Appendix 1

Anvil Hill Coal Project

Independent Hearing and Assessment Panel

Noise and Blasting

CONTENTS

INTRODUCTION

Under Section 75G(1)(a) of the Environmental Planning and Assessment Act 1979, the Minister for Planning has appointed an Independent Hearing and Assessment Panel (Panel) to provide impartial technical advice to the Department of Planning in regard to the Anvil Hill Coal Project.

The Terms of Reference require the panel to:

1. consider and advise on the:

    a) following impacts of the project:

        - noise and blasting;

        - air quality, in particular dust impacts; and

        - flora and fauna, in particular vegetation offsets.

    b) relevant issues raised in submissions in regard to these impacts; and

    c) adequacy of the proponent's response to the issues raised in submissions; and

2. Identify and comment on any other significant issues raised in submissions or during the panel hearings.

I have been appointed to the aforementioned Panel and in particular in respect of noise and blasting issues.

The following report and my findings include consideration of relevant submissions, responses to submissions and the EA assessment. To that end, the EA Noise and Vibration Assessment, prepared by a reputable organisation, is considered to be a thorough, comprehensive and detailed study. Whilst I concur with most elements of the EA's assessment, I have provided some additional recommendations. Such recommendations are over and above those in the EA.

ISSUES RAISED IN SUBMISSIONS

- Vibration levels are predicted to exceed significant damage thresholds for rock structures including Anvil Rock and project approval should include measures to limit damage to rock structures.

- Council approval should be sought to close public roads during blast occurrences and buffer zones established for blasting where public roads are open during blast occurrences.

- Centennial should monitor its blasts and record over pressure and peak particle velocity levels as well as liaise with other mining operators in the area to ensure mine blasting is suitably staged to minimise impacts.

- The EA did not take into account the effects of sound reflections and amplification due to geological structures.

- There is confusion as to what noise mitigation measures would be undertaken by Centennial where impacted properties are not acquired for whatever reason.

- The EA uses traffic noise algorithms usually suited to far different traffic scenarios than that experienced in the local area.

- It is unclear in the EA whether dilapidation surveys would be conducted by Centennial on noise and blast impacted buildings not acquired by the mine.
- Noise mitigation measures for two extra residences affected by increased noise from the Muswellbrook-Ulan train line.
- Low frequency vibrations and associated impacts.
- Noise impacts on horses.
- Noise impacts from off-site transport.

IDENTIFYING NOISE SENSITIVE RECEIVERS AND QUANTIFY EXISTING NOISE LEVELS

One of the early steps in noise assessment for a major project is to identify noise sensitive receivers and quantifiably document the existing background and ambient noise levels.

Based on a desk top review of the information provided in the EA, subsequent documents and submissions to the Panel, I am reasonably satisfied that all potentially affected receivers (or representatives thereof) have been identified.

The NSW State Government Industrial Noise Policy (INP), published by the Environment Protection Authority (now part of the Department of Environment and Conservation (DEC)) in January 2000, requires monitoring to encapsulate at least 1 representative week of valid data (ie unaffected by excessive wind, rain and extraneous noise).

The EA Noise Assessment includes a sufficient quantity of measured background and ambient noise levels. These were recorded over at least 7 contiguous days on each occasion, at each of eight representative residential locations and over all seasons.

Of notable absence from the EA are daily charts of such monitoring and daily assessment background levels and average noise levels, as often required by the DEC for assessment purposes and transparency.

In the absence of such, I conducted my own review of a subset of such data at one representative location. My findings are summarised below and shows that this area is one of the quietest settings I have come across in my professional career. This is a finding consistent with that of the EA noise consultant (expressed during the site Hearing) and DEC (as documented in their submission to the Panel).

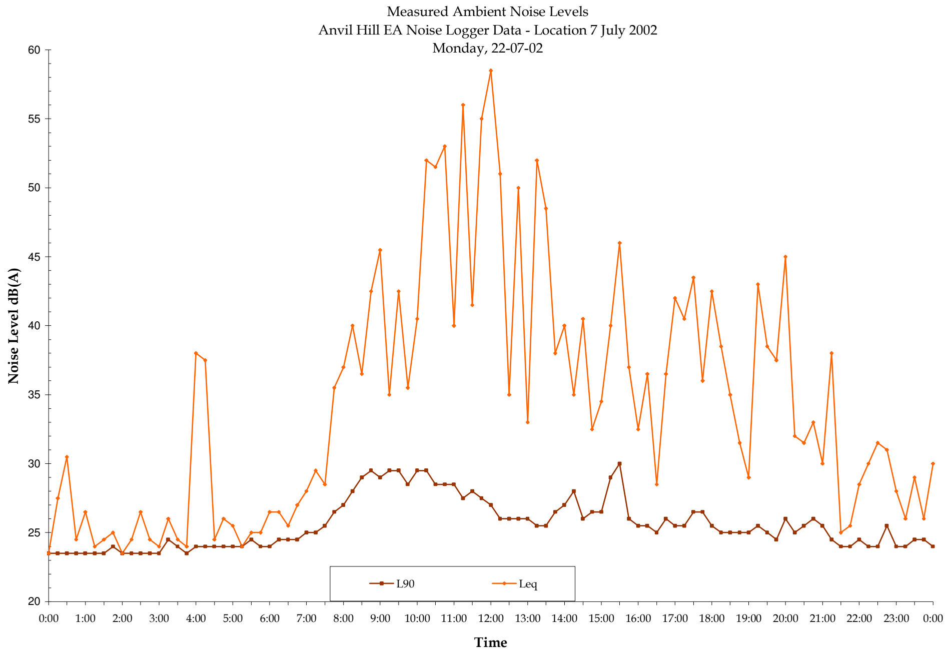
Measured Noise Levels

For the quietest times of the year, measured existing background noise levels are below the DEC recommended minimum of 30dB(A) for all three assessment periods day, evening and night at all eight selected locations. The background noise level is derived from measured L_{90} data or a noise level present for 90% of the time or more.

A typical day for one of the monitoring locations used as representative of residences is provided below. These are actual measured levels at EA Location 7 or Wybong Road to the west of the project area. The chart demonstrates the extremely quiet rural setting of this residence and many others in the area. The chart almost certainly does not quantify how much quieter it may actually be due to the limitation (or noise floor) of the instrument used. This is apparent from the L_{90} curve which 'flat-lines' at approximately 23-24dB(A) during the early hours of the morning. The often logged minimum noise level (L_{min}) data was not available, so the absolute minimum noise levels cannot be reported. It can only be concluded that the L_{min} values would be below 23dB(A).

Such a noise setting can be best described as similar to that experienced inside of a bedroom in the middle of the night, or a recording studio.

This issue will become important in the context of introduced predicted mine noise.



Adopted Representative Background Noise Level

The EA adopts the INP provisions in respect of the representative existing background noise level at residences. The INP recommends that where the representative background noise level is found to be less than 30dB(A) (as is the case here), then it is set at 30dB(A) for noise assessment purposes.

The need for a representative background noise level is to allow assessment of intrusiveness or the level which industrial noise emerges above the baseline. The intrusiveness of an industrial source may generally be considered acceptable if the 'average' noise level from the industry over a 15-minute period (ie $L_{eq,15minute}$) does not exceed the representative background noise (in the absence of the subject industry) by more than 5 decibels. The method used for developing a representative background noise level aims to satisfy the intrusiveness criterion for at least 90% of the time. It is also important to note that this or other noise criteria do not require that new industrial noise sources are inaudible at residential locations.

The value of the representative background noise level is therefore critical to defining intrusive noise impact. Setting a minimum threshold value for the background is also considered reasonable for various reasons. One reason, and using an extreme example that is highly improbable in reality, is if a background noise at residences where nil or 0dB(A). In this situation, an industrial noise level received at residences of higher than 5dB(A) (or background 0dB(A) plus 5dB as per the intrusiveness criterion) will not result in annoyance and impact. This is because 5dB(A) is very low and if perceived by our ears at all would be extremely quiet. The criteria in this hypothetical situation would therefore unnecessarily exceed the required level of community protection and unreasonably restrict industrial development. Hence the need for a practical minimum threshold background noise value.

The minimum background noise threshold value of 30dB(A) used by the DEC originated decades ago and has generally proven to be appropriate since its adoption. This value aims to achieve a balance between adequately protecting the community while still leaving scope for industrial development.

It is also appropriate to acknowledge other Australian State noise policies for comparison with NSW. The South Australian EPA, although not officially documented in policy or guidelines, adopts a 30dB(A) minimum background approach similar to NSW.

A more similarly aligned noise policy document to the NSW INP is the QLD EPA Guideline for Noise (August 2004) 'Planning for Noise Control'. QLD EPA recommends a minimum representative background threshold noise level as low as 25dB(A) for the night in 'Very Rural' residential areas. That is, where measurement indicates background noise levels below 25dB(A), a threshold level of 25dB(A) is to apply as representative of the night time period. As a consequence, following the QLD EPA guideline can result in an industrial noise level criterion of 30dB(A) or lower (depending on adjustment factors) for the night time period.

