Project No: 03007

Noise Impact Assessment
Proposed Modification to Operations
Ashton Coal Mine
Camberwell, NSW

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INTRODUCTION

This report provides the results and findings of an acoustic assessment of a proposed modification to operations at the Ashton Coal Mine near Camberwell, NSW.

The modification consists of extending the height of the eastern overburden emplacement by 10 m (that is, from final RL 125 to final RL 135) and removing the need to utilise a western overburden emplacement on the southern side of the New England Highway.

The western overburden emplacement was assessed in the EIS for the Ashton Coal Project (ACP).

DESCRIPTION OF TERMS

This section of the report aims to convey an understanding of several commonly used acoustical terms to the lay reader. 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".

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.

Temperature Inversion

An atmospheric state in which the air temperature increases with altitude. It would not be uncommon in the Hunter Valley for a ground level temperature of 6°C to increase to a temperature of 20° at 200m altitude during a strong inversion.

Sound travels faster in warmer air than cold air, so that during an inversion the top of a "sound wave" will 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 will experience a "friction drag" at the ground in much the same way as a lava flow will 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 1** shows several examples of how atmospheric effects can bend sound waves.

FIGURE 1
Sound refraction under temperature inversions and wind gradients.

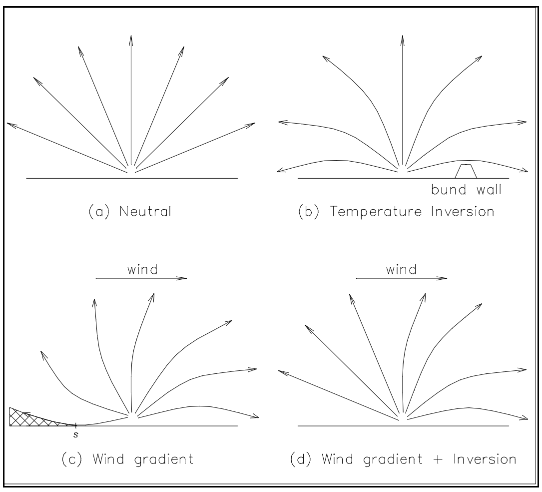


Figure 1(b) shows that sound rays can be refracted over a barrier (usually a bund wall or small hill) during a temperature inversion, greatly increasing noise levels in the 'shadow zone'.

Note the hatched area in **Figure 1(c)** on the upwind side of the lowest (limiting) sound ray. This 'shadow zone' may occur at distances quite close to a source, rendering it far quieter than it would be under neutral or inversion conditions. Also, the shadow zone boundary, *s*, is influenced by low level turbulence and moves about. Thus, a receiver near the shadow zone boundary may experience large sound pressure level fluctuations in the order of 15-20dB. **Figure 1(d)** shows cancelling temperature inversion and wind shear effects on the upwind side of the source.

Neutral Atmospheric Conditions

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

Prevailing Atmospheric Conditions

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

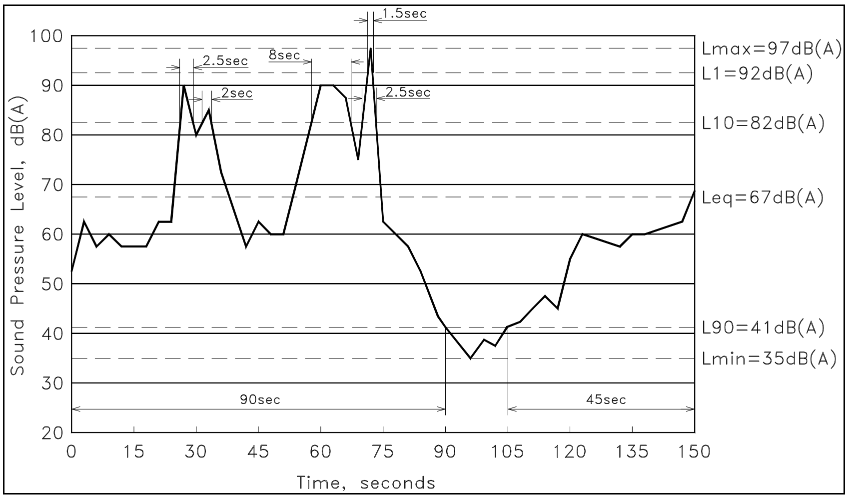
Adverse Atmospheric Conditions

Adverse conditions will include simultaneous winds and temperature inversions, even if the inversions occur for less than 2 nights per week in winter. This represents the worst case scenario for potential noise enhancement due to atmospheric effects.

Noise Level Percentiles

A noise level percentile (Ln) is the noise level (SPL) in decibels which is exceeded for "n" % of a given monitoring period. Several important Ln percentiles will be explained by considering the hypothetical time signal in **Figure 2**.

