Appendix 1

Air Quality and Noise Assessment: Browns Oxide Project, NT

AIR QUALITY AND NOISE ASSESSMENT:
BROWNS OXIDE PROJECT, NT

August 2005

Prepared for
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by

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1 INTRODUCTION

The Browns Oxide Project is a proposal to develop an open cut mine approximately 65 km south of Darwin and 7 km north-west of the Batchelor township. The mine and immediate neighbouring land use is shown in **Figure 1**. This report has been prepared by Holmes Air Sciences for Enesar, as part of an Environmental Assessment for the proponent, Compass Resources NL.

The report is a desktop study and deals with the potential air quality and noise impacts. The project description is based on engineering information available at July 2005.

2 DESCRIPTION OF THE PROPOSAL

The Browns Oxide Project resource comprises a polymetalic oxide ore body underlain by a larger sulphide deposit. The proposal involves only recovery of the oxide material. It is proposed that this material would be mined at a rate of 1 Mtpa for approximately 3 years. Ore would be processed by stockpiling, crushing, leaching, solvent extraction and electrowinning to produce approximately 10,000 tpa of copper cathode. Tailings would be disposed of to a conventional tailings storage facility on-site. Product would be transported by road to Darwin for export by ship.

The oxide ore body comprises weathered rock from the surface to a depth of 20 to 25 m with two deeper pockets reaching to 50 m. Ore from the open pit (see **Figures 1** and **2**) would be delivered by truck to a run of mine stockpile located to the west of the pit. The stockpile would hold up to one month of ore feed to the process plant. A low-grade stockpile would also be formed to the southwest of the pit to hold ore which is of marginal economic grade but which may be viable to treat in the future or when metal prices are higher. The low-grade stockpile would hold up to approximately 1.5 million tonnes.

The process plant would be located along the northern boundary in the western end of the tenements and this would comprise the crushing and grinding circuits and leach tanks. The open pit would be designed in such a way as to facilitate the future mining of the much larger sulphide resource, which extends downward from the base of the oxide pit. The open cut excavation would occupy approximately 15.2 hectares. The waste rock dump would require approximately 2.3 hectares and low-grade ore stockpile would occupy approximately 5.6 hectares.

The mining method would use a conventional excavator and truck operation. The first stage would involve clearing of vegetation and topsoil which would be stored for use in rehabilitation. Much of the oxidised material is weathered and blasting would not be required except for some minor areas comprising harder silicified bands of material. It is estimated that blasting would take place once or twice a week and involve between 80 and 170 holes being fired on a 5 m high bench. Shot holes would be stemmed with gravel and nonel tubing would be used to minimise the ground vibration and air blast and fly rock. Mining would take place at a rate of 350,000 to 400,000 bank cubic metres (bcm) per year and waste rock would be mined at a rate of approximately 440,000 to 300,000 bcm per year. Material would be initially loaded using a 60 t hydraulic excavator into three 50 t off-highway dump trucks. This equipment would be supported by a bulldozer, grader and water cart, blast hole drill and other small ancillary items such as pit pumps and light vehicles.

The oxide ore will initially be delivered to a single stage crushing circuit consisting of a jaw crusher, which will feed to a ball mill with ground product moving to the leach circuit.

3 LOCAL SETTING

The mine is in a relatively isolated area with the closest non-company owned residence being approximately 2 km to the southwest of the open cut (see **Figure 1**). The terrain in the area is flat to gently undulating and vegetation consists of open woodlands with trees extending to heights of five or six metres.

3.1 Existing noise environment

No noise survey to establish quantitative information on background noise levels has been undertaken, however information from individuals who have inspected the site indicates that existing noise levels are low and for the purposes of assessment, the approach taken has been to assume that existing background levels are low. As will be seen later, assuming background levels are low establishes a conservative basis for assessing noise impacts.

3.2 Existing air quality conditions

No direct monitoring of existing air quality has been undertaken. The area is remote from pollution sources and the only air pollutants likely to be present at significant concentrations is particulate matter from wind blown dust and bushfire smoke during the dry season. For most of the time particulate matter concentrations would be expected to be low compared with the assessment criteria (see **Section 4.2**).

3.3 Meteorological conditions

A meteorological monitoring program for the Browns Project was commenced on 11 July 2000 and the station was maintained until 7 February 2003. The location of this monitoring station is approximately 5 km to the north of Batchelor at 12°59'16"S, 130°59'31"E. Its location is shown on **Figure 1**.

