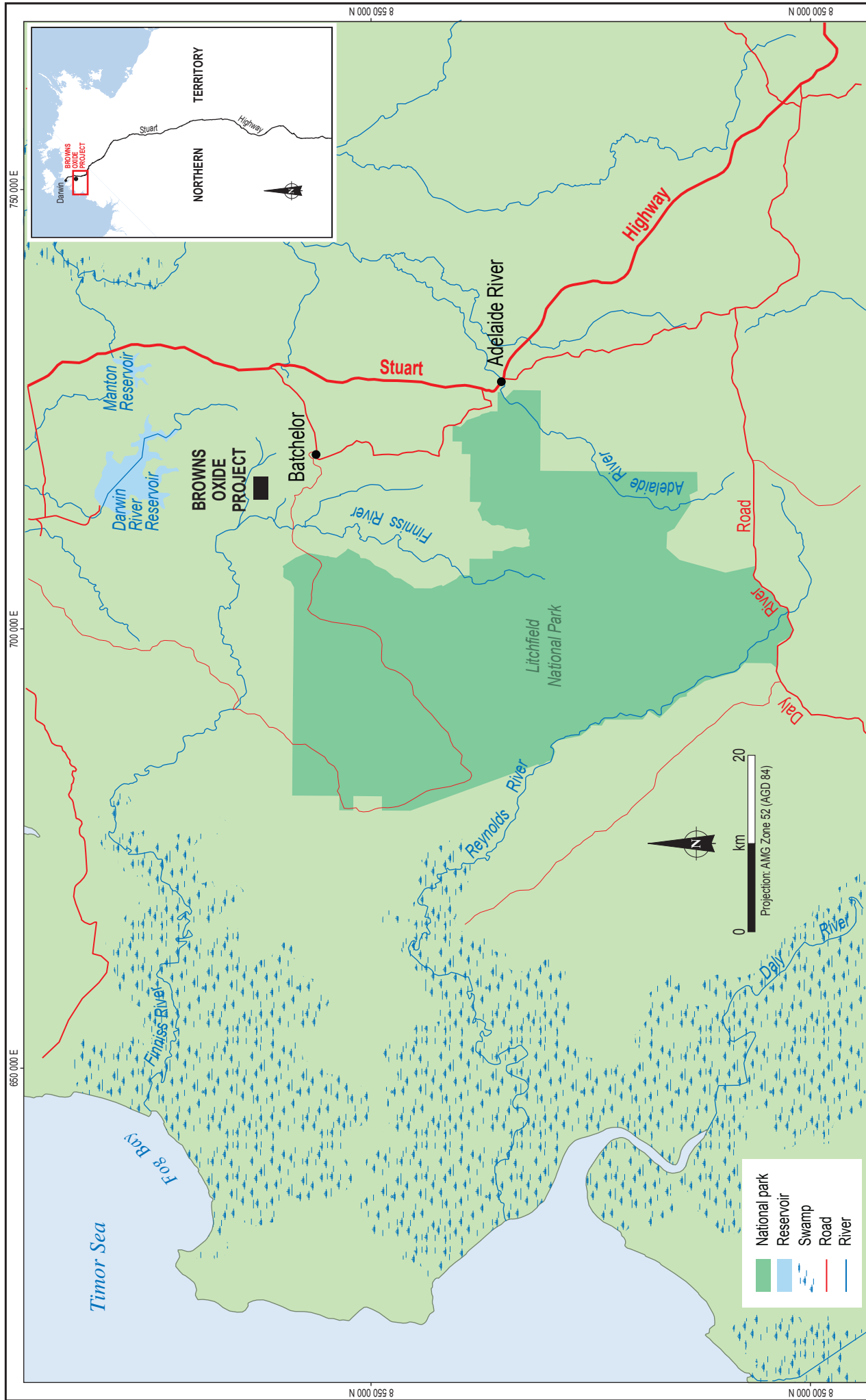
Following submission of a Notice of Intent to the Department of Primary Industry, Fisheries and Mines (DPIFM)<sup>2</sup> and the submission of an EPBC Act referral to the Commonwealth Department of the Environment and Heritage (DEH), it was determined that the project should be assessed via the Northern Territory PER process under the Northern Territory/Commonwealth Bilateral Agreement. The Office of Environment and Heritage (OEH) oversees the assessment process which operates under EA Act administrative procedures (which are modified because of the bilateral agreement). Once evaluated within the Northern Territory, the project is referred to the Commonwealth. The major steps in the assessment process are:

- Submission of the PER.
- PER public exhibition.
- Submission of public and Northern Territory advisory body comments on the PER.
- Preparation and submission of a PER supplement addressing submissions.

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<sup>1</sup> Less than the regulatory exemption level of 1 Bq/g of any naturally occurring radionuclide other than <sup>40</sup>K.

<sup>2</sup> Formerly the Department of Business, Industry and Resource Development (DBIRD).



	Job No: 836 File No: 836_08_ES_F001_HB	<b>Compass Resources NL</b> <b>Browns Oxide Project</b>	<b>Project location</b>	<b>Figure No:</b> <b>ES1</b>
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- OEH assessment of the supplement and decision on the project by the Northern Territory Minister for Natural Resources, Environment and Heritage (28 days).
- DEH review of PER (main document and supplement) together with OEH assessment report and ministerial decision (30 business days).
- Commonwealth decision on the project.
- Notification of determination and recommendations to DPIFM.
- DPIFM proceeds with approvals process under the *Mining Management Act* (MM Act) and the *Mining Act* (MA Act).

Under the MM Act, the proponent submits an Application for an Authorisation of Mining Activities, where this application is supported by a Mining Management Plan (MMP). Once granted, the authorisation (accompanied by the MMP) becomes the key operational document for the mine. Other applicable legislation, agreements and codes of practice will be taken into consideration during project planning, construction and operations.

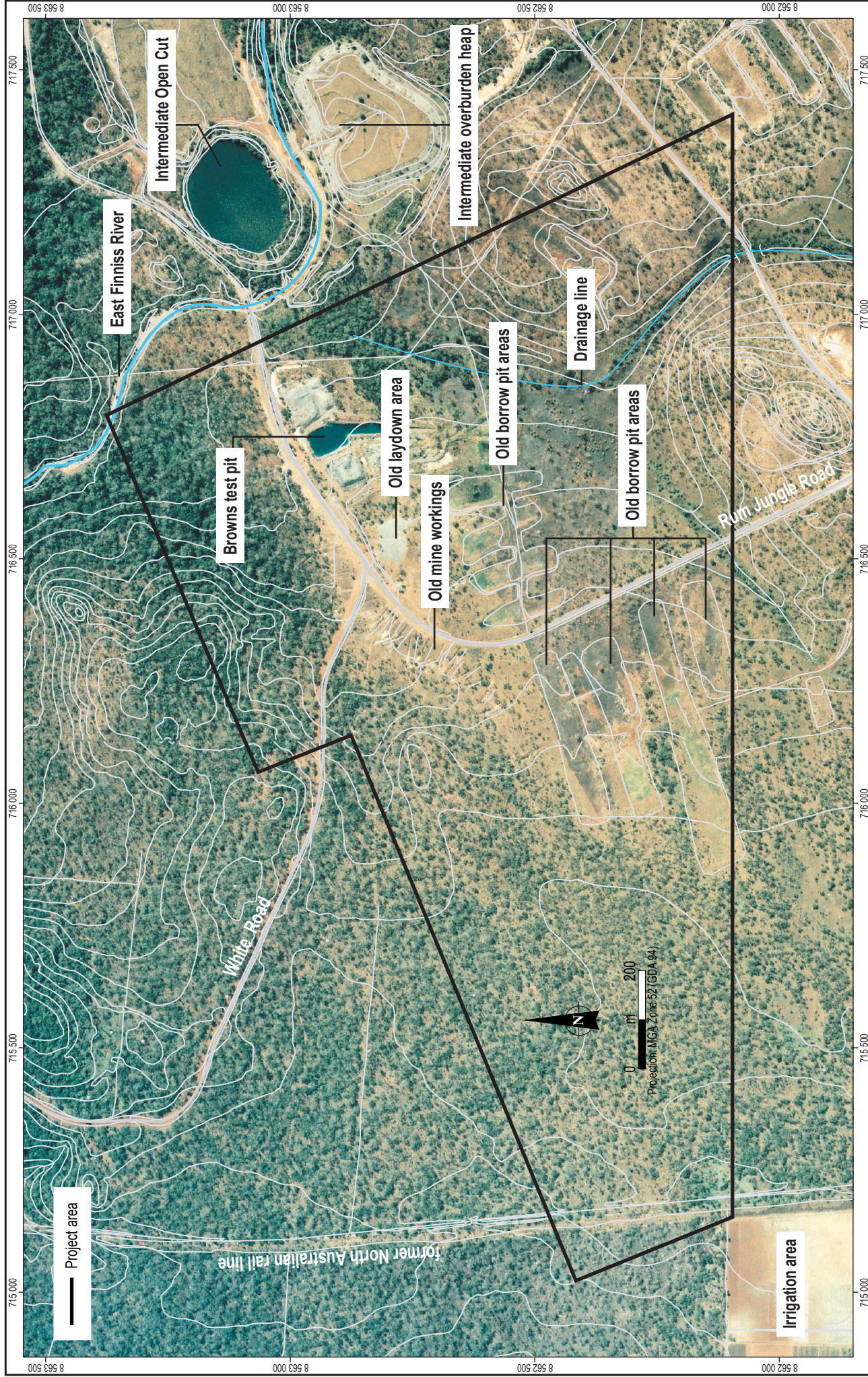
### **3. Environmental Context**

The project area has a modified natural landscape with varying levels of disturbance from previous exploration and mining related activities. The main areas of disturbance occur in and around the Browns test pit, along the Rum Jungle Road and in and around the old borrow material areas in the central and southern parts of the project area (Figure ES2).

The region has a tropical, monsoonal climate with distinct wet (December to March) and dry seasons. The project area is located within the Pine Creek Geosyncline, a landscape that is primarily a peneplain of gently undulating land interspaced by plains. The project lies in the Northern Lateritic Plains Geomorphological Unit marked by lateritic soils formed on rocks of the Brocks Creek Group. The soils of the region are generally nutrient poor, except in the river valleys which usually flood during the wet season and tend to be acidic.

The project area is largely drained by the East Branch of the Finnis River, i.e., the East Finnis River, which is one of the smaller catchments in the northwest of the Northern Territory. The East Finnis River is an ephemeral stream that generally has no flow in the later part of the dry season, i.e., from July to November, and a steady base flow in the wet season which increases significantly during flood events. The water quality of the East Finnis River is heavily influenced by long-term acid rock drainage (ARD) from the former Rum Jungle Mine.

The project lies within the boundaries of the Coomalie Community Government Council, which is based in Batchelor. Batchelor provides basic services and facilities for the area and has a population of 700. The original (and still the main) Aboriginal tribal groups of the area are the Kungarakan and Awarai (Warai) people, although other Aboriginal groups have resided, and in some cases still reside, in the area.



Source: AMDAD.				Job No: 836 File No: 836_08_ES_F002_HB	<b>Compass Resources NL</b> <b>Browns Oxide Project</b>	<b>Project area aerial photograph and topography</b>	Figure No: <b>ES2</b>
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## 4. Project Description

### 4.1 Location

The project footprint is approximately 90 ha and lies entirely within the 175 ha area (Figure ES3) of granted mineral leases MLN 139 to 147 and MLN 150 to 152. The deposit is located in the northern part of the project area and has an east–west orientation. The tailing storage facility (TSF), processing plant and other mine components are located in the western section of the project area.

### 4.2 Project Overview

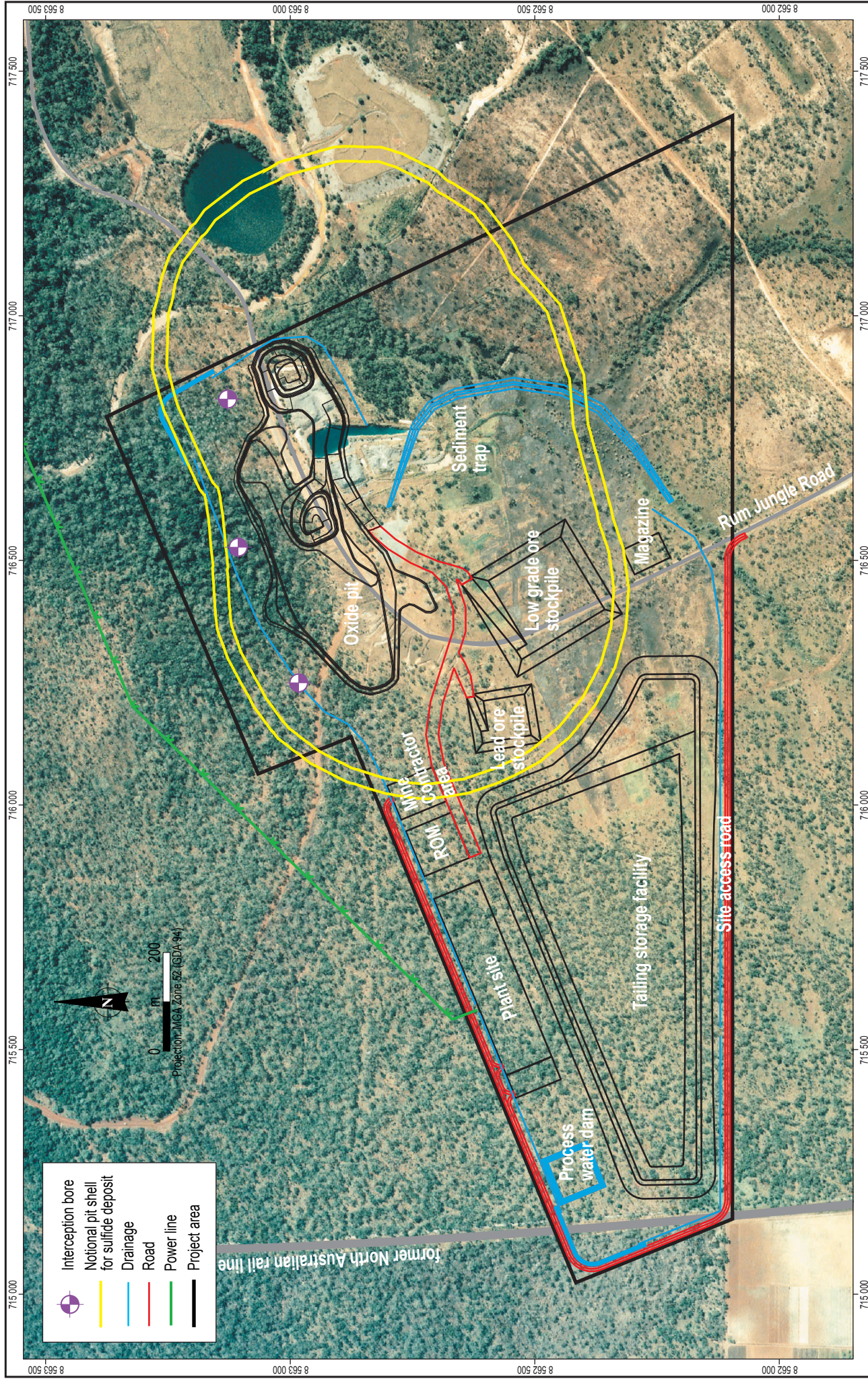
The project involves the development of a 3.9-Mt polymetallic oxide deposit using open pit mining techniques over a mine life of approximately four years. Ore will be mined and processed at a rate of approximately 1 Mt/a using a conventional crushing, leach and solvent extraction-electrowinning circuit to produce copper cathode. The project will also use a chemical precipitation circuit to produce cobalt and nickel. Approximately 10,000 t of copper cathode, 1000 t of contained cobalt and 700 t of contained nickel as hydroxides or sulfides will be produced each year of operation. All products will be transported by road to the Port of Darwin for export by ship. Tailing will be disposed of on site to an engineered TSF.

Key characteristics of the project are summarised in Table 1.

**Table 1 Key characteristics of the project**

Element	Description
Granted MLs	MLN 139 to 147 and MLN 150 to 152
Project area/footprint	175 ha/90 ha
Life of project (mine production)	Four years
Size of deposit	3.9 Mt (confirmed resource of 2.8 Mt)
Mine production rate (maximum)	1 Mt/a
Resource grade	1.06% Cu, 0.13% Co and 0.11% Ni
Depth of mine pit	20 to 25 m on average with two deeper pockets up to 50 m
Extent of mine pit	776 m long and 225 m wide
TSF	35.71 ha, 2.7 Mm <sup>3</sup> capacity
Groundwater level	4 to 8 m below surface level depending on season
Mine operation	Open pit, excavator/truck mining
Raw water source	Interception bores
Raw water requirement (maximum)	40 m <sup>3</sup> /hr, 350,000 m <sup>3</sup> /a (350 ML/a)
Power source	Northern Territory grid
Power requirement	7.5 MW/a
Fuel storage capacity	65,000 L

Construction will commence in the first quarter 2006 for a period of around nine months, with commencement of production later in the year.



N.B Sulfide deposit not part of the Browns Oxide Project. Pit shell is indicated as it impacted placement of project components.				Job No: 836 File No: 836_08_ES_F003_HB	Compass Resources NL Browns Oxide Project	Figure No: <b>ES3</b>
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### 4.3 Mining

The Browns oxide deposit comprises weathered rock from surface to a typical depth of 20 to 25 m, with two deeper pockets reaching 50 m depth. Mining will be undertaken as a conventional excavator/truck operation (with some blasting being required for sections of harder material). Ore will be mined at approximately 1 Mt/a and waste rock will be mined at the rate of 0.89 to 1.13 Mt/a over a period of up to four years. Mined ore will be delivered to the run of mine (ROM) stockpile. A low grade ore and lead ore stockpile will also be constructed. Current planning involves processing of these materials toward the end of operations. However, if the material becomes uneconomic at the end of the mine life it will be returned to the mined-out pit.

### 4.4 Processing

The process plant will comprise a crushing/grinding circuit and leach tanks. Copper will be extracted using solvent-extraction electrowinning technology, while cobalt and nickel will be extracted by hydroxide or sulfide precipitation. The process plant will operate 24 hours per day, seven days per week at a rate of approximately 1 Mt/a, although the crushing circuit will operate on a day-shift only basis. Three metals will be produced at an estimated rate of 10,000 t/a of copper cathode, 1,000 t/a of cobalt (as a hydroxide or sulfide) and 700 t/a of nickel (as a hydroxide or sulfide). The cobalt and nickel are likely to be produced as a combined product.

### 4.5 Waste Rock Management

Waste rock will consist of either oxidised sulfidic shales or carbonate-rich sediments. For mine planning purposes, the different lithologies have been categorised on the basis of their acid-forming potential using sulfur content as the primary indicator (i.e., either non-acid forming (NAF) or potentially acid forming (PAF)). Using this categorisation method about 36% of all of the waste rock that will be generated during mining has been classified as PAF.

The TSF embankment has been designed to incorporate most<sup>1</sup> of the waste rock mined in its construction. PAF material will be selectively placed within the TSF embankment and encapsulated with NAF material to minimise its potential for ARD production (by both limiting exposure to atmospheric oxygen and reducing water infiltration). Compass will provide close supervision during construction of the TSF so as to ensure that the required high degree of geotechnical and structural control is obtained.

### 4.6 Tailing Management

Ore comprises either black shale (70%) or supergene material (30%), most of which will report as tailing after recovery of the copper, cobalt and nickel. Physical characterisation of the tailing samples has shown that the supergene tailing is clayey sand and the black

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<sup>1</sup> Some NAF material will be used for other purposes such as road surfaces.

shale tailing is sandy silt. Geochemical characterisation of tailing samples indicates that the supergene tailing has a low sulfur content (0.16%) and is classified as NAF, while the black shale tailing has a sulfur content of about 1% (although possibly two thirds is present in forms that are not acid generating) and is classified as PAF. The testwork has also shown that a lag time of at least several months is likely before the onset of acidic conditions. Further geochemical characterisation of tailing samples is planned.

The TSF will be constructed with an embankment around all sides, where this will consist of an internal lining of compacted clayey soil, a transition zone of compacted, highly weathered material, a core zone of compacted weathered rockfill for the bulk of the embankment, and a layer of protective rockfill. The exposed foundations beneath the embankment and storage area will be compacted prior to the commencement of deposition. The TSF is designed to retain variable volumes of water in the decant pond, up to a maximum 125,000 m<sup>3</sup> in very wet periods. The actual retained volume will depend on recycle requirements for the process plant and, in extreme events, overflow will occur via a spillway along the eastern section of the TSF embankment.

The tailing management strategy and design measures will be based on consideration of relevant best practice, such as placement of the tailing pipeline within a bund, regular inspection of the pipeline and automatic monitoring of pump pressure to detect line failure, monitoring for the occurrence of significant dusting from the tailing beaches and monitoring of seepage from the TSF during and after operations.

#### **4.7 Infrastructure and Transport**

The electricity demand for the project is estimated to be 7.5 MW which will be supplied by connection to the Northern Territory grid. The proposed power line route is around 23 km in length and follows the alignment of an existing track and fence line to connect to the Manton Dam substation to the northeast of the project area. The final route will be determined in consultation with the Northern Land Council and traditional owners.

The existing Rum Jungle Road will be used as the main site access road. The main transport route for products and supplies will occur via this road, to Batchelor Road and along the Stuart Highway to Darwin. The northern part of Rum Jungle Road and a section of White Road will be closed to the public as part of the project, and alternate access arrangements will be provided along Bevan and Lithgow roads.

#### **4.8 Water Management**

The water management system must accommodate both the normally variable rainfall (i.e., wet/dry season variations), and the occasionally more severe shortages and surpluses of water that may occur over the life of the operation. The following principles apply to the design and operation of the water management system:

- Minimise water consumption.
- Maximise water recycling.
- Establish a preferential hierarchy of uses based on water quality.
- Control discharges from operational areas of the lease.
- Control potential contaminants used on site.

- Minimise land disturbance.

The overall objective for water management on site is for the operation to be as self-sustaining as possible in terms of water use requirements. Raw water for the project will be supplied from groundwater (e.g., interception bores) located within the project area. However, a considerable percentage of water requirements (particularly in the wet season) will be met by recycling water from the TSF (Figure ES4).

#### **4.9 Workforce**

The construction phase of around nine months is expected to employ up to 100 people at its peak. Most of the construction workforce will be employed as contractors who are likely to be sourced primarily from Darwin. The operations workforce will comprise around 79 people. Compass will source employees locally where possible and it is expected that the majority of the operations workforce will come from the Batchelor–Adelaide River–Darwin region.

### **5. Alternatives**

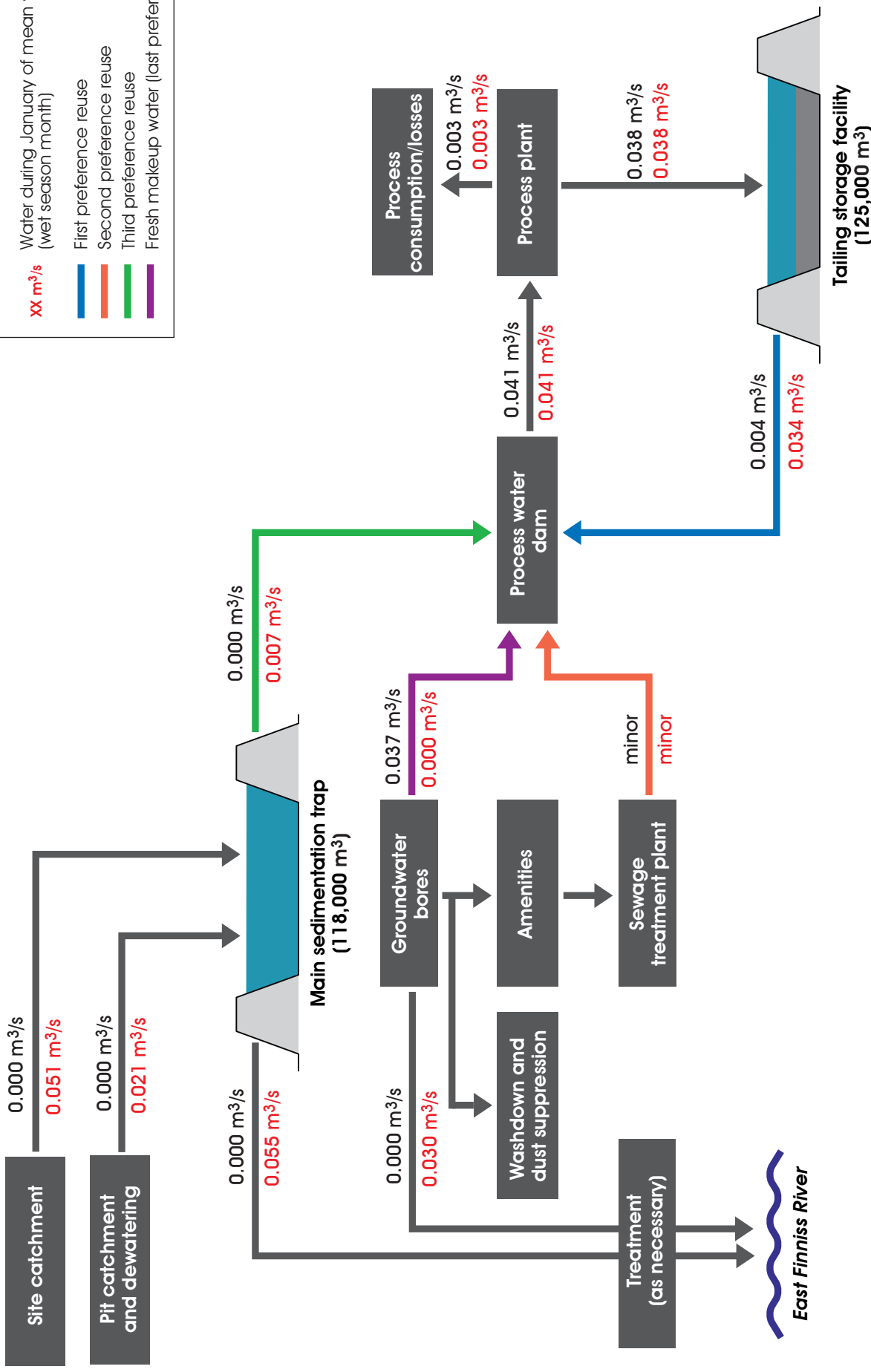
The location of the project (as with all resource development projects) is constrained by the location of the deposit. The alternative to the development of the Browns Oxide Project is no development. A number of alternatives have been considered as part of the planning of the project, including aspects such as project size, processing methods, management of tailing and waste rock, electricity sources and transport routes. The project development concept contained in this PER represents the current (as of 15 August 2005) optimisation of engineering, economic, environmental and social consideration. Further optimisation will occur during detailed design.

### **6. Stakeholder Consultation**

Consultation has commenced with key stakeholders such as Northern Territory regulatory authorities, Coomalie Council and the Northern Land Council (NLC) (representing traditional owners). This consultation will continue during project planning, construction and operations, and will extend through mine closure. The broad outcomes of the stakeholder consultation activities have included:

- Increased government and community awareness and understanding of the project.
- Involvement of regulatory authorities in shaping project activities.
- Identification of areas of concern to residents and other stakeholders.
- Identification of potential business/employment opportunities for local stakeholders.
- Opportunities for members of the local community to voice opinions and concerns.

**XX m<sup>3</sup>/s** Water during July of mean year (dry season month)  
**XX m<sup>3</sup>/s** Water during January of mean year (wet season month)  
 Blue line First preference reuse  
 Red line Second preference reuse  
 Green line Third preference reuse  
 Purple line Fresh makeup water (last preference)



Note: Water balance takes into account evaporation, rainfall and seepage.

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Compass Resources NL  
 Browns Oxide Project

Conceptual water balance  
 Figure No: ES4

## 7. Environmental and Social Impact Assessment

### 7.1 Flora

Most of the project area (approximately 50%) comprises dryland savannah vegetation on gentle lower slopes and foothills that support eucalyptus-dominated communities. The central and eastern sections of the project area are highly disturbed and dominated by weeds and introduced grasses. In general, the plant species recorded within the project area are common and widespread in the region. There are no vegetation communities of declared conservation significance, at either the Commonwealth or territory level, in the project area.

There are no plant species of conservation significance listed under the EPBC Act in the project area nor are there records of any rare or endangered plant species. The only protected species found or likely to be in the project area is the cycad *Cycas armstrongii*, which is listed as threatened under the *Territory Parks and Wildlife Conservation Act*. This species is present within several vegetation communities in the project area.

The project will result in clearing of around 90 ha of land, some of which is already disturbed. Direct impacts will be the removal of individual plants from the area and loss of habitat, and there may also be indirect impacts on the distribution, dispersal and diversity of species in the region. The project may also increase the potential for weeds, although this will be minimised by a targeted weed management program.

### 7.2 Fauna

The project area and immediate surrounds support a range of fauna species including 18 amphibians (including the cane toad [*Bufo marinus*] which has only arrived to the area during the latest wet season), 38 reptiles, 120 birds and 33 mammal species. Four species of nationally or Northern Territory threatened species status exist in the project area, i.e., the northern quoll (*Dasyurus hallucatus*), partridge pigeon (*Geophaps smithii*), brushtailed phascogale (*Phascogale tapoatata*) and red goshawk (*Erythrotrorchis radiatus*). The main impacts to fauna will result from the clearing and fragmentation of habitat within the project area. However, within the regional context, project-related clearing represents a minor habitat loss and will occur in an area that is already disturbed. Impacts on species of conservation significance are expected to be further minimised by retention of the vegetation in the southeast of the project area.

Regardless of the project's status, it is expected that the recent arrival of the cane toad will have an adverse impact on native fauna species in the area, particularly the northern quoll, brush-tailed phascogale, goannas, snakes and frogs.

### 7.3 Air Quality

The main potential air quality issue associated with the project is liberation of particulate matter during the handling and transport of ore and waste, and from wind erosion of disturbed areas. Project emissions of combustion products such as carbon monoxide, nitrogen dioxide and sulfur dioxide from the burning of fuels (mostly diesel) and from

blasting are, in practice, too small and too widely dispersed to impact air quality other than in the immediate vicinity of their discharge. A number of mitigation measures will be implemented to minimise dust generation, including reducing areas of disturbance, managing mine traffic, using water as a dust suppressant, containerised transport of products and wet grinding. Implementation of these measures will enable the relevant ambient air quality criteria to be met.

#### **7.4 Greenhouse Gas Emissions**

Greenhouse gas emissions for the project are estimated to be 3,200 t CO<sub>2</sub>-e during construction and 47,400 t CO<sub>2</sub>-e per year during operations. Compass will minimise emissions wherever practicable to ensure compliance with the Northern Territory Government's objective that greenhouse gas emissions from new and expanding operations are as low as practicable. The project will have a negligible impact on national greenhouse gas emissions.

#### **7.5 Noise**

The main potential noise issue is the increase in noise above background at the closest non-company residence (approximately 2 km to the southwest of the pit). Potential sources of noise and vibration will include mobile mining equipment, reversing alarms, the process plant and blasting. Impacts will be minimised by mining and crushing only during the day and by using 'smart' reversing alarms where necessary. Noise impacts will be controlled to a level that will meet the assessment criteria that would apply to similar mines elsewhere in Australia. Noise and blasting impacts will be monitored by complaint, and if necessary, additional mitigation measures will be introduced.

#### **7.6 Infrastructure and Transport**

Relevant potential issues are the ability of current infrastructure in Batchelor to support the development, and changes to local traffic volumes and the consequent safety and amenity issues. The project is not expected to adversely impact on existing infrastructure in Batchelor, although there will be an increased volume of traffic on the roads. Closure of sections of White and Rum Jungle roads may increase travel distances to Batchelor for landholders located to the northwest of the project area.

#### **7.7 Land and Resource Use**

Utilisation of approximately 90 ha by project components will alter the current landform and, possibly, impact future land and resource use. However, given the relatively small footprint of the project and the fact that it occurs within an already-disturbed area, development of the site will facilitate the expansion of the resource development industry (where this is a key land use objective for the Coomalie region) while not significantly affecting the existing land use.

The project is not located within Darwin's current potable water catchment area; therefore, impacts on the water supply area are not anticipated.

## 7.8 Surface Water

The East Finniss River has been, and continues to be, adversely impacted by discharges from the former Rum Jungle Mine site. Potential downstream water quality impacts associated with the Browns Oxide Project relate to general stormwater runoff, runoff from the TSF embankment, discharge of excess water from the main sedimentation trap, seepage from the TSF and pit water/intercepted groundwater. To enable discharges to the East Finniss River, Compass must obtain a Waste Discharge Licence and it is expected that the licence conditions will take into consideration the existing water quality of the East Finniss River. Compass intends to implement a 'best practice' approach to water management, including:

- Installation of sediment control structures.
- Separation of clean and dirty water.
- Maximum reuse of dirty water.
- Testing and treatment of excess water to ensure it is of suitable quality prior to controlled release.
- Release of excess water during periods of high river flow to ensure maximum dilutions (assuming quality is worse than receiving water quality).
- Establishment of a comprehensive monitoring program of the surface waters that may be affected by the project.

Compass will have a management target of maintaining, and allowing improvement of, the existing ecosystem, consistent with the approach recommended by ANZECC/ARMCANZ for Condition 3 (highly disturbed) ecosystems.

## 7.9 Groundwater

Groundwater fluctuates seasonally and occurs at depths ranging from 2 to 12 m below surface in the project area, with an average depth of about 4 m. The rapid cyclic groundwater response to rainfall indicates that the aquifers in the project area are unconfined.

Advance dewatering and/or in-pit pumping will create a cone of groundwater depression (most probably an elliptical-shaped cone) around the pit, although recovery in groundwater levels due to rapid recharge during the wet season is likely to at least partially offset this drawdown. Impacts from dewatering may include:

- Reduced groundwater availability for other users.
- Reduced baseflows to surface waters.
- Drawdown of water contained within Rum Jungle Mine pits, thereby exposing sulfide material in the pit walls to oxidation and consequently generating ARD.
- Removal of water from the root zone of surrounding vegetation.

Preliminary modelling shows that, in the absence of boundary conditions, drawdown impacts are calculated to extend to between 1,000 and 1,500 m from the mine pit, with drawdown likely to be further extended along local faults. Although it is considered unlikely that significant drawdown impacts will occur in the irrigation area some 1.5 km southwest of the pit, minor impacts cannot be discounted. Compass will endeavour to provide alternate water supplies if material impacts were to occur to groundwater users.

Mine dewatering is not expected to significantly impact the baseflow of the East Finniss River since water produced from interception bores, if of suitable quality, will be discharged to the East Finniss River.

The impacts of groundwater drawdown on habitats and associated fauna species surrounding the proposed mine pit will be diminished by replenishment of the water table during the wet season. Monitoring, particularly of melaleuca woodland and monsoon vine-forest, will determine impacts from mine dewatering and/or alteration of groundwater levels.

### **7.10 Socio-economic**

The population of Batchelor has been increasing since 1991 (727 people at 2001 census), which is consistent with trends in Darwin and the Northern Territory in general. The 2001 census shows that 77% of the population were Australian-born, with 39% of the population being of Aboriginal and/or Torres Strait descent. Batchelor's unemployment rate is 6.9%, the primary employment sectors being education and hospitality.

Batchelor has a range of services and facilities that are adequate for most day-to-day requirements. Facilities include a school (preschool to Year 10), the Batchelor Institute of Indigenous Tertiary Education (BIITE), a health centre, general store, motels, police station, fire brigade and recreational facilities. Darwin is the closest major centre and provides a full range of services and facilities.

Additional employment opportunities as a result of project development will be a major benefit to the local and broader communities. The project will inject approximately \$4.5 million during the nine-month construction period, and \$8.4 million annually during operations, in wages (including contractors) into the community (about 25% locally). This represents approximately 5% of the mining sector's contribution to wages in the Northern Territory and will have consequent flow-on effects.

A large proportion of the capital cost for development of the project will be spent in the Northern Territory, particularly the regional area (including Darwin). This cash injection will have a flow-on effect to other businesses and industries, which in turn will strengthen their economic viability. The Northern Territory and federal governments will also benefit economically in the form of taxes such as company, income and pay-roll tax. Royalties will also be paid to the Northern Territory Government.

The project will have minimal impact on existing services and facilities in Batchelor given that the workforce will be sourced locally or from Darwin and there will be minimal, if any, new demand. No adverse effects are expected on the local tourism industry.

### 7.11 Biting Insects

Biting insect control will be incorporated into project design and management measures will be implemented to minimise breeding areas and provide personal protection.

### 7.12 Archaeology and Heritage

There are no previously recorded archaeological places or objects, and no National Trust-listed properties within a 5-km radius of the project site. However, there are records of sites of significance to Aboriginal people within the vicinity of the project area and Compass intends to apply for an Authority Certificate from the Aboriginal Areas Protection Authority (AAPA) in relation to the project area and works.

An archaeological survey of the project area located four archaeological sites (one of low to moderate significance, with the remaining three being of low significance), seven areas of isolated artefacts (background scatters) and three historic sites (a mine lease marker, a remnant section of the North Australian Railway and the CRA Mine headframe).

Should any archaeological site or background scatter area be disturbed by the current project layout, permission to destroy that site will be sought from the Minister of Natural Resources, Environment and Heritage prior to construction. The CRA Mine headframe will be either donated to an interested party in Batchelor to be displayed in the town or moved to another location to ensure its conservation.

### 7.13 Radiology

While the Browns Oxide Project is adjacent to the historic Rum Jungle copper and uranium mine, the concentration of naturally occurring radioactive material (NORM) in Browns oxide ore is very low, being less than the regulatory exemption level (1 Bq/g of any naturally occurring radionuclide other than  $^{40}\text{K}$ ).

The total radiation dose to workers from all pathways in mining and ore handling and crushing is predicted to be <0.3 mSv/y, well below the allowed exposure limit for a member of the public of 1 mSv/year. Handling of waste rock, which will have lower uranium and thorium concentrations than the ore, will not pose a significant radiological risk.

The presence of radionuclides, including  $^{210}\text{Po}$ , in acid process liquors and intermediate and metal products cannot be predicted but will be monitored during plant operation. The project is expected to have a minimal radiological impact on the environment under normal operating conditions.

## 8. Preliminary Hazard Analysis and Risk Assessment

A preliminary hazard assessment has been undertaken to identify and assess the risks of each component of the project to people (both project-related and the general public), the mining operation and the environment. Risk categories were assigned taking into account likelihood and consequence and the four levels of risk identified were:

- Extreme—development of strategies to reduce or mitigate the level of risk is of the highest priority.
- High—high priority; management attention to develop strategies is still required.
- Medium—moderate priority; management responsibility must be specified.
- Low—these risks fall within the bounds of normal project parameters that can be managed by routine procedures and processes.

The assessment process resulted in the identification and evaluation of 19 risks that warrant particular comment over and above that presented above. Of these, no risks were identified in the extreme category, three risks (all related to fire) were identified in the high-risk category, and another six (pit flooding, TSF failure, ARD generation, fuel leakage/spillage, chemical leakage/spillage and vehicle collision/roll-over) were included in the medium-risk category. All other risks were assessed as low.

A detailed hazard identification and risk assessment that is consistent with DBIRD's (now DPIFM) Advisory Note ENG 509 in terms of both construction and operation activities will be undertaken before these activities commence.

## **9. Environmental Management**

### **9.1 Environmental Management System**

Compass is committed to working within the framework of corporate environmental management systems (EMS) in accordance with the international EMS standard, ISO 14001:1996, adapted for use in Australia and New Zealand as AS/NZS ISO 14001:1996. These standards provide Compass with the elements of an effective, project-specific EMS, that is, a procedure for implementing, achieving, reviewing and maintaining the company's environmental policy. Key elements of the EMS will include:

- Commitment and policy – the corporate environmental policy defines Compass' commitment to conduct business in all operations in an environmentally responsible manner and with full legal compliance.
- Planning – clearly stated project-specific objectives consistent with the policy.
- Implementation and operation – practical procedures to fulfil objectives with personnel responsibilities for environmental management clearly defined through inductions and training, and ongoing consultation with relevant stakeholders.
- Checking and corrective action – involving regular inspection and auditing to assess compliance with environmental management objectives and a system of dealing with incidents and complaints, recording data and reporting.
- Management review – internal review of the EMS with the aim of continual improvement.

## 9.2 Management Plans

The following strategic issue-based management plans have been prepared as part of this PER:

- Emergency Response Plan.
- Fire Management Plan.
- Biological and Land Management Plan (which includes flora and fauna management, weed control, feral animal control and biting insects management).
- Water Management Plan (which addresses both surface and groundwater).
- Air Quality Management Plan.
- Noise and Vibration Management Plan.
- Hazardous Materials and Waste Management Plan.
- Cultural Heritage Management Plan.

These plans present the issues, objectives, performance standards and implementation strategies and measures (including detailed management measures where appropriate) and will be refined after approval has been obtained and the detailed design phase of the project has been completed. The refined plans will form the basis of a detailed MMP as required under the MM Act. The MMP will be completed prior to construction and will expand on the information contained in the PER, including additional detailed implementation measures, schedules and responsibilities.

## 9.3 Monitoring Program

The primary objectives of the environmental and social monitoring program are to:

- Provide information that will determine the adequacy of environmental and, where relevant, 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 remedial measures.

The proposed environmental monitoring program is based on a conventional three-phase surveillance system, incorporating operations, discharge (or emission) and ambient monitoring. The proposed social monitoring program is based on data that, more often than not, would be collected in any case, but would not otherwise be assessed from a social impact perspective.

## 9.4 Rehabilitation and Mine Closure

A strategic mine closure plan has been prepared as part of this PER. This plan will be refined as inputs from detailed project design, stakeholder consultation (particularly concerning matters such as end land uses and completion criteria), and investigations/studies become available. The primary objectives of the plan are to leave the site in a safe condition that is physically and geochemically stable and to ensure that the area is revegetated and does not become a source of water or wind-borne sediment.

Rehabilitation will be undertaken progressively where possible. However, due to the nature of the operations, most rehabilitation will be undertaken upon cessation of mining operations. This will include removal of site infrastructure, stabilisation of land, and ripping and revegetating of disturbed areas. A particular focus of closure planning will be the TSF and the need to minimise the potential for acid drainage to be problematic after closure. Current plans include capping the TSF with a 'store and release' cover and this will be further investigated during operations. The pit will be left as a void and allowed to fill naturally with groundwater and rainfall or, should ARD be considered a significant issue, rapidly filled by diverting the East Finnis River through the pit.

Compass will consult with regulatory authorities after project approval to determine completion criteria and establish the timeline for decommissioning and determination of compliance with regulatory authority requirements.

Once fully rehabilitated, the site will represent a modified natural ecosystem that is largely self-sustaining and has value both as a flora and fauna habitat. The area will have low maintenance requirements and the character and aesthetics of the site will be similar to the surrounding areas.

## 9.5 Summary of Commitments

In planning for the project, Compass has made a number of commitments with respect to the management of potential and residual environmental and social impacts. These commitments, which are outlined in Table 2, are broad and do not include the specific on-site mitigation and management measures that have been incorporated into the design of the project or the various management plans.

Table 2 Commitments

No.	Commitments	Performance Indicators
1	Low grade ore and lead ore stockpile material that is considered uneconomic to process at the end of the project life will be returned to the mined-out pit.	Final Mine Closure Plan detailing the fate of this material.
2	Column leach test results for selected waste rock samples will be reported in the Mining Management Plan, with ongoing reporting as required.	MMP containing waste rock column leach test results.
3	Compass will ensure direct supervision by a qualified person during construction of the TSF and, upon completion, sign off by that qualified person on submission of the 'as constructed' designs and plans.	Sign-off on 'as constructed' designs and plans.
4	The implementation of selective handling of PAF material requires integration with the mine plan, with identification of material types involving continuous in-pit sampling, logging, mapping and testing during mining.	Records of monitoring results. Records of volumes and placement of waste material.
5	Further geochemical testwork will be undertaken to address inconsistencies in tailing testwork results. This testwork will also include column leach tests and tailing liquor characterisation.	Report containing results of further geochemical testwork.
6	Compass will ensure that haulage contracts stipulate that loads are properly secured and in compliance with appropriate road vehicle axis limits.	Compliance with transport requirements. Vehicle log books. On-site records of transport volumes and transportation vehicle details.
7	A particular focus of the ongoing consultation program will be the involvement of indigenous people in the project.	Consultation records.
8	Compass will further develop during detailed engineering the water treatment system for treating water from the main sedimentation trap that is to be discharged to the East Finnis River.	A design for the water treatment system.
9	Compass will obtain improved estimates of ARD during project development and will closely monitor TSF runoff and drainage.	Monitoring records of TSF runoff and drainage. Reporting of geochemical testwork.
10	Additional management and mitigation measures for ARD will be investigated as required (incorporating information obtained as the mine is developed), including options for ongoing collection and treatment of ARD prior to discharge if warranted.	Records of investigations included in annual reporting to DPIFM.
11	Should adverse impacts occur to groundwater users, mitigation measures may involve sourcing suitable alternative water.	Groundwater monitoring data.
12	Compass will implement a preferential employment policy focussing on traditional owners and the local community.	Project employment policy. Employment records.
13	Compass will provide employment and training opportunities for the traditional owners and will develop specific procedures for the administration and implementation of these opportunities.	Employment and training records.

**Table 2 Commitments (cont'd)**

No.	Commitments	Performance Indicators
14	Compass will undertake a detailed hazard identification and risk assessment prior to commencement of construction and operations.	Submission of report detailing outcomes of the assessment.
15	Audits will be undertaken by an appropriately qualified person on a regular basis to ensure compliance with the environmental management procedures. Auditing will be conducted twice during the construction phase and yearly during operations.	Audit records.
16	The issue-based management plans will be refined and will form the basis of a detailed MMP that will be completed prior to construction. The detailed MMP will expand on the information contained herein, including implementation measures, schedules and responsibilities.	Submission of MMP.
17	A detailed Fire Management Plan will be developed in consultation with key stakeholders such as traditional owners, the NLC and local fire authorities (fire brigade and Bushfires Council NT).	Consultation records and submission of detailed fire management plan as part of the MMP.
18	A detailed weed management plan will be developed in accordance with the Northern Territory <i>Weeds Management Act</i> .	Submission of the detailed weed management plan as part of the MMP.
19	A recycling and waste minimisation program will be implemented and regularly (e.g., quarterly) reviewed during the lifetime of the operation.	Maintenance of waste inventory. Record of revisions to program.
20	Detailed radiological and river (water quality and macroinvertebrates) monitoring programs will be developed after discussion with relevant authorities to ensure a cost-effective, integrated program.	Detailed monitoring program.
21	Cavities and karsts will be further examined during detailed site investigations to ensure the suitability of the TSF site.	TSF site geotechnical report and final design.
22	A TSF closure study will examine the technical feasibility of dry cover system designs.	TSF closure study report.
23	The mine closure plan will be refined as inputs from detailed project design, stakeholder consultation on end land uses and completion criteria, and investigations/studies become available.	Consultation records, investigation/study reports. Updates of the Mine Closure Plan as reported in the MMP.
24	As part of Compass' mine closure planning redundancy provisions and consideration of training schemes with long-term benefits will be considered.	Updates of Mine Closure Plan.
25	Ongoing sampling and monitoring of groundwater boreholes (water level and quality), selected surface water sampling locations and mine water will continue for a period of not less than three years from the cessation of operations.	Monitoring records.
26	The TSF will be monitored and audited regularly to assess whether closure objectives have been achieved.	Monitoring records.

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7.14	Old headframe	7-94



# 1. Introduction

## 1.1 Background

Compass Resources NL (Compass) is proposing the development of the Browns Oxide Project, located in the Northern Territory approximately 65 km south of Darwin and 7 km northwest of Batchelor (Figure 1.1). Compass proposes to utilise open cut mining methods and a conventional hydrometallurgical process to extract oxide ore and produce copper, cobalt and nickel over four years. The project is located on granted mineral leases (MLN 139 to 147 and MLN 150 to 152 inclusive) near to, but separate from, former mining areas at Rum Jungle. These leases (175 ha in total) comprise the 'project area', with the actual footprint of project components being 90 ha. Although the Rum Jungle Mine, which operated from 1954 to 1971, produced both uranium and copper, uranium levels in the Browns Oxide deposit are very low<sup>1</sup> and uranium will not be produced as part of the development.

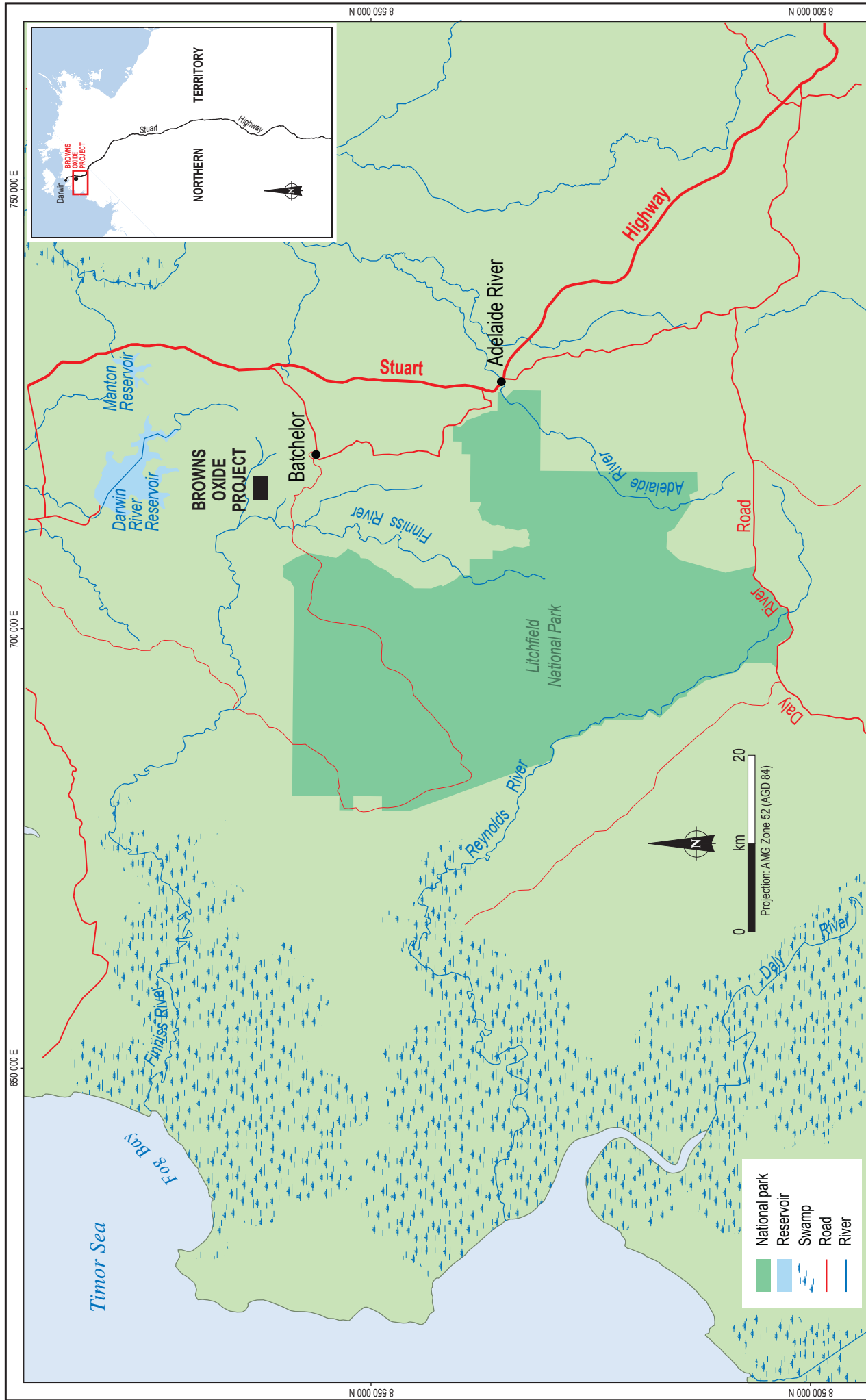
This Public Environmental Report (PER) addresses the environmental and social impacts of, and management strategies for, the Browns Oxide Project. Preparation of the report is based on guidelines prepared by the Office of Environment and Heritage (OEH)<sup>2</sup> following a determination by the Northern Territory Government that a PER was the appropriate level of assessment required under the Northern Territory *Environmental Assessment Act* (EA Act). Following submission of a referral to the Commonwealth Department of the Environment and Heritage (DEH), the project was deemed a 'controlled action' under the *Environment Protection and Biodiversity Conservation Act 1999*. The PER therefore addresses Commonwealth requirements as they relate to this project, as required by the bilateral agreement between the Northern Territory and the Commonwealth (see Chapter 2).

Although the area surrounding the project contains other prospects, e.g., the adjacent Browns East (immediately next to the project area), Area 55 (3 km to the southwest) and Mt Fitch (6 km to the north), any future development of these by Compass will be subject to separate evaluation and permitting. The Browns polymetallic sulfide deposit underlying the Browns oxide ore (see Section 1.2) will also require separate environmental approvals if it is to proceed in the future.

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<sup>1</sup> Less than the regulatory exemption level of 1 Bq/g of any naturally occurring radionuclide other than <sup>40</sup>K.

<sup>2</sup> OEH is part of the Northern Territory Department of Natural Resources, Environment and the Arts (DNRETA).



	Job No: 836 File No: 836_08_F1.01_HB	<b>Compass Resources NL</b> <b>Browns Oxide Project</b>	<b>Project location</b>	Figure No: <b>1.1</b>
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## 1.2 Project History

Evaluation of the Browns Oxide Project area was part of an extensive mineral exploration program covering a wide area during the mid twentieth century. The base-metal potential of the project was recognised in the 1950s, with the Browns copper-lead-cobalt deposit being evaluated by Rio Tinto in the mid 1960s.

Compass commenced its involvement in the project in the late 1980s and this culminated in the purchase of the mineral leases from Rio Tinto in 1994. Compass has undertaken extensive work at Browns including a prefeasibility study for a large sulfide ore project, i.e., the Browns Polymetallic Project, which included resources below the present Browns Oxide Project. Over A\$12M has been spent on the project since 1997. The sulfide ore project was suspended following the prefeasibility study due to its capital cost being too high for Compass to fund in its own right at the low metal prices prevalent at the time. However, associated metallurgical and engineering work indicated that the smaller and lower-cost Browns Oxide Project, which is the subject of this PER, would be a robust and profitable project that could be financed by Compass.

Compass has therefore committed to completing outstanding testwork and updating the financial model for the Browns Oxide Project, and intends to make a construction decision in the fourth quarter of 2005.

## 1.3 Project Objectives

The primary project objective is to mine and process oxide ore from the Browns deposit on a profitable basis, where this will involve:

- A conventional 1,000,000 t/a agitated leach operation producing approximately 10,000 t/a copper.
- Production of 1,000 t/a contained cobalt and 700 t/a contained nickel as hydroxides or sulfides.
- A project life of four years.
- Production to commence in the second half of 2006.

This primary objective will be achieved within a framework defined by the project's environmental and socio-economic objectives, which are to:

- Plan, operate and decommission the project in a manner that is consistent with good industry practice and in compliance with the conditions and standards prescribed by the Northern Territory and, where applicable, Commonwealth governments.
- Ensure that beneficial impacts associated with the development are maximised while at the same time minimising adverse impacts.

## 1.4 Project Proponent

The proponent for the Browns Oxide Project is Compass (ABN 51 010 536 820). Compass is the operator of an unincorporated joint venture between Compass and Guardian Resources NL, each having a right to 90% and 10%, respectively, of the project.

Compass is a Sydney-based Australian mineral exploration company that is listed on the Australian Stock Exchange (ASX code CMR). The company has interests in gold, copper and base metal deposits in the Northern Territory and New South Wales, as well as a project in Peru.

## 1.5 Report Structure

This PER comprises:

- An executive summary that provides a summary of the project.
- The main report (this report) which is intended to be understood without references to the technical reports on which it is based.
- A series of supporting studies (ten in total) whose content is represented in the main report.

The main report comprises 12 chapters and a table of contents that outlines figures, tables and plates in the relevant chapters. The format of the main report is:

Chapter 1 (this chapter)—background, project history, project objectives and project proponent.

Chapter 2—legislative framework (including international conventions, national policies, and codes of practice).

Chapter 3—environmental context (from a generally regional perspective).

Chapter 4—detailed description of the proposed project.

Chapter 5—description of alternatives considered during project design and planning.

Chapter 6—description of consultation undertaken by Compass to date and the proposed consultation program.

Chapter 7—assessment of the existing environment, key issues, avoidance/management/mitigation measures and residual impacts.

Chapter 8—preliminary hazard analysis and risk assessment (from a broad, strategic perspective).

Chapter 9—description (at the conceptual level) of Compass’ proposed environmental management measures and monitoring activities and a summary table of commitments made in the report (these are denoted by ‘[C]’ where they appear in the report).

Chapter 10—bibliographic details of each reference used in the PER.

Chapter 11—details of the study team.

Chapter 12—glossary.

The supporting studies (Table 1.1) were commissioned to identify potential impacts and strategies for minimising or ameliorating those impacts, and to assist in the project design, as described in this PER.

**Table 1.1 Studies and investigations that support the PER**

<b>Topic</b>	<b>Author</b>	<b>Appendix</b>
Air quality and noise	Holmes Air Sciences	1
Water quality and biology	Enesar Consulting Pty Ltd	2
Groundwater	Coffey Geosciences Pty Ltd	3
Fauna	Ecological Management Services Pty Ltd (EMS)	4
Flora (2005 survey)	J. Egan	5A
Flora (2002 survey)	K. Metcalfe	5B
Archaeology and heritage	Begnaze Pty Ltd	6
Radiation	Australian Nuclear Science and Technology Organisation (ANSTO)	7
Tailing management	Australian Tailings Consultants (ATC)	8
Waste rock geochemistry	Environmental Geochemistry International Pty Ltd (EGi)	9

## 1.6 Report Conventions

The Browns Oxide Project is a development proposal and its implementation is conditional on a number of factors such as project approvals and successfully raising the required finance. For reason of style, however, the project and related proposed activities have been described in the active mood ‘will’ rather than ‘would’.

At the time of PER preparation, the project engineering design was yet to be finalised. The PER therefore incorporates engineering design up to the 15 August 2005.



## 2. Legislative Framework and Approvals

### 2.1 Northern Territory

#### 2.1.1 Environmental Assessment Act

The *Environmental Assessment Act* (EA Act) provides for ‘the assessment of the environmental effects of development proposals and for the protection of the environment’. The Minister for Natural Resources, Environment and Heritage is responsible for administering the act and determines the appropriate level of assessment, which depends upon the sensitivity of the local environment, the scale of the proposal and its potential impact upon the environment. The OEH assists the Minister in undertaking the assessment.

The assessment process is initiated by submission of a Notice of Intent (NOI) by the proponent to the Department of Primary Industry, Fisheries and Mines (DPIFM)<sup>1</sup> (Figure 2.1). The NOI is evaluated by DPIFM to determine whether assessment under the EA Act is required, in which case it is referred to the Minister for Natural Resources, Environment and Heritage and the Department of Natural Resources, Environment and the Arts (DNRETA). The proposal is then assessed by a Project Assessment Committee (PAC), comprising representatives from DPIFM, DNRETA, Department of Infrastructure and Planning (DIP)<sup>2</sup> and, when required, the Parks and Wildlife Commission. The PAC recommends the level of assessment as involving either a Public Environmental Report (PER) or an Environmental Impact Statement (EIS). The Minister for Natural Resources, Environment and Heritage then advises the proponent of the required level of assessment.

A PER is generally recommended for projects where potential environmental impacts are considered significant but limited in extent. An EIS is undertaken for projects that require a higher level of assessment. In February 2005, the Minister for Natural Resources, Environment and Heritage determined that, under the EA Act, the Browns Oxide Project was to be assessed via the PER process.

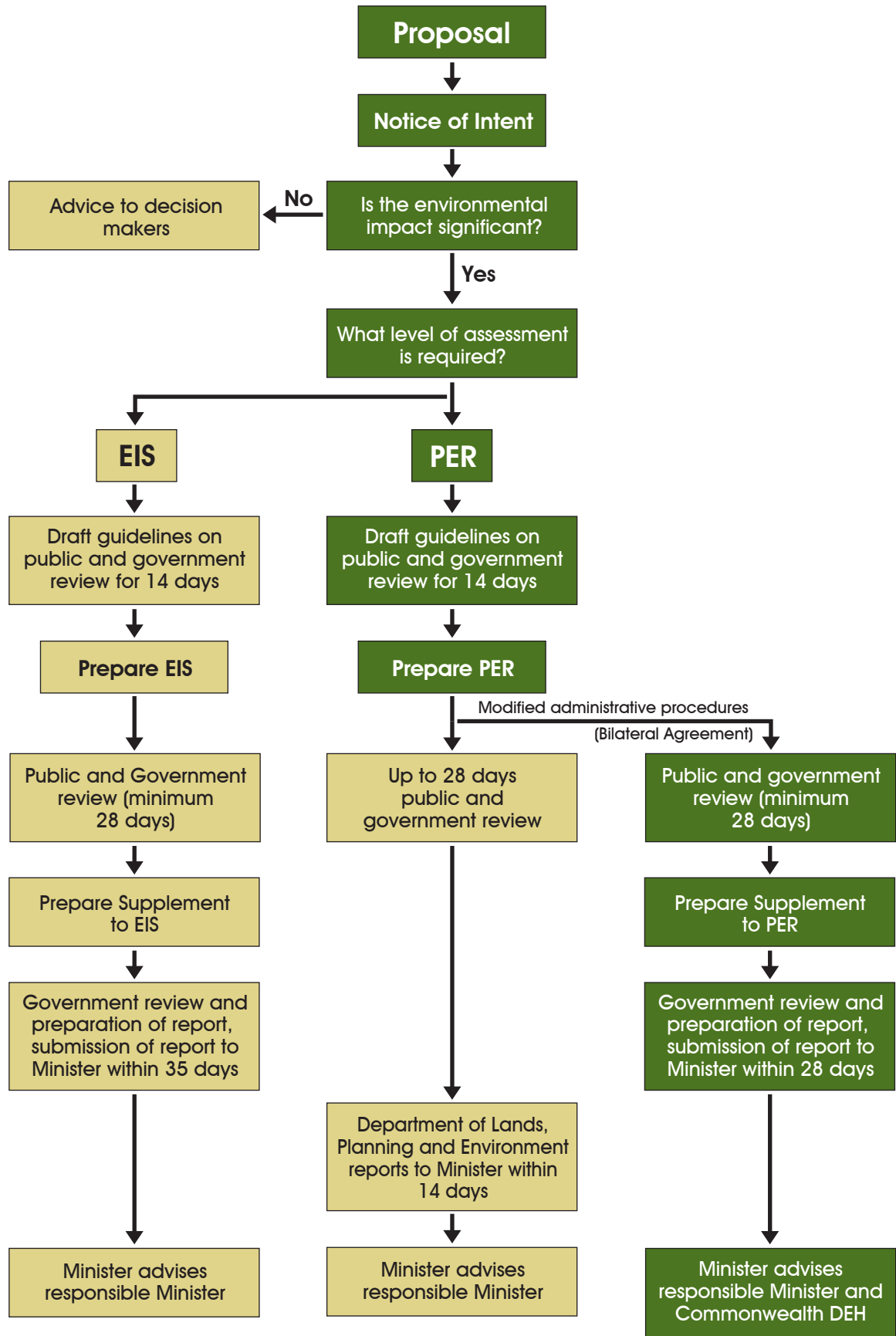
In February 2005, draft PER guidelines were published for public comment for a 14-day period. The guidelines were then finalised and issued to Compass in May 2005. Because the project is being assessed under a Bilateral Agreement between the Northern Territory and the Commonwealth (see Section 2.2), modified EA Act administrative procedures are in place (see Figure 2.1).

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<sup>1</sup> Formerly the Department of Business, Industry and Resource Development (DBIRD).

<sup>2</sup> Formerly the Department of Infrastructure, Planning and Environment (DIPE).

Process applicable to the Browns Oxide Project



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Compass Resources NL  
Browns Oxide Project

Northern Territory environmental assessment process

Figure No: 2.1

Following submission of the PER, the document is exhibited for public comment for a minimum period of 28 days, during which time advisory bodies also provide comment. Compass then prepares a PER supplement document that addresses the submissions received from both the public and advisory bodies. The supplement is then submitted to OEH for assessment (and a copy is also sent to other respondents). This is followed by a 28-day period in which OEH prepares an assessment report and the Northern Territory Minister for Natural Resources, Environment and Heritage signs off on the report and makes an assessment decision.

The complete PER (main document and supplement), together with the OEH assessment report and ministerial decision, is then reviewed by the Commonwealth Department of the Environment and Heritage (DEH). The Commonwealth review period is 30 business days, after which an assessment decision is published.

The Northern Territory Minister for Mines and Energy notifies DPIFM of the determination and recommendations, after which DPIFM proceeds with the approval process under the *Mining Management Act* (MM Act) and the *Mining Act* (MA Act).

### 2.1.2 Mining Legislation

The principal legislation for the regulation of mining in the Northern Territory comprises the MM Act and the MA Act, both of which are administered by DPIFM.

Under the MM Act, the proponent submits an Application for an Authorisation of Mining Activities, supported by a Mining Management Plan (MMP). Once granted, the authorisation (accompanied by the MMP) becomes the key operational document for the mine. The MM Act requires that the MMP has the following as a basis:

- A description of the mining activities to be carried out.
- Safety, health and environmental issues relevant to the mining activities and the management system to be implemented at the mine site.
- Plan and costing of closure activities.

In accordance with the PER guidelines, the strategic environmental management plan provided in this document (Chapter 9) is designed for inclusion in the MMP.

### 2.1.3 Other Relevant Legislation

Northern Territory legislation relevant to the project includes the following acts and associated amendments and regulations:

- *Aboriginal Land Act.*
- *Bushfires Act.*
- *Control of Roads Act.*
- *Dangerous Goods Act.*
- *Dangerous Goods (Road and Rail Transport) Act.*
- *Darwin Port Corporation Act.*
- *Environmental Offences and Penalties Act.*

- *Heritage Conservation Act.*
- *Local Government Act.*
- *Mineral Royalty Act.*
- *National Environment Protection Council (Northern Territory) Act.*
- *National Trust (Northern Territory) Act.*
- *Northern Territory Aboriginal Sacred Sites Act.*
- *Ozone Protection Act.*
- *Planning Act.*
- *Soil Conservation and Land Utilisation Act.*
- *Territory Parks and Wildlife Conservation Act.*
- *Traffic Act.*
- *Waste Management and Pollution Control Act.*
- *Water Act.*
- *Water Supply and Sewerage Act.*
- *Weeds Management Act.*

## **2.2 Commonwealth**

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

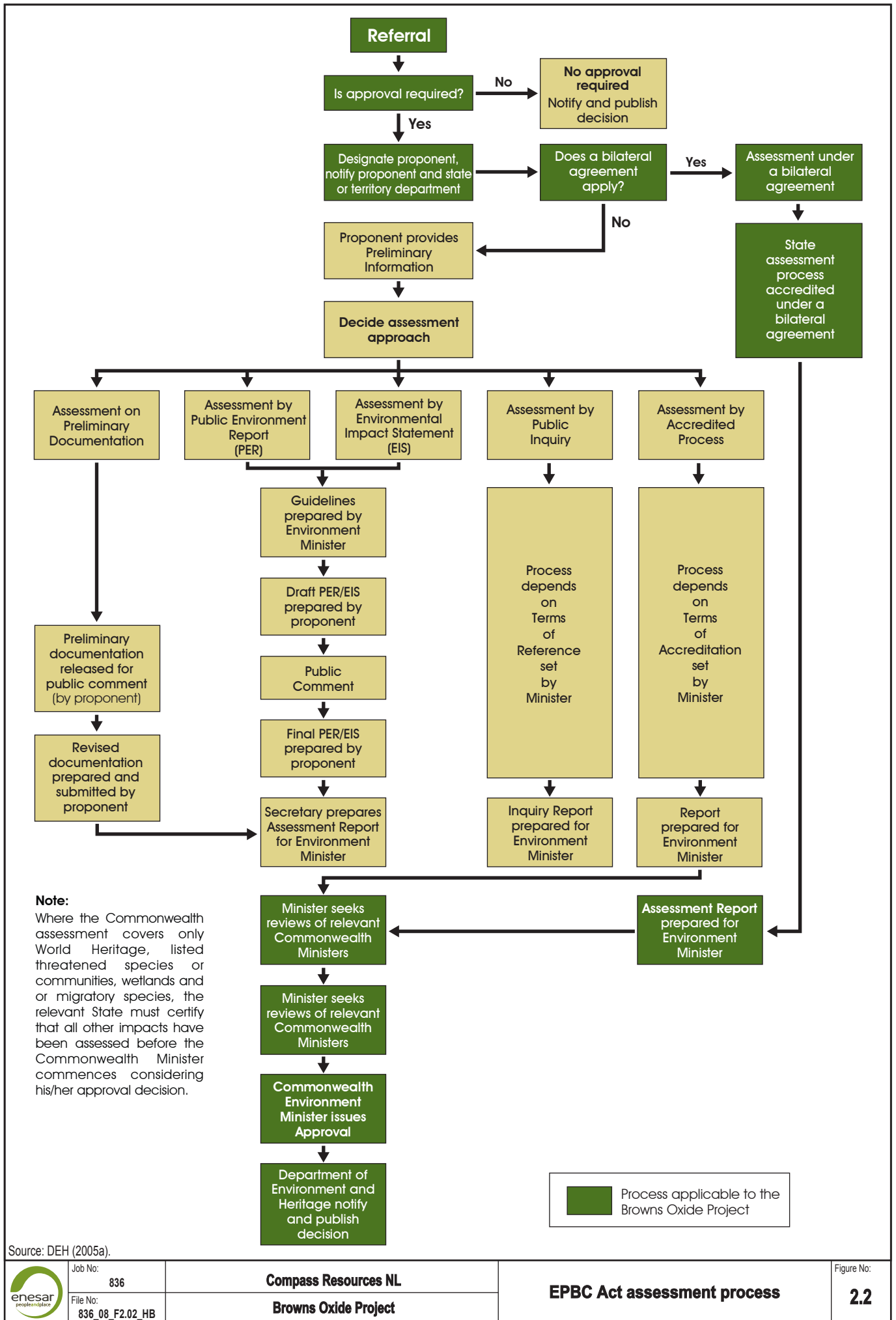
The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), in force since 16 July 2000, enables the Commonwealth to join with the states and territories to provide a national scheme of environment protection and biodiversity conservation.

The EPBC Act replaces five Commonwealth statutes: *Environment Protection (Impact of Proposals) Act 1974*; *Endangered Species Protection Act 1992*; *National Parks and Wildlife Conservation Act 1975*; *World Heritage Properties Conservation Act 1983*; and *Whale Protection Act 1980*.

Under the EPBC Act, actions that are likely to have a significant impact on a matter of national significance are assessed. The DEH is responsible for administering the act. Matters that are considered to be of national environmental significance are:

- 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 (Figure 2.2). The first step in this process is referral of the project to DEH, and the project is then assessed as to whether or not it is a controlled action. If the project is a controlled action, approval under the act is required. A bilateral agreement



Source: DEH (2005a).



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Compass Resources NL  
Browns Oxide Project

EPBC Act assessment process

Figure No:  
2.2

under Section 45 of the act exists between the Commonwealth and the Northern Territory, the aim of which is to minimise duplication of the assessment process. Under this agreement, the Northern Territory assessment process is accredited and, once the assessment has been undertaken under this process, a report is prepared for the Commonwealth Environment Minister, who then seeks views of other relevant Commonwealth ministers. The Commonwealth assessment decision is then announced (see Section 2.1.1).

This project was referred under the EPBC Act on 21 February 2005 and declared a controlled action under sections 18 and 18A (listed threatened species and communities) of the act on 29 March 2005.

## 2.2.2 Other Relevant Legislation

Other Commonwealth legislation relevant to the project includes the following acts and associated amendments and regulations:

- *Aboriginal Land Rights (Northern Territory) Act 1976.*
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984.*
- *Dangerous Goods Amendment Act 2000.*
- *Heritage Act 1975.*

## 2.3 International Conventions and Agreements

The following international conventions, protocols and agreements (with relevant enabling legislation provided in square brackets) have been considered in the course of the preparation of the PER:

- Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar, 1971) [EPBC Act provisions].
- Protection of World Cultural and Natural Heritage (World Heritage Convention, 1972) [EPBC Act provisions].
- International Migratory Bird Agreements (JAMBA, 1974, and CAMBA, 1986) [EPBC Act provisions].
- Conservation of Nature in the South Pacific (Apia Convention, 1976).
- Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979) [EPBC Act provisions].
- Protection of the Natural Resources and Environment of the South Pacific Region (SPREP, 1986).
- Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol, 1987) [Ozone Protection Act].
- United Nations Convention on Biological Diversity (1992).

- Declaration of the United Nations Conference on Environment and Development (Rio Declaration) and Agenda 21 (1992).
- United Nations Framework Convention on Climate Change (1992).
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (1997).

## 2.4 National Policies and Strategies

The following national policies have been considered in the course of the preparation of the PER:

- Intergovernmental Agreement on the Environment (1990).
- National Strategy for Ecologically Sustainable Development (1992).
- National Strategy for the Conservation of Australia's Biological Diversity (1996).
- National Greenhouse Strategy (1998).
- National Environment Protection Measures.

## 2.5 Standards and Codes of Practice

The construction and operation of the Browns Oxide Project will take into consideration all applicable standards and codes of practice including those listed below.

### **Standards**

- National Standard for Manual Handling [NOHSC:1001(1990)].
- National Occupational Health and Safety Certification Standard for Users and Operators of Industrial Equipment, 3rd Edition [NOHSC: 1006(2001)].
- National Standard for Occupational Noise [NOHSC:1007 (2000)].
- National Standard for the Control of Inorganic Lead at Work [NOHSC:1012 (1994)].
- National Standard for the Control of Major Hazard Facilities [NOHSC:1014 (2002)].
- Safe working in a confined space (AS/NZS 2865:2001).
- Recommended practices for eye protection in the industrial environment (AS/NZS 1336:1997).
- Selection, use and maintenance of respiratory protective devices (AS/NZS 1715:1994).
- Occupational protective helmets – selection, care and use (AS/NZS 1800:1998).
- Occupation protective gloves – selection, use and maintenance (AS/NZS 2161.1:2000).
- Occupational protective footwear: guide to selection, care and use (AS/NZS 2210.1:1994).

- Guide to the selection, care and use of clothing for protection against heat and fire (AS 2375-1980).
- Industrial safety belts and harnesses – selection, use and maintenance (AS 2626-1983).
- Occupational noise management – hearing protector program (AS/NZS 1269.3:2005).
- Classification of hazardous areas – examples of classification – general (AS/NZS 2430.3.1:2004).
- Evaluation of human exposure to whole-body vibration – general requirements (AS 2670.1-2001).
- Fixed platforms, walkways, stairways and ladders – design, construction and installation (AS 1657-1992).
- Earthmoving machinery – seat belts and seat belt anchorages (AS 2664-1983).
- Power-actuated hand-held fastening tools - charges (AS/NZS 1873.3:2003).
- Power-actuated hand-held fastening tools - fasteners (AS/NZS 1873.4:2003).
- Clearing saws, brushcutters and grass trimmers – safety requirements (AS 3575-1995).
- In-service safety inspection and testing of electrical equipment (AS/NZS 3760:2003).
- Portable fire extinguishes and fire blankets – selection and location (AS 2444-2001).

#### **Model Regulations**

- National Model Regulations for the Control of Workplace Hazardous Substances [NOHSC:1005(1994)].
- National Model Regulations for the Control of Scheduled Carcinogenic Substances [NOHSC:1011 (1995)].

#### **Codes of Practice**

- National Code of Practice for the Control of Workplace Hazardous Substances [NOHSC:2007(1994)].
- National Code of Practice for the Control of Major Hazard Facilities [NOHSC:2016 (1996)].
- National Code of Practice for the Prevention of Occupational Overuse Syndrome [NOHSC:2013 (1994)].
- National Code of Practice for the Control and Safe Use of Inorganic Lead at Work [NOHSC:2015 (1994)].

- National Code of Practice for the Labelling of Workplace Substances [NHOSC:2012 (1994)].
- National Code of Practice for Manual Handling [NOHSC:2005 (1990)].
- National Code of Practice for Management and Protection of Hearing at Work [NOHSC:2009 (2000)].
- National Code of Practice for the Control of Scheduled Carcinogenic Substances [NOHSC:2014 (1995)].



## 3. Environmental Context

This chapter (where information concerning the terrestrial environment is largely taken from Low (2001)) describes the broad environmental and social context within which the project will be developed. More specific details of site conditions are presented in Chapter 7.

The project area is a modified natural landscape that has varying levels of disturbance from previous exploration and mining-related activities. The main areas of disturbance are in and around the Browns test pit, along the Rum Jungle Road and the old borrow material areas in the central and southern parts of the project area (Figure 3.1).

