BIG ISLAND MINING PTY LTD

ABN 12 112 787 470

Dargues Reef Gold Project

NOISE AND BLASTING Assessment

Prepared by

Spectrum Acoustics Pty Limited

SEPTEMBER 2010

Specialist Consultant Studies Compendium
Volume 1, Part 1

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NOISE AND BLASTING Assessment

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EXECUTIVE SUMMARY

A Noise and Blasting Assessment of the proposed Dargues Reef Gold Project ("the Project"), located approximately 13km to the south of Braidwood, NSW, has been conducted.

The assessment is based on or refers to the following standards, policies, guidelines and documents.

- DECCW NSW Industrial Noise Policy (INP, 2000).
- DECCW Environmental Criteria for Road Traffic Noise (ECRTN,1999).
- Interim Construction Noise Guideline (DECC, 2009).
- ANZECC Technical basis for guidelines to minimise annoyance due to blast overpressure and ground vibration (2000).
- Traffic Impact Assessment (TIA) for the Dargues Reef Gold project, Transport and Urban Planning (2010).
- US EPA document No. 550/9-74-004 "Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974".

A brief summary of essential data, results and recommendations arising from this assessment is as follows.

NOISE AND VIBRATION CRITERIA

Noise and vibration criteria for the various components of the project are as follows.

Site Noise

In accordance with advice from the Department of Environment, Climate Change and Water an initial "construction" period during which elevated noise criteria may be applicable has not been considered for this project. Consequently, all stages of the project have been considered as operations in terms of setting noise emission criteria.

A site noise criterion of **35 dB(A),$L_{eq(15\ minute)}$** applies at all non Project-related residences at all times. This is the lowest 'intrusiveness' criterion applicable under the INP.

Blast Overpressure and Vibration

These criteria are summarised as follows.

- The recommended maximum overpressure level for blasting is 115dB.
- The level of 115dB may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120dB at any time.
- The recommended maximum vibration velocity for blasting is 5mm/s Peak Vector Sum (PVS).
- The PVS level of 5mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10mm/s at any time.
- Blasting should generally only be permitted during the hours of 9am to 5pm Monday to Saturday, and should not take place on Sundays and Public Holidays.

Blasting should generally take place no more than once per day.

Sleep Disturbance

The sleep disturbance criterion applicable for the Project at each non Project-related residence is equal to **45dB(A),$L_{1(1\text{-minute})}$** during the hours 10pm – 7am.

Off-site Traffic

Traffic noise criteria, drawn from the ECRTN, are as follows.

Type of Development	Recommended Criteria – dB(A)	
	Day (7.00am to 10.00pm)	**Night (10.00pm to 7.00am)**
11. Land use developments with potential to create additional traffic on existing local roads.	$L_{Aeq(1hr)}$ 55	$L_{Aeq(1hr)}$ 50

SUMMARY OF PREDICTED IMPACTS

Site Establishment Noise

The following two site establishment scenarios were considered.

1. Night-time building fabrication with associated lighting plants and generator sets, on-site vehicle movements and other low noise activities.

2. The activities nominated in (1) above plus bulk earthworks associated with construction of the box cut, ROM Pad and Tailings Storage Facility.

Noise levels below the site noise criterion have been predicted at all assessed residential receivers for the daytime and night-time site establishment scenarios. INP “modifying factor” corrections for annoyance characteristics such as tonality, intermittency and low-frequency noise have been found not to apply during either the site establishment or operational stages of the project.

Operational Noise

The main finding from the assessment was that targeted noise attenuation measures would need to be applied to several major noise sources in order for the noise criteria to be achieved. The noise controls recommended, and incorporated in noise modelling, include the following.

- Processing plant crusher. Contain within a shed engineered to achieve minimum 12 dB noise reduction (nominally $Rw + C_{tr} = 15$).
- Ventilation fan. Placed at least 10m below ground level rather than at the surface.
- ROM pad. Construct waste rock noise bunds 5m high along the southern and western edges.

Blast Overpressure and Vibration

Noise levels below the blasting criteria have been predicted at all assessed residential receivers, provided maximum instantaneous charge weights (MIC) are kept below 105 kg.

Sleep Disturbance

Noise levels below sleep disturbance criteria have been predicted at all assessed residential receivers.

Off-site Traffic

Noise levels below the traffic noise criteria have been predicted at all assessed residential receivers.

NOISE COMPLIANCE MONITORING

It is recommended that noise compliance monitoring is undertaken during both the daytime and night time periods of the site establishment phase. Routine noise compliance monitoring should then be conducted on a quarterly basis at least during the first two years of the operational stage of the Project. Suitable monitoring locations would include R107, R31, R30, R27 and R34. These locations generally are the closest and surround the Project Site so that compliance at these locations would imply compliance at more distance receivers. Appropriate noise monitoring data must be collected to enable assessment of “modifying factor” corrections as defined in Chapter 4 of the INP.

In summary, the noise and blasting assessment has determined that the Project could operate in compliance with the relevant noise and vibration criteria provided the recommendations contained in this report are implemented.

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1. INTRODUCTION

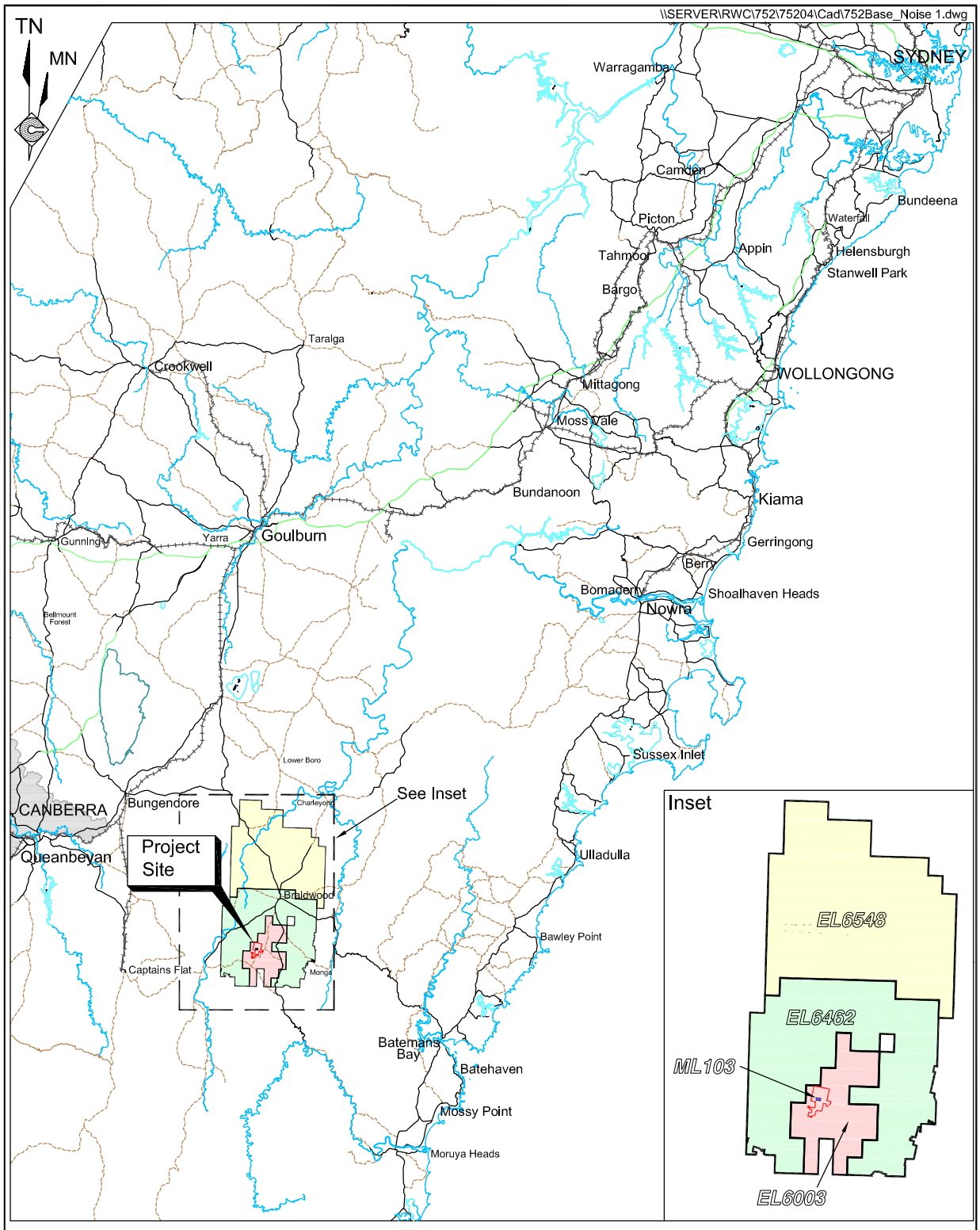
Big Island Mining Pty Ltd ("the Proponent") proposes to construct and operate the Dargues Reef Gold Project ("the Project") located approximately 13km to the south of Braidwood, NSW (**Figure 1**). The Project would comprise an underground gold mine, a processing plant, a temporary waste rock emplacement and a Tailings Storage Facility, as well as ancillary activities and associated infrastructure.

The Project is considered a Major Project under *State Environmental Planning Policy (Major Projects 2005)* and therefore the Minister for Planning is the consent authority. This Noise and Blasting Assessment has been prepared in accordance with relevant Department of Environment, Climate Change and Water (DECCW) and Department of Planning (DoP) guidelines for inclusion in an Environmental Assessment of the Project.

2. PROJECT DESCRIPTION

The Project would include the following components (**Figure 2**).

- Extraction of waste rock and ore material from the Dargues Reef deposit using underground sublevel open stope mining methods with a suitable crown pillar to prevent surface subsidence.
- Construction and use of surface infrastructure required for the underground mine, including a box cut, portal and decline, magazines, fuel store, ventilation rise and power and water supply.
- Construction and use of a processing plant and office area which would include an integrated Run-of-Mine (ROM) pad/temporary waste rock emplacement, crushing and grinding, gravity separation and floatation circuits, Proponent and mining contractor site offices, workshop, laydown area, ablutions facilities, stores, car parking, and associated infrastructure.
- Construction and use of a Tailings Storage Facility.
- Construction and use of a water management system, including construction and use of eight dams and associated water reticulation system, to enable the harvesting and supply of water for mining-related operations. It is noted that the proposed water harvesting operations would be consistent with the Proponent's harvestable right.
- Construction and use of a site access road and intersection to allow site access from Majors Creek Road.
- Transportation of sulphide concentrate from the Project Site to the Proponent's customers via public roads surrounding the Project Site using covered semi-trailers.
- Construction and use of ancillary infrastructure, including soil stockpiles, core yards, internal roads and tracks and surface water management structures.
- Construction and rehabilitation of a final landform that would be geotechnically stable and suitable for a final land use of nature conservation and/or agriculture.



Note: A colour version of this Figure is available on the Project CD

Figure 1
LOCALITY PLAN

\\SERVER\RWC\752\75204\Cad\752EA_Noise 2.DWG

TN
MN

See Detail Right
Site Access Road
Tailings Storage Facility
Tailings Storage Facility Access Road
Ventilation Rise
Spring Creek
Existing Site Access Track (to be decommissioned)
Majors Creek Road

Detail
Proponent & Mining Contractor Offices
Concentrate Storage
Gold Room
Floatation Tanks
Raw Water
Reagent & Other Storage
Concentrator
Crushing & Grinding Circuit
Processing Plant Office Area
+ 692
Water Supply Tanks
ROM Pad
+ 705
Sub-station
Settling Dam
Temporary Waste Rock Emplacement
Fuel Bay
Core Yard
Lay Down Yard
Workshop
Box Cut

SCALE 1:4 000
50 0 50 100 150 200 m

See Detail Left

REFERENCE
- Project Site Boundary
- Contour (m AHD)(Interval = 5m)
- Contour (m AHD)(Interval = 10m)
- + 692 Spot height (m AHD)
- Creek / Drainage Line
- Sealed Road
- Unsealed Road
- Existing Dam/Water Storage
- Proposed Settling Dam
- Proposed Harvestable Rights Dam (Indicative Location)
- Catchment Boundary
- Existing Transmission Line
- Proposed Transmission Line
- Proposed Pipeline (Indicative)
- Proposed Road/Track (Sealed/Unsealed)
- Fence (note: fences not co-incident with cadastral boundaries)

SCALE 1:8 000
100 0 100 200 300 400 m

Base Map Source: Geo-spectrum (Australia) Pty Ltd

Figure 2
INDICATIVE MINE SITE LAYOUT

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It is noted that during the life of the Project the Proponent proposes to undertake additional exploration drilling to further define identified mineralisation and identify additional mineralisation. Extraction of those resources does not form a part of this application. As a result, a subsequent application for approval to extract any identified resources may be prepared once sufficient information is available to adequately identify the proposed activities.

3. DESCRIPTION OF TERMS

3.1 SCOPE

This section of the report aims to convey an understanding of several commonly used acoustical terms. Various terms are explained in plain language and the effects of certain atmospheric phenomena on noise propagation are discussed. Noise level percentiles are explained with the aid of a diagram of a hypothetical noise signal.

The descriptions in this section are not formal definitions of the terms. Formal definitions may be found in AS1633-1985 “Acoustics – Glossary of terms and related symbols”.

3.2 GENERAL TERMS

Sound Power Level

The amount of acoustic energy (per second) emitted by a noise source. Usually written as “Lw” or “SWL”, the Sound Power Level is expressed in decibels (dB) and cannot be directly measured. Lw is usually calculated from a measured sound pressure level.

Sound Pressure Level

The “noise level”, in decibels (dB), heard by our ears and/or measured with a sound level meter. Written as “SPL”, the sound pressure level generally decreases with increasing distance from a source. Noise levels are often written as dB(A) rather than dB. The “A-weighting” is a correction applied to the measured noise signal to account for the ear’s ability to hear sound differently at different frequencies. For example, 40dB at 500Hz (speech frequency) is clearly audible but 40dB at 50Hz (very low bass) would be far less audible. The A-weighted sound pressure level therefore represents the measured (or predicted) noise level as it would be heard by the typical human ear.