I concur with the EA approach on the basis that it adopts current NSW State policy. For this locality, this approach results in a artificial background 7dB (or more) higher than actual background measured levels for given residences. It must be emphasised that introduced noise sources such as the proposed open cut coal mine will consequently be more discernible in this locality than they might otherwise be.

NOISE AND VIBRATION CRITERIA

Construction Noise Criteria

The Environment Protection Authority's Environmental Noise Control Manual or ENCM (EPA 1994), although officially no longer in circulation, remains as the DEC's guidance document with respect to construction noise impacts. The ENCM provides time restrictions for construction activities due to the inherent 'noisy' and intermittent nature of works, which is perceived to be more annoying than say more steady state noise. It also provides noise level based criteria dependent on the duration of construction, for periods up to six months. However, the proposed construction period will extend beyond six months to twelve months. The EA Noise Assessment does not adopt the ENCM and suggests applying noise level criteria equal to that derived for operational noise. The DEC's submission considers this approach acceptable. This is because of the similarities between some construction works and mining operational activities. An example of this is bulk earth works needed to establish ground for plant infrastructure and the rail loop.

I concur with this approach but also note that there will be works that are unique to construction such as installation of buildings and rail tracks etc. Such activities should be limited to usual construction hours as specified in the ENCM or 7am to 6pm Monday to Friday and 8am to 1pm Saturdays, with no works on Sunday or public holidays. This time restriction need not apply where works are demonstrated to be inaudible at residences, consistent with the ENCM. This time restriction is particularly warranted for this project given the impact predicted from construction activities at a relatively large number of properties.

It should be noted that criteria apply at residences only and at a point anywhere within the residential property boundary, or where this is greater than 30m from a dwelling, 30m from the dwelling.

Operational Noise Criteria

Intrusiveness Noise Criteria

The NSW Industrial Noise Policy (INP 2000) provides suitable guidance on noise criteria for this project. The EA assessment adopts this approach inclusive of all on-site operational noise sources, rail load-out and rail spur movements.

The operational Project Specific Noise Level (PSNL) or criteria for residences is 35dB(A)$L_{eq,15minute}$ for this project. Hence, mine noise levels below 35dB(A) at residences are considered to be acceptable according to the INP. Conversely, noise levels above 35dB(A) are considered to result in impact according to the INP. In my experience the DEC also consider that industrial noise levels greater than 10dB above the background results in significant impact. Therefore for this project, the DEC considers significant noise impact is likely at a level greater than 40dB(A)$L_{eq,15minute}$. This is based on the INP's threshold minimum background noise level of 30dB(A). As discussed earlier, the actual background noise level for residences surrounding the mine site is significantly lower than 30dB(A) during both the day and night time.

It should be noted that intrusive operational noise criteria apply at residences only and at a point anywhere within the residential property boundary, or where this is greater than 30m from a dwelling, 30m from the dwelling.

I concur with the 35dB(A)$L_{eq,15minute}$ limit but stress that at this criterion level the mine will be a significant and highly discernible noise source at residences than it might otherwise be in areas with higher background noise. Furthermore, a level of 40dB(A), used to define significant noise impact, is considered high for this area again due to the relatively low background. It is likely that 'significant impact' threshold will be observed at lower noise levels initially.

Amenity Noise Criteria

The EA assessment correctly adopts the INP amenity criteria for residences. For rural suburban residences, the INP recommends acceptable noise levels as follows:

- Day (7am to 6pm) 50dB(A)$L_{eq,11hours}$
- Evening (6pm to 10pm) 45dB(A)$L_{eq,4hours}$
- Night (10pm to 7am) 40dB(A)$L_{eq,9hours}$

This applies to all industrial noise that may impact residences and therefore requires that these criteria are met on a holistic basis or as a result of all industrial sites cumulatively.

Other identified receiver types in the EA are places of worship. This includes a church on Wybong Road and a church on Castlerock Road. For such receivers the INP suggests an internal noise criteria of 40dB(A)L_{eq} for times when in use. The EA assessment adopts a more conservative criteria of 35dB(A) internal or 45dB(A) external. I concur with the EA approach adopted for Amenity noise criteria.

Road Traffic Noise Criteria

The EA Noise Assessment adopts the DEC's Environmental Criteria for Road Traffic Noise (ECRTN, 1999). This is the DEC's current road traffic noise policy. For new developments with potential to create additional traffic on local roads (eg Wybong Road and Bengalla Link Road) the ECRTN recommends a limit of 55dB(A)$L_{eq,1hr}$ and 50dB(A)$L_{eq,1hr}$ for the daytime and night time respectively. This limit applies to the noisiest hour in each period. The ECRTN recommends that where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. In all cases, traffic arising from the development should not increase existing traffic noise by more than 2dB.

In terms of Denman Road, there exists ambiguity as to the classification of this road in terms of whether it is a collector or sub-arterial with respect to the definitions in the ECRTN. The EA Noise Assessment conservatively adopts the collector road classification and hence a traffic noise limit of 60dB(A)$L_{eq,1hr}$ and 55dB(A)$L_{eq,1hr}$ for the daytime and night time respectively.

It should be noted that a typographical error exists in the EA Noise Assessment Table 3-2, which was subsequently verified to the Panel. The error is the term $L_{eq,5hr}$ and should read $L_{eq,1hr}$.

I concur with the EA's adopted approach but also add that guidance from the NSW RTA Environmental Noise Management Manual (ENMM) should be considered. This will be discussed later.

Main Rail Line Noise Criteria

As discussed earlier, rail spur movements are classified as part of the industrial site in the EA and are correctly assessed that way. For rail movements on the main rail line the EA highlights suitable noise targets that exist in the Australian Rail Track Corporation (ARTC) Pollution Reduction Programs (PRP). The limits therein have been adopted for the proposal and include:

- Daytime 65dB(A)$L_{Aeq,15hour}$
- Night time 60dB(A)$L_{Aeq,9hour}$; and
- Anytime 85dB(A)L_{Amax}

I concur with the EA's adopted approach. However, for this proposal the junction of the spur to main line is near to several residences and application of the above criteria can be blurred with that which applies to the spur and other site activities or the INP 35dB(A)$L_{eq,15minute}$ target. Hence separating out these two sets of criteria will be difficult in practice (eg during compliance if the project is approved). Wherever there is any ambiguity then the Stricter INP Based Limit Should Apply.

Blast Noise And Vibration Criteria

Human Comfort Criteria

The adopted Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines are considered appropriate. This is consistent with recommendations in Australian Standard (AS) 2187 Explosives - Storage and Use Part 2 of 2006. Limits apply at residences and other sensitive receiver locations, and include:

- The maximum blast overpressure should not exceed 115dB(Lin) for more than 5% of blasts in any year, and should not exceed 120dB(Lin) for any blast; and
- The maximum peak particle ground vibration velocity should not exceed 5mm/s for more than 5% of blasts in any year, and should not exceed 10mm/s for any blast.

For reference, the higher the blast noise overpressure the noisier the received sound and the higher the ground vibration the more perceptible the blast.

Structural Damage Criteria – Built Structures

The EA adopted Australian Standard AS2187.2-1993 has been superseded by the 2006 revision.

The EA suggested blast noise overpressure threshold of 133dB(Lin) for damage is considered appropriate and is consistent with the safe limit recommendations in AS2187.2 of 2006.

For the expected blast vibration frequencies (assumed to be 10Hz based on information in Volume 6 Appendix 2 of the EA) the 2006 ground vibration limits are slightly less stringent than the previous 1993 standard and therefore the EA adopts a conservative approach in this regard. The adopted limits are:

- Structures that may be particularly susceptible to ground vibration – 5mm/s;
- Houses and low-rise residential buildings; commercial buildings not included below – 10mm/s
- Commercial and industrial buildings or structures of reinforced concrete or steel construction – 25mm/s

I concur with the EA approach.

Mount Piper 500kv Power Transmission Line

The EA states that operators of the power line, Transgrid, have suggested a ground vibration limit of 50mm/s to apply at the power line towers. This is considerably higher than those identified above for structural damage criteria. However, based on what is understood to be Transgrid's formal advice, this limit is considered appropriate.

Rock Structures – Ground Vibration Criteria

The EA Blasting Assessment makes reference to the RCA Geotechnical Report, which is located in Volume 6 of the EA. This Volume is Appendix 13a of the Aboriginal Archaeological Assessment (Part A). Appendix 2 of Volume 6 contains the RCA report.