Instruments and a data-logging device were installed to a 10 m high disused mine-shaft tower. Installation was performed in accordance with the relevant Australian Standard[1] for air quality applications.

The meteorological station recorded the following parameters at 10-minute intervals:

- Wind speed at 10 m
- Wind direction at 10 m
- Temperature at 10 m
- Temperature at 2 m
- Solar radiation
- Rainfall.

The data recorded by the instruments were logged to a memory card via a data-logger. Memory card changing and processing of the recorded data was performed once per month. Monthly processing involved the production of graphs of all the recorded parameters. Only a limited review of the data is provided here. Data recovery over the monitoring period was 100%.

Data for the period 11 July 2000 to 10 July 2001 have been used to prepare seasonal and annual wind roses for the area (see **Figure 3**).

Over the year winds blow mainly from the west, west-northwest and southeast, east-southeast and east. The easterly winds are most common in the autumn and winter and the westerly winds are most common in spring and summer. Dust generated on the site will therefore tend to be transported in the direction of the prevailing winds i.e. to the northwest and the west-northwest and to the east and east-southeast. Very little dust would be expected to be transported to the quadrants centred on the north-northeast and south-southwest directions.

[1] Australian Standard 2923 : Ambient Air – Guide for Measurement of Horizontal Wind for Air Quality Applications

Total rainfall data collected at the site over the year (11 July 2000 to 10 July 2001) was 1722 mm. The majority of the rainfall was collected in the months September through to February. Little rainfall was recorded from March to August. For the two years for which complete years of data were available, 2001 and 2002, annual rainfall was 1686 and 908 mm respectively.

Little seasonal variation has been recorded in the maximum temperature data although the daily minimum temperatures are significantly lower in the winter months. The maximum temperature recorded over the entire recording period was 40.8 °C and the minimum temperature was 8.7 °C.

Wind speed data collected at the site shows that average wind speeds are low, with the two years for which monitoring covered the full year the average was 1.5 m/s. There was a high proportion of calm periods (wind speed was less than 0.5 m/s). The percentage of calm periods in 2001 and 2002 was 34% (for both years).

4 ASSESSMENT CRITERIA

4.1 Noise assessment criteria

In the absence of detailed noise assessment procedures for the Northern Territory, the project has been assessed using the approach set out in the New South Wales Department of Environment and Conservation's (NSW DEC) Industrial Noise Policy (INP) (**NSW DEC, 2000**). Mining in NSW frequently occurs in proximity to areas of human settlement. For this reason, the NSW procedures provide a particular focus on assessing the impact of mining noise and noise from minerals processing plant on residential receivers. The procedures are therefore relevant for the current study.

The NSW DEC procedures are stringent by international standards and would be expected to identify potential noise impacts.

The assessment procedure focuses on two aspects:

1. Controlling short-term intrusive noise impacts for residential receivers, and;
2. Maintaining amenity noise levels for residential areas and other land uses.

The policy provides a number of ways of deriving suitable noise goals and describes how the effects of inversions and wind are be taken into account when assessing impacts, when these effects are relevant.

4.1.1 Intrusiveness criterion

The first step in the assessment procedure is to determine background noise levels to identify the 'underlying level of noise present in the ambient noise when all extraneous noise is removed'. This is referred to as background noise. For assessment purposes, the 24-hour day is divided into three periods, day (7 am to 6 pm), evening (6 pm to 10 pm) and night (10 pm to 6 am) and in most cases different background levels apply.

The NSW DEC INP normally involves measuring ambient noise levels in the day, evening and night periods and using the ambient noise data to determine existing L_{Aeq} for the day, evening and night time assessment periods and to determine a derived parameter known as the Rating Background Noise Level (RBL).

The RBL is determined using procedures set out in the INP (see later in this section) and is derived from $L_{A90,\ 15\text{-minutes}}$[2] values. It represents the lower value of the noise levels that apply

[2] The $L_{A90,\ 15\text{-minutes}}$ for a particular measurement period (day, night or evening) is defined as the lowest 90-percentile of *A-weighted* noise measurements made over 15-minute intervals over the measurement period. *A-weighting* refers to an adjustment made to a measured noise level, based on

in the quietest period of the day, evening and night periods. When no direct measurements of existing noise levels are available it is permissible to conservatively assume that the RBL is 30 dB(A). Intruding industrial noise ($L_{Aeq,15\text{-minute}}$[3]) should not exceed the relevant RBL by more than 5 dB(A).