Temperature Inversion

An atmospheric state in which the air temperature increases with altitude. Sound travels faster in warmer air than in cold air, so that during an inversion the top of a “sound wave” would move faster than the bottom. This bends (refracts) sound back towards the ground just as light bends upon entering and exiting a glass prism. The result is a “trapping” of sound energy near the ground and an increase in noise levels.

Wind Shear

A moving air mass would experience a "friction drag" at the ground in much the same way as a lava flow would flow quickly on top and "roll over" the lava beneath which must drag along the ground. This increasing wind speed with altitude is called "wind shear".

For a sound wave travelling down wind, the top of the wave moves faster than the bottom and the wave bends towards the ground. However, for a wave travelling into the wind the top of the wave is slowed down more than the bottom is and the wave bends upwards. **Figure 3** shows several examples of how atmospheric effects can bend sound waves.

Figure 3 Sound refraction under temperature and wind gradients

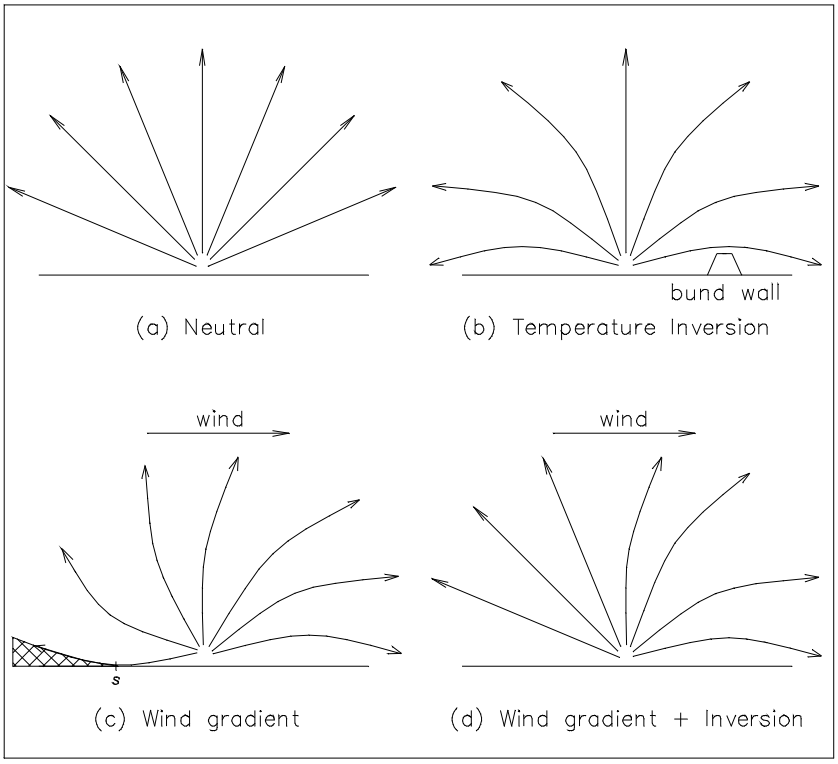


Figure 3 shows that sound rays can be refracted over a barrier (usually a bund wall or small hill) during a temperature inversion, increasing noise levels in the 'shadow zone'.

Neutral Atmospheric Conditions

An atmosphere that is at a temperature of approximately 23°C from ground level to an altitude of 200m or more. There are no fluctuations in density or humidity and no wind. Such conditions rarely occur, as temperature would usually vary with altitude and there is always movement in various directions in different layers of the atmosphere.

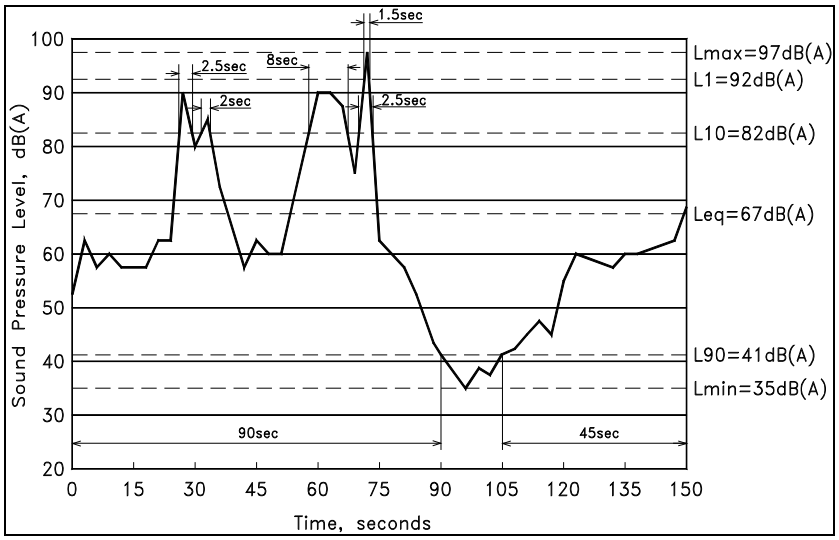
Adverse Atmospheric Conditions

Atmospheric conditions (with regards to potential effects on noise propagation) which are characteristic of the study area. These would typically include seasonal wind directions and velocities (up to 3m/s). Temperature inversions would be included as prevailing if they occur, on average, for more than 2 nights per week in winter.

3.3 NOISE LEVEL PERCENTILES

A noise level percentile (L_n) is the noise level (SPL) in decibels which is exceeded for "n" % of a given monitoring period. Several important L_n percentiles would be explained by considering the hypothetical time signal in **Figure 4**.

Figure 4 Hypothetical time-trace of 150-second sound signal



The signal in **Figure 4** has a duration of 2.5 minutes (ie. 150 seconds) with noises occurring as follows.

- The person holding the instrument is standing beside a road and hears crickets in nearby grass at a level of around 60dB (A).
- At about the 30 second mark a motorcycle passes on the road, followed by a car.
- At 60 seconds a truck passes.
- After the truck passes it sounds its air horn at the 73 second mark.
- The crickets are frightened into silence and the truck fades into the distance.
- All is quiet until 105 seconds when the crickets slowly start to make noise, reaching full pitch by 120 seconds.
- The measurement stops at 150 seconds, just when an approaching car starts to become audible.

L_1 Noise Level

Near the top of **Figure 4**, there is a dashed line at 92dB(A). A small spike of 1.5 seconds duration extends above this line at around 73 seconds. Since 1.5 seconds is 1% of the signal duration (150 seconds), the L_1 (or L_{A1} to signify A-weighting) noise level of this sample is 92dB(A). The L_1 percentile is often called the *average peak noise level* and is used by the NSW Department of Environment Climate Change and Water[1] (DECCW) as a measure of potential disturbance to sleep.

[1] Formerly Environment Protection Authority, EPA.

L_{10} Noise Level

The dashed line at 82dB(A) is exceeded for four periods of duration 2.5 seconds, 2 seconds, 8 seconds and 2.5 seconds, respectively. The total of these is 15 seconds, which is 10% of the total sample period. Therefore, the L_{A10} noise level of this sample is 82dB(A). The L_{10} percentile is called the *average maximum noise level* and has been widely used as an indicator of annoyance caused by noise.

In similar fashion to L_1 and L_{10}, **Figure 4** shows that the noise level of 41dB(A) is exceeded for 135 seconds (90 + 45 =135). As this is 90% of the total sample period, the L_{A90} noise level of this sample is 41dB(A). The L_{90} percentile is called the *background noise level*.

L_{eq} Noise Level

Equivalent continuous noise level. As the name suggests, the L_{eq} of a fluctuating signal is the continuous noise level which, if occurring for the duration of the signal, would deliver equivalent acoustic energy to the actual signal. L_{eq} can be thought of as a kind of 'average' noise level. Recent research suggests that L_{eq} is the best indicator of annoyance caused by industrial noise and the DECCW *NSW Industrial Noise Policy* takes this into consideration.

L_{max} and L_{min} Noise Levels

These are the maximum and minimum SPL values occurring during the sample. Reference to **Figure 4** shows these values to be 97dB(A) and 35dB(A), respectively.

4. THE EXISTING ENVIRONMENT

4.1 INTRODUCTION

The existing meteorological and acoustic environments have been reviewed to determine appropriate noise criteria at assessed receivers and meteorological conditions relevant to the study area. A summary of the relevant information is included below.

4.2 METEOROLOGY

Meteorological data recorded on the Project Site during the period March 2009 to March 2010 were analysed by PAEHolmes, an air quality consultancy specialising in dispersion modelling and impact assessment. The data contained in Sections 4.2.1 to 4.2.3 represents the most significant with respect to noise propagation within and surrounding the Project Site.

4.2.1 Relative Humidity

Atmospheric absorption of mid to high frequency sound is strongly dependent upon Relative Humidity (RH), with absorption generally inversely proportional to RH. Relative humidity varies around an average value of 70% under calm daytime conditions at 20^0C. Higher RH is experienced when the temperature drops and a value of 85% RH was adopted for modelling under cooler conditions.

4.2.2 Temperature Inversions

In accordance with the INP, temperature inversions are assessable if they occur for more than two nights per week during winter months. This corresponds to 4.1% of the total time in one year. Section E4 of the INP considers night-time to be from 6pm to 7am for the purposes of assessing inversions using the sigma-theta approach. Temperature inversions ranging from 1.5^0C/100m to 4^0C/100m correspond to a Pasquill-Gifford Stability Category (referred to as 'Category' hereafter) of F. Inversions stronger than 4^0C/100m correspond to Category G.

Analysis of sigma-theta data conducted by PAEHolmes (2010) has found that the combined occurrence of Category F and G stability was 4.4% of the time during the period March 2009 to March 2010. Given that ground level nocturnal inversions (as opposed to higher altitude subsidence inversions) are generally understood to be a night-time phenomenon during the cooler months, it is possible that inversions could occur above the INP threshold level of two nights per week during winter. Consequently, temperature inversions have been considered in this assessment without further detailed analysis of the meteorological data. A value of 4^0C/100m (ie, the upper limit for Category F stability) has been adopted in the noise modelling.

4.2.3 Winds

Wind roses provided by PAEHolmes (2010) (Appendix D) show winds almost exclusively from the northwest ($\pm$ 45^0) during winter and generally from the north-northwest and south-southeast during other seasons. The majority of all winds are at speeds in excess of 4.5 m/s. The wind roses have been analysed to determine the percentage occurrence of wind components up to 3 m/s from each direction (including data from $\pm$ 45^0) for each of the day, evening and night periods in each of the four seasons.

The INP requires assessment of winds from a given direction if the combined vector components up to 3 m/s from this direction occur for at least 30% of the time in any season and time period (day, evening or night). The analysis of Appendix D shows that low speed (up to 3 m/s) winds do not occur frequently during the day and evening. However, winds up to 3 m/s from the NNW occurred for at least 30% of the time at night during autumn, winter and spring. A wind speed of 3 m/s at 10m above ground level has been adopted in the modelling of night time winds during these seasons.

Typical calm daytime conditions of no wind, 70% RH and -1^oC/100m vertical temperature gradient (ie. dry adiabatic lapse rate, DALR) was also modelled to represent typical daytime noise levels.

4.3 ASSESSED RECEIVERS

Table 1 lists the non-project related residences considered in this assessment with the name of the property owner and the numbering used in this assessment to locate the residence in relation to the Project Site (see **Figure 5**).

Table 1
Non-Project-related Residences

Land Ref	Residence Ref	Lot/DP	Landowner
3	R34	98/755934	Reference not held
7	R31	1/136801, 2/136801, 3/755934, 82/755934, 83/755934, 95/755934, 113/755934, 114/755934, 141/755934, 143/755934	P. & L. Matthias
8	R24	1/199645, 2/199645	S.J. Redden
13	R58	14/27/758636	N.V. Harrington
16	R55	17/27/758636	Reference not held
17	R54	9/31/758636	A.D. & M.S. Phillips
18	R53	2/31/758636	Mangold Investments (NSW) Pty Ltd
21	R59	20/27/758636	L.G. Delamont
25	R21, R71, R72	8/27/758636	Reference not held
29	R60	1/42/758636, 2/42/758636, 3/42/758636, 4/42/758636, 5/42/758636,	R.A. & J.A. South McKenzie
33	R61	5/15/758636, 6/15/758636	A. & C.W.Y.H. Brace & R. Mahncke
39	R44	6/6/758636, 7/9/758636	B.D. & G.B.L. Hayes
40	R45	8/6/758636	A.A. Casey
41	R40	A/336039	N. Tetley & S.L. Buchanan
42	R39	1/665110	B. Sheridan & J. McIntyre
44	R43	1/39/758636, 2/39/758636	S.P. & K.A. Junor
46	R84	6/877483	W.H. & J.F. Butcher
47	R85	5/877483	L.J. Stinson
48	R86	4/877483	R.M. Grant & M. Allatt
49	R87	3/877483	S.L. Bennett
50	R88	1/877483, 2/877483	B.R. Doherty & N.L. Watts
51	R91	23/1004205	M.J. Franz
52	R64	5/13/758636, 5A/13/758636, 6/13/758636, 7/13/758636, 7A/13/758636,	A.H. & C.E. Struzina
53	R65	4/13/758636, 4A/13/758636	K. Angel
54	R66	33/1012809	R. & E.P. Blakely-Kidd
55	R67	2/13/758636	N.L. Amey
56	R68	1/13/758636	J.L. & C.A. Corcoran
57	R63	2/17/758636	J.T. & C.M. Bowman
61	R94	1/18/758636, 2/18/758636, 3/18/758636, 7/18/758636	M.A. Ross
62	R93	4/18/758636, 5/18/758636, 5A/18/758636, 1/26/758636	Star Buttons Enterprises Pty Ltd
64	R70	1/40248, 11/15/758636, 1/16/758636, 2/16/758636,	S.M. McCarron
68	R19	8/1068558	A.P. Dann
71	R20	5/1068558	A. & M.Z. Page
72	R6	1/797719	B. Carruthers
73	R7	253/755934	A.K. & N. Riley
74	R2	3/842928, 6/842928, 7/842928, 8/842928, 45/872802	D.B.R. & B.A. Messum
75	R16	11/709905, 9/735425, 10/735425, 1/986527	L.T. & P.S. Ruzicka

Table 1 (Cont'd)
Non-Project-related Residences

Land Ref	Residence Ref	Lot/DP	Landowner
76	R17	1/831229, 2/831229	B. McDonald
77	R18	14/842928, 1/859129	G. Gibson
78	R23	4/1068558	M.L. Cathro
79	R22	3/1068558	P.J. & L.J. Cram
86	R9	247/755934, 15/22/758636, 16/22/758636, 17/22/758636, 18/22/758636	William Edmund Waterhouse
87	R10	5/21/758636, 6/21/758636	Sarah Elizabeth Vella
88	R11	2/53/758636, 9/53/758636	G.E. & L.H. Ison
89		21/720161	L.A. & G.M. Baillie
90	R13	13/24/758636, 14/24/758636, 15/24/758636, 16/24/758636, 17/24/758636, 18/24/758636, 19/24/758636, 20/24/758636, 21/24/758636, 22/24/758636, 23/24/758636, 24/24/758636	B. Vugec
93	R14	65/755934, 67/755934, 191/755934, 216/755934	D.K. & D.M. Wood
94	R12	163/755934, 164/755934	S, P, P, W & J. Cootes
95	R15	125/755934, 212/755934	M. Flakelar & J. Holmes
96	R32, R36	211/755934	B. Crittenden
98	R29	1/194317, 66/755934, 210/755934	B. & C. James
99	R1	93/755934, 166/755934	M. Toner & R. Manderson
106	R26,R27, R28 & R30	104/755934	Reference Not Held

5. NOISE AND VIBRATION CRITERIA

5.1 INTRODUCTION

This section of the report summarises the noise and vibration criteria for potentially affected non Project-related residences. Components of the Project for which criteria are derived include site activities (including on-site vehicle movements), blasting and off-site traffic on public roads.