The RCA report concedes that, based on preliminary blast ground vibration predictions by Wilkinson Murray Pty Ltd (authors of the EA Noise and Vibration Assessment),

"*blast induced ground vibrations well in excess of the cosmetic damage limit have the potential to cause minor and major damage to the rock shelters and landmark rock structures …*"

The RCA report provides treatment options they state Centennial will investigate as mining proceeds. These options demonstrate the level of concern highlighted by the RCA report. The RCA report also provides in Table 4 Estimated Significant Damage Threshold values for identified rock structures in terms of peak particle velocity (ppv) and measured in mm/s. The threshold is provided as a range of values for some structures. These thresholds range from 90mm/s for Anvil Rock and The Book to 210-280mm/s for a given rock shelter. These thresholds depend on the risk of damage estimation developed for each structure. Table 4 of the RCA report also recommends one or two of the identified treatment options specifically for each structure.

As discussed earlier, the EA Blasting assessment states that the RCA thresholds will be adopted, however, as demonstrated in Table 1 this is not always the case.

Rock Structure Label	RCA Geotechnical Threshold, mm/s	EA Blast Assessment Criterion, mm/s	Discrepancy
AC42	Not provided	220	Unknown
BFC12	210-280	270	Within range, but near upper end.
CG01	90	220	Blast assessment is well above suggested limit.
CG08	190-260	270	Blast assessment is above suggested limit.
CG09	170-240	220	Within range, but near upper end.
CG10	200-260	220	Within range.
WC05	Not provided	270	Unknown
WC25	200-260	220	Within range.
WC26	140-200	270	Blast assessment is well above suggested limit.
WC33	170-220	270	Blast assessment is well above suggested limit.
WC43	140-200	220	Blast assessment is above suggested limit.
WC45	90	220	Blast assessment is well above suggested limit.
AC38	90	220	Blast assessment is well above suggested limit.
WC46	190-260	220	Within range.
WC47	180-230	220	Within range.
WC27	140-200	220	Blast assessment is above suggested limit.
Anvil Rock	90	90	Nil.
The Book	90	100	Blast assessment is above suggested limit.

Table 1 Blast Ground Vibration Targets for Rock Structures – RCA vs EA Blast Assessment

Notwithstanding the above discrepancies, I do not concur with the derived peak particle velocity criteria developed for the EA assessment. These ground vibration criteria are considered too high given the uncertainty surrounding the condition of rock structures and potential impacts from blasting thereon.

My reservations are heightened by the review of the RCA Geotechnical report conducted by Phillip Pells of Pells Sullivan and Meynink Pty Ltd Engineering Consultants Rock-Soil-Water. This review can be found in *Annex B* of this report. I instructed Mr Pells to provide a desktop review for the benefit of the Panel. Mr Pells suggests a precautionary approach to blast induced ground vibration for rock structures and recommends the following:

- Highly Vulnerable (fragile) structures <5mm/s;
- Vulnerable structures 10 to 40 mm/s; and
- Robust structures 100mm/s.

Other references of note include the Wilpinjong Coal Project, which was conditionally approved in February 2006. The proponent of that project adopts 80mm/s ppv as a damage limit for Aboriginal rock shelters. This is said to be based on information in a German Standard DIN4150 Part 3.

Further discussion on potential criteria is provided later in the Noise and Vibration Prediction Section.

ANALYSIS OF METEOROLOGICAL DATA FOR NOISE MODELLING

The Panel was advised that the EA Noise Assessment was based on on-site data collected at Wybong Road between April 2002 and November 2003 inclusive or 21 months. I noted missing data for half o Dec 02 and a quarter of July 03 data, and other minor missing periods. From my experience, a representative minimum data quantity required by the DEC is 12 months. Although the DEC stresses that this is a minimum and that the larger the data set the better representation of long term conditions, and sight 5 years as being an ideal quantity.

I believe the data set is adequate in quantity and is suitably representative as it is local to the site. Although I cannot verify the monitoring device itself and associated hardware and software used to capture the data.

EA Noise Assessment Modelled Meteorological Conditions

Notwithstanding the above, I undertook a detailed analysis of the data provided to the Panel. This was done to review the meteorological conditions accounted for in the EA Noise Assessment. To that end, the Panel was advised that the weather parameters used are the 41 conditions reproduced in *Table 2* below. It is understood that the units for each tabulated parameter are as listed (although this was not provided). The units are unclear for the 'Weighting' column, however the Panel has been advised that this provides an indication of the prevalence of each condition. On this basis I generated the Occurrence (%) column. It is clear that, according to the EA assessment, still winds at night constitute approximately 73% of all conditions (ie sum of the first 4 conditions). This includes times with and without temperature inversions.

Condition	Wind Direction (Degrees from North)	Wind Speed (metres per second)	Inv Strength (Degrees/100m)	Weighting	Occurrence (%)
1	0	0	0	927	4.5%
2	0	0	2	1161	5.7%
3	0	0	4	12668	61.9%
4	0	0	6	112	0.5%
5	0	1	4	270	1.3%
6	45	1	4	309	1.5%
7	90	1	4	210	1.0%
8	135	1	4	184	0.9%
9	180	1	4	130	0.6%
10	225	1	4	204	1.0%
11	270	1	4	283	1.4%
12	315	1	4	365	1.8%
13	0	1	6	5	0.0%
14	45	1	6	79	0.4%
15	90	1	6	27	0.1%
16	135	1	6	1	0.0%
17	225	1	6	15	0.1%
18	270	1	6	3	0.0%
19	315	1	6	8	0.0%
20	0	2	4	149	0.7%
21	45	2	4	13	0.1%
22	90	2	4	60	0.3%
23	135	2	4	134	0.7%
24	180	2	4	39	0.2%
25	225	2	4	39	0.2%
26	270	2	4	532	2.6%
27	315	2	4	794	3.9%
28	0	3	2	30	0.1%
29	90	3	2	9	0.0%
30	135	3	2	6	0.0%
31	180	3	2	2	0.0%
32	225	3	2	2	0.0%
33	270	3	2	302	1.5%
34	315	3	2	422	2.1%
35	0	3	4	36	0.2%
36	90	3	4	11	0.1%
37	135	3	4	37	0.2%
38	180	3	4	6	0.0%
39	225	3	4	5	0.0%
40	270	3	4	361	1.8%
41	315	3	4	501	2.4%
			Total	**20451**	**100.0%**

Table 2 Weather Conditions in EA Noise Assessment – Winter Nights Only

<u>INP Assessable Winds</u>

The weather station data provided to the Panel and said to be used for noise modelling in the EA was analysed in accordance with the DEC's INP.

I was recently involved in a review for the DEC for a pilot wind calculator the DEC is looking to issue as guidance for use with INP assessments. The analysis I have undertaken here is based on a similar calculator developed in-house prior to the DEC's pilot.

The INP requires wind to be assessed where it is a 'feature' of the area. The term 'feature' in the INP is defined as winds of 3 m/s or below occurring for 30 % of the time or greater in any assessment period in any season.

A thorough analysis of the vector components of the 10-minute wind data described above was undertaken. The assessable wind direction is graphically demonstrated in *Annex A* for the 16 standard directions. Where the windrose arm exceeds the 30 % threshold, as indicated by the rose, this direction is considered assessable. The assessable wind speed was also determined in accordance with the intent of the INP and is the upper tenth percentile speed (below 3m/s) for each of the assessable directions. The wind directions and wind speed determined to be a feature of the area in accordance with the INP are summarised in *Table 3.*

It is demonstrated that the assessable winds occur during day, evening and night time, depending on the season.

The highlighted values are those that constitute the highest wind speed for that (standard) direction and therefore the minimum set of conditions that should be modelled for assessment purposes according to the INP. Where day and night operations are the same, only the higher wind speed of those highlighted for a given direction need to be modelled.

The implication for this proposal is most significant for receivers to the north west and west of the site, given the relatively higher wind speeds from the south east and east. This finding is also consistent with Panel member Mr Robin Ormerod's analysis.

Wind Direction	Season	Period	Wind Speed (Upper tenth percentile), m/s
45	Summer	Evening	1.6
67.5	Summer	Evening	2.1
22.5	**Summer**	**Night**	**1.1**
45	**Summer**	**Night**	**1.3**
67.5	**Summer**	**Night**	**1.7**
90	**Summer**	**Night**	**2.2**
112.5	**Summer**	**Night**	**2.4**
135	**Summer**	**Night**	**2.4**
157.5	**Summer**	**Night**	**2.0**
180	**Summer**	**Night**	**1.6**
45	**Autumn**	**Day**	**1.7**
67.5	**Autumn**	**Day**	**2.1**
90	**Autumn**	**Day**	**2.5**
112.5	**Autumn**	**Day**	**2.6**
135	**Autumn**	**Day**	**2.5**
157.5	**Autumn**	**Day**	**2.2**
180	**Autumn**	**Day**	**1.7**
202.5	**Autumn**	**Day**	**1.5**
22.5	Autumn	Evening	1.0
45	Autumn	Evening	1.3
67.5	Autumn	Evening	1.8
90	Autumn	Evening	2.3
112.5	Autumn	Evening	2.6
135	Autumn	Evening	2.5
157.5	Autumn	Evening	2.1
180	Autumn	Evening	1.6
67.5	**Autumn**	**Night**	**1.4**
90	**Autumn**	**Night**	**1.7**
45	Spring	Evening	1.5
67.5	Spring	Evening	2.0
90	Spring	Evening	2.4
112.5	Spring	Evening	2.5

Table 3 INP Assessable Winds – 30% Occurrence or Greater

Temperature Inversions

The same 10-minute wind data (including sigma-theta) was converted to hourly records and used to derive stability class information. This was done by Panel member and Air Quality Specialist Mr Robin Ormerod.