The assessment procedure for intrusiveness requires that the $L_{Aeq,15\text{-minute}}$ noise level due to the introduced noise source should be less than the RBL + 5 dB(A). Since the plant would operate continuously, the intrusiveness criteria requires that the $L_{Aeq,15\text{-minute}}$ should be less than the lowest of the RBLs + 5dB(A) or, in cases where the RBL is less than 30 DB(A), 30 + 5 dB(A), i.e. 35 dB(A). These assumptions recognise that the potential for a noise to annoy a community depends on the extent to which the intruding noise exceeds the background noise level, but also takes into account, that in practice noise levels lower than 35 dB(A) are likely to be considered acceptable by most in the community regardless of the background level.

Provision is made in the INP to adjust the level of the noise being assessed for its tonal qualities, intermittency, impulsive quality, or dominant low frequency. No correction is required for most of the noises that would be generated by the mining equipment with the exception of reversing horns and possibly the “clanking” noise from tracked dozers.

Provisions are also made in the NSW DEC INP for assessing the effects of inversions and wind, which are known to enhance noise levels experienced at a receiver. These will be discussed later.

4.1.2 Noise amenity

The second component of the noise assessment procedure is to ensure that the noise that arises from the combined effects of the existing background and new noise sources does not exceed a noise level appropriate for the land use. The land use for the current case is best defined as rural and the relevant noise levels are shown in **Table 1**.

Table 1. Recommended L_{Aeq} noise level from industrial noise sources for rural area (Source: NSW INP)

Time of day	Acceptable level (L_{Aeq})	Maximum level (L_{Aeq})
Day – 7 am to 6 pm	50	55
Evening – 6 pm to 10 pm	45	50
Night – 10 pm to 7 am	40	45

The purpose of the amenity test is to prevent so called “background noise creep”. This would occur if the intrusiveness test were the only test required for approval. Each time the intrusiveness test is met, and a new noise source is introduced, the background will increase. Successive application of the intrusiveness test, from one project to the next, could allow the new noise sources to be introduced into an increasingly noisy environment. In the absence of existing industrial noise sources the amenity test sets an upper limit to noise emissions (allowable from the proposal) which are higher than those allowed by the intrusiveness test and therefore the intrusiveness test is the critical test.

its tonal composition, to ensure that it best matches the loudness of the noise as perceived by the average human ear. The subscript “15-minute” that appears in this term refers to measurements made over 15-minutes.

[3] The L_{Aeq} is defined as the steady *A-weighted* noise level, which if it occurred continuously over a measurement interval, would involve the same amount of acoustic energy as occurs in the actual time varying noise that occurs over the same measurement interval. *A-weighting* refers to an adjustment made to a measured noise level, based on its tonal composition, to ensure that it best matches the loudness of the noise as perceived by the average human ear. The subscript “15-minute” that appears in this term refers to measurements made over 15-minutes.

4.2 Air quality assessment criteria

The project will result in the liberation of particulate matter Total Suspended Particulate matter (TSP), [4]PM_{10} and [5]$PM_{2.5}$) from the handling and transport of ore, waste and from wind erosion. In addition, there will be emissions of gases such as carbon monoxide, nitrogen dioxide and sulphur dioxide from the burning of fuels (mostly diesel) and from blasting. In practice the sources of emissions of carbon monoxide, nitrogen dioxide and sulphur dioxide are too small and too widely dispersed, even on large open cut mines, to justify special attention and the only significant air quality issue is the potential impact of particulate matter.

To assess the effects of particulate matter emissions it is useful to make reference to the assessment criteria developed by the more populus states such as Victoria and NSW. For the purposes of this assessment we have made use of guidelines developed by the NSW Department of Environment and Conservation (DEC) (**DEC, 2001**). The DEC criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Ambient Air-NEPMs (see **NEPC, 1998**)), which apply throughout Australia. However, the NSW criteria include averaging periods, which are not included in the Air-NEPMs and references to other measures of air quality, namely dust deposition and TSP, which are also not part of the Air-NEPMs. The relevant criteria (including the criterion for PM_{10}) are summarised in **Tables 2**, **3** and **4**.