In accordance with advice from DECCW an initial "construction" period during which elevated noise criteria may be applicable has not been considered for this Project. Consequently, all stages of the Project have been considered as operations in terms of setting noise emission criteria.

5.2 SITE NOISE CRITERIA

The INP specifies two noise criteria:

- an *intrusiveness criterion* which limits L_{Aeq} noise levels from the industrial source to a value of 'background plus 5dB';and
- an *amenity criterion* which aims to protect against excessive noise levels where an area is becoming increasingly developed.

Since there is no existing major industry dominating noise levels at any residences near the Project Site, and road traffic noise is not continuous, only the intrusiveness criteria were considered in setting a Project-specific operational noise limit of **35dB(A),$L_{eq(15\text{-}minute)}$** (day, evening and night) at all non Project-related residences. This is the lowest intrusiveness criterion that can be established under the INP and assumes the default minimum background L_{90} noise level of 30dB(A).

5.3 BLASTING CRITERIA

5.3.1 Annoyance Criteria

Noise and vibration levels from blasting are assessable against criteria proposed by the Australian and New Zealand Environment and Conservation Council (ANZECC) in their publication *"Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990"*.

These criteria are summarised as follows.

- The recommended maximum overpressure level for blasting is 115dB.
- The level of 115dB may be exceeded for up to 5% of the total number of blasts over a 12 month period, but should not exceed 120dB at any time.
- The recommended maximum vibration velocity for blasting is 5mm/s Peak Vector Sum (PVS).
- The PVS level of 5mm/s may be exceeded for up to 5% of the total number of blasts over a 12 month period, but should not exceed 10mm/s at any time.
- Blasting should generally only be permitted during the hours of 9am to 5pm Monday to Saturday, and should not take place on Sundays and Public Holidays.
- Blasting should generally take place no more than once per day.

These criteria are typically adopted by the DECCW when issuing Environment Protection Licences for projects involving blasting.

5.3.2 Building Damage Criteria

Building damage assessment criteria are nominated in AS 2187.2-1993 *"Explosives – Storage, Transport and Use Part 2: Use of Explosives"* and summarised in **Table 2.**

Table 2
Blasting Criteria to Limit Damage to Buildings (AS 2187)

Building Type	Vibration Level (mm/s)	Air Blast Level (dB re 20 μPa)
Sensitive (and Heritage)	5	133
Residential	10	133
Commercial/Industrial	25	133

The annoyance (ANZECC) criteria presented in Section 5.4.1 are more stringent than the building damage criteria (**Table 2**) and would be taken as the governing criteria for the Project.

\\SERVER\RWC\752\75204\Cad\752EA_Noise 5.DWG

TN
MN

INSET A

SCALE 1:15 000
250 0 250 500

INSET B

SEE INSET A

SEE INSET B

1km

2km

SCALE 1:25 000
250 0 250 500 750 1000 1250 m

SCALE 1:10 000
100 0 100 200 300 400 500 m

REFERENCE
Project Site Boundary
Cadastral Boundary
R1 Residence & Identifier
Distance from Processing Plant

Source: Big Island Mining Pty Ltd

Figure 5
SURROUNDING RESIDENCES

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5.4 SLEEP DISTURBANCE CRITERIA

To help protect against people waking from their sleep, the DECCW recommends that 1-minute (L_{A1}) noise levels (effectively, the maximum noise level from impacts – see Section 3.3 and **Figure 4**) should not exceed the background level by more than 15dB when measured/computed at a point 1 metre from a bedroom window. The "sleep disturbance" criterion is only applicable to night-time noise emissions.

The sleep disturbance criterion applicable for this project at each non Project-related residence is equal to the intrusiveness criterion plus 10dB(A), that is, **45dB(A),$L_{1(1\text{-minute})}$**.

5.5 ROAD TRAFFIC NOISE CRITERIA

In NSW, noise from vehicle movements associated with an industrial source is assessed in terms of the INP if the vehicles are on the industrial site (the Project Site in this case). If the vehicles are on a public road, the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN) applies. The Project would produce a limited volume of heavy vehicle traffic which would access the Project Site from the north via Majors Creek Road. Majors Creek Road is assumed to be a local road in this assessment due to the low traffic flow. **Table 3** below shows ECRTN traffic noise criteria for the case where a development creates additional traffic on a local road.

Table 3
Road Traffic Noise Criteria

Type of Development	Recommended Criteria – dB(A)	
	Day (7.00am to 10.00pm)	**Night (10.00pm to 7.00am)**
11. Land use developments with potential to create additional traffic on existing local roads.	$L_{Aeq(1hr)}$ 55	$L_{Aeq(1hr)}$ 50

6. ASSESSMENT METHODOLOGY

6.1 SITE ESTABLISHMENT

The Project would require the following site establishment activities (the locations of which are identified on **Figure 2**) with the potential for noise impact on residential receivers.

1. Construction of surface infrastructure required for the underground mine, including a box cut, portal and decline, magazines, communication tower, fuel store, ventilation rise and power and water supply.
2. Construction of a processing plant and office area which would include:
    - a Run-of-Mine (ROM) pad and temporary waste rock emplacement;
    - crushing and grinding, gravity separation and floatation circuits; and
    - Proponent and mining contractor site offices, workshops, laydown areas, ablutions facilities, stores, car parking, and associated infrastructure.
3. Construction of a Tailings Storage Facility.

4. Construction of a water management system, including construction of eight dams and associated water reticulation system.
5. Construction of a site access road and new intersection with Majors Creek Road.
6. Construction of ancillary infrastructure, including soil stockpiles, core yards, internal roads and tracks and surface water management structures.

Assessment of noise was conducted using RTA Technology's *Environmental Noise Model* v3.06 (ENM). Preliminary noise modelling indicated that heavy earthworks on site would not achieve the noise criterion at several residences under inversion conditions. Consequently, site establishment activities were separated into the two scenarios described below.

Scenario 1a: 24-hour Activities

General building fabrication, associated lighting plants and generator sets were modelled under neutral (day/evening) and inversion (night time) conditions. This scenario, which also includes a small crane and vehicle movements around the Project Site, is indicative of low noise activities within the construction area of the Project Site. Sound power levels of significant site establishment noise sources are shown in **Appendix A**. Noise source locations for this scenario are illustrated in **Figure B1** in **Appendix B.**

Scenario 1b: Daytime Activities

Noise sources for this scenario comprise earthmoving machinery constructing the ROM Pad, box cut and Tailings Storage Facility, as well as the sources discussed above for the 24-hour scenario. Locations of noise sources additional to those discussed above are illustrated in **Figure B2** in **Appendix B**.

6.2 OPERATIONAL NOISE

6.2.1 Introduction

Assessment of operational noise was conducted using the ENM software. The noise sources were modelled at their known (for stationary sources such as the crushing plant) or most exposed (for mobile sources such as trucks) positions and noise contours and/or point calculations were generated for the surrounding area.

6.2.2 Noise Sources

The Project would involve the following noise generating activities, the locations of which are illustrated in **Figure B3** in **Appendix B**.

1. Continuous operation of a front-end loader (to manage stockpiles, blend the ore material and deliver it to the ROM bin), and campaign operations of a rock breaker, on the ROM Pad and temporary waste rock emplacement.
2. Movement of haul trucks between the box cut and the ROM Pad / temporary waste rock emplacement.
3. Processing operations including:
   - a crushing and screening circuit;

- a primary ball mill for grinding; and
- a gravity circuit (comprising a feed screen and centrifugal concentrator) and flotation circuit (where the concentrate and tail streams are separated and the concentrate is directed to a regrind circuit and the tails dewatered via a thickener prior to transfer to the Tailings Storage Facility).

4. Operation of equipment at the Tailings Storage Facility including water pumps, haul trucks and miscellaneous mobile equipment required to progressively lift and maintain the Tailings Storage Facility.
5. Transport of the gold concentrate from the processing area to Majors Creek Road (via semi-trailer).
6. Miscellaneous operations on the Project Site, including:
   - equipment maintenance within laydown areas and workshops; and
   - light vehicles movements to / from, and around the Project Site.

Preliminary modelling was undertaken to predict unmitigated (without noise controls or attenuation) noise levels likely to be received at surrounding residences. The results of this modelling predicted excessive noise levels at some receivers largely related to the operation of the crushing and screening plant, operations on the ROM Pad and the Ventilation Fan. The noise attenuation required to achieve compliance with noise criteria would involve the acoustic treatments as follows.

- Processing plant crusher. Contain within a shed engineered to achieve minimum 12 dB noise reduction (nominally Rw + Ctr = 15).
- Ventilation fan. Place at least 10m below ground level rather than at the surface.
- ROM pad. Construct waste rock noise bunds 5m high along the southern and western edges.

The Proponent has committed to implementing these noise controls and these were subsequently included in a second round of noise modelling. The noise model results presented later in the report assume the implementation of these noise controls.

6.2.3 Modelled Scenario

The noise generating activities were modelled (including the nominated noise controls as described in Section 7.2.2). The source locations for each noise generating activity are illustrated in **Figure B2** in **Appendix B**.

As discussed in Section 4.2, modelling was conducted for the following atmospheric conditions.

- *Daytime lapse:* 20^0C, 70% relative humidity (RH), no wind, -1^oC/100m vertical temperature gradient (dry adiabatic lapse rate, DALR).
- *Inversion:* 5^0C, 85% R.H., inversion strengths of +4^oC/100m.
- *Night-time wind*: 5^0C, 80% R.H., wind speed 3 m/s from the NNW.

6.3 SLEEP DISTURBANCE

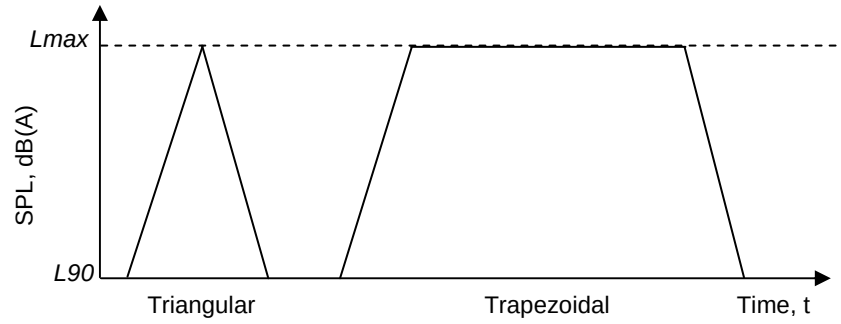
A potential for sleep disturbance would occur during operations within the ROM due to general impact noise from the breaker, front end loader and haul trucks. These sources would produce higher maximum noise levels than the night time site establishment scenario and is considered worst case in terms of potential sleep disturbance impacts. Sound power levels of modelled L_{Amax} noise sources (as an estimation of $L_{A1(1\text{-}min)}$ levels) are shown in **Appendix A**. Impact noise was modelled using the ENM program under neutral and inversion conditions discussed in Section 4.2.

6.4 ROAD TRAFFIC

Additional road traffic generated by the Project will be of an intermittent rather than constant nature. There are many methods available for calculating the cumulative noise impact arising from intermittent signals of various shapes. The methodology employed in this assessment was sourced from the US Environmental Protection Agency document No. 550/9-74-004 *"Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974".*

The document refers to 'triangular' and 'trapezoidal' time signals, which are illustrated in **Figure 6**. A triangular time signal rises from the background level to a peak noise level and then immediately begins to subside. A trapezoidal time signal rises from the background level to a maximum level and sustains that level for a period of time before subsiding.

Figure 6 Triangular and trapezoidal time signals



Road traffic on Majors Creek Road generated by the Project would be intermittent rather than constant with each passing vehicle approximated by a triangular time signal. The value of L_{eq},T for a series of triangular time patterns having maximum levels of L_{max} is given by **Equation 1.**

$$L_{eq},T = L_b + 10\log\left[1+\frac{n\tau}{T}\left(\frac{10^{\frac{\Delta L}{10}}-1}{2.3}-\left(\frac{\Delta L}{10}\right)\right)\right] \quad (1)$$

where,

L_{max} = maximum vehicle noise at residence, dB(A)

L_b = ambient equivalent noise level, dB(A)
ΔL = L_{max} - L_b
T = assessment period (minutes)
τ = "10dB-down" duration per vehicle, and
n = number of vehicles during assessment period.

6.5 BLASTING

The following sections provide standard equations for predicting blast overpressure and ground vibration levels, sourced from the United States Bureau of Mines.

6.5.1 Blast Overpressure

Unweighted air blast overpressure levels (OP) are predicted from **Equation 2** below.

$$OP = 165 - 24(\log_{10}(D) - 0.3 \log_{10}(Q)), \quad \text{dB} \qquad (2)$$

where D is distance from the blast to the assessment point (m) and
Q is the weight of explosive per delay (kg).