FIGURE 2
Hypothetical time-trace of 150-second sound signal.



The signal in Figure 2 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 60 dB (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.

L1 Noise Level

Near the top of Figure 2, there is a dashed line at 92dB(A). A small spike of 1.5 sec duration extends above this line at around 73 seconds. As 1.5 sec is 1% of the signal duration (150 seconds) we say that the L1 noise level of this sample is 92dB(A). The L1 percentile is often called the *average peak noise level* and is used by the NSW EPA as a measure of potential disturbance to sleep.

L10 Noise Level

The dashed line at 82 dB(A) is exceeded for four periods of duration 2.5 sec, 2 sec, 8 sec and 2.5 sec, respectively. The total of these is 15 sec, which is 10% of the total sample period. Therefore, the L10 noise level of this sample is 82 dB(A). The L10 percentile is called the *average maximum noise level* and has been widely used as an indicator of annoyance caused by noise.

L90 Noise Level

In similar fashion to L1 and L10, Figure 2 shows that the noise level of 41 dB(A) is exceeded for 135 seconds (90 + 45 =135). As this is 90% of the total sample period, the L90 noise level of this sample is 41dB(A). The L90 percentile is called the *background noise level*.

Leq Noise Level

Equivalent continuous noise level. As the name suggests, the Leq 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. Leq can be thought of as a kind of 'average' noise level. Recent research suggests that Leq is the best indicator of annoyance caused by industrial noise and the EPA Industrial Noise Policy takes this into consideration.

Lmax and Lmin Noise Levels

These are the maximum and minimum SPL values occurring during the sample. Reference to Figure 2 shows these values to be 97dB(A) and 35dB(A), respectively.

REVIEW OF NOISE ISSUES

The proposed modification will not introduce noise-related elements outside those considered in the EIS. That is, the location of overburden dumping will be confined to the eastern emplacement, the potentially affected residential receivers will be the same and so will the noise sources, meteorological conditions and times of operation. No additional road traffic, rail movements blasting or cumulative impacts will occur as a result of the proposed modification.

Noise issues will therefore be restricted to whether the current noise criterion of **38 dB(A),Leq(15-minute)** can be achieved if the modification proceeds.

Plant Noise Levels

A recommendation arising from the EIS was that the sound power level of machinery operating at the top of the eastern overburden emplacement must not exceed a sound power level of 114 dB(A),Leq(15-minute).

Since commencement of mining operations, extensive noise measurements have been conducted on site to determine sound power levels. A practical test based on procedures in domestic and international standards was used to determine dynamic sound power levels of the fleet of three CAT 630E haul trucks and a CAT D10 tracked dozer. One of the haul trucks had a noise attenuation package installed, while the other two had no attenuation.

Time-trace measurements (1-second resolution) were taken with a Bruel & Kjaer 2260 sound level meter at the nearest safe distance from moving vehicles (9-14 m). Distances to the vehicle centre-lines and the maximum levels during the measurements were used to calculate sound power level for various modes of operation including

- Loaded trucks going uphill
- Unloaded trucks going down hill
- Truck dumping circuit
- Dozer pushing overburden

The Figures 3 – 6 below show calculated Lmax sound power levels for various operations. In the Figures, 4005 and 4008 are the plant numbers of attenuated and unattenuated trucks, respectively.

FIGURE 3
Sound power levels of ACP haul trucks travelling uphill, loaded.

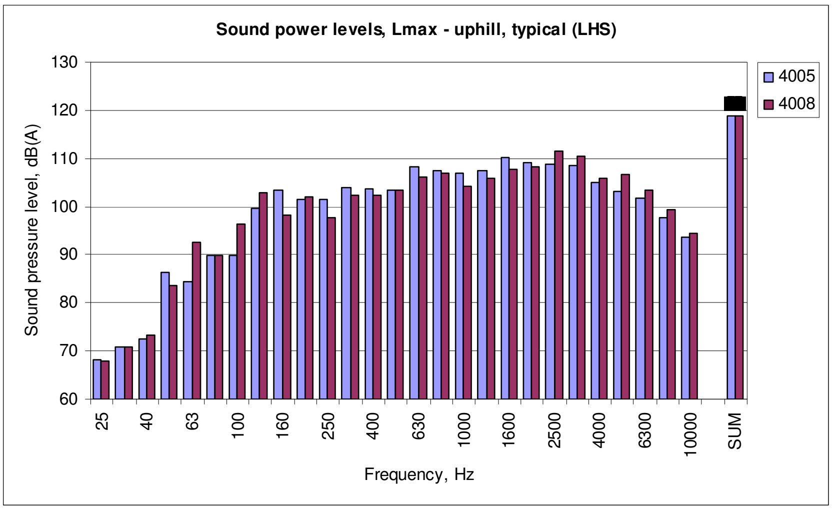


FIGURE 4
Sound power levels of ACP haul trucks travelling downhill, retard engaged.