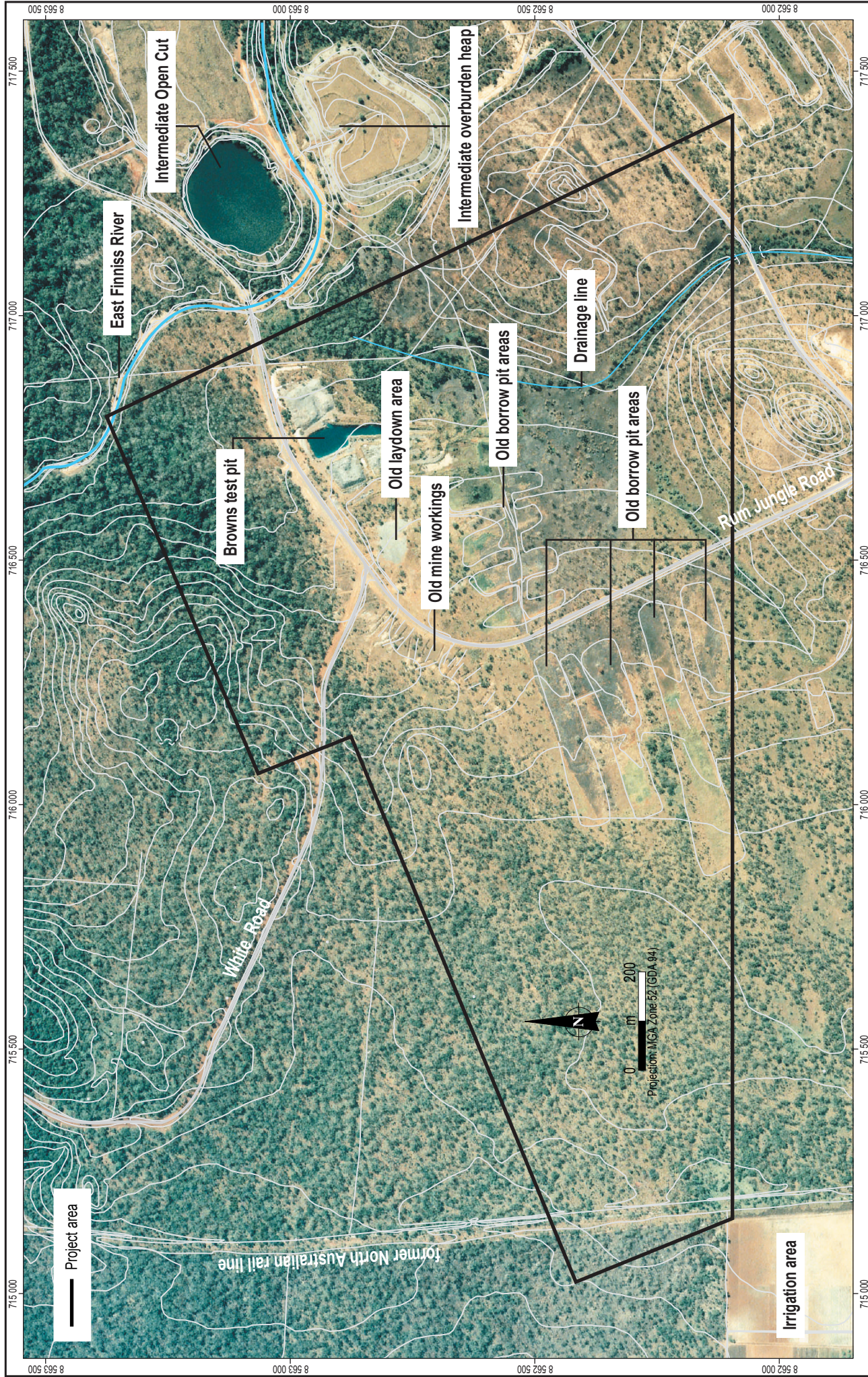
### 3.1 Terrestrial Environment

#### 3.1.1 Climate

Batchelor has a monsoonal climate with distinct wet and dry seasons. The Australian Bureau of Meteorology maintains several weather stations in the region, but the longest data record (over 60 years) is available from Darwin Airport, where the average annual rainfall is 1,714 mm, with an average monthly rainfall ranging from 423 mm (January) to 1.4 mm (July). The highest average monthly temperature at Darwin Airport is 29.3°C (November) and the lowest is 24.9°C (July) (BoM, 2005).

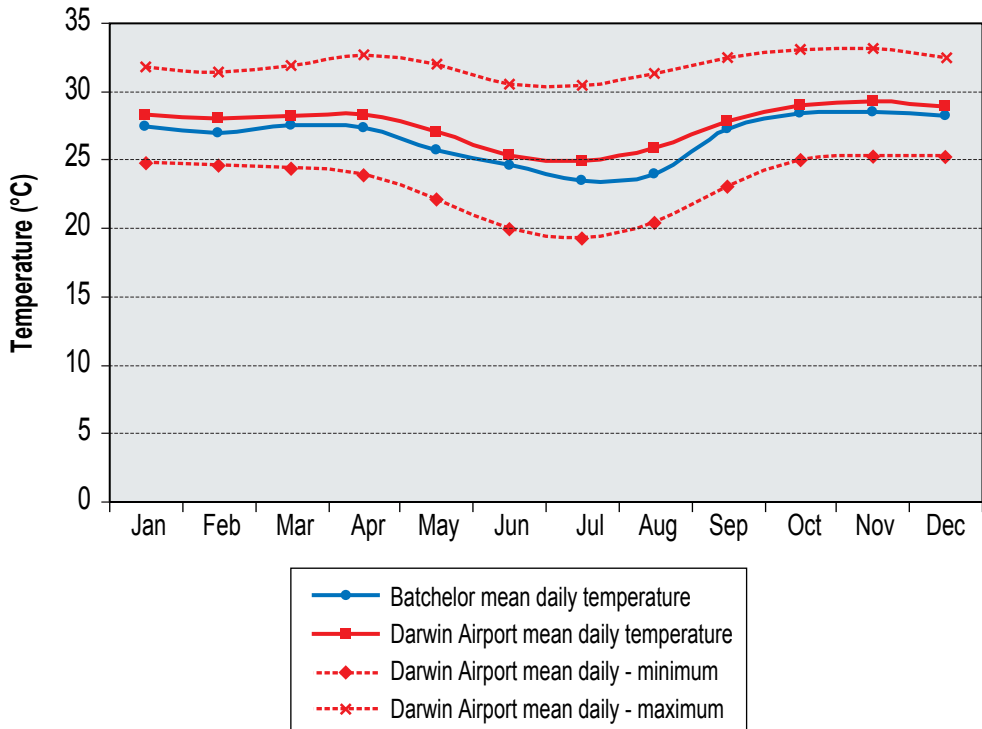
In the project area, monitoring of rainfall, temperature, solar radiation and wind speed and direction was undertaken from 11 July 2000 to 7 February 2003. Within this period, most of the rainfall occurred during the wet season, i.e., December to March, and very little rainfall was recorded over the dry season; this is consistent with the rainfall pattern recorded at Darwin Airport (Figure 3.2) and reflects the monsoonal climate in the top end of the Northern Territory. The relatively high rainfall during the wet season consists of isolated showers and storms with prolonged periods of cyclonic depressions, particularly in the latter half of the wet season.

Average daily temperatures at the site differed by about 4°C between the cooler months of the dry season and other times of the year, with the highest average monthly temperature being 28.5°C (October and November) and the lowest being 23.5°C (July) (see Figure 3.2). Winds showed significant seasonal trends (Figure 3.3). During the dry season, winds were predominantly from the east-southeast and southeast. Wet season winds were predominantly from the west and west-southwest. The dry season wind pattern is consistent with that recorded at Darwin, although the wet season pattern for Darwin has a less dominant westerly wind than recorded on site. Wind speed data showed that there is a high proportion of calm periods, i.e., 30% of the 12-month period from July 2000 to July 2001, where the wind speed was less than 0.5 m/s.

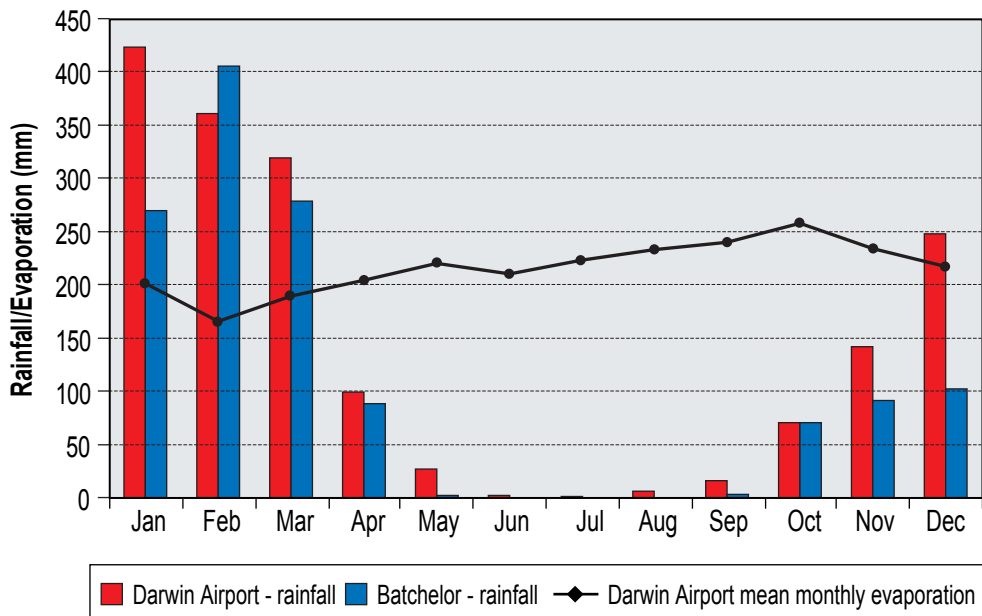


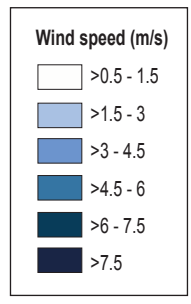
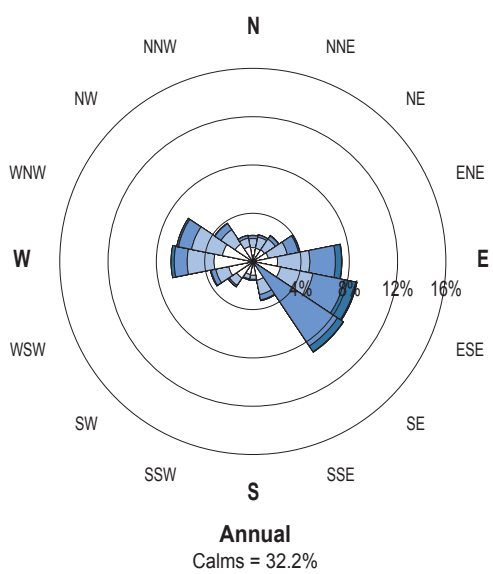
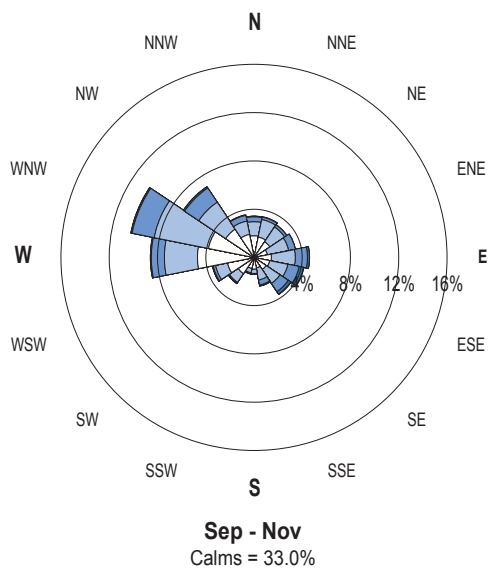
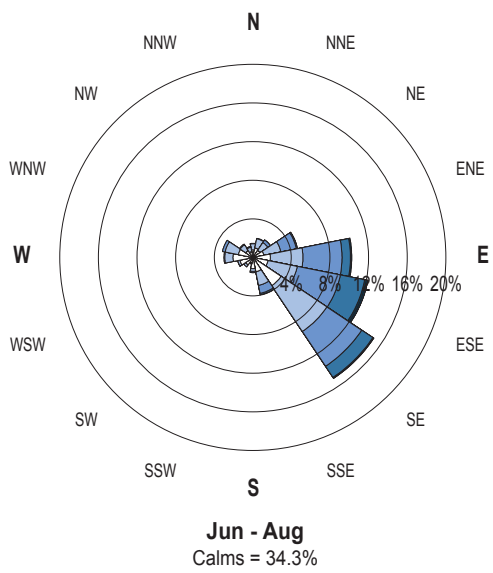
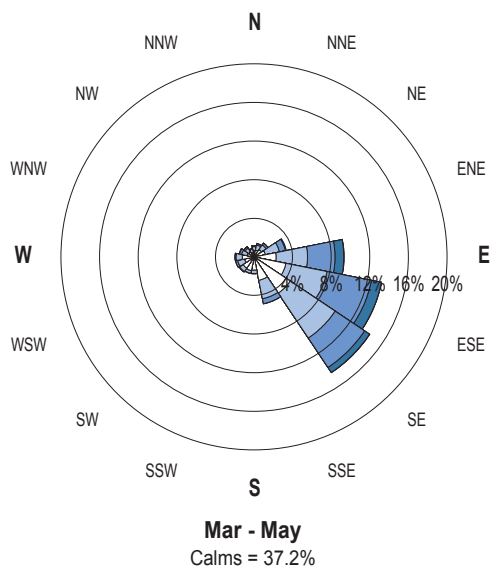
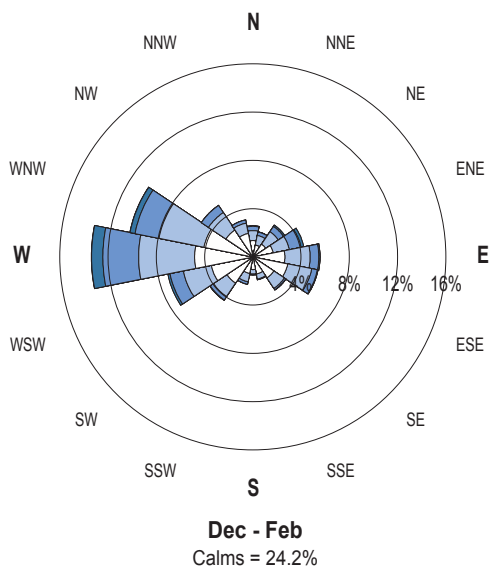
Source: AMDAD.				Job No: 836	Compass Resources NL	Figure No: 3.1
				File No: 836_08_F3.01_HB	Browns Oxide Project	
				Project area aerial photograph and topography		

### Average Monthly Temperature



### Mean Monthly Rainfall and Evaporation





Source: Compass meteorological station (11 July 2000 to 10 July 2001).



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**Compass Resources NL**  
**Browns Oxide Project**

**Annual and seasonal wind roses**

Figure No:  
**3.3**

### 3.1.2 Landscape and Land Systems

The general area around Batchelor is on the north slope of the Pine Creek Geosyncline and can be described primarily as a peneplain of gently undulating land interspaced by plains. Small hills are usually less than 150 m above the surrounding plains. Christian and Stewart (1953) (as cited in Low (2001)) broadly described the land systems of the region, and the project area lies in the northern part of 'elevated backbone country'. Land systems (or elements thereof) that occur in the region are Batchelor, Cullen, Finnis and Brocks Creek Ridge land systems, the main characteristics of which are shown in Table 3.1.

**Table 3.1 Characteristics of land systems in the region**

Land System	Extent within Region	Geology	Geomorphology	Main Soils	Main Plant Communities <sup>1</sup>
Batchelor	Large	Strongly folded slates, quartzites	Mostly hills, some undulating and flat country	Mostly stony soils, yellow podsolic soils, lateritic soils and acid alluvial soils	Tall mixed open forest, patches of grassland on flats
Brocks Creek Ridge	Small	Strongly folded slates, quartzites	Sharp north-south ridges and hills	Rock outcrops and skeletal soils	Deciduous open forest and mixed open forest
Cullen	Large	Granite	Mixed and undulating hills	Rocky skeletal soils, granitic yellow podsolic soils, granitic lateritic podsol	Deciduous open forest, mixed open forest or scrubby open forests
Finniss	Small	Quaternary flood plain alluvia with considerable areas of metamorphics	Flats liable to flooding intermixed with hills and undulating country	Acidic alluvial soils, gravelly yellow podsolic soils and skeletal soils	Grassland on flats, mixed open forest on remainder

<sup>1</sup> Along drainage lines, parts of the mixed open forest may be classed as riparian rain forest.

### 3.1.3 Geology and Geomorphology

The project area is in the northwestern part of the Pine Creek Geosyncline where lower Proterozoic sedimentary rocks were deposited over the Archaean Rum Jungle and Waterhouse granitic complexes (Davy, 1975 as cited in Low, 2001). Regionally, the Pine Creek Geosyncline is composed of sandstones and mudstones, with minor tuffaceous intervals, accumulated in a single basin up to 14 km in thickness (Needham et al., 1980 as cited in Low, 2001). In the project area, the sedimentation is typically transgressive, beginning with older reworked granitic conglomerates and arkoses (the Crater Formation) followed by a massive carbonate sequence (the Coomalie Dolomite). Local faulting appears to have repeated these two lower formations. Overlying the Coomalie Dolomite and hosting the base metal deposits of the area is the Whites Formation, a grey to black carbonaceous shale. These lowermost rocks are then overlain by the slates, sandstones, quartzites and metamorphic rocks of Pine Creek Geosyncline.

The area has been geologically stable since Precambrian time. Sedimentation and erosion during the Tertiary and Quaternary have been major factors influencing the topographic form of the area.

The Browns Oxide Project area lies in the Northern Lateritic Plains Geomorphological Unit marked by lateritic soils formed on rocks of the Brocks Creek Group. Although the area has high rainfall, erosion has generally been retarded by the relative lack of relief and the high permeability of the soils.

#### **3.1.4 Soils**

The soils of the region are generally nutrient poor, except in the river valleys which usually flood during the wet season and tend to be acidic. The topography and soils of the Coomalie area are generally regarded as being highly erodible (DLPE, 2000). Christian and Stewart (1953) (as cited in Low, 2001) have described the soils of the region at a broad scale and these are presented in Table 3.1. More detailed studies of smaller areas (e.g., Wood and Sivertsen, 1984 (as cited in Low, 2001) describe soils in relation to land systems of regions north and south of the Batchelor area. Lateritic massive soils and gravelly yellow podzols dominate the higher grounds while light textured 'acid' alluvial soils and heavy grey pedocals occur in the lowlands (Davison and van Groenou, 1986 (as cited in Low, 2001).

Conclusions from the monitoring studies of the Rum Jungle site that is adjacent to the project site indicate that erosion is a localised problem and is not widespread (Kraatz, 1998 (as cited in Low, 2001).

#### **3.1.5 Fire**

The current practice at the Browns Oxide Project area is to undertake limited burning of seasonal grasses in areas where drilling is proposed (at times as permitted by the local fire regulations). This is undertaken as soon as practical after the wet season, in still weather, to minimise the intensity of the fire. It is, however, not an irregular event for wild fire to travel cross-country and burn other sections of the project area, with intense fires typically occurring late in the dry season. The source and path of such fires vary considerably and their origin is generally unknown.

### **3.2 Aquatic Environment**

A considerable amount of biological and water quality monitoring has been undertaken in the Finniss River system as part of the Rum Jungle Rehabilitation Project. A summary of the monitoring programs undertaken, and the results of those assessments, are presented in Appendix 2.

#### **3.2.1 Drainage and Hydrology**

The project area is about 70 km inland from Fog Bay in the Timor Sea and is mostly drained by the East Branch of the Finniss River, i.e., the East Finniss River, which is one of the smaller catchments in the northwest of the Northern Territory. The catchment area

of the entire Finnis River system is 9,532 km<sup>2</sup> (NGIS, 2004) (Figure 3.4). The river runs for approximately 140 km from the project site to enter the sea at Fog Bay via a wide, swampy, mangrove mudflat estuary.

The East Finnis River generally has no flow in the latter part of the dry season, i.e., from July to November, when the river becomes a series of discontinuous permanent and semi-permanent waterholes and billabongs. In the wet season, flood events are superimposed on a base flow. Very intense storms result in flood peaks with rapid run off down streams that have become broad, deeply incised flood-water channels which can discharge large quantities of water in a very short period of time.

### 3.2.2 Water Quality

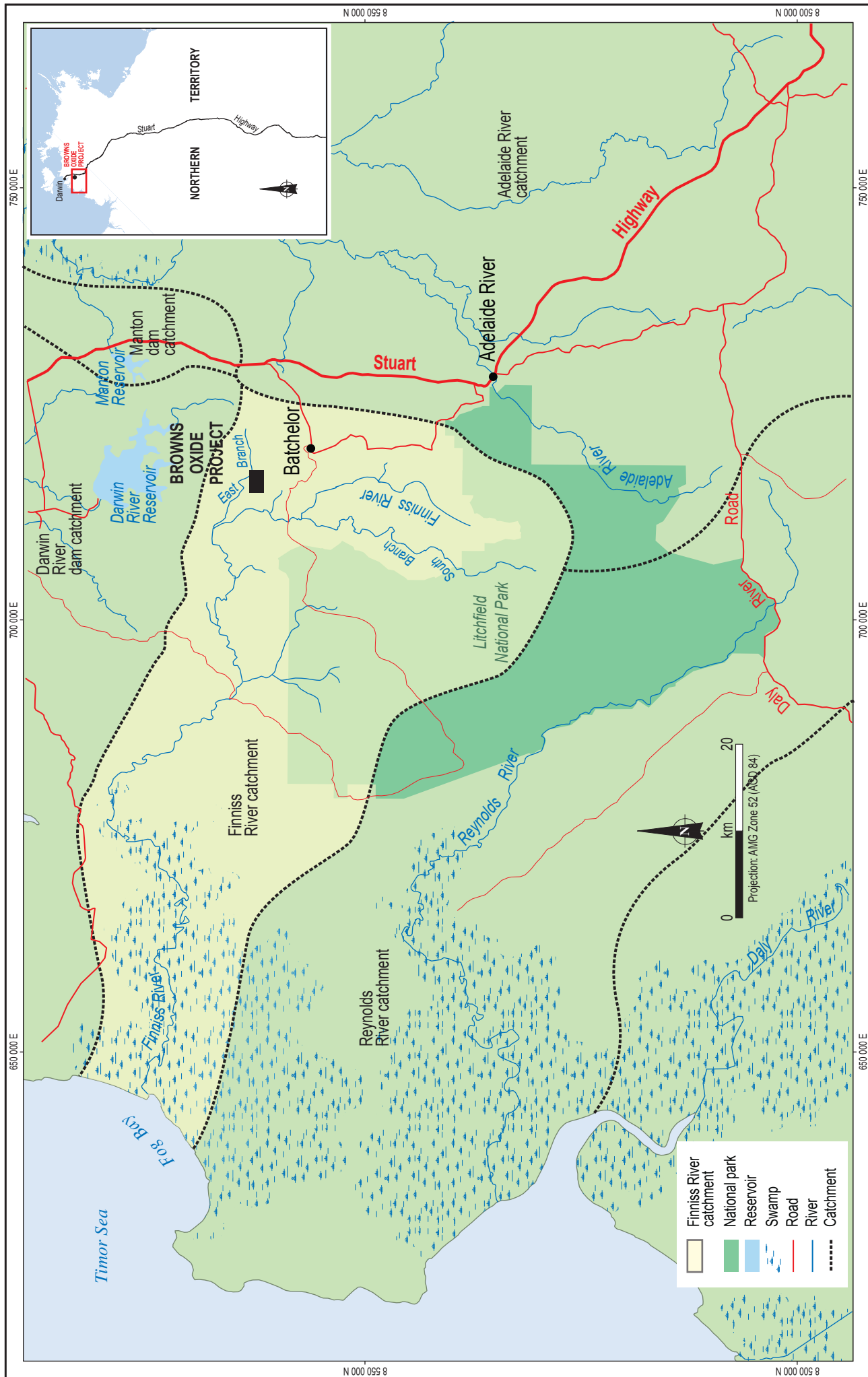
The water quality of the East Finnis River is heavily influenced by long-term acid rock drainage (ARD) from the former Rum Jungle Mine, which is located adjacent to the Brown Oxide Project site (see Figure 1.1). Some discussion about the legacies of this mine, which provide the context for the proposed project, is therefore appropriate.

The Rum Jungle Mine, which operated between 1954 and 1971, was one of Australia's first uranium mines, but also produced copper and small amounts of nickel and lead. Generation of ARD (pH<3 and elevated levels of copper, zinc, nickel, cobalt, manganese, aluminium and iron) from the site, particularly the waste rock dumps, has caused severe adverse impacts on water quality in the East Finnis River and, to a lesser extent, the Finnis River.

In the early 1980s, the Northern Territory and Commonwealth governments agreed to undertake the Rum Jungle Rehabilitation Project, where the main objective was to reduce water infiltration rates into the waste rock dumps to less than 5% of incident rainfall (thereby reducing the oxidation rate of pyrite and the rate at which pollutants were transported to the environment and, specifically, to reduce copper and zinc loadings to the East Finnis River by 70% and manganese loading by 56%)<sup>1</sup>. The waste rock dumps were therefore capped with a three-layer cover between 1983 and 1986. The water infiltration target was met for the first 10 years following cover placement, representing a 10-fold reduction over rates measured prior to rehabilitation. However, there is now evidence that the covers are failing since infiltration rates have increased to 5 to 10% of incident rainfall (Bennett, 2002). As a result, pollutant loads from the waste rock dumps may increase over the next 20 to 30 years to levels that represent about 30 to 50% of loads prior to rehabilitation (Bennett, 2002).

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<sup>1</sup> Other objectives included: reducing public health hazards by reducing radiation levels at the site; reducing pollution in Rum Jungle pits (Whites and Intermediate); and aesthetic improvements.



	Job No: 836	<b>Compass Resources NL</b> <b>Browns Oxide Project</b>	<b>Catchment areas</b>	Figure No: <b>3.4</b>
	File No: 836_08_F3.04_HB			

The rehabilitation project also involved treatment of pit water (via lime addition) and diversion of the East Finniss River to its original path through Whites and Intermediate pits<sup>1</sup> during wet season flows. This annual flushing of the pits during the wet season is designed to prevent build up of acidity and heavy metals. The design restricts contaminant discharges to the East Finniss River until after base flow is established, thereby maximising available dilution. Flows from the pits also cease earlier than flow in the river as low recessional flows are confined to the diversion channel.

### 3.2.3 Aquatic Ecology

The aquatic ecology of the Finniss River system has similarly been adversely affected by ARD from Rum Jungle. Prior to rehabilitation of the Rum Jungle site, very few fish survived at low-flow conditions in the 10-km section of the East Finniss River downstream of the mine, where concentrations of copper and zinc measured in the water were 55 and 44 mg/L, respectively (Jeffree and Twining, 2000). An appreciable decline in fish diversity and abundance in the Finniss River also occurred for at least 15 km downstream of the confluence with the East Finniss River during dry season sampling (Jeffree, 2002). Fish kills occurring in the Finniss River during the first flush of the wet season (when moderate inflow from the East Finniss River coincided with low flows in the Finniss River) were thought to be responsible for the residual impacts on fish populations that were observed in dry season surveys (Jeffree et al., 2001).

Post-rehabilitation surveys in the Finniss River in 1992 and 1995 showed no statistically significant differences in fish diversity or abundance between impact sites, i.e., sites downstream of the confluence with the East Finniss River, and unimpacted sites, i.e., sites upstream of the East Finniss River confluence and downstream of the Florence Creek confluence (Jeffree et al., 2001). The recovery in the abundance and diversity of fish species in the impacted zone of the Finniss River is attributed to the reduction in metal loads and concentrations following remediation, although considerable contaminant loads are still being delivered from the East Finniss River (Jeffree, 2002).

Surveys during 1996 and 1997 found that fish kills continued to occur in the East Finniss River (Twining et al, 2002). However, up to seven species of fish have been recorded in the East Finniss River, indicating some ecological recovery post-remediation, although well short of the potential diversity of up to 18 fish species in similar habitats elsewhere in the Finniss River system (Twining et al, 2002).

Establishment of baseline conditions for the Browns Oxide Project is difficult since the existing environment is in a state of flux and the extent of possible recovery is unknown. It is also possible that, without any further activity on the site, the ecological health of the Finniss River system may again deteriorate due to ongoing failure of the Rum Jungle Mine waste rock dump cover systems.

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<sup>1</sup> Water quality in Whites Open Cut, particularly in deeper waters, is seriously degraded being of low pH and containing copper concentrations of up to 60 mg/L. Intermediate Open Cut is relatively unpolluted, except in the mixed upper layer during the early wet season when contaminated overflow water from Whites Open Cut flows through the pit (Lawton, 1998a).

### 3.2.4 Groundwater

Good supplies of groundwater (more than 5.0 L/s) are generally available in the Batchelor area, with moderate groundwater prospects (up to 5.0 L/s) also being evident throughout the Coomalie region (DLPE, 2000). Groundwater is therefore the main water source in the region and is used for Batchelor's water supply.

The main aquifer is in the top of the Coomalie Dolomite, with water quality reflecting the dolomitic nature of the aquifer, i.e., elevated hardness and total dissolved solids concentrations that are largely due to carbonate (Yin Foo, 1996). The town's annual water consumption is 378 ML (DIPE, 2004), although there is considerable seasonal variability with increased usage in the dry season being attributed to high lawn and garden watering, college intake and increased tourism (Yin Foo, 1996).

The registered bore data for the project area and surrounds indicates 116 registered bores within a 3-km radius of the proposed mine. Of these, 15 appear to be production bores and 10 are located at the groundwater irrigation area (where crops such as mangos and vegetables are grown) located southwest of the mine (Appendix 3).

### 3.3 Socio-economic Environment

The Browns Oxide Project is located within the area administered by the Coomalie Community Government Council, where the council is responsible for ensuring that the area maintains its rural setting while allowing continued, appropriate development.

The Coomalie area was developed through construction of the overland telegraph line in 1872 and the associated discovery of gold, during which period Adelaide River became a convenient service and resting location. Prior to the Second World War, the area around Rum Jungle was the focus of agricultural enterprises. During the war, both Batchelor and Adelaide River were integral to military operations. Following the war, attention in the Coomalie area turned to mineral exploration.

In addition to its role as the commercial and civic centre of Coomalie, Batchelor is regarded as the 'gateway' to Litchfield National Park and thus receives a considerable share of the region's tourist market, with approximately 250,000 visitors to Batchelor each year mostly visiting Litchfield (and generally in the dry season). The smaller town of Adelaide River, located on the Stuart Highway approximately 23 km southeast of Batchelor, is also a popular stop for tourists.

In 2001 (the last census), the population of Batchelor was 727 (0.3% of the Northern Territory population), an increase of 12.7% from 1991. However, access to land and water resources is expected to constrain population growth. Batchelor is largely self-sufficient with respect to day-to-day commercial and community services needs, although residents travel to Coolalinga (approximately 50 km to the north) or to Darwin for specialist commercial and other services.

There were 250 employed persons in Bachelor in 2001 out of a labour force of 269 (i.e., 6.9% unemployment). Education is the largest employer followed by the hospitality industry while, as indicated above, tourism is also an important industry in the area.

Information available to date suggests that, in general, the local community supports the proposed project, although there are possible misperceptions associated with the Rum Jungle site and the earlier Browns Polymetallic (Sulfide) Project proposed in 2001, as well as a number of specific concerns (that are described in Chapter 6).

### **3.4 Aboriginal Groups**

The original (and still the main) Aboriginal tribal groups of Coomalie are the Kungarakan and Awarai (Warai) people; a third group, the Maranunggu, were originally from the Daly River region but gravitated north over a number of years towards the Batchelor area (DLPE, 2000). Many other Aboriginal groups have resided (and in some cases still reside) in the area, such as the Muluk-Muluk, Wadgigan, Brinkin and Djerait groups (DLPE, 2000).

The project area is not subject to Native Title claims, being land granted to the Finnis River Aboriginal Land Trust under ALRA (*Aboriginal Land Rights (Northern Territory) Act 1976*).



## 4. Project Description

### 4.1 Project Location

The Browns Oxide Project is located some 65 km south of Darwin and 7 km northwest of Batchelor, in the northwest of the Northern Territory (see Figure 1.1). The project footprint lies entirely within the 175 ha area (Figure 4.1) of granted mineral leases (MLs) MLN 139 to 147 and MLN 150 to 152 (Table 4.1), hereafter defined as the 'project area' (Figure 4.2). The deposit is located in the northern part of the project area and has an east–west orientation. The tailing storage facility (TSF), processing plant and other mine infrastructure are located in the western section of the project area.

The historic Rum Jungle Mine site is located east of the project area and will not be disturbed by the project. The former Whites uranium and copper open pit is approximately 1 km at its nearest point from the Browns Oxide Project, and the Intermediate copper open pit is approximately 300 m to the east of the project.

The land tenure of the project area is mostly Aboriginal freehold land, with additional areas of road reserve, freehold land and crown land (see Figure 4.2). Compass has been undertaking mineral exploration in the project area since early 1995. The project area is not used for any other purpose, and land uses in the surrounding area are described in Section 7.7. Compass holds three exploration retention licences (ERL125, ERL146 and ERL148) around the project area and also has submitted applications for six nearby mining tenements (MLN 1157 to 1159 and MLN 1161 to 1163) (Figure 4.3).

**Table 4.1 Project mining leases**

Granted Tenements	Land Tenure*	Expiry Date
MLN139	Aboriginal freehold/road reserve	31/12/2022
MLN140	Aboriginal freehold/road reserve/crown land	31/12/2022
MLN141	Aboriginal freehold/road reserve	31/12/2022
MLN142	Aboriginal freehold/road reserve/crown land	31/12/2022
MLN143	Aboriginal freehold/road reserve	31/12/2022
MLN144	Aboriginal freehold	31/12/2022
MLN145	Aboriginal freehold/freehold	31/12/2022
MLN146	Aboriginal freehold	31/12/2022
MLN147	Aboriginal freehold	31/12/2022
MLN150	Aboriginal freehold/crown land	31/12/2022
MLN151	Aboriginal freehold/road reserve	31/12/2022
MLN152	Aboriginal freehold*	31/12/2022

\* The granted MLs are on Aboriginal freehold land but are excluded from the operation of Part IV of the *Aboriginal Land Rights (Northern Territory) Act 1976* due to the leases being granted prior to the Aboriginal freehold land grant.



N.B Sulfide deposit not part of the Browns Oxide Project. Pit shell is indicated as it impacted placement of project components.				Job No: 836	Figure No: <b>4.1</b>
		Compass Resources NL		File No: 836_08_4.01_HB	Project footprint and components
		Browns Oxide Project			

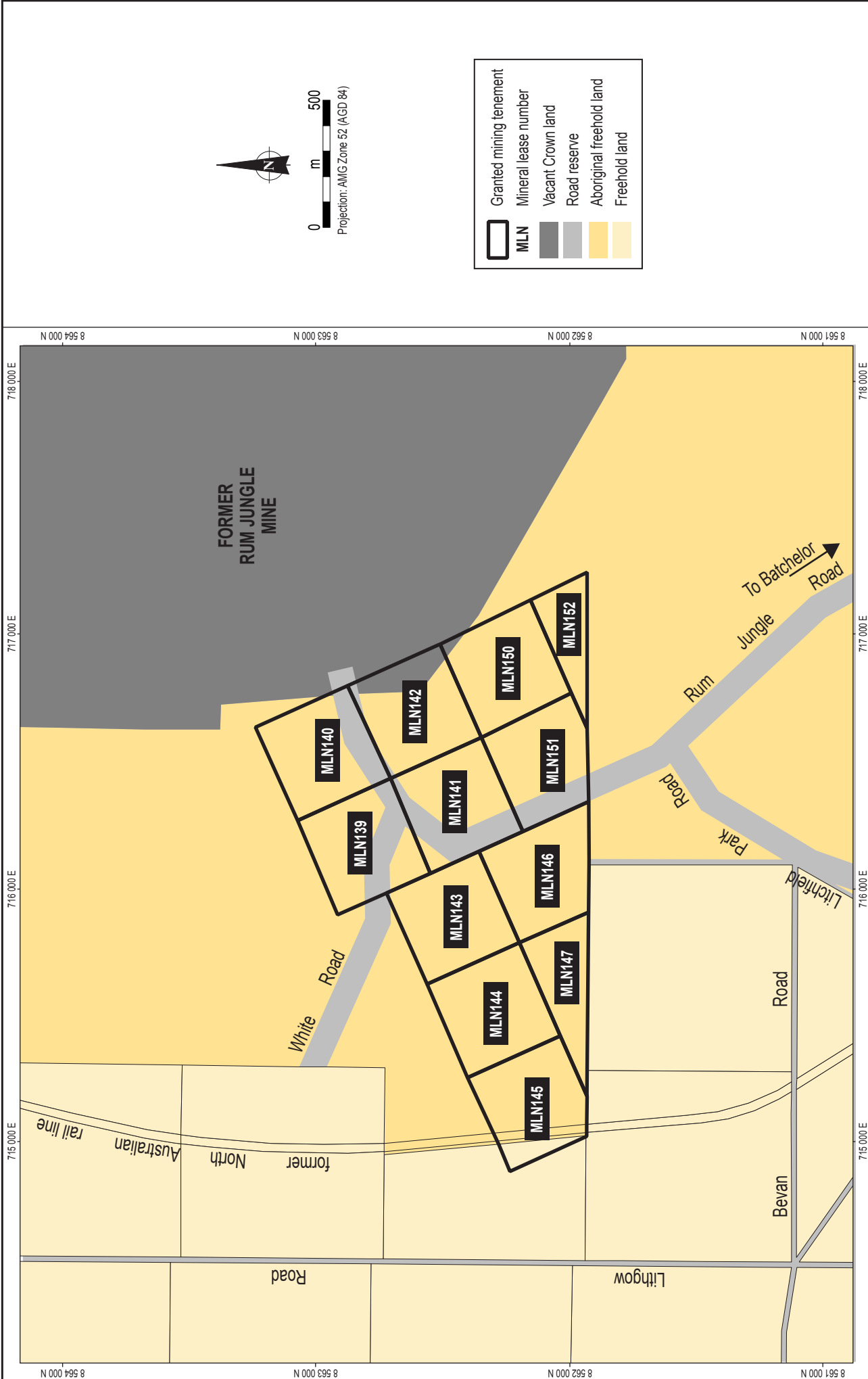


Figure No: <b>4.2</b>	
<b>Granted mining tenements</b>	
 Compass Resources NL	 Browns Oxide Project
Job No: 836	File No: 836_08_F4.02_HB
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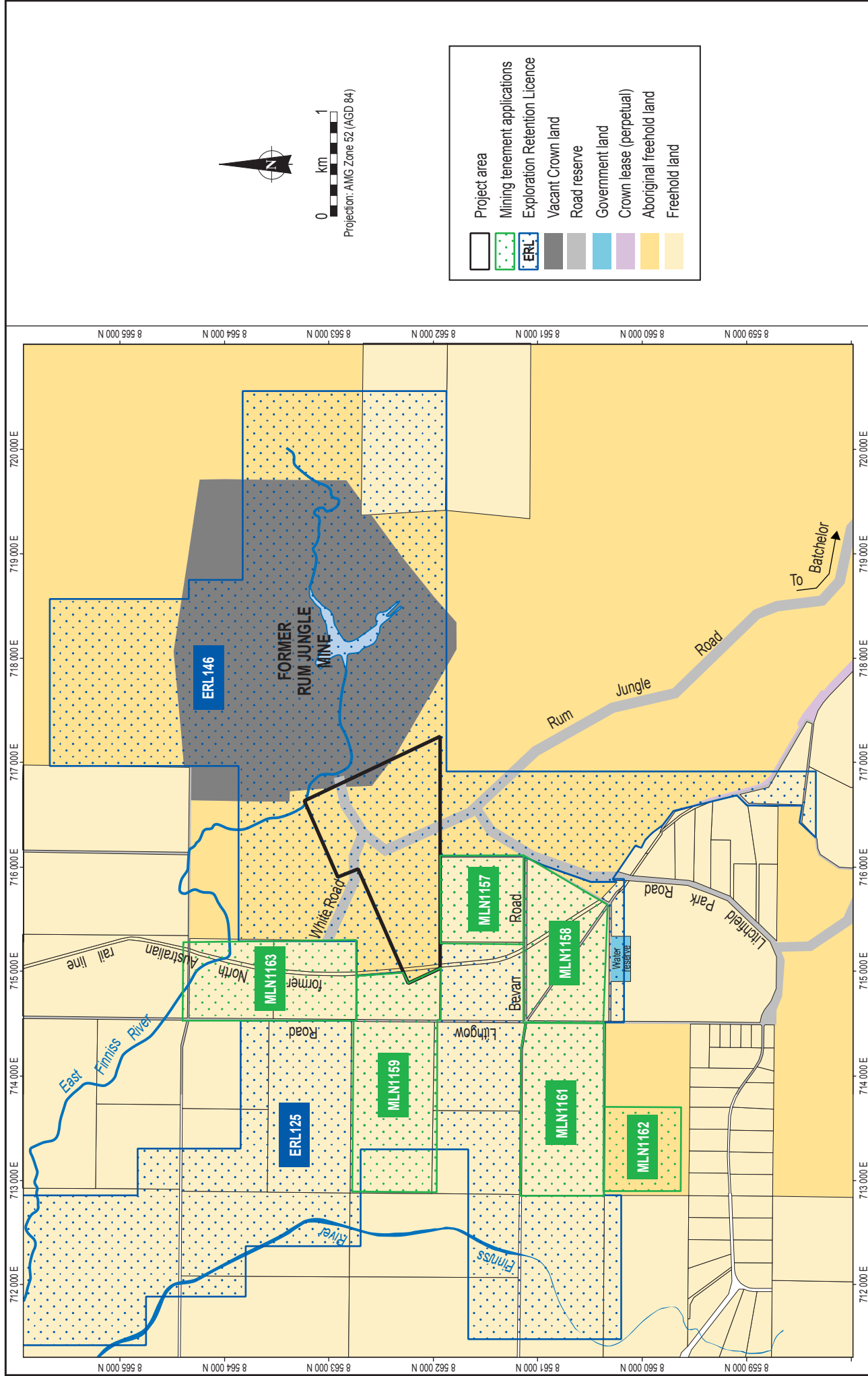


Figure No: **4.3**

**Exploration retention licences and mining tenement applications**

Compass Resources NL

Browns Oxide Project

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## 4.2 Project Overview

The project involves the development of a 3.9 Mt polymetallic oxide deposit using open pit mining techniques over a mine life of approximately four years. Ore will be mined and processed at a rate of approximately 1 Mt/a using a conventional crushing, leach and solvent extraction-electrowinning circuit to produce copper cathode. The project will also use a chemical precipitation circuit to produce cobalt and nickel. Approximately 10,000 t of copper cathode, 1000 t of contained cobalt and 700 t of contained nickel as hydroxides or sulfides will be produced each year of operation. All products will be transported by road to the Port of Darwin for export by ship. Tailing will be disposed of on site to an engineered TSF.

Key characteristics of the project are summarised in Table 4.2.

**Table 4.2 Key characteristics of the project**

Element	Description
Granted MLs	MLN 139 to 147 and MLN 150 to 152
Project area	175 ha
Life of project (mine production)	Four years
Size of deposit	3.9 Mt (confirmed resource of 2.8 Mt)
Mine production rate (maximum)	1 Mt/a
Resource grade	1.06% Cu, 0.13% Co and 0.11% Ni
Depth of mine pit	20 to 25 m on average with two deeper pockets up to 50 m
Extent of mine pit	776 m long and 225 m wide
TSF	35.71 ha, 2.7 Mm <sup>3</sup> capacity
Groundwater level	4 to 8 m below surface level depending on season
Mine operation	Open pit, excavator/truck mining
Raw water source	Interception bores
Raw water requirement (approximate)	40 m <sup>3</sup> /hr, 350,000 m <sup>3</sup> /a (350 ML/a)
Power source	Northern Territory grid
Power requirement	7.5 MW/a
Fuel storage capacity	65,000 L

## 4.3 Project Schedule

A summary of the development schedule is shown in Figure 4.4, and the key milestones from the approval of the PER and granting of the mining Authorisation are shown in Table 4.3. The construction contract will be awarded in the first quarter 2006 with a construction timetable of around nine months and commencement of production in the later part of the year. The scheduling of earthworks will take into account the Northern Territory wet season.

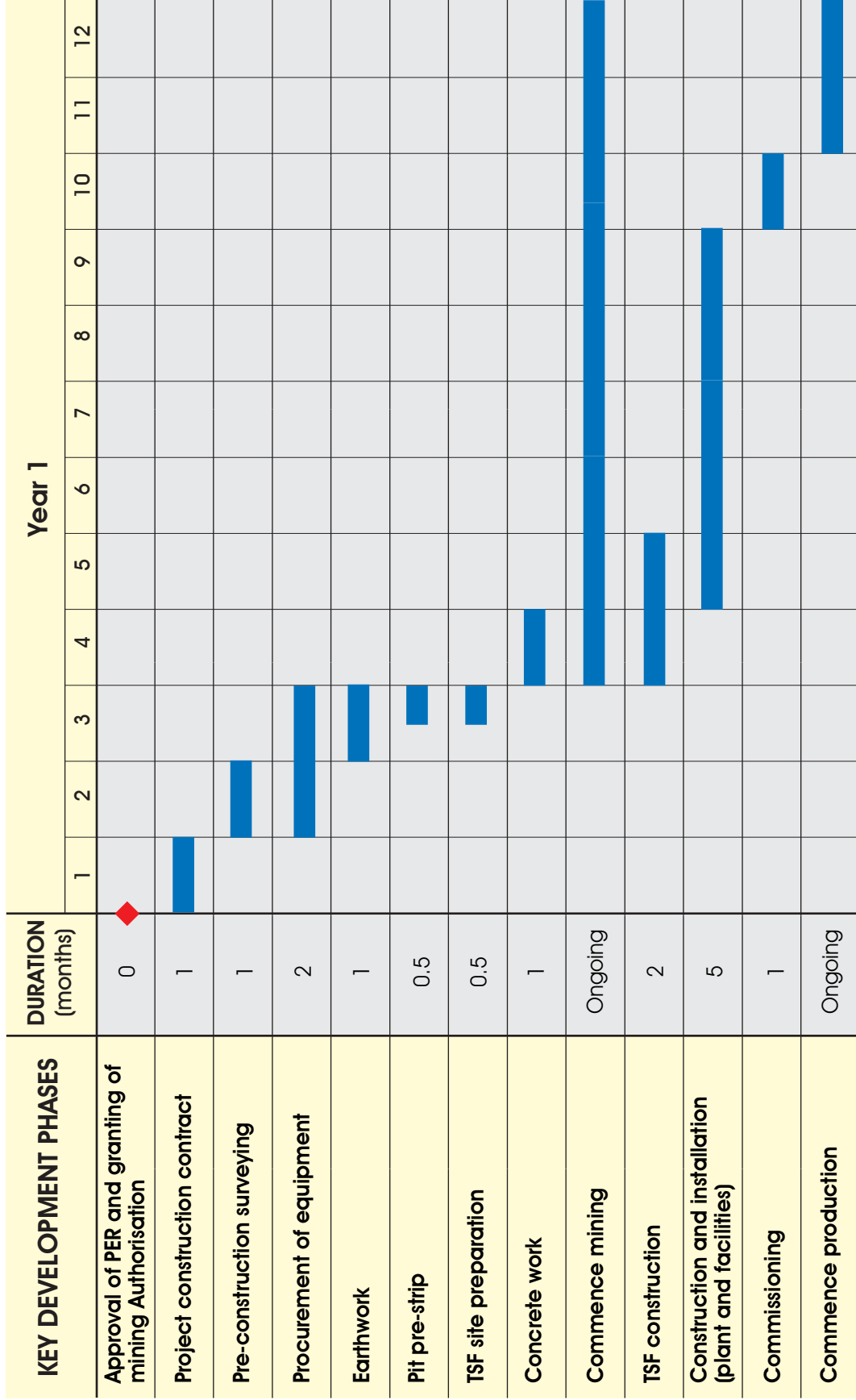


Figure No: **4.4**

**Project development schedule**

Compass Resources NL  
Browns Oxide Project

Job No: 836  
File No: 836\_08\_F4.04\_HB



**Table 4.3 Key development milestones**

<b>Item</b>	<b>Month</b>
Approval of PER and granting of mining Authorisation	0
Project construction contract	1
Pre-construction surveying	2
Procurement of equipment	2
Commence earthworks	3
Commence pit pre-strip	3
TSF site preparation	3
Commence concrete works	4
Commence mining	4
Commence TSF construction	4
Commence construction and installation (plant and facilities)	5
Commissioning	10
Commence production	11
Operation phase commences	11
End of mining	51
Anticipated project closure	57

#### 4.4 Project Components

The major components of the project are identified in Table 4.4 and are described in detail in the following sections. The project components have been located within the confines of the ML area (see Figure 4.1).

**Table 4.4 Maximum area of project components**

<b>Component</b>	<b>Area</b>
Mine pit	15.3 ha
Low-grade ore stockpile	5.6 ha
Lead ore stockpile	1.6 ha
ROM stockpile area	1.0 ha
Process plant	3.9 ha
TSF	35.7 ha
Process water dam	1.0 ha
Haul road	2.3 ha
Access road	2.8 ha
Mining contractor area	0.8 ha
Offices and car park	0.5 ha
Magazine	0.6 ha
Surface water cut-off drains	2.2 ha
Northwest and northeast sedimentation traps	2.5 ha
Main sedimentation trap	10.3 ha
Topsoil stockpile area	3.8 ha
<b>Total</b>	<b>89.9 ha</b>

The project will mine the near-surface oxide ore, although a much larger sulfide deposit lies beneath the oxide pit base. Development of this sulfide material is not part of the current project and, if progressed, will be subject to a separate assessment and approvals process.

A design criterion for the current project is that the underlying sulfide deposit is not sterilised with respect to possible future mining. A simple pit shell has therefore been projected for the sulfide deposit to a depth of 350 m (see Figure 4.1), where this is likely to encompass any future pit or the subsidence profile from underground mining. Only temporary or relocatable elements such as the ore stockpiles and the mining contractor's area have been located within this area.

## 4.5 Construction

### 4.5.1 Construction Materials and Waste

Construction materials will be sourced from the Batchelor–Darwin region where possible. Specialist materials such as the stainless steel tankage and mixer-settler unit liners may need to be sourced from outside the region and transported to site. The main construction materials that will be used are listed in Table 4.5. The main requirement for external borrow material will be the first stage of the TSF construction, and this material will be sourced from within the project footprint or, if this is not possible, from within the footprint of a possible future pit for the sulfide deposit. This list is preliminary and will be refined once detailed engineering is completed (during which time national pollution inventory requirements will also be determined).

**Table 4.5 Anticipated construction material requirements**

<b>Materials</b>	<b>Approximate Quantities</b>
Concrete for footings and plinths	2,000 m <sup>3</sup>
Mechanical and electrical equipment for site	As required
Structural steel	300 t
Site office and facilities	Port-a-cabin
Steel-framed roof for workshop	6 t
Security fencing	1,200 m
TSF embankment	1,945,000 m <sup>3</sup> (waste rock from the mine) 194,000 m <sup>3</sup> (external borrow material)
Road base	10,000 m <sup>3</sup> (waste rock from the mine)

Wastes to be generated during construction are listed in Table 4.6. As with the construction materials, this list is preliminary and will be refined once detailed engineering is completed (and, again, national pollution inventory requirements will be determined upon completion of detailed engineering). Construction contractors will be instructed (and appropriately supervised) to ensure that they apply the waste management principles of reduce, reuse and recycle, and comply with the Waste Management Plan (see Section 9.8.7).

**Table 4.6 Anticipated construction wastes**

Waste Materials	Approximate Quantities	Disposal Method
Scrap steel	50 t	Collection by steel recycling contractor
Wooden pallets	500	Majority returned to supplier for reuse, damaged/excess buried in on-site landfill
Diesel drums	20	Collection by supplier
Domestic waste	1,200 kg	Burial at Batchelor or on-site landfill
Waste oil and grease	200 kg	Removed from site for recycling
Waste paint	50 kg	Disposal by licensed contractor
Sand blast grit	5 t	Burial at on-site landfill, or in TSF
Sewage effluent	100 kL	Disposal by port-a-loo supplier

#### 4.5.2 Construction Methods

The extent of site disturbance will be minimised wherever possible, with the construction footprint (including clearing for pit and ore stockpiles) being similar to the ultimate project footprint. Laydown areas will be located at the western end of the plant site and, during construction, the future office car park area.

Prior to major earthworks commencing, the site drainage system will be constructed to manage site runoff water. The drainage system (see Figure 4.1) will divert surface runoff water away from areas to be disturbed and collect sediment-laden (dirty) water from the disturbed areas. Dirty water will be directed to sedimentation traps where most of the suspended sediment contained in the water will settle. The system will be designed and managed to minimise the potential for off-site release of dirty water. All drainage will be constructed to minimise erosion or sedimentation. If necessary, erosion control measures, such as the use of loose-rock check dams, will be put in place along drainage channels.

Vegetation clearing and grubbing will be the first step in the development of areas required by the project. The vegetation will be pushed into windrows and, where possible, will be used to assist with initial erosion control and establishment of soil structures on the rehabilitated areas. Topsoil will then be progressively stripped and stockpiled as areas are prepared for the construction of project facilities and infrastructure. Topsoil stockpiles will be designed with appropriate diversion and collection drains for the control of surface water runoff and runoff. The total amount of topsoil to be stripped over the life of the project is estimated to be 75,200 m<sup>3</sup>. Stripped topsoil will be used for the rehabilitation of disturbed areas.

The topsoil stockpiles will be formed into low, uncompacted, flat-topped mounds, up to 2 m high. Unnecessary compaction of the topsoil will be avoided in order to minimise degradation of soil structure. Where stockpiles are to be left for more than several months before re-use, they will be sowed with cover crops of fast-growing annual grass species to prevent them becoming a source of dust or sediment.

Earthmoving will be undertaken after topsoil stripping and stockpiling for rehabilitation, by the mining fleet using a conventional excavator/truck configuration and possibly self-loading scrapers. Major earthworks will be undertaken to provide suitable levels for site infrastructure and for mine pre-stripping, with the area of disturbance approximating the

area of project components, i.e., 89.9 ha (see Table 4.4). Drill and blast methods are not envisaged for civil works, although some bulldozer ripping may be required. Haul roads and the site access road will be constructed to ensure that soil erosion is minimised. Revegetation of stripped areas will be encouraged to reduce potential erosion.

## 4.6 Mineral Resources

### 4.6.1 Deposit

The Browns oxide deposit comprises weathered rock from surface to a typical depth of 20 to 25 m, with two deeper pockets reaching 50 m depth. The oxide deposit overlies a major strata-bound polymetallic sulfide deposit hosted by Proterozoic graphitic shales, calcareous sediments and dolomite. The deposit is located on the northern limb of a tightly folded synclinal structure adjacent to the Giants Reef fault zone.

### 4.6.2 Resource Estimates

Work is in progress to complete drilling and determine the necessary technical and economic planning to prepare a Reserves Statement in accordance with the Joint Ore Reserves Committee (JORC) Code (2004). However, almost all of the target mineralisation is in either measured or indicated resource status and the technical, cost and revenue issues are well understood. Announced resources are 2.8 Mt as shown in Table 4.7 and it is anticipated that, on completion of the final reserve calculations, the resource status will reflect the anticipated 3.9 Mt deposit size upon which the preliminary mine scheduling for this project has been based.

**Table 4.7 Resource estimate**

Mineral Resource Category	Resource Mt	Copper Grade % Cu	Cobalt Grade % Co	Nickel Grade % Ni	Contained Metal		
					Copper (t)	Cobalt (t)	Nickel (t)
Measured	2.2	1.14	0.12	0.11	25,150	2,727	2,361
Indicated	0.4	0.77	0.14	0.11	3,427	604	476
Inferred	0.1	0.78	0.12	0.11	1,115	174	151
<b>Total</b>	<b>2.8</b>	<b>1.06</b>	<b>0.13</b>	<b>0.11</b>	<b>29,691</b>	<b>3,504</b>	<b>2,987</b>

Note: Apparent inconsistencies in totals are due to rounding.

### 4.6.3 Mine Plan

The open pit presented in this document is an expanded version of a pit designed to accommodate the currently defined resource likely to be converted to economic mineralisation (Figure 4.5). The expansion increases the pit area by approximately 20% and is to allow for anticipated extensions to the deposit pending further drilling programs.

The open pit will be mined to an average depth of around 20 to 25 m below the relatively flat surface topography. The pit extends 776 m along strike (west-southwest to east-northeast) and is 225 m across at its widest point. Two zones of deeper oxidation with high-grade mineralisation occur half way along the pit length and at the northeast end. The pit will be mined to 50 m depth at these points.



Source: AMDAD.



Job No: 836  
 File No: 836\_08\_F4.05\_HB

Compass Resources NL

Browns Oxide Project

Browns oxide pit schematic

Figure No:

4.5

The design of the open pit will include:

- Wall batter angles: 50° to 65° with overall slope angle of 45°.
- Ramps: one main and two internal ramps at a gradient of 10%.
- In-pit berms: as required to ensure wall stability and safe working conditions.
- Dewatering: interception bores plus a floor sump.
- Overall waste: ore ratio 1:1.

A plan and typical cross sections are shown in Figure 4.6.

Initial planning suggests a staged approach to mining, whereby the northeast end of the pit will be mined first, followed by the southwest end. Although this strategy is based on metal distribution, it also allows a more even balance of non-acid-forming (NAF) and potentially acid-forming (PAF) waste rock over the mine life, which facilitates encapsulation of the PAF rock in the TSF embankment (see Section 4.9.2).

The final mine plan will be developed once final drill results are interpreted and modelled.

#### **4.6.4 Acid Rock Drainage**

The project involves mining the shallow oxidised (and partially oxidised) mineralised material. While most of the deeper sulfidic material will not be mined, excavation of ore and waste rock may expose sulfide-bearing rocks in the pit walls and floor to oxidation, with consequent possible generation of acidic mine water. Arrangements to treat such mine water have been incorporated in the water management section (see Section 4.14).

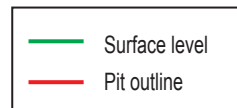
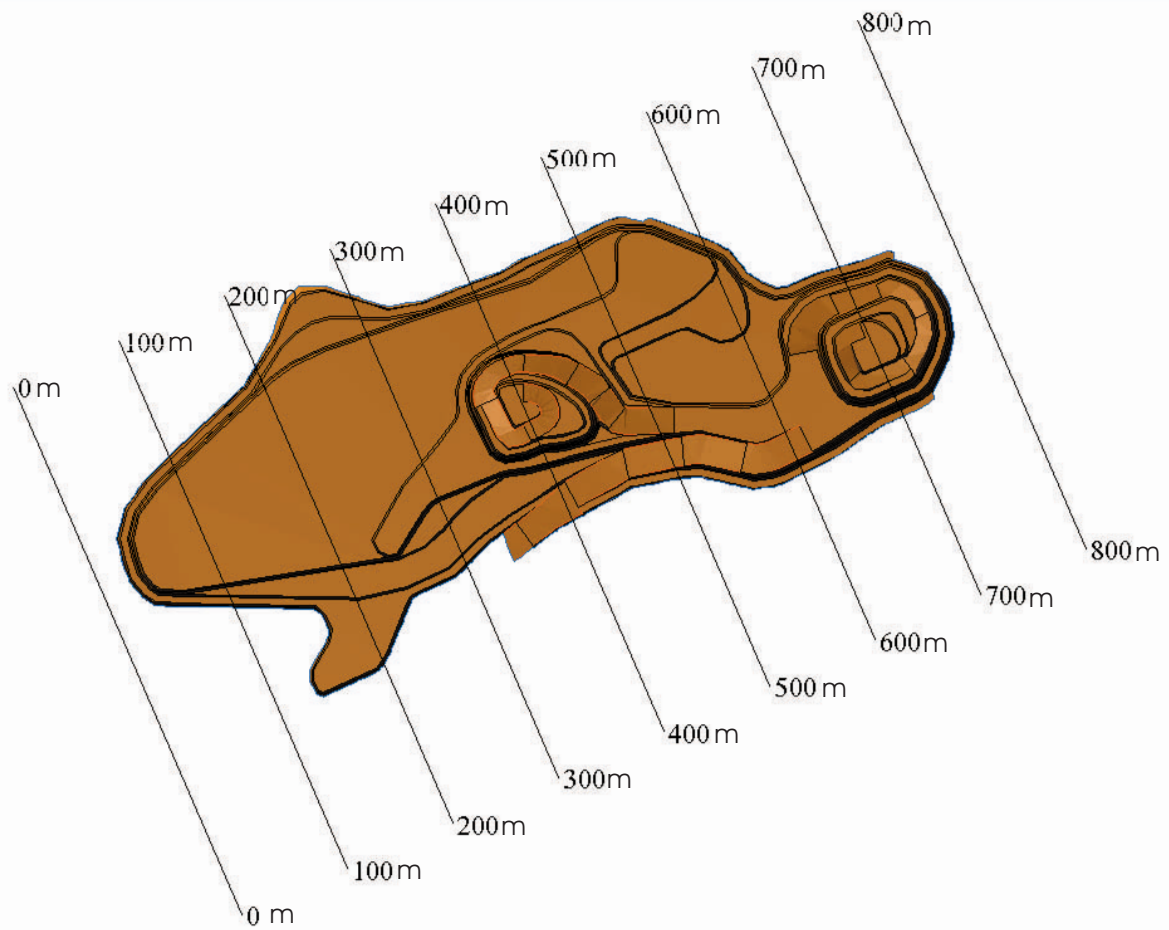
### **4.7 Mining**

#### **4.7.1 Mining Schedule**

Mining is planned to continue throughout the year with reductions in the production rate during periods of heavy or prolonged rainfall. The mine will have a very low waste to ore ratio of approximately 1:1 and mining should be possible based on one 10.5-hour shift per day, six days per week.

#### **4.7.2 Mine Access and Development**

The oxide open pit will be located in the northeast corner of the project area (see Figure 4.1). A haul road will exit the southern side of the pit and run southeast to provide access to the run of mine (ROM) ore stockpile and crusher area, the TSF embankment (which will form the waste dump), the low grade ore stockpile and a lead ore stockpile. Access to the mine offices, process plant and mining contractor's area will occur via a road formed around the southern, western and northwestern boundaries of the project area. There will be no interaction between the site access road and the mine haul road.



**Cross Section 200**



**Cross Section 700**



Source: AMDAD.



Job No:  
836  
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836\_08\_F4.06\_HB

**Compass Resources NL**  
**Browns Oxide Project**

**Browns oxide pit**  
**cross-sections**

Figure No:

**4.6**

### 4.7.3 Ore Stockpiles

Ore mined from the pit will be delivered to the ROM stockpile located to the west of the pit adjacent to the northwestern tenement boundary. Up to one month of ore supply (85 kt) will be stored on the ROM pad to provide continuity of feed to the process plant during periods of mining delays that may be caused by factors such as wet weather.

A low-grade ore stockpile (see Figure 4.1) will be formed southwest of the pit to hold ore which is of marginal economic grade but which may be viable to treat in the future at higher metal prices or lower processing costs. If this material remains uneconomic at the end of the project life, it will be returned to the mined-out pit [C]. The low-grade ore stockpile is designed to hold up to 1.5 Mt.

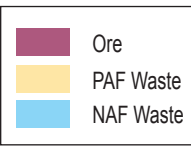
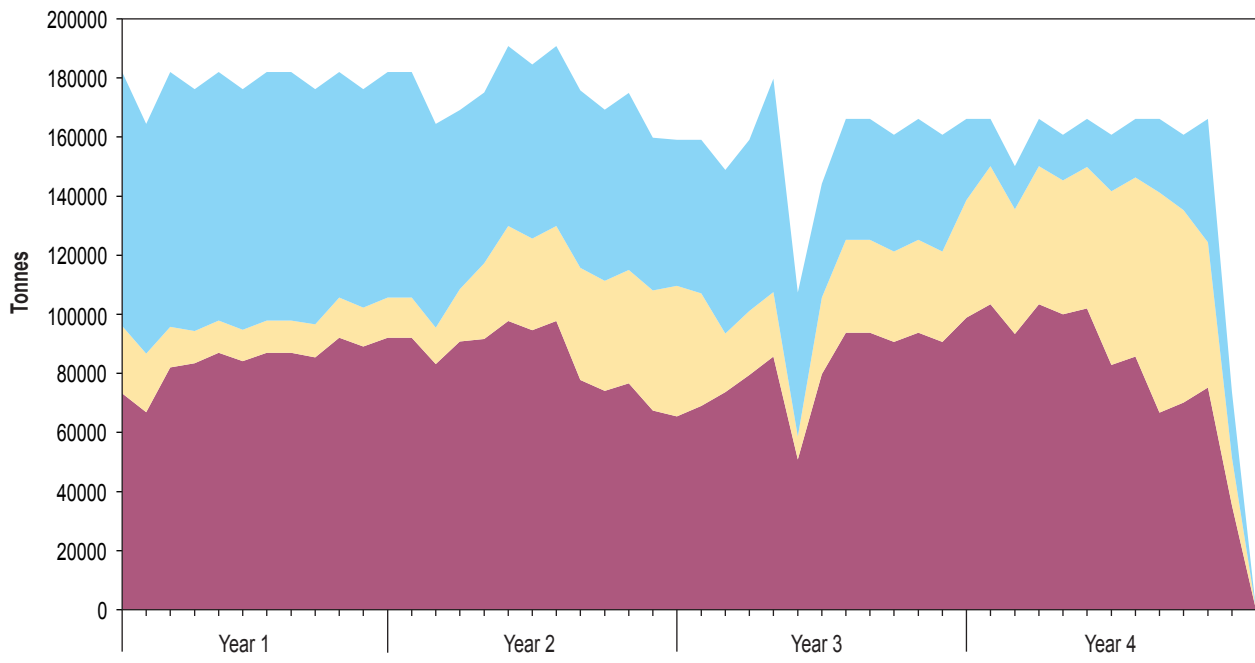
A lead ore stockpile will also be formed adjacent to the low-grade ore stockpile. The process plant will not initially include a gravity circuit (although the project footprint allows for its installation) to recover lead, hence lead ore (containing 4.2% Pb) will be stockpiled. A lead gravity circuit will be installed later in the mine life, once the copper/cobalt/nickel ore is depleted. It is anticipated that the processing of this material will achieve 65% recovery and will involve crushing and wet gravity treatment by a pressure jig to produce a carbonate end product. The lead ore stockpile has 275,000 t capacity. If the material is uneconomic by the end of the project life, it will be returned to the mined-out pit [C].

### 4.7.4 Mining Methods

Mining will be undertaken as a conventional excavator/truck operation. Much of the oxidised material is relatively weak and will be mined without blasting, but the occurrence of harder, silicified bands means that some drilling and blasting will be required throughout the mine life. Detailed blasting requirements will be established as mining progresses but the initial assumption is that half the material will require light blasting. Blasting frequency will depend on the competency of the rock being mined in a given period but will generally be at the rate of one to two blasts per week, with between 80 and 170 holes being fired on a 5-m-high bench in each shot. Gravel stemming, inter-hole delays and low-impact blast-hole connections, such as Nonel tubing, will be used to minimise ground vibration, air blast and fly rock.

Ore will be mined at the rate of approximately 1.00 Mt/a and waste rock will be mined at the rate of 0.89 to 1.13 Mt/a over a period of up to four years (Figure 4.7). A single 60-t hydraulic excavator and three 50-t off-highway dump trucks will form the main mining fleet, and these will be supported by a bulldozer, grader, water cart, blast-hole drill, grade-control drill and small ancillary items such as pit pumps and light vehicles (see Table 4.15 in Section 4.13). A compactor roller will be used to ensure dump compaction.

Mined ore will be hauled to either the ROM, low-grade or lead ore stockpile. Most of the ore delivered to the ROM stockpile will be either direct dumped into the crusher or dumped adjacent to the crusher hopper to allow short haul rehandling into the crusher by front end loader.



The TSF embankment has been designed to contain all of the waste rock material. Potentially acid-forming waste will be selectively placed within the TSF wall, compacted and encapsulated with compacted non-acid-forming waste (see Section 4.9.2 and Appendix 8 for details).

## **4.8 Processing**

### **4.8.1 Process Plant**

The process plant will be located along the northern boundary of the western end of the tenements (see Figure 4.1) and will comprise a crushing/grinding circuit and leach tanks. The layout and general arrangement of the process plant is shown in Figure 4.8.

The process plant will operate 24 hours per day, seven days per week, at a rate of approximately 1 Mt/a, although the crushing circuit will operate on a dayshift only basis. The process plant will produce three products at an estimated rate of:

- 10,000 t/a of copper cathode.
- 1,000 t/a of cobalt, as a cobalt hydroxide or sulfide.
- 700 t/a of nickel, as a nickel hydroxide or sulfide.

The cobalt and nickel are likely to be produced as a combined product.

### **4.8.2 Process Description**

The process flowsheet is shown schematically in Figure 4.9 and is described as follows.

#### ***Crushing and Grinding***

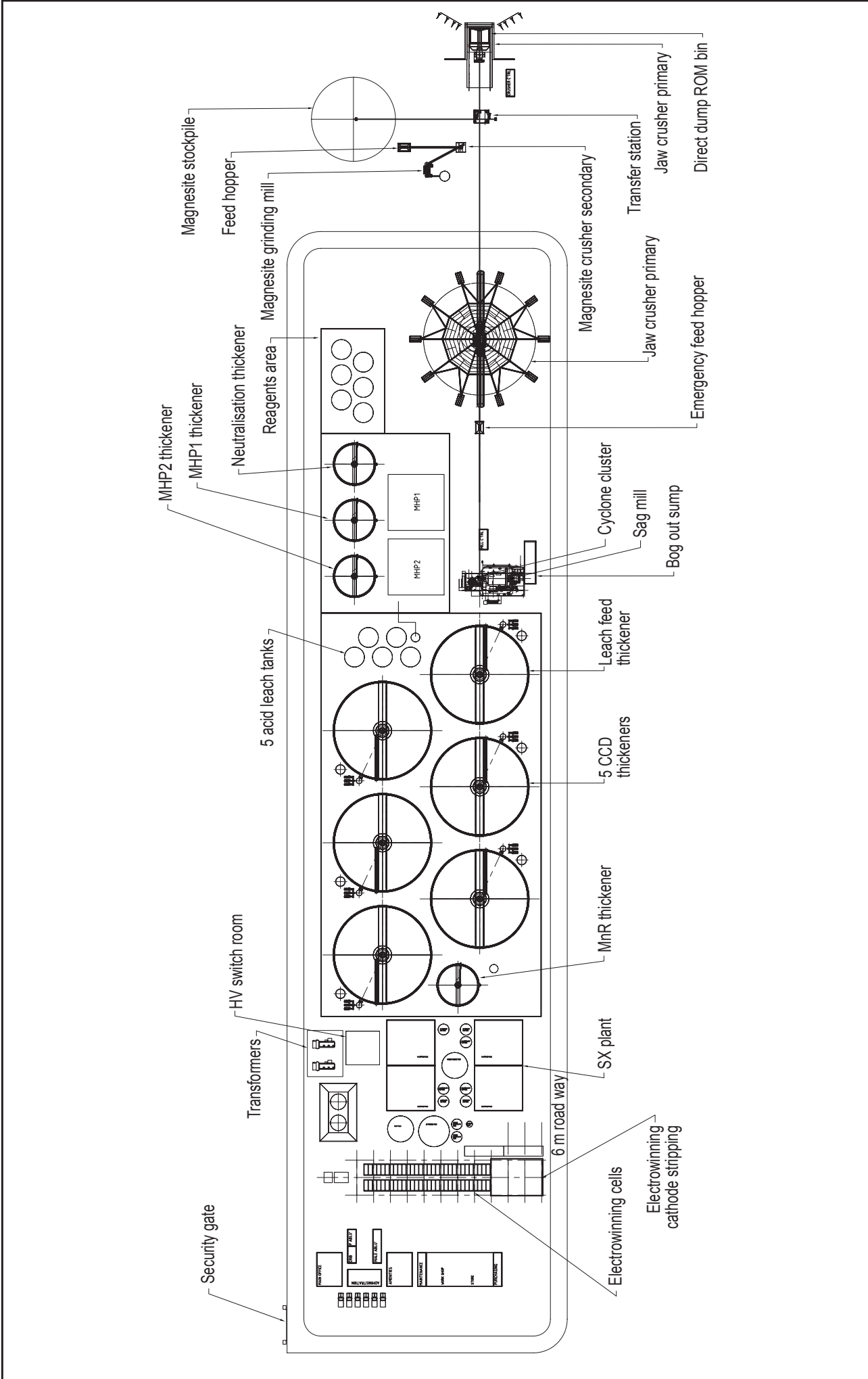
Ore will be conveyed from the ROM pad to a single stage crushing circuit consisting of a jaw crusher. The crushed product will be ground in a SAG mill to achieve a particle size of 80% smaller than 150  $\mu\text{m}$ . Ground product is then sent to the leach circuit.

#### ***Leaching***

Feed from the grinding circuit is diluted to approximately 40% solids. Sulfuric acid, recycled from other components of the plant, is added to the slurry to leach the minerals at 60 to 80°C. Design leaching time is five hours, after which the slurry is sent to the counter-current decantation circuit for solid/liquid separation.

#### ***Counter-current Decantation***

The counter-current decantation circuit separates soluble minerals from solid residues. In the process the solids are washed free of acid. The clear liquor is then sent to the solvent extraction circuit to increase its tenor suitable for copper electrowinning.



Source: Wilshaw Engineering, Drawing No 182-L-002.	<p>Job No: 836</p> <p>File No: 836_08_F4.08_HB</p>	<p>Compass Resources NL</p> <p>Browns Oxide Project</p>	<p>Figure No: 4.8</p>
<p><b>Process plant general arrangement</b></p>			

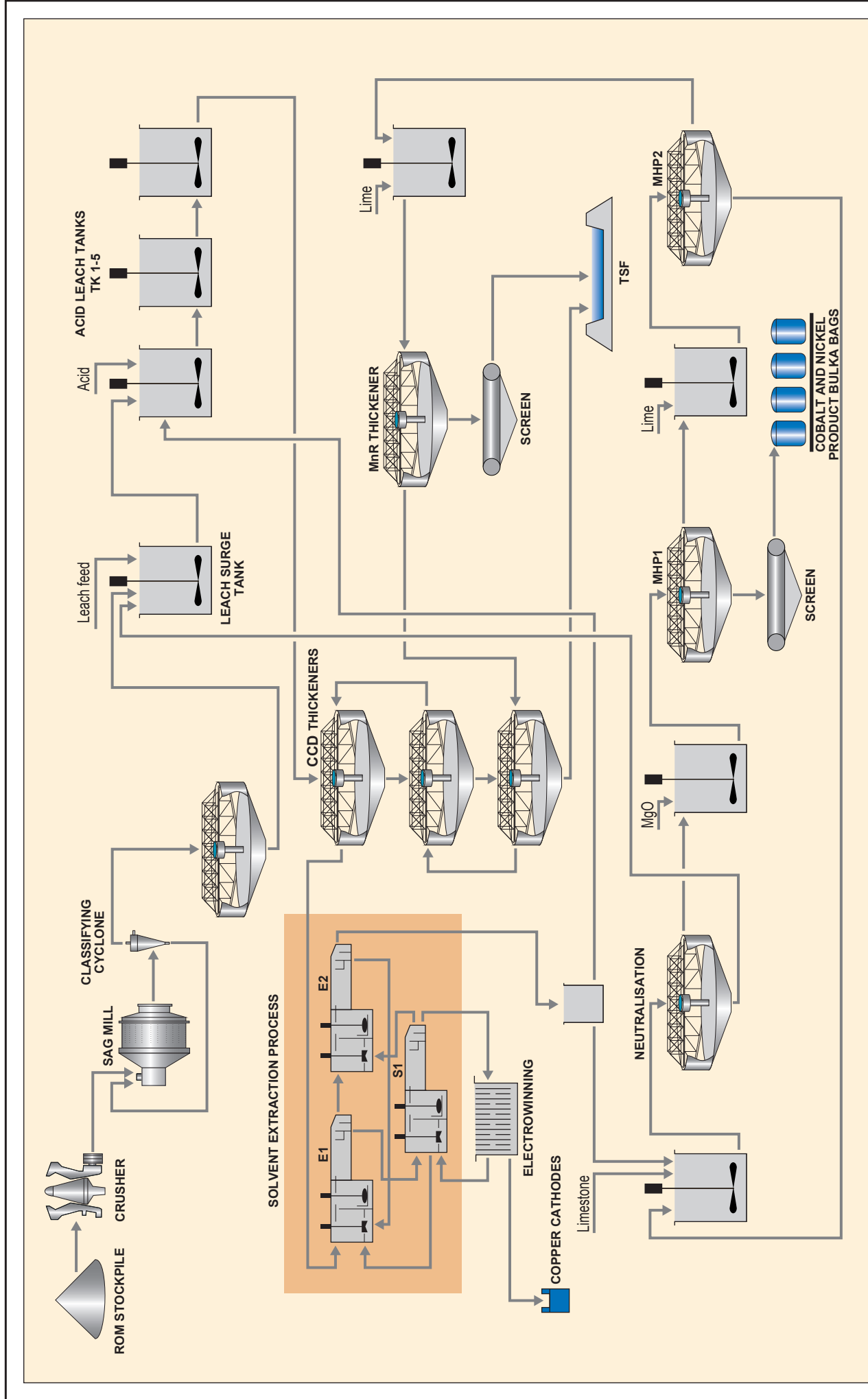


Figure No: **4.9**

**Simplified process flowsheet**

Compass Resources NL  
 Browns Oxide Project

Job No: 836  
 File No: 836\_08\_F4.09\_HB



### **Solvent Extraction**

The solvent extraction circuit purifies and concentrates the copper from the solution. This high-copper pregnant liquor solution is then sent to the electrowinning circuit.