Analysis of blast data from several coal mine in the Hunter Valley has shown Equation 1 to underestimate overpressure levels by up to 3 dB for small blasts (MIC 100-400kg) and overestimate by 1 dB for larger blasts (MIC > 400kg). Given the small MIC values likely to be utilised a 3 dB correction has been applied to Equation 1.

6.5.2 Blast Vibration

The basic equations for calculation of peak particle vibration (PPV) levels from blasting are as follows:

$$PPV = 1140\left(\frac{D}{Q^{0.5}}\right)^{-1.6} \text{, mm/s (for average ground type)} \qquad (3)$$

$$PPV = 500\left(\frac{D}{Q^{0.5}}\right)^{-1.6} \text{, mm/s (for hard rock)} \qquad (4)$$

where D and Q are defined as in Equation 2. The site geology indicates particularly hard ground and Equation 4 will be applied.

7. IMPACT ASSESSMENT

7.1 INTRODUCTION

This section of the report presents predicted noise and vibration levels and provides mitigation recommendations where criterion exceedances are predicted. In all tables of results that follow, any predicted exceedances of the relevant criteria are highlighted in bold type.

7.2 SITE ESTABLISHMENT NOISE ASSESSMENT

7.2.1 Predicted Noise Levels – Night-time Site Establishment (Scenario 1a)

Predicted noise levels at non Project-related receivers from night-time site establishment activities are shown in **Table 4**.

Table 4
Predicted Night-time Site Establishment Noise Levels (Scenario 1a)

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$			Criterion dB(A),$L_{eq(15min)}$
	MGA (E)	MGA (N)	Neutral	Inversion	NNW wind	
R1	747879.1	6061551	<20	30	28	35
R2	748282.7	6060745	<20	26	24	35
R3	747335.2	6060881	<20	26	23	35
R4	747310	6060968	<20	26	23	35
R5	747214.7	6061290	<20	28	25	35
R6	748266.8	6060716	<20	26	24	35
R7	748276.1	6060732	<20	26	24	35
R8	748159.6	6060853	<20	23	22	35
R9	748010.1	6060909	<20	26	22	35
R10	748240.4	6061016	<20	27	24	35
R11	748102.7	6061050	20	28	25	35
R12	747864.5	6061207	23	28	26	35
R13	747765.3	6061162	22	28	25	35
R14	747807.6	6061351	<20	28	26	35
R15	747542.9	6061602	20	29	27	35
R16	748393.9	6060905	<20	27	25	35
R17	748419	6060961	<20	28	26	35
R18	748473.3	6061007	<20	28	26	35
R19	748450.8	6060826	<20	27	25	35
R20	748630.8	6060788	<20	27	24	35
R21	748730	6060750	<20	26	24	35
R22	748579.2	6060863	<20	27	25	35
R23	748542.1	6060980	<20	28	26	35
R24	748822.7	6061033	<20	28	26	35
R25	749348	6060822	<20	27	24	35
R26	749365.2	6060938	<20	27	25	35
R27	749095.3	6061420	21	30	28	35
R28	749285.8	6060974	<20	28	25	35
R29	748315.8	6061770	<20	21	<20	35
R30	748198	6061792	<20	27	29	35
R31	748149	6062512	23	35	35	35
R32	747611.8	6061880	21	31	29	35
R33	747398.7	6061798	20	30	28	35

Table 4 (Cont'd)
Predicted Night-time Site Establishment Noise Levels (Scenario 1a)

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$			Criterion dB(A),$L_{eq(15min)}$
	MGA (E)	MGA (N)	Neutral	Inversion	NNW wind	
R34	751031.3	6065138	<20	24	<20	35
R35	750004.4	6065577	<20	21	<20	35
R37	749010.6	6059938	<20	23	20	35
R38	748195.4	6059877	<20	22	<20	35
R39	748236.4	6060190	<20	24	21	35
R40	748253.6	6060213	<20	24	21	35
R41	748539.5	6059898	<20	24	20	35
R42	748409.8	6060021	<20	23	20	35
R43	748277.4	6060053	<20	23	21	35
R44	748337	6060161	<20	23	21	35
R45	748290.7	6060237	<20	24	22	35
R46	748438.9	6060091	<20	24	21	35
R47	748539.5	6060090	<20	24	21	35
R48	748527.5	6060147	<20	24	21	35
R49	748616.2	6060174	<20	24	22	35
R50	748654.6	6060141	<20	24	21	35
R51	748809.4	6059976	<20	23	21	35
R52	748982.8	6059653	<20	23	<20	35
R53	749010.6	6060221	<20	22	21	35
R54	749026.5	6060262	<20	24	22	35
R55	749017.2	6060340	<20	25	22	35
R56	748843.8	6060352	<20	25	22	35
R57	748702.2	6060373	<20	25	22	35
R58	749092.6	6060503	<20	25	22	35
R59	748981.5	6060594	<20	26	24	35
R60	748645.3	6060525	<20	25	23	35
R61	748445.5	6060472	<20	25	23	35
R62	748409.8	6060537	<20	25	23	35
R63	748284	6060493	<20	25	23	35
R64	748196.7	6060309	<20	24	22	35
R65	748200.7	6060398	<20	25	22	35
R66	748182.1	6060435	<20	25	22	35
R67	748171.6	6060467	<20	25	23	35
R68	748174.2	6060503	<20	25	23	35
R69	750679.4	6060484	<20	<20	<20	35
R70	748385.9	6060620	<20	26	24	35
R71	748845.2	6060632	<20	26	24	35
R72	748911.3	6060628	<20	26	24	35
R73	747442.4	6059728	<20	21	<20	35

Table 4 (Cont'd)
Predicted Night-time Site Establishment Noise Levels (Scenario 1a)

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$			Criterion dB(A),$L_{eq(15min)}$
	MGA (E)	MGA (N)	Neutral	Inversion	NNW wind	
R74	747553.5	6059939	<20	22	<20	35
R75	747606.5	6059971	<20	22	<20	35
R76	747443.7	6060037	<20	22	<20	35
R77	747801	6060080	<20	23	20	35
R78	747771.9	6060148	<20	24	20	35
R79	747732.2	6060252	<20	23	20	35
R80	747909.5	6060033	<20	22	<20	35
R81	747905.5	6059858	<20	22	<20	35
R82	748024.7	6059762	<20	22	<20	35
R83	748082.9	6059758	<20	23	20	35
R84	748118.6	6059952	<20	23	20	35
R85	748131.8	6059979	<20	23	20	35
R86	748138.5	6060009	<20	23	21	35
R87	748150.4	6060083	<20	24	21	35
R88	748171.6	6060141	<20	23	20	35
R89	747361.6	6060279	<20	24	21	35
R90	747532.4	6060360	<20	24	21	35
R91	748178.2	6060230	<20	23	<20	35
R92	747041.4	6060411	<20	25	23	35
R93	748176.8	6060627	<20	25	23	35
R94	748123.9	6060599	<20	25	23	35
R107	746955.3	6062872	26	33	28	35

7.2.2 Recommendations – Night-time Site Establishment (Scenario 1a)

The results in **Table 4** show that predicted night-time site establishment noise levels do not exceed the site noise criterion of 35 dB(A) at any of the assessed residential receivers. Analysis of the results also confirms that "modifying factor" corrections as defined in Chapter 4 of the INP are not applicable. In particular, the C-A weighted levels are generally in the range 3-9 dB and the overall C-weighted levels are below 40 dB(C), indicating that the site establishment would not present a low-frequency noise problem.

7.2.3 Predicted Noise Levels – Day Time Site Establishment (Scenario 1b)

Predicted noise levels at non Project-related receivers from daytime site establishment activities are shown in **Table 5**, which also includes the "differentials" between the predicted levels and the noise criterion. The results are the worst-case predicted impacts with all site establishment activities occurring concurrently, including sources in the night-time site establishment scenario.

Table 5
Predicted Daytime Site Establishment Noise Levels (Scenario 1b)

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$	Criterion dB(A),$L_{eq(15min)}$	Differential dB
	MGA (E)	MGA (N)			
R1	747879.1	6061551	31	35	-4
R2	748282.7	6060745	30	35	-5
R3	747335.2	6060881	27	35	-8
R4	747310	6060968	26	35	-9
R5	747214.7	6061290	30	35	-5
R6	748266.8	6060716	30	35	-5
R7	748276.1	6060732	30	35	-5
R8	748159.6	6060853	28	35	-7
R9	748010.1	6060909	27	5	-8
R10	748240.4	6061016	30	35	-5
R11	748102.7	6061050	31	35	-4
R12	747864.5	6061207	32	35	-3
R13	747765.3	6061162	30	35	-5
R14	747807.6	6061351	30	35	-5
R15	747542.9	6061602	32	35	-3
R16	748393.9	6060905	30	35	-5
R17	748419	6060961	31	35	-4
R18	748473.3	6061007	31	35	-4
R19	748450.8	6060826	30	35	-5
R20	748630.8	6060788	30	35	-5
R21	748730	6060750	30	35	-5
R22	748579.2	6060863	30	35	-5
R23	748542.1	6060980	31	35	-4
R24	748822.7	6061033	31	35	-4
R25	749348	6060822	31	35	-4
R26	749365.2	6060938	32	35	-3
R27	749095.3	6061420	34	35	-1
R28	749285.8	6060974	32	35	-3
R29	748315.8	6061770	26	35	-9
R30	748198	6061792	30	35	-5
R31	748149	6062512	35	35	0
R32	747611.8	6061880	33	35	-2
R33	747398.7	6061798	32	35	-3
R34	751031.3	6065138	30	35	-5
R35	750004.4	6065577	25	35	-10
R37	749010.6	6059938	25	35	-10
R38	748195.4	6059877	25	35	-10
R39	748236.4	6060190	26	35	-9
R40	748253.6	6060213	25	35	-10

Table 5 (Cont'd)
Predicted Daytime Site Establishment Noise Levels

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$	Criterion dB(A),$L_{eq(15min)}$	Differential dB
	MGA (E)	MGA (N)			
R41	748539.5	6059898	25	35	-10
R42	748409.8	6060021	25	35	-10
R43	748277.4	6060053	26	35	-9
R44	748337	6060161	26	35	-9
R45	748290.7	6060237	24	35	-11
R46	748438.9	6060091	24	35	-11
R47	748539.5	6060090	24	35	-11
R48	748527.5	6060147	24	35	-11
R49	748616.2	6060174	24	35	-11
R50	748654.6	6060141	24	35	-11
R51	748809.4	6059976	24	35	-11
R52	748982.8	6059653	23	35	-12
R53	749010.6	6060221	26	35	-9
R54	749026.5	6060262	26	35	-9
R55	749017.2	6060340	26	35	-9
R56	748843.8	6060352	26	35	-9
R57	748702.2	6060373	26	35	-9
R58	749092.6	6060503	30	35	-5
R59	748981.5	6060594	30	35	-5
R60	748645.3	6060525	30	35	-5
R61	748445.5	6060472	26	35	-9
R62	748409.8	6060537	26	35	-9
R63	748284	6060493	26	35	-9
R64	748196.7	6060309	26	35	-9
R65	748200.7	6060398	25	35	-10
R66	748182.1	6060435	26	35	-9
R67	748171.6	6060467	26	35	-9
R68	748174.2	6060503	26	35	-9
R69	750679.4	6060484	26	35	-9
R70	748385.9	6060620	28	35	-7
R71	748845.2	6060632	28	35	-7
R72	748911.3	6060628	28	35	-7
R73	747442.4	6059728	25	35	-10
R74	747553.5	6059939	26	35	-9
R75	747606.5	6059971	20	35	-15
R76	747443.7	6060037	25	35	-10
R77	747801	6060080	25	35	-10
R78	747771.9	6060148	25	35	-10
R79	747732.2	6060252	21	35	-14

Table 5 (Cont'd)
Predicted Daytime Site Establishment Noise Levels

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Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$	Criterion dB(A),$L_{eq(15min)}$	Differential dB
	MGA (E)	MGA (N)			
R80	747909.5	6060033	26	35	-9
R81	747905.5	6059858	25	35	-10
R82	748024.7	6059762	25	35	-10
R83	748082.9	6059758	25	35	-10
R84	748118.6	6059952	25	35	-10
R85	748131.8	6059979	26	35	-9
R86	748138.5	6060009	26	35	-9
R87	748150.4	6060083	26	35	-9
R88	748171.6	6060141	26	35	-9
R89	747361.6	6060279	26	35	-9
R90	747532.4	6060360	20	35	-15
R91	748178.2	6060230	25	35	-10
R92	747041.4	6060411	20	35	-15
R93	748176.8	6060627	29	35	-6
R94	748123.9	6060599	29	35	-6
R107	746955.3	6062872	32	35	-3

7.2.4 Recommendations – Daytime Site Establishment (Scenario 1b)

The results in **Table 4** show predicted daytime site establishment noise levels less than or equal to the site noise criterion of 35 dB(A) at all assessed residential receivers.

7.3 OPERATIONAL NOISE ASSESSMENT

7.3.1 Predicted Noise Levels – Operations (Scenario 2)

Predicted noise levels at non Project-related receivers from operational activities are shown in **Table 6**. The results are the worst-case predicted impacts, assuming that all activities including product haulage may occur at night. Noise contours are shown in **Figures C1** and **C2** in **Appendix C**.

7.3.2 Recommendations – Operations

The results in **Table 6** show predicted operational noise levels below the site noise criterion at all assessed residential receivers. These noise levels are based upon implementation of noise reduction works detailed in Section 6.2.2.

Analysis of the results also confirms that the INP "modifying factor" corrections are not applicable. In particular, the C-A weighted levels are generally in the range 5-13 dB and the overall C-weighted levels are below 45 dB(C), indicating that the operations would not present a low-frequency noise problem.