Sigma-theta is defined as the standard deviation of the horizontal wind direction fluctuations and is one of the ways the INP suggests can be used to approximate stability class. Stability class can be used to define temperature gradient (lapse or inversion) information. This analysis suggests temperature inversions are relatively frequent and occur more than the DEC's 30% occurrence threshold for assessment purposes, particularly in autumn and Winter nights. The EA Noise Assessment correctly identifies this for winter and applies a 4 degree per 100m elevation temperature inversion condition as the dominant meteorological condition for noise assessment. In fact the EA suggests this condition (Condition 4 in *Table 2*) occurs approximately 62% of the time during winter nights (refer to *Table 2*).

Other statistics of interest include capture of 9288 10-minute winter night records out of a possible 9936. This equates to 93% of data captured over the two winter seasons of 2002 and 2003. Of this data, 52% of winter nights are calm conditions (ie wind speeds less than 0.5m/s) and only 15% above 3m/s, and therefore ideal for high occurrence of temperature inversion conditions.

Comparison And Implications – EA Vs INP Assessable Weather Conditions

With respect to weather consideration, the EA noise modelling methodology is a divergence from the INP. In my experience the DEC has in the past accepted a similar approach, including one that I have been involved with, which included a simulation of 198 meteorological conditions and derivation of 10% occurrence noise levels. My experience with several local coal mine noise assessments is that the two methods can result in similar findings and in some cases using the 198 meteorological conditions approach can be conservative, and is considered to provide a more realistic assessment. The EA approach simulated 41 weather conditions for winter nights only. In my opinion, and consistent with the INP, it is important to consider the whole year so that all seasonal effects are addressed. This is discussed further below.

I provide the following comments on the EA method:

- It focussed on winter night time conditions as it is often regarded as the worst case time of the year for noise propagation due to the presence of moderate to strong temperature inversions. Whilst this is true, the INP requires analysis and consideration of all periods day, evening and night for all seasons. The results of my analysis above show that winds are a 'feature' of the area during Summer, Autumn and Spring, whilst winter nights include a large proportion of relatively still wind conditions and therefore little by way of assessable winds. Consequently, the data demonstrates that winter nights have relatively high occurrence of temperature inversions. The EA Noise study identifies and assesses this, and ultimately defines the level of noise impact almost exclusively on the basis of noise propagation for a 4 degrees per 100m elevation inversion condition. That is, the quoted tenth-percentile noise levels in the EA are based mostly on this weather condition.

- It attempts to more closely simulate actual winter night conditions as it includes an approximation for all weather conditions. However, this is represented by a total of 41 sets of weather parameters. This resulted in modelled conditions such as winds up to 3m/s combined with a temperature inversion of up to 4 degrees per 100m elevation;

- Assigning of percentage occurrence to each of 41 sets of weather conditions to derive a tenth percentile noise level, which is assessed against criteria and used to define potential impact. Whilst the weather conditions capture reasonable to worst case weather situations, the weighting assigned to each appears to heavily favour still winds with strong temperature inversion conditions. This results in a 10% occurrence noise level (used in the EA to define impacts) that does not necessarily reflect INP assessable winds;

- The Weighting to each of the 41 weather conditions results in calms constituting approximately 73% of winter night data, whereas my analysis shows this to be 52%. It is unclear why this difference is so large.

In summary, I believe that the INP assessable wind conditions have not been adequately accounted for in the EA assessment. The implication of this is a marginal under estimation of noise levels as will be discussed later in the Predicted Noise and Vibration Levels section. However, this marginal under estimation may translate into potentially more properties exposed to noise exceeding criteria than otherwise stated in the EA.

PREDICTED NOISE AND VIBRATION LEVELS

Construction Noise

The predicted construction noise levels exceed the 35dB(A) adopted criterion at forty-seven of the 282 nominated receiver locations. At twenty of these receiver locations, noise levels exceed 40dB(A), with noise levels of up to 54dB(A) reported.

It should be noted that construction plant for the rail spur was not modelled in a location representative of worst case for receivers immediately south (refer Figure 6.1 in EA Noise Assessment report). Hence, impacts will be higher than those presented in the EA at these receivers for times when works are being carried out on the spur nearer the main line. The predicted construction noise level at one such location (Receiver 78) is 42dB(A) or 7dB above the adopted criteria. The construction noise associated with the rail spur is therefore expected to be higher at this location with works and plant located further south and closer to this property. In my experience construction noise impacts would not normally trigger acquisition. However, such noise impacts should be mitigated where it is reasonable and feasible. Mitigation can include temporary shrouding of equipment and offering impacted residents architectural treatment.

Mine Operational Noise

As described earlier, the operational Project Specific Noise Level (PSNL) or criteria is 35dB(A) for this project. Also, significant noise impact is likely at a level greater than 40dB(A). This is the approach adopted in the EA.

My opinion is that for this particular locality, due to the sub 30dB(A) background, significant impact is likely to occur below 40dB(A).

The EA predictions clearly demonstrate noise impact at a considerable number of private residential properties (notwithstanding discussions on assessable weather earlier). The number of affected residences varies depending on the mine stage. *Table 4* summarises the impacts with respect to the number of properties.

Noise Exceedance	**Management generally required at this level of exceedance**	**No. of private properties**		
		As at EA date	**As at EA date, exc. those with noise agreement**	**As at date of this report, exc. those with noise agreement** (21/12/06)
Marginally Affected Residences (1-2dB exceedance)	Noise mitigation, if possible	37	36	35
Moderately Affected Residences (3-5dB exceedance)	Noise mitigation, inc. noise mitigation at residence	36	35	34
Significantly Affected Residences (>5dB exceedance)	Acquisition	82	71	39
Significantly Affected Vacant Land (>5dB exceedance)	Acquisition	24	17	10
Subtotal - Significantly Affected Properties	**-**	**106**	**88**	**49**
Total Properties Exceeding Noise Criteria	**-**	**179**	**159**	**118**

Table 4 Summary of Noise Affected Properties

In all, the EA reports that 71 private residences (and without agreement with Centennial) will be exposed to noise levels greater than 40dB(A), whilst a further 71 private residences will be in the 35 to 40dB(A) noise range. The potential number of residences impacted is unprecedented to my knowledge in recent times.

The Panel was advised that the EA mine operational noise contours are based on interpolation of predictions at each of the 282 single point receiver locations. Traditionally, ENM (the predictive software used for the EA assessment) would be used to generate noise contours from a finer grid (50m by 50m) of automatically generated receptor locations based on the three-dimensional mine plans and surrounding topography. Hence, care should be exercised when defining noise affectation areas on the basis of noise contour figures in the EA, particularly for areas where receiver locations are relatively sparse.

The Panel understands that negotiation between Centennial and property owners has occurred subsequent to the EA. This has resulted in either purchase of properties or agreement between the parties in respect of potential future impacts. This does not change the predicted noise affection area or potential properties impacted.

Table 4 shows that as of 21 December 2006:

- 39 private residences and a further 10 vacant private properties remain within the significantly affected noise area (ie >40dB(A)); and

- 69 private residences remain within the area where noise levels are predicted to exceed the DEC criteria by up to 5dB ie bet 35-40dB(A). Such properties are typically referred to as being in the 'noise management zone'. These are properties whose owners do not have agreements with Centennial.

The INP requires that all reasonable and feasible noise mitigation be applied to achieve operational noise criteria (ie 35dB(A) in this case). Where this cannot be achieved initially, noise impact must be carefully managed and reduced to within this criterion over time. This typically done through say a Pollution Reduction Program (PRP) spanning not more than 5 years.

In addition to noise contours, the EA provides predicted tenth percentile occurrence noise levels at the 282 nominated receiver locations. The highest predicted noise levels are 61dB(A) at receiver Location 1 and 62dB(A) at receiver Location 13. These are very high levels of industrial noise usually experienced adjacent to industrial facilities. It is understood that these two properties contain private dwellings and that no agreement exists between Centennial and these residents (at the time of writing this report).

It should also be noted that sleep disturbance is predicted at all residences where operational noise levels are above 40dB(A).