### **Electrowinning Circuit**

Copper is removed from the loaded electrolyte solution onto stainless steel starter cathodes. The remaining solution is sent to the precipitation stage. The plated copper cathodes are then washed and the copper is stripped off the steel plates as Grade A copper cathode sheets. The copper sheets are then weighed, sampled and bound in pallets for transport from site.

### **Precipitation of Cobalt and Nickel**

The copper-free solution is neutralised with site-mined magnesite in preparation for nickel and cobalt precipitation. The magnesite lies within the oxide pit area and will be mined as part of the mine pre-strip. Solids formed during neutralisation are returned to the leach stage.

The cobalt and nickel products will be precipitated from the copper-depleted leachate (either separately or together) as hydroxides or sulfides. Selection of the final product form will depend largely on marketing outcomes. These crystalline precipitates will be filtered and packed in 1-t bulka bags for containerised transport off site. Solutions will be recirculated for reuse.

Tailing from the processing circuit will be discharged to the TSF at a slurry density of 45% solids (Section 4.10).

## **4.8.3 Concentrate Storage and Transport**

Copper cathode will be transported on strapped pallets to the Port of Darwin for export via ship. The 1-t bulka bags containing the cobalt and nickel products will be placed inside 20-ft containers that will be transported by road to Darwin.

Product transport will occur via Rum Jungle Road, through Batchelor to the Stuart Highway and then to the Port of Darwin. Product transport will occur two or three days per week. Each truck will carry approximately 50 t of cobalt and nickel product and 100 t of copper cathode.

At the port the containers containing cobalt and nickel products will be unloaded by wheeled fork-lift truck or crane. Product will be loaded onto ships at the Darwin container-handling terminal for export.

## **4.8.4 Reagents and Consumables**

Inputs to the process are ore, water, acid, steam, organic solvents and diluent for solvent extraction, and various other reagents (Table 4.8). Acid will be supplied to site in tankers and stored in tanks in a lined and bunded area, as will organic solvents and diesel fuel.

All chemical transportation and storage will be in accordance with the relevant Australian standards. All products will be stored in a product load-out facility and loaded onto trucks for transport off site.

**Table 4.8 Annual reagent and chemical useage**

Reagent or Chemical	Annual Useage
Steam	33,000 t
Sulfuric acid (98%)	20,800 t
Cobalt sulfate	7.3 t (as $\text{CoSO}_4 \cdot 6\text{H}_2\text{O}$ )
Guar	7.3 t
Diluent	70 m <sup>3</sup>
Extractant	17.5 m <sup>3</sup>
Flocculant	350 t
Lime	9,700 t
Magnesia	1,700 t
Locally mined magnesite	40,200 t

## 4.9 Waste Rock

### 4.9.1 Waste Rock Characterisation

Waste rock will consist of either oxidised sulfidic shales or carbonate-rich sediments. For mine planning purposes, the different lithologies have been categorised on the basis of acid-forming potential (i.e., either non-acid forming (NAF) or potentially acid-forming (PAF)) (Table 4.9). When potentially acid-forming or acid-forming waste rock is exposed to water and oxygen, oxidation of sulfur may produce an acidic leachate. This is less likely for oxidised sulfidic shales since most of the contained sulfur has already been oxidised. Carbonate-rich sediments do not produce acid and have some capacity to neutralise acid.

**Table 4.9 Waste rock acid-forming potential categories**

Lithology	Sulfur (%)	Assigned ARD Category	ARD Type
Dolomite	<0.5	NAF	1
Shale	<0.5	NAF	2
Dolomite	0.5 to 1.5	NAF	3
Shale	0.5 to 1.5	PAF	4
Dolomite	>1.5	PAF	5
Shale	>1.5	PAF	6

Three campaigns of geochemical testwork have been undertaken on samples from the Browns deposits:

- The first in 1997 on six drill hole samples that relate to the present oxide resource (and are nearly all above the zone of oxidation).
- The second on 40 samples in 2002, focussing on the deeper sulfide deposit rather than the oxide material that is to be mined for the current project.

- The third, in 2005, on 16 drill core samples of near-surface rock that will be mined over the life of the Browns Oxide Project (Appendix 9).

Results from this testwork suggest the following:

- Carbonates with total sulfur up to 0.5% will be NAF. This supports the definition used for category 1 in Table 4.9.
- Well-oxidised shale with low (<0.5%) sulfur levels is likely to be NAF, supporting the definition used for category 2.
- Pyritic dolomite with elevated total sulfur (e.g., 5.6%) is likely to be NAF, despite the elevated sulfur concentration. This supports the definition used for category 3 in Table 4.9, where the total sulfur is <1.5%, and suggests that category 5 is conservative, i.e., material included in this category is not likely to be PAF.
- Shale with somewhat elevated total sulfur (e.g., 1.4%) may be either PAF or NAF. However, the limited sample numbers and the dependence of this finding on the availability of sufficient acid neutralising capacity has resulted in a conservative approach being adopted for this project, whereby category 4 has been classified as PAF.
- Shale with substantially elevated total sulfur (e.g., 2.2% to 10.2%) is likely to be PAF, which supports the definition used for category 6, i.e., most material in this category is likely to be PAF.

Using this approach, about 36% of all of the waste rock that will be generated during mining may be classified as PAF (Table 4.10). Examination of the mine schedule (Table 4.11) indicates an increasing percentage of PAF material with each successive year of mining, from 14% in Year 1 to 70% in Year 4. This is consistent with an increasing sulfur concentration in the waste as the pit becomes deeper and the lower boundary of the oxidation zone is approached.

**Table 4.10 Total waste rock**

<b>ARD Category and Type</b>	<b>Total Waste Rock Production (t)</b>	<b>Waste Rock Type as % of all Waste Rock</b>
NAF1	375,737	9.7
NAF2	2,022,743	52.0
NAF3	83,079	2.1
PAF4	416,618	10.7
PAF5	126,831	3.3
PAF6	865,511	22.2
<b>All NAF</b>	<b>2,481,559</b>	<b>63.8</b>
<b>All PAF</b>	<b>1,408,960</b>	<b>36.2</b>
All waste	3,890,518	100.0

Note: NAF/PAF waste rock definitions are as described in Table 4.9.

**Table 4.11 Waste rock NAF and PAF breakdown**

ARD Category and Type	Waste Rock Production Schedule (t)				Waste Rock Types as % of all Waste Rock			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
NAF1	35,710	125,483	127,893	86,651	3.1	11.6	14.5	11.0
NAF2	931,594	585,538	416,969	88,641	82.2	53.9	47.1	11.3
NAF3	4,411	12,313	9,433	56,922	0.4	1.1	1.1	7.2
PAF4	87,799	114,158	125,856	88,805	7.7	10.5	14.2	11.3
PAF5	0	0	10,351	116,481	0.0	0.0	1.2	14.8
PAF6	74,422	248,711	194,341	348,037	6.6	22.9	22.0	44.3
<b>All NAF</b>	<b>971,715</b>	<b>723,334</b>	<b>554,295</b>	<b>232,214</b>	<b>85.7</b>	<b>66.6</b>	<b>62.6</b>	<b>29.6</b>
<b>All PAF</b>	<b>162,221</b>	<b>362,869</b>	<b>330,548</b>	<b>553,322</b>	<b>14.3</b>	<b>33.4</b>	<b>37.4</b>	<b>70.4</b>
All waste	1,133,936	1,086,203	884,843	785,536	100.0	100.0	100.0	100.0

Note: NAF/PAF waste rock definitions are as described in Table 4.9.

The geochemical testwork undertaken on waste rock in 2005 also included multi-element analyses of one sample of pyritic dolomite, one sample of NAF black shale and three samples of PAF black shale (Appendix 9). Elements that were significantly enriched in the samples, relative to literature values for median soil abundances, were:

- Dolomite—arsenic (148 ppm), molybdenum (254 ppm) and magnesium (20%).
- NAF black shale—copper (1,642 ppm), lead (2,588 ppm), cobalt (95 ppm) and beryllium (5.6 ppm), with minor enrichment of arsenic (44 ppm) and molybdenum (8.1 ppm).
- PAF black shale—copper (up to 4,866 ppm), lead (up to 5,709 ppm), cobalt (up to 205 ppm), beryllium (up to 2.8 ppm), arsenic (up to 260 ppm), antimony (up to 9 ppm), molybdenum (up to 45 ppm) and selenium (up to 6.1 ppm).

Elements of most concern from an environmental perspective are copper, lead, cobalt and arsenic, therefore particular attention will be given to monitoring these metals in site water quality monitoring programs. In the event that sulfide oxidation and acid generation occurs, it is also possible that other non-enriched metals, such as manganese, nickel and zinc, could occur at elevated concentrations; these metals will also be included in the monitoring program.

Kinetic NAG testing was undertaken on three of the PAF black shale samples in the 2005 testwork program to provide information on the likely lag time in acid production (Appendix 9). These tests showed that there was an immediate downward trend in pH with time, indicating the generation of acid by sulfide oxidation and an absence of acid neutralising capacity within the samples. Waste rock represented by these samples is therefore likely to become a source of ARD within a short time of exposure to atmospheric conditions, i.e., within weeks to months rather than years, if not appropriately managed.

Further column leach testing has been commissioned by Compass to provide a more realistic assessment of the likely extent and rate of acid production, and the leaching

potential of elements of environmental significance from the different rock types. The first results from this program will be reported in the Mining Management Plan [C].

#### 4.9.2 Waste Rock Management

The TSF embankment has been designed by Australian Tailings Consultants (ATC) (Appendix 8)<sup>1</sup> to incorporate all of the waste rock that will be mined. The embankment, which will enclose all sides of the storage, will be a substantial structure with a base width of over 80 m and an outside perimeter length of approximately 3 km (Figure 4.10). This allows for selective placement of waste types so that PAF rock can be encapsulated by compacted NAF material within the wall.

Using the classification described above for NAF and PAF waste rock, the TSF embankment design includes an 'overlay' of sections of the embankment considered to be suitable for inclusion of PAF material. This design overlay provides for a zone to be constructed using NAF material only, and another zone for mixed PAF material and NAF material (Figure 4.11). The use of pit waste material in the TSF embankment is summarised in Table 4.12 which shows that, in general, the pit waste production will be able to match the sequential requirements for embankment construction.

**Table 4.12 Summary waste rock use in TSF embankment**

Mine Year	Pit Waste Production '000 (m <sup>3</sup> )			Waste Rock Use in TSF Embankment '000 (m <sup>3</sup> )				
	NAF	PAF	Total available	Construction stage	Pit waste		External borrow required (All NAF)	Total
					NAF only zone	PAF & NAF zone		
0	–	–	–	1	0	0	194	194
1	486	81	567	2	75	312	0	387
2	361	181	542	3	301	387	0	688
3	277	165	442					
4	116	277	393	4	220	650	0	870
<b>Total</b>	<b>1,240</b>	<b>704</b>	<b>1,944</b>	<b>Total</b>	<b>596</b>	<b>1,349</b>	<b>194</b>	<b>2,139</b>

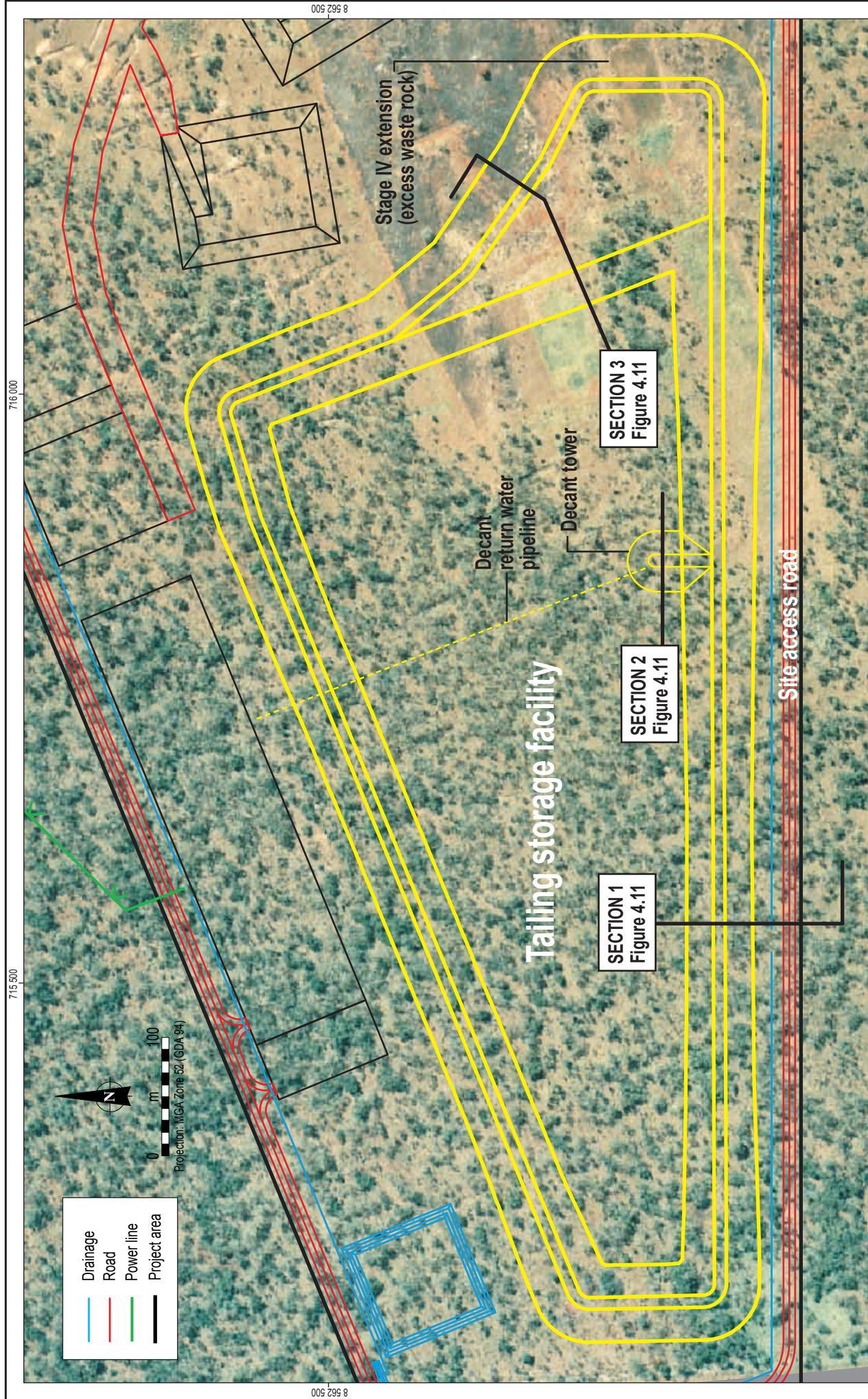
Note 1: Material placed in the TSF embankment has an assumed density of 2.0 t/m<sup>3</sup>.

Note 2: Tables 4.10, 4.11 and 4.12 reflect a total waste rock production of about 4 Mt; slight discrepancies will be reconciled during preparation of the revised mine schedule and the subsequent detailed design of the TSF, which will also allow further alignment of these two aspects of the project.

This selective placement of PAF material in the TSF embankment will therefore involve the following strategies:

- Limiting exposure of PAF material to atmospheric oxygen, thereby minimising the rate at which oxidation can occur within the PAF material.

<sup>1</sup> This is a preliminary design report; a final TSF design will be produced upon completion of the site geotechnical assessment, the final mine schedule and the final metallurgical process flowsheet.



Source: Appendix 8, figure 1.

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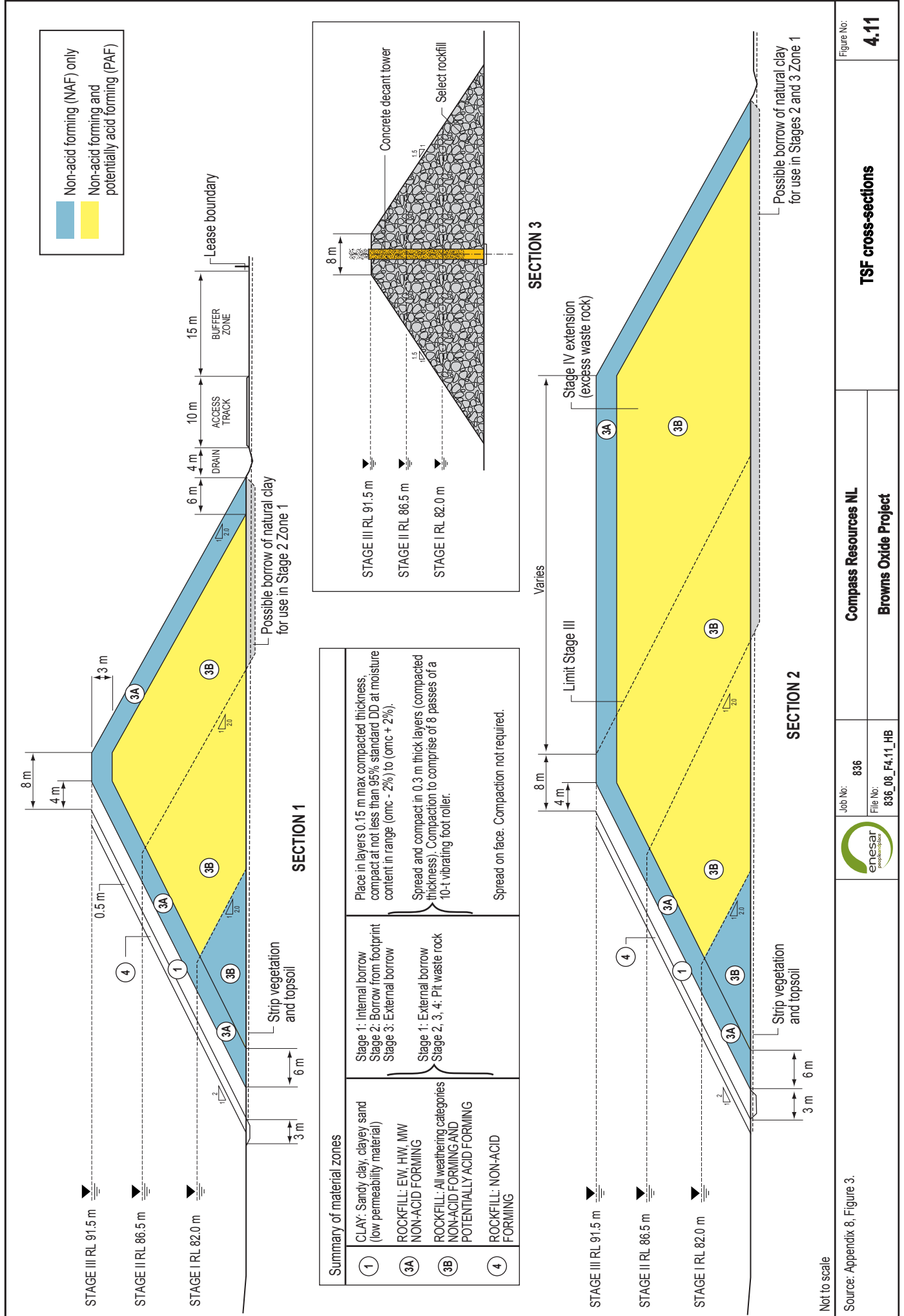
Compass Resources NL  
Browns Oxide Project

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TSF general layout

Figure No:

4.10



Not to scale

Source: Appendix 8, Figure 3.



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Compass Resources NL  
Browns Oxide Project

TSF cross-sections

Figure No:

4.11

- Reducing water infiltration into the embankment, thereby minimising the volume of ARD produced should the PAF rock oxidise and acidify.

Blending of PAF and NAF material may also provide additional buffering capacity, although the extent to which this may occur is not currently known.

At this stage of project development it is expected that the success of the encapsulation strategy will rely primarily on oxidation control that, in turn, will depend of the internal embankment structure and the design of barrier layers. A key factor here is the need to prevent the development of major conduits for transfer of air into the embankment. However, some air movement into the embankment will still occur, and the following factors will be considered in detailed design of the cover layer (so as to provide effective oxidation control):

- The greater the cover layer thickness, the slower the rate of oxygen movement to the site of sulfide oxidation.
- Compaction under controlled moisture conditions, e.g., construction of a barrier with a saturated hydraulic conductivity<sup>1</sup> ( $K_{sat}$ ) less than  $10^{-8}$  m/s and degree of saturation greater than 0.85<sup>2</sup>, can ensure an effective barrier to oxygen diffusion.
- A cover layer containing NAF material with a high carbonate content, e.g., dolomitic rock, will assist in preventing the onset of acid conditions by providing a source of alkaline seepage into the underlying PAF rock.

On mine closure, the TSF and waste embankments will be rehabilitated as described in Chapter 9.

Compass will ensure direct supervision by a qualified person during construction of the TSF and, upon completion, sign off by that qualified person on submission of the 'as constructed' designs and plans [C]. This will ensure that the required high degree of geotechnical and structural control is obtained. The implementation of selective handling of PAF material requires integration with the mine plan, with identification of material types involving continuous in-pit sampling, logging, mapping and testing during mining [C]. Consideration will also be given to the level of discrimination of NAF and PAF material that is likely to be achievable within the pit (i.e., the minimum block size that can be accurately delineated in a bench and selectively mined).

As noted by ANSTO (Appendix 7), 'The concentration of uranium in Browns oxide ore is very low', with levels of uranium in composite ore samples ranging from 8.1 to 28.6 ppm. For comparison, the ore at the Ranger uranium mine averages 2,300 ppm uranium, i.e., about 80 times more than the highest value measured in Browns oxide ore, while the

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<sup>1</sup> Saturated hydraulic conductivity is the rate at which water moves through saturated soil.

<sup>2</sup> Where this may be achieved by watering during construction.

average crustal abundance of uranium is 2.4 ppm (Emsley, 1991). The low degree of mineralisation in waste rock means that uranium concentrations are likely to be lower again in this material. These low levels of uranium are not considered likely to require specific management measures (or impose specific constraints) concerning the use of waste rock in the construction of the TSF embankment.

## 4.10 Tailing

### 4.10.1 Tailing Characterisation

Ore comprises either black shale (70%) or supergene material (30%), most of which will report as tailing after recovery of the copper, cobalt and nickel.

Physical characterisation of the tailing samples has shown that (Appendix 8):

- The supergene tailing can be classified as clayey sand, with 43% being less than 75  $\mu\text{m}$  and a particle density of 2.98  $\text{t/m}^3$ .
- The black shale tailing can be classified as sandy silt, with 79% being less than 75  $\mu\text{m}$  and a particle density of 2.80  $\text{t/m}^3$ .

Geochemical characterisation of tailing samples has shown that (Appendix 8):

- The supergene tailing has a low sulfur content (0.16%) and is classified as NAF.
- The black shale tailing has a sulfur content of about 1% (although possibly two thirds is present in forms that are not acid generating) and is classified as PAF.

The testwork has also shown that a lag time of at least several months is likely before the onset of acidic conditions.

This PAF classification of the black shale tailing is not consistent with the findings from the metallurgical testwork undertaken by Compass. The process for the recovery of copper, cobalt and nickel from the oxide ore will be a sulfuric acid leach (see Section 4.8.2), with the copper, cobalt and nickel rapidly being solubilised. Extending the leaching time results in the continued consumption of sulfuric acid with little or no consequent increase in the dissolution of copper, cobalt and nickel, i.e., the ore contains significant amounts of acid-consuming materials (and it is for this reason that heap leaching has not been used for the Browns Oxide Project since acid would continue to be consumed in the heap by the gangue minerals<sup>1</sup>).

Further geochemical testwork is planned to address this matter after finalisation of the metallurgical process flowsheet [C]. This testwork will include chemical analysis of liquor

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<sup>1</sup> This is why tank leaching is proposed, whereby the leaching time can be controlled with the pregnant solution being separated from the remaining solids, which will then be washed to further recover dissolved metals.

in tailing samples representative of the final flowsheet and the orebody. Column leach testing will also be commissioned by Compass to provide additional information concerning the likely extent and rate of acid production and the leaching potential of elements of environmental significance from the different tailing types [C].

Tailing will also contain residual levels of process reagents, e.g., extractant.

#### 4.10.2 Tailing Storage Facility

As indicated in Section 4.9.2, the TSF will be constructed with an embankment around all sides, where this will consist of (Appendix 8) (see Figure 4.11):

- An internal lining of compacted clayey soil (Zone 1), comprising a number of layers of a minimum thickness of 150 mm after compaction.
- A transition zone of highly weathered material (Zone 3A), placed and compacted in 300-mm-thick layers.
- A core zone of weathered rockfill for the bulk of the embankment (Zone 3B), placed and compacted in 300-mm-thick layers.
- A 0.5-m-thick layer of protective rockfill (Zone 4) placed (loose) over the face of the Zone 1 layer.

Existing clayey soils in the tailing storage area will be compacted immediately prior to the commencement of deposition to provide a base for the TSF. The exposed foundations beneath the embankment will also be compacted. All tree roots and stumps beneath the embankment footprint will be grubbed and removed, while vegetation within the storage area will be cleared and topsoil stockpiled.

Preliminary design suggests that the embankment will be constructed in three stages. Factors such as the rate of filling, water management requirements and the physical characteristics of the tailing means that each embankment raising will be undertaken using 'downstream' methods, i.e., the new wall will be built on the downstream (outer) slope) of the previous wall (see Figure 4.11).

Tailing will be deposited sub-aerially from a ring pipeline and multi-point spigots will be used to form beaches to assist drying and consolidation of the tailing. The tailing is expected to have an 'end of filling' dry density of 1.3 t/m<sup>3</sup>, which gives an overall storage capacity requirement of 2.7 Mm<sup>3</sup> and is sufficient to accommodate 3.5 Mt of tailing<sup>1</sup>.

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<sup>1</sup> The initial design of the TSF is based on 3.5 Mt of ore (and tailing). While this is less than the 3.9 Mt of ore that is the basis of this PER, Appendix 8 notes that 'the tailings dam site and embankment design has sufficient flexibility that additional tailings could be retained', and this is within the context of mining 3.9 Mt (Seddon, pers. com., 2005). As indicated previously, the final TSF design will be produced upon completion of the site geotechnical assessment, the final mine schedule and the final metallurgical process flowsheet.

The TSF is designed to retain variable volumes of water in the decant pond, up to a maximum 125,000 m<sup>3</sup> in very wet periods. The actual retained volume will depend on recycle requirements for the process plant and, in extreme events, overflow will occur via a spillway along the eastern section of the TSF embankment.

#### 4.10.3 Tailing Management

A number of factors suggest that acidification of tailing during operations is not likely to be problematic:

- Only the black shale tailing has been classified as PAF (see Section 4.9.1) and this will be deposited first into the TSF, with the NAF supergene tailing following.
- Under oxidising conditions, acidification of the PAF black shale would occur after a lag of several months.
- The expected rate of rise of tailing within the TSF means that no single surface is likely to be exposed for any significant period of time during operations.

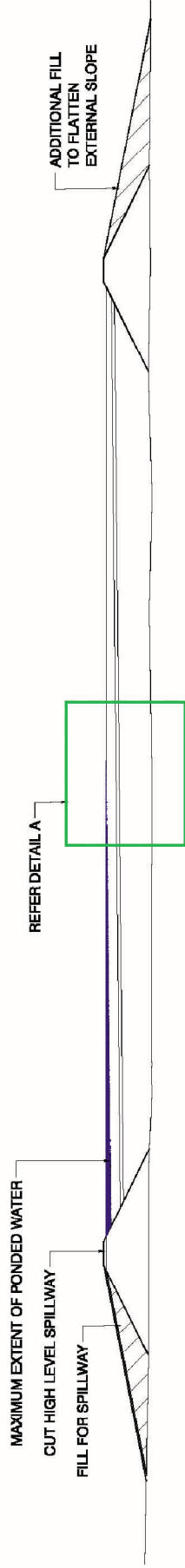
No specific management measures in relation to the potential formation of acid drainage from the tailing are therefore proposed during operations, other than regular monitoring of the tailing and the TSF to confirm these predictions. For TSF closure, a 'store and release' type of cover is proposed to minimise infiltration (Figure 4.12); further detail on the final TSF landform is provided in Section 9.10.

Definitive seepage rates from the TSF have not yet been calculated. However, given the proposed TSF design provisions and the preliminary water balance that indicates a minimum area decant pond, seepage from the storage is expected to be low. Using a number of simplifying assumptions (e.g., significant seepage occurs only from a 5 ha decant pond, in situ tailing has a permeability of  $1 \times 10^{-8}$  m/s, and the foundation clay layer has a permeability of  $1 \times 10^{-9}$  m/s), seepage through the TSF base for the 'mature' storage is likely to be in the order of 20 to 30 m<sup>3</sup>/d (i.e., 0.3 L/s). Higher rates may apply during start-up. On closure, indicative seepage rates are expected to range from 0.25 L/s in the wet season to zero in the dry season.

During operations, 'shallow' seepage through the embankment will be collected in a toe drain and recycled. 'Deep' seepage, i.e., that through the TSF base, will be either detected by monitoring bores, in which case it will be extracted and returned to the TSF and/or process plant, or captured by the groundwater drawdown cone resulting from the pit.

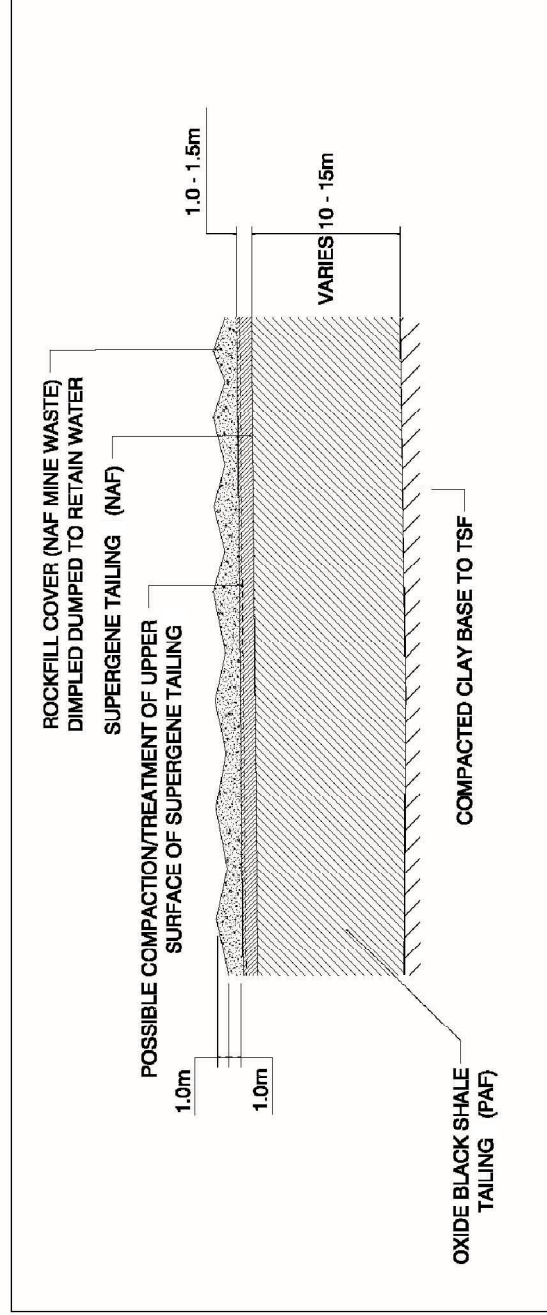
The tailing management strategy, design and operation will be based on consideration of relevant best practice measures such as:

- Detailed design based on the concepts presented herein, but taking into account the findings of detailed site investigations and revised mine schedule.
- Placement of the tailing pipeline within a bund to ensure that no tailing can escape to the surrounding environment in the event of a leak or spill.



**SCHMATIC CLOSURE PROVISIONS**

SCALE 1:2000 @ A3



**DETAIL A**

SCALE 1:500 @ A3

Source: Appendix 8, Figure 2.



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Compass Resources NI

Browns Oxide Project

Schematic TSF closure arrangement

Figure No:

**4.12**

- Regular inspection of the pipeline and automatic monitoring of the pump pressure to detect line failure.
- Placement of a clayey lining on the internal face of the embankment and controlled tailing deposition.
- Maximum water re-use via collection in a decant pond and return to the process plant.
- Monitoring of:
  - Tailing and stored water levels/volumes, and water quality.
  - Installed instrumentation.
  - Seepage from the TSF during and after operations.
- Monitoring for the occurrence of significant dusting from the tailing beaches (and alteration of the tailing deposition regime if this is required).
- Annual surveillance audits.

#### 4.11 Other Waste Material

Anticipated waste production is listed in Table 4.13. This list is preliminary and will be refined once detailed engineering is completed (during which time national pollution inventory requirements will also be determined). All personnel will be instructed (and appropriately supervised) to ensure that they apply the waste management principles of reduce, reuse and recycle, and comply with the waste management plan (see Section 9.8.7)

**Table 4.13 Anticipated waste production**

Waste Materials	Approximate Quantities	Disposal Method
Scrap steel	10 t/a	Collection by steel recycling contractor
Wooden pallets	250 per annum	Majority returned to supplier for reuse, damaged/excess buried in onsite landfill
Diesel drums	10 per month	Collection by supplier
Domestic waste	1 skip per week	Disposal at on-site landfill
Waste oil and grease	1 load per month	Removed from site for recycling
Chemical and reagent containers	10 per month	Disposed of in accordance with relevant Australian Standard, if can't be reused.
Sewage effluent	2.9 ML/a	On-site sewage treatment

#### 4.12 Infrastructure and Transport

##### 4.12.1 Energy Supply

###### *Electricity*

The electricity demand for the project is estimated to be 7.5 MW, and use of an annual load factor of 0.85 shows that this equates to annual energy requirements of approximately 54,000,000 kWh. The project will generally operate on a seven days per

week, 24 hours per day basis, although the crushing circuit will only operate 12 hours per day. The main power requirements are the:

- Processing plant, including grinding, concentrator and electrowinning.
- Site office.
- Laboratory.
- Water supply/dewatering pumps/tailing return water.
- Site lighting.

Connection to the Northern Territory grid is the preferred option for electricity, where the grid is supplied by Power and Water Corporation and sourced from a gas-fired power station located at Channel Island. To access the grid, a new power line of about 23 km in length will be constructed. This will comprise single poles and a 22-kV power line and will connect to the existing Darwin–Katherine 132-kV line at the Manton Dam sub-station. The proposed route passes over Aboriginal freehold land and follows the alignment of an existing track and fence line (Figure 4.13), thereby minimising requirements for clearing and potential for disturbing sites of archaeological significance. The final route will be determined in consultation with the NLC and traditional owners. Other supply options that have been considered are discussed in Chapter 5.

During the construction phase and prior to the establishment of grid power, on-site electricity requirements will be minor and will be met by on-site diesel generators. It is estimated that the peak requirement will be 500 MV/a.

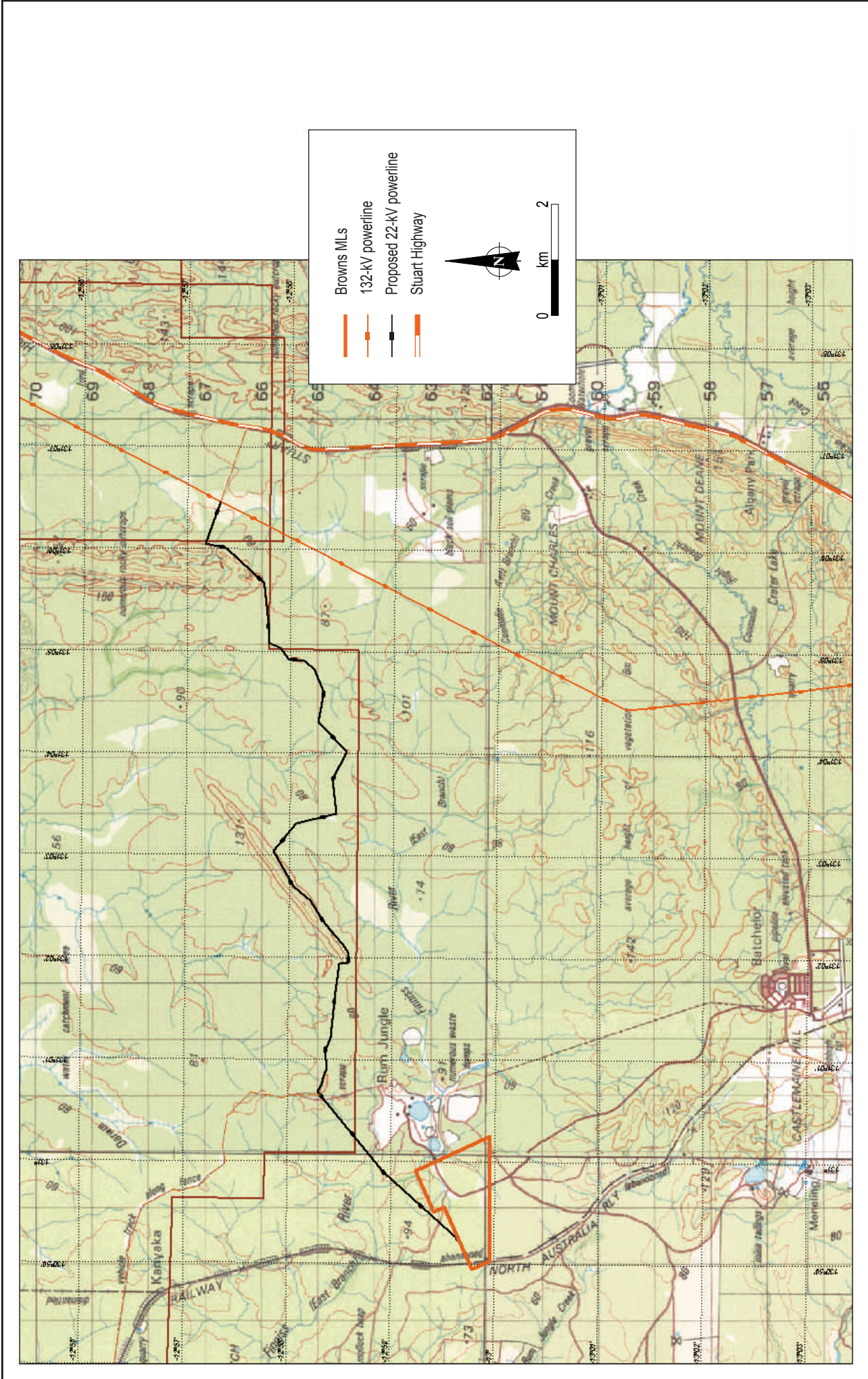
### **Fuel**

Most of the mining equipment and project vehicles will use diesel. Fuel requirements during construction and operations are:

- Construction—25 t per week (including requirements for electricity generators).
- Operations—50 t per week (including light vehicle useage).

Additional project-related weekly fuel useage will comprise:

- Product transport to Darwin:
  - 150 t/week: 3.5 x 60-t road trains.
- Transport of stores and reagents to the site:
  - Acid (400 t): 7 x 60-t semitrailers.
  - Reagents: 10 x 50-t truck.
  - Fuel: 1 x 50-t tanker.
  - Stores: 3 x 20-t truck.
  - Potable Water: 3 x 20-t truck (from Batchelor).
  - Explosives: 1 x 20-t truck.
- Employee transport:
  - 35-person bus: 14 trips (two per day).
  - Private cars: 210 trips to/from Darwin.
  - General: 70 trips to/from Batchelor.



Source: Capricorn COM035

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Compass Resources NL

Browns Oxide Project

Proposed power line route

Figure No: 4.13



- Other:
  - Light truck: 10 trips to/from Darwin.
  - Light vehicle: 35 trips to/from Darwin.

Diesel fuel will be transported to site by tanker and stored in a bunded fuel storage tank located in the mine contractor area (see Figure 4.1). The maximum holding volume for this fuel storage will be 65,000 L.

#### **4.12.2 Water Supply**

Water requirements for the mining and processing operations will be met from the following sources (see Section 4.14):

- Externally supplied drinking water.
- Fresh water from groundwater bores (see Figure 4.1).
- Recycled water from the TSF, site catchment and pit water.

#### **4.12.3 Sewage Treatment Plant**

Sewage from the site office, process plant building and mine contractor building will be piped to a package treatment plant, which will be designed and constructed to approved Northern Territory standards (see Section 4.14.6). The treatment plant will be located in the process plant area and treated effluent will be returned to the process water dam.

#### **4.12.4 Road Access and Transport**

##### ***Changes to Existing Road Infrastructure***

The existing Rum Jungle Road runs from Batchelor to the historic Rum Jungle site and is bituminised to the locked gate into that area. White Road is a graded, unsurfaced road that intersects the Rum Jungle Road near the proposed pit.

As part of the proposed project, the Rum Jungle Road will be used as the main site access road. Public access along this road will be restricted past the Litchfield Park turn-off. The White Road–Rum Jungle Road route to Batchelor will be severed, with alternative public access provided via Bevan and Lithgow roads. Both Bevan and Lithgow roads are gazetted as roads, although Lithgow Road has to date not been formed up. It is anticipated that these roads will be upgraded under the supervision of the local council to provide alternate access for residents. Compass is currently liaising with the Coomalie Community Government Council pursuant to the *Local Government (Road Opening and Closing) Regulations* in relation to the proposed road alterations (as shown in Figure 4.14).

##### ***Site Access***

Vehicular access to the site will be via the Rum Jungle Road. The main transport route for all heavy goods and services required at the minesite will be from Darwin via the Stuart Highway and Batchelor Road to Batchelor and then via the Rum Jungle Road. Product transport will be via the same route, only in the opposite direction.

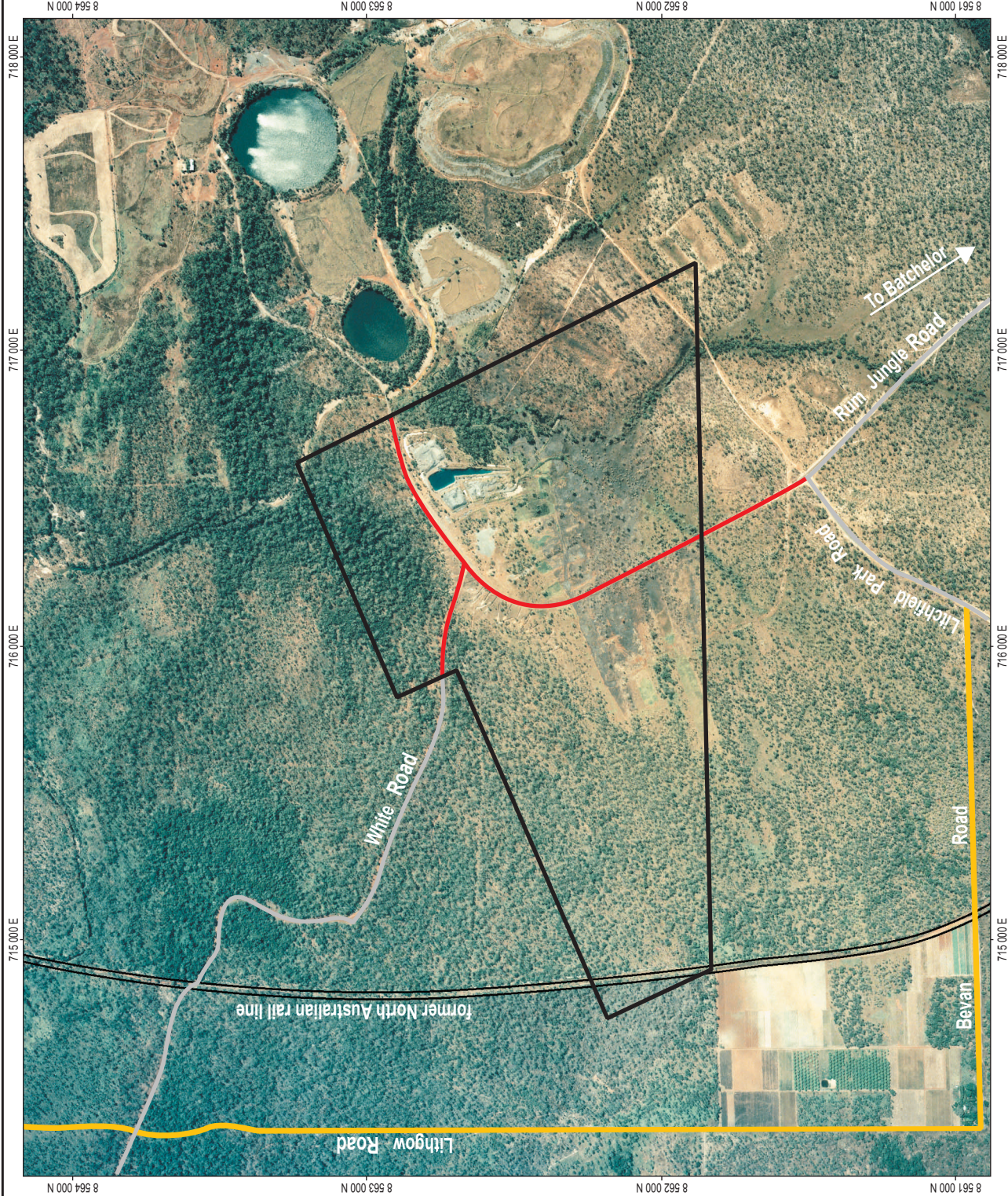


Figure No: <b>4.14</b>	
<b>Changes to existing road infrastructure</b>	
Compass Resources NL	Browns Oxide Project
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The project is a continuous operation and so freight and product dispatch will not be restricted to daylight hours. Shift changes will occur at 6:00 am/6:00 pm for the plant workers and 7:00 am/5:30 pm for mine/office employees. Most personnel are expected to access the site via private vehicles (and car pooling will be encouraged). Consideration will be given to bussing employees from Darwin/Batchelor if demand is sufficient.

Expected transport volumes for both the construction and operation phases are shown in Table 4.14. Loads will be properly secured and there will be compliance with appropriate road vehicle axis limits [C].

**Table 4.14 Estimated transport volumes to and from site**

Description	Vehicle Type	Trips Per Month
<b>Construction phase</b>		
Construction materials	Single trailer	30 (for 5 month period)
Construction workforce	Bus Light vehicles	60 (for 5 month period) 850 (for 5 month period)
<b>Operation phase</b>		
Consumables and materials	Single trailer	Four
Bulk liquid reagents	Tanker (3 x 22-kL load)	33
Employee transit	Light vehicles	1,300
Copper, cobalt and nickel product	Road train (60-t load)	100

#### **Haul and Site Roads**

Proposed haul and site roads (see Figure 4.1) will be constructed and subsequently graded and watered as required to allow efficient mining operations. The site access road and car park will be bitumenised.

#### **4.12.5 Ancillary Infrastructure**

The office for the operations workforce is located to the west of the processing plant next to the main car park. A separate office and workshop area adjacent to the run of mine (ROM) pad is provided for the mining contractor. A security gate office will be located at the main entrance.

The process plant building contains a laboratory, stores room, concentrator office and emergency services/first aid room. Core storage will continue to be off site at Compass' core shed in Batchelor.

#### **4.12.6 Communications**

##### **Telephone**

Multi-line telephone systems will be installed to service the site office, processing plant and mine contractor area. The phone will be linked to the national phone network and will also provide service for fax communications.

**Intranet and Internet**

Intranet and internet ports will be provided for the site office, processing plant area and mine contractor office. Internet access will be broadband.

**Site Radio**

Local minesite communication between vehicles, contractors and management and similar will be via VHF band radio systems.

**4.13 Plant and Machinery Requirements**

Plant and machinery (Table 4.15) will be sourced locally where possible. It is expected that much of the earthmoving equipment acquired for the construction phase will also be utilised for mine operations.

A single 60-t excavator and three 50-t off-highway dump trucks will form the main mining fleet. These will be supported by a bulldozer, grader, water cart, blast hole drill, grade control drill and small ancillary items such as pit pumps and light vehicles.

**Table 4.15 Plant and machinery requirements**

<b>Equipment</b>	<b>Quantity</b>	<b>Primary Functions</b>
<b>Construction</b>		
Excavator (backhoe)	1	Site preparation.
30-t off-highway dump trucks	2	Site preparation.
Scrapers	2	Topsoil removal. Preparation of plant and TSF area.
Bulldozer	1	Clearing of stockpile areas and construction of sedimentation traps.
Compactor/roller	1	Site preparation.
Motor grader	1	Preparation of drains and bunds, servicing of access roads.
Water cart	1	Spraying water to control dust.
500 kVA genset	1	Power for construction activities.
Light vehicles	5	Access during construction.
<b>Operation</b>		
60-t hydraulic excavator	1	Mining and loading material onto dump trucks.
50-t off-highway dump trucks	3	Transporting mined materials to the ROM pad, ore stockpile and TSF (waste rock).
Bulldozer	1	Clearing and levelling of project areas.
Grader	1	Clearing and levelling of project areas.
Compactor/roller	1	TSF embankment compaction.
Water cart	1	Spraying water to control dust.
Blast hole drill	1	Drilling holes in ore for explosives.
Pit pumps	3	Pit dewatering.
Light vehicles	8	Access to pit and project facilities.

## 4.14 Water Management

The region has a tropical climate with pronounced wet and dry seasons (see Section 3.1) and longer-term weather trends ranging from extreme cyclonic rainfall to drought. The water management system must accommodate both the normally variable rainfall and the occasionally more severe shortages and surpluses of water that may occur over the life of the operation. The following principles apply to the design and operation of the water management system:

- Minimise water consumption.
- Maximise water recycling.
- Establish a preferential hierarchy of uses based on water quality.
- Control discharges from operational areas of the lease.
- Control potential contaminants used on site.
- Minimise land disturbance.

The water use hierarchy adopted to meet process water requirements involves recycling process water and input from the following sources (listed in order of preference):

1. TSF decant.
2. Sewage effluent.
3. Sedimentation trap water (comprising mine water and site runoff).
4. Groundwater (e.g., from interception bores).

The various key components of the project's water balance (Figure 4.15) are discussed below.

### 4.14.1 Mine Water

Mine water will comprise incident rainfall over the pit area and groundwater inflows that are not intercepted by advance dewatering (via the interception bores). The mine water will be pumped from the pit to the main sedimentation trap.

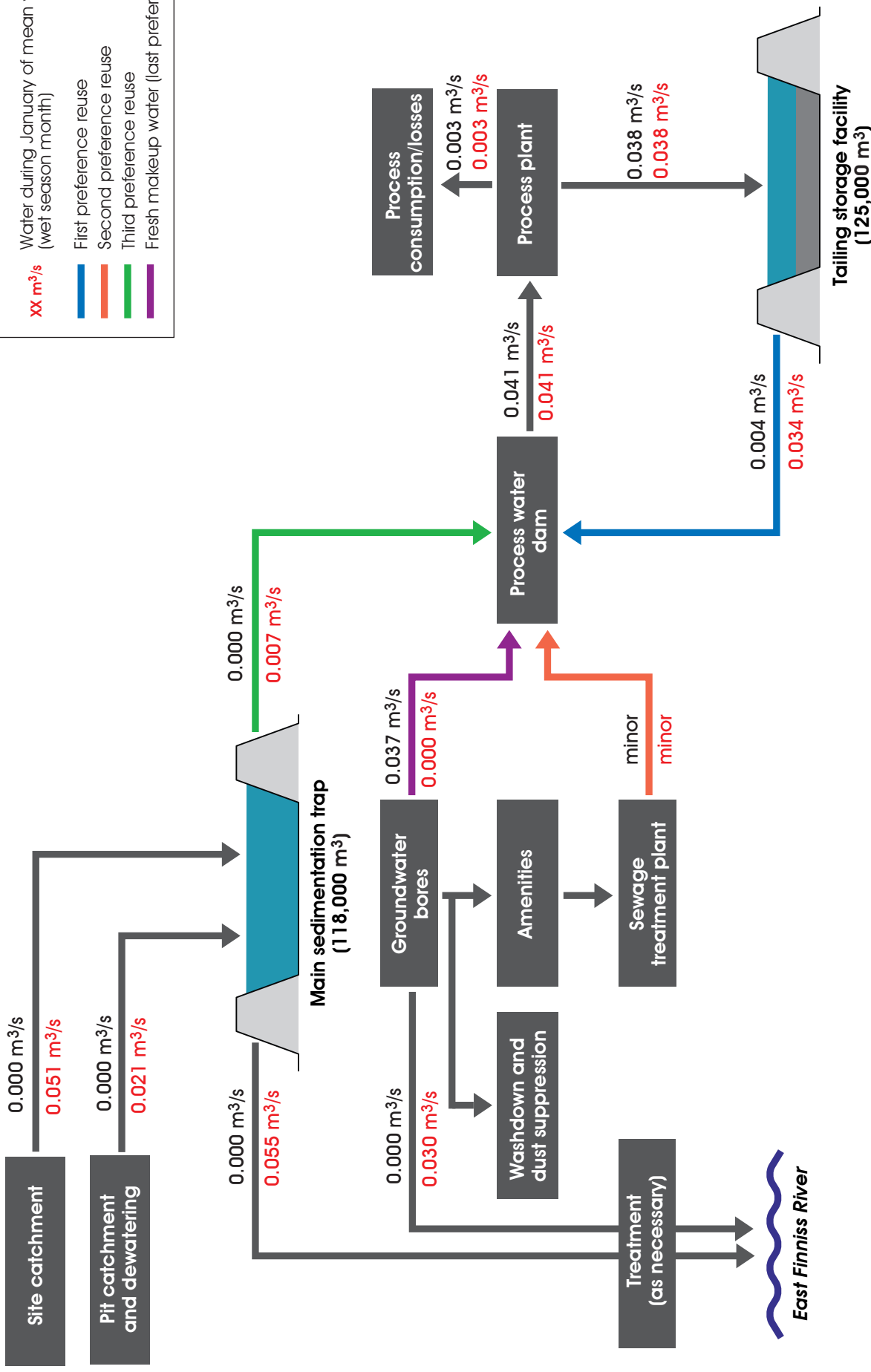
### 4.14.2 Site Runoff

Runoff from disturbed areas will be captured in collection drains and directed to one of three sedimentation traps, located in the northeast corner, the northwest corner and, for the main sedimentation trap (Table 4.16), in the centre of the lease area. The main sedimentation trap drains most of the site and, as indicated above, will also contain mine water pumped from the pit.

**Table 4.16 Main sedimentation trap design parameters**

Parameter	Description
Maximum storage	118,000 m <sup>3</sup>
Maximum water depth	3.5 m
Disturbed area (if full)	10.3 ha
Overflow	At southern end
Crest width	5 m
Slopes	1 vertical: 2 horizontal

**XX m<sup>3</sup>/s** Water during July of mean year (dry season month)  
**XX m<sup>3</sup>/s** Water during January of mean year (wet season month)  
 Blue line First preference reuse  
 Red line Second preference reuse  
 Green line Third preference reuse  
 Purple line Fresh makeup water (last preference)



Note: Water balance takes into account evaporation, rainfall and seepage.

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Compass Resources NL  
 Browns Oxide Project

Figure No:  
**4.15**

**Conceptual water balance**

Water from the main sedimentation trap will be recycled to the process water dam, while the other two sedimentation traps will be pumped out as required to the main sedimentation trap (see Figure 4.1). During the peak of the wet season, the sedimentation trap may contain more water than necessary for processing requirements. If the capacity of the sedimentation trap is exceeded, water will be discharged to the East Finniss River. Water quality within the sedimentation trap will be monitored regularly and any discharge to the East Finniss River will be treated as necessary to ensure conformance with the water discharge licence (see Section 4.14.6).

Treatment system specifications will be developed during detailed design. The most probable treatment technology for solids removal would involve addition of a suitable flocculant via a mixing box prior to passage to an engineered settlement pond. Should further treatment be required to reduce metal concentrations, water would be pumped to a treatment plant located at the process plant. Treatment would involve lime addition to increase pH and precipitate metals, either using the neutralisation facilities required for metallurgical processing or a parallel circuit constructed specifically for discharge water.

Runoff from undisturbed areas will be prevented from running on to areas of disturbance by the collection drain bund and allowed to drain naturally.

#### **4.14.3 Interception Bores**

Three interception bores will intercept groundwater before it seeps into the pit, thereby providing raw water for the process plant. The bores will also supply fresh water for amenities (including, kitchen areas, toilets and safety showers), vehicle wash down and dust suppression. The interception bores will be located in the dolomite beyond the pit perimeter (see Figure 4.1), as this is where the transmissivity is expected to be the greatest. Additional interception bores will be added around the pit perimeter if required. Extracted groundwater in excess of plant requirements will be discharged to the East Finniss River. Should groundwater be contaminated due to legacies from the Rum Jungle Mine (see Section 7.8.4), management strategies may involve treatment prior to discharge using the liming facilities located at the process plant (see Section 4.14.2), or other options as described in Section 7.8.4.

#### **4.14.4 Process Water and TSF Decant**

Within the process plant, as much water as possible is recovered and, together with TSF decant, returned to the process circuit via the process water dam (which will have a compacted clayey soil base). Rainwater in the process plant area and any other water (e.g., washdown water) is collected and returned to the process water dam. The TSF is designed to retain sufficient volume (up to 125,000 m<sup>3</sup>) for retention of runoff from major rainfall events (see Section 4.10.2). In extreme rainfall events, where the TSF capacity is exceeded, excess water will be released via the emergency high-level spillway and will drain to the main sedimentation trap (see Section 4.14.2). Under these conditions, the sedimentation trap may also be at capacity, hence excess water will discharge to the East Finniss River.

Seepage will either be collected in a toe drain and recycled, intercepted by bores and recycled, or captured by the groundwater drawdown around the pit (see Section 4.10.3).

#### 4.14.5 Wastewater

Wastewater will be generated principally from ablutions and will be collected and treated in a package sewage treatment plant. After treatment, the water quality will be in accordance with the levels shown in Table 4.17. Treated effluent will be recycled to the process water dam.

**Table 4.17 Sewage treatment plant water quality**

Parameter	Concentrations
Biochemical oxygen demand (BOD)	15 mg/L
Non-filterable residue (NFR)	20 mg/L
Total nitrogen	15 mg/L
Total phosphorous	3 mg/L
Oil and grease	10 mg/L
Ammonia – N	5 mg/L
Thermotolerant coliforms	200 colony forming units/100 mL
pH	6.5 to 8.5 (range)

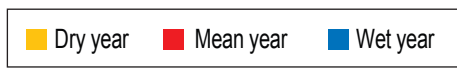
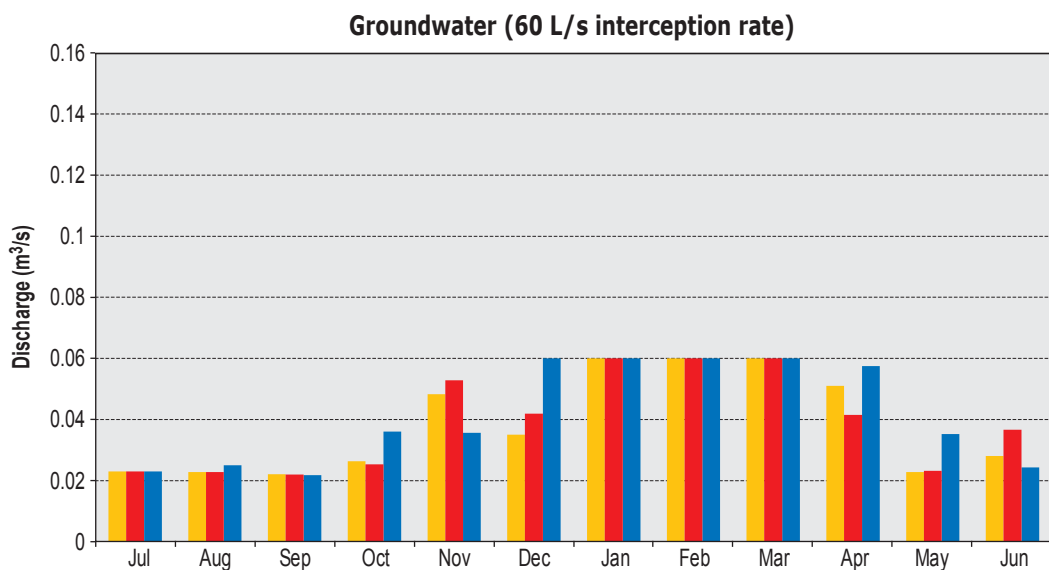
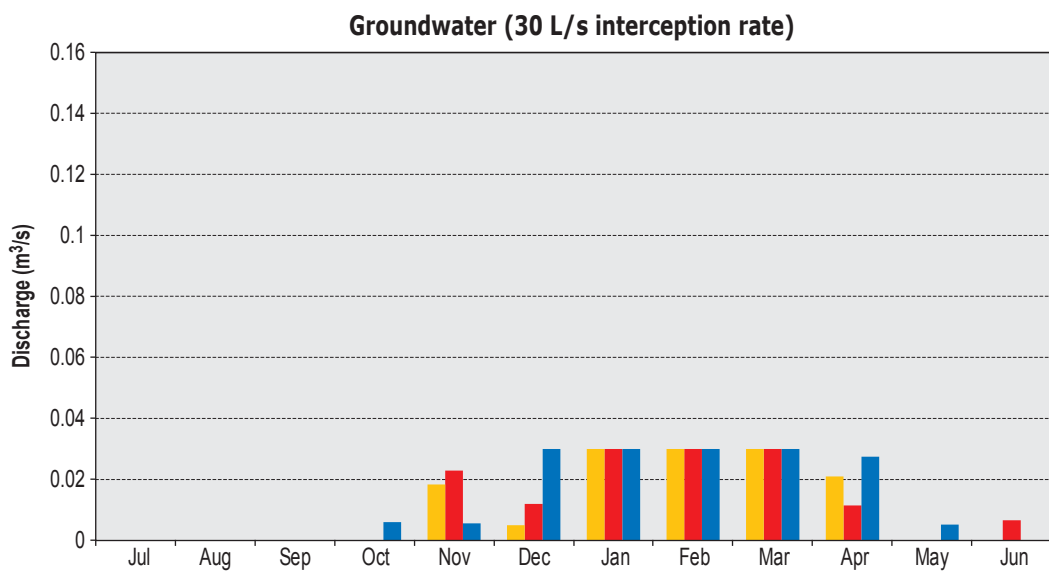
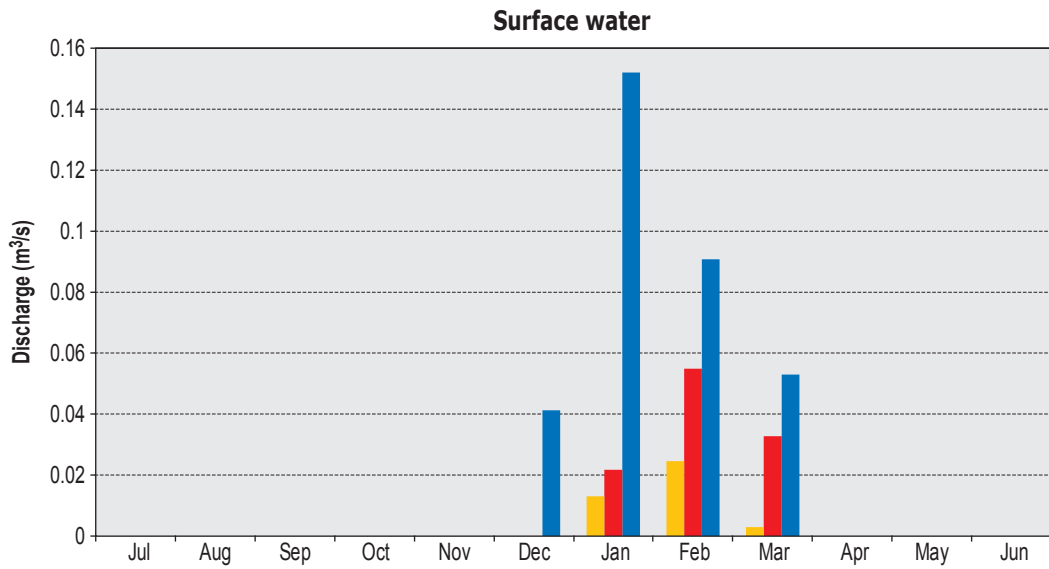
#### 4.14.6 Water Discharges

The overall objective for water management on site is for the operation to be self-sustaining in terms of water use requirements, i.e., process and mining requirements will be met through recycling both process and mine water, with make-up water being obtained from the main sedimentation trap and interception bores. A preliminary water balance has been calculated based on the climatic conditions described in Appendix 8 for the driest, mean and wettest years on record and assessment of the various streams described above. As described in Section 7.8.4, there is some uncertainty regarding the amount of groundwater likely to be produced from interception bores during mine dewatering. The water balance has therefore been prepared considering a range of groundwater yields, namely 30 L/s and 60 L/s.

Water will be discharged via pipeline(s) to the East Finniss River where the Rum Jungle Road crosses the river (see Section 7.8.1), upstream of existing hydrological station GS8150200.

#### ***Preliminary Water Balance***

Calculation of the preliminary water balance (which, for modelling purposes, ignores groundwater that will report to the pit) has been undertaken for interception bore pumping rates of 30 and 60 L/s, where these reflect the expected range of groundwater inflows (Appendix 3). These calculations show that project-related discharges from the main sedimentation trap (i.e., excluding groundwater that is intercepted via the interception bores) will occur only during the wet season months of December, January, February and March (Figure 4.16). For the 30 L/s scenario, excess groundwater from the interception bores would require discharge to the East Finniss River between the months of November and April (extending to October and June for wet and mean years,



respectively). The maximum rate of discharge would be 30 L/s (0.030 m<sup>3</sup>/s). For the scenario where advance dewatering yields 60 L/s, a minimum of 22 L/s (0.022 m<sup>3</sup>/s) is predicted to require discharge during the dry season, increasing to 60 L/s (0.060 m<sup>3</sup>/s) in wet months (see Figure 4.16). This is discussed in more detail in Section 7.8.4.

#### **4.15 Hazardous Materials Management**

Hazardous materials such as chemicals and hydrocarbons will be fenced and banded in accordance with the relevant Australian standards (as described in Section 9.8.7).

Explosives will be purchased on a shot-by-shot basis delivered as a 'down-the-hole' service. The explosives manufacturing, storage and transportation requirements will be the responsibility of the supplier. A small explosive and detonator magazine will be located in the southern part of the site (see Figure 4.1).

#### **4.16 Construction and Operating Standards**

The project will be constructed and operated in accordance with appropriate legislation, codes and standards as detailed in Chapter 2. Where relevant, consideration will also be given to addressing likely future changes in approaches to such projects, e.g., by incorporating features that reflect the carcinogenic, mutagenic and reprotoxic nature of cobalt and nickel.

##### **4.16.1 Management Structure**

The day-to-day operation of the site will be the responsibility of the General Manager Operations (GMO) (Figure 4.17). Reporting directly to the GMO will be a team of key personnel comprising the mine geologist, mine engineer, process plant manager, metallurgist, safety officer, administration manager and the environmental manager. The majority of the workforce will report to the mine engineer as part of the mining contractor team or will be the responsibility of the process plant manager.

##### **4.16.2 Site Inductions**

All personnel and visitors will be required to undergo appropriate inductions (see Section 9.5.3 for details). Inductions will cover health, safety and environment (including cultural heritage and archaeological matters) aspects of the project.

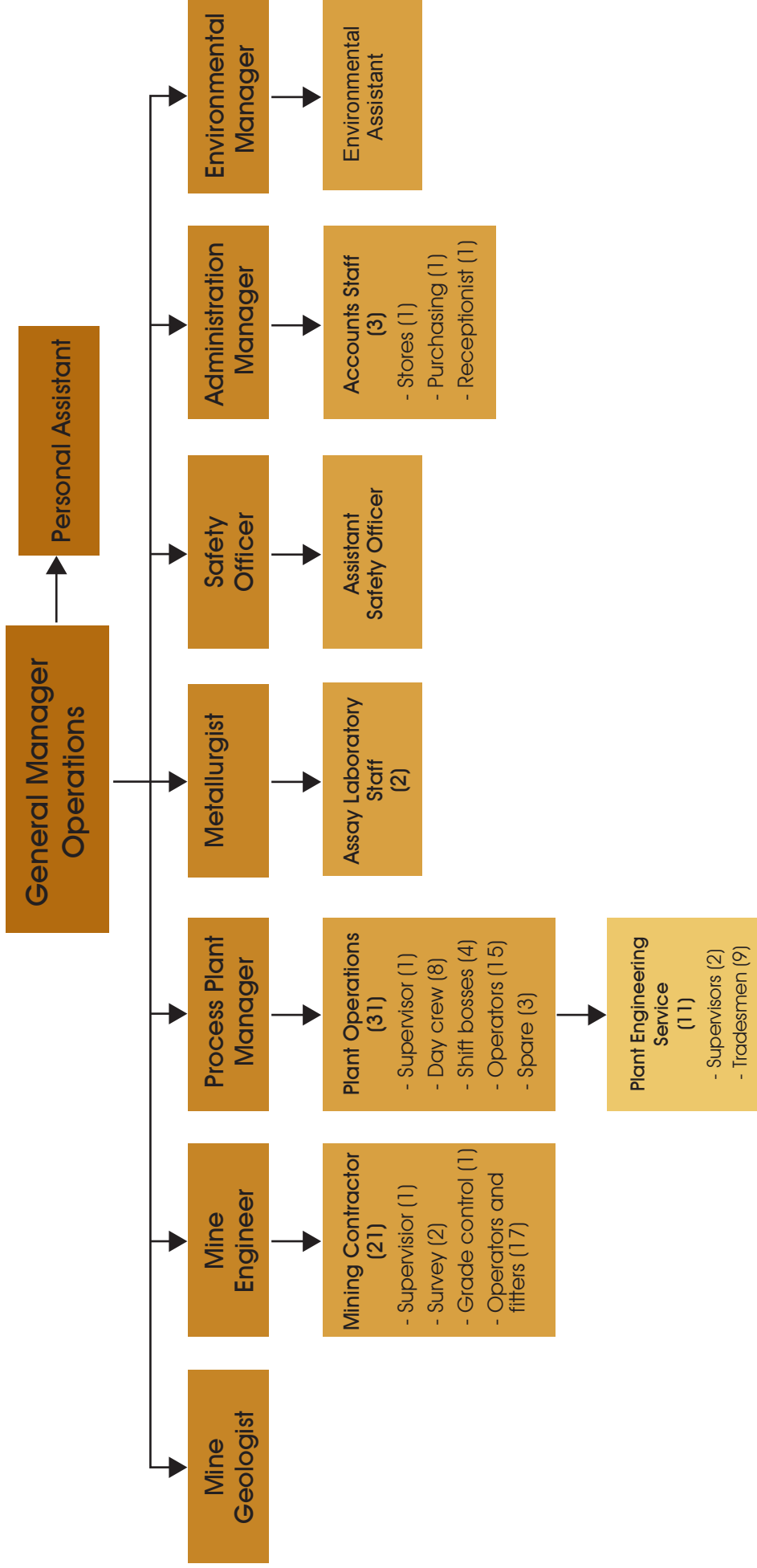
##### **4.16.3 Occupational Health and Safety**

Operations will be carried out in accordance with applicable national and Northern Territory OH&S laws and regulations. This will ensure that correct workplace practices are followed, thereby providing a satisfactory level of workplace safety. Safety measures will include:

- The employment of only suitably trained personnel.
- Ensuring workers are drug free.

# Browns Organisational Chart

Total workforce: 79-site-based employees (excluding exploration)



	Job No: 836	Compass Resources NL	Management structure	Figure No: 4.17
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- The use of safety clothing, footwear and headgear, where required.
- The use of hearing and eye protection equipment, where required.
- Development, implementation and enforcement of workplace safety and emergency response procedures.
- Provision of adequate and appropriately located first-aid equipment.
- Development and implementation of procedures which ensure that all personnel are warned and confirmed clear of blast areas prior to blasting.

#### **4.16.4 Site Security**

The project area will be fenced and access to the site will be controlled by the security gate.

### **4.17 Workforce and Accommodation**

#### **4.17.1 Construction Workforce**

Up to 100 people will be employed during the 9-month construction phase. The construction workforce will operate 12 hours per day, six days per week on a rotational basis. The majority of the construction workforce will be employed as contractors and is likely to be sourced primarily from Darwin.

The construction workforce will be accommodated in existing facilities in the Batchelor–Adelaide River–Darwin region. Temporary accommodation facilities in Batchelor are currently limited; however, local accommodation options may be expanded by local businesses. A significant proportion of the workforce is expected to commute from the Darwin area.

#### **4.17.2 Operations Workforce**

The operations workforce is expected to comprise some 59 people including project management and processing plant staff, with another 20 people being employed by the mining contractor. Compass intends to source locally where possible, although specialist mining positions and senior management roles will require previous mining experience and may need to be sourced from a wider area. It is expected that the majority of the operations workforce will come from the Batchelor–Adelaide River–Darwin region. It is anticipated that Aboriginal people will comprise a significant portion of the workforce.

The operations workforce will provide its own accommodation in the Batchelor–Adelaide River–Darwin region.

### **4.18 Rehabilitation and Mine Closure**

Section 9.10 contains the strategic rehabilitation and mine closure plan. This strategic plan will be refined and costed after PER approval has been obtained and the detailed

design phase of the project completed. The revised plan will then be included as part of the project's MMP which is submitted to DPIFM for approval prior to commencement of construction.

# 5. Alternatives

## 5.1 Introduction

Resource development projects are subject to a number of constraints:

- Physically, by the location of the orebody and the climatic, topographic and geotechnical constraints imposed by the project setting.
- Environmentally, by the environmental sensitivities of the project setting.
- Socially, by the expectations and concerns of stakeholders.
- Economically, by the need to obtain the requisite funding to establish the mining operation and subsequently to extract and process the ore profitably.

In particular, a fundamental constraint of all mineral resource developments is that they can only occur where a commercial deposit is found. The alternative to the development of the Browns Oxide Project is no development.

Notwithstanding these constraints, the project development concept contained in this PER represents the current optimisation of engineering, economic, environmental and social considerations. Further optimisation will occur during detailed design.

## 5.2 Not Proceeding with the Project

The direct consequences of not proceeding with the project can be summarised as follows:

- The social and economic benefits described in Section 7.10, e.g., wages, royalties and taxes, would be lost at all levels, i.e., local, regional, Northern Territory and national.
- In particular, up to 79 full-time jobs during operations would not be available.
- The land, water and air impacts (and associated physical, biological and social impacts) associated with the development of a well-managed small open pit mine located in a rural setting would not occur.

## 5.3 Alternatives Considered in Project Planning

### 5.3.1 Mining

In the 2001 Browns Polymetallic Project Notice of Intent (NSR, 2001), Compass presented two possible development options: the 'small development option' and the 'large development option'. The small development option required extracting oxide and sulfide ores from the Browns deposit using an open pit excavated by conventional truck-and-shovel methods and later progressing to underground mining. The large

development option consisted of mining the Browns and Browns East deposits using a larger pit and underground mine than envisaged for the small development option. The larger pit would consume the Whites and Intermediate open pits of the historic Rum Jungle Mine.

The capital cost of the sulfide project was determined to be beyond the financial resources of Compass in its own right. However, the smaller and metallurgically simpler Browns Oxide Project (as detailed in Chapter 4 of this PER) is considered viable for Compass.

An underground mine is not required to access the oxide ore (nor is it feasible for such a shallow deposit). Compass considered a number of different open pit designs and extraction scenarios prior to settling on that described in Chapter 4.

Various mining schedules were considered prior to settling on the schedule discussed in sections 4.7 and 4.9. The preferred schedule represents an economic optimisation of ore production while still allowing for selective placement of PAF waste rock within the TSF embankment. Further refinement of the mine schedule and TSF design will allow closer links between these two aspects of the project, thereby minimising possible adverse impacts associated with the increased proportion of PAF material over the life of the mine.

### 5.3.2 Ore Processing

Ore processing will be undertaken on site using a hydrometallurgical circuit (see Section 4.8).