Table 6
Predicted Operational Noise Levels

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$			Criterion dB(A),$L_{eq(15min)}$
	MGA (E)	MGA (N)	Neutral	Inversion	NNW wind	
R1	747879.1	6061551	21	29	28	35
R2	748282.7	6060745	20	30	30	35
R3	747335.2	6060881	<20	24	22	35
R4	747310	6060968	<20	24	22	35
R5	747214.7	6061290	20	31	29	35
R6	748266.8	6060716	20	30	30	35
R7	748276.1	6060732	20	30	30	35
R8	748159.6	6060853	<20	24	22	35
R9	748010.1	6060909	<20	24	22	35
R10	748240.4	6061016	20	29	29	35
R11	748102.7	6061050	21	32	32	35
R12	747864.5	6061207	22	32	32	35
R13	747765.3	6061162	20	32	31	35
R14	747807.6	6061351	20	31	30	35
R15	747542.9	6061602	22	33	31	35
R16	748393.9	6060905	20	31	31	35
R17	748419	6060961	21	31	31	35
R18	748473.3	6061007	21	32	32	35
R19	748450.8	6060826	20	31	31	35
R20	748630.8	6060788	20	31	31	35
R21	748730	6060750	20	30	31	35
R22	748579.2	6060863	20	31	31	35
R23	748542.1	6060980	21	31	31	35
R24	748822.7	6061033	21	32	32	35
R25	749348	6060822	21	31	31	35
R26	749365.2	6060938	22	31	32	35
R27	749095.3	6061420	24	33	34	35
R28	749285.8	6060974	22	31	32	35
R29	748315.8	6061770	<20	23	20	35
R30	748198	6061792	20	25	24	35
R31	748149	6062512	25	31	31	35
R32	747611.8	6061880	23	31	32	35
R33	747398.7	6061798	22	30	30	35
R34	751031.3	6065138	<20	31	<20	35
R35	750004.4	6065577	<20	27	<20	35
R37	749010.6	6059938	<20	27	27	35
R38	748195.4	6059877	<20	27	27	35
R39	748236.4	6060190	<20	28	27	35
R40	748253.6	6060213	<20	28	28	35

Table 6 (Cont'd)
Predicted Operational Noise Levels

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$			Criterion dB(A),$L_{eq(15min)}$
	MGA (E)	MGA (N)	Neutral	Inversion	NNW wind	
R41	748539.5	6059898	<20	27	27	35
R42	748409.8	6060021	<20	28	28	35
R43	748277.4	6060053	<20	28	28	35
R44	748337	6060161	<20	28	28	35
R45	748290.7	6060237	<20	29	29	35
R46	748438.9	6060091	<20	28	28	35
R47	748539.5	6060090	<20	28	28	35
R48	748527.5	6060147	<20	28	28	35
R49	748616.2	6060174	<20	28	28	35
R50	748654.6	6060141	<20	28	28	35
R51	748809.4	6059976	<20	28	28	35
R52	748982.8	6059653	<20	27	27	35
R53	749010.6	6060221	<20	29	29	35
R54	749026.5	6060262	<20	29	29	35
R55	749017.2	6060340	<20	29	29	35
R56	748843.8	6060352	<20	29	29	35
R57	748702.2	6060373	<20	29	29	35
R58	749092.6	6060503	20	25	24	35
R59	748981.5	6060594	20	30	30	35
R60	748645.3	6060525	20	30	30	35
R61	748445.5	6060472	<20	29	29	35
R62	748409.8	6060537	<20	30	30	35
R63	748284	6060493	<20	30	29	35
R64	748196.7	6060309	<20	29	28	35
R65	748200.7	6060398	<20	29	29	35
R66	748182.1	6060435	<20	29	29	35
R67	748171.6	6060467	<20	29	29	35
R68	748174.2	6060503	<20	29	29	35
R69	750679.4	6060484	<20	29	<20	35
R70	748385.9	6060620	<20	30	30	35
R71	748845.2	6060632	20	30	30	35
R72	748911.3	6060628	20	30	30	35
R73	747442.4	6059728	<20	27	25	35
R74	747553.5	6059939	<20	28	26	35
R75	747606.5	6059971	<20	22	21	35
R76	747443.7	6060037	<20	28	26	35
R77	747801	6060080	<20	28	27	35
R78	747771.9	6060148	<20	28	23	35
R79	747732.2	6060252	<20	24	27	35

Table 6 (Cont'd)
Predicted Operational Noise Levels at Non-Project-Related Residences

Residence	Residence coordinates		Predicted level dB(A),$L_{eq(15min)}$			Criterion dB(A),$L_{eq(15min)}$
	MGA (E)	MGA (N)	Neutral	Inversion	NNW wind	
R80	747909.5	6060033	<20	28	27	35
R81	747905.5	6059858	<20	27	27	35
R82	748024.7	6059762	<20	27	26	35
R83	748082.9	6059758	<20	27	27	35
R84	748118.6	6059952	<20	27	27	35
R85	748131.8	6059979	<20	28	27	35
R86	748138.5	6060009	<20	28	28	35
R87	748150.4	6060083	<20	28	28	35
R88	748171.6	6060141	<20	28	27	35
R89	747361.6	6060279	<20	28	27	35
R90	747532.4	6060360	<20	22	21	35
R91	748178.2	6060230	<20	28	28	35
R92	747041.4	6060411	<20	22	21	35
R93	748176.8	6060627	<20	30	30	35
R94	748123.9	6060599	<20	30	30	35
R107	746955.3	6062872	27	33	27	35

7.4 SLEEP DISTURBANCE ASSESSMENT

7.4.1 Predicted Noise Levels – Sleep Disturbance

Predicted sleep disturbance (maximum) noise levels at all non Project-related residences under the worst of the modelled night time adverse conditions (temperature inversion or NNW wind) are shown in **Table 7** which also includes the "differentials" between the predicted levels and the noise criterion.

7.4.2 Recommendations – Sleep Disturbance

Predicted maximum noise levels in **Table 7** are below the sleep disturbance criterion at all receivers.

7.5 ROAD TRAFFIC NOISE ASSESSMENT

Table 8 (reproduced from *Table 4.1* of the Traffic Impact Assessment (TIA) by Transport and Urban Planning [TUP, 2010]) lists the existing traffic volumes on the local road network, and future volumes and percentage increases due to additional traffic from the Project.

Table 7
Predicted Sleep Disturbance Levels

Residence	Residence coordinates		Predicted level dB(A),L_{max}	Criterion dB(A),L_{max}	Differential dB
	MGA (E)	MGA (N)			
R1	747879.1	6061551	39	45	-6
R2	748282.7	6060745	40	45	-5
R3	747335.2	6060881	34	45	-11
R4	747310	6060968	34	45	-11
R5	747214.7	6061290	40	45	-5
R6	748266.8	6060716	40	45	-5
R7	748276.1	6060732	40	45	-5
R8	748159.6	6060853	34	45	-11
R9	748010.1	6060909	32	45	-13
R10	748240.4	6061016	40	45	-5
R11	748102.7	6061050	41	45	-4
R12	747864.5	6061207	41	45	-4
R13	747765.3	6061162	40	45	-4
R14	747807.6	6061351	40	45	-5
R15	747542.9	6061602	42	45	-3
R16	748393.9	6060905	41	45	-4
R17	748419	6060961	41	45	-4
R18	748473.3	6061007	42	45	-3
R19	748450.8	6060826	40	45	-5
R20	748630.8	6060788	41	45	-4
R21	748730	6060750	40	45	-5
R22	748579.2	6060863	41	45	-4
R23	748542.1	6060980	42	45	-3
R24	748822.7	6061033	42	45	-3
R25	749348	6060822	41	45	-4
R26	749365.2	6060938	42	45	-3
R27	749095.3	6061420	42	45	-3
R28	749285.8	6060974	42	45	-3
R29	748315.8	6061770	33	45	-12
R30	748198	6061792	35	45	-10
R31	748149	6062512	42	45	-3
R32	747611.8	6061880	41	45	-4
R33	747398.7	6061798	40	45	-5
R34	751031.3	6065138	41	45	-4
R35	750004.4	6065577	38	45	-7
R37	749010.6	6059938	38	45	-7
R38	748195.4	6059877	38	45	-7
R39	748236.4	6060190	39	45	-6

Table 7 (Cont'd)
Predicted Sleep Disturbance Levels

Residence	Residence coordinates		Predicted level dB(A),L_{max}	Criterion dB(A),L_{max}	Differential dB
	MGA (E)	MGA (N)			
R40	748253.6	6060213	38	45	-7
R41	748539.5	6059898	37	45	-8
R42	748409.8	6060021	38	45	-7
R43	748277.4	6060053	39	45	-6
R44	748337	6060161	38	45	-7
R45	748290.7	6060237	39	45	-6
R46	748438.9	6060091	39	45	-6
R47	748539.5	6060090	39	45	-6
R48	748527.5	6060147	39	45	-6
R49	748616.2	6060174	40	45	-5
R50	748654.6	6060141	39	45	-6
R51	748809.4	6059976	38	45	-7
R52	748982.8	6059653	38	45	-7
R53	749010.6	6060221	40	45	-5
R54	749026.5	6060262	40	45	-5
R55	749017.2	6060340	41	45	-4
R56	748843.8	6060352	40	45	-5
R57	748702.2	6060373	40	45	-5
R58	749092.6	6060503	36	45	-9
R59	748981.5	6060594	41	45	-4
R60	748645.3	6060525	40	45	-5
R61	748445.5	6060472	39	45	-6
R62	748409.8	6060537	40	45	-5
R63	748284	6060493	41	45	-4
R64	748196.7	6060309	40	45	-5
R65	748200.7	6060398	39	45	-6
R66	748182.1	6060435	39	45	-6
R67	748171.6	6060467	39	45	-6
R68	748174.2	6060503	40	45	-5
R69	750679.4	6060484	39	45	-6
R70	748385.9	6060620	40	45	-5
R71	748845.2	6060632	40	45	-5
R72	748911.3	6060628	41	45	-4
R73	747442.4	6059728	37	45	-8
R74	747553.5	6059939	39	45	-6
R75	747606.5	6059971	33	45	-12
R76	747443.7	6060037	38	45	-7
R77	747801	6060080	39	45	-6

Table 7 (Cont'd)
Predicted Sleep Disturbance Levels

Residence	Residence coordinates		Predicted level dB(A),L_{max}	Criterion dB(A),L_{max}	Differential dB
	MGA (E)	MGA (N)			
R78	747771.9	6060148	38	45	-7
R79	747732.2	6060252	34	45	-11
R80	747909.5	6060033	39	45	-6
R81	747905.5	6059858	38	45	-7
R82	748024.7	6059762	37	45	-8
R83	748082.9	6059758	37	45	-8
R84	748118.6	6059952	37	45	-8
R85	748131.8	6059979	37	45	-8
R86	748138.5	6060009	38	45	-7
R87	748150.4	6060083	38	45	-7
R88	748171.6	6060141	38	45	-7
R89	747361.6	6060279	38	45	-7
R90	747532.4	6060360	34	45	-11
R91	748178.2	6060230	38	45	-7
R92	747041.4	6060411	33	45	-12
R93	748176.8	6060627	40	45	-5
R94	748123.9	6060599	39	45	-6
R107	746955.3	6062872	42	45	-3

Table 8
Increases in Weekday Traffic Volumes on the Road Network Due to the Project

Road	Existing Weekday Volumes			Project Volumes			Total Volumes With Project			Increase Due to Project
	Light Vehicles %	Heavy Vehicles %	Total Vehicles	Light Vehicles %	Heavy Vehicles[1] %	Total Vehicles	Light Vehicles %	Heavy Vehicles %	Total Vehicles	Total Vehicles
Majors Creek Road	314 93%	23 7%	337 100%	+20	+14 + 4	+38	334 88%	41 12%	375 100%	11.3%
Araluen Road	619 88%	76 12%	695 100%	+20	+14 + 4	+38	639 87%	94 13%	733 100%	5.6%
Captains Flat Road	984 90%	103 10%	1 087 100%	+20	+14 + 4	+38	1 004 89%	121 11%	1 125 100%	3.5%
Coghill Street	973 89%	118 11%	1 091 100%	+20	+14 + 4	+38	993 88%	136 12%	1 129 100%	3.5%
Wallace Street	1 081 89%	140 11%	1 221 100%	+20	+14 + 4	+38	1 101 88%	158 12%	1 259 100%	3.1%

Light Vehicles - Austroads 1 and 2 vehicle classification
Heavy Vehicles - Austroads 3 – 12 vehicle classification
[1] 4 Bus movements for staff trips included as heavy vehicles

TUP (2010) makes the following assessments based on data in the **Table 8** above.

- Over most of the road network, the increase in total traffic volumes due to the Project would range between 3.1% and 5.6%. On Majors Creek Road, the increase in total traffic volume would be greater (11.3%), however, it is noted that Majors Creek Road carries relatively low traffic volumes (337vpd on a weekday) which accounts for the larger proportional increase on this road.

- The proportion of heavy vehicles using the road network increases by 1% on most sections of the road network, when compared to the existing 2010 traffic volumes, due to the Project and would remain in the order of 11 to 12%.

- The largest increase occurs in Majors Creek Road where the proportion of heavy vehicles will increase from 7% to 12%.

All roads considered in **Table 8** currently have very small traffic volumes (<1 500 vpd) with proportion of heavy vehicles around 10%. These parameters indicate existing traffic noise levels well below the traffic noise criteria in **Table 6** at any residence more than 15m from the road edge. Further, an increase in traffic volume by less than 10% corresponds to less than a 1dB noise increase due to the Project and a full quantitative assessment of traffic noise impacts is not warranted.

Majors Creek Road carries the smallest traffic volume of all roads likely to carry Project-related traffic. The projected increase of marginally greater than 10% and some quantitative assessment is warranted.

The maximum numbers of existing hourly vehicle movements and hourly vehicle movements generated by the Project, as reproduced from *Table 4.2* of TUP (2010), are presented in **Table 9**.

Table 9
Maximum hourly existing and project-related Traffic Volumes

Road	Existing Maximum Hourly Volumes		Additional Maximum Hourly Volumes from Project	Total Volumes with Project	
	6am-9am	3pm-7pm		6am-9am	3pm-7pm
Majors Creek Road	28	34	+10	38	44
Araluen Road	67	66	+10	77	77
Captains Flat Road	97	100	+10	107	110
Coghill Road	73	105	+10	83	115
Wallace Street	88	115	+10	98	125

TUP (2010) includes a recommendation that Project-related heavy vehicles should be limited to 80km/h on Majors Creek Road. Even assuming an unrealistic worst case that all 10 additional vehicles in one hour in **Table 9** are heavy vehicles, the calculated traffic noise contribution at a nominal distance of 20m from the road edge is 50 dB(A),$L_{eq(1\ hour)}$. This is 5 dB below the night time traffic noise criterion and 10 dB below the daytime criterion. Given the very low volume of Project-related traffic and the resultant low noise levels it is unlikely that traffic noise generated by the Project will have significant impact on any receiver.