Table 2: NSW DEC Impact assessment criteria for pollutants (for use in modelling)

Pollutant	Averaging period	Concentration
		µg/m^3
PM_{10}	1-day annual	50 30

In addition, the guidelines provide the criteria for TSP (see **Table 3**) and for the insoluble component of deposited dust (see **Table 4**).

Table 3: NSW DEC amenity based criteria for dust fallout

Pollutant	Averaging period	Concentration
TSP	Annual	90 µg/m^3

Table 4: NSW DEC amenity based criteria for dust fallout

Pollutant	Averaging period	Maximum increase in deposited	Maximum total dust deposition
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

The National Environmental Protection Council (NEPC) has recently published an advisory National Environmental Protection Measure (NEPM) for $PM_{2.5}$ (**NEPC, 2002**). The numerical values for $PM_{2.5}$ NEPM are:

1. 8 µg/m^3 – annual average
2. 25 µg/m^3 – maximum 1-day average.

At this stage, the proposed advisory $PM_{2.5}$ standard is not part of the NSW DEC assessment criteria and for this reason these standards have not been considered further in the assessment.

The above suite of ambient air quality criteria for particulate matter is comprehensive and would be expected to protect against all harmful effects of the emissions from the Proposal including health and nuisance effects.

[4] Particulate matter with equivalent aerodynamic diameter less than 10 micrometres.
[5] Particulate matter with equivalent aerodynamic diameter less than 2.5 micrometres.

5 EMISSIONS

5.1 Noise

The major noise emissions sources associated with the project and their estimated sound power levels are summarised in **Table 5**.

Table 5. Inventory of noise generating equipment

Item	**Number**	**Sound-power level – dB(A) re:10^{-12} Watts (per item)**
60 t Hydraulic Excavator	1	116
50 t off-highway dump trucks	3	113
Water truck	1	108
Bulldozer	1	110
Drill	1	114
Grader	1	110
Jaw crusher	1	110
Mill	1	123
Total (taking into account number of each item)		123 (note the addition of noise levels is a logarithmic addition)

In practice the excavator, drill and bulldozer will operate for much of the time in the pit and therefore the effective sound power level, for receivers outside the pit, will be significantly lower than that shown in the table. The noise level of the mill is based on measurements published for the mill at Olympic Dam in South Australia. The Olympic Dam Mills capable of processing 415 t/h and is approximately 10.4 m in diamter and so is significantly larger than will be required for the Browns Project. Thus this estimate of noise level is likely to be conservative. Precise noise emission levels for the mill to be employed on the project are not available at this stage. However as will be seen in **Section 6.1** mill noise has the potential to cause the assessment criterion of 35 dB(A) to be exceeded and this mill will need to be acoustically treated or shielded by acoustic barriers/bunds to reduce noise emission levels.

5.2 Atmospheric

Atmospheric emission will arise from the handling of ore and waste rock and from wind erosion of exposed areas. The NSW Minerals Council have undertaken an analysis of dust emissions from typical open cut metalliferous mines using good, average and minimal dust controls (**NSWMC, 2000**). The estimates are provided as total emission expressed as kg of TSP dust liberated per bank cubic metre of material handled (kg/bcm). The work concluded that dust emissions are 0.3, 3.1 and 27.9 kg/bcm for the "good", "average" and "minimal" controls respectively. The Browns project is estimated to handle up to 840,000 bcm per year and if managed to a "good" level of control would liberate approximately 252 t of TSP dust per year.

6 ASSESSMENT OF IMPACTS

6.1 Noise

A conservative estimate as to noise level (L) likely to apply at distant receivers due to noise emissions from the equipment in **Table 5** can be made using the equation provided in Australian Standard 2436-1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites" (**AS 2436-1981**). The equation is as follows:

$L = L_W - 20 \log_{10} R - 8$,

Where,

R = the distance from the source to the receiver in metres, and
L_w = the sound power level of the noise source in dB(A).

Equation 1

The equation takes into account the effect of geometrical spreading of the sound energy as it propagates from the source but does not take account of shielding by topographical features, ground absorption or atmospheric attenuation.

The closest receiver is approximately 2000 m to the southwest of the mine and approximately 1700 m to the southwest of the mill. It is predicted to experience a sound pressure level of 50 dB(A) before any allowance is made for ground effect and atmospheric attenuation. It would be reasonable to allow an additional 0.5 dB attenuation per 100 m for ground attenuation and a further 3 or 4 dB reduction for atmospheric attenuation. This would result in a further attenuation of approximately 14 dB or so and a noise level of approximately 36 dB(A) would occur at the closest receiver.