As with virtually all mining operations, project economics dictate that ore processing occurs as close to the mine as possible. The only economically viable alternative might involve transporting the ore via truck, rail or pipeline to a suitable processing plant that is already operational (i.e., is servicing other mine(s) in the area) and located relatively close to the mine. Such an alternative does not exist.

The production of copper sulfate as an alternative to copper cathode has been considered. This would involve production of some 40,000 t/a of copper sulfate, well in excess of the Australian useage of around 30,000 t/a. Marketing of copper cathode is simple, whereas marketing into a diverse copper sulfate market carries considerable market risk. The premium price of copper sulfate and slightly lower costs were not considered attractive enough to outweigh this market risk. Copper sulfate production could be attractive for a smaller scale project.

A variety of options for the production of cobalt and nickel remain. A chemical product will be produced, and this may be either a mixed cobalt-nickel hydroxide, a mixed cobalt-nickel sulfide, or separate cobalt and nickel hydroxides or sulfides. A final decision will be made during final project design, based largely on market acceptance of the product specifications. In all cases, the product will be bagged and placed in containers for shipment and transportation.

### 5.3.3 Environmental Management (Tailing and Waste Rock)

A major focus of environmental management at the site will be on tailing and waste rock, and the alternatives considered during project planning are discussed in this section.

Tailing will be stored in a TSF formed by embankments constructed from suitable waste rock (see Section 4.9), with PAF material being encapsulated within the embankments. One alternative would be to place waste rock and/or tailing in the existing Whites and Intermediate pits. These pits (particularly Whites pit) periodically discharge metal-rich, acidic water to the East Finniss River and existing knowledge does not allow the accurate prediction of the impact on pit water quality from the addition of Browns waste rock or tailing to these pits. In addition, the issue of potential liability is not likely to be easily resolved, given the current and ongoing contamination of the East Finniss River from the Rum Jungle pits. Therefore, this has been discounted as an option.

Another option that has been considered is placing the waste rock and/or tailing back in the Browns Oxide pit. In addition to sterilising the underlying resource, the proposed mining method is not conducive to the progressive back-filling of the pit, while the variable groundwater table could exacerbate the potential for acid formation from PAF material and/or provide a transport pathway for contaminants from the mine waste into the surrounding groundwater. This option has therefore been discounted.

Production of a centrally thickened tailing discharge was not considered viable due to the areal requirements of this system and the limited space available on the granted MLs.

### 5.3.4 Electricity

Three potential sources of electrical power have been evaluated:

- Electricity from the Northern Territory grid, as supplied by PAWC (see Section 4.12.1).
- On-site diesel generation.
- On-site gas generation.

On-site generation of electricity using diesel is likely to be the most expensive option (and will also incur the greatest economic risk due to possible future increases in oil prices), while there are potential supply issues with on-site electricity generation using gas. Therefore, the preferred option is for the project to source electricity from PAWC.

### 5.3.5 Transport Route

Copper cathode and cobalt and nickel product will be transported to Darwin along the Stuart Highway by road train (see Section 4.12.4). Two alternatives for accessing the Stuart Highway involve:

- Using existing roads via Batchelor.
- Using a mine access road constructed between the mine and the Stuart Highway north of the intersection of the Batchelor Road with the highway.

It was decided that the existing roads will be used for the Browns Oxide Project, thereby minimising the project's footprint and adverse impacts that might result from the construction of a dedicated mine access road.

### **5.3.6 Infrastructure Corridor**

The small scale of the project makes it impractical to contemplate the building of new transport routes or a dedicated gas pipeline to the site. The proposed power line to the site is a 22-kV line connecting to the Manton substation. Numerous alternative routes for power line access to the project site were considered, and the proposed route was selected because it is largely along an existing track (requiring minimal clearing) and is shorter than the alternatives (with less power losses and a lower capital cost), thereby removing the need for an 'infrastructure corridor'. The final route (expected to be based on the proposed route) will be determined in consultation with the NLC and traditional owners.

## 6. Stakeholder Consultation

An effective, ongoing consultation program involving Compass, government, local residents and communities, indigenous groups and other stakeholders is essential to the development of the project.

Consultation has commenced with key stakeholders such as Northern Territory regulatory authorities, Coomalie Council and local indigenous groups (under the auspices of the NLC). This consultation will continue during project planning, construction and operations, and will extend through mine closure.

### 6.1 Goals

The goal of Compass' stakeholder consultation program is to provide a framework that will ensure that stakeholders are provided with accurate information about, and involved to an appropriate degree in, the development of the project.

The specific aims of ongoing consultation with stakeholders are to:

- Ensure that the stakeholders are well informed about the project.
- Enable interested parties to assess economic and commercial opportunities that arise as a result of the project development.
- Reduce the potential for misunderstanding and subsequent stakeholders' disaffection due to real or perceived exclusion from the impact assessment and permitting process.
- Identify areas of concern for stakeholders, and allow them to provide input to the environmental assessment process.
- Ensure that the necessary regulatory requirements are met.
- Generate a framework for ongoing consultation through project development, implementation and closure.

### 6.2 Stakeholders

Stakeholders associated with the project can be grouped into broad categories that reflect their interest in the project. Table 6.1 provides a summary of the key external stakeholders.

**Table 6.1 Project stakeholders**

<b>Interest Group</b>	<b>Stakeholder</b>
Northern Territory Government	Department of Primary Industry, Fisheries and Mines (DPIFM) Department of Natural Resources, Environment and the Arts (DNRETA) - Office of Environment and Heritage (OEH) DNRETA - Heritage Advisory Council (HAC) Minister for Primary Industry, Fisheries and Mines Minister for Natural Resources, Environment and Heritage Department of Infrastructure and Planning (DIP) Northern Territory Tourist Commission (NTTC) Parks and Wildlife Commission of the Northern Territory (PWCNT) Power and Water Corporation (PAWC)
Commonwealth Government	Department of the Environment and Heritage (DEH) Local Federal Member of Parliament Minister for Industry, Science and Tourism
Indigenous groups	Aboriginal Areas Protection Authority (AAPA) Northern Land Council (NLC) Traditional owners
Local community	Coomalie Community Government Council Coomalie Landcare Group Batchelor Institute of Indigenous Tertiary Education Local businesses Landholders and local community groups
Non-government organisations	Environment Centre of the Northern Territory
Media	Local, regional, Northern Territory and national
Industry	The Australasian Institute of Mining and Metallurgy (AusIMM) Darwin Port Corporation Northern Territory Mineral Council (NTMC) AusIndustry Minerals Council of Australia (MCA) Northern Territory Industry Capability Network (NTICN)

Other stakeholders include Compass (and its Board, employees, shareholders and advisors), consultants and suppliers to the project, potential purchasers, and parties who have been involved in assessment of the Rum Jungle site and its impacts (e.g., ANSTO).

### **6.3 Consultation Activities**

Compass has consulted with a range of organisations and individuals regarding the project. A representative of Compass maintains regular contact with members of the Batchelor community, and further comments from the community will be sought as part of the PER approval process. Compass also maintains a notice board at the Batchelor General Store. Copies of Compass announcements to the ASX are posted on the board along with other material about the project.

Table 6.2 outlines the consultation activities to date with key stakeholder groups, and the matters discussed.

**Table 6.2 Stakeholder consultation to date**

Stakeholder	Date	Matters Discussed
Coomalie Community Government Council	February 2005	<ul style="list-style-type: none"> <li>Project briefing.</li> </ul>
	April 2005	<ul style="list-style-type: none"> <li>Project update.</li> <li>Feedback from council planning questionnaire.</li> </ul>
	July 2005	<ul style="list-style-type: none"> <li>Level of information the council is seeking.</li> <li>Regular provision of project information by Compass for monthly local newsletter.</li> <li>Timing of community consultation meeting.</li> <li>Changes in local council arrangements.</li> <li>Mining tenements likely to be rateable by councils within 18 months.</li> <li>Article in 'Stop Press'.</li> </ul>
	August 2005	<ul style="list-style-type: none"> <li>Letter requesting road closure.</li> <li>Article in 'Stop Press'.</li> </ul>
	September 2005	<ul style="list-style-type: none"> <li>Article in 'Stop Press'.</li> </ul>
Department of Primary Industry, Fisheries and Mines	November 2004	<ul style="list-style-type: none"> <li>Draft Notice of Intent.</li> <li>Update of proposed project.</li> </ul>
	December 2004	<ul style="list-style-type: none"> <li>Proposed project activities.</li> </ul>
	February 2005	<ul style="list-style-type: none"> <li>Project briefing.</li> </ul>
	April 2005	<ul style="list-style-type: none"> <li>Project update.</li> </ul>
	June 2005	<ul style="list-style-type: none"> <li>Project update.</li> </ul>
	July 2005	<ul style="list-style-type: none"> <li>Department briefing.</li> <li>Additional exploration in the region.</li> <li>Questions from DPIFM staff members.</li> <li>Timetable for development.</li> <li>Need for infrastructure corridor for the project, and the required application process.</li> </ul>
	August 2005	<ul style="list-style-type: none"> <li>Project update.</li> </ul>
	September 2005	<ul style="list-style-type: none"> <li>Draft PER.</li> </ul>
Federal Member for Solomon, David Tollner	December 2004	<ul style="list-style-type: none"> <li>Proposed project activities.</li> </ul>
	July 2005	<ul style="list-style-type: none"> <li>Project update.</li> <li>Power supply to Northern Territory.</li> <li>Federal support for the project.</li> </ul>
Heritage Advisory Council	June 2005	<ul style="list-style-type: none"> <li>Site visit and project briefing.</li> </ul>
Local community	Ongoing	<ul style="list-style-type: none"> <li>Project related issues and concerns.</li> </ul>
Local residents/landholders	February 2005	<ul style="list-style-type: none"> <li>Project briefing.</li> </ul>
	April 2005	<ul style="list-style-type: none"> <li>Project update.</li> </ul>
	August 2005	<ul style="list-style-type: none"> <li>Announced planned Batchelor public meeting.</li> </ul>
Minister for Primary Industry and Fisheries	November 2004	<ul style="list-style-type: none"> <li>Update of proposed project.</li> </ul>
	February 2005	<ul style="list-style-type: none"> <li>Project briefing.</li> </ul>
	June 2005	<ul style="list-style-type: none"> <li>Project update.</li> </ul>

**Table 6.2 Stakeholder consultation to date (cont'd)**

<b>Stakeholder</b>	<b>Date</b>	<b>Matters Discussed</b>
Minister for Primary Industry and Fisheries (continued)	July 2005	<ul style="list-style-type: none"> <li>• Need for infrastructure corridor for the project and application process for this.</li> <li>• Potential sources of power for the project.</li> <li>• Possible 'special project' status for the project.</li> </ul>
Northern Territory Mineral Council	November 2004	• Update of proposed project.
	February 2005	• Project briefing.
	April 2005	• Project update.
	July 2005	• Project update.
	August 2005	• Project update.
Northern Land Council	December 2004	• Proposed project activities.
	February 2005	<ul style="list-style-type: none"> <li>• Project briefing.</li> <li>• Planning of proposed traditional owner meetings for 2005.</li> </ul>
	April 2005	• Project update.
	June 2005	• Project update.
	July 2005	<ul style="list-style-type: none"> <li>• Options for the power line route.</li> <li>• Preference by NLC of provision of one route for them to consider rather than two.</li> </ul>
	August 2005	<ul style="list-style-type: none"> <li>• Proposed power line route.</li> <li>• Project update.</li> </ul>
	September 2005	• Draft PER.
Office of Environment and Heritage	December 2004	• Proposed project activities.
	February 2005	• Project briefing.
	April 2005	• Project update.
	June 2005	• Project update.
	July 2005	<ul style="list-style-type: none"> <li>• Groundwater.</li> <li>• Acid rock drainage.</li> <li>• Construction and composition of the TSF.</li> <li>• Archaeological survey requirements.</li> </ul>
	August 2005	<ul style="list-style-type: none"> <li>• Update on submission of PER.</li> <li>• Acid rock drainage considerations.</li> </ul>
	September 2005	• Draft PER.
Power and Water Corporation	April 2005 and July 2005	<ul style="list-style-type: none"> <li>• Alternatives for power supply to the project site.</li> <li>• Alignment of power supply route.</li> <li>• Price estimates for power supply to the project site.</li> </ul>
AusIMM (Darwin)	November 2004	• Technical project presentation.
Media (ABC)	November 2004	• Interview on the 'Country Hour' program.
	August 2005	• Browns Project news slot (17 August)
Rum Jungle Resort and Hotel	July 2005	<ul style="list-style-type: none"> <li>• Proposed project activities.</li> <li>• Potential accommodation of construction workforce.</li> <li>• Requirements for planning approvals to extend accommodation facilities.</li> </ul>

## **6.4 Consultation Outcomes**

### **6.4.1 Consultation to Date**

The broad outcomes of the stakeholder consultation activities associated with the current project to date have included:

- Increased government and community awareness and understanding of the project.
- Involvement of regulatory authorities in shaping project activities.
- Identification of areas of concern to residents and other stakeholders.
- Identification of potential business/employment opportunities for local and indigenous stakeholders.
- Opportunities for members of the local community to voice opinions and concerns.

More specifically, matters raised during stakeholder consultation include:

- Potential impacts associated with vegetation clearing for the project.
- Potential water quality impacts, including groundwater.
- Potential interaction with the Rum Jungle Mine site.
- Opportunities for alternative uses of water that may be discharged from site.
- Alternative road access, in particular the Lithgow Road and Bevan Road route.
- The need for a detailed archaeological and heritage assessment of the project area to establish Aboriginal and other heritage in the project area.
- The desire for a community meeting in Batchelor to discuss project activities and the best timing for this to maximise community attendance.
- The opportunity for Compass to provide regular information about the project for inclusion in the monthly local newsletter.
- NLC questions regarding power line routes and access across Aboriginal land, as well as employment, business and training opportunities.
- The potential opportunity for accommodation of the construction workforce in local facilities.

### **6.4.2 Consultation for the Browns Polymetallic Project**

Consultation associated with the Browns Polymetallic (Sulfide) Project that was undertaken by Compass in 2001–2002 identified a range of council and community concerns, including:

- Potential access routes to the site.
- Size and duration of potential employment of local labour during the project.
- Poor mining practices associated with past mining projects in the region.

- Potential for uranium mining from Compass leases.
- Management of acid rock drainage during the project.
- Water management during the project, especially groundwater.
- Potential changes to Batchelor's non-industrial lifestyle due to the project.
- Need for regular contact with the community through the project.

These concerns are being considered and addressed within the context of the current project.

## **6.5 Ongoing Consultation**

### **6.5.1 General Consultation**

Consultation with stakeholders is ongoing, and will continue through the life of the project. Regular consultation with OEH, DIP, DPIFM and other regulatory authorities will continue through the approvals process, and the construction and operations phase of the project, to ensure due consideration of all project-related opportunities and concerns. Compass proposes regular meetings with these authorities, supplemented by site inspections and informal meetings or discussions as required.

Consultation with the broader community will increase during the PER approvals and assessment process. One particular focus will be consultation regarding the management of project-related traffic passing through Batchelor. The ongoing consultation program will involve both formal and informal mechanisms, where the environmental assessment process will provide formal mechanisms for consultation, and informal mechanisms may include:

- Project information bulletins or brochures.
- Information on the Compass web site.
- Direct access to the project manager.
- An information display.
- Presentations, meetings and liaison:
  - Presentations by project personnel to community and other groups.
  - Media releases.
  - Northern Territory Government briefings.
  - Liaison and site inspections with government agencies and regulators.
  - Interviews and articles in 'local' media.
  - Open days at the site during both construction and operations.
  - Stakeholder information sessions.

### **6.5.2 Indigenous Consultation**

A particular focus of the ongoing consultation program will be the involvement of indigenous people in the project, where this will build on Compass' normal process (since 1998) of communicating its activities and plans to the NLC and traditional

owners [C]. In February 2005, a meeting was held with the NLC (see Table 6.2) at which Compass requested early consultation with traditional owners<sup>1</sup> specifically about the project, and it was agreed that the NLC would establish a program of meetings with traditional owners. Compass understands that an initial meeting between the NLC and the traditional owners to discuss the Browns Oxide Project took place in October 2005, and Compass looks forward to discussing any issues raised with these parties.

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<sup>1</sup> Under current legislation and practice, consultation between Compass and the traditional owners is required to occur through the NLC.



# 7. Environmental and Social Impact Assessment

This chapter describes the material impacts of the project on the existing environment. Compass will endeavour to minimise the adverse effects and maximise the beneficial aspects of its operation wherever possible. This involves evaluating each impact to assess its significance, establish mitigative or ameliorative measures and present environmental and socio-economic safeguards.

The prediction and evaluation of the key impacts are based on a knowledge of the existing environments likely to be affected, the results of specific investigations, surveys and monitoring programs, identification of site-specific issues, experience gained from mining projects in comparable environmental settings, reviews of scientific literature and professional judgement.

Residual environmental impacts are those that remain after avoidance, management and mitigation measures have been applied. For some impacts, quantitative predictions can be made and subsequent monitoring need only be minimal to validate the predictions. For impacts where accurate predictions are not possible, based on currently available information, a correspondingly greater emphasis will be placed on monitoring, as described in Chapter 9.

## 7.1 Terrestrial Flora

A flora impact assessment for the Browns Oxide Project was undertaken by Judy Egan, Botanical Consultant, and is included as Appendix 5A. This assessment built on the previous flora assessment of the broader project area by Metcalfe in 2002 (Appendix 5B). This section summarises the findings of these assessments.

### 7.1.1 Background

The composition, structure and diversity of flora species in the project area is based on a desktop review of vegetation mapping and aerial photography, and field surveys undertaken in May 2002 and August 2005.

The 2002 survey sampled an area of 37.5 km<sup>2</sup> (3,750 ha) in and around the project area, while the 2005 survey focussed on the 1.75 km<sup>2</sup> (175 ha) project area and selected surrounding vegetation types.

Egan (Appendix 5A) mapped preliminary vegetation community boundaries based on aerial photographs of the project area, and compared them to those prepared by Metcalfe (Appendix 5B). In general, a high level of correlation between the two maps is apparent. From this, Egan (Appendix 5A) selected 20 sites across a range of vegetation communities for ground truthing. Of these, 17 were assessed using 20 m x 20 m quadrats (400 m<sup>2</sup>) and the following characteristics were recorded:

- Vegetation structure (height of upper, mid and ground stratum species).
- Species composition and dominance.
- Percentage canopy cover for each species.
- Presence or absence of introduced species (weeds).
- Level of disturbance (including fire, feral animal and anthropogenic impacts).
- Environmental features including landform, aspect, soils and drainage patterns.

Three of the 20 locations selected by Egan (Appendix 5A) were not fully assessed due to the level of disturbance at two of the sites that was caused by fire several weeks prior to assessment, and the degraded nature of one area of riparian vegetation. A species list only was compiled for these locations.

Unknown plant species were collected and pressed for botanical identification utilising Northern Territory herbarium resources.

### 7.1.2 Existing Conditions

#### **Summary**

Native vegetation distribution in the project area closely reflects the interplay of topography and soils, and the influence of seasonal fluctuations in fresh water supply and drainage. Consequently, the pattern of vegetation broadly corresponds to major topographic contours.

Most of the project area (approximately 50%) comprises dryland savannah vegetation on gentle lower slopes and foothills that support eucalyptus-dominated communities. These communities comprise various formations ranging from open woodland to woodland.

The central and eastern sections of the project area are highly disturbed and dominated by weeds and introduced grasses. The remaining vegetation in the project area comprises riparian, floodplain and vine forest communities with varying degrees of weed infestation. In general, the plant species recorded within the project area are common and widespread in the region. There are no vegetation communities of declared conservation significance, at either the Commonwealth or territory level, in the project area. Similarly, there are no plant species of conservation significance listed under the EPBC Act in the project area, nor do records exist of any rare or endangered plant species. The only protected species found or likely to occur in the project area is the cycad *Cycas armstrongii*, which is listed as threatened under the *Territory Parks and Wildlife Conservation Act*. This species is present within several vegetation communities in the project area.

#### **Vegetation Communities**

Appendix 5B identified 10 major vegetation communities (VC) – in addition to previously mined or disturbed areas – within the 3,750 ha survey area. A total of seven of these vegetation communities (VC 1, 2, 3, 5, 6, 7, 10) were found within the smaller 175 ha project area (Appendix 5A). In addition, a further three communities (VC 12, 13 and 14) have been identified in the 175 ha project area as a result of the more detailed mapping in Appendix 5A. Appendix 5B also includes an additional vegetation classification

(VC 11) to reflect the presence of the highly disturbed areas. The vegetation communities present within the project area are summarised in Table 7.1 and described in detail below, and shown in Figure 7.1.

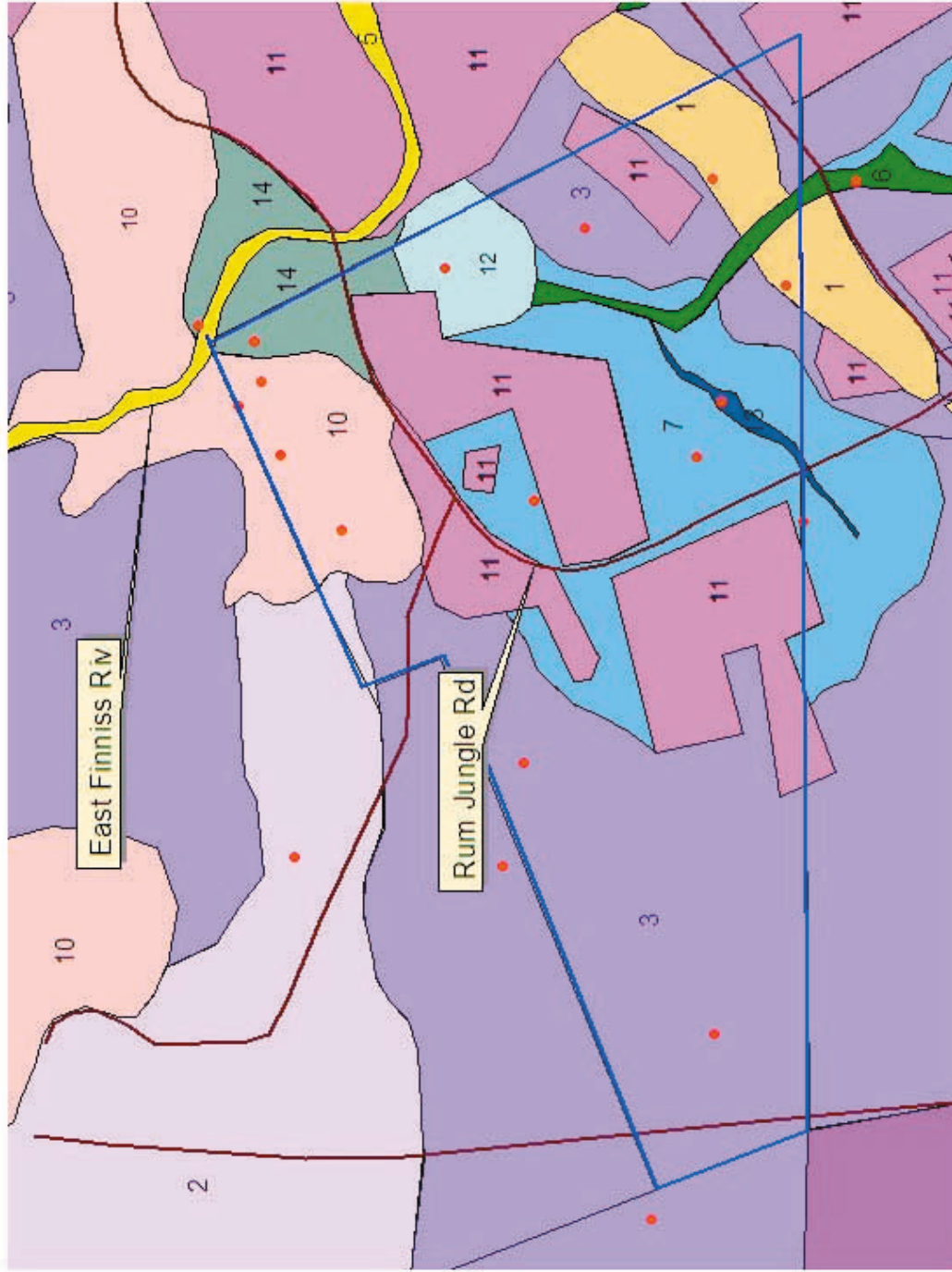
**Table 7.1 Vegetation communities within the project area**

Unit	Vegetation Community	Mean Species Richness		Approx. Area (ha)	% Project Area
		2002	2005		
1	<i>Eucalyptus phoenicea/Corymbia bleeseri</i> Open Woodland.	17	35	6.5	3.7
2	<i>Eucalyptus tetradonta/ Eucalyptus miniata/ Erythrophleum chlorostachys</i> Tall Open Forest to Woodland.	31	35	1	0.6
3	<i>Eucalyptus tetradonta/E. miniata</i> Open Woodland.	28	30	65	37.1
5	Riparian corridor.	26	27	0.5	0.3
6	<i>Lophostemon</i> community Open Woodland to Grassland.	20	18	2.3	1.3
7	<i>Eucalyptus papuana/Corymbia foelscheana/ Melaleuca</i> spp. Open Woodland to Grassland.	17	21	28	16
10	<i>Acacia auriculiformis</i> community Woodland to Open Forest.	31	31	13	7.4
11	Disturbed areas – including old mines, borrow pits, rehabilitated areas and recent exploration activities.	N/A	N/A	41	23.4
12	<i>A. auriculiformis/Melaleuca dealbata/Lophostemon</i> Forest, with exceptionally heavy weed infestation.	N/A	30	5.7	3.3
13	<i>Pandanus spiralis</i> Woodland over <i>Imperata cylindrica</i> .	N/A	12	1	0.6
14	Extensively degraded <i>Erythrophleum/A.auriculiformis</i> Woodland with dense weed infestation.	N/A	23	4	2.3

N/A: Not Assessed.

**VC 1 – *Eucalyptus phoenicea/Corymbia bleeseri* Open Woodland (6.5 ha, 3.7%)**

This community has a limited distribution in the project area, occurring on the rocky crests of several low hills in the southeastern section. The dominant species, *Eucalyptus phoenicea*, is typically a mid-height, multi-trunk Eucalypt characteristic of rocky habitats, ridges and hills, that forms an open woodland formation to 8 m with a sparse mid and ground stratum. Common species in this vegetation community are listed in Table 7.2; no introduced species were recorded.



- Mineral Lease Boundary
- Roads, Tracks etc
- Plot Locations
- Disturbed Areas (unit 11)
- Unit 1
- Unit 2
- Unit 3
- Unit 5
- Unit 6
- Unit 13
- Unit 7
- Unit 10
- Unit 12
- Unit 14.
- Horticultural property



0 1 2 Kilometers

Source: Appendix 5A

	Job No: 836	Compass Resources NL	Vegetation map	Figure No: 7.1
	File No: 836_08_FT.01_HB	Browns Oxide Project		

**Table 7.2 Common species in VC 1**

Vegetation Structure		
Upper Stratum	Middle Stratum (to 4 m)	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Corymbia bleeseri</i></li> <li>• <i>Eucalyptus miniata</i></li> <li>• <i>Erythrophleum chlorostachys</i></li> <li>• <i>Eucalyptus tetrodonta</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Xanthostemon paradoxus</i></li> <li>• <i>Owenia vernicosa</i></li> <li>• <i>Acacia</i> spp.</li> <li>• <i>Livistona humilis</i></li> </ul>	<ul style="list-style-type: none"> <li>• Dense annual grasses (<i>Heteropogon contortus</i>, <i>Themeda triandra</i>, <i>Sorghum</i> spp.)</li> <li>• Juvenile Eucalypts</li> <li>• Herbs (<i>Bonamia</i> sp., <i>Sauropus glaucus</i>, <i>Gomphrena</i> spp., <i>Pachynema</i> spp.)</li> <li>• Sub-shrubs including <i>Petalostigma quadriloculare</i> and <i>Grevillea dryandrii</i>.</li> <li>• <i>Cycas armstrongii</i></li> </ul>

**VC 2 – *Eucalyptus tetrodonta*/E. *miniata*/*Erythrophleum chlorostachys* Tall Open Forest to Woodland (1.0 ha, 0.6%)**

This vegetation community comprises well-developed, tall open forests on deeper soils of low plateau surfaces, upper hill slopes and rises, and is found to the far north of the project area. An extensive area of this vegetation community occurs to the northwest outside of the project area. Open woodland formations are common where this vegetation community merges with the eucalypt-dominated savannah woodland habitat. A few introduced species (occurring at low densities) were recorded in this vegetation community.

The dominant upper stratum species of *Eucalyptus tetrodonta*, *E. miniata* and *Erythrophleum chlorostachys* (ironwood) form a moderate to dense upper stratum to 15 m high. Ironwood is an outstanding and typically large, ubiquitous tree throughout this community. Table 7.3 lists other common species in this community.

**Table 7.3 Common species in VC 2**

Vegetation Structure			
Upper Stratum	Dense Understorey (to 6 m)	Middle Stratum (in areas of seasonally elevated soil moisture)	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Eucalyptus confertiflora</i></li> <li>• <i>Syzygium suborbiculare</i></li> <li>• <i>Alstonia actinophylla</i></li> <li>• <i>Acacia auriculiformis</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Buchanania obovata</i></li> <li>• <i>Flueggia virosa</i></li> <li>• <i>Persoonia falcata</i></li> <li>• <i>Livistona humilis</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Exocarpus latifolius</i></li> <li>• <i>Petalostigma pubescens</i></li> <li>• <i>Acacia auriculiformis</i></li> <li>• <i>Ficus opposita</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Sorghum</i> spp.</li> <li>• <i>Themeda triandra</i></li> <li>• <i>Chrysopogon latifolius</i></li> <li>• <i>Eriachne</i> spp.</li> <li>• <i>Cycas armstrongii</i></li> </ul>

**VC 3 – *Eucalyptus tetrodonta*/E. *miniata* Open Woodland (65 ha, 37%)**

This vegetation community largely comprises eucalypt-dominated open woodlands with minor areas of denser woodland habitat. The introduced tall grass *Andropogon gayanus*

(gamba grass) is abundant, mainly in disturbed areas such as roadsides. Table 7.4 lists common species in this community.

**Table 7.4 Common species in VC 3**

Vegetation Structure		
Upper Stratum (12 to 20 m)	Middle Stratum (2 to 6 m)	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Eucalyptus miniata</i></li> <li>• <i>E. tetradonta</i></li> <li>• <i>E. confertiflora</i></li> <li>• <i>Erythrophleum chlorostachys</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Acacia</i> spp.</li> <li>• <i>Cycas armstrongii</i></li> <li>• <i>Brachychiton megaphyllus</i></li> <li>• <i>Calytrix exstipulata</i></li> <li>• <i>Petalostigma pubescens</i></li> <li>• <i>Gardenia megasperma</i></li> </ul>	<ul style="list-style-type: none"> <li>• Grasses, including <i>Sorghum</i> spp., <i>Eriachne</i> spp., <i>Chrysopogon latifolius</i> and <i>Heteropogon contortus</i></li> <li>• Introduced grasses, including <i>Andropogon gayanus</i> and <i>Pennisetum</i> spp.</li> <li>• <i>Flemingia lineata</i></li> <li>• <i>Fleuggia virosa</i></li> <li>• <i>Distichostemon hispidulus</i></li> <li>• <i>Waltheria indica</i></li> <li>• <i>Ampelocissus</i> spp.</li> <li>• <i>Cycas armstrongii</i></li> </ul>

The dominant species varies locally with changing topographic conditions and associated variations in drainage and soil type:

- On the well-drained upland areas and low foothills of the survey area, the dominant species is characteristically *Eucalyptus miniata* (Darwin woollybutt), with *E. tetradonta* either alone or in co-dominant stands; *E. confertiflora* may be locally abundant.
- *Eucalyptus miniata* is the most widespread dominant tree on the shallower, yellowish soils of the upper slopes. In these areas, *Eucalyptus tetradonta* may also be present, with occasional *E. tectifera* (especially in rockier areas and on low crests).
- On the lower slopes, and particularly where this community intergrades with alluvial flats and low-lying areas, *E. confertiflora*, *Corymbia polycarpa* and *E. papuana* may become locally common.
- Other species including *Corymbia grandifolia* and *Erythrophleum chlorostachys* may become abundant towards drainage areas.

#### **VC 5 – Riparian Corridor (0.5 ha, 0.3%)**

Riparian vegetation exists along the corridor of the East Finniss River in the far northeast of the project area. Although this riparian vegetation shows obvious signs of degradation, it currently supports a reasonable density and diversity of riparian species, with common species being listed in Table 7.5.

**Table 7.5 Common species in VC 5**

Vegetation Structure		
<b>Semi-aquatic</b>		
<ul style="list-style-type: none"> <li>• <i>Phragmites vallatoria</i></li> <li>• <i>Pseudoraphis spinescens</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Pitrogramma colmelanos</i></li> <li>• <i>Eleocharis geniculata</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Cyperus aquatilis</i></li> <li>• <i>Hygrophila angustifolia</i></li> </ul>
<b>Terrestrial</b>		
<b>Upper Stratum (12 to 20 m)</b>	<b>Middle Stratum</b>	<b>Ground Layer</b>
<ul style="list-style-type: none"> <li>• <i>Acacia auriculiformis</i></li> <li>• <i>Melaleuca</i> spp.</li> <li>• <i>Terminalia carpentariae</i></li> <li>• <i>Corymbia polycarpa</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Pandanus spiralis</i></li> <li>• <i>Barringtonia acutangula</i></li> <li>• <i>Leptospermum longifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Ischaemum australe</i></li> <li>• <i>Imperata cylindrica</i></li> <li>• Weeds, including <i>Mimosa pigra</i>, <i>Stachytarpheta</i> spp., <i>Hyptis suaveolens</i> and <i>Andropogon gayanus</i>.</li> </ul>

**VC 6 – Lophostemon (2.3 ha, 1.3%)**

The small, linear drainage line that drains the southeast of the project area supports a narrow but dense woodland community in which *Lophostemon lactifluus* is dominant. A second species, *Lophostemon grandiflorus*, also forms monospecific stands in localised areas of the broad drainage way flanking Rum Jungle Creek and the Finniss River floodplain system, outside the project area. Weeds are present in highest densities along creek banks and levees. Table 7.6 lists the common species associated with this community.

**Table 7.6 Common species in VC 6**

Vegetation Structure		
<b>Upper Stratum</b>	<b>Middle Stratum</b>	<b>Ground Layer</b>
<ul style="list-style-type: none"> <li>• <i>Lophostemon lactifluus</i></li> <li>• <i>Lophostemon grandiflorus</i></li> <li>• <i>Eucalyptus papuana</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Melaleuca viridiflora</i></li> <li>• <i>Pandanus spiralis</i></li> <li>• <i>Planchonia careya</i></li> <li>• <i>Corymbia polycarpa</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriachne burkittii</i></li> <li>• <i>Paspalum scrobiculatum</i></li> <li>• <i>Themeda triandra</i></li> <li>• <i>Ischaemum</i> spp.</li> <li>• <i>Fimbristylis pauciflora</i></li> <li>• <i>Sporobolus pyramidalis</i></li> <li>• <i>Limnophila fragrans</i></li> </ul>

**VC 7 – Eucalyptus papuana/Corymbia foelscheana/Melaleuca Open Woodland to Grassland (28 ha, 16%)**

This community is highly variable, both floristically and structurally, and commonly occurs on the seasonally flooded flats surrounding the major drainage lines. Common species are listed in Table 7.7. Ten weed species occur in this community and introduced grasses may form dense infestations on river levees, particularly where seasonal flooding and/or feral animals have disturbed the native vegetation. Previous clearing and grazing has also encouraged the weed proliferation.

Vegetation varies with local variations in the soils and especially drainage across floodplain areas. Typically:

- Ghost gums (*Eucalyptus papuana*) are ubiquitous in lowland and floodplain areas and generally occur as scattered trees above dense grassland (open woodlands).
- Toward upland areas with greater site drainage, *Corymbia foelscheana* can become locally abundant to dominant.
- In more swampy areas of the floodplain *Melaleuca* spp. becomes locally prevalent.
- A distinctive corridor of grassland, in which *Ischaemum australe* forms dense monospecific stands, characteristically flanks the riparian vegetation fringing the drainage line in the southeast of the project area.

**Table 7.7 Common species in VC 7**

Vegetation Structure	
Upper Stratum	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Eucalyptus papuana</i></li> <li>• <i>Corymbia foelscheana</i></li> <li>• <i>Lophostemon grandiflorus</i></li> <li>• <i>Melaleuca dealbata</i></li> <li>• <i>Acacia auriculiformis</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Ischaemum australe</i></li> <li>• <i>Andropogon gayanus</i></li> <li>• <i>Stachytarpheta</i> spp.</li> <li>• <i>Hyptis suaveolens</i></li> </ul>

**VC 10 – *Acacia auriculiformis* Woodland to Open Forest (13 ha, 7.4%)**

Although these habitats are floristically rich and support a suite of species not associated with other more widespread eucalypt woodland habitats, the *Acacia auriculiformis* (Darwin black wattle) communities typically represent degraded or regenerating vine-forest habitats within the north of the project area, where forest appears to be recovering from the impacts of disturbance (e.g., clearing, fire and mining). Many vine-forest species are frequently fire-sensitive and may become restricted to habitats associated with permanent water or to fire-protected rocky outcrops.

Vegetation structure reflects the lack of perennial water supply, with open forest and woodland structural formations more common than closed canopy forests. Table 7.8 lists common species for this community.

**Table 7.8 Common species in VC 10**

Vegetation Structure		
Upper Stratum	Middle Stratum	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Acacia auriculiformis</i></li> <li>• <i>Erythrophleum chlorostachys</i></li> <li>• <i>Terminalia microcarpa</i></li> <li>• <i>Ficus virens</i></li> <li>• <i>Alstonia actinophylla</i></li> </ul>	<ul style="list-style-type: none"> <li>• Vines, including <i>Tinospora smilacina</i>, <i>Parsonsia velutina</i>, <i>Smilax australis</i> and <i>Abrus precatorius</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Hypoestes floribunda</i></li> <li>• <i>Cheilanthes nitida</i></li> <li>• Weeds, including <i>Hyptis suaveolens</i>, <i>Sida acuta</i>, <i>Senna obtusifolia</i> and <i>Pennisetum polystachion</i></li> <li>• Vines, including <i>Cardiospermum halicacibum</i>, <i>Passiflora foetida</i> and <i>Calopogonium mucunoides</i></li> </ul>

**VC 11 – Disturbed Areas (41 ha, 23.4%)**

Significantly disturbed areas include old mine pits, borrow pits, rehabilitated areas and recent exploration areas. Disturbed areas were not fully assessed in the surveys undertaken for the project. Much of the disturbed land in the centre of the project area appears to have previously been *Eucalyptus papuana/Corymbia foelscheana/Melaleuca* open woodland to grassland (VC 7), although a considerable proportion of these areas is now heavily infested with weed species.

**VC 12 – Acacia auriculiformis/Melaleuca dealbata/Lophostemon grandiflorus Forest with Exceptionally Dense Weed Infestation (5.7 ha, 3.3%)**

This community is restricted to an area immediately adjacent to the East Finnis River in the east of the project area. The moister, southerly fringes of this vegetation community contain native grasses and sedges, although there is evidence of ongoing weed invasion. Common species found in this community are listed in Table 7.9.

**Table 7.9 Common species in VC 12**

Vegetation Structure		
Upper Stratum (18 to 20 m)	Middle Stratum	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Acacia auriculiformis</i></li> <li>• <i>Melaleuca dealbata</i></li> <li>• <i>Lophostemon grandifloru</i></li> <li>• <i>Timonius timon</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lophostemon grandiflorus</i></li> <li>• <i>Acacia auriculiformis</i></li> <li>• <i>Flueggea virosa</i></li> <li>• <i>Jasminum aemulum</i></li> </ul>	<ul style="list-style-type: none"> <li>• Weeds, including <i>Andropogon gayanus</i>, <i>Calopogonium mucunoides</i> and <i>Pennisetum spp.</i></li> </ul>

At the time of the assessment much of the herbaceous material had dried and withered, with some areas being patchily burnt. During the growing (wet) season, the percentage cover of these areas by weed species is estimated to approach 100%, forming an impenetrable mass that would smother any germinating seedlings of other species.

**VC 13 – Pandanus spiralis Woodland over Imperata cylindrica (1.0 ha, 0.6%)**

This vegetation type occupies drainage channels to the south of the project area. Common species are listed in Table 7.10. The lack of apparent diversity in this community is likely to be at least partly attributable to the time of year (late dry season) when the flora assessment was conducted. Many more seasonally perennial or annual species could be expected to occur in the same habitat throughout the wetter times of the year.

**Table 7.10 Common species in VC 13**

Vegetation Structure		
Upper Stratum (to 6 m)	Middle Stratum	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Pandanus spiralis</i></li> <li>• <i>Melaleuca dealbata</i></li> <li>• <i>M. viridiflora</i></li> </ul>	<ul style="list-style-type: none"> <li>• Juvenile <i>Pandanus spiralis</i></li> <li>• <i>Flemingia lineata</i></li> <li>• <i>Grewia asiatica</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Imperata cylindrica</i></li> <li>• <i>Themeda triandra</i></li> <li>• <i>Ischaemum australe</i></li> </ul>

**VC 14 – Extensively Degraded *Erythrophleum/Acacia auriculiformis* Woodland with Dense Weed Infestation (4 ha, 2.3%)**

This degraded woodland community (where common species are listed in Table 7.11) is found immediately next to the East Finniss River and links with the adjacent *Acacia auriculiformis* community (VC 10). Due to its position close to the river and bridge crossing, it is likely to have had a long history of disturbance and of being burnt each dry season. This community is considered to be the extensively degraded remnants of open forest akin to that of *Eucalyptus tetrodonta/E. miniata*, combined with the outer intergrading margins of the adjacent *Acacia auriculiformis* community.

**Table 7.11 Common species in VC 14**

Vegetation Structure		
Upper Stratum	Middle Stratum	Ground Layer
<ul style="list-style-type: none"> <li>• <i>Erythrophleum chlorostachys</i></li> </ul>	<ul style="list-style-type: none"> <li>• Absent due to fire</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Petalostigma quadriloculare</i></li> <li>• <i>Persoonia falcata</i></li> <li>• <i>Jasminum molle</i></li> <li>• Weeds, including <i>Andropogon gayanus</i>, <i>Pennisetum</i> spp. and <i>Hyptis suaveolens</i>.</li> </ul>

The area had been burnt about four weeks prior to the site assessment, and virtually no mid stratum remained. All shrub or tree species other than the emergent *Erythrophleum* trees were present only as resprouting shoots from lignotubers or rootstocks. The ground stratum had also been burnt.

**Vegetation Communities of Conservation Significance**

In general, the plant species recorded within the project area are common and widespread in the region. There are no vegetation communities of declared conservation significance, at either the Commonwealth or territory level, in the project area.

The locally and regionally important evergreen monsoon vine forest is not present within the project area. The *Acacia auriculiformis* vine thicket community (VC 10), restricted to the northeast of the project area, is recognised as being of high plant diversity with a distinct floristic assemblage providing food and habitat for native fauna. The project area contains approximately 13 ha of the relatively intact *Acacia auriculiformis* vegetation community (VC 10), with another 5.7 ha of extensively degraded habitat of this general type (VC 12). The 13 ha patch of forest abuts a larger area of approximately another 40 ha outside the project area.

**Plant Species of Conservation Significance**

There are no plant species of conservation significance listed under the Commonwealth EPBC Act in the project area.

No rare or endangered plant species have been recorded in the project area. There is also an absence of plant communities of restricted distribution or vegetation types known to contain significant numbers of rare species.

A high proportion of Northern Territory plant species from the Orchidaceae and Cycadaceae families have significant status, and these groups are generally regarded as having some intrinsic ecological value due to their relatively restricted distribution (Cowie, cited in Appendix 5B). The cycad *Cycas armstrongii*, which is endemic to the Northern Territory and is a common understorey species within Eucalypt-dominated woodlands, is listed as a threatened species under the *Territory Parks and Wildlife Conservation Act*. This plant is present within VCs 1, 2, 3 and 14, although its distribution and density are both variable across the eucalypt woodland savannah regions of the project area. These vegetation communities occupy approximately 50% of the total project area, with the estimated mean density of *Cycas armstrongii* within these communities being about 130 individuals per hectare.

Three additional protected species (*Habenaria elongata* (Orchidaceae), *Helicteres* sp. 'Glenluckie Creek' (Sterculiaceae) and *Indigofera schultziiana* (Fabaceae)) have been investigated for their potential presence in the project area. It has been determined unlikely that *Helicteres* sp. 'Glenluckie Creek' or *Indigofera schultziiana* are present and there is no evidence of *Habenaria elongata* in the project area, nor is there any substantial area of its preferred habitat.

### 7.1.3 Potential Issues

#### **Clearing of Vegetation**

About half of the vegetation within the 175 ha project area will be cleared to accommodate project infrastructure such as access roads, plant site, pit, tailing storage facility, stockpiles and sedimentation traps. Measures to minimise vegetation loss during the design of the project infrastructure layout are discussed in Section 7.1.4.

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. The removal of vegetation also has the potential to further fragment and reduce the area of habitat available for fauna species dependent on it for resources. The consequences of habitat fragmentation for fauna species are discussed in Section 7.2.4.

Patches of remnant vine forest (VC 10) and degraded vine forest (VC 12) will potentially be cleared. These vegetation communities have ecological significance largely due to the general scarcity of perennial water and the frequency and extent of annual burning. Vine forest communities are characteristically fire sensitive (i.e., killed by fire) and are fire restricted, and typically occur as small disjunct patches in a 'sea of savannah' (Appendix 5b). They contain a distinct and diverse flora, and their scattered and relatively restricted distribution in the region present challenges for their adequate conservation.

#### **Weed Density and Distribution**

Vegetation clearing can lead to a change in the environmental conditions along vegetation corridors (such as increased light, wind and temperature). This can often favour the establishment and spread of 'edge' species, which are usually exotic, leading

to a shift in vegetation community composition. A total of 33 introduced plant species have been recorded in the total survey area, with several of these such as gamba grass and mission grass being of particular concern.

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

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. Several weed species also have the potential to alter the extent and intensity of fire in the project area.

### **Fire**

Fire is a natural, annual event in the landscape of northern Australia, with up to 50% or more of the region burnt each year (Williams 1995, cited in Appendix 5b). Early-season, low intensity fires are common, although project-related activities have the potential to alter fire frequency, intensity and timing in the region. For example, gamba and mission grass both form extremely dense clumps of vegetation 3 to 4 m tall and are capable of supplying large fuel loads that can create fires up to eight times as intense as those in native grasses (Rossiter et. al., 2003, cited in Appendix 5a). These altered fire regimes can lead to further changes in vegetation structure and composition.

#### **7.1.4 Avoidance, Mitigation and Management Measures**

Avoidance, management and mitigation measures will be developed to minimise the impact of the project on the flora, and specifically vegetation communities, of the area. The primary impacts to flora relate to vegetation clearing and the potential for increased weed density and distribution in vegetation communities surrounding the project area.

The on-going implementation of the site-specific Biological and Land Management Plan (Section 9.8.3) will ensure that impacts to vegetation communities and threatened species are managed in a sensitive manner.

### **Clearing of Vegetation**

The extent and amount of vegetation to be cleared in the project area will be dependent on the final design and layout of the project components. Measures designed to avoid, mitigate and manage the clearing of vegetation include:

- Appropriate siting of project components by specifically considering the following:
  - Retaining vegetation in the southeast of the project area containing the threatened species, *Cycas armstrongii*, to reduce the total number of individuals removed.
  - Minimising clearing of vine forest vegetation in the north of the project area.
  - Retaining *Eucalyptus miniata* and *E. tetradonta* +/- *E. chlorosachys* open forest to woodland, as this vegetation supports the highest diversity of fauna in the

project area, including the northern quoll, the red goshawk and the brush-tailed phascogale (see Section 7.2). Near-threatened fauna species are also found in this habitat.

- Severing of riparian corridors will be avoided where possible.
- Use of previously disturbed and modified areas will be maximised in preference to clearing intact habitat.
- Areas to be disturbed will be subject to written clearance authority and will be clearly defined and identified.

### ***Weed Density and Distribution***

Measures designed to avoid, mitigate and manage the density and distribution of weeds in the project area include:

- A focus on the control of recognised problem weed species such as gamba grass and mission grass, and the prevention of their spread during the life of the project.
- Targeted application of weed control measures.
- Regular monitoring of areas with a high potential for, or susceptibility to, weed invasion, such as along roadsides, in recently cleared areas, and the vine forest vegetation communities to the north of the project area.
- Control and/or prevention of weed infestations in topsoil stockpiles to minimise the likelihood of weed introduction during respreading of topsoil.
- Wash down units for vehicles and project equipment moving on or off the project area.

### ***Fire***

The planning and management of fire within the project area will play a significant role in managing impacts on the diversity and composition of vegetation communities in and around the project area. Management measures to control fire are described in the Fire Management Plan (Section 9.8.2) and will include:

- Implementation of a controlled burn regime that takes into account the requirements of vegetation communities and flora species within the project area.
- Procedures to avoid, control and regulate potential unplanned fires.
- Controlling the spread of weeds such as gamba grass in the project area.

## **7.1.5 Residual Impact Assessment**

### ***Clearing of Vegetation***

The vegetation to be cleared contains common and widespread vegetation types of no declared conservation significance within the local and regional contexts (Appendix 5B).

The terrestrial vegetation communities within the project area are typical of eucalypt forest and woodland of the 'Top End' and comprise part of an extensive bioregion i.e., the Pine Creek bioregion that covers 30,404 km<sup>2</sup>. Thus, in the regional context, the conservation value of the terrestrial flora found in the project area is not significant and clearing represents a minor vegetation loss in an area where disturbance and other impacts from past mining, clearing, fires, roads and tracks, and the introduction of weeds, have impacted on the condition and structure of vegetation communities. The nearby Litchfield National Park contains at least comparative, if not greater, composition and diversity of species in an undisturbed area. Additionally, approximately 43% of the Pine Creek bioregion is currently reserved, predominantly for conservation purposes (Woinarski, Connors and Oliver, 1996, cited in Appendix 5b).

Natural regeneration of vegetation, and ultimately rehabilitation, will compensate for vegetation lost during clearing (apart from areas such as the pit).

In terms of specific species, the *Eucalyptus tetradonta*/*E. miniata* open woodland is the dominant vegetation community in the project area, occupying 37% of the land. Most of this vegetation community within the project area will be cleared during construction. The significant species *Cycas armstrongii* is found within this and other eucalypt woodland vegetation communities in the project area, and Egan (Appendix 5a) has estimated that approximately 10,200 individuals of this species could be removed. *Cycas armstrongii* is present as part of a widespread, and relatively common, population in the region and is represented in a range of conservation reserves, including the Litchfield National Park. The retention of about 22 ha of eucalypt woodland in the southeast of the project area will significantly reduce the number of *Cycas armstrongii* to be cleared.

The removal and/or fragmentation of minor areas of riparian, floodplain, *Lophostemon* and melaleuca communities associated with drainage lines in the project area will be avoided where possible. These are of no declared conservation significance but have local and regional ecological importance since they support a distinct fauna composition, and are fire sensitive. Management and mitigation measures will be implemented to minimise the impact to these vegetation communities.

### **Weed Density and Distribution**

Vegetation clearing and other project-related activities have the potential to accelerate the spread of gamba grass over the project area and into adjacent woodlands and forests. This species is capable of spreading into undisturbed bushland, although its easiest and most rapid mode of spreading is along roads and cleared corridors. Mission grasses (*Pennisetum* spp.), *Mimosa pigra* and *Grewia asiatica* are also examples of species with the potential for expansion in distribution as a result of vegetation clearing.

Clearing of the fragmented *Acacia auriculiformis* vine forest communities in the north of the project area has the potential to increase the rate of invasion of weed species into the surrounding vine forest community. The southeastern edge of this vegetation community has been extensively infiltrated by gamba grass, mission grass and other weed species. The design and layout of project infrastructure will include consideration of minimising the area of this vegetation community that will require complete removal.

The implementation of the Biological and Land Management Plan (Section 9.8.3) will mitigate the risks associated with an increase in the density and abundance of weed species in the project area. Active weed management will reduce the density and extent of weed distribution, thereby leading to an improvement in the composition and structure of remnant vegetation communities.

### **Fire**

The impact of a large-scale wildfire on vegetation communities would be extensive, notwithstanding the fact that the pit, haul roads and site access road will form a natural fire break against fire coming from the north and northwest. Implementation of appropriate measures is expected to satisfactorily manage the risk of smaller-scale fires with respect to flora species and vegetation communities, with these smaller fires having the potential to increase diversity and reduce weed infestation across the project area.

## **7.2 Terrestrial and Aquatic Fauna**

A fauna impact assessment for the Browns Oxide Project was undertaken by Ecological Management Services Pty Ltd (EMS) and is included as Appendix 4. This section summarises the findings of the assessment.

### **7.2.1 Background**

Description of the type, number and density of fauna species in the project area is based on a desktop review and field surveys undertaken during the dry season of 2002 and the wet season of 2005 (see Appendix 4).

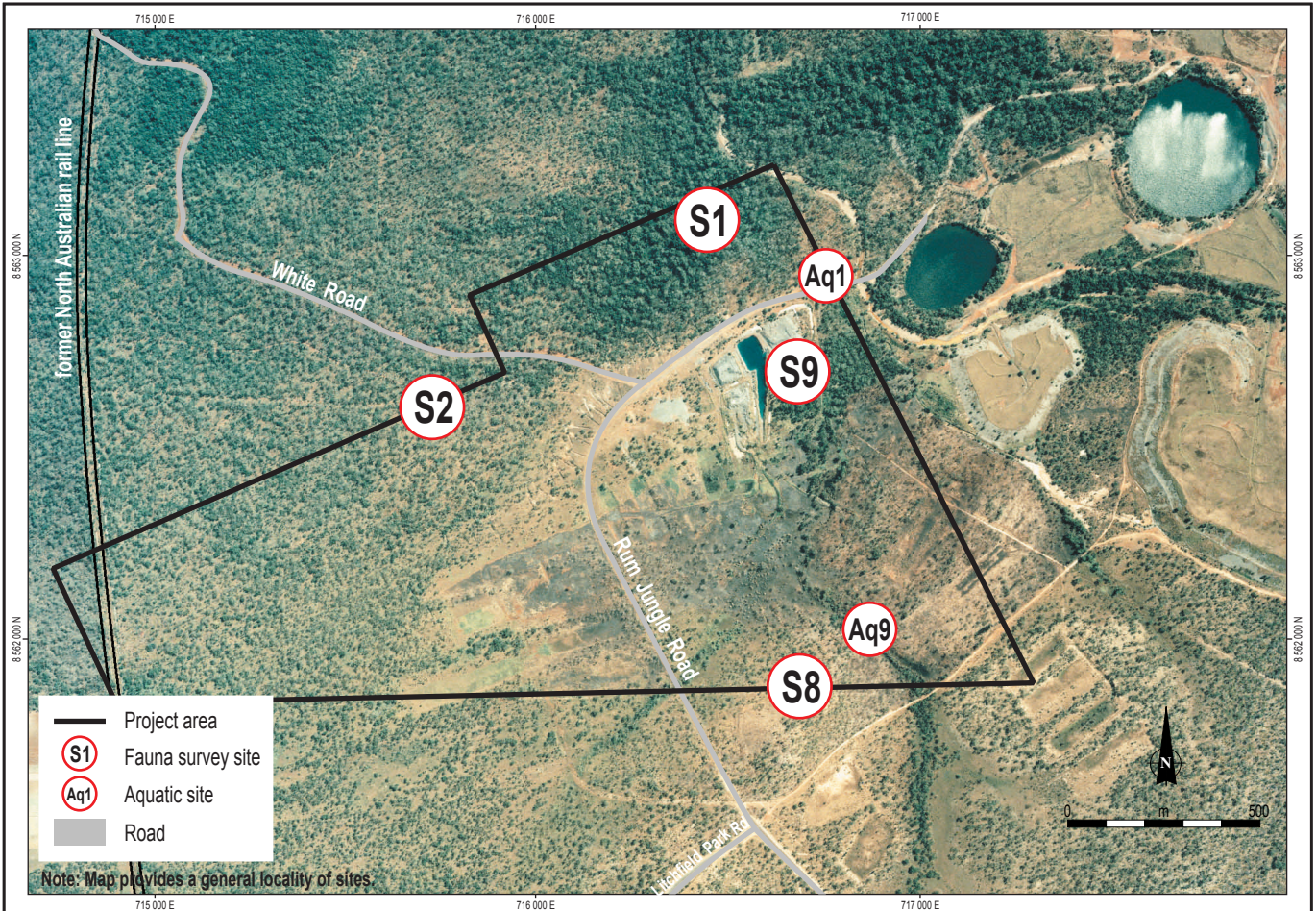
The dry season survey sampled a study area of 37.5 km<sup>2</sup> (3,750 ha) in and around the project area, while the wet season survey focused on the 1.75 km<sup>2</sup> (175 ha) project area and surrounding selected habitat types.

Eight terrestrial, 8 aquatic and 12 herpetofauna sites were systematically surveyed during the 2002 dry season, while 4 terrestrial and 2 aquatic sites were systematically sampled during the 2005 wet season (Figure 7.2). A summary of the fauna survey methods is given in Table 7.12.

### **7.2.2 Existing Conditions**

#### **Summary**

The project area and immediate surrounds support a range of fauna species including 18 amphibians (including the cane toad [*Bufo marinus*] which has only arrived to the area during the latest wet season), 38 reptiles, 120 birds and 33 mammal species (29 native and 4 introduced).



Source: Appendix 4 figures 3 and 2

**Table 7.12 Fauna survey methods**

Type of Survey	Site Number		Method of Survey
	2002 Dry Season	2005 Wet Season	
Terrestrial Fauna	S1 – S7	S1, S2, S8, S9	Hair funnels
	S1 – S8	S1, S2, S8, S9	Tree-mounted traps
	S1 – S8	S1, S2, S8, S9	Elliot Type A traps
	S1 – S8	S1, S2, S8, S9	Elliot Type B traps
	S1 – S8	S1, S2, S8, S9	Wire cage traps
	S1 – S7	S1, S2, S8, S9	Pitfall trap
	S1 – S8	S1, S2, S8, S9	Timed area bird survey
	S1 – S8	S1, S2, S8, S9	Nocturnal call playback
	S1 – S8	S1, S2, S8, S9	Timed active area search (diurnal)
	S1 – S8	S1, S2, S8, S9	Timed active area search (nocturnal)
	S1 – S8	S1, S2, S8, S9	Spotlight survey
	S1 – S8, Aq1/Aq2, Aq5 – Aq8	S1, S2, S8, S9	Bat call detection (fixed point)
	Aquatic Fauna	Aq1 – Aq8	Aq1, Aq9
Aq1 – Aq8			Turtle trapping
Additional Reptile Search	H3 – H5, H9		Timed area search (rock outcrops)
	Aq6 – Aq8		Timed area search (riverine habitat)
	H2 – H6 – H7		Timed area search (upland Eucalypt habitat)
	H1 – H11 – H12		Timed area search (vine-forest habitat)
	Av1 – Av2		Timed area bird survey
Additional (Non-standard) Surveys	S1, S2, S4, S6, Aq5	S1, S2, S8, S9	Harp trap
			Vehicle spotlighting
			Bat roost searches
			Collection of scats and or skeletal remains

Three species listed as vulnerable or endangered under the EPBC Act are present, or potentially present, within the project area:

- Northern quoll (*Dasyurus hallucatus*).
- Partridge pigeon (*Geophaps smithii*).
- Red goshawk (*Erythrotrorchis radiatus*).

Additional species listed as vulnerable or near threatened under the TPWC Act that are present, or potentially present, within the project area are:

- Northern death adder (*Acanthophis praelongus*).
- Yellow-spotted monitor (*Varanus panoptes*).
- Brush-tailed phascogale (*Phascogale tapoatafa*).

- Bush stone-curlew (*Burhinus grallarius*).
- Black-footed tree rat (*Mesembryomys gouldi*).
- Arnhem Land pebblemound mouse (*Pseudomys calabyi*).
- Pale field-rat (*Rattus tunneyi*).
- Arnhem sheathtail bat (*Taphozous kapalgensis*).

### **Amphibians**

The number and abundance of amphibian species in the region is consistent with that of the wider 'Top End' of the Northern Territory, with diversity comparative to that of the nearby Litchfield National Park. Seventeen native amphibian species were observed during the combined dry and wet season surveys. To date the cane toad (*Bufo marinus*) is present in low numbers, having arrived in the area within a few weeks or months prior to the 2005 wet season (Earthrowl, pers. com., 2005 cited in Appendix 4).

During the dry season, amphibian species such as the bilingual frog (*Crinia bilinguala*) and Tornier's frog (*Litoria tornieri*) are unlikely to exist in areas other than the major river systems and spring-fed streams in the region, including Rum Jungle Creek, the main Finnis River channel and the East Finnis River. This pattern of amphibian diversity and abundance within the project area is likely to be similar to that observed within adjacent areas of Litchfield National Park, where streams and drainage depressions support a high proportion of the frog fauna during the dry season (Griffiths *et al.*, 1997 cited in Appendix 4).

During the wet season, amphibians are found in greater abundance and diversity across the project area due to an expansion in suitable habitat. During and following rainfall events, amphibian species are often found in typically drier habitat types (including upland eucalypt forest, monsoon vine thicket and rocky habitats), with species including *Limnodynastes ornatus*, *Litoria tornieri* and *Uperoleia inundata*.

**Significant Species.** There are no species of amphibian recorded in the project area that are listed as rare or threatened under the relevant legislation (TPWC Act, EPBC Act). However, many amphibian species in the region have been listed as data deficient under the TPWC Act due to the potential impact of the cane toad.

### **Reptiles**

A high diversity of aquatic and terrestrial reptile species occurs in and around the project area.

The aquatic and semi-aquatic reptile species found in the region include the northern yellow-faced turtle (*Emydura tanybaraga*), estuarine crocodile (*Crocodylus porosus*), freshwater crocodile (*Crocodylus johnstonii*), Merten's water monitor (*Varanus mertensi*) and Macleay's water snake (*Enhydryis polyepis*). The common tree snake (*Dendrelaphis punctulata*) and small litter-dwelling skink species (*Carlia gracilis* and *Carlia rufilatus*) are also commonly associated with riparian and aquatic habitat in the area.

Reptile species richness is high in the dry rock outcrops and scree areas, with common species including the bar-shouldered ctenotus (*Ctenotus inornatus*, dark vertebral stripe

form), northern spotted rock dtella (*Gehyra nana*) and olive python (*Liasis olivaceus*). The open forest habitat supports a high diversity of skinks and lizards, while the acacia regrowth/monsoon vine-forest habitat and the open drainage areas support a reduced reptile diversity and abundance.

One species of snake, the northern small-eyed snake (*Rhinoplocephalus pallidiceps*), was recorded during the dry season 2002 survey in vine-forest and is not listed in regional fauna databases. It has not been previously recorded in the local area, including Litchfield National Park (Griffiths *et al.*, 1997 cited in Appendix 4).

During the wet season, reptile species appear to be less abundant in the region than during the dry season, although this may be due to difficulties in observing reptiles in the dense exotic and native grasses that dominate the landscape after rain. Species present only during the wet season 2005 survey included the frilled lizard (*Chlaydosaurus kingii*), ornate snake-eyed skink (*Notoscincus ornatus*) and the slender blind snake (*Ramphotyphlops nema*).

**Significant Species.** Habitats within the project area support reptile species that are generally common in the region, and none of the taxa recorded are considered to be endangered or vulnerable by relevant conservation authorities. Two 'near threatened' (under the TPWC Act) reptile species were noted (Table 7.13), although the listing of these two species is due primarily to the threat posed by lethal toxic ingestion of cane toads. Many reptile species in the region have been listed as data deficient under the TPWC Act due to the potential impact of the cane toad.

**Table 7.13 Significant reptile species**

Scientific Name	Common Name	Listing	Habitat	Location and Season
<i>Acanthophis praelongus</i>	Northern death adder	Near threatened, TPWC Act	Upland eucalypt	S2 (dry)
<i>Varanus panoptes</i>	Yellow-spotted monitor	Near threatened, TPWC Act	Drainage areas	S5 (dry)

### **Birds**

There are approximately 120 bird species in and around the project area, and this is about half the number of species in surrounding areas, including Litchfield National Park. The majority of species are widely distributed in the open forest/woodland habitats, with the remaining species usually associated with wetlands or freshwater habitats; a limited number occur primarily in riparian forests or vine thickets.

Birds that have restricted ranges during the dry season occur in broader habitat types during the wet season, when dense grasses support species such as the masked finch (*Poephila personata*) and the tailed finch (*Poephila acuticauda*). Migratory species such as the dollarbird (*Eurystomus orientalis*), channel-billed cuckoo (*Scythrops novaehollandiae*), and the fork-tailed swift (*Apus pacificus*) are present in the project area during the wet season, when waterbirds are also more common than in the dry season.

**Significant Species.** Three significant bird species occur in the study area, all of which are listed under the TWPC Act, with two of them also being listed under the EPBC Act (Table 7.14) (Figure 7.3).

**Table 7.14 Significant bird species**

Scientific Name	Common Name	Listing	Habitat	Location and Season
<i>Burhinus grallarius</i>	Bush stone-curlew	Near Threatened, TPWC Act	Upland eucalypt forest, rocky rises	S8 (dry)
<i>Erythrotrichochis radiatus</i>	Red goshawk	Vulnerable, EPBC Act Vulnerable, TPWC Act	Upland eucalypt woodland, riparian corridors	S3, S4, S8 (dry) S2 (wet)
<i>Geophaps smithii</i>	Partridge pigeon	Vulnerable, EPBC Act Near Threatened, TPWC Act	Upland eucalypt forest, rocky rises	S2, S8, S9 (wet)

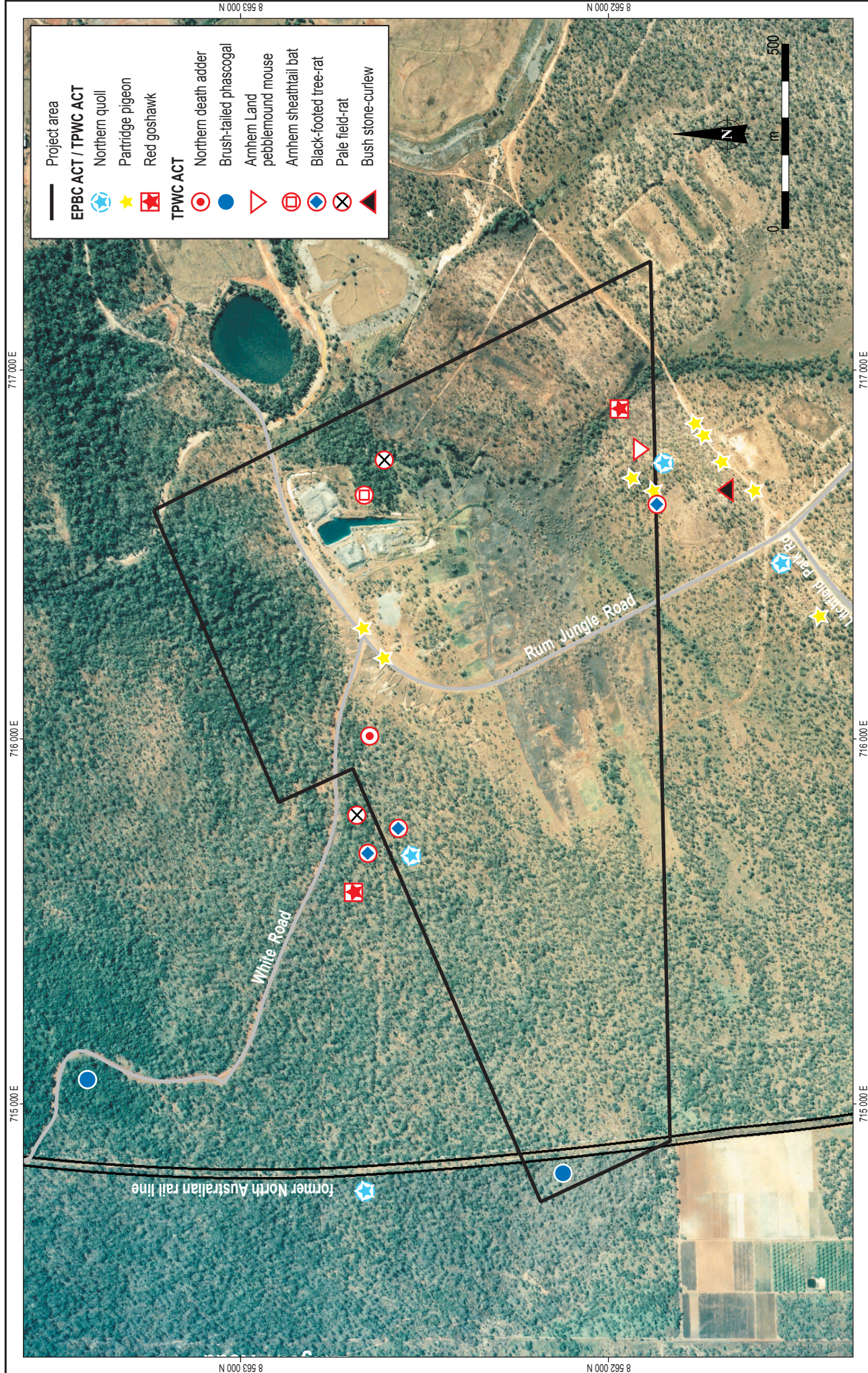
The bush stone-curlew is relatively common in northern Australia and is at times very common in Litchfield National Park (Price and Barker, 2003 cited in Appendix 4). Predation by feral cats, land clearing and altered fire regimes represent threatening processes for this species, although it remains common in the local area and persists in modified areas such as pastures and township margins.

The red goshawk occurs at very low densities across northern Australia and has been recorded in the local area in Litchfield National Park and adjacent properties (Woinarski, 2002a cited in Appendix 4). This bird inhabits coastal and sub-coastal tall open forests and woodlands, tropical savannahs traversed by forested rivers and the margins of rainforest. It is likely to utilise eucalypt forest types, open forests and woodlands in drainage areas and riverine forests in and around the project area. The red goshawk is threatened by land clearing, as well as the disturbance of nest sites. No nest sites for this species occur within the project area.

The partridge pigeon, which prefers mixed eucalypt woodland habitat with a structurally diverse understorey, is restricted in range to the sub-coastal areas of the northern parts of Northern Territory and is known to occur in Litchfield National Park (Woinarski, 2004 cited in Appendix 4). Land clearance and predation by feral cats are key threatening processes.

### **Mammals**

Twenty-eight native mammal species have been identified in the project area, including microchiropteran bats, rodents and macropods. The highest diversity of mammals is in the upland eucalypt forest habitat, while the open drainage and floodplain habitats have low species diversity. Species such as the northern brushtail possum (*Trichosurus vulpecular arnhemensis*) and the agile wallaby (*Macropus agilis*) are common throughout the region. Similar species are present throughout the dry and wet seasons.



Source: Appendix 4 figures 4 and 5

Job No: 836  
 File No: 836\_08\_FT.03\_HB

Compass Resources NL  
 Browns Oxide Project

Records of threatened and near threatened fauna species

Figure No: 7.3

Nocturnal species common in the project area include the brush-tailed phascogale (*Phascogale tapoatafa pirata*), antilopine wallaroo (*Macropus antilopinus*), black flying-fox (*Pteropus alecto*), sugar glider (*Petaurus brevipes*) and feral pig (*Sus scrofa*).

A variety of microchiropteran bat species is present in a range of habitat types across the project area, with the most common species/groups including the *Scotorepens* spp., *Miniopterus schreibersii* and *Nyctophilus* spp.

**Significant Species.** Six significant species of mammals occur in the project area. All are listed under the TWPC Act and one is also listed under the EPBC Act (Table 7.15) (see Figure 7.3).

**Table 7.15 Significant mammal species**

Scientific Name	Common Name	Listing	Habitat	Location and Season
<i>Dasyurus hallucatus</i>	Northern quoll	Endangered, EPBC Act Vulnerable, TPWC Act	Upland eucalypt forest, rocky rises	S3, S4, S8 (dry) S2 (wet)
<i>Mesembryomys gouldi</i>	Black-footed tree rat	Near Threatened, TPWC Act	Eucalypt forest and woodland	S2, S8 (dry) S2 (wet)
<i>Phascogale tapoatafa pirata</i>	Brush-tailed phascogale	Vulnerable, TPWC Act	Upland eucalypt woodland, riparian corridors.	S2, S3 (dry) S2 (wet)
<i>Pseudomys calabyi</i>	Arnhem Land pebblemound mouse	Near Threatened, TPWC Act	Stony woodland	S8 (wet)
<i>Rattus tunneyi</i>	Pale field-rat	Near Threatened, TPWC Act	Melaleuca woodland and open forest	S2, S9 (wet)
<i>Taphozous kapalgensis</i>	Arnhem sheathtail bat	Near Threatened, TPWC Act	Melaleuca woodland	S9 (wet)

The northern quoll is considered common in Litchfield National Park and the local area, although its distribution appears to have decreased from a once-wider extent (Griffiths et al., 1997 cited in Appendix 4). The reduction in range is directly related to disturbance of habitat, i.e., woodland and open woodland on rock outcrops. Predation by feral cats, disease and changed fire regimes are also possible causes for this reduction. It is likely that the northern quoll population in the region will be impacted by the recent arrival of cane toads.

The black-footed tree rat has contracted in distribution across the Northern Territory, with populations appearing to be thinly spread. It is known to occur in Litchfield National Park. Suitable habitat generally includes eucalypt forest and woodland with a dense understorey of small trees and shrubs (Lee, 1995 cited in Appendix 4). Grazing and changes in fire regime appear to reduce the understorey vegetation required by this species.

The brush-tailed phascogale is uncommon and patchily distributed in the region. It has been recently documented in Litchfield National Park, but is not common (Woinarski, 2002b cited in Appendix 4). This animal inhabits drier forest types, although there are some records from riparian/woodland and deciduous vine-thicket. The typical home range for this species is large (up to 150 ha for males), suggesting that a local population is likely to utilise a large area. It is likely that the brush-tailed phascogale population in the region will be impacted by the recent arrival of cane toads.

The Arnhem Land pebblemound mouse is known to exist in Litchfield National Park, although there are no previous records from the Batchelor/Rum Jungle area (Griffiths et al., 1997 cited in Appendix 4). The mouse inhabits stony woodland and eucalypt woodland on stony hills. The threatening processes for this species not known but is expected to include land clearing and fire.

The pale field rat is known to exist in Litchfield National Park and throughout the Coomalie sub-region, and is locally common and widespread. Its habitat is becoming increasingly fragmented and is restricted to melaleuca woodland within the project area.

The Arnhem sheathtail bat has very few records of description and its distribution is restricted to open woodland on floodplain edges, dense melaleuca forest and a mixture of sandstone woodlands and riparian areas (Woinarski and Milne, 2002 cited in Appendix 4). Habitat modification and land clearing are expected to be the key threatening processes for this species.

### ***Migratory Species***

Eight species in or near the project area are covered by the migratory provisions of the EPBC Act (Table 7.16).

**Table 7.16 Migratory species listed under the EPBC Act**

<b>Scientific Name</b>	<b>Common Name</b>	<b>Habitat</b>	<b>Location and Season</b>
<i>Crocodylus porosus</i>	Estuarine crocodile	Riverine	Aq7 Finnis River main branch (dry)
<i>Apus pacificus</i>	Fork-tailed swift	Aerial feeder	S1, S2, S8 (wet)
<i>Coracina tenuirostris melvillensis</i>	Cicadabird	Upland Eucalypt woodland, monsoon vine-forest	S1, S2 (wet)
<i>Gallinago megala</i>	Swinhoe's snipe	Drainage areas	Aq5 Finnis River (wet)
<i>Haliaeetus leucogaster</i>	White-bellied sea eagle	Riparian	Av2 (wet)
<i>Hirundapus caudacutus</i>	White-throated needletail	Aerial feeder	S2 (wet)
<i>Merops ornatus</i>	Rainbow bee-eater	Most forest types	S1 - S4, S6, S7 (dry) S1, S2, S8 (wet)
<i>Rhipidura rufifrons</i>	Rufous fantail	Riparian, monsoon vine-forest	S1, Finnis River main branch (dry)

The estuarine crocodile inhabits large rivers and streams, freshwater swamps and floodplain billabongs across the north of the Northern Territory. Several large specimens have been recorded near the project area, although no suitable habitat for this species

occurs within the project area itself. Acid rock drainage and aquatic pollution are the main threatening processes.