<u>EA Noise Model Sensitivity Analysis</u>

As a general note, the quantity of representative mobile plant listed in the EA Noise Assessment is critical to the predictions, as is the location of such in a geographical sense with respect to residences. To that end, in my experience the quantity of plant identified and modelled appears small with respect to an operation of this capacity or up to 10.5Mtpa coal production. Nonetheless, it is accepted that this is a representative fleet of equipment for noise modelling purposes.

A sensitivity analysis was undertaken for Year 10 Coal mining operations only in the north pit for Receiver 39, chosen arbitrarily. The location of receiver 39 is to the north west of the site on Ridgelands Road and it is shielded from the mine site by natural topography.

The modelled plant included a drill, excavator and bull dozer. This activity in this area of the proposed mine is one of the dominant noise sources for this receiver area. This is based on my review of the detailed breakdown of noise source contributions provided to the Panel.

Effects of Temperature Inversions

For calculation purposes I used the most prominent weather condition as determined in the EA Noise assessment of zero wind speed and a 4 degrees centigrade per 100m temperature inversion (4^0 C/100m). This is Condition 3 in *Table 2* and according to the EA occurs for 61.9% of winter nights. Other meteorological conditions were set as per the ENM input files provided and included air temperature of 10^0 C and 90% humidity. I calculated a noise level of 34.5dB(A) from these three plant items. I did this using the ENM predictive software, which was also used in the EA assessment, and using ENM input files as provided to the Panel. My calculations were confirmed with the EA noise specialist. The corresponding tenth percentile noise level, as defined in the EA Noise assessment, for this group of sources alone is 33.9dB(A). This was also provided to the Panel in the breakdown of noise levels for each receiver.

It is demonstrated therefore that, for this receiver north west of the site, the tenth percentile noise level is marginally (0.6dB) lower than that during the presence of the aforementioned inversion condition. This appears to be a time based statistical correction.

It should be noted that this is only one portion of the mine noise and that inclusion of other proposed activities results in higher noise levels at this receiver. To that end, the tenth percentile noise level reported in the EA for the combination of all mining operations for Year 10 night time is 41dB(A) at this receiver.

My opinion is that given the relatively high occurrence of such an inversion condition (61.9% as per Condition 3 in *Table 2*), this is one weather condition that results in representative noise levels, suitable for understanding the potential for noise impact. In addition to the 10% noise levels in the EA, noise predictions under such an inversion should also be used to define noise levels to be assessed against criteria.

Additional information was provided to the Panel indicating the relative difference between received noise levels for particular Year 15 operations under a 4^0 C/100m as compared to the corresponding 10% noise level. As the actual total received noise level from all activities was not provided, it was not possible to conclusively determine a difference between the two results. However, the information provided does demonstrate that for certain receivers the 10% noise levels for certain operations are higher than that for an inversion of 4^0 C/100m. For other receivers the 10% noise level is lower. Hence, it is not possible to simply apply a standard correction to all the predicted noise levels presented in the EA, as this varies for different receiver locations.

The **recommendation** therefore is to remodel using the 4^0 C/100m weather condition to assist in better defining potential noise impact. Alternatively, rely on thorough noise monitoring to determine the extent of impacted properties.

INP Winds and Noise Enhancement

Taking the above analysis further, I investigated the effect of one of the INP assessable wind conditions for receiver Location 39. For this receiver, applying a 2.5m/s wind from the south east (or 135 degrees from north), with zero temperature gradient, would result in the most enhancement of noise. As detailed in *Table 3*, this condition occurs for more than 30% of the time during autumn days, with a similar condition during summer nights.

Applying this wind speed and direction in the ENM model, the noise from north pit coal plant alone is calculated as 35.4dB(A). This is a further 0.9dB higher than that for a 4^0 C/100m temperature inversion condition alone, defined earlier. Hence, for receivers to the north west of the mine, according to this analysis, my finding is that the mine noise levels quoted in the EA are potentially 1.5dB below what I consider as representative.

This increase is again considered marginal and therefore inconsequential in terms of noise level. Such variations in noise level are within reasonable modelling accuracy. To that end, the ENM software developer quotes an accuracy of ±5dB.

However, for this particular site there are many receiver locations that are located in areas potentially impacted by mine noise. Therefore, defining a 'line-in-the sand' for noise impact using modelling becomes critical. For example, the EA has defined this line as the 40dB(A) noise contour. Applying the above 1.5dB modelling underestimation for residence to the north west will result in more properties identified as inside this 'line' or significantly impacted. As with inversion effects, it is not possible to simply apply a standard correction to all the predicted noise levels presented in the EA, as this varies for different receiver locations. Importantly though, the noise criteria does not change and therefore the actual impact once measured and verified retrospectively will ultimately define the impact area.

The **recommendation** therefore is to remodel using the INP winds derived earlier in Table 3 (eg 2.5m/s from the south east and east) to define potential noise impact for receivers to the north west and west of the site. Alternatively, rely on thorough noise monitoring to determine the extent of impacted properties.

Notwithstanding the above, where noise compliance monitoring demonstrates an exceedance of 40dB(A), the same negotiated agreement and or acquisition provisions should apply.

In addition to private residences inside 40dB(A), it is **recommended** that those private residences in the 35 to 40 dB(A) noise zone are offered noise mitigation such as architectural building treatment and air conditioning.

ROAD TRAFFIC NOISE

Project Related Traffic Noise

The EA states that due to the proposal the expected increase in road traffic volumes on Wybong Road and Bengalla Link Road, will result in a significant increase in related traffic noise levels. These increases are 7dB and 11dB for Wybong Road and Bengalla Road respectively.

In my opinion such increases will be highly noticeable given the current low ambient noise environment. This is a view consistent with the DEC's submission.

The EA indicates that predicted peak hourly traffic noise levels at Wybong Road and Bengalla Link Road will exceed DEC recommended criteria by up to 1.5dB. The EA recommends that monitoring be undertaken to check such predictions and mitigation offered to affected residences if levels are above DEC criteria.

A submission was made in respect of the calculation algorithm used in the traffic noise predictions. The two commonly used algorithms are the UK based Calculation of Road Traffic Noise (CoRTN) and US based Federal Highways (FHWA). The EA adopted CoRTN is often said to be inaccurate at relatively low traffic volumes. However, both algorithms have limitations, and adoption of either should be justified through actual validation or supported by literature. The Panel accepts use of CoRTN in this case for reasons described later, but also acknowledges that it is common practice to use the FHWA for relatively low volumes.

The proponent's response to this submission concludes the two methods are within 1dB of the other and therefore are in general agreement.

I conducted my own sensitivity analysis on the two methods for the stated volumes for Receiver 168 on Wybong Road, selected arbitrarily. There exists some ambiguity as to the 'soft' versus 'hard' ground parameter setting that should apply between the two methods. Nonetheless, the resulting discrepancy is either zero dB or up to 2.6dB. That is, the analysis indicates that CoRTN (and therefore the EA) calculation can be up to 2.6dB lower than that for FHWA for the relatively low volumes on Wybong Road. This suggests the EA traffic noise levels may be underestimated.

I conclude that the main issue here is firstly that there will be a marked increase in traffic noise for Wybong Road and Bengalla Link Road residences, which is likely to create concern. The level of impact and exceedance of suitable criteria, whether 1.5dB as stated in the EA or 4dB, is best determined through monitoring as suggested in the EA.

I concur with the EA in that where traffic noise levels are measured to be above DEC criteria then building architectural treatment should be offered to protect internal noise amenity. In saying this, it should be noted that the DEC criteria is externally based and therefore architectural treatment will not result compliance with such criteria.

<u>Maximum Traffic Noise Levels</u>

Table 7-11 of the EA Noise Assessment provides calculated Lmax noise levels from heavy vehicle pass-bys. This highlights the potential of sleep disturbance to residents on Wybong Road and Bengalla Link Road. It is suggested that "*health and well being will not be significantly impacted*" as a result of the assessment.

I do not concur with this finding given calculated internal noise levels are above 55dB(A) in some cases. At noise levels below 55dB(A) awakening reactions are unlikely according to the research in the DEC's ECRTN. This coupled with the relatively low ambient noise environment and low existing traffic volumes suggests mitigation (eg building architectural treatment) should be offered for residences adversely impacted. To that end, existing traffic volumes on Wybong Road are typically not more than 26 vehicles an hour as compared to 125 per hour for peak operational shift change.

<u>Cumulative Traffic Noise</u>

The EA states that cumulative traffic noise impact as a result of the proposal and proposed Mount Pleasant Mine is significant.

For Wybong Road, traffic noise levels remain relatively unchanged as compared to the impacts highlighted as a result of Anvil Hill project alone. This is possibly due to relatively small movements of Mount Pleasant mine related vehicles on Wybong Road.

For Bengalla Link Road residences, cumulative traffic noise levels are higher. Although only 1 additional receiver is predicted to be impacted as a result of both projects as compared to Anvil Hill alone.