Under night time conditions the effects of inversions and wind can lead to increased noise level of the order of 10 dB(A) (**NSW INP, 2000**). This would negate much of the effects of ground and atmospheric absorption. The enhancement of 10 dB(A) would occur under inversion conditions, which occur at night when the sky is clear and winds are light. During the day the total reduction in noise levels from equipment on the mine due to all the attenuation effects along the noise propagation path would be approximately 87 dB(A) [- 73 dB(A) due to geometrical spreading – 10 dB(A) due to ground absorption and – 4 dB(A) due to atmospheric absorption]. Thus all noise sources with sound-power emission levels less than 122 dB(A) [87 + 35 dB(A)] would be expected to meet the 35 dB(A) criterion. Since the mill will almost certainly be more than 1 dB(A) quieter than the 123 dB(A) that was measured for the much larger Olympic Dam mill it can be concluded that the project would comply with the criteria during the day.

At night, the overall attenuation of noise along the propagation path to the nearest residence would be up to 10 dB(A) less, and sound power emission levels would need to be equal to or lower than 112 dB(A) in order to comply with the criterion of 35 dB(A) at the nearest residence.

In practice, all equipment, apart from the mill, the excavator and the drill would be expected to comply (see **Table 5**). The excavator and drill would operate in the pit most of the time and in practice shielding from the pit would allow these items to comply. The mill however would need to be acoustically treated, or otherwise controlled to achieve a sound power emission level of 113 dB(A) or less. This is 10 dB(A) less than the estimated emission level of the untreated mill (based on the Olympic dam mill). Note daytime operations would not need this reduction.

6.2 Reversing horns

Some equipment such as bulldozers, trucks and other earthmoving equipment will be fitted with reversing horns. Because of the tonal and repetitive nature of the noise emissions from these the assessment criteria is lower than 35 dB(A). A penalty of 5 to 10 dB(A) is imposed for assessment purposes. This makes the assessment criterion for these type of noise 25 to 30 dB(A) at the closest residence. Standard reversing alarms, which typically have a sound power level of 115 dB(A), would almost certainly give rise noise impacts at night over distances of 2 km and further. However, if smart alarms, which reduce noise emissions, depending on background noise conditions, and use a less tonal sound are used, then the effect of the alarms can be significantly reduced.

6.3 Air Quality

The estimated emission rate of TSP from the mine is 250 t/year (see section 5.2) or (or 8 g/s). This is a modest emission rate and can be compared with mines of much higher emission rates, for example open cut coalmines in the Hunter Valley in NSW. When operating with a buffer zone of 2 km or so these mines are able to comply with the ambient air quality criteria referred to in **Section 4.2**.

To ensure that emissions from the mine fall into the range relevant for metalliferous mines with "good" controls it is useful to list the controls required. These are as follows:

1. Exposed areas susceptible to wind erosion should be kept to the smallest area practicable;
2. Trafficked areas should be clearly defined and management practices should be in place to ensure that vehicles keep to official roadways and travel at appropriate speed and that such areas are kept in a damp condition;
3. Drills should be operated with dust controls;
4. Blast holes should be stemmed with aggregate or appropriate material to reduce dust emissions;
5. Water spays should be used at all transfer points where dry material is transferred including the dump hopper, but normally this would exclude truck-loading in the pit, or dumping to ore or waste stockpile;
6. The crusher should be enclosed;
7. Conveyors and conveyor transfer points should be enclosed or shielded from the wind, and;
8. If dry grinding takes place, it should be controlled using bag filters.

7 CONCLUSIONS

The proposed operations of the Browns Project have been reviewed with a view to determining likely noise and air quality impacts. It is concluded that noise impacts will be able to be controlled to a level that would meet the assessment criteria that would apply to similar mines in NSW provided that the mill was controlled so that its sound power level did not exceed 113 dB(A) and smart alarms are used on items of mobile plant that are required to use alarms for safety reasons. It is likely that some acoustical treatment or acoustic shielding of the mill would be required to achieve this.

Relevant assessment criteria for dust should be relatively easy to meet provided standard dust control techniques, which meet contemporary standards for mines in Australia, are adhered to. The types of controls and management practices that need to be adopted are discussed in **Section 6.3**.

8 REFERENCES

AS 2436-1981
"Guide to Noise Control on Construction, Maintenance and Demolition Sites" Published by the Standards Association of Australia, Standards House, 80 Arthur Street, North Sydney, NSW 2065.