7.6 BLASTING ASSESSMENT

Blasting is likely to be required at the surface to develop the mine access drift and then small blasts would be required underground to fracture material for subsequent extraction. The greatest potential for blast impacts on residential receivers would occur with blasting on the surface. The nearest residence to the southern most point of the access drift would be R31 (Mathias) at a distance of 750m. All other residences are greater than 1km from the area designated for surface blasting.

The predicted blast overpressure level at R31 is equal to the 5% exceedance criterion of 115dB (including a +3dB correction to equation 2 as discussed in Section 6.5.1) for a maximum instantaneous charge weight (MIC) of 105kg. The calculated peak ground vibration level at this receiver is 0.5mm/s for this MIC, which is one-tenth of the 5% exceedance criterion for ground vibration.

Blast overpressure and vibration levels are therefore expected to be below the criteria at the worst affected receiver for MIC values less than 105kg. Advice from the Proponent is that this MIC considerably exceeds the blast sizes that would be necessary for the Project.

8. SUMMARY

A Noise and Blasting Assessment of the Project, located approximately 13km to the south of Braidwood, NSW, has been conducted.

The assessment has found that building fabrication activities, and associated lighting power generation plant, would achieve the night-time noise criterion. Earthworks and drilling associated with the establishment of the box cut, ROM Pad and Tailings Storage Facility at the ROM area, access portal and tailings storage dam, have been predicted to exceed the noise criterion under inversion (night-time) conditions at several receivers. Noise emissions from these earthworks, however, are predicted to be below the noise criterion under neutral atmospheric conditions and would therefore be restricted to daytime construction hours only.

The main finding from the assessment was that noise control would need to be applied to several major noise sources in order for the nominated noise criteria to be achieved. The noise control recommended, and incorporated in noise modelling, included the following.

- Processing plant crusher. Contain within shed engineered to achieve minimum 12 dB noise reduction (nominally Rw + C_{tr} = 15).
- Ventilation fan. Place at least 10m below ground level rather than at the surface.
- ROM pad. Construct waste rock noise bunds 5m high along the southern and western edges.

No exceedances of noise and vibration criteria for construction works, sleep disturbance, road traffic and blasting have been predicted.

It is recommended that noise compliance monitoring is undertaken during both the daytime and night time periods of the site establishment phase. Routine noise compliance monitoring should then be conducted on a quarterly basis at least during the first two years of the operational stage of the Project. Suitable monitoring locations would include R107, R31, R30, R27 and R34. These locations generally are the closest and surround the Project Site so that compliance at these locations would imply compliance at more distance receivers.

In summary, the noise and blasting assessment has determined that the Project could operate in compliance with the relevant noise and vibration criteria provided the recommendations contained in this report are implemented.

APPENDICES

Appendix A Noise Source Sound Power Levels

Appendix B Noise Source Locations

Appendix C Representative Noise Level Contours

Appendix D Seasonal Wind Roses

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Appendix A

Noise Source Sound Power Levels

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Table A1
Noise Source Sound Power Levels, Lw

Noise Source	Lw,dB(A)	
Site establishment noise sources	$L_{Aeq(15min)}$	
Building fabrication at surface facilities	106	
Lighting plant[1]	82	
Generator set	98	
Crane	104	
Front end loader (FEL)	112	
Dozer (D9)	114	
Excavator	114	
Topsoil scraper	114	
Haul truck	115	
Drill	113	
Operational noise sources	$L_{Aeq(15min)}$	L_{Amax}
Front end loader (CAT 950H)	107	114
Crushing plant[2]	109	112
Breaker (used 5 minutes per hour)	101	113
Ventilation fan[3]	94	--
Haul truck[4]	102	116
Flotation cell	105	105
Ball mill (rubber lined)	105	108
Water pump	98	98
Semi-trailer[4]	98	103

[1] With conveyor belt noise barrier, as measured on site March 2010.
[2] Enclosed in shed (unattenuated sound power level is 122 dB(A) as measured at a similar operation).
[3] Located at least 10m below ground level.
[4] Time-based correction as the trucks would only briefly be at the surface in a given 15 minute period.

Acoustic data for the front end loader and breaker were obtained from manufacturers' data sheets and adjusted according to the percentage of time each item is to be in use in a 15-minute period. A maximum noise level for the haul trucks was provided by the client and levels for the flotation cell were sourced from file data. Noise levels for the ball mill (which will be rubber lined, small diameter unit) were estimated at 5 dB below levels previously measured for a large, unlined industrial ball mill and are likely to be conservatively high.

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Appendix B

Noise Source Locations

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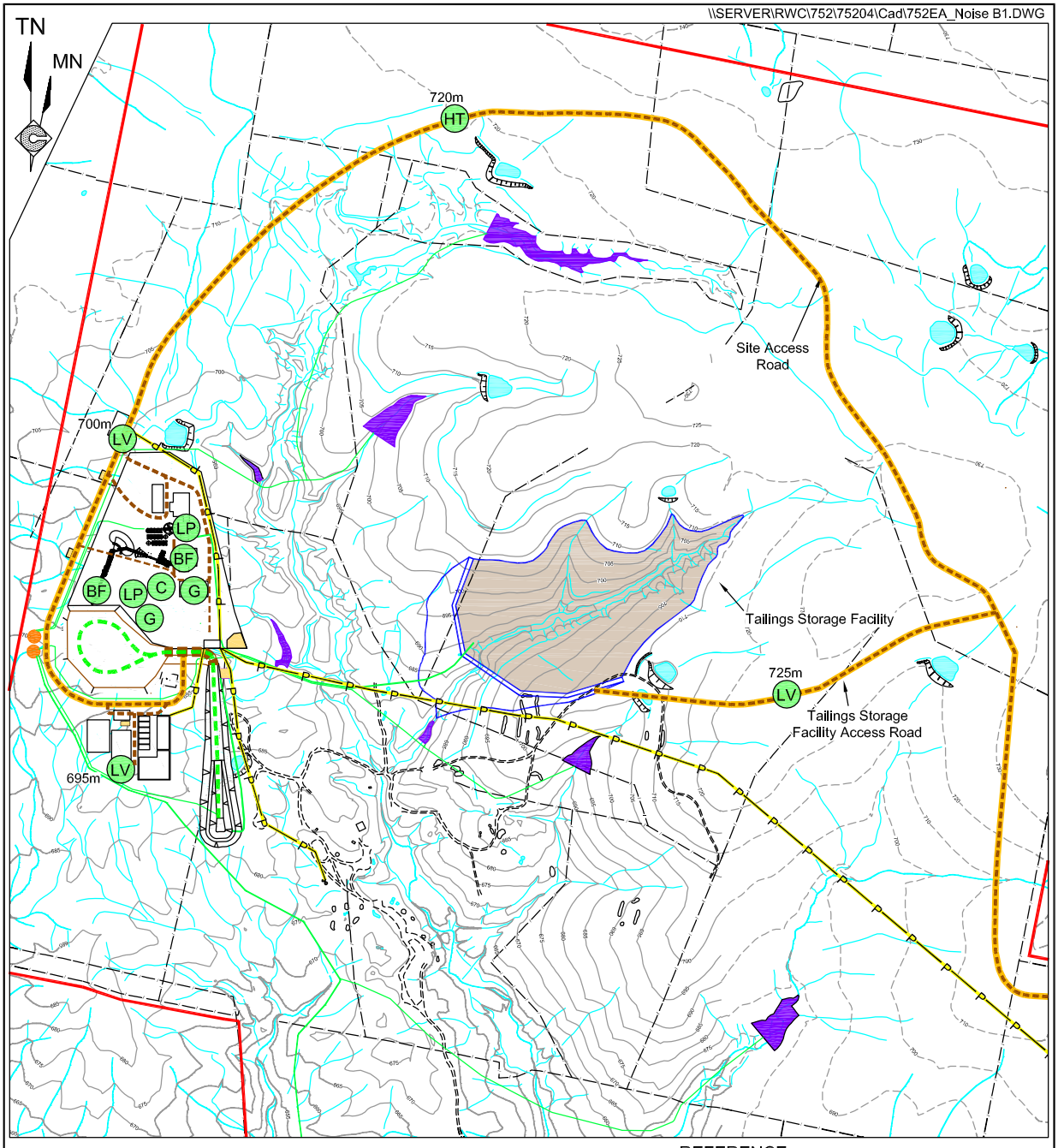

Figure B1
MODELLING SCENARIO 1a
(NIGHT-TIME CONSTRUCTION AND INITIAL DEVELOPMENT)

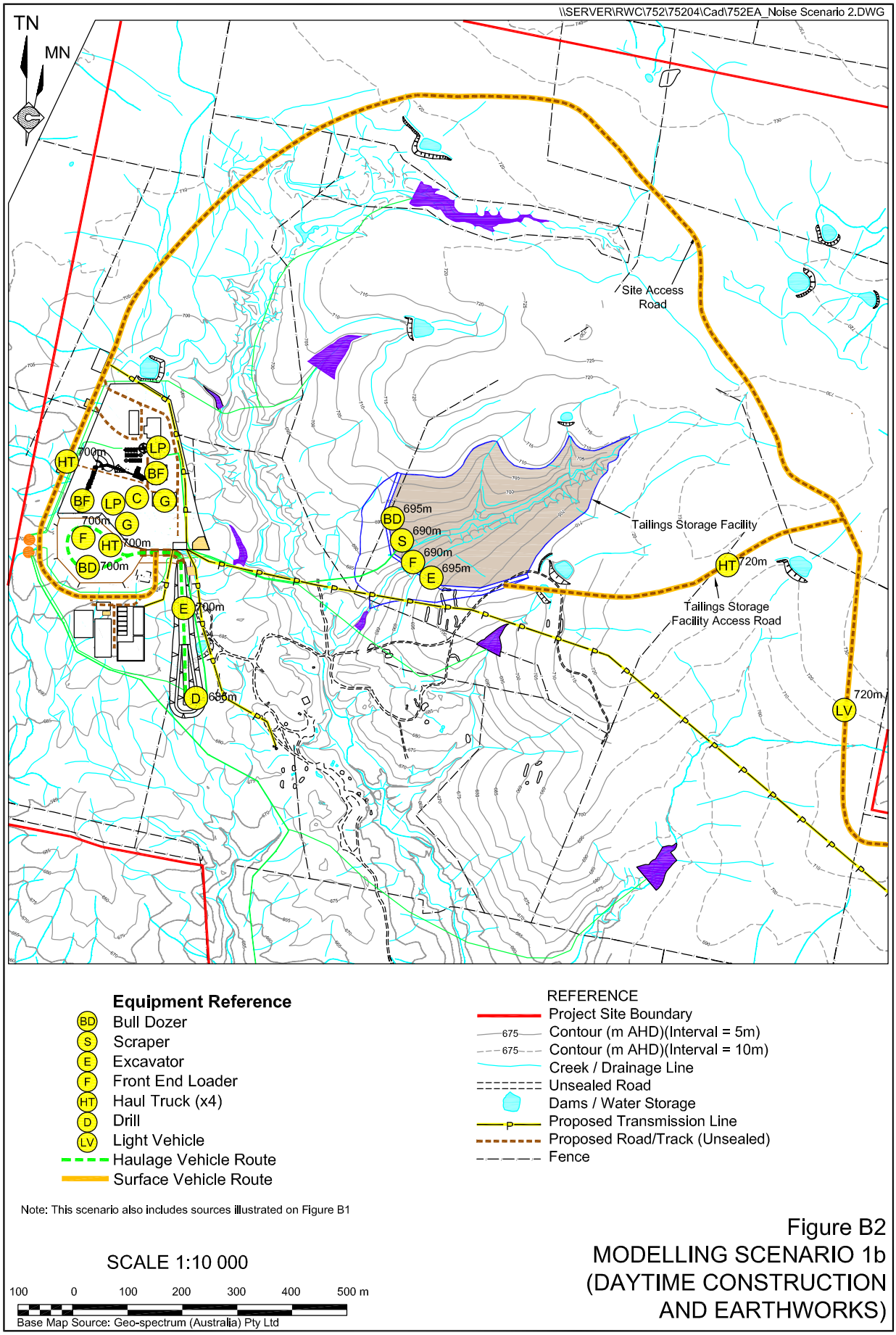

Figure B2
MODELLING SCENARIO 1b
(DAYTIME CONSTRUCTION AND EARTHWORKS)