The fork-tailed swift and white-throated needletail are aerial-feeding species that were not observed using terrestrial habitats within the project area. It is unlikely that vegetation clearing would impact on the population of these species. The rainbow bee-eater is generally a common and widespread species throughout the Northern Territory, with broad habitat requirements. There are no major habitats in the project area for the Swinhoe's snipe, although it is possible that small numbers of migrating waterbirds might temporarily use artificial water sources or flooded areas. The wide range of the white-bellied sea eagle and an absence of nest sites in the project area suggest that this species does not have a significant presence in the project area.

The rufous fantail is common year round in this part of the Northern Territory and does not tend to be migratory. Populations of the cicadabird are seasonally nomadic, retreating to pockets of rainforest in the dry season and locally common during the wet season.

### ***Introduced Species***

Four introduced vertebrate fauna species have been identified in the project area and are common in the region: the domestic dog, feral pig, cane toad and feral cat. Of these, the feral pig, cane toad and feral cat are of most concern within the project context.

The feral pig (*Sus scrofa*) is relatively common in the area and is considered the most numerous and destructive introduced mammal species in the region. These animals frequent areas associated with permanent open water and/or drainage channels during the dry season, causing significant ground disturbance. During the wet season, they also cause significant damage to the melaleuca woodland associated with low-lying drainage areas.

The cane toad (*Bufo marinus*) is in the process of colonising the area and large numbers of toads are likely to invade local habitats in the immediate future. It is known that in recently colonised populations such as at the project site, cane toad numbers rapidly increase to levels far in excess of those in older established populations (DEH, 2005b). The biological effect, including lethal toxic ingestion, caused by cane toads is listed as a key threatening process under Schedule 3 of the EPBC Act, with its impact on the northern quoll and reptiles of particular concern (DEH, 2005b).

The feral cat (*Felis catus*) was observed in the project area during the wet season 2005 survey and is relatively common in the region. Predation of native wildlife by feral cats is also listed as a key threatening process under Schedule 3 of the EPBC Act, with particular concern given to their impact on reptile, bird and small mammal populations in the region (DEH, 2005b).

## 7.2.4 Potential Issues

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

The proposed project will require the total clearing of areas of land. None of the habitats or ecosystems that are to be cleared or affected by the proposed project are listed as threatened ecological communities under the EPBC Act (DEH, 2005b). There are no World Heritage properties in close proximity, and the nearest conservation reserve is the Litchfield National Park, approximately 30 km west of Batchelor.

Vegetation clearing will potentially increase fragmentation of habitats 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.

Habitat fragmentation can also lead to a change in the environmental conditions along vegetation corridors (such as increased light, wind and temperature). This can often favour the establishment and spread of 'edge' species, which are usually exotic, leading to a shift in vegetation community composition.

*Eucalyptus miniata* and *E. tetradonta* (+/- *E. chlorosachys*) open forest to woodland (VC 2 and 3) supports the highest diversity of fauna in the project area, including the northern quoll, the red goshawk and the brush-tailed phascogale. Near-threatened species are also found in this habitat type. The proposed layout consists of a haul road, ROM pad, crushing pad, processing plant and office/administration facilities, all of which are located in this habitat. Project development is likely to include modification, disturbance and some loss of this vegetation community.

The project is not expected to fragment the eucalypt open woodland on rocky rises, riparian, or melaleuca woodland habitat types.

### ***Significant Species***

The project will clear vegetation that supports three fauna species of national (and Northern Territory) significance, i.e., the northern quoll, partridge pigeon and the red goshawk. Species that are listed as vulnerable or near threatened under the TPWC Act in the project area include the northern death-adder, yellow-spotted monitor, bush-stone curlew, brush-tailed phascogale, Arnhem sheath-tail bat and several rodent species. Habitat used by these species may also be cleared.

The impact on threatened species by clearing of this vegetation may be compounded by the recent arrival of the cane toad to the region.

### ***Fire***

Many of the threatened and significant fauna species observed within the project area are negatively impacted by specific fire regimes. Increased project-related activity could result in an increase in unplanned fires with consequent impacts on fauna biodiversity.

and habitat. The presence and spread of exotic grasses (including gamba grass) can also influence the intensity and distribution of fires.

### ***Introduced Species***

A number of the fauna species within the project area, including the northern quoll, brush-tailed phascogale, goannas, snakes and frogs, are likely to be negatively impacted by the recent arrival of cane toads in the Batchelor area.

Feral pigs and feral cats are present in the study area. Feral pigs can cause habitat disturbance and increase the spread of weeds, while feral cats may represent a risk to some of the significant fauna species such as the partridge pigeon.

### ***Acid Rock Drainage***

Toxic metal concentrations at low pH, most likely the result of acid rock drainage, are considered the main factor in fish kills and the low fish abundance and diversity in the east branch of the Finnis River below the former Rum Jungle Mine site (Jeffrey and Twining, 1998 cited in Appendix 4). However, current practices appear to be aiding the recovery of fish populations.

Mining activities that significantly increase erosion, sedimentation, inflows of toxic metals and changes in pH (e.g., acid rock drainage) are likely to have an impact on local aquatic fauna populations.

### ***Mine Dewatering and Watertable Changes***

Mine dewatering, advance dewatering and other hydrological changes have the potential to affect habitats and associated fauna species in the area surrounding the proposed mine pit, although such changes will occur within a context of considerable seasonal fluctuation of groundwater levels. Two potentially vulnerable habitats that occur adjacent to the mine pit are melaleuca woodland and monsoon vine-forest.

### ***Sedimentation of Waterways***

Disturbance to soils from construction activities may result in increased soil erosion and transport of soils to local waterways, such as the East Finnis River. This can affect water quality parameters such as total suspended solids, pH and dissolved oxygen, which can alter the quality of habitat for aquatic species.

### ***Traffic***

Traffic through the project area and surrounds may lead to collisions with fauna, with the partridge pigeon being particularly vulnerable to traffic impacts.

## **7.2.5 Avoidance, Mitigation and Management Measures**

Avoidance, management and mitigation measures will be developed to minimise the impact of the project on local fauna. The primary impacts to fauna and significant fauna habitats relate to the proposed vegetation clearing and project layout.

The on-going implementation of the site-specific Biological and Land Management Plan (see Section 9.8.3) will ensure that impacts to vegetation communities, habitat and threatened species are sensitively managed.

### **Habitat Loss and Fragmentation**

Measures designed to avoid, mitigate and manage habitat loss will include the preparation of a Mining Management Plan (MMP) to the satisfaction of the Northern Territory Parks and Wildlife Commission prior to vegetation clearing. Other measures are as described in Section 7.1.4.

### **Fauna Management**

In addition to the mitigation and management measures outlined for minimising habitat loss and fragmentation, additional measures to be implemented for the protection of fauna will include:

- No trapping or killing of native wildlife (including fishing) within the mining lease area.
- Controls on firearms, feeding native wildlife and domestic pets.
- Good industry housekeeping practices.

### **Significant Species**

To minimise the effects of the development on significant species, the following measures will be implemented:

- Vegetation disturbance associated with the proposed infrastructure will be minimised where possible to prevent unintended changes in the structure and condition of *Eucalyptus miniata* and *E. tetradonta* +/- *E. chlorosachys* open forest to woodland and smaller remnants of vine forest.
- During construction, habitat will be protected from disturbance to the greatest extent possible.
- Maintenance of preferred red goshawk habitats, in particular riparian vegetation and *Melaleuca* communities, will be taken into account when designing fire management practices in the project area.

Impact mitigation will also be achieved by retention of the open woodland and riparian vegetation habitat in the southeast of the project area.

### **Sedimentation of Waterways**

This has been addressed in Section 7.8.3.

### **Acid Rock Drainage**

This has been addressed in Section 7.8.3.

**Fire**

This has been addressed in sections 9.8.2 and 7.1.4.

**Introduced Pests**

Management measures to control introduced pests, and hence mitigate potential impacts on significant fauna species, may include:

- Controlling feral pigs and cats in the vicinity of the project area.
- The establishment of small-scale measures, if possible, to reduce the impact of cane toads.

Where relevant and appropriate, site-specific control measures will be consistent with regional and/or Northern Territory management plans.

**Mine Dewatering and Water Table Changes**

Ongoing monitoring will be undertaken of habitats surrounding the mine pit, especially those dependent on stable water table levels such as the melaleuca woodland, which can provide indication of impacts of mine dewatering and or alteration of groundwater levels.

**Traffic Collisions**

Appropriate speed limits will be established along roads to enable vehicles to avoid colliding with ground-dwelling fauna emerging from vegetation. Personnel inductions will include road safety and awareness of fauna activity, especially at dawn and dusk.

**7.2.6 Residual Impact Assessment****Habitat Loss and Fragmentation**

The project's footprint is about 90 ha. Construction will result in habitat loss and fragmentation by the clearing of *Eucalyptus miniata* and *E. tetradonta* (+/- *E. chlorosachys*) open forest to woodland. This habitat supports high species diversity and significant species in the dry season. However, within the regional context, this represents a minor vegetation and habitat loss in an area where disturbance and other impacts from past mining, clearing, fires, roads and tracks and the introduction of weeds and the feral pig have impacted on the condition and structure of fauna habitat. The nearby Litchfield National Park contains at least comparative, if not greater, composition and diversity of species in an undisturbed area.

Natural regeneration of vegetation, and ultimately rehabilitation, will at least partially compensate for habitat lost during clearing (apart from areas such as the pit).

### **Significant Species**

Significant species will be impacted by the removal of vegetation during clearing of access tracks, ROM pad and other project infrastructure. Specifically, the project will have an impact on the following EPBC and TPWC listed species:

- Disturbance results in sub-optimal conditions for the northern quoll, although previous disturbance of these areas may have already influenced the population of northern quolls at this location.
- Refuge habitat for the brush-tailed phascogale is removed and/or fragmented. The local population of this species is likely to utilise large areas of open forest and woodland habitat in the region as part of a home range. Areas of suitable open forest and woodland habitat surrounding the project area may provide compensatory habitat for this species.
- The project results in altered fire regimes that remove preferred native grass habitat for the partridge pigeon. Carefully managed fire regimes will address this.

Fragmentation of habitat may impact on significant species, making them more vulnerable to predation. Vegetation clearing may also improve conditions for introduced predators such as feral cats, although this is already a significant problem across the Northern Territory.

Vegetation clearing will result in significant species being faced with a reduction in, rather than the complete removal of, suitable habitat. Natural regeneration and rehabilitation of vegetation following project closure will (at least partially) reinstate this habitat for fauna species.

There is the potential large impact of cane toads on significant species in the project area, although this would not be expected to be greater than the impact across the region as densities of the cane toad increases.

### **Sedimentation of Waterways**

This has been addressed in Section 7.8.4.

### **Acid Rock Drainage**

This has been addressed in Section 7.8.4.

### **Fire**

The impact of a large-scale wildfire on fauna would be extensive, notwithstanding the fact that the pit, haul roads and site access road will form a natural fire break against fire coming from the north and northwest. Implementation of appropriate measures is expected to satisfactorily manage the risk of smaller-scale fires with respect to fauna.

### **Introduced Pests**

Management measures are expected to adequately control the impact to fauna of introduced pests such as the feral pig and feral cat within the project area. These species are relatively common in habitats in the wider area. The impact of the cane toad on significant fauna species is likely to be more difficult to manage and cannot be quantified.

### **Traffic Collisions**

Collisions between fauna and traffic are unavoidable, although it is unlikely that these will significantly impact local fauna populations. The noise and vibration from haulage trucks and four-wheel drive vehicles within the study area may act as a deterrent to fauna crossing the road during haulage. Other site roads will be speed-limited.

## **7.3 Air Quality**

An air quality impact assessment for the Browns Oxide Project was undertaken by Holmes Air Sciences and is included as Appendix 1. This section summarises the findings of the assessment.

### **7.3.1 Existing Conditions**

The project area is remote from pollution sources and the only air pollutant that is likely to be present at significant concentrations is particulate matter from wind-blown dust and bushfire smoke during the dry season.

No direct monitoring of existing air quality has been undertaken.

### **7.3.2 Potential Issues**

The main potential air quality issue is liberation of particulate matter (measured as total suspended particulates (TSP),  $PM_{10}$  and  $PM_{2.5}$ )<sup>1</sup> from the handling and transport of ore and waste, and from wind erosion.

Project emissions of combustion products such as carbon monoxide, nitrogen dioxide and sulfur dioxide from the burning of fuels (mostly diesel) and from blasting are in practice too small and too widely dispersed, even on large open cut mines, to impact air quality other than in the immediate vicinity of their discharge.

### **7.3.3 Avoidance, Mitigation and Management Measures**

The following measures will be taken (see Section 9.8.5 for more detail):

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<sup>1</sup> See glossary for definitions.

- Exposed areas susceptible to wind erosion will be kept to the smallest area practicable.
- Trafficked areas will be clearly defined and management practices put in place to ensure that vehicles keep to official roadways and travel at an appropriate speed.
- Dust suppression will be implemented for trafficked areas, exposed surfaces, material transfer points, and similar.
- Containerised transport of products.
- Progressive revegetation.

**7.3.4 Residual Impacts**

The use of the standard dust control measures for mines in Australia and the specific measures outlined in Section 7.3.3 are expected to ensure that relevant dust assessment criteria (generally based on NSW Department of Environment and Conservation and National Environment Protection Measures for Ambient Air Quality) are met (see Appendix 1). It is estimated that the mine will emit 260 t/a of TSP (or 8 g/s). This is a modest emission rate and mines with a higher TSP and operating with a buffer zone of approximately 2 km are able to comply with ambient air quality criteria.

**7.4 Greenhouse Gas Emissions**

**7.4.1 Emissions Estimates**

Greenhouse gas emissions produced during the construction and operation phases of the project have been estimated using AGO [Australian Greenhouse Office] Factors and Methods Workbook (AGO, 2004). Estimates do not include the one-off greenhouse emission from vegetation clearing (see Section 7.1) or minor emissions from the hydrometallurgical process.

During construction, it is estimated that 25 t of diesel (30 kL) will be consumed each week by transport, earthmoving and similar activities, and by one or more on site generators. This will result in an annual point source production of 4,200 t CO<sub>2</sub>-e (Table 7.17) and, over the peak nine months of construction, a total of 3,200 t CO<sub>2</sub>-e.

**Table 7.17 Greenhouse gas emissions**

Energy Source	Use	Amount per Year	Energy Content*	Energy per Year (PJ)	Emission Factor*	GHG Emissions per Year (t CO <sub>2</sub> -e)
<i>Construction</i>						
Automotive diesel	Transport, earthmoving equipment, construction equipment, generators	1,300 t (1,560 kL)	38.6 GJ/kL	0.06	2.7 t CO <sub>2</sub> -e/kL (point source)	4,200

**Table 7.17 Greenhouse gas emissions (cont'd)**

Energy Source	Use	Amount per Year	Energy Content*	Energy per Year (PJ)	Emission Factor*	GHG Emissions per Year (t CO <sub>2</sub> -e)
<i>Operations</i>						
Automotive diesel	Transport, earthmoving equipment, mining equipment	2,600 t (3,120 kL)	38.6 GJ/kL	0.12	2.7 t CO <sub>2</sub> -e/kL (point source)	8,400
Electricity	Processing plant, on site power	0.19 PJ (54 GWh)	-	0.19	206 Gg CO <sub>2</sub> -e/PJ (full fuel cycle)	39,000
Operations total		-	-	0.31	-	47,400

\* AGO (2004).

During operations (excluding exploration), it is estimated that 50 t of diesel (30 kL) will be consumed by the project each week (see Section 4.12.1), with a maximum electrical load of 7.5 MW being sourced from the Power and Water Corporation (PAWC)<sup>1</sup> (see Section 4.12.1). Therefore, annual greenhouse gas emissions are estimated to be 47,400 t CO<sub>2</sub>-e during operations (see Table 7.17).

#### 7.4.2 Potential Issues

Compass will need to minimise emissions wherever practicable to ensure compliance with the Northern Territory Government's objective that greenhouse gas emissions from new and expanding operations are as low as practicable.

#### 7.4.3 Avoidance, Mitigation and Management Measures

Methods used throughout construction and operation will reflect best practice for greenhouse gas emission reduction. Specific activities will include:

- Develop and apply policies and procedures for efficient mine operation.
- Minimise haul distances.
- Monitor energy consumption (e.g., diesel and electricity), calculate greenhouse emissions and compare to target emissions.
- Identify and assess economically viable opportunities for improvement.

<sup>1</sup> Energy for the project area will be sourced from the Northern Territory PAWC through gas turbine generators at the Channel Island Power Station.

- Where appropriate, establish measurable greenhouse emission targets that reflect ongoing improvement.
- Prepare bi-annual reports outlining the details of improvement programs designed to reduce total greenhouse gas emissions and improve efficiency.
- Consider use of alternative fuels (e.g., bio-diesel).
- Present a summary of Compass' commitment to minimising the project's contribution to greenhouse gas emissions in the company's annual reports.

The project's environmental management plan will outline a program for greenhouse gas emissions monitoring, review and reporting. The project will not be classified as a large energy user (0.5 petajoules or more per year) that would require public reporting of greenhouse gas emissions.

#### **7.4.4 Residual Impacts**

In 1990, total Australian emissions were 395,061 Kt CO<sub>2</sub>-equivalent, of which the predicted operations emissions from the Browns Oxide Project will represent an increase of about 0.012%. The project will therefore have a negligible impact on national greenhouse gas emissions.

For comparison, project-related emissions (during operations) are equivalent to the annual greenhouse gas emissions of about 3,160 Australian households (where the average emission is about 15 t of greenhouse gases per year).

### **7.5 Noise**

A noise impact assessment for the Browns Oxide Project was undertaken by Holmes Air Sciences and is included as Appendix 1. This section summarises the findings of the assessment.

#### **7.5.1 Existing Conditions**

Anecdotal evidence indicates that existing noise levels in the project area are low, although no quantitative noise survey has been undertaken. The noise assessment assumes that the rating background noise level (RBL) is 30dB(A), which establishes a conservative basis for assessing noise impacts.

#### **7.5.2 Potential Issues**

The main potential noise issue is noise increment above background at the closest non-company residence (approximately 2 km to the southwest of the pit). Potential sources of noise and vibration include:

- Mobile mining equipment, including the excavator, drill and bulldozer.
- Reversing alarms.
- Process plant.
- Blasting operations.

### 7.5.3 Avoidance, Mitigation and Management Measures

The following measures will be taken:

- Mining will occur during day shifts.
- Mobile mining equipment such as bulldozers, trucks and other earthmoving equipment will be fitted with reversing horns. Standard reversing alarms, which typically have a sound power level of 115 dB(A), would almost certainly give rise to noise levels above the night time assessment criterion at least 2 km away. Instead, smart alarms will be used, which reduce noise emissions and use a less tonal sound.
- Crusher will operate during day shift only.
- Noise and blasting impacts will be monitored by complaint. If necessary, additional mitigation measures will be introduced. Strict management of blasting procedures will be undertaken to mitigate the impact from blasting activities. This will address both the design and implementation phases of the blasting process.

### 7.5.4 Residual Impacts

Noise impacts will be controlled to a level that will meet the assessment criteria that would apply to similar mines in NSW based on the use of acoustic treatment or shielding for the process plant and smart alarms on items of mobile plant.

## 7.6 Infrastructure and Transport

### 7.6.1 Existing Conditions

#### *Electricity*

Batchelor is connected to the Northern Territory electricity grid and is supplied via a 22-kV branch line from the main 132-kV service line (that runs parallel to the Stuart Highway from Channel Island Power Station on Darwin Harbour to Katherine).

#### *Water and Sewerage*

Potable water is supplied to Batchelor via two potable supply bores located within the town boundary. These bores feed a 4.8 ML storage tank from which water is distributed via the local distribution system. There is surplus storage and bore capacity at present with no major upgrades proposed in the next five years (Pudney pers. com. 2005a). Rural areas are serviced by bore water and/or rain tanks.

The Batchelor township is serviced by a gravity-reticulated sewerage system which conveys sewage to waste stabilisation ponds located southwest of the town centre. No system upgrades are proposed in the next five years; however, additional loads may require system augmentation (Pudney pers. com. 2005a).

### **Telecommunications**

Telephone and facsimile services are available in Batchelor via the Telstra network. Telstra's code division multiple access (CDMA) network provides mobile phone coverage.

### **Transport**

Coomalie is presently served by a road network that is based around the Stuart Highway. A sub-arterial road provides access to Batchelor and Litchfield National Park. June to September, inclusive, are the busiest months of the year for traffic with daily vehicle counts from 774 to 959 between the Stuart Highway and Batchelor (Figure 7.4). Similarly, the road from Batchelor to Litchfield National Park is busiest from June to August, inclusive, with vehicle counts ranging between 517 and 700. More than 80% of the vehicles on these roads are sedans/wagons/4WDs/utilities/light vans/bicycles and motorcycles and up to a further 5% are towing trailers/boats/caravans. Up to 3% of vehicles are articulated (Territory Asset Management Services, 2004).

In contrast to the Batchelor and Rum Jungle roads, both of which are sealed, the remainder of roads in the area are connector roads that service the rural and pastoral land uses and, for the most part, are unsealed, which can create difficulties for users with restricted access in times of heavy rain and flooding.

The Darwin to Alice Springs Railway was opened for freight and passengers in January and February 2004, respectively. The railway completes the national railway network and generally runs immediately west of the Stuart Highway alignment. The closest station to the project is Darwin.

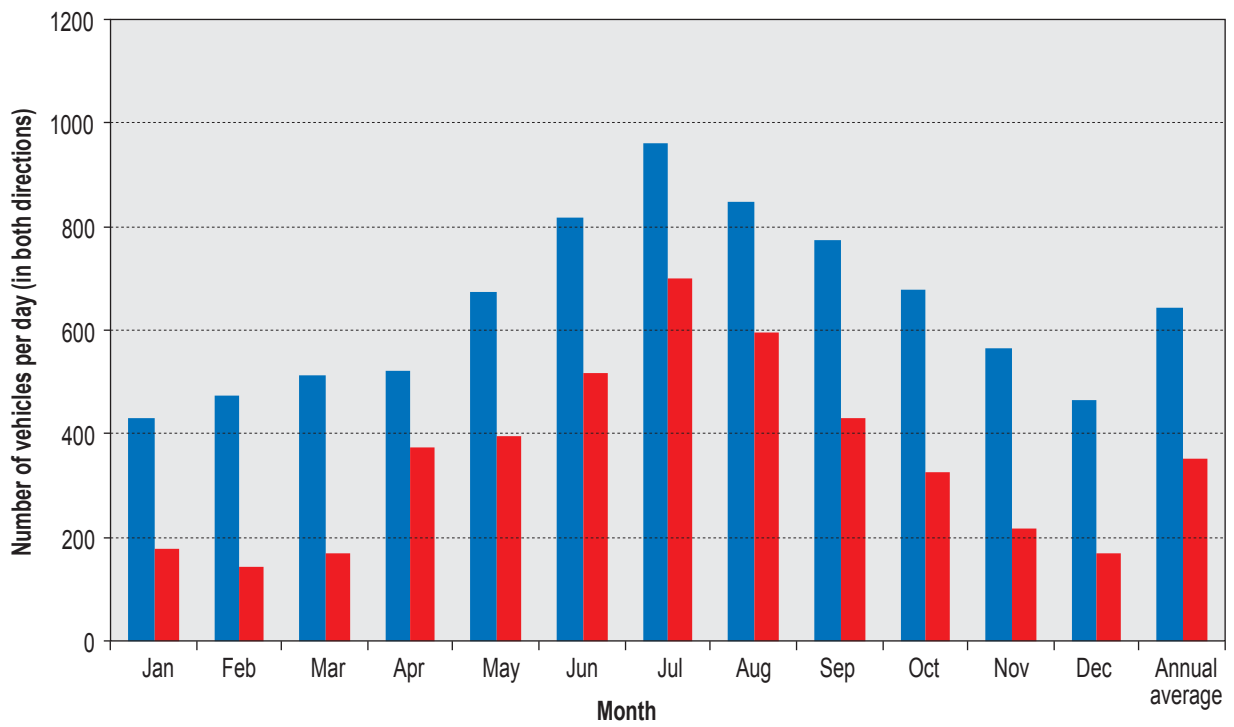
#### **7.6.2 Potential Issues**

Potential issues relating to the project include:

- The ability of current services and facilities to support the development (in terms of Batchelor's ability to support an increased population associated with the workforce and the provision of services to the development).
- Changes to local traffic volumes and resulting safety and amenity issues.

#### **7.6.3 Avoidance, Mitigation and Management Measures**

Where possible, employees will be sourced from the local area, e.g., Batchelor and Adelaide River, or within commuting distance (this would include employees resident in Darwin, particularly the southern rural areas) so that relocation will be minimised.



■ Batchelor Road   
 ■ Litchfield National Park Road

Source: Territory Asset Management Services (2004) [R020].

	Job No: 836	Compass Resources NL	<b>Average daily traffic</b>	<b>7.4</b>
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Project-associated traffic, e.g., larger construction vehicles and smaller vehicles associated with operations traffic (mainly associated with suppliers and servicing requirements) will be managed to minimise hazards and disruptions. This will include the encouragement of car pooling to reduce traffic quantities and driver fatigue, and instructing employees and contractors to adhere to speed limits on public roads. Compass will monitor amenity issues associated with project-related traffic and transport and, if necessary, will consider other mitigation measures. Contractors employed to transport products and supplies will be expected to comply with appropriate legislation and have their own OHS policies (that include fatigue management) in place.

Lithgow Road is currently a gazetted road that has not been maintained, and it is anticipated that this road will be upgraded and, together with Bevan Road, will provide alternate access for residents who currently rely on the Rum Jungle–White Road route (Plate 7.1). The Rum Jungle Road north of the Litchfield Park turnoff and White Road will be restricted access for the mine site only. Maintenance (especially after the wet season) of these sections of road will be the responsibility of Compass (see Section 4.12).

#### **7.6.4 Residual Impacts**

##### ***Electricity***

The power requirement for the site is approximately 7.5 MW. Electricity requirements for the project will be met by extending the current mains power line from the Northern Territory electricity grid to the site. Compass has discussed this option with the Power and Water Corporation. The existing Batchelor power supply will not be affected by the project.

##### ***Water and Sewerage***

Water requirements for the project, both potable and processing, will be met by groundwater extraction from an unconfined shallow aquifer (the environmental impacts associated with groundwater extraction are discussed in Section 7.9). It will not be necessary to utilise Batchelor's water scheme.

Taking into account peak tourist demands, population increases associated with short-term construction requirements or the relocation of key operations personnel will be accommodated within Batchelor's existing water scheme, as the biggest influence over demand and supply is outdoor water supply, e.g., sporting ovals and swimming pools (Pudney pers. com., 2005b).

Similarly, based on the average demand per person for sewage treatment, sufficient capacity exists in the sewerage system to accommodate a project-related increase in Batchelor's population (Pudney pers. com., 2005b).



**Plate 7.1**  
Rum Jungle Road and White Road  
intersection



**Plate 7.2**  
Gauging station GS8150200, immediately  
downstream of the former Rum Jungle  
mine site



**Plate 7.3**  
East Finnis River viewed looking upstream  
from Rum Jungle Road during the late  
wet season (March 2005)

## **Transport**

Road upgrading and maintenance has been identified as one of the major issues affecting the local community. Because of climatic conditions, costs for road maintenance are high.

During operations, the traffic generated by the project will include employee vehicles, fuel trucks and supply trucks (on a regular basis), and up to four (100 t) trucks per day will transport acid to site and copper cathode product and cobalt and nickel hydroxide or sulfide products from site to the Port of Darwin.

An increase in local traffic will probably be noticeable during construction, which is scheduled to commence in the first quarter of 2006, i.e., the wet season and a quieter time of the year. However, traffic volume will decrease significantly following completion of construction. There will be approximately 365 vehicle movements per week (52 per day) during operations which, for the Litchfield Park Road, is equivalent to approximately 7% of the current maximum daily peak during the tourist season in July, and 30% of the current daily peak during December. Mitigation and management measures outlined in Section 7.6.3 will ensure that traffic hazards and adverse impacts on amenity will be minimal.

Landholders beyond the mine site may experience slightly increased travel distance to and from Batchelor associated with the closure of White Road and a section of the Rum Jungle Road.

## **7.7 Land and Resource Use**

### **7.7.1 Existing Conditions**

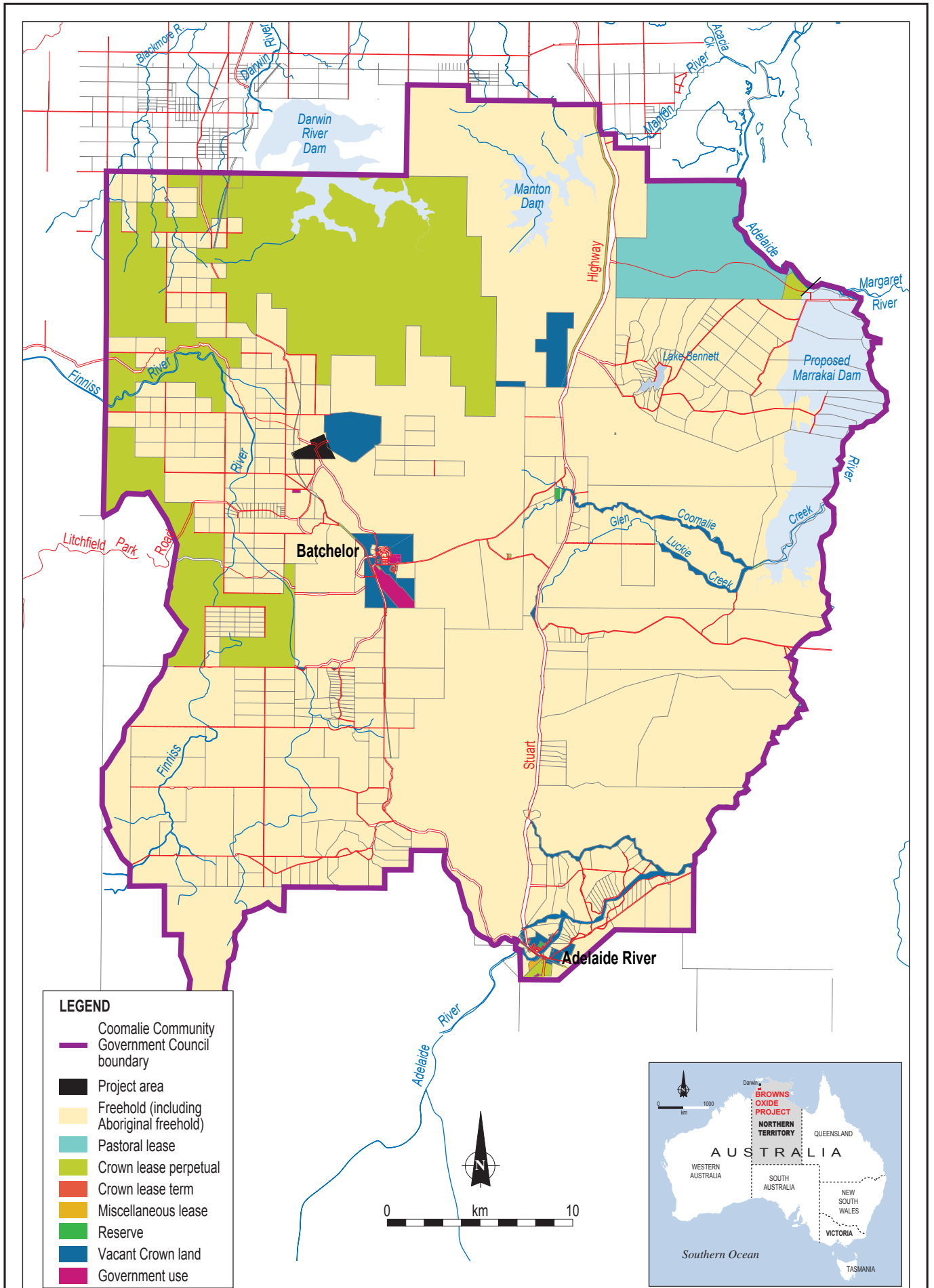
The description of land and resource use is drawn from DLPE (2000).

#### **Land Tenure**

The project is located within the Coomalie Community Government Council (Coomalie), which covers a total area of 1,507 km<sup>2</sup> (Figure 7.5). In 2002, approximately 80% of the properties in the area were under freehold title (and this is considerably higher than in any other Northern Territory region, with the exception of urban centres) (Price and Baker, 2003).

Less than 2% of the land was vacant Crown land, including the former Rum Jungle Mine site. Only one property, comprising about 0.01% of the region, is classified as a reserve, and this is located along Coomalie Creek where it intersects the Stuart Highway (Price and Baker, 2003).

The Power and Water Corporation owns or manages 17% of the Coomalie region for protection of the Darwin River Dam catchment. The Northern Territory Land Corporation



Source: DLPE (2000) [R004].



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836

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836\_08\_F7.05\_HB

**Compass Resources NL**

**Browns Oxide Project**

**Coomalie land tenure**

Figure No:

**7.5**

also holds Crown leases over approximately 5% of the area, these being old pastoral stations in the west of the region, and riparian corridors along the Adelaide River. The Finniss River Aboriginal Land Trust owns several freehold blocks covering 180 km<sup>2</sup> (12% of the region) (Price and Baker, 2003).

The project is located in areas of predominantly Aboriginal freehold land (see Figure 7.5) immediately west of, and adjacent to, the historic Rum Jungle Mine. Mining and exploration licences associated with the project are described in Section 4.1.

### **Land Use Objectives**

The Northern Territory *Planning Act* provides for a single integrated Northern Territory Planning Scheme, which comprises land use objectives (policy), development provisions (town, area and community plans) and incorporated documents (assessment criteria and guidelines). For the Browns Oxide Project area, the relevant document under this act is the Coomalie Planning Concepts and Land Use Objectives (DLPE, 2000). Mining activity in this area is consistent with the planning scheme.

The key land use objectives for the Coomalie region are to (DLPE, 2000):

- Protect land and water resources.
- Promote and use the natural attributes of the region.
- Provide an integrated transport network.
- Promote human health.
- Promote tourism development.
- Promote development of mining and extractive industries.
- Protect vegetation and prevent land degradation.
- Protect sites with significant heritage status.

Additional land use objectives in relation to the mining and extractive industry include:

- Providing mine access routes.
- Establishing appropriate land uses on mine sites, as part of the rehabilitation program, prior to mining lease surrender.
- Minimising the impact of mining and extractive industries on human health.

### **Land Use**

Current and proposed land use in Coomalie is defined in DLPE (2000) and summarised in Figure 7.6.

Residential development in Coomalie is either urban, as occurs at Adelaide River and Batchelor, or rural.

Commercial and retail activity is primarily focused in Adelaide River and Batchelor, with some additional services along the Litchfield Park Road. Three zones within the Batchelor Town Plan are allocated for business use.

The main industrial precinct within Coomalie is located at Batchelor where 19 lots cater for industrial, light industrial and service commercial land uses. A second industrial area of 30 lots is located near Batchelor, approximately 2.5 km southwest of the proposed project site.

Horticulture/agriculture is considered to be one of the major and more sustainable contributors to the local economy. There is a strong and growing interest in horticulture with an increasing number of landowners entering the industry, particularly in areas with high ground water potential around Batchelor and along the fertile levees of the Adelaide and Finnis rivers.

Cattle grazing occurs mainly in the southeastern and southwestern parts of Coomalie, although there is property to the south of the project site that is also used for cattle grazing.

The Litchfield National Park is located approximately 30 km west of Batchelor and provides reserved and recreational land use. The 1,800-km<sup>2</sup> park is a large wildlife reserve that protects extensive examples of 'Top End' habitat and is capable of supporting viable populations of most species that live there. The park also includes numerous waterfalls, historical sites and landscape features of geomorphological interest.

Figure 7.6 shows that the Browns Oxide Project is located in an area delineated as 'grazing (natural pastures)' in the Coomalie Land Use Structure Plan.

### **Resource Use**

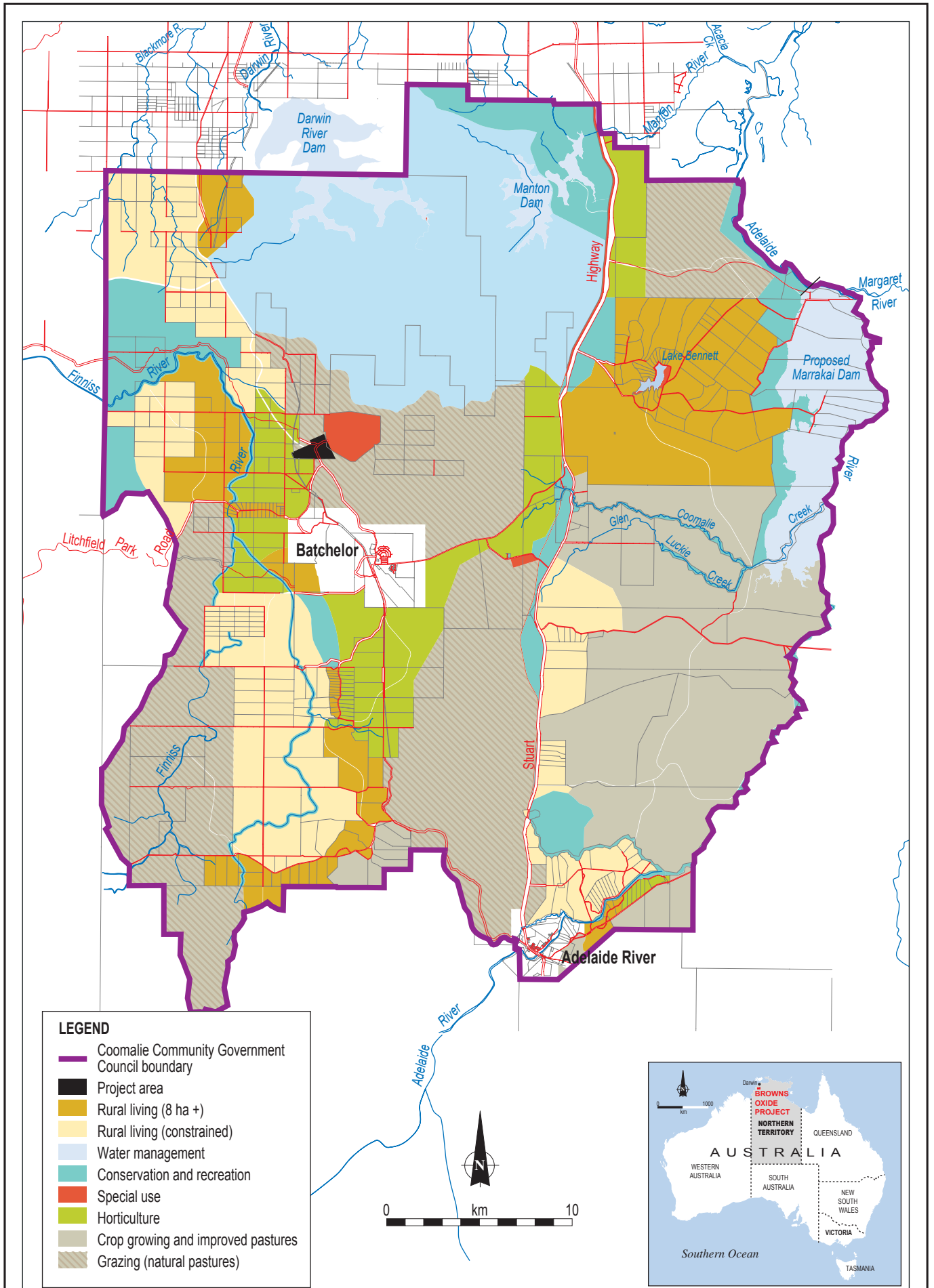
The Coomalie region provides the main source of potable water for greater Darwin, via the Darwin River Dam (and the Manton Dam, now rarely used) (see Figure 7.6). It is proposed that Coomalie will play an important role in Darwin's future water supply with two additional dams being planned.

Good supplies of groundwater are generally available in a range of locations within Coomalie, including the town of Batchelor and areas to the northwest of Batchelor (where the project is located).

Coomalie is recognised as being highly prospective and mineral-rich and the mineral and extractive industry is considered one of Coomalie's strongest sources of employment and economic growth.

### **7.7.2 Potential Issues**

The Browns Oxide Project will utilise approximately 90 ha to extract and process copper, cobalt and nickel. This will alter the current landform and possibly impact land and resource use.



### 7.7.3 Avoidance, Management and Mitigation Measures

The project will be designed, constructed and operated in a manner that is consistent with the Coomalie Planning Concepts and Land Use Objectives (DLPE, 2000), which provides the framework for developing the Coomalie region in a manner that preserves its rural nature while allowing continued development at a sustainable level.

These land use objectives will primarily be achieved by:

- Ongoing consultation and negotiation with the Northern Land Council and traditional owners, to ensure that consideration is given to the traditional use by Aboriginal people of land surrounding the project area when planning project activities.
- Siting and designing infrastructure and ancillary facilities to minimise the footprint to the greatest practical extent.
- Implementing the environmental management plan (Chapter 9).
- The mine closure planning process, including the identification of appropriate post-closure land uses (see Section 9.10).

### 7.7.4 Residual Impact Assessment

Development of the Browns Oxide Project will be an extension of preliminary mining activities, i.e., exploration and evaluation of resources, that have been undertaken in the region since the late 1940s. Indeed, early records show mining in the area as early as 1907. Given the relatively small footprint of the project within an existing mining area, development of the site will not significantly change the existing land use and will facilitate the expansion of the resource development industry (which is a key land use objective for the Coomalie region).

The project is not located within Darwin's current potable water catchment area; therefore, impacts on the water supply area are not anticipated.

Residual impacts on groundwater resources are discussed in Section 7.9.

Development of the project and associated increased traffic volumes are not expected to deter tourists from visiting the Litchfield National Park. Other opportunities for tourism are discussed in Section 7.10.

## 7.8 Surface Water

### 7.8.1 Existing Conditions

#### *Hydrology*

**East Finniss River.** The East Finniss River is an ephemeral stream that drains to the northwest, meeting the Finniss River some 8 km downstream from the project area. A gauging station (GS8150097) is located on the East Finniss River, 5.6 km downstream of the former Rum Jungle Mine site and 2.3 km upstream of the confluence with the Finniss

River (Figure 7.7). This station has been the designated site for estimating annual pollutant loads for the Rum Jungle Rehabilitation Project (see Section 3.2). A continuous gauging station (GS8150200) also operated immediately downstream of the former Rum Jungle Mine site (see Figure 7.7 and Plate 7.2) during the periods 1981–1988 and 1991–1998.

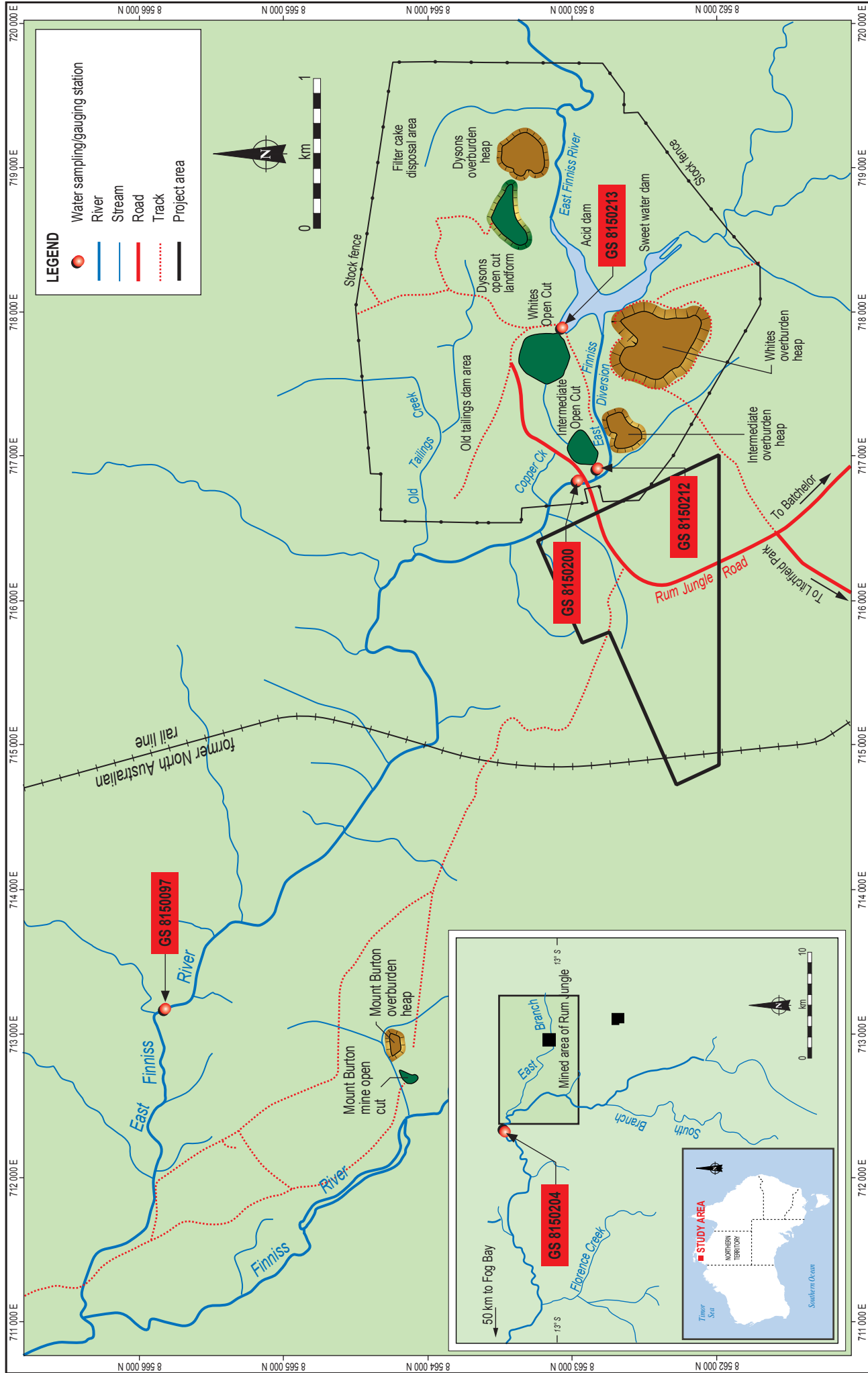
Base flow is generally not established in the East Finniss River (Plate 7.3) until sustained monsoonal rains arrive in January and is generally sustained until April. An annual hydrograph of the East Finniss River at GS8150097 for 1972/73, when rainfall was similar to the annual mean, is shown in Figure 7.8, while a hydrograph for the available record (1965 to 2005) is shown in Figure 7.8. Flow usually commences up to one month later at GS8150097 than at GS8150200, due to early wet season rainfall patterns and the time required to wet-up the river bed (Lawton and Overall, 2002a). Salts evaporated on the river bed following the recessionary flow of the previous year (Plate 7.4) are remobilised during these first rain events. Contaminant inputs to the East Finniss River then occur due to flows from the open cut pits and seepages from the overburden heaps at Rum Jungle.

**Finniss River.** During the dry season, the Finniss River typically consists of a series of long still pools of about 3 m water depth connected by shallower sections. During the wet season, overbank overflow often occurs and the depth and speed of flow along the river is more uniform than during the dry season (Jeffree and Williams, 1980).

A stream gauging station (GS8150204) operated on the Finniss River several kilometres downstream of the confluence of the East Finniss River (see Figure 7.7) during 1982–88 and 1993–95. Stream gauging stations that are currently operating on the Finniss River are located upstream of the confluence with the East Finniss River (Batchelor; GS8150010) and some distance downstream from the confluence (Gitchams; GS8150180), both at potential dam sites. Hydrographs for the available record for these two locations are shown in Figure 7.9.

### ***Water Quality***

Information on water (and sediment) quality of the East Finniss and Finniss rivers is mostly provided by monitoring undertaken by the Department of Natural Resources, Environment and the Arts (DNRETA) and Australian Nuclear Science and Technology Organisation (ANSTO) as part of the Rum Jungle Rehabilitation Project. Additional data is also provided by First National Assessment of River Health (FNARH) macroinvertebrate surveys in 1998–99 and Charles Darwin University (CDU) surveys undertaken during 2003–2005. Data from these programs is described in detail in Appendix 2.



<p>Job No: 836</p> <p>File No: 836_08_F7.07_HB</p>		<p>Compass Resources NL</p> <p>Browns Oxide Project</p>		<p>Figure No: 7.7</p>
<p>Source: Lawton and Overall, 2002.</p>				

Period 1 Year Plot Start 00:00\_01/07/1972  
 Interval 12 Hour Plot End 00:00\_01/07/1973

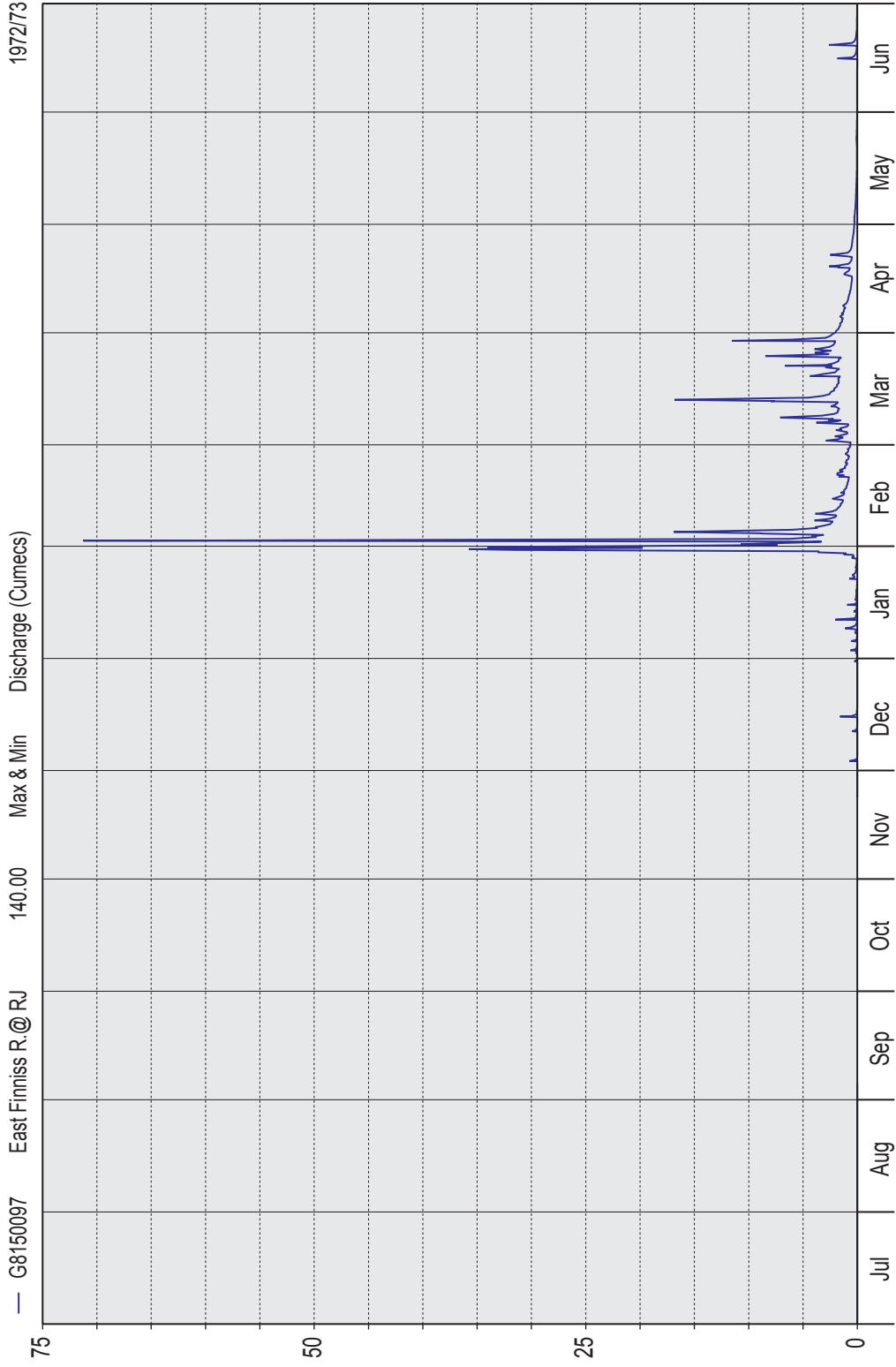


Figure No: **7.8**  
**Annual hydrograph for the East Finniss River at G8150097 during 1972/73**

Compass Resources NL  
 Browns Oxide Project

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 File No: 836\_08\_F7.08\_HB





**Plate 7.4**

East Finnis River viewed looking upstream from Rum Jungle Road during the dry season (July 2002). Note the salts evaporated on the river bed.



**Plate 7.5**

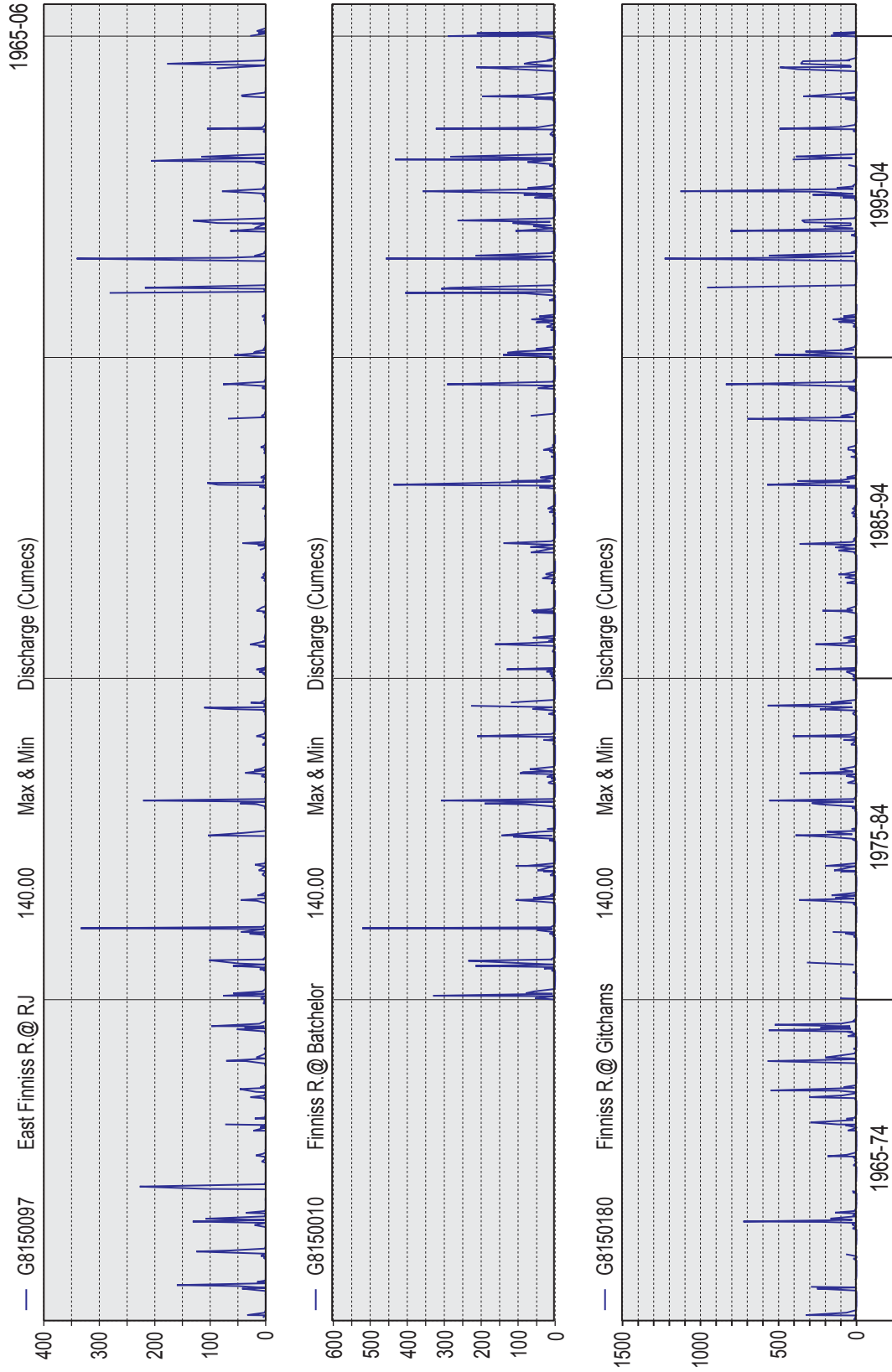
Finnis River at Litchfield Park Road (July 2002)



**Plate 7.6**

Finnis River immediately downstream of Litchfield Park Road (July 2002)

Period 41 Year Plot Start 00:00\_01/01/1965  
 Interval 1 Month Plot End 00:00\_01/01/2006



**East Finnis River.** Metal loads and concentrations have decreased compared to levels prior to remediation of the Rum Jungle Mine site, however, they remain sufficiently elevated to impact on the freshwater ecosystem of the East Finnis River (Lawton, 1998b). Median total Cu concentrations at GS8150097, 5.6 km downstream of the former Rum Jungle Mine site, have decreased from about 7 mg/L pre-remediation (1968–81) to less than 0.5 mg/L post-remediation (1990–95), i.e., greater than a 90% reduction in concentration (Lawton and Overall, 2002a). Median total Zn concentrations have reduced from about 1.6 mg/L pre-remediation to about 0.4 mg/L post-remediation, i.e., a 75% reduction in concentration. Median total Mn concentrations have reduced from about 3 mg/L pre-remediation to about 1 mg/L post-remediation (1990–95), i.e., a 67% reduction in concentration.

Concentrations of pollutants in the East Finnis River tend to be highest during the first flush of the wet season and during the late wet season recessional flows when dilution effects are minimal.

Approximately 70 t/a of Cu, 80 t/a of Mn and 25 t/a of Zn was estimated to be delivered to the Finnis River from the former Rum Jungle Mine site via the East Finnis River during years of normal rainfall before remediation. Jeffree et al. (2001) determined post-remediation loads (for the period 1990–93) to have been reduced seven times for Cu, five times for Zn, four times for Mn and three times for sulfate. The latest data obtained by CDU in 2003–04 (see Appendix 2) indicates that annual loads of Cu, Mn and Zn remain generally similar to loads reported by Lawton and Overall (2002a) during the late 1990s.

Summary statistics of metal concentrations from 14 sampling occasions undertaken by CDU during the wet seasons of 2003–04 and 2004–05 near GS8150097 are shown in Table 7.18. Also shown in the table are ANZECC/ARMCANZ (2000) Australian water quality guideline (AWQG) trigger values (TVs) for protection of slightly to moderately disturbed ecosystems, which apply to filtered metal concentrations. Values are adjusted for water hardness, based on water being classified as 'very hard'<sup>1</sup>. There is some evidence of a further decrease in metal concentrations since 1990–95. However, concentrations of Cu on all sampling occasions have exceeded TVs for protection of slightly to moderately disturbed ecosystems, which are based on protecting 95% of species with 50% confidence. For ecosystems that can be classified as highly disturbed, it may be considered appropriate to apply a less stringent trigger value, such as TVs that protect 90% of species, or perhaps even 80% (ANZECC/ARMCANZ, 2000). The trigger value for Cu that protects 80% of species and is adjusted for 'very hard' water hardness is 0.013 mg/L, and is still exceeded on all sampling occasions. The median Cu concentration is over four times higher than this less stringent TV.

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<sup>1</sup> Data presented in Lawton and Overall (2002a) show water hardness of the East Finnis River to range from 'extremely hard' (400 mg CaCO<sub>3</sub>/L) about 1 km downstream from the Rum Jungle Mine site to 'very hard' (180–240 mg CaCO<sub>3</sub>/L) towards the confluence with the Finnis River.

**Table 7.18 Metal concentrations in East Finniss River at GS8150097 during wet seasons of 2003–04 and 2004–05**

Metal (n=14)		Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)	% of Metal Present in Filterable Form	AWQG TVs (95% protection level) (mg/L)
Al	Total	0.016	0.483	0.284	0.248	-	-
	Filtered	0.005	0.095	0.032	0.034	14	ID
Cd	Total	0.0002	0.0009	0.0003	0.0004	-	-
	Filtered	0.0002	0.0009	0.0003	0.0003	93	0.0011
Co	Total	0.072	0.215	0.111	0.120	-	-
	Filtered	0.071	0.214	0.110	0.118	99	ID
Cu	Total	0.053	0.182	0.134	0.136	-	-
	Filtered	<b>0.018</b>	<b>0.143</b>	<b>0.057</b>	<b>0.062</b>	46	0.0073
Fe	Total	0.127	0.411	0.278	0.269	-	-
	Filtered	0.0007	0.023	0.0006	0.0007	2	ID
Mn	Total	0.221	1.36	0.439	0.534	-	-
	Filtered	0.215	1.29	0.445	0.531	99	1.9
Ni	Total	0.066	0.204	0.099	0.109	-	-
	Filtered	<b>0.065</b>	<b>0.202</b>	<b>0.097</b>	<b>0.107</b>	98	0.057
Pb	Total	0.0003	0.0015	0.0010	0.0009	-	-
	Filtered	0.00002	0.0002	0.00002	0.00004	5	0.040
U	Total	0.005	0.014	0.008	0.009	-	-
	Filtered	0.003	0.011	0.005	0.005	58	ID
Zn	Total	0.063	0.277	0.115	0.126	-	-
	Filtered	0.054	<b>0.289</b>	<b>0.107</b>	<b>0.118</b>	94	0.072

ID = insufficient data to establish trigger value.

Values in bold exceed AWQG TV for protection of slightly to moderately disturbed ecosystems (95% protection level).

Concentrations of Ni and Zn also exceed TVs that protect 95% of species.

There is a consistent pollution gradient in the East Finniss River downstream from the former Rum Jungle Mine site. An extensive survey conducted during late wet season flow in 1994 showed that concentrations decrease in a gradient to about half the initial concentration 5.6 km downstream at GS8150097 (Lawton and Overall, 2002a). The recent water quality surveys undertaken by CDU during the 2003–04 and 2004–05 wet seasons also found that metal concentrations near the former Rum Jungle Mine site were up to about two-fold higher than measured further downstream at GS1850097 (see Table 7.18).

The same pollution gradient is evident during the dry season. Dostine (2002) reports that total Cu concentrations in the early 1998–99 dry season were 1.6 mg/L immediately downstream of the former Rum Jungle Mine site, decreasing to 0.02 mg/L near the confluence with the Finniss River. Total Cu concentrations along the East Finniss River were lower during the late dry season, ranging from 0.32 to 0.015 mg/L. The same trend of decreasing concentrations along the East Finniss River and lower concentrations

during the late dry season compared to the early dry season were also observed for total Mn and Zn.

The CDU surveys in 2003 and 2004 also included sampling of water pools formed in the East Finniss River during the dry season. At site GS8150097, metals concentrations in these pools were lower compared with concentrations in water flowing down the stream during the wet season, with the exception of Mn. In contrast, concentrations of metals in pools at GS8150200 near the former Rum Jungle Mine site were much higher than concentrations in water flowing down the stream during the wet season.

Extensive dolomite and magnesite formations underlie the former Rum Jungle Mine site. The acid-buffering capacity of these minerals has attenuated many of the impacts from acid rock drainage, although the buffering capacity of carbonate-dominated groundwater pre-remediation was often overwhelmed by the acid generated in the waste rock dumps (Lawton and Overall, 2002a). The median pH of water at GS8150097 was pH 4.2 pre-remediation (1967–81), but has improved since remediation such that the median pH for the period 1990–95 was pH 6.3 (Lawton and Overall, 2002a). CDU surveys in 2003–05 determined the pH at this location to range between 6.2 and 7.5 during the wet season (Appendix 2). The pH of water in two pools formed during the dry season of 2004 was more alkaline, with pH of 7.9 and 8.1. In contrast, upstream near the mine site at GS8150200, water in pools formed during the dry season was acidic with pH ranging between 3.5 and 4.4. The pH increased with the onset of wet seasons flows, ranging between 5.3 and 6.4.

There is limited data for total suspended solids (TSS) in the East Finniss (and Finniss) River, with most of the available data collected during the 1993–94 wet season. This data showed that approximately 111 t of suspended solids passed GS8150200 in the East Finniss River immediately downstream of the former Rum Jungle Mine site, while twice this load (219 t) passed GS8150097, 5.6 km further downstream (Lawton and Overall, 2002a). Concentrations of TSS in 12 flow-weighted composite samples collected at GS8150097 during that wet season ranged between <0.1 and 20.4 mg/L, with 11 of the 12 samples being less than 5 mg/L. The mean concentration of all of these samples was 3.3 mg/L.

More recent sampling between 3 and 28 January 2005 (by CDU) during periods of flow near GS8150097 showed TSS concentrations to range between 3.1 and 6.0 mg/L, with a mean concentration of 4.9 mg/L (Appendix 2). Slightly higher TSS concentrations were measured immediately downstream of the former Rum Jungle Mine site, ranging between 7.4 and 9.5 mg/L. During the same period, TSS concentrations in three samples from the Finniss River (immediately upstream of the confluence with the Finniss River) ranged between 10 and 37 mg/L.

**Finniss River.** Measurements of water quality of the Finniss River (plates 7.5 and 7.6) were undertaken during post-remediation fish surveys in the dry seasons of 1992 (July–August) and 1995 (July–August). General water quality characteristics of the Finniss River during these dry seasons were generally similar and can be summarised as follows (Jeffree et al. 2001):

- Shallow water depths (2 to 4 m).

- Water temperatures ranging from 19 to 24°C.
- Dissolved oxygen concentrations typically ranging from 70 to 100% saturation near the surface decreasing to approximately 10 to 30% saturation in bottom waters.
- pH ranging between 6 and 8, except at the site downstream from the confluence with Florence Creek (i.e., the furthestmost downstream site, 18 km downstream from the confluence with East Finniss River) where pH at the surface was approximately pH 6 decreasing to pH 4.5 at depth.
- Conductivity ranging from 0.01 to 0.38 mS/cm, with the lowest values measured downstream of Florence Creek due to the influence of softer waters from this watercourse which is fed by perennial springs from a sandstone aquifer.
- Low turbidity, ranging from <1 to 7 NTU.

Concentrations of total metals measured in the Finniss River pre- and post-remediation during dry season biological surveys are presented in Jeffree et al. (2001). Average concentrations of Cu, Zn, Co and Ni measured post-remediation in 1992 and 1995 decreased by one to two orders of magnitude downstream of the confluence of the East Finniss River compared with concentrations measured pre-remediation in 1973–74. Manganese concentrations also decreased but to a lesser extent. A decline in metal concentrations was also evident between 1992 and 1995. Concentrations measured along the Finniss River in the 1995 survey are shown in Table 7.19. There is only a small increment in metal concentrations, if any, downstream of the East Finniss River compared with upstream locations.

**Table 7.19 Total metal concentrations in Finniss River during the 1995 dry season**

Distance from East Finniss River Confluence (km)	Co	Cu	Ni	Mn	Ca	Mg
	mg/L					
-18.0	0.0004	0.001	0.002	0.007	22	31
-0.1	0.0006	0.002	0.002	0.021	18	38
1.0	0.0005	0.004	0.005	0.005	24	39
3.0	0.0011	0.007	0.005	0.003	18	38
15.0	0.0002	0.003	0.003	0.0004	16	26
30.0	0.0008	0.003	0.004	0.021	1	1.4
<b>AWQG TVs</b>	ID	0.0073	0.057	1.9	-	-

ID = insufficient data to establish trigger value.

Also shown in Table 7.19 are AWQG TVs for protection of slightly to moderately disturbed ecosystems. Values are adjusted for water hardness, which is classified as being 'very hard' near the confluence with the East Finniss River. Concentrations of total Cu, Ni, and Mn at all locations in the Finniss River during the 1995 dry season sampling event complied with the TVs (which are applicable to filtered concentrations).

More recent surveys were undertaken in the 1998–99 dry season for the Australia-wide Assessment of River Health (AWARH) (Dostine, 2002). Results presented in Appendix 2 show no evidence of an increase in metal concentrations in the Finniss River

downstream of the confluence with the East Finniss River. Total Cu concentrations measured in the 1998–99 are generally similar to concentrations measured in 1995.

Intensive water sampling was undertaken in the Finniss River at two locations, 1.2 km and 2.5 km downstream of the confluence with the East Finniss River, prior to and during the first flush of the East Finniss River in the 1997–98 wet season (Jeffree et al., 2001; Twining et al. 2002). Filtered metal concentrations in the Finniss River at the time when the impact of the first flush from the East Finniss River was greatest are shown in Table 7.20. Concentrations of Cu were over an order of magnitude higher than the AWQG TV, and Ni and Zn concentrations also exceeded respective TVs. However, metal concentrations were substantially reduced from concentrations measured during the first flush in 1973–74 and 1974–75, i.e., prior to remediation of the former Rum Jungle Mine site, particularly Cu which was about two orders of magnitude lower (Jeffree et al., 2001).

More recent wet season surveys have been undertaken by CDU during 2003–04 and 2004–05 in the Finniss River at Litchfield Park Road, located upstream of the confluence with the East Finniss River. Maximum filtered concentrations of all metals were less than AWQG TVs (Appendix 2).

**Table 7.20 Filtered metal concentrations in Finniss River during the first flush of the 1997–98 dry season**

Distance Downstream from East Finniss River Confluence	Co	Cu	Mn	Ni	Zn
	mg/L				
1.2 km	0.098	<b>0.155</b>	0.502	<b>0.082</b>	<b>0.301</b>
2.5 km	0.084	<b>0.120</b>	0.396	<b>0.075</b>	<b>0.134</b>
<b>AWQG TVs</b>	ID	0.0073	1.9	0.057	0.072

ID = insufficient data to establish trigger value.

Values in bold exceed AWQG TV for protection of slightly-moderately disturbed ecosystems (95% protection level).

### **Sediment Quality**

**East Finniss River.** A sediment survey was undertaken during April 1993 at 27 sites along the East Finniss River between sites GS8150097 and GS8150200 (Lawton, 1998b). Bed sediments in the East Finniss River were found to be appreciably contaminated with metals. No appreciable decrease in metal concentrations was evident with increasing distance (over 5.6 km) from the former Rum Jungle Mine site. Mean 'total' metal concentrations in the <2000  $\mu\text{m}$  fraction measured in that survey are shown in Table 7.21, along with mean background metals concentrations from control sites and interim Australian sediment quality guidelines (ISQG) recommended by ANZECC/ARMCANZ (2000). The guidelines contain two values, ISQG-low and ISQG-high, which delineate three biological effects ranges:

- Concentrations below the ISQG-low represent a range where adverse biological effects on benthic biota will rarely be observed.

- Concentrations between the ISQG-low and ISQG-high represent a range where adverse biological effects on benthic biota will occasionally be observed.
- Concentrations above the ISQG-high represent a range where adverse biological effects on benthic biota frequently occur.

**Table 7.21 Mean 'total' metal concentrations in East Finniss River**

Site	Cu	Zn	Mn	Ni
	mg/kg (dry weight)			
<b>1993 survey</b>				
East Finniss River (0–5.6 km downstream of mine; n=27)	<b>695</b>	95	240	<b>80</b>
Control sites	16	3.5	3.9	3.9
<b>2003/04 survey</b>				
East Finniss River at GS8150097 (n=4)	<b>632</b>	35	193	<b>79</b>
ISQG-low	65	200	-	21
ISQG-high	270	410	-	52

Values in bold are exceeding the ISQG-low and/or ISQG-high.

Copper and Ni concentrations in sediment of the East Finniss River are well in excess of the upper ISQG, therefore being in the range where adverse biological effects are frequently expected to occur.

A more recent sediment survey was conducted by CDU during 2003–04 (Appendix 2). These data indicate that there has been no improvement in sediment quality in the East Finniss River over the last decade.

**Finniss River.** Sediment sampling was undertaken in the Finniss River during 1996 at two sites (up to 18 km) upstream of the confluence and three sites (up to 11 km) downstream of the confluence with the East Finniss River (Jeffree et al., 2001). Total metal concentrations in those samples are shown in Table 7.22, along with ISQG recommended by ANZECC/ARMCANZ (2000). There is a marked elevation in metal concentrations at sites downstream of the confluence, decreasing with distance downstream. Metal concentrations in sediment of the Finniss River downstream of the confluence with the East Finniss River are markedly higher than metals concentrations in the sediment of the East Finniss River (see Table 7.21). Copper and Ni concentrations in sediment 4 km downstream of the East Finniss River confluence are about an order of magnitude higher than the ISQG-high, at which levels adverse biological effects frequently occur. At the furthestmost downstream site sampled (11 km downstream), Cu and Ni concentrations remain approximately two times higher than ISQG-high values. Zinc and Pb concentrations downstream of the confluence are also at levels where adverse effects could frequently be expected to occur.

**Table 7.22 Total metal concentrations in sediment of the Finnis River during 1996**

Distance from East Finnis River Confluence	Cd	Co	Cu	Fe	Mn	Ni	Pb	U	Zn
	(mg/kg dry weight)								
-18 km	0.05	5	17	5,454	101	5	16	4	<DL
-0.2 km	0.04	11	30	9,221	230	5	15	2	<DL
4 km	0.30	269	<b>3643</b>	12,284	582	<b>371</b>	<b>127</b>	129	<b>1,896</b>
8 km	0.35	193	<b>1061</b>	8,426	209	<b>191</b>	45	45	<b>1,748</b>
11 km	0.22	202	<b>404</b>	10,510	551	<b>98</b>	37	17	112
ISQG-low	1.5	-	65	-	-	21	50	-	200
ISQG-high	10	-	270	-	-	52	220	-	410

Values in bold exceed the ISQG-high.

### **Aquatic Ecology**

**East Finnis River.** Pre-remediation fish surveys during low flow showed that very few fish survived in the 10-km section of the East Finnis River downstream of the former Rum Jungle Mine to the Finnis River confluence, where concentrations of Cu and Zn measured in the water were 55 and 44 mg/L, respectively (Jeffree and Twining, 2000). Fish kills were observed to be associated with fish entering the East Finnis River from side streams (Twining, 2002). Post-remediation, in 1996 and 1997, fish kills were still observed to occur in the East Finnis River (Twining, 2002). However, up to seven species of fish have been seen living in the stream, indicating some ecological recovery post-remediation, although this is well short of the potential diversity of up to 18 fish species in similar habitats elsewhere in the Finnis River system (Twining, 2002). Twining (2002) does not list Lorentz's grunter (*Pingella lorentzi*) as one of the seven species observed in the East Finnis River, or 18 species present in the Finnis River system. However, this species is reported to occur in the East Finnis River below the former Rum Jungle Mine site by Allen et al. (2002) and Stirrat (2002) (as cited in Appendix 4). This species is known to occur in Australia only in this location and northern Cape York and is listed as vulnerable under the *Territory Parks and Wildlife Conservation Act*. It is not listed under the EPBC Act.

Pre-remediation surveys of benthic macroinvertebrates in the East Finnis River undertaken in 1973–74 showed similar results to the fish surveys, i.e., numbers of species and individuals were reduced in the 10-km section of the East Finnis River downstream of the former Rum Jungle Mine. A post-remediation survey was undertaken in 1993 (Jackson and Ferris, 1998). The study found that macroinvertebrates remained significantly less diverse and less abundant in the lower reach of the East Finnis River compared with control sites; however, there was evidence of some recovery compared to the severe degradation observed in the pre-remediation survey. A survey of benthic macroinvertebrates was also undertaken on eight occasions over a one year period during 1994–95 to investigate the spatial and temporal effect of effluent from the former Rum Jungle site (Twining et al., 2002; Edwards, 2002). There were significant spatial

and temporal changes in macroinvertebrate community composition, which were highly correlated with changes in water quality. The poorest water quality was observed to occur late in the dry season at sites closest to the former Rum Jungle Mine. During the wet season, there was little difference in water quality between impact and reference sites due to the large dilutions and flushing out of any contaminants. Impacts on macroinvertebrates during the wet season are attributed to the physical impacts of high flows rather than toxicity from contaminants (Edwards, pers. com., 2001).

A decapod crustacean survey was undertaken in the East Finniss River on one occasion during 1994, and opportunistically during 1996 (Twining et al., 2002). This taxonomic group was chosen because of its known sensitivity to pH and metals, particularly copper. Numbers of decapod genera were low, which was not unexpected since the East Finniss River is an ephemeral stream. Nonetheless, the survey indicated that contaminants from the former Rum Jungle Mine site were affecting decapods in the East Finniss River, since populations declined to zero upstream of the confluence with the Finniss River and re-appeared only in unaffected sidestreams or upstream of the mine site. However, the distribution of decapods in 1994 had improved from 1974–75 when no decapods were found in the East Finniss River downstream of the former Rum Jungle Mine to its confluence with the Finniss River (Twining et al., 2002).

More recently, extensive macroinvertebrate sampling and AUSRIVAS assessment of the East Finniss River was undertaken between 1995 and 1999 as part of the Australia-wide Assessment of River Health (AWARH), undertaken as part of the National River Health Program. These investigations, which involved 38 early dry season and 34 late dry season site visits, found most locations in the East Finniss River to be severely or extremely impaired.