The cumulative assessment assumes Mount Pleasant traffic is part of 'existing' traffic. This artificially inflates existing traffic noise levels and reduces the net increase in traffic noise as a result of Anvil Hill. With a higher existing traffic noise, a DEC allowance criteria can be adopted. For this situation allowance criteria for receiver Locations 203F and 203G on Bengalla Link Road are adopted. This results in compliance with such allowance criteria at 203G and only a marginal exceedance at 203F. I do not concur with the assumption that Mount Pleasant traffic is existing traffic. However, the consequences of such an assumption are not significant.

The traffic noise impact due to Anvil Hill alone at Bengalla Link Road residences is not as significant as that due to potential Mount Pleasant traffic. Nonetheless, exceedance of criteria due to Anvil Hill is highlighted at 203G and hence I **recommend** mitigation should be offered for this residence and those exceeding DEC criteria along Wybong Road.

Main Rail Line Noise

The EA Noise assessment identifies two additional residences that will be impacted as a result of rail movements on the Anvil Hill to Mount Pleasant section and Bengalla to Muswellbrook. These additional impacts are as a result of the project and are for the night time period. It should also be added that the project is proposed to add 6 daytime and 4 night time movements to the rail network.

This issue highlights the 'creeping' effect of rail traffic and therefore rail noise impact in the Hunter. A consolidated approach to noise mitigation is needed, lead by ARTC and having buy-in from all major rail users.

BLAST NOISE AND VIBRATION

Human Comfort

The EA assessment identifies 23 residences likely to experience ground vibration levels above recommended criteria. Also, 21 residences are predicted to experience blast noise overpressure levels above criteria. These receivers are said to be a subset of those impacted by operational noise and dust also.

Structural Damage

It is unclear which dwellings are likely to be subject to structural damage due to blasting (from either noise overpressure or ground vibration).

From Figure 8.3 of the EA Noise assessment, it can only be concluded that dwellings inside the 5mm/s blast induced ground vibration contour prediction are likely to be damaged to some degree.

The adopted damage limit of 50mm/s for the Transgrid 500kV power transmission towers is said to be exceeded. In fact the EA quotes that "*Several of the pylons have predicted blast vibration levels significantly exceeding the proposed maximum level.*" However, specific calculated vibration levels at pylons are missing from the EA.

It is **recommended** that privately owned residences inside the 5mm/s blast contour are inspected prior to commencement of any blasts and inspected again after blasting in areas nearest to these homes. This should be done irrespective of the existence of agreements between the resident and Centennial. Where damage is identified, repairs should be undertaken at the expense of Centennial.

Notwithstanding the above, blast times should be strictly limited to daytime only (ie 9am to 5pm).

Rock Structures

The EA highlights blast induced ground vibration levels in excess of adopted limits during the latter part of mining when blast locations are closest to such rock structures.

The EA particularly notes significant exceedances at Anvil Rock and The Book structures.

The potential impact on Aboriginal rock shelters and other rock features in the area remains significant. In my opinion the risk of potentially significant damage to rock structures remains high.

My **recommendation** is to adopt a precautionary approach. In the earlier stages of mining when blasting is stated to occur furthest from rock structures, all blasts are to be monitored and ground vibration transmissibility better defined. This will allow more accurate and site specific predictions of future blasts. During such early blasts, appropriate qualified persons must inspect the rock structures of significance to better understand effects of the blasting on these structures. This is consistent with recommendations in the EA. However, this will need to include ground vibration monitoring at the structures so that effects can be analysed with respect to actual blast ground vibration levels at the structures. From this information a threshold ground vibration limit may be derived depending on the results of this analysis. Notwithstanding this, where from derived site specific predictions, identified rock structures of significance are predicted to be exposed to ground vibration above 40mm/s ppv, monitoring of these structures should be carried out. Such monitoring is to include ground vibration levels at the structures and inspection of rock condition before and after each blast. Where such monitoring identifies and demonstrates ppv limits above 40mm/s is not likely to cause damage, then higher limits may be able to be applied

NOISE MITIGATION

At Source Mitigation

Section 2.4 of the EA noise assessment outlines several mitigation options that were considered. This included the following:

- Restrict truck and dozer movements at night time to below maximum elevation of overburden emplacement areas. This was further clarified such that these plant would operate at approximately half the height of such overburden dumps. This was adopted.

- Infrastructure plant noise – through a combination of cladding and locating plant in shielded topography. This was adopted.

- Rail spur noise – part of the rail loop is in cut and therefore shielded from residences. To the south, where the spur emerges from the cutting, a solid 4m high fence is proposed along the eastern side and extends to where the spur meets the main line.

- Restriction of operations during adverse weather conditions. This was not adopted due to the excessive occurrence of adverse weather. Hence, such a restriction would not be viable for the project.

- Trolley assist system. This allows haul trucks to use power from fixed over head power lines and allowing the diesel engine to simply idle. This was not adopted given the limited length of haul roads within the mine.

It is **recommended** that a comprehensive real time noise and wind data monitoring program be developed and implemented. This will include real time noise monitoring at several locations representative of the most exposed residences at the time. Together with real time weather data, this should be available and used by operators to modify operations as appropriate to reduce noise impact wherever possible.

Mitigation In The Source-To-Receiver Path

The EA assessment found that bunding on overburden emplacement areas was not as effective as limiting truck and dozer elevations. We understand that this is due to practical considerations. Hence bunding was not adopted. It is well established that barriers such as bunding or other, are not effective in adverse weather conditions.

At Receiver Mitigation

For traffic noise impacts the EA suggests building architectural treatment be adopted.

The main form of noise mitigation described in the EA and subsequent information provided to the Panel is property acquisition or forming agreements with residents predicted to be significantly impacted by mine operational noise. This is a common practice by large scale industry such as mines. However, it is worth re-iterating that the scale of impact identified in the EA is unprecedented.

It is **recommended** that agreements should be in place with all residents whose properties are identified as being significantly impacted by the proposal prior to commencement or that the pursuit of such an agreement is given highest priority. The definition of significant impact is described earlier and is consistent with that used for other mines in the Hunter. For example, an operational noise level of 40dB(A)$L_{eq,15minute}$.

There should also be provision for architectural treatment for properties predicted to exceed 35dB(A), as this is the level where impact starts according to the DEC's INP. This is of particular concern for this locality due to the unusually low existing background noise levels.

Modifying Mining Operations

An analysis was undertaken by breaking down the various operational activities within the mine. This allows the noise contribution to be quantified for each activity. This was done again for Receiver 39 as shown in *Table 4*.

As stated earlier the tenth percentile noise level determined in the EA and used to assess impact at this receiver is 41dB(A). The breakdown in *Table 4* shows that Coaling and Overburden activity in the North Pit are the main contributing noise sources for this receiver location (at 34dB(A) and 35dB(A) respectively). This would also apply to those residences in the vicinity of this location. The results also demonstrate that cessation of either of these two activities, so that they do not occur concurrently, provides a marginal 1dB reduction to total received noise.

Similarly, cessation of say Overburden activity in the Tailings and North Pit results in a 2dB reduction. Many other permutations of activities can be used to achieve similar outcomes. However, some may not be considered practical from an operational perspective. It should be noted that these simulations are based on the results in the EA and do not consider ramifications of potential underestimation of noise levels identified earlier. The simulations demonstrate that only a minor reduction in overall received mine noise can be achieved.

Source	EA 10% Noise Level	Modification 1	Modification 2	Modification 3
Push Dozer (Main Pit)	30	30	30	30
Push Dozer (North Pit)	29	29	29	29
Coaling (North Pit)	34		34	34
Haul (North Pit)	29	29	29	29
Overburden Plant (Main Pit)	32	32	32	32
Overburden Haul (Main Pit)	31	31	31	31
Overburden Plant & Haul (South B Pit)	26	26	26	26
Overburden Plant & Haul (Tailings Pit)	32	32	32	
Overburden Plant & Haul (North Pit)	35	35		
Infrastructure & Rail	22	22	22	22
Total	**41**	**40**	**40**	**39**

Table 5 Modification of Mining Operations Test - Receiver 39

In conclusion, there appears to be very limited benefit gained from modifying isolated operations in varies areas of the mine.

CONCLUSION

This report considers relevant submissions, responses to submissions and the EA assessment. The prominent issue identified in the EA and this Panel is the potential number of residences impacted by the proposal due to construction, operational and road traffic noise levels, as well as blast noise and vibration. It is acknowledge that the proponent has embarked on a campaign to mitigate impacts through property acquisition and negotiated agreements with potentially affected property owners.

However, a relatively large and unprecedented number of properties (39), predicted to be significantly impacted, remain without such agreements. Agreements should be in place with all residents whose properties are identified as being significantly impacted by the proposal prior to commencement or the pursuit of such an agreement must be given highest priority.