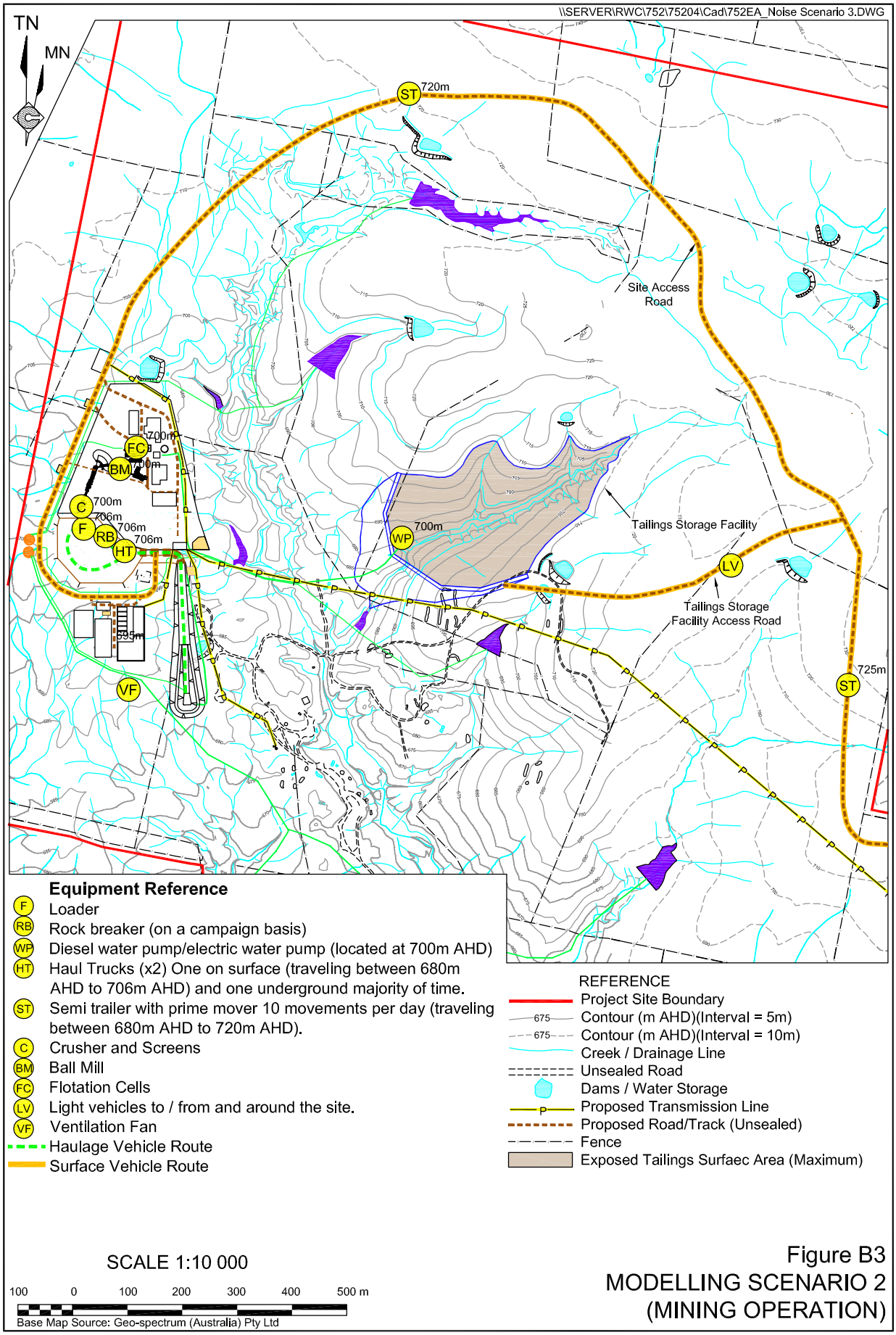

Figure B3
MODELLING SCENARIO 2
(MINING OPERATION)

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Appendix C

Representative Noise Level Contours

(No. of pages excluding this page = 3)

Note: Noise levels at any given receiver, as read off the noise contours, can vary from the exact values included in the Tables by several dB due to interpolation errors. The magnitude of the errors generally increases with increasing distance from the source. In all cases, the tabulated values should be relied on in preference to values read of the noise contours.

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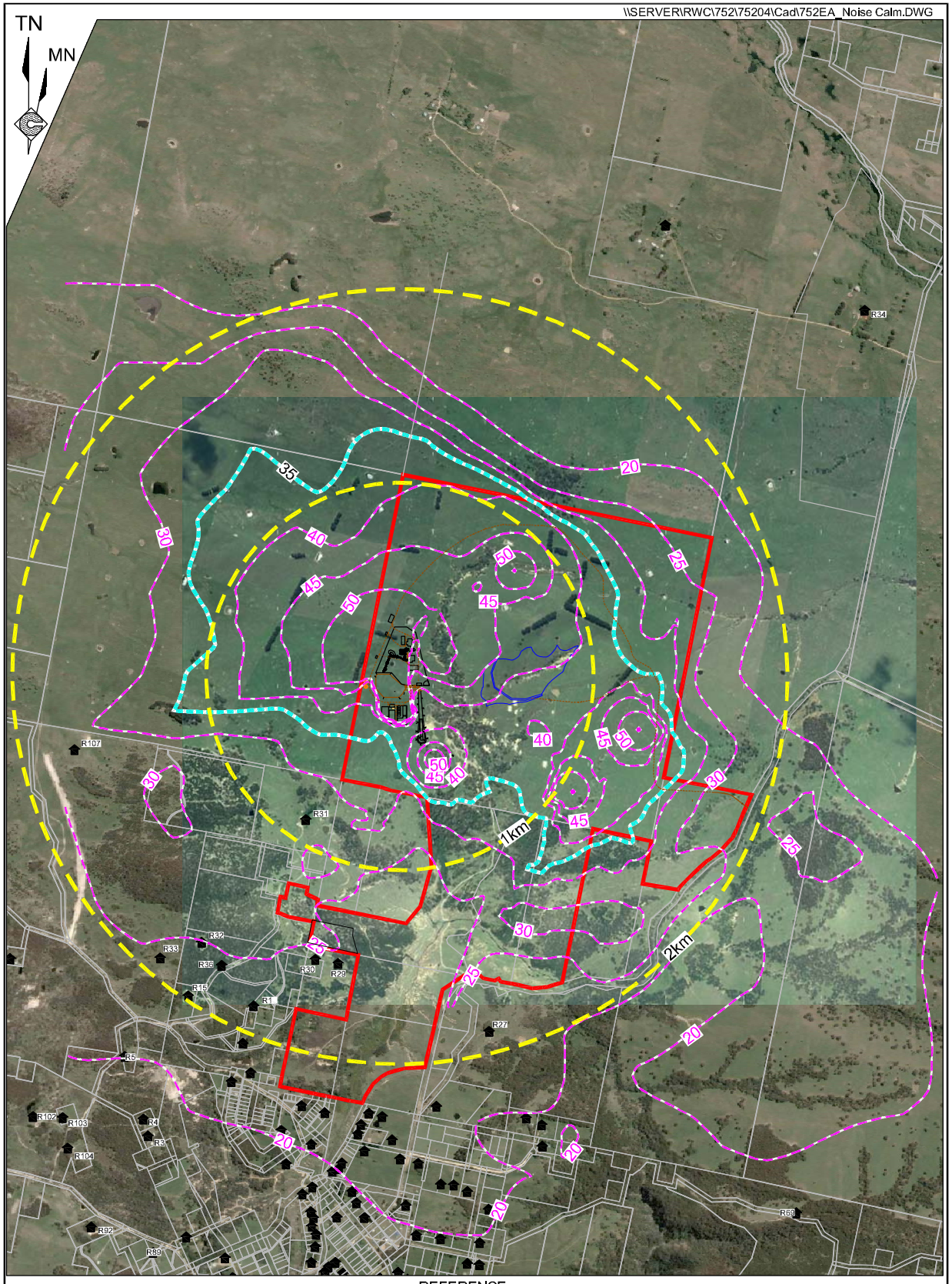