NEPC (1998)
"Final Impact Statement for Ambient Air Quality National Environment Protection Measure" National Environment Protection Council Service Corporation, Level 5, 81 Flinders Street, Adelaide SA 5000.

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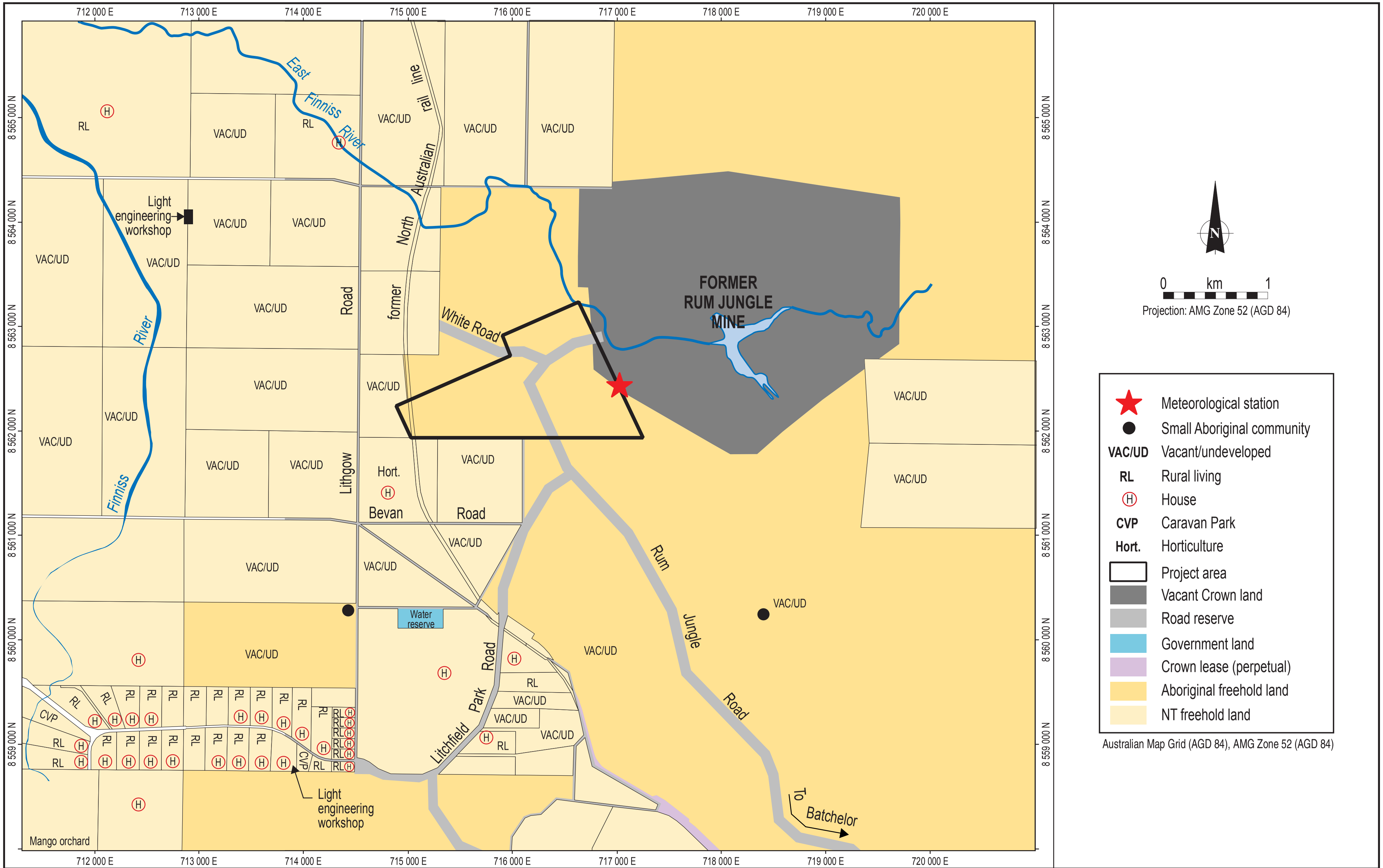
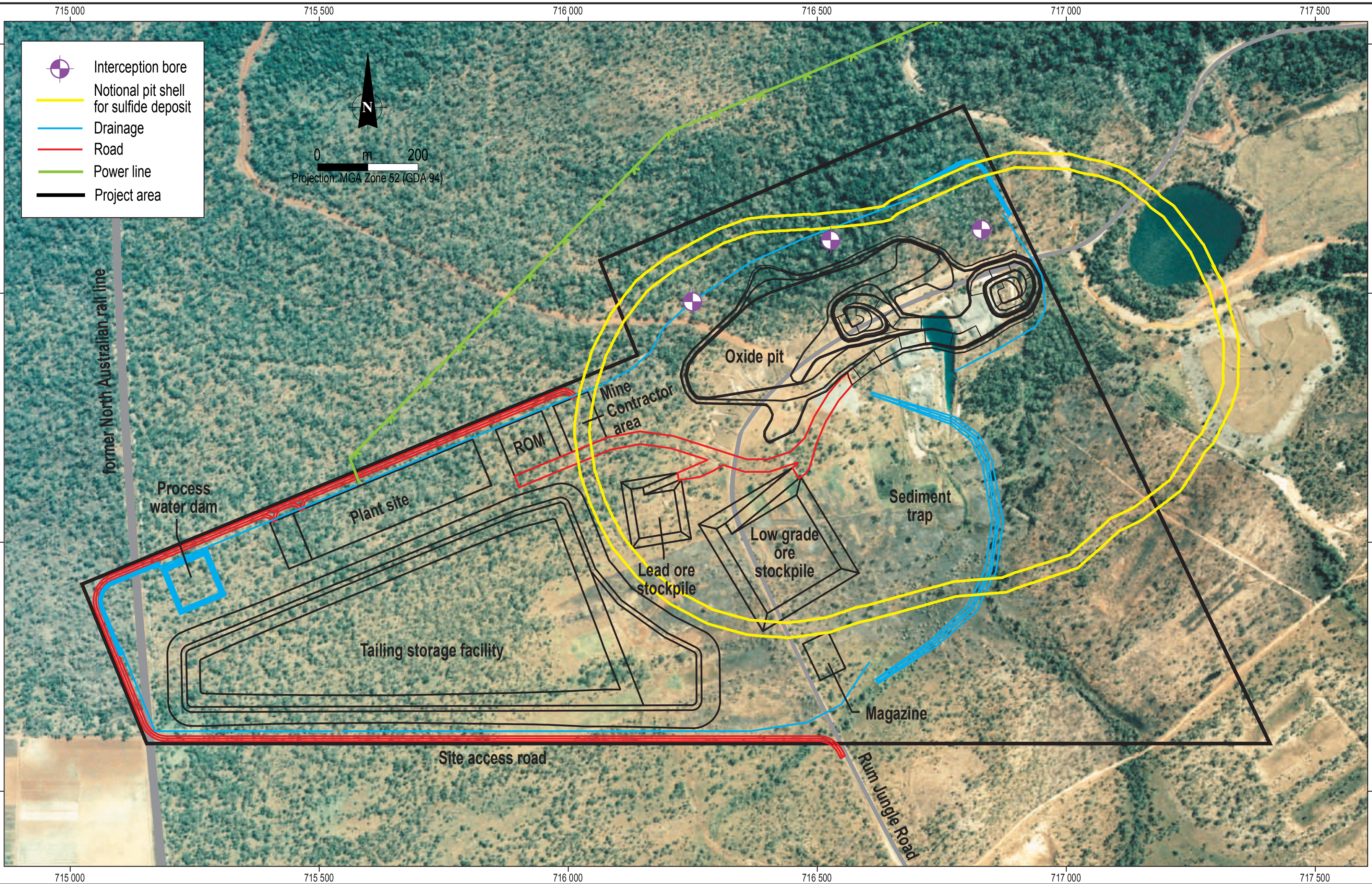
NSWMC (2000)
"Technical Paper, Particulate Matter and Mining Interim Report" Prepared by NSW Minerals Council, Level 13, Elizabeth Street, Sydney, NSW 2000.