**Finniss River.** Pre-remediation, fish kills occurred in the Finniss River for at least 15 km downstream of the confluence with the East Finniss River during the first flush of the wet season when moderate inflow from the East Finniss River coincided with low flows in the Finniss River (Jeffree and Williams, 1975). Post-remediation fish surveys were repeated in the Finniss River during the dry seasons of 1992 and 1995 (Jeffree et al., 2001). Comparison of these results with those of the pre-remediation surveys showed appreciable changes to fish communities downstream of the confluence with the East Finniss River (Jeffree et al., 2001). Prior to remediation, the impacted region of the Finniss River had reduced diversity and abundance of fish compared to sites unexposed to elevated concentrations of contaminants. Post-remediation, no statistically significant differences were observed in fish diversity or abundance between impact sites, i.e., sites downstream of the confluence with the East Finniss River, and unimpacted sites (sites upstream of the East Finniss River confluence and downstream of the Florence Creek confluence). An average of seven species were taken from the unimpacted zone compared with nine to ten species collected at sites in the impact zone.

The recovery in the abundance and diversity of fish species in the impacted zone of the Finniss River is attributed to the reduction in metal loads and concentrations following remediation (Jeffree et al. 2001). Prior to remediation, fish kills during the first flush were thought to be responsible for the residual impact on fish populations observed in the dry season surveys (Jeffree et al., 2001). The recovery in fish abundance and diversity may

also possible be due to evolutionary tolerance to elevated concentrations of contaminants over four decades of exposure (Jeffree et al., 2001).

Pre-remediation surveys of decapod crustaceans in the Finniss River undertaken in 1973–74 showed similar results to the fish surveys, i.e., numbers of species and individuals were reduced downstream of the confluence with the East Finniss River. Below the confluence with Florence Creek, 30 km downstream of the confluence with the East Finniss River, no effect was observed. Post-remediation surveys of decapod crustaceans in the Finniss River were undertaken during the dry seasons of 1994, 1995 and 1996 (Twining et al., 2002). In the 1994 survey, there was a marked reduction in the population of shrimps and prawns for at least 14 km downstream of the confluence, similar to trends obtained in fish surveys prior to remediation (Jeffree and Williams, 1975). However, in 1996, decapod populations were higher immediately downstream of the confluence with the East Finniss River than at control sites. These data suggest that there was an improvement in the Finniss River system over the three years of the surveys (1994–96) which was attributed to a decrease in the impact of mine wastes, although such an interpretation is complicated by some inconsistencies in the surveys (Twining et al., 2002).

Macroinvertebrate sampling and AUSRIVAS assessment was also undertaken in the Finniss River under the National River Health Program between 1995 and 1999 (Dostine, 2002). Assessment using a model considered the least sensitive to seasonal bias showed the Finniss River immediately downstream of the confluence with the East Finniss River to be significantly impaired, whereas upstream of the confluence was similar to reference conditions (Dostine, 2002). However, assessments using alternative models showed that conditions at sites downstream of the East Finniss River confluence were similar to reference conditions.

## **7.8.2 Potential Issues**

### ***Key Issues***

A range of activities associated with the project will generate stressors that could report to the local drainage, as shown in Table 7.23.

Given the nature of the project, i.e., a mine involving an open pit and a processing plant to generate metal products, the primary contaminants at issue are sediments and trace metals. Other miscellaneous chemicals that are typically used during mining and ore processing (e.g., oils, grease and process reagents) and contaminants associated with treated sewage effluent, are considered to be minor contaminants, since wastes and wastewaters will be collected and managed to appropriate standards, as described in sections 4.11 and 4.14.5. Hazardous materials will be managed as described in Section 4.15.

**Table 7.23 Summary of project activities and potential water quality stressors**

Activity	Consequence	Primary Stressors
Land clearing/earth works	Erosion	TSS Metals
Mining	Pit dewatering/waste rock dump drainage	TSS Metals Sulfate pH
Ore processing	TSF discharges (if required)/runoff/spills/seepage	TSS Metals Sulfate Process reagents
Road traffic	Runoff	TSS Metals Tyre/brake lining particles Fuel/lubricant/coolant/hydraulic fluid
Vehicle maintenance	Runoff/spills	Oil and grease/solvents Metals Detergents
Offices and amenities	Runoff/sewage discharges	TSS Metals Nutrients Organic matter Pathogens

Key potential issues are those associated with impacts on downstream water quality that may occur due to the following:

- General stormwater runoff.
- Runoff from TSF embankment (containing encapsulated PAF material)<sup>1</sup>.
- Discharge of excess water from the main sedimentation trap.
- Seepage from the TSF.
- Pit water/intercepted groundwater (during operations and post-closure).

These issues are addressed in the following sections.

**Water Management Framework**

Water quality management in Australia is based on the following approach (ANZECC/ARMCANZ, 2000):

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<sup>1</sup> Acid rock drainage is, and has been, an issue at a number of operations in the Northern Territory and hence also requires consideration in this project.

- Identify the environmental values that are to be protected in a particular waterbody and the spatial designation of the environmental values (i.e., decide what values will apply where).
- Identify management goals and then select the relevant water quality guidelines, tailored to local environmental conditions, for measuring performance. Based on these guidelines, set water quality objectives to maintain the environmental values (taking account of social, cultural, political and economic concerns).
- Develop statistical performance criteria to evaluate the results of the monitoring program.
- Develop tactical monitoring programs focusing on the water quality objectives.
- Initiate appropriate management responses to attain (or maintain if already achieved) the water quality objectives.

The management and protection of the Northern Territory's water resources is controlled under the *Water Act* and managed according to the National Water Quality Management Strategy (as described above). Beneficial uses (environmental values) recognised under the act are:

- Agricultural—to provide irrigation water for primary production including related research.
- Cultural—to provide water to meet aesthetic, recreational and cultural needs.
- Aquaculture—to provide water for commercial production of aquatic animals including related research.
- Public water supply—to provide source water for drinking purposes delivered through community water supply systems.
- Environment—to provide water to maintain the health of aquatic ecosystems.
- Riparian—public rights and ownership rights to take water for domestic and/or stock purposes.
- Manufacturing industry—to provide water for secondary industry including related research.

Waste discharge to natural waters is prohibited unless licensed under the act. Waste discharge licences are only available where beneficial uses of the receiving waters have been declared after consultation with relevant stakeholders. Beneficial uses are currently not declared for the Finnis River system.

Once the environmental values for the Finnis River system have been declared, the level of water quality necessary to maintain each value must then be determined. This may be broadly defined through the establishment of management goals that describe in more detail what is to be protected. These goals should again consider stakeholder needs and desires and reflect specific problems and threats to environmental values. Establishment of environmental concerns and management goals allows identification of

appropriate water quality indicators, which may be biological, physical and/or chemical parameters (e.g., toxicant concentrations). It is then possible to select guidelines for establishing specific water quality objectives, which are the specific water quality targets that also consider social, cultural, economic or political constraints agreed between stakeholders or set by local jurisdictions.

ANZECC/ARMCANZ (2000) recognises that water quality needed to support desired environmental values may not be attainable immediately and that there may be considerable costs associated with achieving the desired water quality. A lower quality may therefore be accepted based on a full cost-benefit analysis, i.e., agreed environmental values and management goals should consider practicality as well as desirability.

In principle, the framework described above can be applied to the Finnis River system downstream of the project. However, a number of factors that are specific to this river system (and are described in more detail in sections 7.8.1 and 3.2) need to be taken into account in terms of setting achievable and realistic objectives:

- The current degraded nature of the river downstream of the former Rum Jungle Mine site (and the project area).
- The occurrence of metal concentrations in the East Finnis River that exceed ANZECC/ARMCANZ (2000) freshwater aquatic ecosystem trigger values for the protection of 80% of species, with the median copper concentration measured in the wet seasons of 2003–2004 and 2004–2005 being more than four times higher than the trigger value.
- The contamination gradient along the East Finnis River, and the Finnis River downstream of their confluence.
- A degree of recovery in the Finnis and East Finnis rivers since remediation of the former Rum Jungle site, as indicated by biological and water chemistry data collected to date. Establishment of baseline conditions for the Browns Oxide Project will therefore be difficult since the existing environment is in a state of flux and the future extent of possible recovery (if any—see the following point) is unknown.
- The potential deterioration in water quality with no further activity. A rehabilitation design specification for the former Rum Jungle waste rock dump cover system was to reduce water infiltration rates to less than 5% of incident rainfall, and to reduce the oxidation rate of pyrite and the rate at which pollutants were transported to the environment. This target was met for the first 10 years following cover placement, representing a 10-fold reduction over rates measured prior to rehabilitation. However, there is now evidence that the covers are failing since infiltration rates have increased to 5–10% of incident rainfall (Bennett, 2002). As a result, pollutant loads from the waste rock dumps may increase over the next 20 to 30 years to a level about 30 to 50% of loads prior to rehabilitation. It is therefore possible that, with no further activity on the site, the ecological health of the Finnis River system may again deteriorate.

It should therefore be recognised that, while it may be possible to set measurable objectives, it may be impossible or impractical to set requirements based on water quality (or similar) measurements or testing. Compass therefore proposes that requirements be established in terms of works to be implemented and practices to be adopted based on Best Practice Environmental Management.

Given the above and the fact that making reasonable quantitative predictions of achievable objectives is not possible at this stage, Compass proposes the following water management strategy for the project:

- Implementation of a 'best practice' approach to water management, including:
  - Installation of sediment control structures.
  - Separation of clean and dirty water.
  - Maximum reuse of dirty water.
  - Testing and treatment of excess water to ensure it is of suitable quality prior to release.
  - Release of excess water during periods of high river flow to ensure maximum dilutions (when discharge water quality is worse than receiving water quality).
  - Establishment of a comprehensive monitoring program of the surface waters that may be affected by the project.
- A management target of maintaining, and allowing improvement of, the existing ecosystem, consistent with the approach recommended by ANZECC/ARMCANZ (2000) for Condition 3 (highly disturbed) ecosystems. The water quality of any point source discharges and the East Finniss River upstream and downstream of the project area will be monitored, and regular AUSRIVAS surveys (or similar) conducted, to determine whether this target is achieved.

### **7.8.3 Avoidance, Mitigation and Management Measures**

#### ***General Stormwater Runoff***

Construction methods to be implemented to minimise site disturbance are described in Section 4.5.2. Management of stormwater runoff is described in Section 4.14.2.

Surface water from disturbed areas will be collected and directed to sedimentation traps to allow settling of suspended sediments. There will be two smaller sedimentation traps and a main sedimentation trap, with the latter draining most of the site. Water from this trap will be recycled to the process water dam for reuse in the plant. Excess water in the two smaller sedimentation traps will be pumped to the main sedimentation trap. If the capacity of the main sedimentation trap is exceeded, water will be discharged to the East Finniss River. This water will be monitored to determine if it is of suitable quality for release and treated as required. Compass will further develop this water treatment system in the detailed engineering design (see Section 4.14) [C].

**Acid Rock Drainage**

**Waste rock.** Key features of the proposed waste rock management strategy (Section 4.9.2) include:

- Using most of the waste rock mined as bulk fill in the TSF embankment construction.
- Encapsulating all PAF rock generated by the project within the TSF embankment.
- Providing direct supervision by suitably experienced personnel during construction to ensure that the required high degree of geotechnical and structural control is obtained.

**Tailing.** Key features of the proposed tailing management strategy (Section 4.10.3) include:

- Construction of a TSF that will comprise an embankment around all sides, where this embankment will consist of various 'zones' of different material.
- Subaerial deposition of the tailing.
- Collection of excess water in a decant pond for re-use in the process plant.
- Monitoring for variables such as dusting (from the tailing beaches) and seepage (through the TSF embankment).
- Installation of a suitable cover on the TSF on closure, such as a 'store and release'-type cover (see Section 9.10.5).

**Pit.** During operations, pit water reports to the main sedimentation trap. The potential for development of ARD from pit walls will be monitored during development of the mine. If necessary, various management strategies would be investigated to control ARD, such as application of layers of Virotech Terra B® and shotcrete to PAF material in pit walls to inhibit oxidation. Pit water quality will be monitored during operations (and post-closure) to determine if ARD is occurring.

An option for final void closure, should ARD be considered a significant issue, is to divert the East Finniss River through the pit to rapidly fill the void. As described in NTMC (2004), rapidly flooding an open pit where the potential exists for ARD is considered the best means of creating a water body of reasonable quality, since this limits the opportunity for sulfide oxidation to occur in the pit walls and floor. Maintaining good quality pit water is important since it represents a valuable resource, and also facilitates pit dewatering at a later date to access further ore reserves (without the need for expensive water treatment).

**Discharge of Excess Water from the TSF**

Tailing decant will be recovered and returned to the process circuit via the process water dam (see Section 4.14.4). The TSF is designed to retain sufficient volume for retention of runoff from major rainfall events, including the wettest year on record (1996/97) for the period 1958 to 2004. Under extreme conditions, water would be released via the

emergency spillway and drain to the main sedimentation trap. As described above, if the capacity of the main sedimentation trap is exceeded, water would be discharged to the East Finniss River, after monitoring and treatment as required (see Section 4.14).

#### ***Seepage from the TSF***

Management of seepage from the TSF is described in Section 4.10.3.

#### ***Water Produced from Mine Dewatering***

Mine water produced during operations, comprising groundwater inflows and incident rainfall over the pit area, will be pumped to the main sedimentation trap. Any water discharged from this trap will be monitored and treated as required, as discussed in Section 4.14.

As described in Section 4.14.3, interception bores will also be used to assist in the pit dewatering. It is proposed that excess water produced from these bores will be discharged directly to the East Finniss River, depending upon the quality of the groundwater. Possible strategies for managing this water, should it be contaminated due to historical legacies associated with the Rum Jungle Mine site, are further discussed in Section 7.8.4.

### **7.8.4 Residual Impact Assessment**

#### ***General Stormwater Runoff***

Increased loads of TSS may be expected to report to the East Finniss River, despite the incorporation of design and management measures specifically aimed at minimising and mitigating off-site releases. Sediment delivery will be highest in the early construction phases of the project and will decrease as sediment controls come online, progressive rehabilitation is undertaken and sediment erodibility decreases. Issues associated with delivery of sediment to receiving waters primarily relate to elevation of suspended sediment loads and in-stream sediment deposition downstream of the mine site. The majority of suspended sediment will be transported downstream during high-flow events. Therefore, during mining construction and operations significantly increased TSS concentrations are likely to be associated with storm events.

The main impacts are therefore expected to be:

- Changes in water quality (increased TSS and, to a lesser extent, metal concentrations).
- Physical alteration of stream habitats (in-stream deposition).
- Changes in stream trophic structure including fish and macroinvertebrate food supplies.

These impacts may cause a temporary decrease in the abundance and biomass of fish and macroinvertebrates in the already-stressed East Finniss River, and the displacement of sediment-intolerant species into clear water tributaries. Predictions concerning impacts on the aquatic environment are generally difficult to accurately quantify.

Correspondingly greater emphasis will therefore be placed on monitoring, with Compass establishing a comprehensive monitoring program of the East Finniss and Finniss rivers.

Impacts on water quality due to excess water discharges from the main sedimentation trap are considered further below.

### ***Acid Rock Drainage***

The management and mitigation measures that are to be incorporated into the construction, operation and closure of the TSF are expected to ameliorate the volume and/or quality of ARD. Nevertheless, given the difficulties in quantitatively predicting the effectiveness of these measures, Compass will obtain improved estimates of ARD during project development and will closely monitor TSF runoff and drainage [C].

In addition to examining indicators of ARD (e.g., pH, conductivity and sulfate concentrations), the monitoring program will include trace metals that may occur in elevated concentrations in the waste rock, as indicated by recent geochemical testwork (Appendix 9) and described in Section 4.9.1. The observed enrichments of greatest environmental significance were arsenic, copper, cobalt and lead. It is also possible that other non-enriched metals, such as manganese, nickel and zinc, could occur at elevated concentrations in the event that sulfide oxidation occurs and acid generation occurs. The findings of that testwork will be reviewed in light of additional information to be obtained from further geochemical testwork that has been commissioned by Compass, and the monitoring program revised as required [C]. Monitoring for these elements will reflect the possibility that runoff and drainage can contain elevated concentrations of certain metals (and salt), even in the absence of acid conditions (NTMC, 2004).

Additional management and mitigation measures will be investigated as required (incorporating information obtained as the mine is developed), including options for ongoing collection and treatment of ARD prior to discharge should this prove to be warranted [C].

### ***Discharge of Excess Water from the Main Sedimentation Trap***

It is not currently possible to predict the likely quality (or exact quantity) of excess water in the main sedimentation trap requiring discharge to the East Finniss River and hence subsequent impacts on receiving water quality (which is already severely degraded).

A preliminary (monthly) water balance for the main sedimentation trap has been prepared using records from the wettest year, driest year and a year close to the mean annual rainfall for the period 1958 to 2004 (Section 4.14). As described in Section 4.14.3, interception bores will be installed to intercept groundwater before it seeps into the pit. The water balance for the main sedimentation trap therefore assumes that minimal volumes of groundwater report to the trap.

The water balance shows that excess water would require discharge from the main sedimentation trap between January and March of the mean year (1972/73) and driest year (1985/86), and between December and March of the wettest year (1996/97). Note

that this excess water would not include any overflow from the TSF, which has sufficient capacity to hold water for the wettest year on record for the period 1958 to 2004.

Corresponding flows in the East Finniss River for these months, obtained from the hydrological record at GS8150097 (see Figure 7.7), are shown in Table 7.24 along with the excess water discharge rates for the various rainfall scenarios. During the mean rainfall year (1972/73), between 57 and 81 dilutions of the main sedimentation trap discharge would be expected to be achieved in the East Finniss River at GS8150097. The main sedimentation trap discharge therefore represents between 0.5 and 2.0% of the total water volume at this location under the climatic scenarios considered in this analysis.

During detailed design and operations, Compass will both undertake to obtain improved estimates and closely monitor water quality in the trap. Analysis results for the water and receiving water would be provided to DPIFM on a regular basis, e.g., fortnightly, during periods when discharge is likely to occur. This information, together with discharge data, will allow assessment of impacts on receiving water quality. Provision will also be made for the water to be treated, if necessary, prior to release (see Section 4.14).

As described in Section 7.8.2, it is proposed that the management target be to maintain, and allow improvement of, the existing ecosystem, consistent with the approach recommended by ANZECC/ARMCANZ (2000) for Condition 3 (highly disturbed) ecosystems. The water quality of point source discharges and the East Finniss River upstream and downstream of the project area will be monitored, and regular biological surveys conducted, to determine whether this target is achieved.

**Table 7.24 Flow rates and dilutions of excess sedimentation trap water discharged to the East Finniss River**

		Dec	Jan	Feb	Mar
Mean year (1972/73)	Excess trap water (m <sup>3</sup> /s)	-	0.022	0.055	0.033
	East Finniss flow (m <sup>3</sup> /s)	-	1.261	3.279	2.674
	<i>Dilutions</i>	-	<i>57</i>	<i>60</i>	<i>81</i>
Wettest year (1996/97)	Excess trap water (m <sup>3</sup> /s)	0.041	0.152	0.091	0.053
	East Finniss flow (m <sup>3</sup> /s)	2.887	15.41	8.173	9.236
	<i>Dilutions</i>	<i>70</i>	<i>101</i>	<i>90</i>	<i>174</i>
Driest year (1985/86)	Excess trap water (m <sup>3</sup> /s)	-	0.013	0.024	0.003
	East Finniss flow (m <sup>3</sup> /s)	-	2.268	1.159	0.394
	<i>Dilutions</i>	-	<i>174</i>	<i>48</i>	<i>131</i>

### **Seepage from the TSF**

'Shallow' seepage through the embankment will be collected in a toe drain and recycled, while 'deep' seepage, which preliminary calculations indicate to be in the order of 0.30 L/s (Appendix 8), will be captured during operations by either interception bore(s) or

the groundwater drawdown cone resulting from the pit. On closure, indicative seepage rates are expected to range from 0.25 L/s in the wet season to zero in the dry season (see Section 4.10.3). Flow in the East Finniss River at GS 8150200 during the wet season is in the order of 1000 L/s (Lawton and Overall, 2002a). Seepage from the TSF reporting to the East Finniss River would therefore comprise less than 0.03% of the total volume of water in the river and is therefore expected to have insignificant impact on existing water quality.

### ***Excess Water Produced from Interception Bores***

Some uncertainty currently exists concerning the quality of water that will be produced from interception bores. The studies described in Appendix 3 indicate that a single aquifer is operating in the project area. Consequently, as groundwater is drawn down during dewatering, contaminated groundwater from the Rum Jungle site may join deeper, cleaner groundwater that is moving toward the mine. As described in Section 7.9.1, monitoring of groundwater quality to the east of the project area has occurred as part of the Rum Jungle Rehabilitation Project. The contaminated shallow groundwater, containing high levels of metals, high salinity and low pH due to leachate from the waste dump, generally flows radially away from the dumps before deviating with the regional groundwater flow towards the East Finniss River. Lawton and Overall (2002a) found that in-flow of groundwater to the East Finniss River approximately 500–700 m downstream of GS8150200 was not a source of contaminants from the former Rum Jungle Mine site. Rather, the acid buffering capacity of the carbonate-dominated groundwater discharge at this location may be attenuating impacts on the East Finniss River from acid drainage by increasing pH and thereby precipitating metals.

Some of the water contained within Intermediate Open Cut at Rum Jungle may also be drawn into the groundwater system and report to interception bores. This will depend upon whether the East Finniss River presents a barrier to groundwater movement due to a relic water mound beneath the river or, conversely, whether there is increased transmissivity due to the presence of fracture zones. The drawdown predicted in the vicinity of Intermediate Open Cut due to mine dewatering for the Browns Oxide Project is between one and eight metres, assuming that the East Finniss River does not present a constraint to such drawdown (Appendix 3). Drawdown within the open cut is unlikely to be much greater even if there is connectivity between Intermediate Open Cut and the Browns Oxide Pit, since the depth of most of the latter pit will generally be only 20 to 25 m, limiting the hydraulic gradient along any fracture lines.

Physico-chemical profiles of the water column in Intermediate Open Cut were undertaken in April 1998 (Lawton and Overall, 2002b). Results from measurements taken at 5 m intervals to 30 m depth are presented in Table 7.25. Also shown in the table are measurements of water quality in the East Finniss River immediately downstream of the Rum Jungle Mine site, undertaken by CDU (Appendix 2).

**Table 7.25 Water quality of Intermediate Open Cut compared with East Finniss River**

Parameter	Intermediate Open Cut	East Finniss River at GS8150200	
	(range between 0 to 30 m depth; n=7)	(range during wet seasons 2003/04 and 2004/05; n=11)	(concentrations measured in pools formed in dry season, Aug 2003 and Nov 2004; n=2)
<i>Filtered metals (mg/L)</i>			
Cu	0.10–0.30	0.07–0.34	137–171
Mn	0.38–0.91	0.27–1.52	327–411
Zn	0.02–0.06	0.08–0.51	322–419
Ni	0.08–0.15	0.08–0.31	156–197
Fe	0.02–0.38	0.003–0.07	0.38–2.2
Al	0.15–0.22	0.02–0.19	481–693
pH	5.3–6.9	5.3–6.4	3.5–3.9
DO (% sat.)	64–92	75–112	93–103
Conductivity ( $\mu$ S/cm)	125–161	149–466	4,500–5,230
Ca (mg/L)	4–6	-	-
Mg (mg/L)	9–12	-	-
SO <sub>4</sub> (mg/L)	48–71	-	-

These data show that water in Intermediate Open Cut is generally of similar, or better, quality to that flowing in the East Finniss River. During the dry season, water in the open cut is of much better quality than water contained in pools formed along the river bed. Water drawn into groundwater from Intermediate Open Cut, and consequently discharged to the East Finniss River during dewatering of the Browns Oxide Pit, is therefore unlikely to have adverse impact on the river system. Minimal drawdown (less than 1 m) is predicted to occur in Whites Open Cut (see Appendix 3), hence water from this pit is not expected to significantly impact the quality of water produced from interception bores.

Rather, the potential exists for groundwater discharges to improve the condition of the river system. This could occur by discharging groundwater to the East Finniss River during the dry season, thereby preventing the accumulation of contaminants in seepage from Rum Jungle waste rock dumps accumulating in the river bed due to evaporative concentration and precipitation (see Section 7.8.1). This would reduce contaminant concentrations in the river system during the first flush (which has previously been associated with fish kills) and recessional flows, when concentrations are highest due to the minimal dilution of contaminants migrating from the Rum Jungle site (see Appendix 2). The benefit of such a strategy would depend on the hydrological regime of the East Finniss and Finniss rivers, and the quality of the groundwater. If implemented, monitoring would be undertaken to determine that the Finniss River system is not adversely impacted during the dry season by inflows from the East Finniss River.

As described in Appendix 3, there is some uncertainty concerning groundwater transmissivity and therefore the amount of groundwater likely to be produced by

interception bores. Groundwater inflows are predicted to vary between 30 and 60 L/s depending on the stage of excavation, although higher inflows may occur depending on the influence of geological faults. These estimates, which were predicted using analytical methods, are conservative when placed in the context of groundwater yields measured during excavation of Whites Open Cut, when 750 million gallons was pumped from the pit during its four year life (AIMM, 1965). That pumping rate equates to about 25 L/s for the 110 m deep pit, which is located along the same geological fault line as the proposed Browns Oxide Project pit. Note that during excavation of Whites Open Cut, the groundwater entered the mine at a depth of 50 to 60 m (Lawton, 2005; pers comm.), i.e., at much greater depth than the Browns Oxide Pit (which is mostly 20 to 25 m).

Since some uncertainty exists regarding the quality and quantity of groundwater that will be produced by the interception bores, it is proposed that a similar water management approach be adopted as for excess water discharges from the main sedimentation trap, i.e., Compass will obtain improved estimates of quality and quantity of possible discharges and will fully inform DPIFM of such information. Additional water management strategies would be implemented should groundwater discharges be considered to adversely impact the existing water quality of the East Finniss River. These could include:

- Preferential use of contaminated groundwater as makeup water in the process plant.
- Treatment, by lime addition to increase pH and precipitate metals, to achieve a suitable quality prior to discharge.
- Pumping groundwater to Whites and Intermediate open cuts and, to increase storage capacity, possibly stopping the wet season diversions of the East Finniss River through these pits.

It should be noted that, in relation to the second and third options, liability issues associated with this possibly contaminated groundwater would need to be addressed.

## **7.9 Groundwater**

This section is based primarily on the groundwater assessment described in Appendix 3.

### **7.9.1 Existing Conditions**

#### ***Groundwater System***

Groundwater occurs at depths ranging from 2 to 12 m below surface in the project area, with an average depth of about 4 m. The groundwater levels fluctuate seasonally, with an average range of about 5 m. Groundwater hydrographs coincide with the monsoonal climate, with rainfall recharging aquifers during the wet season. Groundwater levels commence to rise about December in the early wet season and peak in February. The peak is followed by recession that continues until the annual rise starts again in the following wet season.

The rapid cyclic groundwater response to rainfall indicates that the aquifers in the project area are unconfined. The regular recessions also indicate that the groundwater system is dynamic, with groundwater discharging to creeks or taken up by transpiration. There is some evidence that groundwater levels have increased over recent years, which is thought attributable to the above average rainfall that has occurred during the 1990s.

Previous studies have proposed that there is both a shallow and deep aquifer system in the east of, and extending towards, the project area (Appendix 3). The shallow aquifer was considered to be only a few meters deep in the shallow lateritic soil and responsible for most of the contaminant migration from the old Rum Jungle dumps. The deeper aquifer was regarded as being a fractured system that is poorly connected and has little groundwater movement.

More recent studies undertaken for the Browns Oxide Project suggest a different conceptual model for the groundwater system (Appendix 3). Analysis of hydrographs shows that there is dynamic groundwater recharge and discharge in both deep and shallow bores. The uniformity of the responses suggests that similar groundwater processes such as recharge and discharge are occurring over a wide area and through a deep, relatively continuous saturated zone. Fracture zones may enhance this connectivity between shallow and deep aquifers. The aquifer boundaries and extent of connectivity are therefore considered to be uncertain, although it is thought that the aquifer may be regarded as a single unit rather than as separate and shallow deep aquifers. A trial pit (Plate 7.7) was excavated to 31 m depth in 1999 to obtain bulk ore samples for the project. Observations during the excavation were that groundwater inflows were observed to occur from the footwall carbonates, faulted ground and hanging wall amphibolites. It is therefore thought likely that some separation in groundwater levels occurs between individual water-bearing features.

Testing of the Coomalie Dolostone aquifer for water supply purposes at Batchelor in the early 1980s indicated a transmissivity somewhat higher than values obtained for the aquifer at the project site. It is also worth noting the presence of transmissive karstic features within the fresh to slightly weathered aquifer.

### **Groundwater Flow**

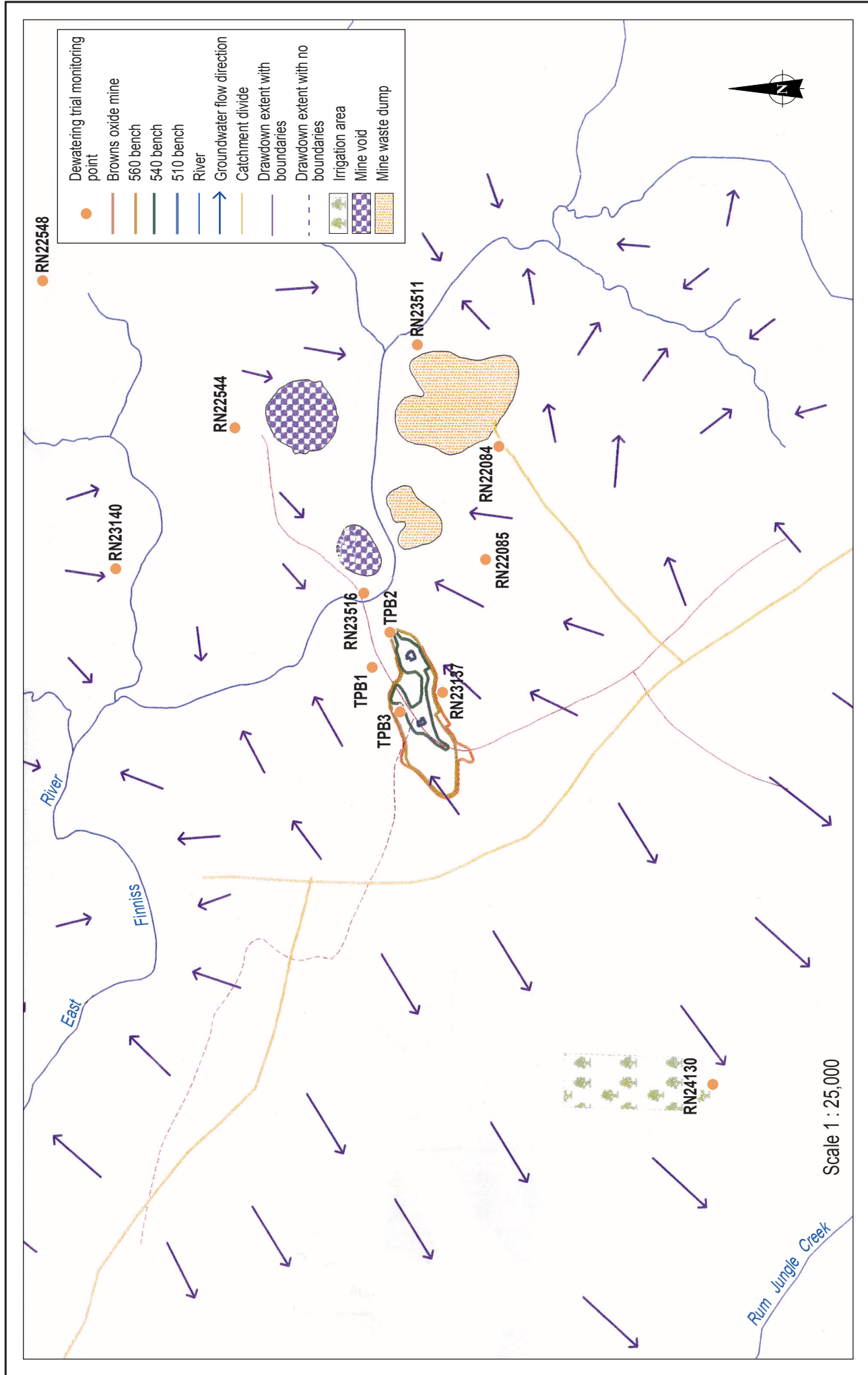
Insufficient information is currently available to prepare a groundwater map showing watertable contours. However, general trends in groundwater flow can be predicted based on the conceptual model of the groundwater system. If the aquifer is unconfined, groundwater movement would be expected to reflect the surface topography. Groundwater would therefore move towards the major creeks where it may sustain baseflow following the wet season or may sustain water in pools in otherwise dry creek beds. Potential groundwater flow paths in the project area based on the topography are shown in Figure 7.10.



**Plate 7.7**  
Partially backfilled trial pit (March 2005)



**Plate 7.8**  
Groundwater borehole monitoring near  
the trial pit



Compass Resources NL		Figure No: <b>7.10</b>	
Browns Oxide Project		Potential groundwater flow paths	
Job No: 836	File No: 836_08_FT.10_HB		
			

During excavation of the trial pit, groundwater was intercepted approximately 8 m below surface. Evaluation of groundwater monitoring (Plate 7.8) undertaken during dewatering of the pit indicates that drawdown is also influenced by lithology or geological structure (Appendix 3). Groundwater might therefore be intercepted by mine excavations at between 4 and 8 m below surface, depending on the time of the year.

Groundwater drawdown in most of the bores monitored during the trial pit dewatering is considered to be attributable to the natural recession with season and not due to dewatering (Appendix 3). However, three bores (TPB1, 2, and 3) located between 140 and 240 m from the centre of the trial pit showed clear responses to pumping, with drawdown ranging from 0.8 to 3.3 m. A fourth bore (RN 23516) located 360 m from the trial pit also exhibited a drawdown of 0.14 m attributable to dewatering. Geological mapping indicates that this bore is linked to the pit by a fault. The drawdown registered at this bore may therefore not be representative of other locations in the aquifer equidistant from the trial pit.

### **Groundwater Users**

Groundwater users near the project area are described in Section 3.2.4.

### **Groundwater Quality**

Monitoring of groundwater quality to the east of the project area has occurred as part of the Rum Jungle Rehabilitation Project. The 'shallow aquifer' was found to be contaminated with high levels of metals, high salinity and low pH due to leachate from the waste dumps, with typical concentrations being 10 to 100 mg/L copper, manganese, nickel and cobalt, pH of 3 to 4 and conductivity of 2,000 to 13,000  $\mu\text{S}/\text{cm}$  (Appendix 3). This contaminated shallow groundwater generally flows radially away from the dumps before deviating with the regional groundwater flow towards the East Finnis River (Appendix 3). Monitoring conducted up to 1986 indicated that the contamination of the 'deep aquifer' was confined to the immediate vicinity of the former Rum Jungle overburden heaps and open cuts. Water quality near Whites overburden heap had a conductivity in excess of 30,000  $\mu\text{S}/\text{cm}$  and pH of about 4. Pollutant transport is thought to be minor in the 'deep aquifer' compared with the 'shallow aquifer' (Appendix 3). There is considered to be insufficient data to make reasonable estimates of pollutant loads in groundwater originating from the former Rum Jungle Mine site (Gibson, 1998).

Investigations undertaken for the Rum Jungle Rehabilitation Project indicate that, although there is in-flow of groundwater to the East Finnis River approximately 500–700 m downstream of GS8150200, this is not a source of contaminants from the former Rum Jungle Mine site. Rather, the acid buffering capacity of the carbonate-dominated groundwater discharge at this location may be attenuating impacts on the East Finnis River from acid drainage by increasing pH and thereby precipitating metals (Lawton and Overall, 2002a).

With respect to the actual project area, groundwater quality was measured in observation bores impacted by drawdown during dewatering of the trial pit. The results are summarised in Table 7.26. Shallow groundwater in the weathered zone of the Whites Formation is poorer quality and slightly acidic compared with the deeper water reported in Table 7.26 (Appendix 3).

**Table 7.26 Groundwater quality in trial pit monitoring bores**

Bore	Aquifer	pH	Conductivity ( $\mu\text{S/cm}$ )
TPB1	Weathered carbonate aquifer	7.1	235
TPB2	Weathered Whites Formation/carbonate contact	5.9	3,550
TPB3	Fault zone	6.9	260

### 7.9.2 Potential Issues

Development of the Browns Oxide Project will require advance dewatering and/or in-pit pumping to prevent groundwater from accumulating in the pit. Removal of groundwater will create a cone of groundwater depression (most probably an elliptical-shaped cone) around the pit that may:

- Reduce water groundwater availability for other users.
- Reduce baseflows to surface waters.
- Drawdown water contained within Rum Jungle Mine pits, exposing sulfide material in pit walls to oxidation and consequently generating ARD.
- Remove water from the root zone of surrounding vegetation.

Note that the impact on surface water quality due to discharge of groundwater produced from interception bores and/or pit dewatering, and issues associated with drawing contaminated groundwater from the Rum Jungle Mine site, are addressed in Section 7.8.

### 7.9.3 Avoidance, Mitigation and Management Measures

The groundwater drawdowns predicted in Appendix 3 are calculated based on an infinite mine life. Since the mine life is four years only, predicted impacts are likely to be less than indicated. The high rainfall and rapid recharge during the wet season also suggests that there will be recovery in groundwater levels following impacts generated during the dry season. Targeted drawdown may provide some reduction in impact on groundwater levels.

As described in Section 4.14.3, water produced from dewatering bores will be discharged directly to the East Finnis River, thereby mitigating impacts on the baseflow of this stream.

Given the uncertainty regarding the extent and duration of impacts, emphasis will be placed on refining the predictions concerning groundwater behaviour. Should adverse impacts occur to groundwater users, mitigation measures may involve supplying suitable alternative water [C].

## 7.9.4 Residual Impact Assessment

### ***Reduced Groundwater Availability***

Mine dewatering will impact the aquifers by lowering groundwater and changing groundwater flow directions. Impacts have been predicted using analytical methods and extrapolating observations from the trial pit dewatering (Appendix 3)<sup>1</sup>.

In the absence of boundary conditions, drawdown impacts are calculated to extend to between 1,000 and 1,500 m from the mine pit. The extent of the drawdown is shown in Figure 7.11, considering both constraint by catchment boundaries and no such constraint. It should be noted that this assessment does not consider the influence of faults. The association of high aquifer yield with faults suggests that drawdown preferentially extends in the direction of these structures. Although it is considered unlikely that drawdown impacts will extend to the irrigation area some 1.5 km southwest of the mine, minor impacts cannot be discounted due to the existence of geologic faults that extend from the mine to this area. As discussed in Section 7.9.3, if impacts were to occur to groundwater users, alternate water may be supplied from suitable dewatering bores.

### ***Reduced Baseflows to East Finniss River***

Mine dewatering is not expected to significantly impact the baseflow of the East Finniss River since water produced from dewatering bores, if of suitable quality, will be discharged to the East Finniss River.

### ***Reduced Water Levels in Rum Jungle Mine Pits***

As discussed in Section 7.8.4, the drawdown predicted in the vicinity of Intermediate Open Cut due to mine dewatering for the Browns Oxide Project is between one and eight metres, assuming that the East Finniss River does not constrain groundwater movement. Drawdown within the Intermediate Open Cut is unlikely to be much greater even if there is connectivity between this pit and the Browns Oxide Pit, since the depth of most of the latter pit will only be 20 to 25 m, limiting the hydraulic gradient along fracture

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<sup>1</sup> Note that drawdowns will be influenced by geological boundaries and recharge sources (such as surface streams) and the influence of these boundaries has yet to be determined.

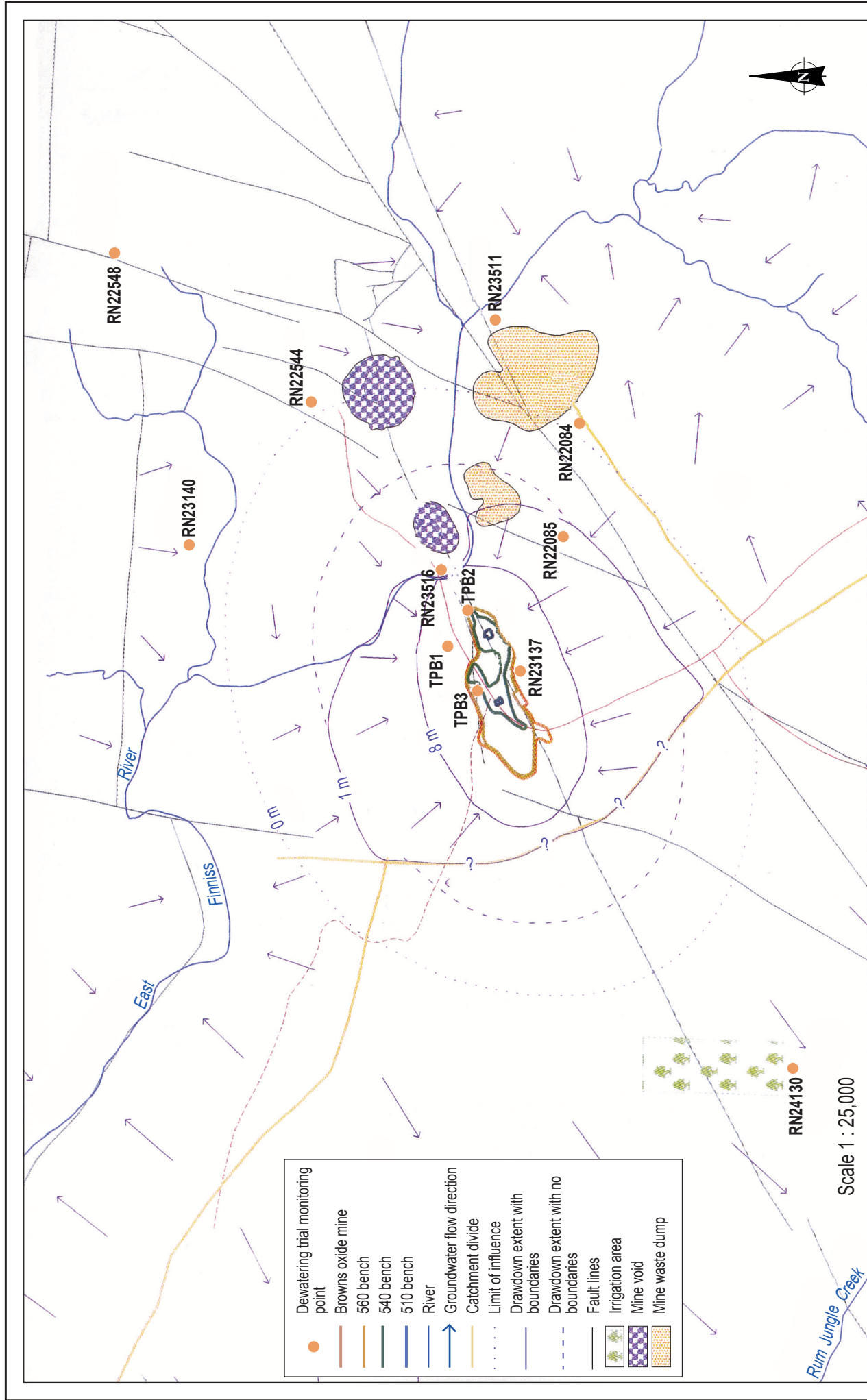


Figure No: **7.11**

**Possible groundwater drawdown with distance from the mine**

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lines. The drawdown predicted in Whites Open Cut is less than one metre (see Figure 7.11). As described above, groundwater drawdowns are likely to be less than predicted since calculations are based on an infinite mine life whereas the mine life is only four years and there will be water table recharge during wet seasons.

Given the limited drawdown predicted within the Rum Jungle open cuts, it is considered unlikely that fresh sulfide material within pit walls will be exposed to the atmosphere. Water levels within the open cuts and the presence of sulfide materials on exposed pit walls will be monitored. In the event that there is potentially an issue with ARD generation due to drawdown, appropriate management measures would be implemented. These might include returning extracted groundwater back into the pits to raise water levels.

### ***Reduced Water in Root Zones***

Mine dewatering and other hydrogeological changes may impact habitats and associated fauna species surrounding the proposed mine pit, with two potentially vulnerable habitats containing melaleuca woodland and monsoon vine-forest occurring in the vicinity (Appendix 4). However, the impacts of groundwater drawdown will be diminished by replenishment of the water table during the wet season. Monitoring will be undertaken of vegetation surrounding the mine pit, particularly melaleuca woodland and monsoon vine-forest, to determine potential impacts due to mine dewatering and/or alteration of groundwater levels.

## **7.10 Socio-economic**

### **7.10.1 Existing Conditions**

#### ***Population Characteristics***

The population of Batchelor has been increasing since 1991 (Table 7.27), which is consistent with trends in Darwin and the Northern Territory in general (ABS, 2002a).

**Table 7.27 Population characteristics 1991 to 2001**

<b>Year</b>	<b>Population</b>	<b>Change in Number</b>	<b>% Change over time</b>
<i>Batchelor</i>			
1991	635		
1996	645	10	1.5
2001	727	82	12.7
<i>Darwin</i>			
1991	88,147		
1996	99,601	11,454	13.0
2001	109,419	9,818	9.9

Source: ABS (2002a), ABS (2002b).

The population of rural areas (which excludes Batchelor and Adelaide River) within Coomalie nearly doubled between 1991 and 1996, which reflects a trend toward rural living. However, the population is unlikely to grow significantly further in the short-term

due to physical constraints imposed by available land and water resources (DLPE, 2000).

Figure 7.12 shows that a high proportion of the population is aged between 10 and 14 years and 35 and 39 years, with these two groups accounting for 13.1% and 10.8% of the total population, respectively. This illustrates a predominantly family-orientated population with a high number of dependents. The smaller number of elderly people may indicate that people do not tend to retire to the area, although Day (pers. com. 2005) indicated that Batchelor is a popular retirement place for those who do not want to leave the Northern Territory, as it is well serviced and close to Darwin.

The gender ratio of the population, i.e., 51% females versus 49% males, slightly favours females.

### ***Ethnicity***

The 2001 census shows that 77% of the population were Australian-born and that 39% of the population are of Aboriginal and/or Torres Strait descent (ABS, 2002b).

### ***Religion***

The majority of people are affiliated with a Christian religion (55%), with most following either the Anglican or Catholic church (ABS, 2002b).

### ***Employment***

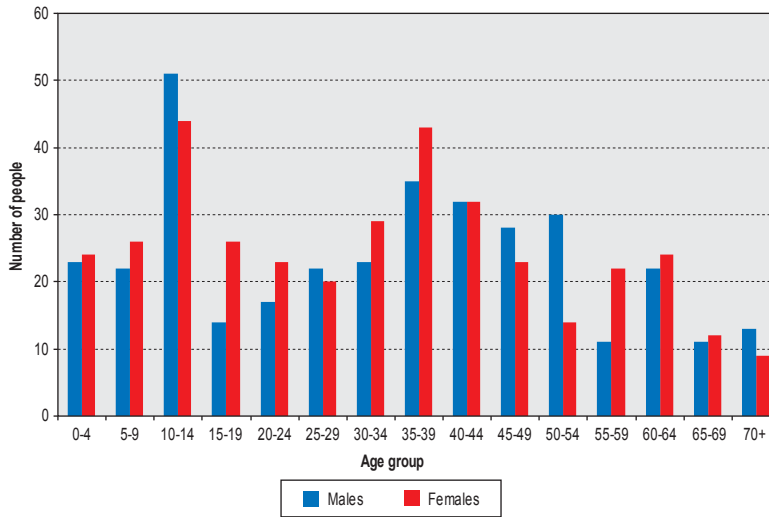
According to 2001 census data, 250 people were employed in Batchelor, representing 93.1% of the labour force<sup>1</sup>. This is similar to the Northern Territory in general, where 94.1% of the labour force was employed (compared with 92.6% in 1996 and 88.6% in 1991 (ABS, 2002a). Consequently, Batchelor has a slightly higher unemployment rate than that for the entire Northern Territory, i.e., 6.9% compared with 5.9%, respectively (ABS, 2002a) and (ABS, 2002b).

Employment distribution indicates that the education sector is the largest employer with 42% (105 people) of the workforce being employed in this sector (see Figure 7.12). The hospitality industry is the second largest employer, comprising 9% (23 people) of Batchelor's workforce. This is followed by health and community services (7%) (17 people), retail trade and cultural recreational services (each 6% [16 people]). The mining industry employs 2% (6 people) of Batchelor's workforce.

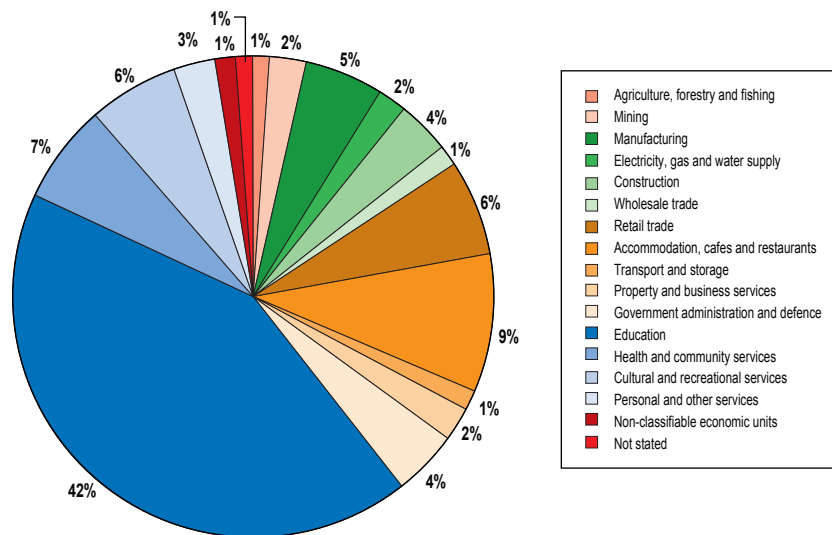
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<sup>1</sup> Labour force is defined, for the population aged >15 years, as those currently employed (full-time and part-time) plus those unemployed and looking for work.

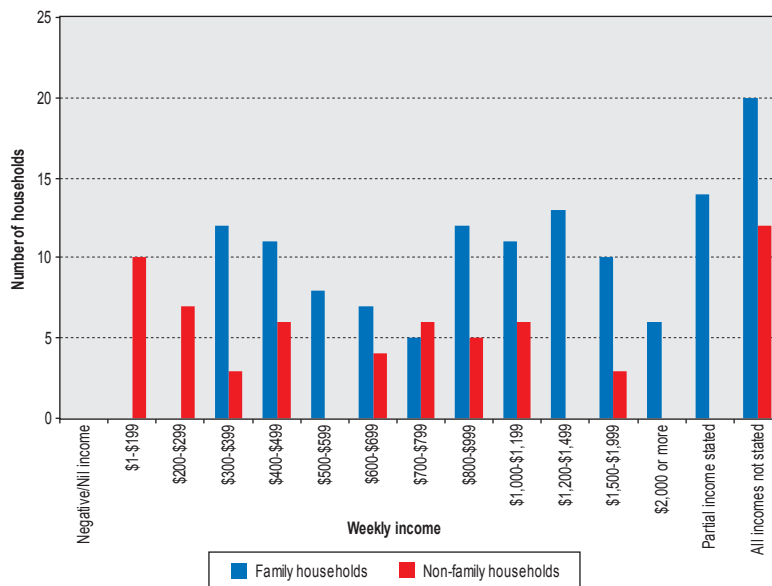
Age and sex of Batchelor population 2001



Distribution of employment in Batchelor 2001



Weekly household income by household type in Batchelor 2001



Source: ABS (2002b) Census data.



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Compass Resources NL  
Browns Oxide Project

Batchelor demographics

Figure No:  
7.12

### **Education and Child Care**

2001 census data for Batchelor indicated that 18% of people (over 15 years of age) had obtained a qualification beyond secondary schooling, while 46% had no qualification (ABS, 2002b).

The Batchelor Area School caters for students from preschool to Year 10 and provides study facilities for Year 11 students (with facilities for Year 12 by correspondence). The school currently accommodates 160 students but has the capacity to accommodate 350 students (Otway pers. com. 2005).

Sailing, archery, mountain biking, bush walking, canoeing and climbing are some of the services offered to students from all over the Northern Territory at the Batchelor Outdoor Education Centre (Otway pers. com., 2005).

The Batchelor Institute of Indigenous Tertiary Education (BIITE) is controlled and operated by indigenous Australians and specialises in working with Aboriginal and Torres Strait Islander students from across Australia. The institute offers courses in education, humanities, business, community studies, health and science for over 3,000 students, and contains a well-equipped trade education centre which is currently not being utilised.

Child care and after-school care facilities are provided at the Yera Child Care Centre in Batchelor for children aged up to 12 years. Although licensed and staffed for up to 50 children, the average attendance is 22 children per day (Burnett pers. com., 2005).

### **Income**

The average weekly income per household in Batchelor depends on whether it is a family<sup>1</sup> or non-family household. The 2001 census data revealed that family households, on average, had a higher weekly income than non-family households. The most common income for family households was \$1,200 to \$1,499 per week (i.e., \$62,400 to \$77,948 per annum) compared with \$1 to \$199 per week (i.e., \$52 to \$10,348 per annum) for a non-family household (see Figure 7.12).

### **Accommodation**

2001 census data recorded 272 private dwellings in the township of Batchelor, 53% of which were separate houses. A total of 239 (88%) dwellings were occupied and 33 (12%) unoccupied. Of those private dwellings that were occupied, 21% were fully owned, 10% were being purchased and 46% were rented. The remaining dwellings were either under another tenure scheme (such as rent-free or life tenure schemes (10%) or tenure was not stated (13%) (ABS, 2002b).

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<sup>1</sup> Family is defined by the ABS as two or more persons, one of whom is at least 15 years of age, who are related by blood, marriage (registered or defacto), adoption, step or foster, and who are usually resident in the same household.

Most of the rental properties are rented by BIITE staff. Approximately five to eight properties are currently available for rent and about the same number is available for sale (Wain pers. com., 2005a).

A range of temporary accommodation options is available in Batchelor, such as motels (including budget rooms), resort accommodation, self-contained cottages, stockman's quarters, and camping and caravan parks. Sufficient accommodation venues exist to cater for the demand during the tourist season, although accommodation is booked to capacity most of the time (Wain pers. com., 2005b).

### **Tourism**

A regional tourist information centre is located at Batchelor. The town has approximately 250,000 visitors each year as they travel to Litchfield National Park. The tourist season coincides with the dry season and extends from April to September, when the weather is pleasant and flooding does not prohibit access or swimming.

Most of the tourists are on self-drive tours and use Batchelor as a base to explore the surrounding area, often spending the night in town. Organised bus tours bring day visitors from Darwin.

Tourism forms a significant part of Batchelor's economic base.

### **Community Services and Facilities**

Batchelor contains a range of day-to-day services and facilities. However, residents travel to Coolalinga (approximately 50 km north of Batchelor) for regular shopping trips and to Darwin (approximately 65 km north of Batchelor) for non-essential purchases and to access health, education and financial services.

The following community services and facilities are provided in Batchelor (Table 7.28 and Figure 7.13).

**Table 7.28 Summary of community facilities and services in Batchelor**

<b>Service/Facility</b>	<b>Facility/Service Available in Batchelor</b>
Health	<ul style="list-style-type: none"> <li>• Batchelor Community Health Centre (general practitioner available Monday, Tuesday, Thursday and Friday morning, 24-hr emergency medical care)</li> <li>• Specialist doctors visit regularly</li> <li>• Chemist agencies (health centre and general store)</li> </ul>
Childcare and Education	<ul style="list-style-type: none"> <li>• Batchelor Area School (Prep to Year 10; Year 11 and Year 12 by correspondence)</li> <li>• Batchelor Institute of Indigenous Tertiary Education</li> <li>• Batchelor Outdoor Education Centre</li> <li>• Batchelor playgroup</li> <li>• Yera Child Care Centre</li> <li>• Batchelor Community Library</li> </ul>

**Table 7.28 Summary of community facilities and services in Batchelor (cont'd)**

<b>Service/Facility</b>	<b>Facility/Service Available in Batchelor</b>
Shops and Commercial Services	<ul style="list-style-type: none"> <li>• Batchelor General Store (Plate 7.9)</li> <li>• Post office</li> <li>• Motels</li> <li>• Caravan parks</li> <li>• Laundromat</li> <li>• Hair salon</li> <li>• Car wash</li> <li>• Conference facilities</li> <li>• Restaurants</li> </ul>
Local Police and Emergency Services	<ul style="list-style-type: none"> <li>• Police station</li> <li>• Fire brigade</li> <li>• Bushfires Council NT</li> </ul>
Local Industrial Services	<ul style="list-style-type: none"> <li>• Airfield</li> <li>• Bore rehabilitation and installation services</li> <li>• Building contractors</li> <li>• Earth-moving contractors</li> <li>• Electrical contractors</li> <li>• Petrol suppliers</li> </ul>
Recreational Facilities	<ul style="list-style-type: none"> <li>• Tennis courts</li> <li>• Basketball/netball courts</li> <li>• Swimming pool</li> <li>• Bowling club and bowling green</li> <li>• Cricket oval and cricket nets</li> <li>• Touch football</li> <li>• Batchelor oval</li> <li>• Bicentennial Park</li> <li>• ANZAC Park</li> <li>• Jack White Park</li> <li>• Rum Jungle South Recreation Lake</li> <li>• Gliding club</li> <li>• Parachute club</li> </ul>
Cultural/Entertainment Facilities	<ul style="list-style-type: none"> <li>• Coomalie Cultural Centre</li> <li>• Batchelor butterfly farm</li> <li>• Havlik Park (mini replica of old gothic European castle)</li> <li>• WWII aerodrome and museum</li> <li>• Scenic flights</li> <li>• St Francis Anglican Church</li> <li>• Outback Gospel Ministries Assembly of God</li> </ul>
Waste Disposal Facilities	<ul style="list-style-type: none"> <li>• Batchelor dump (rubbish tip for dry waste and transfer station for domestic waste)</li> </ul>

Source: CCGC (2004).

# Batchelor Township



## Batchelor Index

### Accommodation/dining

- 1 Batchelor Resort
- 2 Lake Bennett Wilderness
- 3 Jungle Drum Bungalows
- 4 Batchelor Historic Retreat
- 5 Batchelor Resort
- 6 Lake Bennett Wilderness Resort
- 7 Jungle Drum Bungalows
- 8 Batchelor Bird and Butterfly Resort

### Motor Vehicle Services

- 1 Batchelor Service Station

### Health Services

- 1 Batchelor Health Clinic
- 1 St. Johns Ambulance

### Emergency Services

- 1 Batchelor Police Station
- 2 Fire Station
- 3 Bushfire Control

### Caravan Park / Campground

- 1 Batchelor Resort Caravillage
- 2 Banyan Tree Caravan Park
- 3 Coomalie Caravan Park
- 4 Wangi Falls Kiosk and Van Park
- 5 Litchfield Tourist Park
- 6 Wangi Tourist Park
- 7 Litchfield Campground and Monsoon Café

### Services

- 1 Batchelor General Store
- 2 Batchelor Post Office
- 3 Batchelor Information Centre
- 4 Coomalie Cultural Centre
- 5 Parks and Wildlife
- 6 Batchelor School Office
- 7 Batchelor Institute

### Historic Sites

- 1 Battle of Australia WWII Commemorative Cairn

### Sites

- 1 Karlstein Castle
- 2 Batchelor Bird and Butterfly Farm

### Sport and Recreation

- 1 Darwin Parachute Club
- 2 Northern Air Charter
- 3 Bicentennial Park
- 4 Batchelor Swimming Pool
- 5 Rum Jungle Recreation Park
- 6 Bowling Green
- 7 Tennis Courts
- 8 Batchelor Oval



**Plate 7.9**  
Batchelor General Store



**Plate 7.10**  
Site RM1 facing southeast



**Plate 7.11**  
Site RM1 viewing mine lease marker

Services provided in Darwin include:

- Darwin General Hospital.
- Darwin Private Hospital.
- Specialist medical services.
- Shops and services not available in Batchelor.
- Secondary schools.
- Technical and further education centres.
- University.
- Registered training organisations.

### ***Northern Territory Economics***

The ABS estimates that the Northern Territory real gross state product (GSP) increased by 0.4% in 2003/2004 to \$9.2 billion. This was below the national increase of 3.8% and represented the lowest GSP growth of all state and territory jurisdictions (Northern Territory Treasury, 2005).

Mining is the most significant industry in the Northern Territory, accounting for 21.9% of the GSP in 2002/2003 and averaging 21.3% per annum over the past five years. The territory's expenditure on mineral exploration in 2002/2003 was \$49 million, representing an increase of 1.2% from the previous year (only the second year of growth since 1995/1996) and 6.7% of Australian exploration expenditure. In response to declining mineral exploration, the Northern Territory Government has implemented a four-year initiative that provides \$15.2 million to provide geoscientific data to promote prospectivity (Northern Territory Budget, undated).

In 2002/2003, the mining sector contributed \$175 million in wages and spent a further \$778 million on operational expenses within the Northern Territory<sup>1</sup> (Kirby pers. com., 2005). It is estimated that in 2003/2004, \$37 million was contributed to the government in the form of royalty revenue (Northern Territory Budget, undated).

### **7.10.2 Potential Issues**

Socio-economic issues associated with the project include:

- Employment opportunities for the local community.
- Increased economic activity within the community and the Northern Territory.
- Potential attraction for the tourism industry (e.g., establishing tours of the project).
- Potential impacts on local traffic, roads and infrastructure.
- Altered local lifestyle and public amenity.

The main issue is the need to maximise the socio-economic benefits associated with the project while minimising adverse impacts.

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<sup>1</sup> Comparable figures are not yet available for 2003/2004.

### 7.10.3 Avoidance, Mitigation and Management Measures

During operations, the project will create approximately 79 full-time jobs. During construction, up to 100 jobs will be created. Where possible, recruitment of these jobs will focus on the local community in accordance with Compass's employment policy [C]. Based on recent experiences at similar operations, it is anticipated that approximately 20% (13) of employees will be Aboriginal. In particular, Compass will provide employment and training opportunities for the traditional owners and will develop specific procedures for the administration and implementation of these opportunities [C]. Compass will use goods and services provided by local companies where possible.

Key personnel are most likely to commute from Darwin. Approximately 20 employees are expected to already live locally in either Batchelor or Adelaide River, with the balance of the workforce commuting from Darwin on a daily basis. It is anticipated that senior management, consultants and short-term contractors will utilise the available hotel/motel accommodation in Batchelor.

Compass will expand community consultation to include community meetings, maintenance of noticeboards and information sessions as required to keep the community informed as development proceeds (see Chapter 6). A complaint mechanism will also be established and disseminated.

Key socio-economic indicators will be assessed via the monitoring program for the project (Section 9.9.5).

### 7.10.4 Residual Impacts

#### *Employment*

Additional employment opportunities will be a major benefit to the local and broader communities. The project will inject approximately \$4.5 million during the six to nine-month construction period, and \$8.4 million annually during operations, in wages (including contractors) into the community (approximately 25% locally). This represents approximately 5% of the mining sector's contribution to wages in the Northern Territory and will have consequent flow-on effects.

#### *Economic*

The majority of the capital cost for development of the project will be spent in the Northern Territory, particularly the regional area (including Darwin). This cash injection will have a flow-on effect to other businesses and industries, which in turn will strengthen their economic viability. During operations, annual expenditure on regional goods and services is expected to be approximately \$18 million, which will provide an economic boost to existing services and industries. Of this, approximately \$200,000 to \$300,000 annually will be spent locally in Batchelor, i.e., 2% of the mining sector's operational expenditure in the Northern Territory.

Monetary benefits will flow to the Northern Territory and federal governments in the form of taxes such as company, income and pay-roll tax. Royalties will also be paid to the Northern Territory Government.

### **Community Services and Facilities**

The project will have minimal impact on existing services and facilities in Batchelor given that the workforce will be sourced locally or from Darwin and there will be minimal, if any, new demand.

### **Education**

One hundred and sixty students currently attend the Batchelor Area School, but there is sufficient capacity to cater for double the number of students at all levels from preschool to Year 10 if, and as, required.

### **Accommodation**

The construction workforce is expected to be sourced from Darwin; however, some may choose to stay locally if accommodation is available. Given that the construction peak is scheduled to occur in July/August 2006, coinciding with the tourist season, availability will be constrained by tourist demand. Daily commuting of the construction (and some of the operations) workforce, to and from Darwin raises road safety issues such as driver fatigue. Compass will consider establishing a bus service to transport employees to and from Darwin if there is sufficient demand.

### **Tourism**

Other business opportunities could be associated with development of the project, such as the potential for mine site visits as a tourist activity building on the interest that is already associated with the historical Rum Jungle Mine.

## **7.11 Biting Insects**

### **7.11.1 Existing Environment**

The project is located in an area with distinct dry and wet seasons (see Section 3.1). Surface drainage is ephemeral and distinct ponds and billabongs form during the dry season, in contrast to extensive flooding during the wet season, that often results in large areas of shallow-ponded water. These conditions are conducive to mosquito breeding.

The Medical Entomology Branch (MEB) of the Centre for Disease Control in the Department of Health and Community Services in Darwin has determined that breeding populations of mosquitoes and biting midges are present in the vicinity of the Browns Oxide Project, e.g., Batchelor and surrounding areas such as Mt Grace Magnesium Mine and Woodcutters Mine (Whelan, P. et. al., 2000 and MEB, 2001).

### 7.11.2 Potential Issues

Twenty different pest mosquitoes occur in the Northern Territory, some of which are capable of spreading harmful diseases such as Murray Valley encephalitis, Ross River and Barmah Forest virus disease (CDC, undated).

The potential for large and uncontrollable mosquito and biting midge breeding presents a potential nuisance and health risk (DLPE, 2000). This potential risk applies to Batchelor and surrounding areas given the ephemeral nature of, and riparian vegetation associated with, creeks draining the project area.

Inappropriate management with respect to impounded and pit water, surface drainage and sewage associated with the project could exacerbate existing, or create new, mosquito-breeding habitats.

### 7.11.3 Avoidance, Mitigation and Management Measures

Biting insect control will be incorporated into project design and management measures will be implemented to eliminate breeding areas and provide personal protection in accordance with:

- Guidelines for preventing mosquito breeding sites associated with mining sites (MEB, 1997).
- The prevention of mosquito breeding in sewage treatment facilities (Whelan, 1997).
- Recommendations for design details of sewage pond effluent reuse or disposal facilities to prevent mosquito breeding (Whelan, 1998).
- Personal protection from mosquitoes and biting midges in Northern Territory (Whelan, 2004).

Specific management measures are detailed in the Biological and Land Management Plan (Section 9.8.3).

Advice will be sought from the MEB if mosquito breeding is detected within the project area or biting insects become pests.

### 7.11.4 Residual Impacts

Soil erosion and sediment deposition, ponding of rain water in excavations, e.g., borrow pits, and disturbance to drainage lines during the construction phase will have the potential to create temporary mosquito breeding sites. Maintenance and rehabilitation of these areas in accordance with the guidelines and recommendations listed in Section 7.11.3 will minimise opportunities for mosquito-breeding habitats to establish.

Appropriate design of water storages (including the TSF which will contain standing water) with respect to depth and slope and management of marginal semi-aquatic reeds and grass will further reduce the potential for mosquito breeding.

Artificial containers can collect rainwater and become potential mosquito breeding sites; however, appropriate management of these containers will minimise this potential. The introduction of exotic mosquito species will be prevented by taking adequate precautions with respect to the import and disposal of artificial containers (receptacles).

Biting insect problems, when they occur, are likely to be greatest one hour either side of sunset and sunrise.

## 7.12 Archaeology and Heritage

### 7.12.1 Legislative Context

#### *Commonwealth Legislation*

The Commonwealth EPBC Act and *Environment and Heritage Legislation Amendment Act (No 1) 2003* protect significant heritage sites. The Register of the National Estate or the National Heritage List may provide listings relevant to this assessment.

Places included on the National Heritage List are deemed to be of exceptional natural and/or cultural significance. Places included on the Register of the National Estate represent places with significant Aboriginal, historic or environmental values. The register contains places that have varying status, as described in Table 7.29.

**Table 7.29 Site status on the Register of the National Estate**

<b>Status</b>	<b>Description</b>
<b>R</b>	Registered. The place is listed on the Register of the National Estate.
<b>ID</b>	Identified. The Commission has formally considered the values of this place and decided that it should be publicly proposed for entry in the register. The place is awaiting publication in the gazette and the press to give full effect to this decision.
<b>RE</b>	Removed from the register or Interim List. The place has been removed from the Register or list via a public process that provides for the submission of objections.
<b>IL</b>	Interim List. The place has been publicly proposed for entry in the register and the Australian Heritage Council (AHC) may be awaiting objections, considering objections, or seeking other data before making a decision on whether the place should be entered on the register proper.
<b>IP</b>	Indicative Place. Data provided to or obtained by the Commission has been entered into the database and the place is at some stage in the assessment process. The AHC has not made a decision on whether the place should be entered into the Register.
<b>D</b>	Destroyed. The place has been destroyed before being assessed or listed.
<b>REJ</b>	Rejected. The AHC has assessed the place and found that it does not warrant entry in the register in its own right.

Source: AHC (2005a).

Places listed on either the Register of the National Estate or the National Heritage List are included on the Australian Heritage Database.

### **Northern Territory Legislation**

It is an offence under the Northern Territory *Heritage Conservation Act* to damage, destroy, alter or carry out work of any sort on declared or prescribed archaeological or heritage sites without the consent of the Minister or Minister's delegate. This act places constraints on owners of private property, local government and the Crown in relation to two types of heritage sites, i.e.:

- Places or objects listed on the Northern Territory Heritage Register are declared heritage places and objects. These are protected under Section 33 of the act.
- Prescribed archaeological places and objects that are protected under sections 29 and 31 of the act.

Declared heritage places and objects are categorised on the Northern Territory Heritage Register database (NTHR, 2005) according to their site status, as described in Table 7.30.

Prescribed archaeological places and objects are listed on the Archaeological Sites Register. The listing of a place or object on this register does not necessarily mean that the place or object is protected or holds any legal significance under the Northern Territory *Heritage Conservation Act*.

**Table 7.30 Site status on the Northern Territory Heritage Register**

<b>Status</b>	<b>Description</b>
<b>D</b>	Declared heritage place.
<b>NR</b>	Not recommended. Heritage Advisory Council (HAC) determined that the place did not meet heritage assessment criteria and did not hold sufficient value to warrant declaration under the Act.
<b>RF</b>	Refused by the Minister. HAC recommended for declaration and Minister refused to do so.
<b>P</b>	Proposed. HAC has determined that the place warrants declaration under the act but has not yet made its recommendation to the Minister.
<b>RV</b>	Revoked. Declaration as a heritage place has been revoked.
<b>N</b>	Nominated. HAC has yet to complete its assessment of the heritage value of the place.

Source: NTHR (2005).

### **7.12.2 Existing Conditions**

The following is a summary of the AAPA authority certificates, a desktop study of the Australian Heritage Database and findings of the archaeological survey performed by Bengaze Pty Ltd (Appendix 6).

#### **AAPA Authority Certificates**

Compass has previously obtained Authority Certificate No. 95/013 and No. 98/104 in relation to works within or adjacent to the project area, and intends to obtain a further Authority Certificate from the AAPA in relation to the project.

### Desktop Study

The Australian Heritage Database lists five locations of heritage significance in the general area surrounding the project site (AHC, 2005b). These are listed in Table 7.31.

There are no previously recorded archaeological places or objects and no National Trust-listed properties within a 5 km radius of the project site (NTNT, 2005)

The historic Rum Jungle Mine Manager's House is listed on the Northern Territory Heritage Register database. The house, which is situated on 2,960 m<sup>2</sup> of land, is located in Batchelor itself and provides a reminder of the town's past link to the former Rum Jungle Mine during the 1950s and 1960s.

As previously indicated, the project site is immediately west of the former Rum Jungle Mine site. Parts of this mine have recently been nominated to the NTHR, under the summary of 'Uranium Mining in the Northern Territory', where it is proposed that the Rum Jungle Uranium Project has acquired historic significance as one of the Commonwealth Governments' largest industrial undertakings in the Northern Territory during the 1950s. The recent nomination is awaiting assessment and a recommendation to the Minister after a period of public comment.

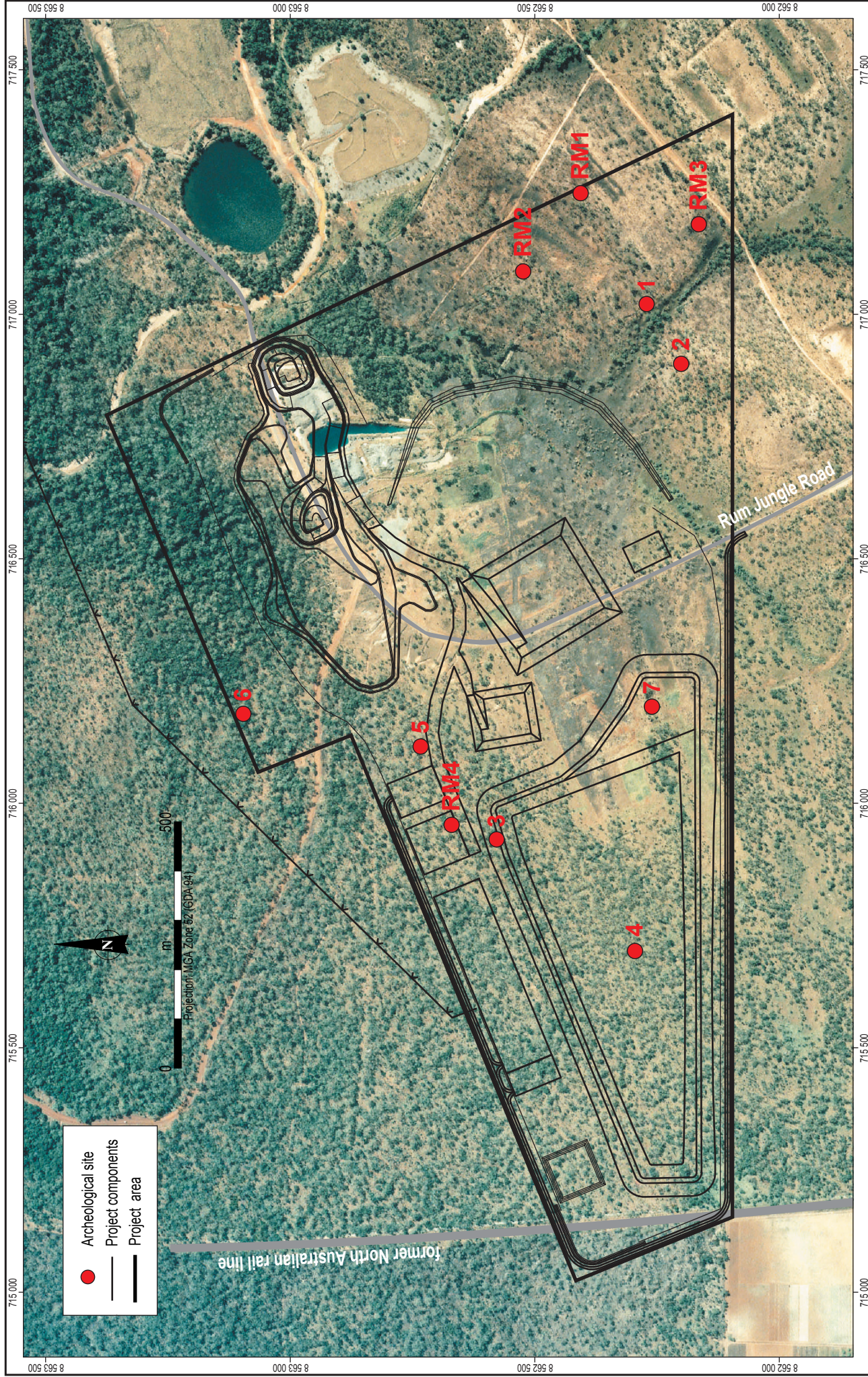
**Table 7.31 Australian Heritage Database listings for the Batchelor region**

Place	Location	List, Class & Legal Status	Description
Coomalie Dolomite site, Batchelor	Batchelor Road, 2.5 km east of Batchelor	All sites are listed on the Register of the National Estate as 'indicative places'.	Prominent outcrop of Coomalie Dolomite containing stromatolite fossils of regional significance.
Coomalie Creek cut	Stuart Highway, 11 km northeast of Batchelor		Perennial freshwater stream between two steep rocky hills.
Finniss and Reynolds rivers floating grass mats	Finniss and Reynolds rivers floodplains, Batchelor		Series of billabongs with well-developed floating grass mats, an important habitat for the estuarine crocodile.
Kubiling Springs jungle	10 km west-northwest of Labelle Downs Outstation		Floristically diverse Group 4 monsoon rain forest.
Reynolds River Tabletop Range	Channel Point Rd, 12 km west of Batchelor to coast		Very large area that includes a wide variety flora and fauna species and communities (including many rare and endangered species).