Figure C1
PREDICTED OPERATIONAL NOISE LEVELS
- CALM (NEUTRAL) CONDITIONS

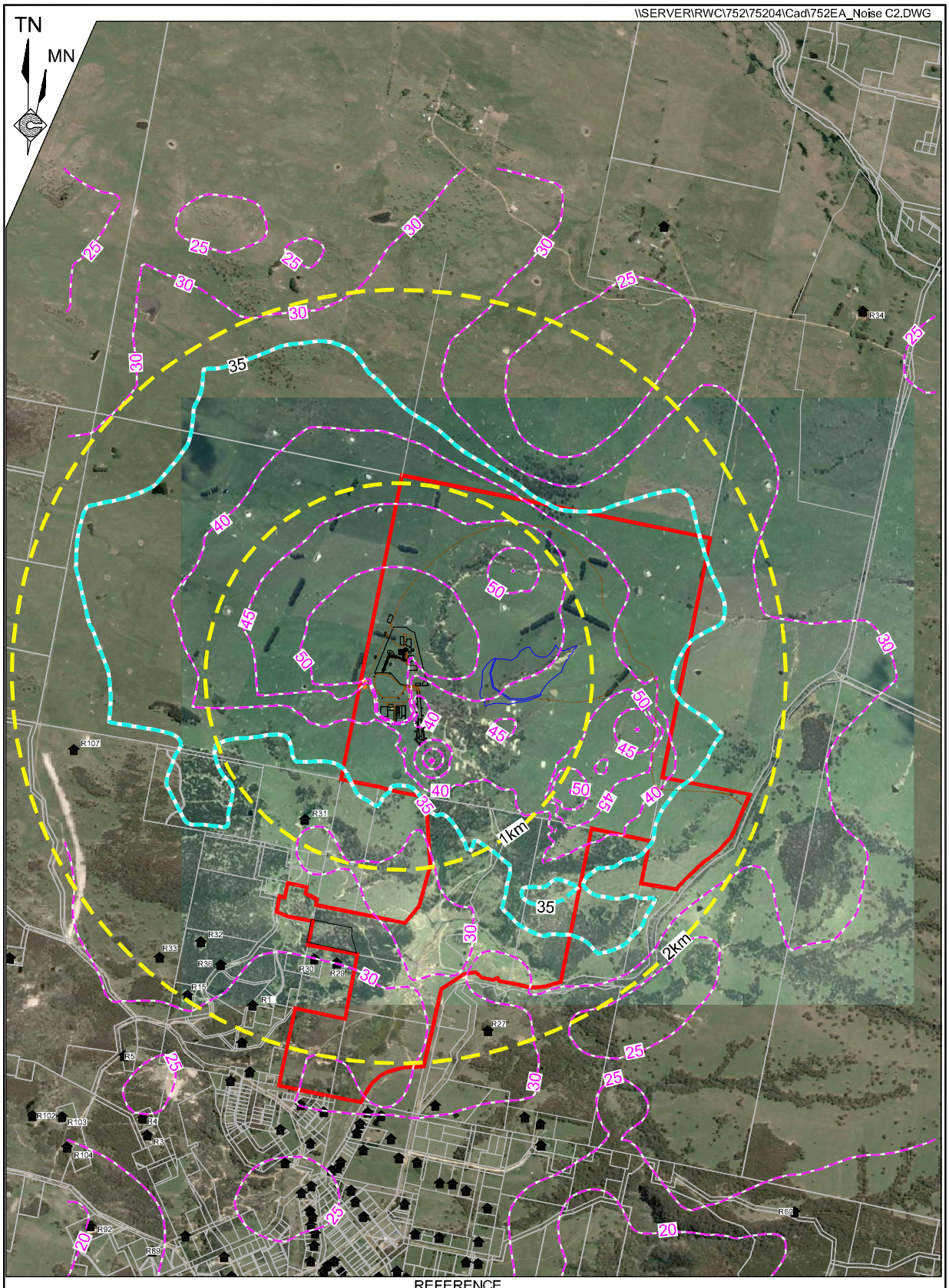

Figure C2
PREDICTED OPERATIONAL NOISE LEVELS - INVERSION CONDITIONS

Appendix D

Seasonal Wind Roses

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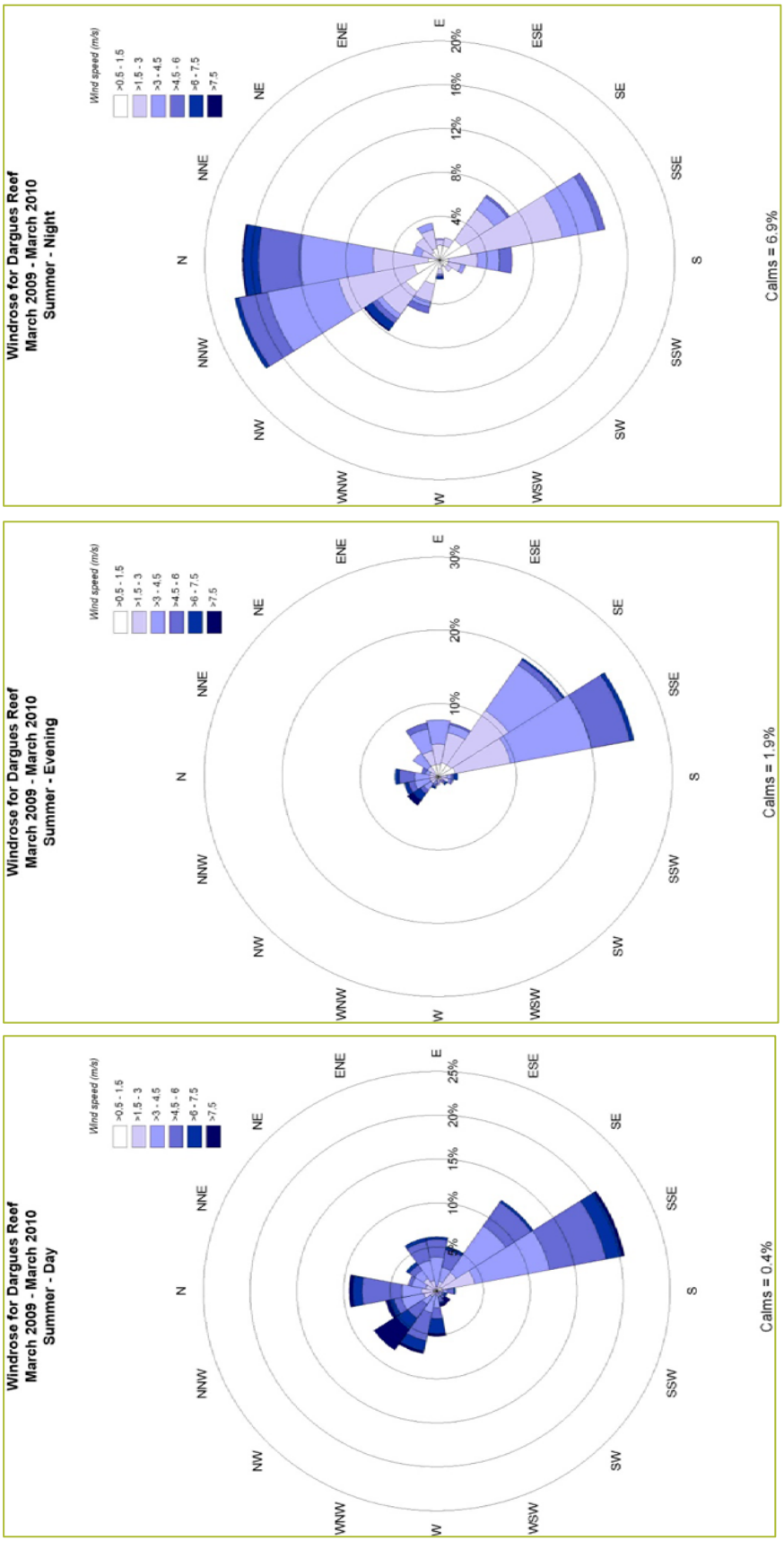
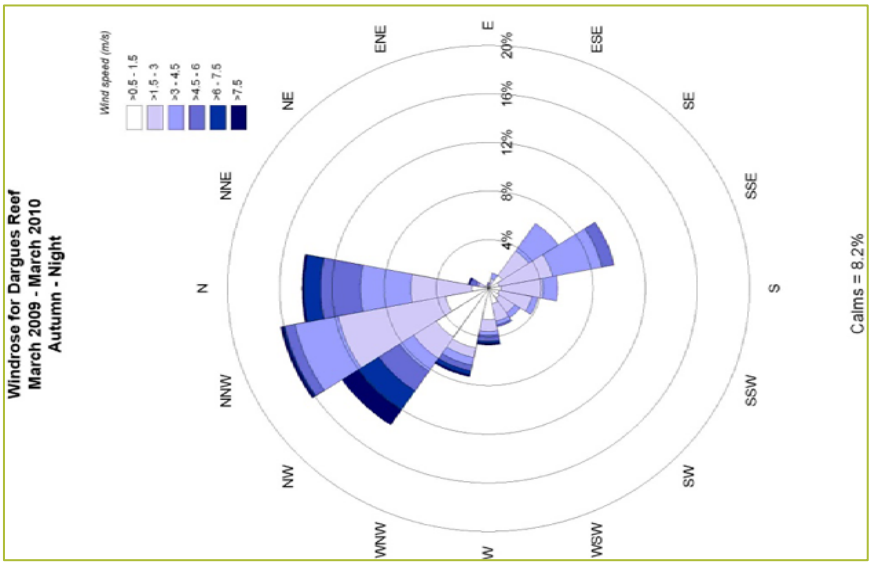
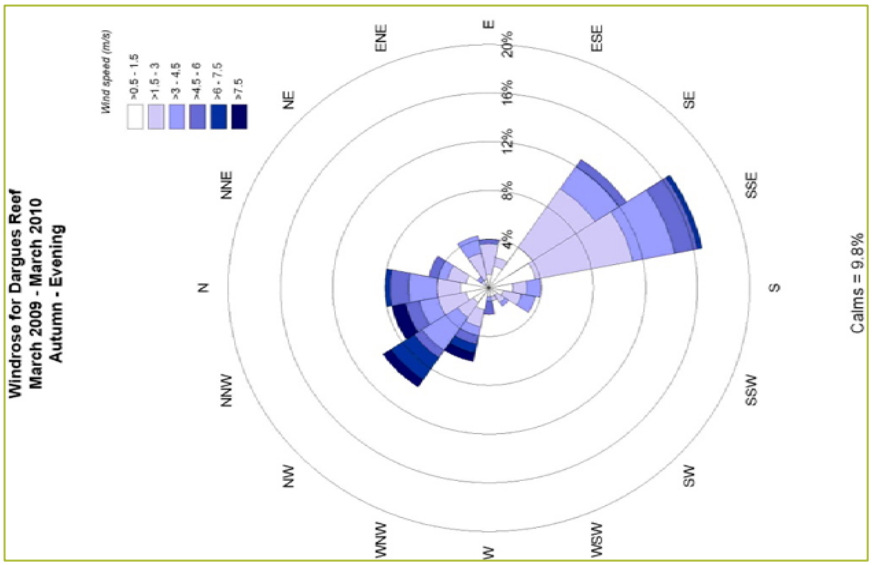
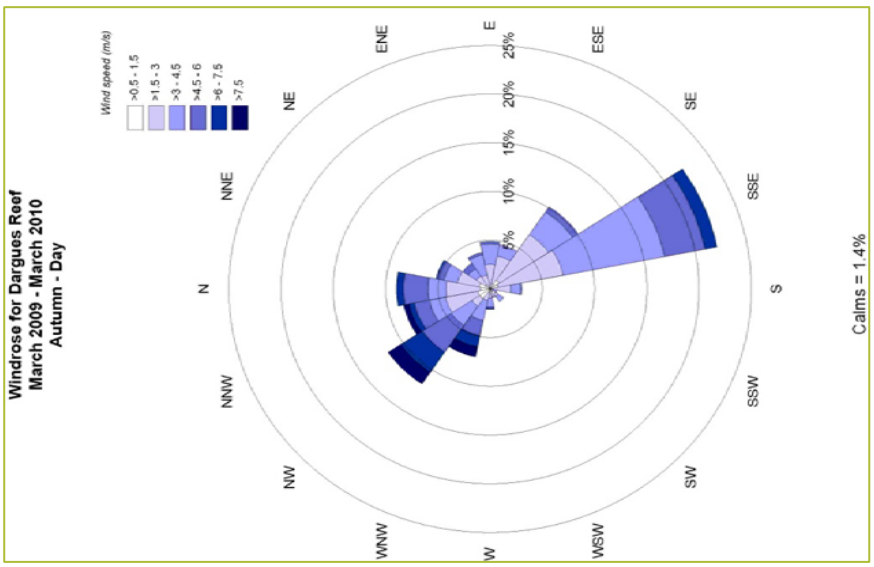
Summer


Windrose for Dargues Reef
March 2009 - March 2010
Summer - Night
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
Calms = 6.9%
Windrose for Dargues Reef
March 2009 - March 2010
Summer - Evening
Calms = 1.9%
Windrose for Dargues Reef
March 2009 - March 2010
Summer - Day
Calms = 0.4%

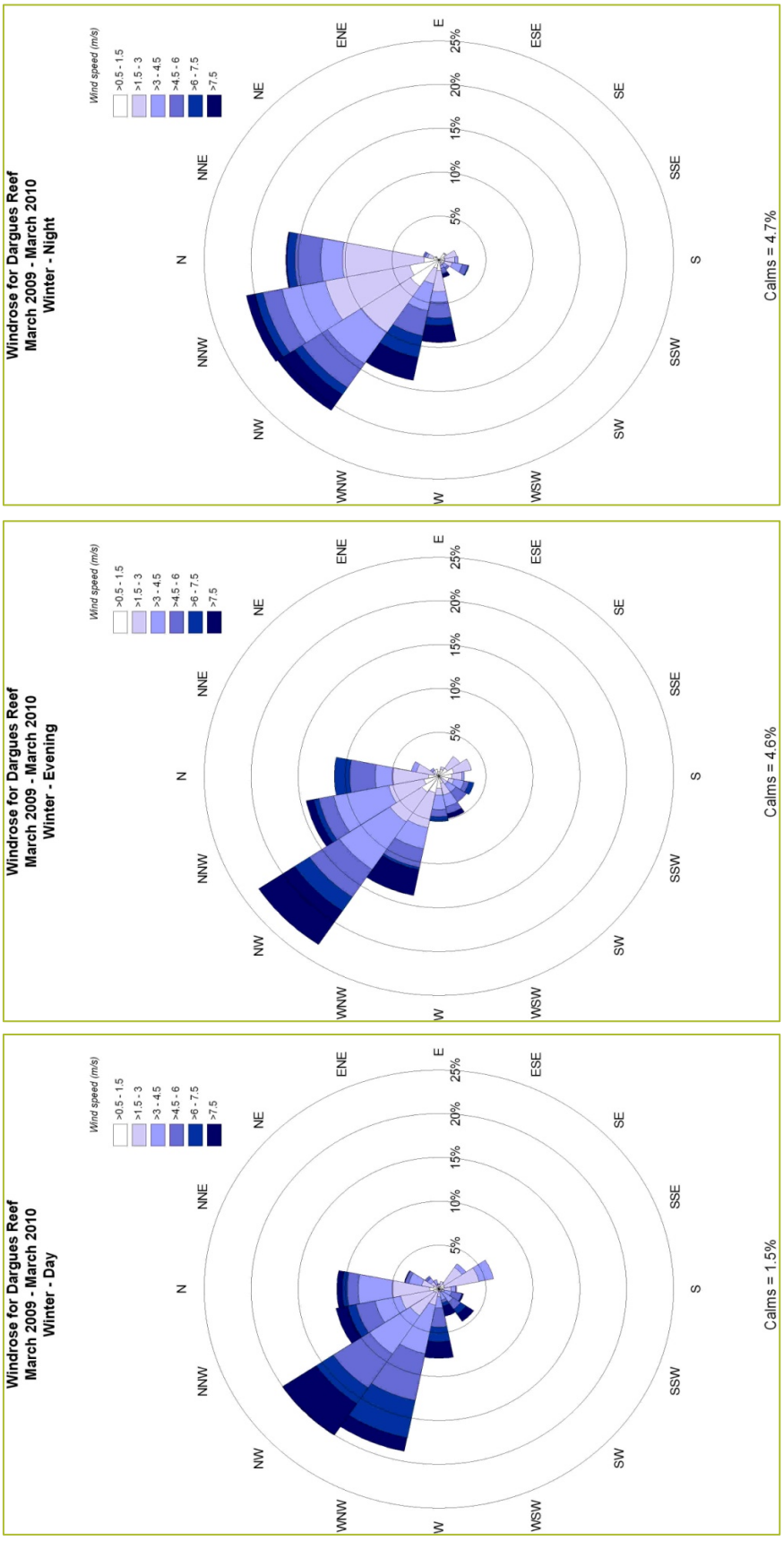
Autumn


Windrose for Dargues Reef
March 2009 - March 2010
Autumn - Night
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
4%
8%
12%
16%
20%
Calms = 8.2%

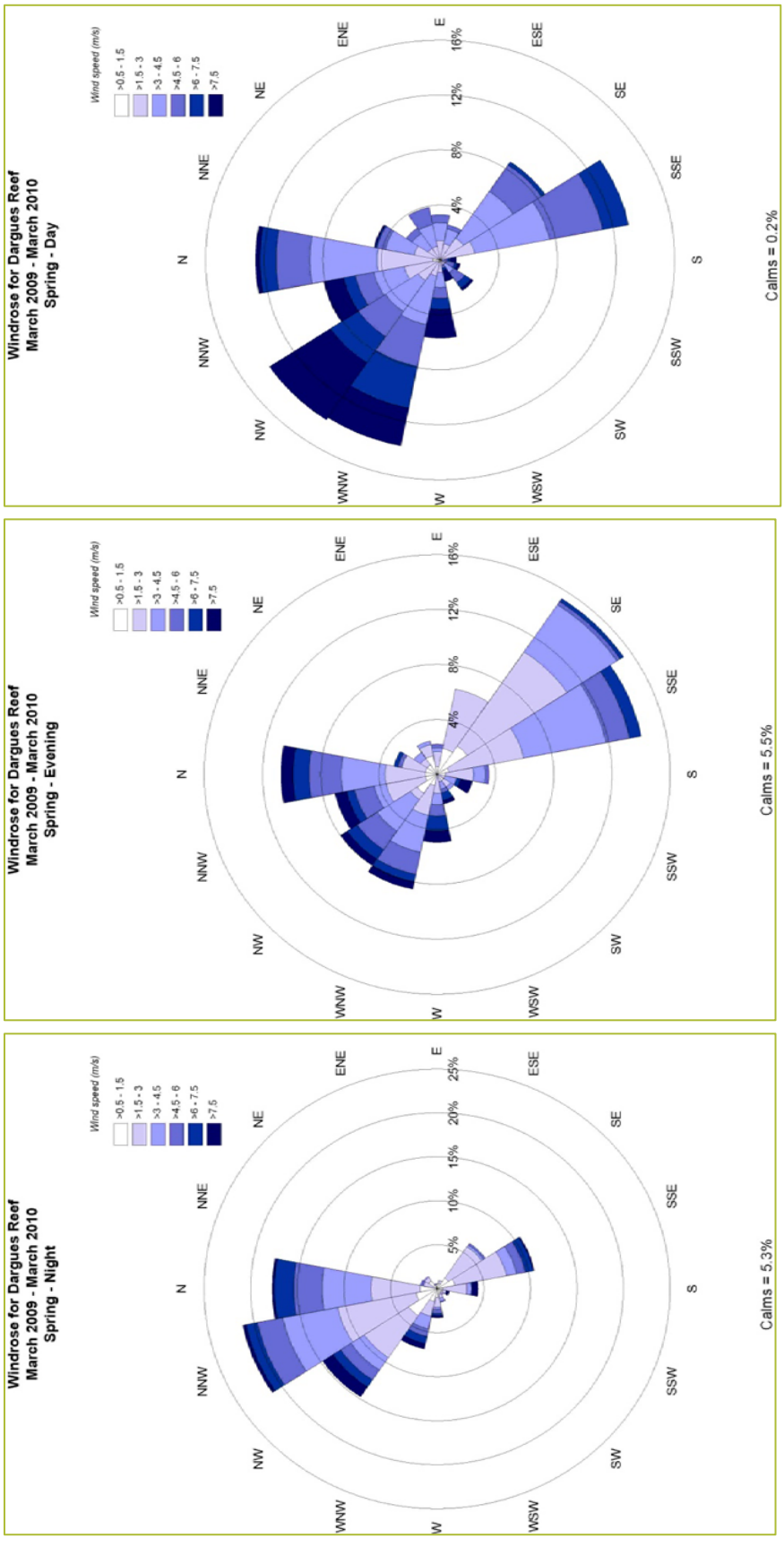

Windrose for Dargues Reef
March 2009 - March 2010
Autumn - Evening
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
4%
8%
12%
16%
20%
Calms = 9.8%


Windrose for Dargues Reef
March 2009 - March 2010
Autumn - Day
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
5%
10%
15%
20%
25%
Calms = 1.4%

Winter


Windrose for Dargues Reef
March 2009 - March 2010
Winter - Night
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
5%
10%
15%
20%
25%
Calms = 4.7%
Windrose for Dargues Reef
March 2009 - March 2010
Winter - Evening
Calms = 4.6%
Windrose for Dargues Reef
March 2009 - March 2010
Winter - Day
Calms = 1.5%

Spring


Windrose for Dargues Reef
March 2009 - March 2010
Spring - Day
Wind speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 4.5
>4.5 - 6
>6 - 7.5
>7.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
4%
8%
12%
16%
Calms = 0.2%
Windrose for Dargues Reef
March 2009 - March 2010
Spring - Evening
Calms = 5.5%
Windrose for Dargues Reef
March 2009 - March 2010
Spring - Night
5%
10%
15%
20%
25%
Calms = 5.3%