NSW EPA (2001)
"Approved Metyhods and Guidance For the Modelling and Assessment of Air Pollutants in New South Wales" New South Wales EPA 59-61 Goulburn Street, Sydney, NSW 2000. (Available www.epa.nsw.gov.au/air/amgmaap.pdf/).

FIGURES



enesar	Job No: 836 File No: 836_8_App01_F001_HB	Compass Resources NL Browns Oxide Project	Layout of mine and neighbouring residences	Figure No: 1



N.B Sulfide deposit not part of the Browns Oxide Project. Pit shell is indicated as it impacted placement of project components.	enesar people and place	Job No: 836 File No: 836_8_App01_F002_HB	Compass Resources NL Browns Oxide Project	Layout of infrastructure	Figure No: 2

Annual and seasonal windroses for Compass Resources NL meteorological station (11 July 2000 to 10 July 2001)

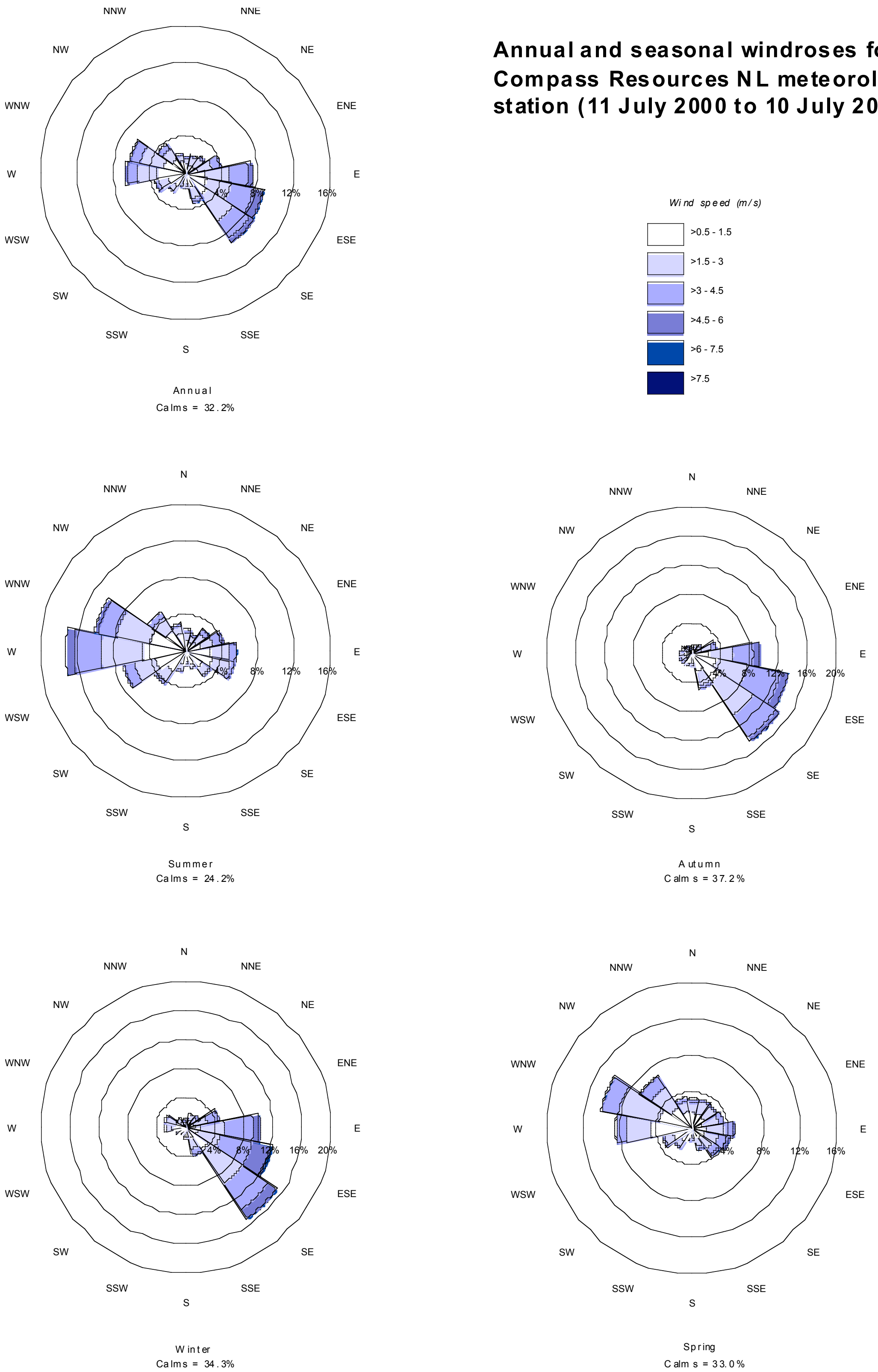


Figure 3