Also of importance is the relatively large and unprecedented number of private residences (69) predicted to be within the mine operational 'noise management zone'. These are properties also without agreement with Centennial. Managing noise impact at these properties will be extremely challenging.

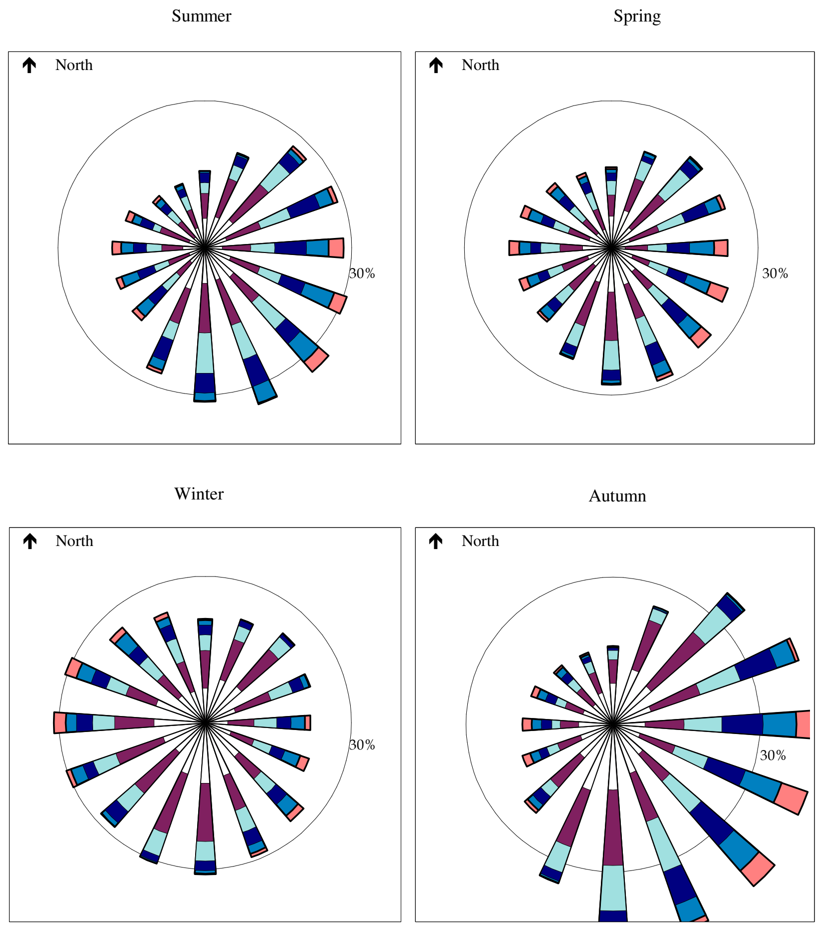
It is clear that the mine noise will change the noise climate at surrounding properties and therefore impact on the residents lifestyles.

Other issues of importance include structural damage to aboriginal rock shelters and valued rock features. A strict precautionary approach must be adopted for blast impacts as described in this report.

Annex A

INP Wind Rose Analysis

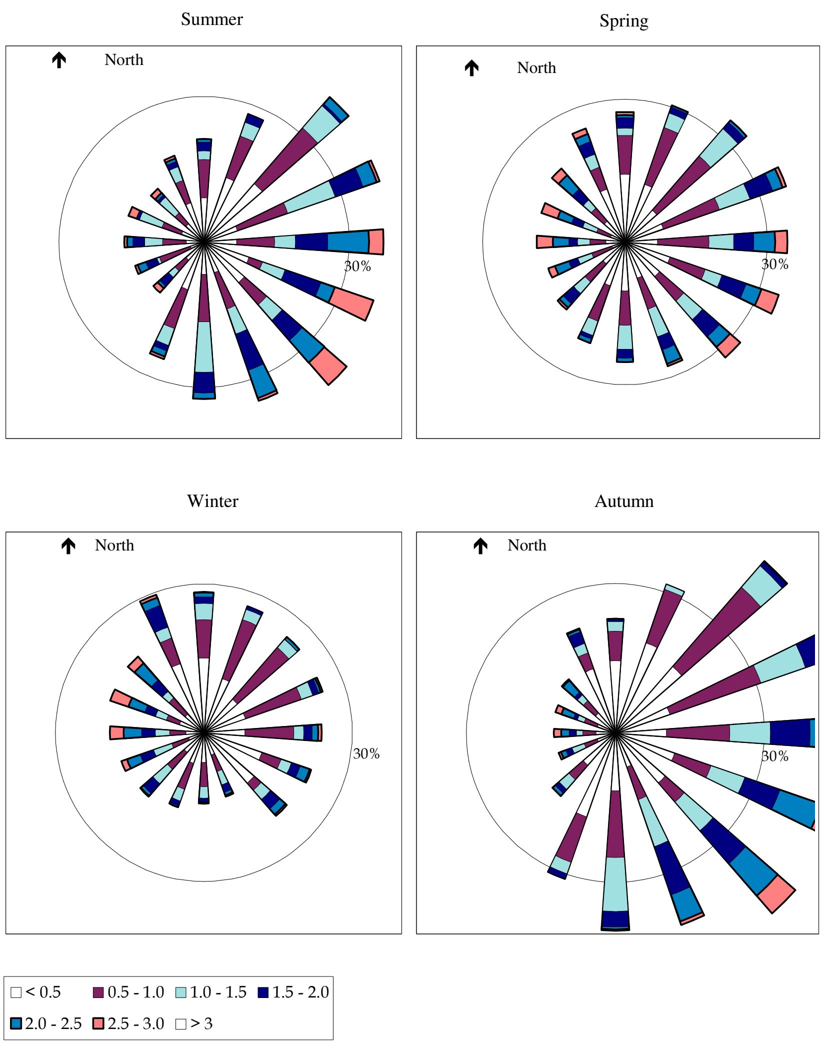
Day



The segments of each arm represent the six valid wind speed classes, with increasing windspeed from the centre outwards. The length of each arm represents the vector components (for each direction) of wind speeds 3m/s or below as a proportion of the total time for the period .
The circle represents the 30% occurrence threshold.

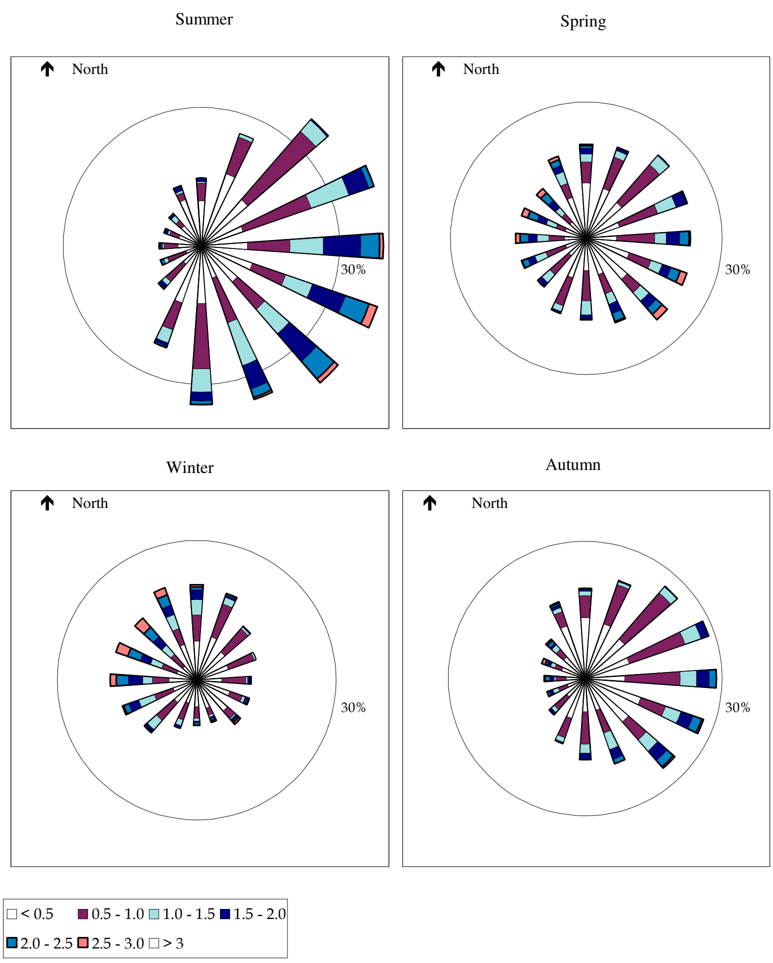
Data Source: Anvil Site at Wybong Rd
Data Range: 10 min, 01-04-02 to 30-11-03

Evening



Summer
North
30%
Spring
North
30%
Winter
North
30%
Autumn
North
30%
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
> 3

Night


Summer
Spring
Winter
Autumn
North
North
North
North
30%
30%
30%
30%
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
> 3

Annex B

Pells Sullivan Meynink Pty Ltd - Review of EA Geotechnical Report

PSM

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Our Ref: PSM1077.TL1
Date: 15 November 2006

Environmental Resources Management
Ground Floor, 33 Saunders Street
PYRMONT NSW 2009

ATTENTION: MR N ISHAC

Dear Sir

RE: ANVIL HILL PROJECT – BLASTING IMPACTS ON ROCK SHELTERS

1. INTRODUCTION

As requested in an email dated 9 November 2006, PSM has reviewed Appendix 2 of Volume 6 – Appendix 13a of the Anvil Hill Project Environmental Assessment.