Source: AHC (2005b).

### Archaeological Survey

Begnaze Pty Ltd (Appendix 6) undertook an archaeological survey in August 2005 to describe the nature and significance of any archaeological material located within the boundaries of the proposed mine site. Four archaeological sites, seven areas of isolated artefacts (background scatters) (Figure 7.14) and three historic sites were located during the survey. The sites are:



		Job No: 836 File No: 836_08_FT.14_HB	Compass Resources NI Browns Oxide Project	Archaeological sites <b>7.14</b>	Figure No:
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- **RM1.** An artefact scatter and mine lease marker. This is a small low-density stone artefact scatter (Plate 7.10 and Plate 7.11). Sixteen artefacts, consisting of unretouched flakes that were all manufactured from quartz, were identified. The average density was one artefact per square meter, with the highest density of five per square metre. The site is located in the area that is not proposed to be disturbed and was assessed as being of low archaeological significance.
- **RM2.** A stone artefact scatter (Plate 7.12). This site is in an area that has been previously disturbed by mining activities and contains a maximum density of five stone artefacts per metre square, with an average density of two artefacts per metre square. The site contains unretouched flakes, two bifacial quartz points and two quartz cores, all made from quartz. Also present was one quartzite core, four tuff flakes and a flake made from volcanic material. The site was assessed as being of low to moderate archaeological significance.
- **RM3.** A small low-density stone artefact scatter. This site is located on a low quartz outcrop, although there was evidence that quarrying occurred at the site. The site was four by three metres with an average density of less than 0.2 artefacts per square metre and a maximum density of three artefacts per square meter. The artefacts were quartz flakes and two broken tuff flakes. The site was assessed as having low archaeological significance.
- **RM4.** A stone artefact scatter. This is a small artefact scatter site of three by one meters, with an average density of five artefacts per square meter. The site consisted of unretouched flakes made of quartz with one quartzite flake and was assessed as having low archaeological significance.
- **Background scatters.** Seven areas with a background scatter of isolated stone artefacts were identified. The majority of the artefacts were unretouched flakes manufactured from quartz.
- **Historic Site – Mine lease marker.** Located in the same position as RM1 (see Plate 7.11), the marker is associated with past mining activities. It is considered to be of low to moderate historic significance.
- **Historic Site – North Australian Railway.** A gravel bed on which the tracks were laid and in some sections the top layer of gravel has been removed (Plate 7.13). Metal bolts and other metal fragments were found along the line, which is considered to be of low historic significance.
- **Historic Site – CRA Mine headframe.** Located in the southern side of Rum Jungle Road near the corner with Whites Road. The mine headframe is relatively intact and in good condition (Plate 7.14).

### 7.12.3 Issues

Issues relating to the conservation of Aboriginal and non-Aboriginal heritage in the proposed project area focus on the need to:



**Plate 7.12**  
Site RM2 facing west



**Plate 7.13**  
North Australian rail line remnant



**Plate 7.14**  
Old headframe

- Avoid, where possible, current known locations of significance.
- Minimise the potential disturbance to locations of archaeological significance discovered during project activities.
- Manage adverse impacts where they are unavoidable.

#### **7.12.4 Avoidance, Mitigation and Management Measures**

The sites identified during the archaeological survey will be protected through the establishment of exclusion zones in consultation with the Northern Territory Heritage Office.

However, if sites RM1, RM3, RM4, the background scatters of isolated artefacts, the mine lease marker or the North Australian Railway line are to be destroyed or disturbed by the development, permission to destroy the sites will be sought from the Minister for Natural Resources, the Environment and Heritage. No further mitigating procedures will be necessary for compliance with the provisions of the Northern Territory *Heritage Conservation Act*.

If site RM2 is to be disturbed by the development, then permission to destroy the site will be sought from the Minister for Natural Resources, the Environment and Heritage, and a detailed surface survey will be carried out before it is to be disturbed.

The CRA Mine headframe will be either donated to an interested party in Batchelor to be displayed in the town or moved to an alternative site where it will be protected.

It is possible that artefacts may be discovered during the development of the project. Therefore, a process will be implemented to identify and protect such future finds. Aboriginal and historical archaeologists will be on call during project construction in the event that archaeological material is detected.

The site-specific Cultural Heritage Management Plan detailed in Section 9.8.8 will ensure that impacts are managed in a culturally sensitive manner.

#### **7.12.5 Residual Impact Assessment**

There will be limited residual impacts. If the sites of archaeological significance are not to be disturbed during the development then they will be considered restricted areas and will not be entered.

### **7.13 Radiology**

A radiological assessment for the Browns Oxide Project was undertaken by the Australian Nuclear Science and Technology Organisation (ANSTO) and is included as Appendix 7. This section summarises the findings of the assessment.

### 7.13.1 Existing Conditions

While the Browns Oxide Project is adjacent to the historic Rum Jungle copper and uranium mine, the concentration of naturally occurring radioactive material (NORM) in Browns oxide ore is very low and is below the regulatory exemption level (1 Bq/g of any naturally occurring radionuclide other than  $^{40}\text{K}$ ).

Uranium concentrations have been measured in a series of ten composite ore core samples collected from 4 to 10 m depth. The mean uranium concentration was 13.9 mg/kg (8.1 to 28.6 mg/kg), while the total combined activity of the ore was  $5.32 \pm 0.59$  Bq/g. The  $^{238}\text{U}$  in the ore contributed 0.29 Bq/g to this total and each of its progeny contributed less than 0.43 Bq/g. The activity of  $^{232}\text{Th}$  and its progeny are all less than 0.022 Bq/g. The concentration of uranium and thorium in waste rock has not been measured, as the concentrations of these elements are expected to be higher in the mineralised ore than in the waste rock.

The concentrations of uranium and thorium in groundwater were both found to be  $<1 \mu\text{g/L}$  with the corresponding radionuclide activities being less than the detection limits ( $<0.02$  to  $<3.6$  Bq/L).

### 7.13.2 Potential Issues

The potential radiological issues are:

- Radiological doses to the workforce and the public.
- Uranium concentrations in ore and throughout the processing circuit.
- Radioactivity of end-products.
- Radiological impacts on the environment.
- Radiological issues at mine closure such as NORM in the TSF and disposal of contaminated process plant equipment.

### 7.13.3 Avoidance, Mitigation and Management Measures

The entry of NORM into the environment will be minimised through the physical control of waste rock (see Section 4.9.2), tailing (see Section 4.10.3), erosion (see Section 4.5.2) surface water (see sections 4.14.2 and 7.8), discharge of excess water from the TSF (see Section 9.8.4), seepage from the TSF (see Section 9.8.4) and dust (see Section 7.3.3).

Should radioactive scales, equipment, materials and/or neutralisation waste become evident during operations, specialist advice about maintenance and disposal will be sought.

Given that the radiological dose received by mine workers will be less than the allowed exposure limit for a member of the public (1 mSv/year), there will be minimal occupational health and safety requirements specific to radioactivity. However, procedures to minimise the inhalation of dust will also reduce the radiation dose received through this pathway. Minimisation of radiological dose to workers and the public will be further addressed in the Occupational Health and Safety Plan.

### 7.13.4 Residual Impact Assessment

Appendix 7 concludes that ‘the use of available modelling tools for dose calculation indicates that the impact of the Browns project on the environment will be minimal’ under normal operating conditions.

#### **Radiological Dose**

Radiological doses to the workforce and the public have been calculated by ANSTO (Appendix 7) based on a conservative range of exposure scenarios to various workgroups and the public. Potential radiation exposure pathways considered were:

- External gamma radiation.
- Inhalation of long-lived radionuclides via dust.
- Inhalation of radon.
- Ingestion of long-lived radionuclides.
- Injection of radionuclides through wounds or accidents.

The dose calculations only consider the first three pathways, with the last two pathways, ingestion and injection, being insignificant if normal occupational hygiene practices are followed. The estimated dose to indicative workgroups and the public from each of these pathways and the estimated total dose is summarised in Table 7.32.

**Table 7.32 Estimated radiological doses**

Workgroup	Estimated Dose (mSv/year)			
	External Gamma Radiation	Inhalation of Long-lived Radionuclides via Dust	Inhalation of Radon	Total
Ore stockpile	0.25	0.04	<0.01	<0.30
Ore transport	0.06	0.04	<0.01	<0.11
Ore loading and unloading	0.06	0.20	<0.01	<0.27
Public exposure	0.03	<0.01	negligible	<0.04

The total dose rate to members of the general public from mining and ore processing activities (<0.04 mSv/year) is well below the allowed exposure limit for a member of the public of 1 mSv/year.

The total dose to workers from all pathways in mining and ore handling and crushing is <0.3 mSv/y, well below the allowed exposure limit for a member of the public. Handling of waste rock, which will have lower uranium and thorium concentrations than the ore, will not pose a significant radiological risk.

#### **Ore Processing**

It is expected that uranium will dissolve in the process leach stage. The uranium will accumulate in recycled process water to be removed as part of the neutralisation waste. In addition, <sup>226</sup>Ra may also be present at low concentrations in the leach solutions and

appear at high concentrations in scales on equipment surfaces and/or absorbed into synthetic materials such as filter cloths and rubber linings.

### ***Presence of Radioactivity in End-Products***

The regulation of naturally occurring radioactivity in the mining industry is currently changing internationally and within Australia. The presence of radioactivity in end-products being transported and marketed overseas is also becoming of increasing importance, because of more stringent exemption concentrations specified by the regulatory authorities. These exemption concentrations are the basis for products exported from Australia possibly being classified as radioactive.

The presence of radionuclides, including  $^{210}\text{Po}$ , in acid process liquors, intermediate (Pb, Co/Ni) and metal products cannot be predicted but will be monitored during plant operation.

### ***Radiological Impacts on the Environment***

Current regulatory controls on radiological impact are based on the assumption that the protection of humans will result in the protection of the environment. On this basis, given that the radiation dose to the public is well below the allowed exposure limit, the environment is considered to be adequately protected.

A radiological risk assessment (RRA) has been undertaken by ANSTO (Appendix 7) examining two worst-case scenarios: 1) a tailing spill resulting in tailing solids covering the bottom of a pool in the East Finniss River and 2) tailing dust containing the highest recorded  $^{238}\text{U}$  concentrations is not suppressed and blankets an area of naturally vegetated ground.

For Scenario 1, the initial (tier-1) RRA dose estimates indicate that the maximum dose to the most susceptible wildlife group (frogs),  $4,800 \mu\text{Gy/h}$ , may exceed the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) guideline ( $4,800 \mu\text{Gy/h}$ ).

For Scenario 2, the initial (tier-1) RRA dose estimates indicate that the maximum dose to fungi is  $26 \mu\text{Gy/h}$ , which is lower than the UNSCEAR guideline of  $40 \mu\text{Gy/h}$ .

Given that these scenarios will be avoided by the implementation of an environmental management program, ANSTO concludes, '[t]he use of available modelling tools for dose calculation indicates that the impact of the Browns project on the environment will be minimal' (Appendix 7).

### ***Mine Closure***

The tailing will contain some NORM, and the TSF will be constructed and operated to prevent mobilisation of tailing solids as dust and to prevent environmentally significant radionuclide concentrations entering groundwater or surface water after mine closure.

Following closure, any radioactively contaminated process plant equipment will require appropriate decontamination and disposal.



# 8. Preliminary Hazard Analysis and Risk Assessment

## 8.1 General

The probability of accidents associated with the development and implementation of the project is low, given that the design, operating and control measures adopted by Compass will have the specific aim of their prevention. Similarly, natural events of sufficient magnitude to cause significant damage have a very low probability of occurrence.

General safeguards that will be adopted by Compass include:

- Implementation of emergency response plans (including spill contingency) and procedures for accidents and hazardous events (see Section 9.8.1).
- Induction training and periodic refresher training for all employees on all aspects of safety and site-specific by-laws concerning safety.
- Attention to government statutory compliance, notification and liaison procedures.

Nevertheless, a preliminary hazard assessment has been undertaken to identify and assess the key risks of each major component of the project to people (both project-related and the general public), the mining operation and the environment.

A detailed hazard identification and risk assessment that is consistent with DPIFM's Advisory Note ENG 509 (DBIRD, 2005) in terms of both construction and operation activities will be undertaken before these activities commence [C].

## 8.2 Risk Identification and Analysis

Hazard identification was based on experience gained by the project team in the development and operation of similar projects in similar environmental and social settings. Qualitative risk analysis was based on the method outlined in Standards Australia HB 203-2004 (Standards Australia, 2004), and took into account both the likelihood and consequence of the various risks. Four levels of risk were identified:

- Extreme—the development of strategies to reduce or mitigate the level of risk is of the highest priority.
- High—high priority; management attention to develop strategies is still required.
- Medium—moderate priority; management responsibility must be specified.
- Low—these risks fall within the bounds of normal project parameters that can be managed by routine procedures and processes.

### 8.3 Risk Evaluation

The assessment process resulted in the identification and evaluation of 19 risks that warrant particular comment over and above that presented in Chapter 7. These are listed at the end of this chapter in Table 8.1, which also includes mitigative and preventative controls, and the residual risk after taking these controls into account.

No risks were identified in the extreme risk category.

Three risks (all related to fire) were identified in the high-risk category, with another six falling in the medium-risk category. These are discussed below.

#### 8.3.1 Fire (High Risk)

Mining and ore processing operations, including the storage and handling of flammable substances such as those involved in the solvent extraction process at Browns, can lead to the generation of potentially explosive and/or flammable gas emissions. Potential environmental impacts may include breakout of fire into surrounding vegetation, release of significant quantities of air emissions and contaminated runoff from firewater. Other impacts include damage to property and injury, as well as possible plant shutdown.

Similarly, the project may be subjected to bushfire that originates from elsewhere in the area.

Detailed project design will address specific plant and facility design criteria for fire prevention, detection, control and personnel safety requirements [C]. Other measures to reduce this risk are described in the Fire Management Plan (Section 9.8.2) and address matters such as:

- Appropriate induction and training of personnel.
- Procurement of fire equipment adequate for the level of risk identified for the project and regularly maintained and tested to ensure good working order.
- Storage and handling of all substances, including waste, under conditions that minimise the risk of fire, explosion or toxic emissions, with specific measures that address the use of solvent-extraction reagents.
- Implementation of specific procedures for high-risk tasks such as 'hot work' (e.g., welding) and use of chainsaws.
- Liaison (e.g., Northern Territory Bushfire Council) and monitoring (e.g., fire danger ratings).

#### 8.3.2 Pit Flooding (Medium Risk)

The project (and particularly the pit) is located close to the East Finniss River and in an area that receives monsoonal rain. Flooding as a result of an extreme rainfall event and possible flood flow in the river, and/or excessive groundwater inflows, is therefore a possibility that must be considered, although this risk will be minimised by measures such as groundwater level monitoring and ensuring adequate maintenance of pumps (see Table 8.1).

In addition to disrupting operations and posing a potential risk to the safety of mine employees, such flooding would result in the eventual need to dispose of large volumes of water likely to contain elevated levels of suspended solids and, potentially, PAF material. Unless managed effectively, this could adversely affect downstream environmental values, although this must be evaluated within the context of the already-degraded East Finniss River. Compass therefore proposes to manage this water taking into account the following:

- Discharge of this water into the East Finniss River at high flow is likely to have reduced impacts due to the already-elevated TSS concentrations in top end streams under these conditions and the dilution that is available at high flow.
- Compass will monitor the quality of this water prior to discharge and, if necessary, treat it. Treatment could include flocculant addition, pH adjustment and/or diversion through the main sedimentation trap.

Ongoing geotechnical assessment of pit wall stability and, if necessary, implementation of measures to improve wall stability in case of pit flooding will minimise the likelihood of massive failure of the wall should such flooding occur.

### 8.3.3 TSF Failure (Medium Risk)

The project is located in an area that has an earthquake hazard risk as measured by the acceleration coefficient of 0.05 to 0.1 (Geoscience Australia, 2005). This means that, in any 50-year period, there is a 90% chance that the peak ground acceleration<sup>1</sup> will not exceed 0.05 to 0.1. This value may be compared to some more seismically active areas of Australia where acceleration coefficients greater than 0.1 apply<sup>2</sup>. Therefore, seismic activity (within the Australian context) in the area, and the associated risk, is considered to be moderate.

No known major active faults, which control the location and occurrence of earthquakes, occur at the project site and the nearest recorded earthquakes to the project area are (Geoscience Australia, 2005):

- A 0 to 2.5 magnitude earthquake approximately 40 km away.
- A 0 to 2.5 magnitude earthquake approximately 70 km away.
- Two 3.5 to 4.5 magnitude earthquakes located 50 to 60 km away.

None of these events would have posed a threat to the security of the TSF.

Nevertheless, the possibility of TSF failure is considered in Appendix 8, where an initial consequence category of High C has been adopted under ANCOLD<sup>3</sup> guidelines

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<sup>1</sup> Peak ground acceleration is a dimensionless coefficient of acceleration that is used by civil engineers to estimate forces on structures.

<sup>2</sup> The higher the value of the coefficient, the higher the risk of earthquake occurrence.

<sup>3</sup> Australian National Committee on Large Dams.

(Appendix 8) due to the location of the storage facility next to the plant area and the importance of the TSF to the viability of the overall project. The design of embankment structures to accommodate earthquake loads will be based on ANCOLD Guidelines for Design of Dams for Earthquake, and specific minimum requirements will be met concerning flood requirements, stability under seismic conditions, monitoring and surveillance of performance. An appropriate design earthquake acceleration for a dam having a consequence category of 'High C' would be an annual exceedance probability of around 1 in 1000.

If an earthquake of sufficient magnitude were to occur during operations, the inner slope of the embankment may fail and slide into the TSF. However, this failure is unlikely to extend back to encompass the whole of crest of the embankments and tailing would probably not be released. As the tailing level rises and buttresses the inner embankment slopes, the potential for failure decreases since the tailing provides increased support. Once the TSF is full, failure of inner slopes cannot occur.

The majority of the embankment will be constructed from compacted rockfill, which is relatively resistant to deformations in seismic events, particularly in low-height embankments such as the subject site.

However, should the outer slopes fail, it is possible that the embankment would breach and the less-consolidated tailings could be released. If failure is accompanied by significant rainfall, then tailing solids could be washed into the East Finniss River, with consequent adverse impacts on water quality due to both solids and, possibly, metals. In addition, PAF material that is encapsulated within the embankment could report to downstream watercourses.

It is worth noting that the severe consequences associated with TSF failure in recent years at operations in countries other than Australia are most unlikely to occur at the Browns Oxide Project due to the incorporation of a range of safeguards. These include overall method of embankment construction (i.e., by downstream raising), design and construction of the embankments to be stable up to the design event, controlled discharge of excess water during extreme events (via an emergency spillway), supervision of TSF construction by appropriately qualified personnel, TSF structural inspections, and other measures as detailed in Table 8.1.

#### **8.3.4 Generation of ARD (Medium Risk)**

As indicated in sections 4.9 and 4.10, some of the waste rock is likely to be PAF while the black shale tailing has also been classified as PAF. Geochemical analysis of the material has also identified elevated concentrations of metals such as copper, lead, cobalt and arsenic, that are potentially problematic in terms of the quality of drainage from the TSF.

Successful implementation of the management measures described in sections 4.9 and 4.10, e.g., selective handling and encapsulation of PAF waste rock, and rapid burial of PAF black shale tailing under successive layers of deposited material, will result in a low likelihood of significant volumes of ARD being generated. However, the consequences of ARD (should this occur to a significant extent), particularly as the time period involved could extend beyond mine closure, have resulted in an overall classification of this risk as 'medium' (taking into account the already degraded nature of the East Finniss River).

Management of PAF wastes will therefore be an ongoing, high-priority focus during project development and implementation.

### **8.3.5 Fuel Leakage/Spillage (Medium Risk)**

Spillage of fuels or lubricants, either from routine usage of the fuels or accidental spillage or leakage from, and ruptures of, storage vessels, will have the potential to cause environmental damage.

Minor spillage of fuel and lubricant, such as during vehicle maintenance and refuelling, will be safeguarded against through bunding and a high level of operator training, supplemented by measures such as regular inspections and monitoring. Major spills that result from tank rupture will be contained by bunding, which will be constructed in accordance with the relevant standards and codes (see Section 4.15).

Measures to address hydrocarbon spills/leakages are described in the Waste Management Plan (Section 9.8.7). Any minor spillage at the process plant will be cleaned up by the application of loose sorbent material and disposed of by incineration. Hydrocarbon spills will be reported through the incident reporting management system to Compass management, government authorities and emergency services as required. The response to major spills is described in the Emergency Response Plan (Section 9.8.1).

### **8.3.6 Chemical Leakage/Spillage (Medium Risk)**

Chemical spillage could occur during unloading, transfer to the process feed storage, or mixing.

Major areas containing hazardous materials will be designed to contain spills within the area, in order to prevent the possible mixing of acidic and alkaline materials. All areas subject to possible spills or leakage will be bunded (to collect washdown and rainwater) and will drain to sumps from where the spillage can be returned to the appropriate part of the process.

During the design phase, detailed training manuals will be prepared specifically for the Browns Oxide Project. All workers will be required to undergo formal training before commencing work at the mine or process plant. This will include specific safety training dealing with chemical safety, as well as ensuring familiarity with MSDSs and the more general safety aspects of the operation. Additional specialised training will be provided to operators with specific process or material handling jobs.

Measures to address chemical spills/leakages are described in the Hazardous Materials and Waste Management Plan (Section 9.8.7). Any minor spillage at the process plant will be cleaned up in accordance with MSDS requirements. Chemical spills will be reported through the incident reporting management system to Compass management, government authorities and emergency services as required. The response to major spills is described in the Emergency Response Plan (Section 9.8.1).

### **8.3.7 Vehicle Collision/Roll-over (Medium Risk)**

The potential exists for vehicles bringing reagents, supplies and similar to the site to be involved in an accident. This could result in release of product, hydrocarbons or chemicals with consequent adverse impacts on the environment, and/or injury or fatality.

Contractors will be required to comply with Compass's procedures and the relevant codes and standards for transport, storage and handling of hazardous materials (including emergency response). Similarly, contractors will be required to adhere to Northern Territory road rules.

Fuel trucks will carry equipment necessary to respond to an accident that may result in a spill. In the event that product is spilt during transport, the material will be excavated and recovered as quickly as possible. The General Manager will be notified immediately of spills that occur during transport and Compass will then notify the relevant authorities.

Should fuel or product come into contact with surface drainage, water quality will be monitored to ensure that the area is appropriately remediated, if necessary.

It should be noted that, while a number of risks involve a possible fatality (see Table 8.1), i.e., a severe consequence, only the vehicle collision/roll-over is given a rating greater than 'low'. This reflects the increased likelihood of such an event occurring relative to events such as pit wall failure or explosions.

Table 8.1 Preliminary hazard analysis

Mine Component	Hazard	Hazard No.	Incident/Event	Potential Consequence/Impacts	Mitigation and Prevention Measures	Potential Offsite Impact?	Qualitative Risk
Mine pit	Pit wall failure	1.1	Failure due to seismic activity, geotechnical instability or groundwater pressure.	Injury/fatality. Disruption to operations.	Material constrained to the confines of the pit. Design of pits slopes, bench heights and berms. Stability monitoring, e.g., pins, ongoing geotechnical and hydrological review. Dewatering, i.e., control of water behind pit walls.	No	Low
	ARD	1.3	ARD is generated as a result of exposure of reactive sulfides in pit wall/floor.	Contaminated pit water enters watercourse.	No mining of primary ore. Pumping pit water to main sedimentation dam for use in the process plant. Treatment prior to discharge from main sedimentation dam. Rapid flooding of pit on closure.	Yes	Low

Table 8.1 Preliminary hazard analysis (cont'd)

Mine Component	Hazard	Hazard No.	Incident/Event	Potential Consequence/Impacts	Mitigation and Prevention Measures	Potential Offsite Impact?	Qualitative Risk
Mine pit (cont'd)	Post-closure pit wall failure into flooded pit	1.5	Post-closure failure of pit wall results in water in the already flooded pit overtopping the walls.	Contaminated pit water enters watercourse.	Pit wall and berm design. Post-closure pit water quality monitoring.	Yes	Low
TSF and associated infrastructure	Embankment failure	2.1	Failure due to seismic activity, overtopping embankment/spillway results in release of tailing solids and liquid.	Exposure of PAF material in embankment walls with subsequent oxidation and onset of acid conditions. Tailing solids and/or contaminated water enters watercourse.	Downstream construction of embankment raises. TSF structural inspections. Daily decant level monitoring. Supervision by qualified engineer during construction. Development of detailed TSF operating procedures. Development of contingency plans. Engineered capping on closure.	Yes	Medium
	Tailing pipeline failure	2.2	Failure due to seismic activity, structural failure or heavy equipment damage.	Release of tailing slurry to vegetation. Release of tailing slurry to watercourse.	Bunding. Emergency containment ponds. Monitoring pipeline flow. Development of contingency plans.	Yes	Low
	ARD	2.3	Significant volumes of ARD are generated from waste rock (placed in the TSF embankment) and/or tailing.	Contaminated water enters watercourse.	Encapsulation of PAF material in TSF embankment. Minimal atmospheric exposure of PAF tailing during operations. Engineered capping on closure. Monitoring.	Yes	Medium

Table 8.1 Preliminary hazard analysis (cont'd)

Mine Component	Hazard	Hazard No.	Incident/Event	Potential Consequence/Impacts	Mitigation and Prevention Measures	Potential Offsite Impact?	Qualitative Risk
Stockpiles	Stockpile failure	3	Failure due to seismic activity or changed material properties (e.g., moisture content).	Smothering of vegetation. Surface water contamination.	Location of stockpile. Appropriate dumping practices. Drainage control. Development of recovery plan.	Yes	Low
Process plant	Tank or pipeline rupture or breach	4	Exceedance of design criteria.	Release of process water, hydrocarbons or other chemical. Surface/ground water contamination. Fire or explosion.	Bunding. Monitoring pipeline flow. Monitoring tank levels. Development of contingency plans.	Yes	Low
Process plant and magazine	Fire and explosion	5	Ignition of flammable material.	Escape of fire into surrounding vegetation. Release of air emissions. Contaminated runoff from firewater enters watercourse. Injury/fatality.	Compliance with standards for the storage and handling of explosives and flammable material, including: - Buffer zones. - Fire detection requirements. - Fire control equipment. - Ignition free zones. Specific measures for the use of solvent-extraction reagents. Regular maintenance and testing of fire equipment. Regular fire response training. Development of fire management plan and emergency response plan.	Yes	High

Table 8.1 Preliminary hazard analysis (cont'd)

Mine Component	Hazard	Hazard No.	Incident/Event	Potential Consequence/Impacts	Mitigation and Prevention Measures	Potential Offsite Impact?	Qualitative Risk
Confined spaces	Irrespirable atmosphere	6	Entering confined space without appropriate safety equipment.	Injury/fatality. Mill shut-down.	Standard procedures for operating in confined spaces.	No	Low
Chemical storage and handling facilities Maintenance facilities	Fire and explosion	7.1	Ignition of flammable material.	Escape of fire into surrounding vegetation. Release of air emissions. Contaminated runoff from firewater. Injury/fatality.	Minimal flammable material to be stored on site. Other measures as described for hazard no. 5.	Yes	High
	Fuel leakage/spillage	7.2	Spillage during tanker unloading or leakages from tanks.	Fire and explosion. Soil contamination. Surface water contamination. Groundwater contamination.	Regular inspection of tanks, pipes, connections and bunds. Soil and groundwater monitoring. Operator training. Spill response training. Spill response kits maintained and located in appropriate areas. Development of waste management plan. Development of emergency response plan (including spill contingency).	Yes	Medium

Table 8.1 Preliminary hazard analysis (cont'd)

Mine Component	Hazard	Hazard No.	Incident/Event	Potential Consequence/Impacts	Mitigation and Prevention Measures	Potential Offsite Impact?	Qualitative Risk
Chemical storage and handling facilities Maintenance facilities (cont'd)	Chemical leakage/spillage	7.3	Spillage during unloading, transfer to process feed storage or mixing.	Release of chemical resulting in surface water and ground contamination. Release of gases.	Storage that prevents possible mixing of acidic and alkaline materials. Bundling with washdown and runoff collection systems. Use of appropriate protective clothing during handling. Operator training for mixing and use of chemicals. Spill response training. Management in accordance with MSDS. Development of waste management plan. Development of emergency response plan (including spill contingency).	Yes	Medium
Services	Powerlines	8	Mobile equipment contact with powerlines.	Fire. Injury/fatality.	Overhead lines marking and signage.	Yes	Low
Transport activities	Vehicle collision or roll-over	9	Road accident.	Release of product, hydrocarbons or chemicals to the environment. Fire or explosion. Injury/fatality.	Compliance with appropriate statutory standards for the transport of hazardous materials. Adherence to speed limits (where applicable) and road rules.	Yes	Medium

Table 8.1 Preliminary hazard analysis (cont'd)

Mine Component	Hazard	Hazard No.	Incident/Event	Potential Consequence/Impacts	Mitigation and Prevention Measures	Potential Offsite Impact?	Qualitative Risk
Transport activities (cont'd)					Develop emergency response plan (including spill contingency). Trim roadside vegetation to increase line of sight. Maintenance schedule for all vehicles.		
	Fire	10.1	Fire started within the project area or entering the project area from offsite.	Disruption to operations. Vegetation damage. Explosion. Release of air emissions. Contaminated runoff from firewater. Injury/fatality.	Weather monitoring. UHF communications on site. Fire extinguishers on board all vehicles. Other measures as described for hazard nos. 5 and 7.1.	Yes	High
	Flooding	10.2	Flooding caused by extreme rainfall event and/or flood flows in the East Finniss River (and its tributaries).	Disruption to operations. Injury/fatality. Large volume water requiring disposal.	Weather monitoring. Groundwater level monitoring. Maintenance of pumps. River/pit water level monitoring.	Yes	Low

# 9. Environmental Management

## 9.1 General

The environmental management measures described herein will be readily adapted for inclusion in the Mining Management Plan, as required under the *Mining Management Act*, following PER approval (see Chapter 2). With respect to environmental management and monitoring, the management plans described in this chapter are generally in principle and strategic, set out the management issues identified during the preparation of this report and, for each, presents Compass' policy position and management intentions. Where possible and appropriate, detailed management measures are also described (as required by the PER guidelines).

## 9.2 Environmental Management System

Compass is committed to working within the framework of corporate environmental management systems (EMS) in accordance with the international EMS standard, ISO 14001:1996, adapted for use in Australia and New Zealand as AS/NZS ISO 14001:1996. These standards provide Compass with the elements of an effective, project-specific EMS, that is, a procedure for implementing, achieving, reviewing and maintaining the company's environmental policy.

An EMS is a structured approach to managing an environmental program and provides a quality system to guide the:

- Development and implementation of environmental management procedures.
- Monitoring of environmental impacts and performance.
- Review of procedures to ensure continual improvement.

The extent to which the various components of an EMS will be implemented by Compass will reflect the scale of the project. Key elements of the Browns Oxide Project EMS will include:

- Commitment and policy – the corporate environmental policy defines Compass' commitment to conduct business in all operations in an environmentally responsible manner and with full legal compliance.
- Planning – clearly stated project-specific objectives consistent with the policy.
- Implementation and operation – practical procedures to fulfil objectives with personnel responsibilities for environmental management clearly defined through inductions and training, and ongoing consultation with relevant stakeholders.
- Checking and corrective action – involves regular inspection and auditing to assess compliance with environmental management objectives and a system of dealing with incidents and complaints, recording data and reporting.
- Management review – internal review of the EMS with the aim of continual improvement.

Implementation of these EMS elements is outlined in the sections below.

### 9.3 Commitment and Policy

Compass is committed to managing its activities in an environmentally responsible manner and pursuing environmental excellence. Compass has a corporate environmental policy approved by the Compass Board (Box 9.1) that reflects this commitment. The Environmental Policy is the pinnacle document within the EMS, and environmental performance is measured and reported against this policy.

The Company's environmental policy is based on the recognition that all activities, including resource development and processing, impact on the environment. Since it is not possible to eliminate impact, the Company's policy is to engineer and conduct operations with the objective of achieving best practice so that adverse effects on the environment are either avoided or kept to an acceptable level.

#### Box 9.1 Compass Resources Environmental Policy

The Company's environmental policy objectives are:

- Assess potential environmental impacts before conducting new activities.
- Comply with applicable State, Territory and Federal laws and regulations.
- Implement, maintain and audit all environmental standards, regulations and good working practices which have applications to our operations and where such do not exist, to adopt the most practical methods available.
- To ensure that our operations do not create a significant hazard to employees, the public and any wildlife and are compatible with the environmental, social and economic aspirations and needs of the community, and to take immediate and positive action where any significant hazard arises.
- To work actively with government agencies to foster and encourage timely development of regulations in respect of our operations as may be needed to achieve both desirable and attainable environmental standards.
- To work in co-operation with outside groups toward a consensus on environmental quality standards which are both desirable and obtainable.
- To ensure public awareness and understanding of the nature of any individual environmental problems which may occur within our operations and of the action being taken by the Company in resolving or minimising such problems.
- To recognise the important roles played by individual employees in the achievement of the Company's environmental conservation goals, and where necessary to assist employees with any orientation of training on particular environmental issues.

### 9.4 Planning

The planning elements for the Browns Oxide Project are addressed throughout this PER document that identifies the project's regulatory framework (Chapter 2) and potential environmental impacts (Chapter 7). Planning for environmental risk is incorporated into the 'Avoidance, Mitigation and Management Measures' sections in Chapter 7, and is also presented in greater detail in the individual issue-based management plans (see Section 9.8).

## 9.5 Implementation and Operation

### 9.5.1 Procedures

The environmental management procedures for the project, as far as they have been developed at this stage of the project, are presented in the management plans (see Section 9.8).

### 9.5.2 Responsibilities

The project is to be managed by Compass. The General Manager Operations will be responsible for ensuring that all activities associated with the project are undertaken in full compliance with statutory regulations and are consistent with the Compass environmental policy.

Compass will ensure that the environmental approval conditions are accessible to senior management and other personnel on request at all times. All personnel are responsible for ensuring that their work complies with these conditions and the described environmental management measures. Individual accountability will be defined through conditions of contracts of employment.

Planned responsibilities of the various personnel involved in the project are outlined in Table 9.1.

**Table 9.1 Environmental management responsibilities**

<b>Personnel</b>	<b>Responsibilities</b>
Compass Chairman	<ul style="list-style-type: none"> <li>• Overall responsibility for the project.</li> </ul>
General Manager Operations	<ul style="list-style-type: none"> <li>• Overall responsibility for site-specific implementation of environment policy, systems and management measures.</li> </ul>
Environmental Manager	<ul style="list-style-type: none"> <li>• Ensures EMS is implemented uniformly, revised and maintained.</li> <li>• Assesses the suitability and effectiveness of the EMS.</li> <li>• Ensures that contractors fulfil their contractual obligations.</li> <li>• Implements induction procedures and appropriate training.</li> <li>• Ensures compliance with licence conditions and company policy via the establishment and maintenance of appropriate reporting systems and databases.</li> <li>• Participates with personnel to improve work practices on site.</li> <li>• Undertakes internal site environmental audits.</li> <li>• Provides advice as required to other project personnel.</li> <li>• Liaises with stakeholders.</li> <li>• Ensures implementation and regular review of environmental management measures.</li> </ul>
Other managers	<ul style="list-style-type: none"> <li>• Ensures implementation and regular review of relevant environmental management measures.</li> <li>• Liases with Environmental Manager as required.</li> </ul>
Contractors	<ul style="list-style-type: none"> <li>• Fulfil contractual obligations.</li> </ul>
Archaeologist on call	<ul style="list-style-type: none"> <li>• Provides advice and assessment on call in the event that archaeological material is uncovered during construction.</li> <li>• Liaises with the relevant community groups and government agencies.</li> </ul>
Independent Environmental Auditor	<ul style="list-style-type: none"> <li>• Conducts regular independent environmental audits of the operations to ensure compliance with Mining Management Plan (MMP) and statutory regulations.</li> </ul>

### 9.5.3 Inductions and Training

Compass management will ensure that personnel have the appropriate knowledge and skills to achieve environmental policies, objectives and targets. The General Manager Operations will be responsible for organising environmental inductions (linked with safety inductions for efficiency) for employees and contractors to address environmental issues and responsibilities, including:

- Obligations under Compass' environmental policy, other policies and relevant sections of the EMS and permitting conditions.
- Site layout and areas of particular environmental or social significance.
- Community attitudes to the project and measures that could enhance the positive aspects of these attitudes.
- Site environmental guidelines.
- Specific procedures as detailed in the MMP concerning key environmental management aspects of the operation, including fire control, minimisation of impacts on flora/fauna, weed and pathogen management, recognition of potential heritage sites, segregation of rock types, water management, waste management, and hazard prevention.

An appropriately qualified person will conduct the environmental inductions. All personnel will be required to undertake and pass a knowledge questionnaire based on the induction presentation. Records will be retained of all persons being inducted. Weekly 'tool box' meetings will identify environmental issues that may arise from time to time.

Additional specific environmental training will be provided to personnel involved in:

- Maintaining and operating pollution control equipment/structures.
- Storing and handling hazardous materials.
- Responding to environmental incidents, e.g., fuel spills.

Additional training will be undertaken on an as-needs basis and, if required, key personnel will be provided with support to explain management procedures to their staff. All personnel will have access to hard copies of the MMP, to be located in the site office.

### 9.5.4 Consultation

The General Manager Operations (or his delegate) will maintain on-going consultation with stakeholders, including (see Section 6.2):

- DPIFM.
- DNRETA.
- Coomalie Community Government Council.
- Batchelor community.
- Nearby residents/landowners.
- Project personnel.
- Northern Land Council and traditional owners.
- Other stakeholders as relevant.

Matters for consultation will include construction progress, potential impacts of the project on other parties and their management, and safety or environmental incidents. Consultation may be required on an ad-hoc basis for some stakeholders (in terms of issues to be covered and timing of communications), while for others a structured program may be required. Depending on the stakeholder involved, consultation may take the form of telephone communications, formal written correspondence, one-on-one informal meetings or formal gatherings. Significant stakeholder consultation will be recorded in a stakeholder database and kept in the site office.

Compass was operating in the region prior to development of the Browns Oxide Project and had established relationships with the majority of the key stakeholders (see sections 6.3 and 6.4).

## **9.6 Checking and Corrective Action**

### **9.6.1 Supervision and Inspection**

The General Manager Operations (or his delegate) will undertake regular supervision and inspections of activities to ensure that environmental management procedures are being implemented satisfactorily. The frequency of inspection will depend on the magnitude of risk associated with the particular hazard. Inspection results will be maintained by the General Manager Operations and reported to Compass periodically.

### **9.6.2 Compliance Audits**

Audits will be undertaken by an appropriately qualified person on a regular basis to ensure compliance with the environmental management procedures. Auditing will be conducted twice during the construction phase and yearly during operations [C].

### **9.6.3 Incidents**

Environmental incidents that occur either as a result of an emergency, accident or equipment malfunction and which cause or threaten serious or material environmental harm will be reported to DPIFM within 24 hours of the event. In addition, the Compass Board will be made aware of any such incident within the same timeframe. Incidents can include (but are not limited to):

- Fire outbreak from the project area.
- Motor vehicle accident.
- Hydrocarbon or reagent spill.
- Contamination of a waterway.
- Injury to wildlife.

The incident will be recorded in a Non-compliance Report (NCR) which any employee, contractor or consultant can issue when policy breaches (or incidents) are noted and investigation is required. These reports will be submitted to the General Manager Operations, who will generate a Corrective Action Request (CAR) specifying the required rectification action as soon as practicable after submission of the NCR.

The incident will be registered in a record system and investigated and a report prepared. In addition to statutory reporting requirements, the report will detail any deficiencies in the MMP, with such deficiencies resulting in revision of the MMP and

notification to DPIFM. Personnel will be reminded of environmental incidents or near-miss incidents through tool-box meetings.

The Incident Register will be maintained throughout construction and operations. An incident summary will be included in regular compliance reports (see Section 9.6.5).

#### 9.6.4 Complaints

A Complaints Register will be established to:

- Record complaints received from stakeholders.
- Identify the party/person responsible for dealing with the complaint.
- Record the action(s) taken to resolve the complaint.
- Record communication with the complainant (including feedback).

Compass will aim to resolve complaints received from stakeholders as soon as possible, although the nature of the complaint will determine the timeframe and actions to be taken. Table 9.2 sets out indicative timeframes for resolving typical complaints that might be received. Response time is the time taken to secure initial attendance by the General Manager Operations (or delegate) at site after first being made aware of an incident or complaint. Containment time is the time taken to contain the incident after first being made aware of its occurrence.

**Table 9.2 Indicative timeframes for response and containment of typical complaints**

Type of Complaint	Initial Response Time	Containment Time
Chemical, petrol or oil spill	Within 2 hours of notification	Within 24 hours of notification
Inappropriate vegetation clearing	Within 2 hours of notification	During initial response
Weed/pathogen hygiene not observed	Within 2 hours of notification	During initial response
Dust nuisance	Within 2 hours of notification	Within 24 hours of notification
Noise nuisance	Within 2 hours of notification	Within 24 hours of notification
Damage to land or property not in MLA	Within 24 hours of notification	Depends on nature of damage
Unacceptable behaviour or abuse of personnel	Within 24 hours of notification	N/A
Request for further information	Initial acknowledgement letter within 24 hours with further follow-up within 5 working days	N/A

The concept of 'response time' will also apply to requests for further information, but in this case will allow for an initial acknowledgment letter and subsequent investigation of the issue, with a final response in writing.

#### 9.6.5 Recording

The EMS will become part of an auditable record system maintained by Compass that will also include the following:

- PER and associated documents.
- MMP.

- Compliance inspection and audit reports.
- Non-compliance reports (NCRs).
- Corrective action requests (CARs).
- Incidents register.
- Complaints register.
- Consultation records including meeting notes.

In accordance with the principles of AS/NZS ISO 14001:1996, the above EMS documentation will be:

- Easily located and logically filed in hard copy and electronic copy form, including date of issue.
- Available for all Compass personnel, contractors and consultants.
- Periodically reviewed and revised as necessary (and clearly dated) by authorised personnel.
- Removed from all points of issue when obsolete.

The General Manager Operations will be responsible for ensuring that feedback is assessed and implications for the EMS are acted upon.

### **9.6.6 Reporting**

#### ***Routine Reporting Systems***

Compass will employ the following environmental and social reporting systems:

- Results from environmental monitoring and investigation programs will be reported formally to DPIFM on a quarterly basis.
- A report dealing specifically with environmental issues will be submitted to Compass's Board on a quarterly basis. This will include a summary of non-compliance reports, corrective actions, and major issues arising from daily supervision and inspection and compliance audits.
- Updates of the Mining Management Plan (annually or as otherwise agreed).
- Annual NPI report.

#### ***Databases***

Compass will maintain a computerised database for monitoring data and other relevant information. The primary functions of the system will include:

- Recording water quality data, including details such as:
  - Location code, description (including elevation) and map reference.
  - Sampling interval.
  - Sampling date.
  - Variable.
  - Unit of measure.
  - Method of analysis.

- Result.
- Last monitored date.
- Recording relevant regulatory documents, e.g., acts of parliament, government policies, permits and dangerous goods or other licences.
- Recording additional information such as training records and the results of environmental audits and reviews.
- Providing other information, e.g., waste rock net acid-generation (NAG) and net acid-producing potential (NAPP) test results.
- Recording hydrocarbon usage.

### 9.7 Management Review

Continual improvement is the implicit aim of any EMS. The EMS will therefore be subject to review and modification to reflect issues that arise as the project is developed.

### 9.8 Issue-based Management Plans

This section provides issue-based management plans for the key environmental aspects identified within the PER as relevant to the proposed project (and taking into account the requirements of the MMP (DBIRD, 2002)). The management plans are:

- Emergency Response Plan.
- Fire Management Plan.
- Biological and Land Management Plan (which includes flora and fauna management, weed control, feral animal control and biting insects management).
- Water Management Plan (which addresses both surface and groundwater).
- Air Quality Management Plan.
- Noise and Vibration Management Plan.
- Hazardous Materials and Waste Management Plan (which includes both hazardous and non-hazardous wastes).
- Cultural Heritage Management Plan.

The management plans consist of four components:

- Issue(s).
- Objective(s).
- Performance standard(s).
- Implementation strategies and selected specific measures.

The management plans will be refined after approval has been obtained and the detailed design phase of the project has been completed. These revised plans will form the basis of a detailed MMP that will be completed prior to construction, and will expand on the

information contained herein, including implementation measures, schedules and responsibilities [C].

This approach has the following advantages:

- The PER report contains sufficient information to allow an assessment to be made of the strategic approaches that will be reflected in the detailed plans.
- The MMP will incorporate detailed project-related information as it becomes available and at the appropriate stage of project development.

### **9.8.1 Emergency Response Plan**

#### ***Issue***

Accidents and incidents can occur during mining, processing and transport activities. The risk of certain events having significant consequences requires the preparation of an Emergency Response Plan (ERP).

#### ***Objective***

The objective of the ERP is to ensure that a prompt and appropriate response is made to unplanned incidents where life, property or significant environmental or social values are threatened during construction and operations.

#### ***Performance Standards***

To ensure that this management plan complements the emergency response procedures of DPIFM and other relevant agencies, Compass will consult with relevant authorities regarding:

- On-site emergency procedures.
- Special risks and appropriate procedures to minimise those risks.
- Commercial ambulance and medical services.

The Emergency Response Plan will consider the relevant aspects of 'Small Mine Occupational Health and Safety Management System', which is published by DPIFM and is designed to help develop information for use at a mining site before and during emergencies.

#### ***Implementation Strategies and Measures***

Strategies and measures that will be implemented to ensure that the objective is achieved include:

- Demonstrate clear commitment and leadership by management through policy, participation, communication and allocation of resources (personnel, time, facilities and finances).
- Provide a current, written, project-specific plan, i.e., a detailed operating emergency response plan that addresses, among other matters, communication to employees, contractors and the public and, where appropriate, the recovery needs of the community after an emergency.

- Foster employee ownership in the processes of emergency management and response.
- Identify all hazards and risks of an unplanned incident (detailed hazard and risk analysis). Develop an assessment process, periodically reviewed and updated, of potential risks from an accidental release or other emergencies to employees, contractors and local communities, and initiate actions to reduce significant risks. Review quarterly and update as necessary, and display in the site office. Credible emergencies that could potentially occur at the project site include (see Chapter 8):
  - Accidental spill of hydrocarbons or chemicals while being transported, stored or used.
  - Accidental detonation of explosives while being transported, stored or used.
  - Gale-force wind or rainfall, including cyclones, or a flood event in the East Finniss River, that causes extreme flooding or destruction of facilities.
  - Lightning or fire that damages facilities or the surrounding environment.
  - Injury to personnel.
  - Vehicle accident.
  - Pit wall collapse or rock fall.
- Develop a cyclone response plan.
- Ensure that facilities allocated to emergency response are maintained in working order (e.g., phone, facsimile, CB radios, satellite phone, fire tanks).
- Ensure that all personnel wear personal protective equipment (PPE) at all times while on site, as required. The level of PPE equipment for each person is dependent on the location and nature of the activity being undertaken.
- Induct all personnel in emergency response procedures during environmental and safety induction (nobody will be allowed on site (other than to the administration/reception area) unless inducted).
- Develop, conduct and maintain a training program, addressing operating procedures, emergency and safety procedures, regulatory compliance requirements and communication responsibilities, designed to improve the proficiency of emergency response of all employees and contractors.
- Identify emergency authorities and, where relevant, provide tours of the project area for them to promote emergency preparedness, by having current knowledge of facility operation and relevant emergency response planning information.
- Conduct emergency exercise sessions with emergency authorities and others where appropriate, to test the workability of the emergency response plan.
- Share information and experience with other nearby facilities in the community relating to emergency response planning, exercises and incident handling.

- Clearly define roles and responsibilities for personnel involved in the emergency response.
- In the event of an emergency, immediately contact the General Manager Operations and other relevant personnel as provided for in the detailed emergency response plan, and provide details of the emergency such as:
  - Nature of the emergency (e.g., injury, fire, fall).
  - Location.
  - How it may have occurred.
  - Current status (e.g., who is injured, where the fire has spread to).
  - What may be needed to stop/control the emergency.
- In the event of fire, accident, environmental hazard, personal injury, flood or similar, the response will be in accordance with the detailed operating emergency response plan. Emergency response will be prioritised according to the following hierarchy:
  - Protection and rescue of human life.
  - Minimisation of the area impacted by the incident.
  - Protection of the environment, plant and property.
  - Rendering the area safe in which the emergency has occurred.
  - Restoration of all disrupted services.
  - Decontamination and rehabilitation of the incident scene and surrounding area.

### 9.8.2 Fire Management Plan

#### **Issues**

Project development activities may lead to fire ignition within the project area or the surrounding vegetation. Sources of fire ignition include:

- Sparks from chainsaws.
- 'Hot work' (e.g., metal grinding or welding).
- Vehicles.
- Inappropriate handling or storage of combustible substances.
- Discarding lit tobacco products, matches or other burning material.
- Mechanical malfunction in project facilities, vehicles or machinery, or explosion of the magazine.
- Vegetation coming into contact with overhead powerlines.
- Sparks caused by lightning.

The project also needs to be protected from bushfire that originates from surrounding vegetation, regardless of source.

#### **Objectives**

The objectives of the Fire Management Plan are to:

- Minimise fire risk.
- Protect the public and personnel.
- Protect property and minimise property damage or loss.
- Protect flora and fauna and minimise damage or loss.
- Prevent the spread of fire in the event of ignition.
- Provide adequate response in the event of an ignition.

**Performance Standards**

The Fire Management Plan has been prepared under the following legislation, guidelines and codes:

- *Northern Territory Bushfires Act.*
- Northern Territory Bushfire Regulations.

**Implementation Strategies and Measures**

Strategies and measures that will be implemented to ensure that the objectives are achieved include:

- Induct personnel in fire prevention and response.
- Enforce a total fire ban within the project area, unless prescribed burning is deemed necessary, in which case it will occur in a controlled regulated environment in consultation with traditional owners, pastoralists and organisations such as the Bushfires Council Northern Territory.
- Implement a controlled burn regime to maintain a mosaic of vegetation and habitats, including structural and spatial diversity and development.
- Monitor and record fire danger ratings on a weekly basis during the fire season and comply with all relevant statutory requirements and permits.
- Liaise with the Bushfires Council Northern Territory during the fire season regarding fire risk, danger ratings, preparedness and fire control.
- Establish fire evacuation procedures and an emergency assembly area.
- Provide emergency contact numbers in the site office in an easily accessible area (i.e., noticeboard). Contacts should include the local fire brigade, local police station, medical centre, SES).
- Report all uncontrolled fire to the General Manager Operations, who will report it to the relevant authorities.
- In the event of a fire during a fire danger period, ensure that at least one employee stays with the fire (without endangering themselves) until it is completely extinguished or the relevant authorities take over responsibility.
- Provide relevant information on project development and operating practices to fire authorities.
- Ensure particular diligence when transporting, storing or using flammable materials such as solvent extraction reagents.
- Implement specific measures such as:
  - Maintain a full trailer-mounted fire-fighting tanker on site at all times.
  - Provide and maintain appropriate fire-fighting equipment, including fire extinguishers, water knapsacks and rake hoes at strategic project locations. Fire

extinguishers will be provided in all project-related vehicles. All equipment will be compatible with that of local fire authorities.

- Do not undertake ‘hot work’ (e.g., welding) on days of declared Total Fire Ban without a permit.
- When undertaking ‘hot work’, ensure that spark guards are used, the immediate area is clear of flammable materials (excepting vegetation) and fire extinguishers are on hand. Develop a ‘hot work’ procedure and ensure compliance.
- Construct 50-m-radius fire breaks around sensitive areas, such as the explosives magazine.
- Park vehicles in a cleared car park on site and not over tall groundcover vegetation.
- Keep vehicles clean, e.g., clear grasses from belly-plates.
- Fit chainsaws used for vegetation clearance with spark arresters.
- Ensure all flammable materials are clearly marked and stored appropriately with fire-fighting equipment.
- Use diesel-fuelled vehicles when practicable.
- Do not discard any lit tobacco products, matches or any other burning material into vegetated areas.
- Clear and maintain vegetation under overhead power lines to a height considered safe (for the continued operation of the power line in the event of a fire).

The measures listed above will provide a basis for a detailed fire management plan, where this will be developed in consultation with key stakeholders such as traditional owners, the NLC and local fire authorities (fire brigade and Bushfires Council Northern Territory) [C].

### **9.8.3 Biological and Land Management Plan**

The Biological and Land Management Plan addresses flora and fauna management, weed control, feral animal control and biting insects management.

#### **Issues**

Biological and land management issues associated with the project include:

- Clearing of vegetation and associated impact on native flora and fauna values. This may result in:
  - Loss of feeding, breeding and nesting habitat.
  - Loss of distribution, dispersion and genetic diversity of populations in the region.
  - Habitat fragmentation.
- Loss of fauna due to increased traffic.

- Fire management and associated impacts on vegetation, flora and fauna biodiversity and habitats.
- Effects on vegetation and fauna habitat surrounding the proposed mine due to mine dewatering and other hydrological changes.
- Effects on aquatic flora and fauna due to disturbance of soils from construction activities resulting in increased soil erosion and transport of soils to local waterways with consequent adverse impacts.
- Introduction and/or spread of weed species by project-related vehicles and equipment (especially earth-moving equipment).
- Feral animals.
- Spread of diseases due to biting insects such as mosquitoes.

### **Objectives**

The objectives of the Biological and Land Management Plan are to:

- Promote and maintain stable vegetation cover.
- Minimise soil disturbance and soil erosion.
- Minimise impacts to flora and fauna.
- Prevent and minimise impacts of bushfires (see Section 9.8.2 for corresponding performance standards and implementation strategies and measures).
- Prevent and control pest animal invasion.
- Prevent and control weed invasion.
- Prevent the occurrence of biting insects build-up.

### **Performance Standards**

The Biological and Land Management Plan has been prepared under the following legislation, guidelines and codes:

- Northern Territory *Weeds Management Act*.
- Territory *Parks and Wildlife Conservation Act*.
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
- Guidelines for preventing mosquito breeding sites associated with mining sites (MEB, 1997).
- The prevention of mosquito breeding in sewage treatment facilities (Whelan, 1997).
- Recommendations for design details of sewage pond effluent reuse or disposal facilities to prevent mosquito breeding (Whelan, 1998).

- Personal protection from mosquitoes and biting midges in Northern Territory (Whelan, 2004).

### ***Implementation Strategies and Measures***

Strategies and measures that will be implemented to ensure that the objectives are achieved include:

#### *Flora and Fauna Management/Vegetation Clearing*

- The project will be designed to minimise vegetation loss due to project infrastructure layout.
- Where possible, previously disturbed and modified areas will be used in preference to undisturbed areas.
- The project will be designed to minimise and, where possible, avoid unintended changes in the structure and condition of areas which contain flora and fauna of significance (as outlined in sections 7.1.4 and 7.2.5). For example, clearing of vine forest vegetation in the north of the project area will be minimised.
- No land disturbance activities will take place without written authority in the form of a Land Clearance Certificate or similar.
- The project area will be maintained in accordance with good industry housekeeping practices to discourage vermin.
- Specific measures such as:
  - Cleared vegetation will be used as erosion control (to dissipate rainfall) where appropriate. Cleared vegetation will not be stockpiled against retained vegetation nor will it be pushed into retained vegetation along creeks or into creeks.
  - Stripped topsoil will be stockpiled separately and used for revegetation.
  - Construction equipment, material stockpiles and other infrastructure will be placed on cleared land rather than in areas of native vegetation.
  - Where practicable, trees will be retained within the project area.
  - Access to the site will be restricted (by security fencing and security gate) to minimise entry of non-project vehicles to the area.
  - All vehicles will stay on designated tracks/roads and avoid creating new tracks.
  - Soil disturbance outside the nominated construction zones will be minimised.
  - No trapping or killing of native wildlife within the project area will be permitted.
  - No firearms or domestic pets, such as cats and dogs, will be brought into the project area.
  - Native wildlife or introduced species (especially cats) will not be intentionally fed.

- No food will be discarded within the project area. All waste materials (particularly food scraps) will be stored in lidded containers.

#### *Weed Control*

- A detailed weed management plan will be developed in accordance with the Northern Territory *Weeds Management Act* [C]. This will incorporate the following management measures:
  - All personnel will be inducted in weed management procedures.
  - Monitoring for weed outbreaks during project development will take place and such outbreaks will be eradicated at the appropriate time using the most efficient means, preferably with target-specific, non-persistent (i.e., biodegradable) herbicides.
  - Heavy vehicles and equipment that work in areas off formed roads, e.g., TSF construction and initial clearing of the hard-stand area for the process plant, will be visually inspected for clumps of soil or vegetative material before leaving the project area. If present, material will be removed by using a high-pressure/low-volume water spray unit.
- A 'clean vehicles' policy will be maintained whereby heavy vehicles and equipment will be cleaned prior to entry into the project area. Other vehicles will be cleaned if they leave designated access tracks.
- Hard-stand material at the process plant will consist of NAF waste rock sourced from the project area. Material sourced from outside the project area will be generally avoided but, if necessary, will be from a known source (which will also be a DPIFM or Council-approved site).

#### *Biting Insects*

- All personnel will be inducted on the risks associated with biting insects, how to prevent bites and how to treat them.
- The site will be managed to minimise pooling of water so as to prevent the formation of mosquito breeding sites.
- Disposal of wastes will occur in a manner that does not increase biting insect populations.
- Sewage treatment will be managed in accordance with the guidelines outlined in Whelan (1997) and Whelan (1998). Treated water will be returned to the process water pond.
- Advice will be sought from Northern Territory authorities if problematic mosquito breeding is detected within the project area or biting insects become pests.
- Specific measures such as:
  - Any container capable of holding water, e.g., tyres, drums and tanks, will be either stored under cover, provided with drainage holes, emptied on a weekly

basis or disposed of in an appropriate landfill site to prevent the formation of mosquito breeding sites.

- Insect repellent, appropriate clothing and other personal protective equipment will be made readily available to all personnel.
- All buildings will either be fitted with mosquito-proof insect screening or, if sealed, will be air-conditioned.

#### **9.8.4 Water Management Plan**

##### ***Issues***

Project development may potentially impact on surface waters in the project area due to changes in water flows, degraded water quality or sedimentation in streams. This may result from:

- Stormwater runoff.
- Discharge of excess water from the main sedimentation trap.
- Seepage from the TSF and TSF embankment (containing encapsulated PAF material).
- Intercepted groundwater/pit water (during operations and post-closure).

Advance dewatering and/or in-pit pumping to prevent groundwater from accumulating in the pit will also create a cone of groundwater depression around the pit that may:

- Reduce groundwater availability for other users.
- Reduce baseflows to surface waters.
- Reduce the water level in Rum Jungle Mine pits, thereby exposing sulfide material in pit walls to oxidation and generating ARD.
- Remove water from the root zone of surrounding vegetation.

Possible impacts of a TSF-derived groundwater mound, and acidification of groundwater on recharge of the drawdown cone, also require consideration.

##### ***Objective***

As described in Section 7.8.2, water quality management is based on identification of environmental values to be protected and setting objectives to maintain these agreed values. However, a number of factors, including the current degraded nature of the East Finniss River and the possibility that water quality may further deteriorate due to influences from the Rum Jungle Mine site, need to be considered in terms of setting targets for surface waters in the project area. Compass therefore proposes that requirements be established in terms of works to be implemented and practices to be adopted, based on Best Practice Environmental Management. The management target for surface water quality would be to maintain, and allow improvement of, the existing ecosystem, consistent with the approach recommended by ANZECC/ARMCANZ (2000) for Condition 3 (highly disturbed) ecosystems.

It is also a water management objective for the operation to be self-sustaining in terms of water use requirements.

### **Performance Standards**

This Water Management Plan will consider the relevant aspects of the following legislation, policies, guidelines and codes:

- Northern Territory *Water Act* – the Water Act legislates the extent to which surface water and groundwater can be used and for what purpose. Discharges to natural waters are prohibited unless licensed under the act. Discharge licences are only available in waters for which beneficial uses (environmental values) have been declared.
- National Environment Protection Measure for National Pollutant Inventory (NEPC, 2000) – provides lists of contaminants that must be reported if they are emitted to water above a certain annual mass threshold. It is not expected that these thresholds will be exceeded and therefore it is unlikely that reporting under the inventory will be required.
- Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ, 2000) – provide a guide for setting ambient water quality objectives required to sustain current, or likely future, environmental values for natural and semi-natural water resources in Australia and New Zealand. The water quality guidelines and the beneficial use process set out in this document are used by DNRETA for water quality management in the Northern Territory.
- Best practice environmental management in mining: Water management (DEH, 1999) – booklet that describes best practice approaches for minesite water management in Australia.
- Minesite water management handbook (MCA, 1997) – provides practical guidance, based on scientific principles and leading industry practice, on how to investigate and manage surface water and groundwater during exploration, mining and mineral processing.

### **Implementation Strategies and Measures**

Strategies and measures that will be implemented to achieve the objectives include:

- Construct and maintain clean water diversion drains around disturbed areas.
- Capture runoff from disturbed areas in collection drains and direct to one of three sedimentation traps. Pump water from the two smaller sedimentation traps to the main sedimentation trap as required to maintain sufficient holding volumes in the smaller traps.
- Monitor water quality within the main sedimentation trap and ensure controlled release to East Finniss River when flow conditions are appropriate.
- If necessary, treat excess water discharged from the main sedimentation trap to the East Finniss River.

- Flag vegetation clearing boundaries to minimise clearing, minimise clearing areas with highly erodible soils and steep slopes, and revegetate disturbed areas as soon as is practical.
- Undertake regular maintenance of road drainage.
- Minimise continuous slopes where scouring can occur, line drainage lines with crushed rock or geotextile fabric or install baffles to reduce water-flow velocities and, if necessary, install sediment control structures, e.g., sediment fences.

#### *Protection of Water Quality*

The water management implementation strategy that will minimise impacts on water quality is summarised in Table 9.3. It should be noted that, concerning ARD, management measures will be reviewed and refined on the basis of information obtained from column leach tests (established using waste rock samples during November 2005) and operational monitoring data.

#### *Minimisation of Abstraction and Discharges*

- Dewater tailing and return water to process plant.
- Recycle treated sewage and wastewater to the process water dam for use in the process plant.
- Pump mine water from the pit to the main sedimentation trap for use in the process plant.
- Use water from groundwater interception bores to provide fresh water for amenities (kitchen, toilets, showers), vehicle wash down and dust suppression, and raw water for the process plant.

The water use hierarchy adopted to meet process water requirements for the project involves recycling process water and inputs from the following sources (listed in order of preference):

1. TSF decant.
2. Sewage effluent.
3. Sedimentation trap water (comprising mine water and site runoff).
4. Groundwater (e.g., from interception bores).

**Table 9.3 Management strategies to minimise impacts on surface water quality**

Source	Potential Contaminants/Stressors	Mitigation/Treatment	Receiving Environment	See Section
<i>Runoff</i>				
Runoff from process plant	SPM Oil and grease/solvents Metals	Runoff will be collected, recycled internally or pumped to the process water dam for use in the process plant.	-	4.14.4
Runoff from site catchment	SPM Metals	Directed to sediment trap. Excess water in two smaller sedimentation traps will be pumped to the main sedimentation trap for use in the process plant, as required. Water in this trap will be monitored and excess water discharged to East Finniss River when quality and river flow regime are appropriate; further treatment will be provided if necessary.	East Finniss River	4.14.2
Runoff from main access road	SPM	Table drain diverting runoff to standing vegetation. Silt fences will be installed if required.	Standing vegetation	-
Runoff from undisturbed areas	-	Directed away from areas of disturbance and allowed to drain naturally.	Standing vegetation	4.14.2
<i>Tailing Decant</i>				
Water from TSF	Metals Process reagents	TSF decant will be returned to the process circuit via the process water dam. The TSF is designed to retain sufficient volume for runoff from major rainfall events and no excess discharge is expected. In an extreme rainfall event, excess water would drain via a spillway to the main sedimentation trap.	-	4.14.4
<i>Process Water</i>				
Water from process plant	Metals Process reagents	Water from the plant will be returned to the process circuit via the process water dam.	-	4.14.4

**Table 9.3 Management strategy to minimise impacts on surface water quality (cont'd)**

Source	Potential Contaminants/Stressors	Mitigation/Treatment	Receiving Environment	See Section
<i>Seepage from TSF</i>				
Water seeping through TSF embankment and basement during operations	Metals Process reagents	During operations, 'shallow' seepage through the embankment will be collected in a toe drain and recycled. 'Deep' seepage will be captured by either bores or the groundwater drawdown cone resulting from the pit dewatering.	-	4.10.3
Post-closure seepage from TSF embankment (containing encapsulated PAF material) and TSF	SPM Low pH water Metals	Management and mitigation measures are to be incorporated into the construction and operation of the TSF to ameliorate the volume and/or quality of ARD. Improved estimates of ARD will be obtained during project development and TSF runoff and drainage closely monitored. Additional management and mitigation measures will be investigated as required, including options for ongoing collection and treatment of ARD prior to discharge should this prove to be warranted.	East Finniss River	4.9.2, 4.10.3, 7.8.4
<i>Mine Water</i>				
Water produced from mine dewatering	Oil and grease SPM Metals	Mine water will be monitored to test for the development of ARD within the pit (and treated as required). Water will be pumped to the main sedimentation trap for use in the process plant, as required. Water in this trap will be monitored and excess water discharged to East Finniss River when quality and river flow regime is appropriate; further treatment will be provided if necessary.	East Finniss River	4.14.1, 4.14.2
<i>Interception Bores</i>				
Groundwater extracted to assist mine dewatering	Low pH water Metals	Water excess to amenity, dust suppression and raw water requirements is to be discharged to East Finniss River, if of suitable quality. Alternative strategies to be developed in consultation with DPIFM if water is contaminated due to historical legacy of Rum Jungle mine.	East Finniss River	4.14.4, 7.8.4

**Table 9.3 Management strategy to minimise impacts on surface water quality (cont'd)**

Source	Potential Contaminants/Stressors	Mitigation/Treatment	Receiving Environment	See Section
<i>Grey Water and Sewage</i>				
Grey water and sewage from ablutions buildings	Surfactants Nutrients Organic matter Pathogens	Treated in package sewage treatment plant to required standards and recycled to process water dam for use in the plant.	-	4.14.5
<i>Post-closure Pit Water</i>				
Water in the disused open pit	Low pH water Metals	The potential for development of ARD from pit walls will be monitored during development of the mine. If necessary, various management strategies will be investigated to control ARD, such as application of layers of Virotech Terra B® and shotcrete to PAF material in the pit walls to inhibit oxidation. On closure, the pit may also be rapidly filled by diverting the flow of the East Finniss River, thereby limiting exposure of sulfide materials to the atmosphere. Pit water quality will be monitored post-closure.	East Finniss River (if the pit overflows)	7.8.3

### 9.8.5 Air Quality Management Plan

#### **Issues**

Air quality issues associated with the project are dust generation from vehicle travel on unsealed roads, particulate matter from the handling and transport of ore and waste (from wind erosion) and, to a lesser extent, dust generated from earthworks associated with vegetation clearing, construction of the access road, stockpiles and tailing beaches.

Exhaust fumes from vehicles, plant, mill and the portable electricity generators will also contribute to localised temporary changes in air quality. In practice, the sources of gas emissions are too small and too widely dispersed to justify special attention.

#### **Objectives**

The objectives of the Air Quality Management Plan<sup>1</sup> are to minimise:

- Atmospheric emissions, including dust and odour.
- Greenhouse gas emissions.
- Creation of safety hazards from air emissions.
- Disturbance to the community.

#### **Performance Standards**

The Air Quality Management Plan has been prepared under the following policies, guidelines and codes:

- National Environment Protection Measure for Diesel Vehicle Emissions (NEPC, 2001) – relevant in terms of maintaining diesel-operated vehicles in good working order.
- National Greenhouse Strategy; Strategic Framework for Advancing Australia's Greenhouse Response (AGO, 1998) – specifically states that the minerals and mineral processing industries should pursue best practice environmental management to reduce greenhouse gas emissions.
- Final Impact Statement for Ambient Air Quality National Environment Protection Measure. National Environment Protection Council Service Corporation (NEPC, 1998).

#### **Implementation Strategies and Measures**

Strategies and measures that will be implemented to ensure that the objectives are achieved include:

- Identify dust sources and ensure that the project is suitably resourced and equipped to address these sources.

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<sup>1</sup> This encompasses the requirements of the Fugitive Dust Control Plan as requested by the PER guidelines (OEH, 2005).

- Site topsoil stockpiles in areas sheltered from strong winds if possible. Allow plant material to colonise stockpiles.
- Minimise the extent of exposed surfaces and the length of time for which they occur, e.g., apply rock screenings to cleared surfaces at infrastructure sites, promote conditions for prompt vegetation regeneration to stabilise soils along road verges and other exposed areas, and revegetate progressively.
- Ensure vehicles and plant are mechanically sound and well tuned, and fitted with appropriate emission control equipment.
- Minimise the likelihood of fire by implementing the Fire Management Plan (see Section 9.8.2).
- Implement specific measures such as:
  - Apply dust suppression measures, such as spraying the road surface (access road), topsoil stockpiles, low grade ore stockpile and lead ore stockpile with water if dust starts causing unacceptable nuisance/hazard.
  - Apply dust suppression measures on drill equipment if dust causes unacceptable nuisance/hazards. Dust monitoring of personnel working with drills will be undertaken in accordance with the project's Occupational Health and Safety policy.
  - Apply water sprays in the crusher and conveying system, including transfer points.
  - Maintain unsealed roads to a high standard.
  - Restrict vehicle speed on the access road to 40 km/hr.
  - Drive vehicles only on designated roads, unless otherwise unavoidable.

### **9.8.6 Noise and Vibration Management Plan**

During project operations, noise and vibration emissions may be generated by vehicles (including reversing alarms), machinery, the plant, and blasting. Due to the remoteness of the project from residential areas and individual residences, noise nuisance will not be a significant issue for the project.

#### **Issues**

The issues in relation to noise and vibration are:

- Disturbance to local residents.
- Disturbance to wildlife.

#### **Objectives**

The objectives of the Noise and Vibration Management Procedures are to:

- Minimise operational noise and vibration impacts to local residents.
- Minimise operational noise and vibration impacts to wildlife.

### **Performance Standards**

The Noise and Vibration Management Plan has been prepared under the following policies, guidelines and codes:

- Australian Standard for Explosives – Storage, Transport and Use (Standards Australia, 1993).
- Australian Standard for the Guide to Noise Control on Construction, Maintenance and Demolition sites (Standards Australia, 1981).
- Industrial Noise Policy. Environment Protection Authority. New South Wales. (EPA, 2000).

### **Implementation Strategies and Measures**

Strategies and measures that will be implemented to ensure that the objectives are achieved include:

- Maintain construction plant, machinery and vehicles regularly.
- Install standard noise abatement devices (e.g., mufflers) on construction machinery and vehicles.
- Keep blasting and crushing to regular daylight hours.
- Provide nearby residents with appropriate contact details so they can alert Compass to any noise or vibration issues.
- Use smart alarms on items of mobile plant that are required to use alarms for safety reasons.
- Acoustic treatment or acoustic shielding of the process plant may be implemented if required.
- Vibrations will be managed in accordance with the Australian Standard (Standards Australia, 1993).

#### **9.8.7 Hazardous Materials and Waste Management Plan**

During the project, domestic and industrial wastes such as waste oils, packaging, drums and general refuse will be generated. Hazardous materials (mainly hydrocarbons, reagents and explosives) require specific transport, storage, handling and disposal procedures. Waste material and hazardous materials can pose significant health, environmental and aesthetic risks if not appropriately managed.

### **Issues**

The environmental issues in relation to waste and hazardous materials management are:

- Contamination of soil and water (including groundwater).
- Health risks to project personnel and the public.
- Adverse effects on flora and fauna.

- Reduction in visual amenity.
- Inefficient resource use.

### **Objectives**

The objectives of the Hazardous Materials and Waste Management Plan are to:

- Avoid the contamination of soil and water (including groundwater).
- Minimise potential risks to operations personnel and the public.
- Minimise adverse effects on flora and fauna.
- Minimise impacts to visual amenity.
- Ensure that all wastes, including hazardous material, solid putrescibles and biodegradable and inert wastes, are managed safely and in an environmentally appropriate manner.
- Promote efficient use and conservation of resources, reduce the need for waste treatment facilities and reduce the requirement of raw materials.

### **Performance Standards**

The Hazardous Materials and Waste Management Plan is consistent with the following standard waste minimisation principles (listed in order of preference):

1. Avoid.
2. Minimise.
3. Reuse.
4. Recycle/reclaim.
5. Treat.
6. Dispose.

The Hazardous Materials and Waste Management Plan has been prepared under the following legislation, guidelines and codes:

- *Dangerous Goods Act* (and regulations and amendments) – main aim is to reduce as far as practicable the risks of personal injury, property damage and environmental harm arising from the manufacture, storage and other handling of dangerous goods and the use of dangerous goods
- Northern Territory *Waste Management and Pollution Control Act*, guidelines and regulations.

### **Implementation Strategies and Measures**

Strategies and measures that will be implemented to ensure that the objectives are achieved include:

#### *General Waste*

- Adopt waste minimisation principles as summarised above.

- Ensure a high level of staff employee and contractor awareness of the Hazardous Materials and Waste Management Plan.
- Incorporate waste and hazardous materials management into site induction programs and training.
- Ensure that all employees and contractors operate in accordance with Compass' procedures for waste and hazardous materials management.
- Promote a high standard of housekeeping, thereby minimising litter and vermin infestation.
- Develop and implement a recycling and waste minimisation program that will be regularly (e.g., quarterly) reviewed during the lifetime of the operation [C]. This will include consideration of the following:
  - Ordering supplies in bulk and selecting suppliers who have return policies in place for unused goods.
  - Minimising waste generation.
  - Segregating main waste types into dedicated receptacles for disposal, reuse or recycling (e.g., food waste, plastics, aluminium, timber, paper).
  - Reusing materials or equipment where feasible.
  - Taking recyclable material to a suitable waste transfer station.
  - Taking non-recyclable waste to a suitable landfill.
- Maintain records of all wastes managed on site or sent to an off-site treatment, recycling, storage and disposal facility. Concerning the latter, the following information is required:
  - Waste generator facility name and address.
  - Date of shipment for recycling, treatment or disposal.
  - Type of waste.
  - Quantities of waste.
  - Method of recycle, treatment or disposal.
  - Description of waste, including restricted characteristics.
  - Transporter name and address.
  - Name of recycling, treatment, storage or disposal facility accepting waste.
  - Where available, record receipt of waste from waste facility.
- Implement additional specific measures such as:
  - Ensuring that waste storage areas are well signed and delineated.
  - Ensuring that licensed contractors dispose of waste off site when suppliers cannot remove waste.

In addition to the measures described above, Compass will implement a range of management measures for the various solid wastes that will be generated on site (Table 9.4).

**Table 9.4 Solid waste management procedures**

Waste Type	Minimise	Reuse/ Recycle	Treatment/ Destruction	Comments
Putrescible/ biodegradable litter	Minimise over- ordering	-	Collect in lidded 200-L drums located at designated points, transfer to the holding point, then remove off site by licensed contractor.	Lidded drums will prevent ingress of water and deny access to animals and birds. Drums will be colour-coded to differentiate contents.
Packaging, paper, plastic, recyclable cans, containers, glass	Purchase in bulk	Separate white paper and PET – HPDE, glass, plastic, cans	Collect in lidded 200-L drums located at designated points, transfer to process plant then remove off site by licensed contractor.	Drums will be colour-coded to differentiate contents.
Scrap steel	Minimise over- ordering	Collect for recycling	Store at designated site.	-
Tyres	Maintain vehicles and equipment	Collect for recycling (no tyres will be disposed of on site)	Store at workshop.	Small quantities expected.

#### *Hazardous Materials*

- Develop a waste minimisation program that includes alternatives and front-end purchasing decisions.
- Identify the needs and storage requirements for emergency containment of materials.
- Ensure that operators and contractors are suitably trained with respect to transport, handling, storage, spill and disposal requirements.
- Implement a recording system to:
  - Reconcile hydrocarbon and reagent usage against stock and minimum/maximum storage requirements.
  - Maintain records of wastes managed on site or sent to an off-site treatment, recycling, storage and disposal facility. For off-site recycling, treatment, storage and disposal, record the same information as described above for general waste.