Appendix 2 is titled "Geotechnical Report for Rockshelters". This document seeks to address the risk of damage to various caves and overhangs (termed "rockshelters") arising out of blast vibrations.

2. METHODOLOGY

2.1. Mapping of the Rockshelters

Appendix 2 provides geometric and geotechnical mapping of 18 rockshelters. This documentation is considered to be appropriate and indicates that many of the shelters represent differential weathering of massive conglomerate. However, some represent weathering of clay rich beds within the Triassic rocks, and there are associated inclined and near vertical joints.

2.2. Procedure for Assessment

The procedure used by the Consultants in evaluating the risk to the shelters is difficult to follow but appears to be (from Appendix D of Appendix 2):

STEP 1 Determine a "damage threshold Peak Component Particle Velocity (PCPV)" based on ACARP Report C9040. This PCPV value also appears to be called "Estimated Significant Damage Threshold for Rock Strctures" (Table D1).

STEP 2 Determine an "Estimated Risk of Damage" (see pages 10 and 11 of Appendix 2), apparently based on a subjective assessment of the morphology and roof conditions of the shelters.

The writer considers that there are three issues with Steps 1 and 2, namely:

(a) ACARP Report C9040 "Structure Response to Blast Vibrations" refers to the response of "brick veneer test houses in the Muswellbrook and Singleton areas".

(b) The Consultants give two sets of definitions for categorising damage limits (or thresholds as they term them). Firstly in Appendix D they provide the following table:

The assumed damage threshold for the rock shelters/structures are as follows:

Cosmetic damage likely to occur at PCPV & frequency given in AS2018.2-2006 Figure J4.4.2.1
Minor damage is likely to occur when mass concrete tensile strain exceeded
Major damage likely to occur when mass concrete compressive failure strain exceeded

However, in Section 5.4 of the main body of Appendix 2 they define a different category, 'significant damage threshold' (line 2 of Section 5.4).

"Significant damage is defined as blast induced impacts that significantly increase the risk of instability or impact the structural integrity of the rock shelters and landmark rock structures, resulting in the loss of amenity to the rock shelters and change in the appearance of the landmark rock structures.

In the writer's view the second definition is partially "circular" in that it appears to say that significant damage is significant damage. It is also not clear how this 'significant damage threshold' relates to the 'cosmetic', 'minor' and 'major' thresholds in the previously quoted table.

Matters are made even more confusing by the Risk table in Section 5.3 (used for Step 2) that also adopts the terms 'cosmetic', 'minor' and 'major', namely as follows:

Table 1 Risk Level Implications

Risk Level		*Example Implications*[(1)]
H	*High Risk*	*Major Damage is possible as a result of blast impact. Major damage defined as rock shelter roof fall/ collapse or change in appearance of landmark rock structures.*
M	*Moderate Risk*	*Minor damage is possible as a result of blast impact. Minor damage is defined as the formation of new defects in the rock mass and possible detachment of "hanging" joint blocks.*
L	*Low Risk*	*Cosmetic damage is possible as a result of blast impact. Cosmetic damage is defined as an increased rate of sloughing of the weathered crust from weaker sandy beds/lenses and the propagation of existing defects along joints and bedding partings.*

Note: (1) Damage classification adapted from AS 2187.2-2006 Table J4.4.2.2 attached in Appendix B of this report and potential blast induced damage consequences as discussed in section 5.2 of this report.

(c) The Consultant's make the assumption that the weathered, jointed, Triassic rock (conglomerate and clay rich beds) can be evaluated as equivalent to mass concrete.

The writer is not aware of any test of observational data that would provide justification for this assumption.

2.3. Conclusions Reached by the Consultants

Notwithstanding the difficulty the writer has in following the procedure used by the Consultants it is quite clear from their Table D1 that they do not expect "Significant Damage" (see definition in 2.2, above) at peak particle values of:

- < 90mm/sec for 6 shelters
- ≤ 140mm/sec to 200mm/sec for 3 shelters
- ≤ 170mm/sec to about 250mm/sec for 2 shelters
- ≤ 180mm/sec to 280mm/sec for 7 shelters.

It would appear that the prime source for these peak particle velocity levels is AS 2187.[1]2-2006. However, it is not at all clear to the writer as to how AS2187.2-2006 can be used to justify the values listed in the bullet points above.

3. OPINION

The writer is not aware of research or observational data relating to the stability of the cliff faces, overhangs and 'shelters' in relation to blast induced vibrations[2]. Such natural features have formed over the geological time scale and their level of stability is very

[1] AS 2187.2-2006 is also used to calculate the Vibration Periods for the shelters. The writer is not aware that AS2187.2-2006 is intended for application to such natural geological features that are part of the ground.
[2] It is possible that such data has been collected or could be collected at a place such as Ulan Mine where there are rock shelters within the potential zones of blasting influence.

difficult to assess. Some are clearly fragile and yet remain in position for centuries, some appear robust and then suddenly collapse due to the presence of some joint or fissure that was not apparent. In the writer's view a prudent approach would be to adopt the limits typical for relatively sensitive man made structures.

It may be possible, by observation, to assign a scale of 'vulnerability' to the various shelters thereby applying different criteria to different shelters. However, notwithstanding this it would in the writer's opinion, be appropriate to select guidelines from typical tables such as those reproduced below from References 1 to 3. These give a wide range of values, with USA based guidelines being far more bullish than European Guidelines, but given that there is little or no published data on rock overhangs prudence would dictate values of the following order:

Highly Vulnerable (fragile) shelters	<5mm/sec
Vulnerable Shelters	10 to 40mm/sec
Robust Structures	≈ 100mm/sec

Table 4. Typical vibration criteria addressing building damage.

Category	Source	Particle Velocity mm/s (in/s)
Industrial Buildings	Wiss (1981)	100 (4)
Buildings of Substantial Construction	Chae	100 (4)
Residential	Nichols, *et al.*, Wiss (1981)	50 (2)
Residental, New construction	Chae	50 (2)
Residential, Poor Condition	Chae	25 (1)
Residential, Very Poor Condition	Chae	12.5 (0.5)
Buildings Visibly Damaged	DIN 4150	4 (0.16)
Historic Buildings	Swiss Standard	3 (0.12)
Historic and Ancient Buildings	DIN 4150	2 (0.08)

Table 4 from Reference 1

Table 4.2.3 DIN 4150 - Structural Damage - Safe Limits for Building Vibration

Group	Type of Structure	Vibration Velocity in mm/s			
		At Foundation At a Frequency of			Plane of Floor of Uppermost Storey
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note: For frequencies above 100 Hz, the higher values in the 50 Hz to 100 Hz column should be used

Table 4.2.3 from Reference 2

TABLE I

PROBABLE DAMAGE ASSOCIATED WITH VARIOUS VELOCITIES

Velocity in/s	Velocity mm/s	Probable Degree of Damage
above 7.5	190	Major — serious structural failure through cracking, distortion or shifting.
above 5.5	140	Minor—no apparent weakening of the structure; glass, plaster, masonry damage.
above 4.0	100	Threshold — very minor perceptible damage, plaster cracks, dislodgement of loose objects.
below 2.0	50	Recommended safe vibrational level (by USBM and used by others, including UK).

Table 1 from Reference 3

TABLE II (German Standard)

VIBRATION LIMITS PROPOSED BY DIN 4150
(8-80 Hz)

Class of Building	Type of Building	Max Velocity (v_m)* mm/s
I	Historical and ancient buildings, ruins and monuments	2
II	Buildings visibly damaged, cracked	4
III	Structurally sound buildings (technically in good order)	8
IV	Industrial buildings, concrete buildings — generally without plaster	10-40

*$v_m = \sqrt{v^2_{xm} + v^2_{ym} + v^2_{zm}}$ See page 3

Table 11 from Reference 3

Please contact the undersigned if we can be of further assistance in this matter.

For and on behalf of
<u>PELLS SULLIVAN MEYNINK PTY LTD</u>

<u>P.J.N. PELLS</u>

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2. Richard Heggie Associates Pty Ltd Report 5311-R1. West Ryde Stormwater Tunnel – Noise and Vibration Impact Assessment, 6 March 1996.

3. Tynan, A E. Ground Vibrations: damaging Effects to Buildings, 1973.