- Ensure that all contractors operate in accordance with Compass' procedures for:
  - Transportation.
  - Storage and handling.
  - Recycling and disposal.
  - Incident reporting for all spills.
- Implement other specific measures such as:
  - Take waste oil directly to a central storage tank for off-site disposal by a registered contractor.
  - Collect other hydrocarbon wastes, engine coolants, grease and used absorbent materials within separate receptacles and transfer to a central on-site bunded storage facility for off-site disposal by a registered contractor.
  - Wherever possible, return all hazardous wastes and packaging to the supplier for recycling or disposal. Where this cannot occur, dispose of used containers and drums, and batteries, off site by a registered contractor.
  - Place hydrocarbon-contaminated soils in a centrally located, lined or bunded (impervious to hydrocarbons) area for collection and disposal by a registered contractor.
  - Locate MSDSs for all materials used in the project on site and in a readily accessible location.
  - Ensure that containers/tanks to be used for storage are suitably labelled, compatible with the material to be stored, and tested/inspected for leakages prior to use and periodically during use.
  - Construct bunding to meet appropriate Australian standards (AS 1940:1993 and AS 4452:1997) and regularly inspect bunds to ensure their good condition.
  - Locate vessels containing controlled wastes or dangerous goods in excess of 250 L in a bunded facility. Hold vessels containing controlled wastes or dangerous goods of 250 L or less that are not located in a bunded facility on spill trays of appropriate capacity to contain and recover spills.
  - Store hazardous material more than 50 m from a waterway.
  - Undertake fuel transfers in designated area that have appropriate collection drainage.
  - Supply portable spill kits and a supply of absorbent material at key areas on site (e.g., workshops, storehouse) and place trays containing absorbent material under local work areas when an oil spill is unavoidable, e.g., removing hydraulic hoses, replacing filters.

- In the event of a hazardous material spill, implement the following spill response plan:
  - Stop work and contain the spill.
  - Implement clean-up and remediation procedures. Treat and dispose of spilt substance, contaminated materials and debris in accordance with MSDS requirements, relevant guidelines and waste management procedures.
  - Ensure that the General Manager Operations reports the spill containment to DNRETA in accordance with legislative requirements.
  - If necessary, implement the Emergency Response Plan (Section 9.8.1).

### **9.8.8 Cultural Heritage Management Plan**

Four sites and seven areas of background scatter of Aboriginal archaeological and three sites of heritage significance were identified during a survey completed in August 2005 (see Section 7.12).

#### ***Issues***

The environmental issues in relation to cultural heritage management during operations concern the potential to disturb known sites, and to uncover new Aboriginal archaeological or heritage sites during construction.

#### ***Objectives***

The objectives of the Cultural Heritage Management Plan are to:

- Avoid impacts to known sites on or near the project facilities.
- Conserve cultural heritage sites or artefacts that may be uncovered during project development.

#### ***Performance Standards***

The Cultural Heritage Management Plan has been prepared under the following policies, guidelines and codes:

- Northern Territory *Heritage Conservation Act*.
- Northern Territory *Aboriginal Sacred Sites Act*.
- *Aboriginal Lands Rights (Northern Territory) Act 1976*.
- *Environment Protection and Biodiversity Conservation Act 1999*.
- *Environment and Heritage Legislation Amendment Act (No 1) 2003*.

#### ***Implementation Strategies and Measures***

Strategies and measures that will be implemented to ensure that the objectives are achieved include:

- Maintain the existing relationships between Compass and the NLC and traditional owners, which have resulted in the successful management of advised 'no-go' areas in surrounding tenements<sup>1</sup>.
- Through induction, instruct construction personnel in recognition of cultural heritage features for avoidance and reporting processes in the event that new cultural heritage features are uncovered during construction.
- Protect known sites (see Section 7.12) identified during the archaeological survey from disturbance by the establishment of exclusion zones or by the removal of artefacts in accordance to the Northern Territory *Heritage Conservation Act*, prior to construction.
- If the northeast section of the proposed development near the hill adjacent to the East Finniss River (as outlined in Appendix 6) is to be disturbed, the area will first be burnt under conditions outlined in Section 9.8.2 – Fire Management, and then a heritage survey will be undertaken in accordance with the Northern Territory *Heritage Conservation Act*.
- Aboriginal and historical archaeologists will be on call during project construction in the event that ground surface visibility is poor or archaeological material is detected.
- If a potential heritage site/artefact is found, the construction contractor and General Manager Operations will be notified, and the latter will contact the on-call archaeologist. The following measures will then be implemented:
  - Construction activities at the potential heritage site will be discontinued until the on-call archaeologist advises on further action.
  - Flag potential heritage site as a temporary no-go zone until, and during, site assessment by the archaeologist (if deemed necessary by the archaeologist).
  - Archaeologist will assess, record and register the site in accordance with statutory requirements and state heritage policy if deemed significant under relevant legislation.
  - For an Aboriginal heritage site, the archaeologist will consult with the Northern Land Council and local Aboriginal communities to determine appropriate actions.
  - Where required, application will be made for a permit under Northern Territory *Heritage Conservation Act* and options to avoid impacts will be explored.
  - For a non-Aboriginal heritage site, the archaeologist will consult with Northern Territory Heritage Office to determine appropriate action.

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<sup>1</sup> No such areas have been advised within the project area.

- If the site is believed to contain human skeletal remains, stop all works in the vicinity, secure the site from interference and treat as a crime scene. Notify police, AAPA and OEH.
- Await further instructions from police. If/when police have no further need for the remains, contact the archaeologist and arrange for an on-site assessment, if the archaeologist deems it necessary.

Compass will seek to liaise with the traditional owners to develop a detailed cultural heritage management plan.

## **9.9 Monitoring Program**

### **9.9.1 Approach**

The primary objectives of an environmental and social monitoring program are to:

- Provide information that will determine the adequacy of environmental and, where relevant, 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 (as described in Chapter 7 of this PER) and identify unforeseen effects and the need for additional remedial measures.

The proposed environmental monitoring program is based on a conventional three-phase surveillance system, incorporating operations, discharge (or emission) and ambient monitoring. These are discussed below.

The proposed social monitoring program is based on data that, more often than not, would be collected in any case, but would not otherwise be assessed from a social impact perspective.

In situ measurements will be collected using an appropriate field meter while all laboratory analyses will be undertaken by a NATA-registered (or otherwise approved) laboratory.

### **9.9.2 Monitoring**

Compass will maintain comprehensive routine records for cost control, technical efficiency and safety reasons, as well as for environmental purposes. General monitoring of the operation, which will take place on a routine (and frequent) basis, will include the following:

- Waste rock production (including discrimination between NAF and PAF material).
- Water balance.
- Diesel and other consumables usage rates.
- Potable water quality.
- Rehabilitation progress.

- Inspection of drainage and sediment controls.
- Waste production and recycling rates.

### 9.9.3 Discharge (Emission) Monitoring

Discharge or emission monitoring records the passage of contaminants at points outside the perimeter of activity. Discharge monitoring provides direct information concerning the concentrations and loads of contaminants being discharged from the operation, and also serves as a link between ambient monitoring results and the operation itself.

NPI reporting requirements will be determined during detailed design and will be incorporated into the final monitoring program.

Water discharge from the site will occur primarily via the main sedimentation dam. Monitoring will therefore be undertaken (based on fortnightly sampling intervals during the wet season) to characterise the nature of the water contained within this dam. Variables to be determined will include:

- pH, conductivity, turbidity (and TSS on selected samples).
- Oil and grease (on selected samples).
- Al, As, Cd, Co, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (unfiltered and filtered [ $<0.45 \mu\text{m}$ ]) (on selected samples).

The volume of water discharged from the main sedimentation dam will also be recorded.

**Pit Water and TSF Embankment Runoff/Seepage.** The possibility of acid formation due to exposed sulfides in the pit walls cannot be discounted, while the encapsulation of PAF waste rock within the TSF embankment means that monitoring is required to ensure that formation of ARD has been minimised. Monitoring of pit water and TSF embankment runoff and seepage will therefore be undertaken on a monthly basis for the following:

- pH, conductivity, alkalinity, sulfate.
- Al, As, Cd, Co, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag, Zn (unfiltered and filtered [ $<0.45 \mu\text{m}$ ]) (selected samples).

### 9.9.4 Ambient Monitoring

While operational and discharge monitoring should determine if environmentally significant releases have occurred, effects on the ultimate receptors within the receiving environment can be determined only by ambient monitoring.

#### **River Water**

Key factors to be considered in the design of the ambient stream water quality monitoring program include:

- Physico-chemical and biological indicators.
- Statistical design.
- Spatial design and sampling frequency.
- Sampling site access.

- Possible mixing zone(s) downstream of project inputs.
- Procedural details, e.g., detection limits for trace metal determinations and sampling methods, and the availability of appropriately experienced laboratories to undertake the analyses.

The goal of the ambient water quality monitoring program is to determine the status of the aquatic ecosystems in the catchments that potentially can be affected by the project, and to detect improvements or deterioration over time.

A range of factors has been examined to allow selection of monitoring indicators that would:

- Be changed by the mine.
- Are significant in terms of the quality of the receiving aquatic ecosystems.

**Physico-chemical Indicators.** From a water quality perspective, the primary mine-derived stressors are metals and TSS. The active and passive management features of the project mean that, in effect, the impact from metals is expected to be negligible, particularly within the context of the already-degraded East Finniss River. These considerations have been reflected in the program's subsequent emphasis on the following variables:

- Physical characteristics (e.g., TSS, turbidity, conductivity, temperature).
- Water chemistry (e.g., pH, sulfate, trace metals, total nitrogen, total phosphorus, chlorophyll-a, dissolved organic carbon (which ameliorates toxicity due to metals)).
- Stream flow rate.

Water sampling will include both routine and opportunistic event sampling where the latter is focused on obtaining samples from the river during a flood event, thereby taking into account flow-related variations in water quality. Sampling sites will coincide with selected stream gauging stations, i.e., GS 8150200, GS 8150097 and GS 8150204 (see Figure 7.7).

Bed sediment samples will be sampled annually (in conjunction with the biological monitoring described below) from river water quality sampling sites. Analyses will be undertaken for total metals in the <2000  $\mu\text{m}$  fraction and particle size distribution (PSD).

**Biological Monitoring.** Benthic macroinvertebrate surveys of the East Finniss and Finniss rivers will be undertaken to determine indices of stream health and identify temporal changes in the river system. Macroinvertebrates will be sampled annually using standard methods outlined by AUSRIVAS (Australian River Assessment Scheme) or other appropriate sampling protocols.

Given the interest of a number of parties in determining the ongoing water quality and ecological status of the East Finniss and Finniss rivers due to the impacts from the Rum Jungle Mine site, Compass intends to discuss the proposed sampling program with the relevant Northern Territory and Commonwealth authorities with a view to ensuring that a cost-effective, integrated program is implemented. Details of the monitoring program will therefore be determined during these discussions [C].

**Groundwater**

Groundwater monitoring will be undertaken at nine bores as follows (Figure 9.1):

- Five bores located around the perimeter of the TSF. These will detect seepage and, if necessary, will provide a focus for collection and recycling of seepage plumes, should this provide necessary.
- Three interception bores located north of the pit. These will provide make-up water for the process and, in addition to recording volumes of water extracted, will be monitored for water quality.
- One monitoring bore located between the Browns pit and the Rum Jungle pits and waste rock dumps.

Samples will be taken at quarterly intervals and the following variables determined:

- Physical characteristics (e.g., conductivity, temperature).
- Water chemistry (e.g., pH, sulfate, trace metals).
- Water level.

Compass will also undertake monitoring at a number of existing bores in the surrounding area.

**Noise, Blasting and Air Quality**

No formal nuisance noise, blasting or air quality monitoring is proposed; monitoring will be by complaint.

Noise and air quality for staff and contractors will be performed as part of the project's Occupational Health and Safety system.

**Biological and Land Monitoring**

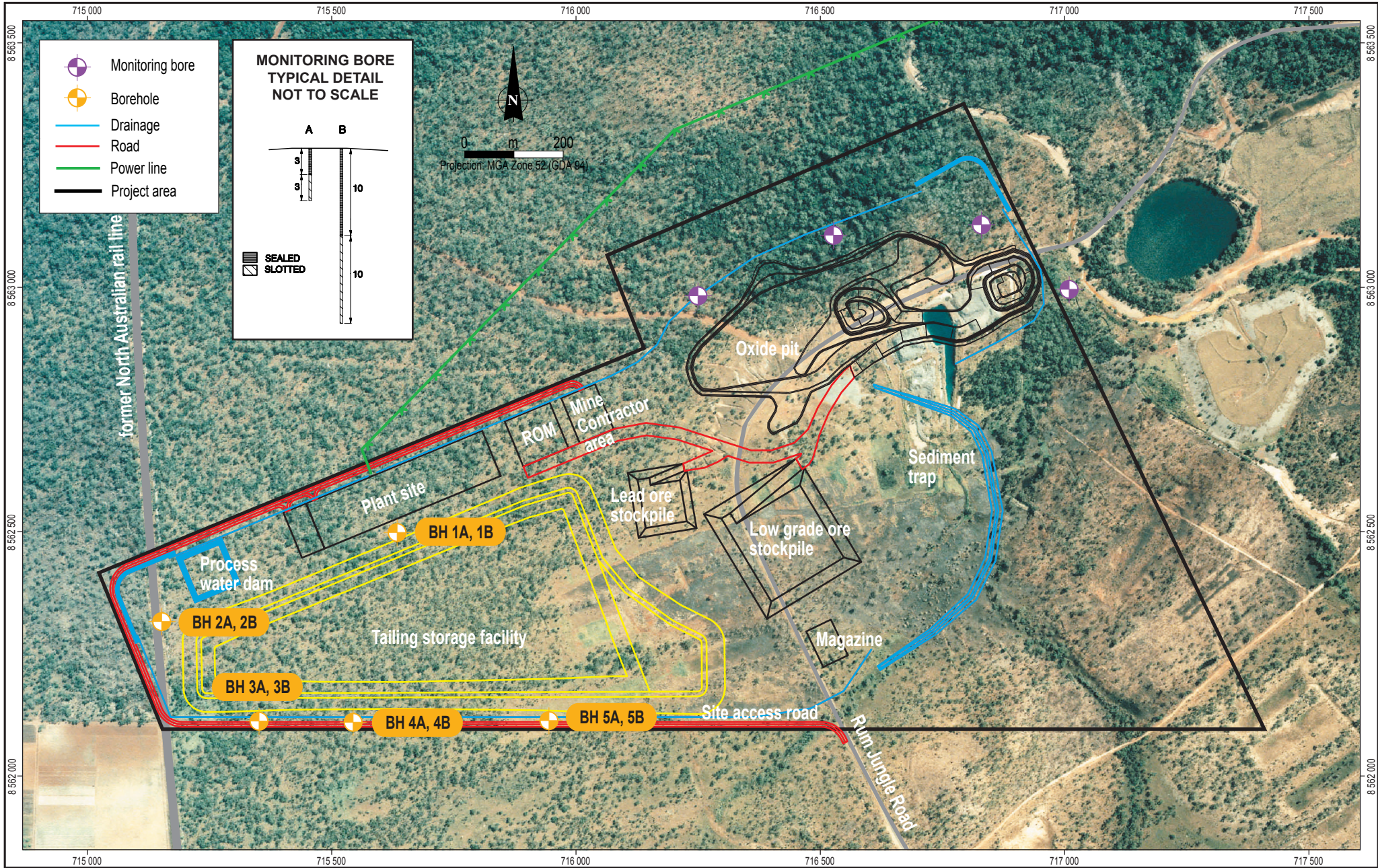
Visual monitoring will be undertaken for pest animal species that may become established (or further established) on site and control measures will be implemented as appropriate.

To prevent and control weed infestation, visual monitoring will be undertaken of occurrence of weed outbreaks during project development and operations (in addition to those already evident).

The effectiveness of erosion and sedimentation controls will be monitored on a regular basis and these controls will be repaired or replaced when necessary (i.e., when sediment is not being contained).

Visual monitoring will also be undertaken to determine the presence of other fauna not observed during the initial surveys. If relevant, the impacts associated with the project on these fauna will be assessed and the appropriate management plans reviewed and, if necessary, modified.

Unless otherwise specified, the frequency of visual monitoring activities will be regular and constant (and incorporated into daily or weekly work routines), rather than at specified times.



	Job No: 836	<b>Compass Resources NL</b>  <b>Browns Oxide Project</b>	<b>Proposed monitoring bore locations</b>	Figure No: <b>9.1</b>
	File No: 836_08_F9.01_HB			

Monitoring of adult mosquitoes will occur once a month prior to and during construction to establish a baseline mosquito monitoring program. This program will provide an indication of the seasonal distribution of the mosquito species present and allow refinement of the likely risk of mosquito-borne disease to mine personnel.

### **Fire**

Fire danger ratings issued by the local fire authority will be monitored on a weekly basis during the fire season to ensure that personnel are fully prepared for fire prevention or control during high fire danger periods.

### **Radiological Monitoring**

The following radiological monitoring will be undertaken (as recommended in Appendix 7):

- Collections of background radioactivity data and operations monitoring:
  - Gamma survey.
  - Dust monitoring, including radionuclides.
  - Radon monitoring.
  - Analysis of radionuclides in surface water and groundwater samples.
  - Analysis of radionuclides in green tissue<sup>1</sup>.
- A site radiological survey (e.g., radon and dust in the pit and around the TSF) after the plant has been in continuous operation for a year and, if required, in subsequent years.

As with the river monitoring program, Compass intends to discuss the proposed radiological monitoring program with the relevant Northern Territory and Commonwealth authorities. Again, details of the sampling program will be determined during these discussions [C].

**Rehabilitation.** Rehabilitation progress will be monitored at seven 360°-photo-monitoring points located throughout the project area on an annual basis.

The success rate of seedling emergence and survival, weed invasion, browsing levels (i.e., insect and animal attack of regenerating vegetation) and erosion will be monitored at the same time annually, comparing photos taken each year from the 360°-monitoring points. This will be supported by vegetation surveys to determine species diversity, density and canopy cover at and around the photo monitoring points to enable the evaluation of rehabilitation success between sites and over time. Compass will review these results and, should they indicate poor rehabilitation success, remedial rehabilitation works will be undertaken.

**Post-decommissioning Monitoring.** This is addressed in Section 9.10.7.

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<sup>1</sup> The data provided from green tissue analyses will allow any changes in radionuclide concentrations in local crops to be determined.

### 9.9.5 Social Monitoring

The following indicators will be monitored on an ongoing basis:

- Workforce statistics, including:
  - Gender and age.
  - The number of project-related people moving to the Batchelor–Adelaide River–Darwin region.
  - Specific training provided by Compass (with a particular focus on employment and training opportunities for the traditional owners).
- Service and goods supply statistics. These will include details regarding:
  - Type and quantity of goods/service.
  - Value.
  - Location of supplier.
- Local and regional business opportunities provided by the project.
- Local attitudes towards the project.
- The number of complaints documented in the complaints register.
- The impact of the project on the local health centre at Batchelor.
- Compass sponsorship of events in the Batchelor–Adelaide River–Darwin region or other contributions made by Compass to the local communities.

### 9.9.6 Investigations

#### ***Cavities and Karsts Terrain Testing***

Cavities and karsts will be further examined during detailed site investigations to ensure the suitability of the TSF site. [C]

#### ***TSF Closure Trials***

The objective of these trials will be to examine the technical feasibility of dry cover system designs for the tailing that will be placed in the TSF [C]. The work programme will include:

- Tailing material and potential cover material characterisation.
- Review of other covers used in the Northern Territory (e.g., Rum Jungle, Woodcutters).
- Soil-atmosphere cover design modelling to evaluate the performance of several cover design alternatives.
- Small-scale field trials to develop the preferred cover system design.

## 9.10 Rehabilitation and Mine Closure

### 9.10.1 Introduction

This section of the report outlines a strategic rehabilitation and mine closure plan for the Browns Oxide Project. Mine closure planning is a continuous process and this strategic plan is the first step. The mine closure plan will be refined as inputs from detailed project design, stakeholder consultation on end land uses and completion criteria, and various investigations/studies become available [C].

Socio-economic impacts of mine closure are often significant, particularly where the mine operates in a small community such as Batchelor. As part of Compass' mine closure planning, redundancy provisions and consideration of training schemes with long-term benefits will be considered [C].

### 9.10.2 Performance Standards

This closure plan considers the relevant aspects of the following codes and best practice guidelines:

- Environmental risk management–Principles and process (Standards Australia, 2004) – presents an integrated framework of principles, practices and criteria for implementing best practice in environmental risk management.
- National Environment Protection Measure of Assessment of Site Contamination (NEPC, 1999) – aimed at establishing a nationally consistent approach to site contamination assessment and provides a recommended general process for assessment of site contamination.
- Strategic Framework for Mine Closure (ANZMEC and MCA, 2000) – provides a framework for mine closure in Australia without prescriptive measures, and outlines strategies for stakeholder involvement, planning, financial provisions and closure implementation.
- Best Practice Environmental Management in Mining: Rehabilitation and Revegetation (EPA, 1995).
- Best Practice Environmental Management in Mining: Mine Decommissioning (Environment Australia, 2002) – provides an overview of the principles of mine decommissioning illustrated by case studies representing current best practice in Australia.

### 9.10.3 Objectives

The objectives of the plan are to:

- Leave the site in a physically and geochemically stable condition with low maintenance requirements.
- Leave the site in a safe condition, including securing of the pit void, so as to minimise risks to public safety.
- Prevent excessive erosion and ensure that the site does not become a source of water or wind-borne sediment.

- Revegetate the project area to the point where a self-sustaining community comprised largely of native species characteristic of the surrounding country is established (i.e., a modified natural habitat).
- Minimise the visual impact of the project.

#### 9.10.4 Responsibilities

Closure planning and management of rehabilitation activities through the operations phase of the project will be the responsibility of the General Manager Operations, who will be assisted in this function by the Environmental Manager. Post-closure, mine decommissioning and rehabilitation activities will be the responsibility of the Compass board.

#### 9.10.5 End Land Use

Subject to discussion with stakeholders, which will be ongoing throughout project development, operation and closure planning, Compass proposes that the end land uses for the area are to be such that the public amenity and the conservation value are improved where practicable, or maintained where not. The proposed end uses (assuming no further mining) shown in Table 9.5 will be documented in the mine closure plan. Working towards this plan will be part of daily operations, with final detailed closure design prepared before cessation of operations (see Section 7.7 for further details on land use).

**Table 9.5 Proposed end use for project components**

Component	Final Landform	End Land Use
Mine pit	Walls left in stable condition, perimeter secured by fence. Final void left to naturally fill with groundwater/rainfall unless ARD is a significant issue, in which case the final void may be rapidly filled by diverting the East Finniss River through the pit.	Partially-filled void with possible value as aquatic habitat.
TSF	Tailing material capped with a 'store and release' type cover (see Figure 4.10), spread with topsoil and revegetated with shallow rooted species. Excavation of a long-term spillway notionally in the location of the existing decant tower to prevent ponding of large amounts of excess water and overtopping. Possible additional flattening of external slopes of the embankments. See Appendix 8 for further details.	Modified natural habitat.
Ore stockpiles	Ore removed for processing or returned to pit, area ripped, topsoiled and revegetated.	Modified natural habitat.
Processing plant, mine contractor area and site offices	Plant and material salvaged, structures removed, area ripped, topsoiled and revegetated.	Modified natural habitat.
Magazine	Material salvaged, structures removed, area ripped, topsoiled and revegetated.	Modified natural habitat.

**Table 9.5 Proposed end use for project components (cont'd)**

<b>Component</b>	<b>Final Landform</b>	<b>End Land Use</b>
Topsoil stockpiles	Topsoil removed for rehabilitation of other project components and base revegetated.	Modified natural habitat.
Sediment traps	Cleaned out, stabilised and left. The main sedimentation trap will remain with its emergency spillway.	Sediment traps.
Runoff drainage	Cleaned out, stabilised and left.	Runoff drainage.
Haul and site roads	Ripped and revegetated.	Modified natural habitat.
Rum Jungle Road	Ripped and revegetated (unless consultation outcomes suggest otherwise).	Modified natural habitat.

Upon the relinquishment of the MLs, the project area will be returned to use as Aboriginal freehold.

### **9.10.6 Implementation Strategies and Measures**

#### ***Consultation***

- Identify and engage key stakeholders in a consultation program whereby their concerns and interests can be addressed during mine closure planning. Key stakeholders are listed in Section 6.2.
- Allocate adequate resources to the consultation process to enable effective and open communication (the local community will require the necessary information and resources to participate in the consultation process).
- Initiate the mine closure consultation process during the planning phase, with a key focus being the proposed end land uses for the area (as currently described above in Section 9.10.5).

#### ***Planning***

- Allocate sufficient personnel, physical and monetary resources for closure planning, implementation and monitoring. A dedicated team may be required with clearly delineated roles and responsibilities.
- Determine legal and other obligations relating to mine closure.
- Identify and assess risks associated with closure, including the feasibility of removing surface infrastructure.
- Determine closure completion criteria in consultation with stakeholders; relevant discussions will commence after detailed design and project approval.
- Following approval of the project, prepare and periodically review (taking into account progressive rehabilitation and changing community standards and expectations) a detailed Mining Management Plan (MMP).

- Develop a cost estimate for closure from the detailed MMP.
- Review the mine closure cost estimate regularly, e.g., annually, to reflect changing circumstances.
- Ensure that, at the end of mine life when income has ceased, there is sufficient accounting provision to cover both mine closure and ongoing (post-closure) expenditure.

#### **Contamination Assessment and Treatment.**

- Remove contaminants such as hydrocarbons (e.g., oil and grease) at the process plant site and remove residual soil contaminated by spills.
- Prepare a separate plan (as part of the detailed mine closure and rehabilitation plan for implementation) for the assessment, treatment and removal of hydrocarbon and other contamination in accordance with the NEPC (NEPC, 1999).

#### **Land Stabilisation**

Key aspects of land stabilisation include the following:

- Minimising Disturbance – A key element to successful land stabilisation is minimising the area of land disturbed. Compass has reduced the potential area disturbed by project infrastructure by locating the facilities close together, and committing to clear land only when required. When clearing, the vegetation will be stored (where practicable) for future use in the rehabilitation program.
- Topsoil Management – The topsoil from all areas to be developed will be stripped and used for subsequent rehabilitation. Details of topsoil management are described in Section 4.5.2.
- Erosion Control – The two natural elements that disturbed areas need to be protected from are wind and water. Prior to establishment of vegetation cover, wind erosion will be controlled by protecting the soil surface with mulch or other materials and maintaining the soil surface in an erosion-resistant condition (e.g., moist, or with a cloddy structure). Runoff management will include diverting clean runoff away from disturbed areas, collecting turbid runoff (dirty water) from disturbed areas and reducing the velocity of runoff on disturbed areas by appropriate landforming. Section 4.5.2 describes the methods by which runoff will be managed for the site.
- Landforming – This involves shaping slopes and contours, and ripping and scarifying the soil so as to reduce runoff velocity, promote infiltration and minimise erosion. Ripping/scarifying also provides protection for germinating seeds and assists root penetration. The final landforms created will be compatible with the surrounding landscape.

#### **Rehabilitation**

Rehabilitation will be undertaken progressively where possible. However, due to the nature of the operations, most rehabilitation will be undertaken upon cessation of mining operations. This will include removal of site infrastructure, stabilisation of land, and

ripping and revegetating of disturbed areas as described below. General rehabilitation procedures include the following:

- Revegetation of disturbed areas will occur progressively throughout the operation, where practicable.
- Topsoil stockpiled during the mining process will be replaced as the final landforms are achieved. Ideally the topsoil stockpiles will retain their seed resources allowing revegetation to occur naturally. If this does not occur to a sufficient degree, the area will be seeded and fertilised, with the application of seeds and fertilisers being timed to take best advantage of moisture and seasonal conditions.
- To reduce susceptibility to erosion, complete sections will not remain void of vegetative cover for any length of time.
- In general, site revegetation will occur in two stages, i.e., primary revegetation and secondary revegetation. The aim of the primary revegetation stage is to establish good vegetative cover on the disturbed area as soon as possible (thereby reducing potential for erosion). The secondary stage of revegetation aims to establish a more long-term cover of low maintenance vegetation that will eventually be self-sustaining. The two vegetation stages require different plant species:
  - Primary revegetation: includes selection of a suitable mixture of grass species to adequately control erosion until indigenous tree and shrub species become fully established. Primary vegetation will normally be invaded by indigenous species from adjacent undisturbed areas.
  - Secondary revegetation: includes the establishment of indigenous tree and shrub species.
- Where possible, native grass species will be used. Specialist advice on vegetation species and fertiliser requirements will be sought.

Steps involved in vegetation maintenance will include:

- A vegetation maintenance program to ensure revegetated areas maintain effectiveness. This will include the development of a long-term maintenance strategy detailing the permanent control measures to be employed.
- Correct maintenance of all areas of vegetation cover to ensure a persistent and uniform protective sward. Topdressing revegetated areas with fertiliser and supplementary seed will be undertaken after the first growing season if required. Weed control, insect and pest control will also be undertaken as necessary.

Following mine closure, all other disturbed areas will be contoured, respread with topsoil and revegetated as described. Apart from the pit, no batter will exceed a grade greater than 1:3 (v:h) and will be generally rounded to conform to the landforms of the area.

### **Surface Water Management**

Surface drainage, including sediment traps, established during operations will be retained post-closure. The reasons for this are that:

- Surface drainage established during operations will be complete and stable.
- Clean water will remain separated from water draining areas of disturbance.
- Although vegetation will be allowed to establish, sediment traps will continue to provide a final filter for runoff from the rehabilitated site.
- These areas may have been colonised by fauna, thereby creating new habitat areas.
- Re-contouring to return runoff to pre-existing drainage would damage vegetation established during progressive rehabilitation activities.

Upon mine closure, the final void will be allowed to naturally fill with groundwater, direct rainfall and surface runoff. As described in Section 7.8.3, an option for final void closure, should ARD be considered a significant issue, is to divert the East Finniss River through the pit to rapidly fill the void. Maintaining good quality water in the final void is considered important since it represents a valuable resource and facilitates dewatering the pit at a later date to access further reserves (without the need for expensive water treatment).

### **9.10.7 Post-closure Monitoring and Maintenance**

#### ***Water Quality***

Ongoing sampling and monitoring of groundwater bores (water level and quality), selected surface water sampling locations and final void water will continue for a period of not less than three years from the cessation of operations [C]. The responsibility for ongoing monitoring, if required, will be negotiated with the government once stable conditions have been reached and water quality reflects the agreed closure criteria.

#### ***TSF***

The TSF will be monitored and audited regularly to assess whether closure objectives have been achieved [C]. In addition to water quality monitoring described above, visual monitoring will include checking for:

- Slumping.
- Erosion.
- Excessive seepage.
- Revegetation success.
- Ponding.

Dam safety inspections will be carried out on a regular basis in accordance with ANCOLD guidelines.

#### ***Revegetation Works across the Site***

Methods to monitor and maintain rehabilitated and revegetated areas will include:

- Establishing 360°-photo-monitoring points throughout the project area.
- Conducting post-closure follow-up visits to the project area on a regular and frequent basis (frequency decreasing with time) to monitor the success rate of seedling

emergence and survival, weed invasion, browsing levels (i.e., insect and animal attack of regenerating vegetation) and erosion, using the photo-monitoring points to track progress.

- Establishing water quality monitoring locations to monitor the success of rehabilitation works.
- Ensuring that the monitoring program reflects the agreed closure criteria established through consultation with stakeholders.
- Where monitoring has identified erosion, weed invasion, failure of revegetation (to any material degree) or excessive browser damage to regenerating vegetation, maintenance activities will be implemented to ensure regeneration progresses successfully and rapidly. These may include:
  - Repairing eroded areas.
  - Weed control.
  - Pest control.
  - Enrichment planting.
  - Spot sowing.
  - Reseeding.
  - Watering.
  - Fertilising.

#### **9.10.8 Final Decommissioning**

As part of the closure process a final decommissioning plan will be developed in consultation with regulatory authorities during operations. This plan will detail completion criteria and establish the timeline for decommissioning and determination of compliance with regulatory authority requirements.

#### **9.11 Summary of Commitments**

In planning for the project, Compass has made a number of commitments with respect to the management of potential and residual environmental and social impacts. These are provided throughout this PER (specifically chapters 4, 7 and 9). The commitments outlined in Table 9.6 are generally broader and do not include specific on-site mitigation and management measures that have been incorporated into the design of the project.

**Table 9.6 Commitments**

<b>No.</b>	<b>Section</b>	<b>Commitments</b>	<b>Performance Indicators</b>
1	4.7.3	Low grade ore and lead ore stockpile material that is considered uneconomic to process at the end of the project life will be returned to the mined-out pit.	Final Mine Closure Plan detailing the fate of this material.
2	4.9.1	Column leach test results for selected waste rock samples will be reported in the Mining Management Plan, with ongoing reporting as required.	MMP containing waste rock column leach test results.
3	4.9.2	Compass will ensure direct supervision by a qualified person during construction of the TSF and, upon completion, sign off by that qualified person on submission of the 'as constructed' designs and plans.	Sign-off on 'as constructed' designs and plans.
4	4.9.2	The implementation of selective handling of PAF material requires integration with the mine plan, with identification of material types involving continuous in-pit sampling, logging, mapping and testing during mining.	Records of monitoring results. Records of volumes and placement of waste material.
5	4.10.1/ 7.8.4	Further geochemical testwork will be undertaken to address inconsistencies in tailing testwork results. This testwork will also include column leach tests and tailing liquor characterisation.	Report containing results of further geochemical testwork.
6	4.12.4	Compass will ensure that haulage contracts stipulate that loads are properly secured and in compliance with appropriate road vehicle axis limits.	Compliance with transport requirements. Vehicle log books. On-site records of transport volumes and transportation vehicle details.
7	6.5.2	A particular focus of the ongoing consultation program will be the involvement of indigenous people in the project.	Consultation records.
8	7.8.3	Compass will further develop during detailed engineering the water treatment system for treating water from the main sedimentation trap that is to be discharged to the East Finniss River.	A design for the water treatment system.
9	7.8.4	Compass will obtain improved estimates of ARD during project development and will closely monitor TSF runoff and drainage.	Monitoring records of TSF runoff and drainage. Reporting of geochemical testwork.
10	7.8.4	Additional management and mitigation measures for ARD will be investigated as required (incorporating information obtained as the mine is developed), including options for ongoing collection and treatment of ARD prior to discharge if warranted.	Records of investigations included in annual reporting to DPIFM.
11	7.9.3	Should adverse impacts occur to groundwater users, mitigation measures may involve sourcing suitable alternative water.	Groundwater monitoring data.
12	7.10.3	Compass will implement a preferential employment policy focussing on traditional owners and the local community.	Project employment policy. Employment records.
13	7.10.3	Compass will provide employment and training opportunities for the traditional owners and will develop specific procedures for the administration and implementation of these opportunities.	Employment and training records.

**Table 9.6 Commitments (cont'd)**

<b>No.</b>	<b>Section</b>	<b>Commitments</b>	<b>Performance Indicators</b>
14	8.1	Compass will undertake a detailed hazard identification and risk assessment prior to commencement of construction and operations.	Submission of report detailing outcomes of the assessment.
15	9.6.2	Audits will be undertaken by an appropriately qualified person on a regular basis to ensure compliance with the environmental management procedures. Auditing will be conducted twice during the construction phase and yearly during operations.	Audit records.
16	9.8	The issue-based management plans will be refined and will form the basis of a detailed MMP that will be completed prior to construction. The detailed MMP will expand on the information contained herein, including implementation measures, schedules and responsibilities.	Submission of MMP.
17	9.8.2	A detailed Fire Management Plan will be developed in consultation with key stakeholders such as traditional owners, the NLC and local fire authorities (fire brigade and Bushfires Council NT).	Consultation records and submission of detailed fire management plan as part of the MMP.
18	9.8.3	A detailed weed management plan will be developed in accordance with the Northern Territory <i>Weeds Management Act</i>	Submission of the detailed weed management plan as part of the MMP.
19	9.8.7	A recycling and waste minimisation program will be implemented and regularly (e.g., quarterly) reviewed during the lifetime of the operation.	Maintenance of waste inventory. Record of revisions to program.
20	9.9.4	Detailed radiological and river (water quality and macroinvertebrates) monitoring programs will be developed after discussion with relevant authorities to ensure a cost-effective, integrated program.	Detailed monitoring program.
21	9.9.6	Cavities and karsts will be further examined during detailed site investigations to ensure the suitability of the TSF site.	TSF site geotechnical report and final design.
22	9.9.6	A TSF closure study will examine the technical feasibility of dry cover system designs.	TSF closure study report.
23	9.10.1	The mine closure plan will be refined as inputs from detailed project design, stakeholder consultation on end land uses and completion criteria, and investigations/studies become available.	Consultation records, investigation/study reports. Updates of the Mine Closure Plan as reported in the MMP.
24	9.10.1	As part of Compass' mine closure planning redundancy provisions and consideration of training schemes with long-term benefits will be considered.	Updates of Mine Closure Plan.
25	9.10.7	Ongoing sampling and monitoring of groundwater boreholes (water level and quality), selected surface water sampling locations and mine water will continue for a period of not less than three years from the cessation of operations.	Monitoring records.
26	9.10.7	The TSF will be monitored and audited regularly to assess whether closure objectives have been achieved.	Monitoring records.



## 10. References

- ABS. 2002a. 2001 census basic community profile and snapshot. 705 Darwin (Statistical Division). Australia. Northern Territory. Australian Bureau of Statistics. A WWW publication accessed on 29 March 2005 at <http://www.abs.gov.au/Ausstats/abs@census.nsf/Lookup2001Census/E98D5018D0218F32CA256BBF0001C120#CensusCounts>
- ABS. 2002b. Basic community profile. 2001 census for Batchelor (L) (UCL 701000). ABS Catalogue Number 2001.0. Australian Bureau of Statistics. Commonwealth of Australia.
- AGO. 1998. *The national greenhouse strategy: strategic framework for advancing Australia's greenhouse response*. Australian Greenhouse Office. Pirie Printers. Canberra.
- AGO. 2004. AGO factors and methods workbook. Australian Greenhouse Office. Australian Government. August.
- AHC. 2005a. The register of the national estate. A WWW publication accessed in April 2005 at <http://www.ahc.gov.au/register/index.html>. Australian Heritage Commission.
- AHC. 2005b. The Australian heritage database. A WWW publication accessed in April 2005 at <http://www.deh.gov.au/cgi-bin/ahdb>. Australian Heritage Commission.
- AIMM. 1965. Volume 3 of the Proceedings of the Eighth Commonwealth Mining and Metallurgical Congress, 1965. Ed. J. T. Woodcock. Australasian Institute of Mining and Metallurgy, Melbourne. p. 213.
- ANZECC/ARMCANZ. 2000. Australian and New Zealand water quality guidelines for fresh and marine water quality. Australian and New Zealand Environment and Conservation Council and Agricultural and Resources Management Council of Australia and New Zealand. October.
- ANZMEC and MCA. 2000. Strategic framework for mine closure. Australian and New Zealand Environment and Conservation Council and Minerals Council of Australia. Commonwealth of Australia.
- Bennett, J. W. 2002. The effectiveness of the covers on the Rum Jungle overburden heaps after fifteen years. In the Finniss River: a natural laboratory of mining impacts—past, present and future. The Finniss River Symposium, Darwin, August 23-24, 2001. Eds: S.J. Markich and R.A. Jeffree. Australian Nuclear Science and Technology Organisation. Sydney. March.
- BoM. 2005. Climate averages for Darwin Airport No. 014015. Bureau of Meteorology. A WWW publication accessed at <http://www.bom.gov.au> in February 2005.

- CCGC. 2004. Coomalie community directory 2004/2005. Coomalie Community Government Council. Seventh Edition. May.
- CDC. Undated. Mosquitoes and disease in the NT. Centre for Disease Control. Northern Territory. Medical Entomology Branch. A WWW publication accessed on 18 March 2004 at <http://www.nt.gov.au/health/cdc/fact-sheets/mozzie-factsheet.pdf>
- DBIRD. 2002. Advisory note: mining management plan (MMP). Department of Business, Industry and Resource Development. Mines Division. PA6-005. 11 February.
- DBIRD. 2005. Advisory note ENG 509: hazard identification & risk assessment. Department of Business, Industry and Resource Development. Minerals and Petroleum Management Division. PA6-005. 5 January.
- DEH. 1999. Best practice environmental management in mining: water management. Environment Australia. Federal Department of the Environment and Heritage. May.
- DEH. 2005a. Environment Protection and Biodiversity Conservation Act flow chart. Federal Department of the Environment and Heritage. A WWW publication accessed in August 2005 at <http://www.deh.gov.au/epbc/assessmentsapprovals/flowchart>.
- DEH. 2005b. The biological effects, including lethal toxic ingestion, caused by cane toads (*Bufo marinus*). Federal Department of the Environment and Heritage. A WWW publication accessed in July 2005 at <http://www.deh.gov.au/biodiversity/threatened/ktp/cane-toads.html>
- DIPE. 2004. Town water supplies. Department of Infrastructure, Planning and Environment. A WWW application accessed in August 2005 at <http://www.ipe.nt.gov.au>.
- DIPE. 2005. Environmental impact assessment flow chart. Department of Infrastructure, Planning and Environment. A WWW publication accessed in July 2005 at <http://www.ipe.nt.gov.au/enviro/POLDOC/eiaguide/Assess.jpg>
- DLPE. 2000. Coomalie planning concepts and land use objectives. Department of Lands, Planning and Environment. Lands Planning and Environment. Northern Territory Government.
- Dostine, P. L. 2002. Australia-wide assessment of river health: Northern Territory bioassessment report (NT final report). Monitoring river health initiative technical report No. 8. Commonwealth of Australia and Department of Infrastructure, Planning and Environment, Canberra and Palmerston.
- Edwards, C. A. 2002. An evaluation of seasonal change in benthic macroinvertebrate community composition in the East Branch of the Finnis River. In the Finnis River: a natural laboratory of mining impacts—past, present and future. The Finnis River Symposium, Darwin, August 23–24, 2001. Eds: S.J. Markich and R.A. Jeffree. Australian Nuclear Science and Technology Organisation. Sydney. March.
- Emsley, J. 1991. *The elements*. 2nd ed. Oxford University Press, Oxford.

- Environment Australia. 2002. Mine decommissioning. One booklet in a series on best practice environmental management in mining. Environment Australia. Commonwealth of Australia. July.
- EPA. 1995. Best practice environmental management in mining: rehabilitation and revegetation. Environmental Protection Agency.
- EPA. 2000. Industrial noise policy. Environmental Protection Authority, New South Wales. January.
- Geoscience Australia. 2005. Geoscience earthquake online search. A WWW application accessed in August 2005 at <http://www.agso.gov.au>.
- Gibson, D. K. 1998. Groundwater hydrology. Chapter 4. Monitoring report 1988–1993. Rum Jungle rehabilitation project. M. Kraatz (Ed). Technical report No. R97/2. Land Resources Division, Northern Territory Department of Lands, Planning and Environment. March.
- Jackson, S. and Ferris, J. M. 1998. Macro-invertebrate ecology of the Finnis River east branch at the beginning of the 1993 dry season. Chapter 8. Monitoring report 1988–1993. Rum Jungle rehabilitation project. M. Kraatz (Ed). Technical report No. R97/2. Land Resources Division, Northern Territory Department of Lands, Planning and Environment. March.
- Jeffree, R. A. 2002. Characterisation of the impacts of pre- and post-remedial contaminant loads from Rum Jungle on riparian vegetation and fishes of the Finnis River system. In the Finnis River: a natural laboratory of mining impacts—past, present and future. The Finnis River Symposium, Darwin, August 23-24, 2001. Eds: S.J. Markich and R.A. Jeffree. Australian Nuclear Science and Technology Organisation. Sydney. March.
- Jeffree, R. A. and Twining, J. R. 2000. Contaminant water chemistry and distribution of fishes in the East Branch, Finnis River, following remediation of the Rum Jungle uranium/copper mine site. Contaminated site remediation: from source zones to ecosystems. Proceedings CSRC 2000 Conference, Melbourne, Victoria, 4–8 December 2000, 51–56.
- Jeffree, R. A. and Williams, N. J. 1975. Biological indications of pollution of the Finnis River system especially fish diversity and abundance. Chapter 7. Rum Jungle environmental studies. D. R. Davy (Ed). Australian Atomic Energy Commission Research Establishment, Lucas Heights.
- Jeffree, R. A. and Williams, N. J. 1980. Mining pollution and the diet of the purple-striped gudgeon *Mogurnda mogurnda richardson* (eleotridae) in the Finnis River, Northern Territory, Australia. Ecological Monographs, 50; 457–485.
- Jeffree, R. A., Twining, J. R. and Thomson, J. 2001. Recovery of fish communities in the Finnis River, Northern Australia, following remediation of the Rum Jungle uranium/copper mine site. Environmental Science and Technology, 35; 2932–2941.

- JORC. 2004. Australasian code for reporting of exploration results, mineral resources and ore reserves: The JORC code. 2004 edition. Prepared by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia. December.
- Lawton, M. D. 1998a. Water quality and mixing dynamics Whites and Intermediate open cuts. Chapter 5. Monitoring report 1988–1993. Rum Jungle rehabilitation project. M. Kraatz (Ed). Technical Report No. R97/2. Land Resources Division, Northern Territory Department of Lands, Planning and Environment. March.
- Lawton, M. D. 1998b. Surface water quality and hydrology East Finniss River 1988/89–1992/93. Mine site surface water quality 1989–91. Chapter 3. Monitoring report 1988–1993. Rum Jungle rehabilitation project. M. Kraatz (Ed). Technical Report No. R97/2. Land Resources Division, Northern Territory Department of Lands, Planning and Environment. March.
- Lawton, M. D. and Overall, R. 2002a. Surface water monitoring. Chapter 3. Rum Jungle rehabilitation project monitoring report. S.M. Pidsley (Ed). Draft. Technical Report No. 01/2002. Department of Infrastructure, Planning and Environment. May.
- Lawton, M. D. and Overall, R. 2002b. Water quality in Whites and Intermediate open cuts. Chapter 4. Rum Jungle rehabilitation project monitoring report. S.M. Pidsley (Ed). Draft. Technical Report No. 01/2002. Department of Infrastructure, Planning and Environment. May.
- Low, W. A. 2001. Flora and fauna of the Browns Project Region, N.T: a desktop assessment of information available and required for environmental impact assessment of Browns Polymetallic Project. Report prepared for NSR Environmental Consultants Pty Ltd Melbourne, Victoria and Compass Resources NL, Sydney, NSW. November.
- MCA. 1997. Minesite Water Management Handbook. Minerals Council of Australia.
- MEB. 1997. Guidelines for preventing mosquito breeding sites associated with mining sites. Medical Entomology Branch. Department of Health and Community Services. Northern Territory Government. May.
- MEB. 2001. Mount Grace Magnesium Mine biting insect investigation. Medical Entomology Branch Territory Health services.
- NEPC. 1998. National environmental protection measure: final impact statement for ambient air quality. National Environmental Protection Council.
- NEPC. 1999. National environment protection measure: assessment of site contamination. National Environment Protection Council.
- NEPC. 2000. National environment protection measure: national pollutant inventory. As varied 20 June 2000. National Environment Protection Council.

- NEPC. 2001. National environment protection measure for diesel vehicle emissions. National Environment Protection Council.
- NGIS Australia. 2004. Australia's tropical rivers – data audit. Report prepared by NGIS Australia. Published by Land & Water Australia, Canberra. April.
- Northern Territory Budget. 2004 - 2005. Undated. Related papers. Northern Territory Economy. Chapter 8. Mining and Energy. Northern Territory Treasury. Northern Territory Government. A WWW publication accessed on 29 March 2005 at: [http://www.nt.gov.au/ntt/financial/budget04-05/nt\\_economy.shtml](http://www.nt.gov.au/ntt/financial/budget04-05/nt_economy.shtml).
- Northern Territory Treasury. Territory Economic Review. Northern Territory Government. February.
- NSR. 2001. Browns Polymetallic Project. Notice of intent. Report prepared for Compass Resources NL by NSR Environmental Consultants Pty Ltd. CR836/2/v2. November.
- NTHR. Declared Heritage Places and Objects. Northern Territory Heritage Register. A WWW publication accessed in April 2005 at <http://www.ipe.nt.gov.au/heritage/register/default.htm>
- NTMC. 2004. TEAM NT: Technologies for environmental advancement of mining in the Northern Territory: Toolkit. D. R. Jones and M. Fawcett, principal authors. Northern Territory Minerals Council and the Mines and Petroleum Management Division of the Northern Territory Government.
- NTNT. 2005. Council of the National Trust of Australia (Northern Territory). A WWW publication accessed in April 2005 at <http://www.members.iinet.net.au/~ntnt/profile.html>.
- OEH. 2005. Public environmental report guidelines: Compass Resources NL, Browns Oxide Project, Batchelor, NT. Prepared by the Office of Environment and Heritage, Northern Territory Government. May.
- Price, O., and Baker, B. 2003. A natural resource strategy for Coomalie sub-region. Draft for public comment. Prepared for the Coomalie Community Government Council by the Biodiversity Unit, Department of Infrastructure, Planning and Environment (DIPE). July.
- Standards Australia. 1981. AS 2436-1981: Guide to noise control on construction, maintenance and demolition sites. Standards Australia.
- Standards Australia. 1993. AS 2187.2-1993: Explosives - storage, transport and use. Standards Australia.
- Standards Australia. 2004. HB 203:2004: Environmental risk management—principles and process. Standards Australia.

- Territory Asset Management Services. 2004. Northern Territory Government; Department of Infrastructure Planning and Environment; Road Network Division - annual traffic report. Prepared on behalf of the Northern Territory Government.
- Twining, J. 2002. Post-remedial ecological recovery in the East Branch of the Finniss River: fish and decapods. In the Finniss River: a natural laboratory of mining impacts—past, present and future. The Finniss River Symposium, Darwin, August 23-24, 2001. Eds: S.J. Markich and R.A. Jeffree. Australian Nuclear Science and Technology Organisation. Sydney. March.
- Twining, J., Markich, S. and Edwards, C. 2002. Chapter 7. Measures of ecological impact in the Finniss River downstream of the Rum Jungle Mine, 1993–98. Chapter 7. Rum Jungle rehabilitation project monitoring report. S.M. Pidsley (Ed). Draft. Technical Report No. 01/2002. Department of Infrastructure, Planning and Environment. May.
- Whelan, P. 1997. The prevention of mosquito breeding in sewage treatment facilities. Senior Medical Entomologist. Darwin. Northern Territory. Department of Health and Community Services. Northern Territory Government.
- Whelan, P. 1998. Recommendations for design details of sewage pond effluent reuse or disposal facilities to prevent mosquito breeding. Senior Medical Entomologist. Medical Entomology Branch. Territory Health Services. Northern Territory Government.
- Whelan, P. 2004. Personal protection from mosquito and biting midges in the NT. Senior Medical Entomologist. Darwin. Department of Health and Community Services. Northern Territory Government.
- Whelan, P., Hayes, G., Carter, J., Wilson, A. and Haigh, B. 2000. Detection of the exotic mosquito *Culex gelidus* in the Northern Territory. Communicable Disease Intelligence. Volume 24 Supplement March 2000. A WWW publication accessed on 18 March 2004 at <http://www.health.gov.au/internet/wcms/publishing.nsf/content/cda-pubs-cdi-2000-cdi2403s-cdi24msf.htm>
- Yin Foo, D. 1996. Batchelor farm water use impact assessment. Report 53/1996D, Power and Water Authority.

### **Personal Communications**

- Burnett, C. Director. Yera Child Care Centre. Telephone. 30 March 2005.
- Day, D. General Manager, Water Services, Power and Water Corporation. Telephone. 30 March 2005.
- Edwards, C. 2001. Senior Scientist, Natural Resources Division, Department of Infrastructure, Planning and Environment, Northern Territory. Telephone. 17 December.

Kirby, G. Department of Business Industry and Resource Development. Email. 25 July 2005.

Lawton, M. 2005. Director Waste and Pollution Management. Office of Environment and Heritage, Department of Infrastructure, Planning and Environment, Northern Territory. E-mail. 31 July.

Otway, T. Principal. Batchelor Area School. Email. 18 April 2005.

Pudney, J. Manager Water Engineering. Power and Water Corporation. Email. 4 April 2005.

Pudney, J. Manager Water Engineering. Power and Water Corporation. Telephone. 12 July 2005.

Seddon, K. Technical Manager, Australian Tailings Consultants. Meeting. 26 August 2005

Wain, L. Chief Executive Officer, Coomalie Community Government Council. Email. 23 March 2005.

Wain, L. Chief Executive Officer, Coomalie Community Government Council. Email. 30 March 2005.



# 11. Study Team

Compass appointed Enesar to prepare this PER. The PER draws on the work of a range of specialist consultants and their contributions are gratefully acknowledged.

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P. Scott	Mining Consultant
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P. Banovich Engineering

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**Simulus**

B. Muller Metallurgy simulation

**Energy Consultant**

O. Peake Power

# 12. Glossary

## 12.1 Units and Symbols

%	percentage (proportion out of one hundred).
/	per.
$\mu\text{g}$	micrograms (one millionth of a gram).
$\mu\text{g/L}$	micrograms per litre; unit commonly used to express the concentration of trace metals in a liquid.
Bq	Becquerel; unit of radioactivity, equal to one transformation per second.
$\text{CO}_2\text{-e}$	carbon dioxide equivalent.
dB	decibel, unit used to express sound intensity.
dB(A)	decibels, A-weighted scale; unit used for most measurements of environmental noise; the scale is based upon typical responses of the human ear to sounds of different frequencies.
g	gram.
Gg	gigagram (1,000 tonnes).
GJ	gigajoules.
Gy	gray, the standard unit of physically absorbed, ionising-radiation dose, equivalent to one joule per kilogram.
ha	hectare.
kg	kilogram.
kL	kilolitre.
km	kilometre.
$\text{km}^2$	square kilometre.
kV	kilovolt.
L	litre.
m	metre.
$\text{m}^2$	square metre.
mg	milligrams (one thousandth of a gram).
mg/kg	milligrams per kilogram; unit commonly used to express the concentration of metal (such as copper) in a rock or sediment; is equal to parts per million.
mg/L	milligrams per litre; unit commonly used to express the concentration of suspended solids or major ions in a liquid.
$\text{mg/m}^3$	milligrams per cubic metre.
ML	megalitre, one million litres.
ML/day	megalitres per day.
ML/year	megalitres per year.
mm	millimetre.
mm/s	millimetres per second.
$\text{Mm}^3$	million cubic metres.
mSv	millisievert.
Mt	million tonnes.
Mt/year	million tonnes per year.
MW	megawatt.

MWh	megawatt hours.
PJ	petajoules ( $10^{15}$ joules).
ppm	parts per million.
s	second.
Sv	sievert. The standard unit of equivalent ionising-radiation dose used for radiation protection purposes. One Sv is equivalent to one joule per kilogram.
t	tonne.
t/day	tonnes per day.
t/m <sup>3</sup>	tonnes per cubic metre.
t/yr	tonnes per year.
w/m <sup>2</sup>	watts per square metre; measure of solar radiation.

## 12.2 Glossary Words

acid(ic)	having a pH less than 7.0; the lower the pH, the higher the corrosive ability of the substance.
acid formation	the process whereby acid is formed by the oxidation of minerals (particularly sulfides) exposed to air and water.
acid rock drainage (ARD)	runoff of acidic water, typically from mined materials, following acid formation within the material.
AGO	Australian Greenhouse Office.
alkaline	having a pH greater than 7.0.
amenity	the desirability of an area.
amphibians	animals (such as frogs) adapted to live both on land and in water.
ANSTO	Australian Nuclear Science and Technology Organisation.
aquatic	living in or on water, or concerning water.
aquifer	a water-bearing layer of sediment or rock.
archaeology	the scientific study of human history, particularly the relics and cultural remains of the distant past.
artefact	anything made by human workmanship, particularly by previous cultures (such as chipped and modified stones used as tools).
AS	Australian Standard.
background	the conditions (e.g., noise levels, bird populations) already present in an area before the commencement of a specific activity (e.g., a mining operation).
best practice	a process, technique, or use of technology, equipment or resource that has a proven record of success.
biodiversity	the diversity of different species of plants, animals and micro-organisms, including the genes they contain, in the ecosystem of which they are part.
blasting	detonation of explosive charge in a mine to assist in the removal of hard rock.
bore	a well, usually less than 20 cm diameter, sunk into the ground and from which water is pumped.
bund	an earth, rock, or concrete embankment constructed to prevent the inflow or outflow of liquids or the transmission of noise.

carbon dioxide equivalent	a unit of greenhouse gas emissions calculated by multiplying the actual mass of emissions by the appropriate Global Warming Potential. This enables emissions of different gases to be added together and compared with carbon dioxide.
carcinogenic	capable of producing cancer.
catchment	the entire land area from which water (e.g., rainfall) drains to a specific water course or waterbody.
cathode	negatively charged conductor (electrode) used in electrolysis.
channel	river or irrigation channel, includes bed and bank.
clay	a discrete mineral species, belonging to the layered silicate group, of less than 2 microns in diameter.
compaction	the process of close packing of individual grains in a soil or sediment as a response to pressure.
concentration	the amount of a substance per unit of mass or volume of the medium in which it occurs.
conservative	a prediction, assumption, or measurement that errs on the side of safety.
contingency plan	plan put in place to handle an event considered unlikely to occur.
contractor	specialist brought in to perform a specific task, such as the construction of mine infrastructure or the excavation (mining) of the open pit.
cross-section	a two-dimensional diagram of an object presented as if the object had been cut across its width.
crusher	that part of an ore-processing plant where the ore is mechanically crushed into smaller pieces.
cyclone	a device that generates a vortex to clear particulate matter from air or water.
DBIRD	Department of Business, Industry and Resource Development (now DPIFM).
DCM	Department of the Chief Minister.
density	<ol style="list-style-type: none"> <li>1. the mass of a substance (e.g., sediment) divided by its volume; water has a density of exactly 1 kilogram per litre; gold has a density of 19.3 kilograms per cubic metre.</li> <li>2. the coverage of vegetation (e.g., trees) per unit of distance (along a linear transect) or unit of area (in an area transect).</li> </ol>
deposition	laying down of particulate material (e.g., sediment in a lake or tailing solids in a tailing storage).
dewater	to remove water from (e.g., a mine pit or an aquifer).
DIP	Department of Infrastructure and Planning (formerly DIPE).
DIPE	Department of Infrastructure, Planning and Environment.
dissolved oxygen	the amount of gaseous oxygen dissolved in water and available for a biochemical activity (e.g., fish respiration).
distribution of species	the entire area in which a population of a species, subspecies or other taxon is found.
diversity of species	the number or relative abundance of species in a defined area.
DNRETA	Department of Natural Resources, Environment and the Arts.
DPC	Darwin Port Corporation.
DPIFM	Department of Primary Industry, Fisheries and Mines (formerly DBIRD).

drilling	the action of boring holes (usually less than 30 centimetres in diameter and up to several hundred metres deep) into the ground, typically to establish a water bore or to investigate the geology found at depth.
ecology	the science dealing with the relationships between organisms and their environments.
ecosystem	an interacting system of animals, plants, other organisms and non-living parts of the environment.
emission	a discharge of a substance (e.g., dust) into the environment.
environment	a general term for all the conditions (physical, chemical, biological and social) in which an organism or group of organisms (including human beings) exists.
environmental planning	planning (e.g., of a mining operation) that places emphasis on the possible environmental impacts of a development.
ephemeral	not permanent, e.g., a stream that flows only seasonally or after rainfall or a lake that periodically dries out.
erosion	the wearing away of the land surface (whether natural or artificial) by the action of water, wind and ice.
evaporation	the loss of water as vapour from the surface of a liquid that has a temperature lower than its boiling point.
excavators	vehicles used to excavate holes and move soil, earth, or rocks.
exotic	introduced to a particular environment (see also introduced).
extinction	when the entire population of a species (across the world) has died out.
failure	(of wall) structural collapse or breach.
fault	major fracture of the earth's crust caused by the relative movement of the rock masses on either side.
fauna	a general term for animals (birds, reptiles, marsupials, fish, etc.), particularly in a defined area or over a defined time period.
feasibility study	a preliminary technical and economic study to assess the viability of a project.
feed	material being fed into a process.
filterable metal	dissolved metal able to pass through a filter, normally having a pore size of 0.45 micron.
flocculant	chemical substance added to a flotation process to aid flocculation.
flood plain	a low-lying plain adjacent to a river subject to occasional or frequent flooding and formed by sediment deposition during flooding episodes.
flora	a general term for plants, particularly those found in a defined area or characteristic of a defined time period.
flowsheet	<ol style="list-style-type: none"> <li>1. diagram representing the sequence of events and decision-making logic of a particular process.</li> <li>2. the series of steps within the processing plant by which metals are recovered from ore.</li> </ol>
fluvial	relating to, or formed by, a stream or river.
food chain	the assemblage of organisms of various energy (trophic) levels linked by the transfer of food energy.
foraging	searching for food over a wide area.
formation	a large stratigraphic sequence of rock beds (sandstone, shale, limestone, etc.) generally deposited over a distinct geological period (e.g., during a glacial period).
fugitive	noise, dust, or light that has escaped into the environment (e.g., from a mine site).

gangue	a mineral without economic value that is part of an ore deposit; quartz, calcite, and fluorite are common gangue minerals.
general arrangement	plan of the project area, including pit, tailing storage, process plant, etc.
geochemistry	the study of the chemical composition of the earth or of the chemical interaction of elements, molecules, or particles derived from the earth.
geotechnical	a term currently employed to cover the fields of soil mechanics, rock mechanics, and engineering geology.
grade	the concentration of metal, e.g., copper, either in an individual rock sample or averaged over a specified volume of rock.
grader	vehicle used to smooth a soil or rock surface.
gradient	rate of change of a given variable (such as temperature or elevation) with distance.
gravel	sedimentary particles or rock fragments generally between 2 and 10 mm in size.
greenhouse gases	carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulfur hexafluoride.
grinding	a process used to reduce the particulate size of a mine rock or soil, typically occurs after crushing.
ground vibration	vibration transmitted through the ground following blasting.
groundwater	all waters occurring below the land surface; the upper surface of the soils saturated by groundwater in any particular area is called the water table.
groundwater discharge	discharge of groundwater into rivers, streams or open pits.
guar	drought-tolerant herb grown for forage and for its seed which yields a gum used as a thickening agent or sizing material.
habitat	the particular local environment occupied by an organism.
haul trucks	heavy vehicles used for the transportation of ore or waste rock.
heavy metals	generally used to describe the following metals: arsenic, iron, manganese, silver, mercury, chromium, lead, zinc, copper, nickel, selenium and cadmium.
herpetofauna	the population of reptiles and amphibians inhabiting a specific area.
highest order predator	an organism that is not consumed, but consumes other organisms, which in turn consume organisms lower in the food chain.
hydrology	the study of water, particularly its movement in streams, rivers, or underground.
hydroxides	an oxide compound derived from water by the replacement of one of the hydrogen atoms by another atom or group (e.g., sodium hydroxide, NaOH).
hypothesis	a supposition put forward in explanation of observed facts.
indicator	any physical, chemical, or biological characteristic of the environment used to assess (i.e., indicate) environmental condition.
indigenous	belonging to, or found naturally in, a particular environment (see also exotic).
inflow	flow directed into a particular feature, such as a lake or a mine pit.
infrastructure	the supporting installations and services that supply the needs of a project.
introduced	see exotic.
intruded	geological term for (igneous) rock formed by the injection of molten magma up into the earth's crust and its subsequent cooling and crystallisation.

invertebrates	commonly, animals without a backbone (jellyfish, worms, molluscs, etc.).
irrigation	the artificial flooding of agricultural land to promote cultivation.
LAeq	the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.
landform	a specific feature of a landscape (such as a hill) or the general shape of the land.
leach	dissolution and removal of a soluble substance from a soil or a rock, e.g., the leaching of salt (by water) from a soil or the leaching of gold (by cyanide) from a rock.
leachate	the fluid in which a leached substance is dissolved or transported.
lift	each separate layer placed in the construction of an embankment or waste rock emplacement.
lithology	the description of rocks on the basis of colour, mineralogical composition, and grain size.
load	the amount of a substance discharged into a body of water (e.g., salt or sediment); usually expressed as mass over a specified time (e.g., tonnes per year).
macropods	marsupials belonging to the family Macropodidae, which includes kangaroos, wallabies, tree kangaroos, pademelons, and several others.
mean	average; the sum of the data divided by the number of data points.
mean annual rainfall	the average amount of rain that falls each year.
median	the middle value of a set of numbers arranged in order of magnitude (or the mean of the middle two numbers).
metallurgical	pertaining to metals, particularly their extraction from ore.
microchiropteran	one of two suborders of bats in the world.
microhabitat	a habitat peculiar to a small area, particularly an area distinct from that surrounding it (e.g., a decaying log in a grazing paddock).
mill	ore processing plant.
mine materials	material removed during excavation of the mine pit (e.g., topsoil, waste rock, or ore).
mine waste	by-products of mining operations with no economic value.
mine water	all water used in mining and processing (for dust suppression, in leach tanks, etc.).
mineralisation	the occurrence of metals or ore-bearing minerals within a rock sequence.
MMP	Mining Management Plan.
model	a mathematical simulation of a natural system (such as the variation of particulate levels within a lake) used to predict how the system will change with time, particularly where external changes have been imposed upon it (such as from mining operations).
monitoring	systematic sampling and, if appropriate, sample analysis to record changes over time caused by impacts such as mining.
multi-element geochemical signature	a suite of elements in geochemical concentrations above local background values in soils (or other surface materials) indicating the presence of mineralisation.
mutagenic	capable of inducing genetic mutations.
native	see indigenous.
natural	existing in, or formed by, nature (generally excludes anything obviously modified by human beings).

natural degradation	deterioration occurring due to natural circumstances (such as extreme weather conditions).
natural succession	natural replacement of an animal or plant species with another in the same habitat.
neutral	neither acidic nor basic (e.g., pH equal to 7.0).
nitrate	NO <sup>3-</sup> , nitrogen compound commonly found in waterbodies and used by plants and algae as a nutrient.
NOI	Notice of Intent.
non-combustible residue	dust residue that cannot be burnt (i.e., free of organic litter).
NORM	naturally occurring radioactive material.
noxious	introduced species considered to be harmful to native species or to the habitat of native species.
nutrient status	state of nutrient (nitrogen and phosphorus) concentration of a waterbody.
nutrients	generally refers to nitrogen and phosphorus, which are essential for biological growth.
OEH	Office of Environment and Heritage.
open pit	large hole excavated in an open-cut mining operation to remove the ore.
operations	mining and ore processing activities.
operations phase	that period of the mining project, after construction and prior to decommissioning, during which pit excavation and metal extraction takes place.
order of magnitude	an approximate 10-fold difference between two numbers (e.g., 21 and 230) is one order of magnitude; an approximate 100-fold difference is two orders of magnitude (e.g., 21 and 2,150), etc.
ore	a mineral or mixture of minerals containing a metal in sufficient amounts for its extraction to be profitable.
ore processing	the mechanical and chemical process by which a metal is extracted from an ore.
orebody	a solid mass of ore (both high and low grade) that is geologically distinct from the rock that surrounds it and that is commercially extractable.
overburden	material that overlies a deposit of ore.
oxidation	the process by which an element or compound undergoes a chemical reaction involving the removal of electrons; often involves reaction with oxygen to form an oxide (e.g., the rusting of iron).
PAC	Project Assessment Committee.
particle size distribution	the relative proportions of particles (e.g., in a sediment) that fall within specific size categories.
passive	performing a function without electrical or mechanical action or movement (e.g., a jar-and-funnel rain gauge).
PAWC	Northern Territory Power and Water Corporation.
perimeter	outer boundary.
permeability	the ability of a rock or soil to allow fluid to pass through it.
pH	a measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral and 14 is most basic (alkaline).
piezometer	a small-diameter cased bore used to measure groundwater levels.
pit	see open pit.

pit water	water inflow into the pit from incident rainfall or groundwater seepage from pit walls.
plant site	the site of the ore-processing plant.
plutonic	coarse-grained igneous rock which has solidified far beneath the earth's surface.
PM <sub>10</sub>	the fraction of dust with a particle size of 10 µm or less; a health indicator for the fine particles of respirable dust capable of being inhaled into the lungs.
PM <sub>2.5</sub>	the fraction of dust with a particle size of 2.5 µm or less; a health indicator for the very fine particles of respirable dust capable of deep penetration into the lungs and alveoli.
pollution	the alteration of air, soil, or water as a result of human activities such that it is less suitable for any purpose for which it could be used in its natural state.
potable water	water of quality suitable for human consumption.
precipitation	1. the process of changing from a dissolved compound into a solid, insoluble compound. 2. rain, hail and snow.
process method	method used to extract metals from ore.
process plant	where the extraction of metals from the mined ore occurs.
process reagents	the chemicals and solutions used in the process method.
process water	water used during the processing of ore.
progeny	the isotopes or elements formed by the nuclei of radionuclides during radioactive decay; also known as 'decay chain products' and 'daughter products'.
progressive rehabilitation	rehabilitation of mined or disturbed areas as soon as practicable after they are released during the life of the mine.
project area	the total area covered by the project, including pit, processing plant, tailing storage, waste emplacements, stockpiles, bunds, dams, etc.
prospective	potentially containing an economic ore deposit.
PWC	Parks and Wildlife Commission.
PWCNT	Parks and Wildlife Commission Northern Territory.
quality control	procedures built into a sampling and analytical program to maintain the quality of the results obtained.
quantify	to determine the quantity or amount of a component in a substance.
quarry	an open pit from which construction materials are excavated.
radius	distance from the centre of a circle to its perimeter.
rainfall events	periods of rainfall.
reagents	chemicals used as part of an industrial process.
receptor	a designated place at which an impact may occur (e.g., a dwelling).
recessionary flow	the volume of water that passes a given point in a given period of time at the end of the wet season.
recharge	the addition of water to an aquifer, directly from the surface, indirectly from the unsaturated zone, or by discharge from overlying or underlying aquifer systems.
recolonise	the process of animal and plant species re-establishing themselves in a disturbed area.
refining	to bring to pure state.
regrowth	natural regeneration of vegetation following clearing, fire, etc.

rehabilitation	the restoration of a landscape and especially the vegetation following its disturbance.
remobilisation (of sediment)	resuspension of deposited sediment.
replicate samples	samples taken as close to each other in time and space as possible to test analytical accuracy.
reprotoxic	capable of causing reproductive impairment in adults and developmental impairment or death in a foetus.
reptiles	cold-blooded vertebrates, including lizards, snakes, turtles, and crocodiles.
reserve	commercially extractable minerals.
residual environmental impacts	impacts from an activity (e.g., mining) that remain after management and mitigation measures.
residue	see tailing.
resource	minerals in the ground, but not necessarily commercially extractable.
revegetated	an area that has been planted with trees, bushes and grasses after being disturbed.
richness (of fauna or flora)	a measure of the number of species in a given area or assemblage.
riparian	pertaining to, or situated on the bank of, a body of water, especially a water course such as a river.
river system	a river and its tributaries draining a catchment.
RL	relative level.
ROM	run-of-mine; see run-of-mine ore stockpile.
routine monitoring	monitoring performed on a regular basis, with the same observations and tests conducted each time.
run of mine (ROM) ore stockpile	the stockpile of freshly mined ore used to feed the mill and process plant.
runon	that portion of precipitation (rain, hail and snow) that can potentially flow across a specific area as water.
runoff	that portion of precipitation (rain, hail and snow) that flows from a specific area as water.
SAG	semi-autogenous grinding.
sampling period	range of time over which samples are taken.
sand	siliceous group of particles within the size range 63 $\mu\text{m}$ to 2 mm.
scree	small, loose rocks that gather on a slope and often at the base of cliffs.
sediment load	see load.
sediment transport	the movement of sediment particles by the action of water, wind or gravity.
sedimentary rocks	rocks resulting from the consolidation of loose sediment that has accumulated in layers.
seepage	1. subsurface movement of water. 2. emergence of subsurface flow at the ground surface.
seismic risk	the possibility of earth movement (e.g., an earthquake).
sequence (geological)	layers of (predominantly) sedimentary rocks sourced from a common geological environment or period.
sheet flow	runoff that is of substantial lateral extent and relatively uniform depth (rather than concentrated in channels).

silt	a sediment with particles finer than sand and coarser than clay, i.e., 2 to 63 $\mu\text{m}$ .
site-specific	an observation that is particular to one site.
slurry	mixture of fluid and solid (e.g., tailing water and solids).
soak	a small area where the water table has intersected the ground surface.
soda ash	sodium carbonate.
solubilisation	the process of dissolving.
solvents	organic liquids that will dissolve solids (e.g., benzene or toluene).
species	a taxonomic grouping of organisms that are able to interbreed with each other but not with members of other species.
species diversity	a measure of the number of different species in a given area.
spigot	a tap for controlling the flow of liquid from a pipe.
standing water	water that is pooled and still.
station	a specific location established for repeated sampling, gauging, weather measurements, etc.
stockpile	a pile used to store material (such as low-grade ore) for future use.
stockpiled	stored in a stockpile.
storage capacity	the maximum volume of liquid able to be retained in a structure or container (e.g., a reservoir or lake).
stream gauging	determination of water level and velocity in a stream or river for the purpose of calculating the volume of flow.
stripping	removal of vegetation and topsoil.
sub-aerial	exposed to the air.
sub-aqueous	below the surface of water.
subsistence	farming where produce is consumed by farmer and family leaving no surplus for marketing.
substrate	an underlying layer (e.g., of sediment under water).
sumps	pits sunk to collect water.
supernatant	the layer of water above settled solids.
surface waters	all water flowing over, or contained on, a landscape (e.g., runoff, streams, lakes, etc.).
suspended (solids)	solids held in suspension by the turbulent flow of a fluid.
tailing	by-product of the metal extraction process consisting of crushed rock from which the metal has been extracted (the solid fraction or portion) and a liquid fraction or portion composed of water and residual chemicals used in the extraction process.
tailing storage facility (TSF)	a storage facility for tailing.
TDS	total dissolved solids.
temperature inversion	an atmospheric phenomenon in which air temperature increases with height over a particular interval.
tenure (of land)	terms of holding or authority of ownership.
terrestrial	pertaining to land.
throughput	quantity of material (ore, chemicals, etc.) moving through a system (e.g., an ore-processing plant).
tissue	cellular fabric of which animals or plants are made.
topography	physical relief and contour of a region.

topsoil	upper layer of soil, usually containing more organic material and nutrients than the subsoil beneath it.
total metal	total mass of filterable and non-filterable metal in a sample.
total suspended particulate matter (TSP)	mass of all suspended particulates (see TSS).
total suspended solids (TSS)	a common measure used to determine suspended solids concentrations in a waterbody and expressed in terms of mass per unit of volume (e.g., milligrams per litre).
toxic	poisonous to a specific organism, sometimes resulting in death.
toxicant	a substance that is poisonous.
toxicity	effect of any substance that produces a harmful effect on living organisms; described as acute (short term) or chronic (long term).
transect	a line across a study area along which observations are made and changes can be observed (e.g., changes in vegetation).
transport	movement (e.g., of sediment) via a medium such as river water.
tributary	a stream or river that flows into a larger river or lake.
TSP	see total suspended particulate matter.
TSS	see total suspended solids.
turbidity	the optical property of water that prevents light from being transmitted; turbidity or muddiness is caused by the presence of very fine suspended matter such as clay or organic matter.
understorey	the smaller species of plants that form neither the canopy nor the ground cover.
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation.
upper limits	the higher values within a defined range.
variable	not constant, subject to change (e.g., temperature, rainfall or population).
vegetated	covered with plants.
velocity	speed in a given direction.
vibration	oscillating movement.
wash thickener	a structure used to both wash and thicken slurries.
waste emplacement	structure to hold waste rock, formed by the placement of waste rock in stacked layers (typically 7 to 10 m thick), engineered in such a way as to maximise stability and minimise erosion.
waste oils	old oils and lubricants retrieved from machinery.
waste rock	uneconomic rock extracted from the ground during a mining operation to gain access to the ore.
water balance	the sum of the inputs and outputs and changes in storage levels of water in a given locality.
water chemistry	the interaction of the chemical constituents (dissolved metals, suspended particles, etc.) of water.
water column	the body of water overlying the bed of a stream, lake, swamp, or ocean.
water hardness	the concentration in water of certain mineral salts (particularly calcium carbonate, CaCO <sub>3</sub> ); generally a function of calcium and magnesium concentrations.
water quality	degree of the lack of contamination of water.

water quality criteria	generally refers to numeric levels specified for key water quality variables, such as dissolved metals or pH, which can be measured to determine the suitability of water for human consumption, supporting aquatic life, etc.
water table	the surface of the groundwater, below which soil and rock are saturated.
watercourse	stream or river, running water.
watershed	area of land that catches precipitation and drains into a waterbody such as a river.
weathering	the insitu physical disintegration and chemical decomposition of rock materials at or near the earth's surface.
weed	any plant (in particular an herbaceous one) that survives in an area where it is harmful or troublesome to the desired land use.
wetland	a low-lying area regularly inundated or permanently covered by shallow water.
worst-case scenario	a sequence of events likely to result in the worst-case effects on the environment.
yield	(of a water bore). <ol style="list-style-type: none"><li>1. the capacity of the bore to produce water.</li><li>2. the amount of water actually withdrawn.</li></ol>