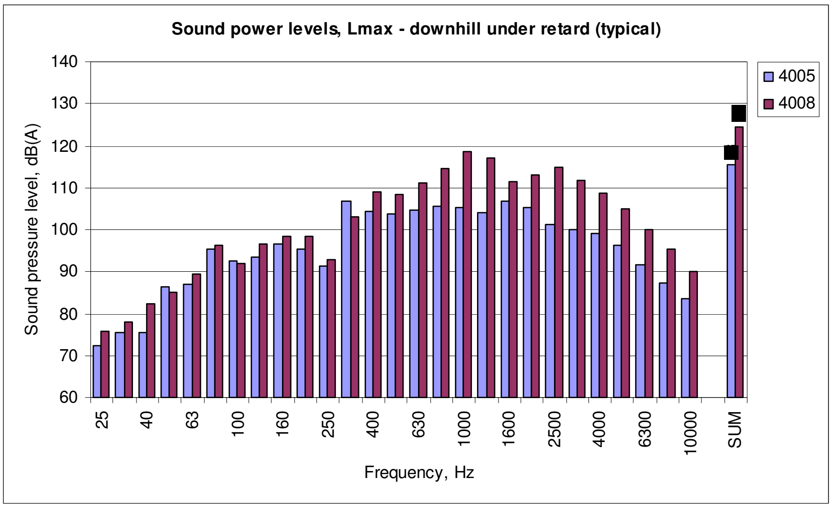


FIGURE 5
Sound power levels of ACP haul trucks dumping. Measured from the front.

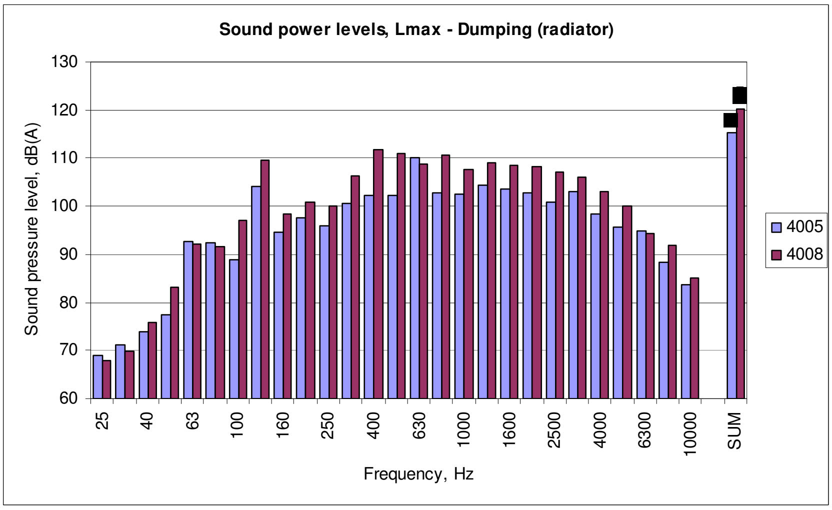
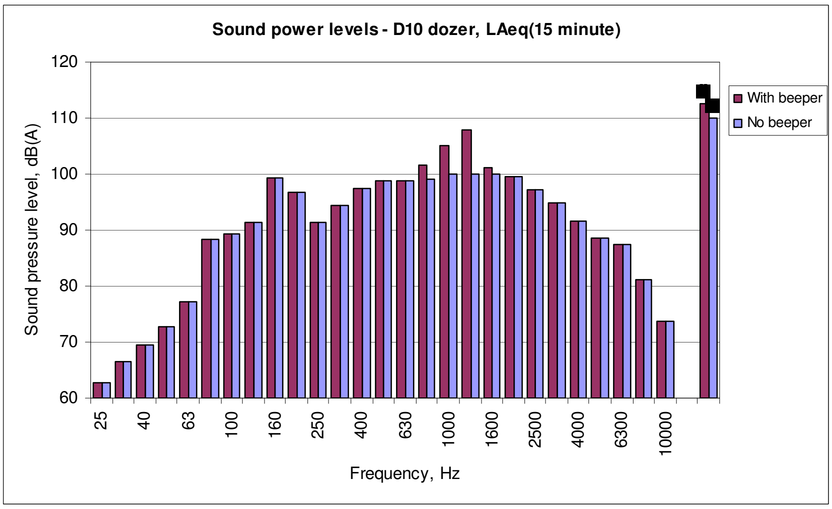


FIGURE 6
Sound power levels of ACP D10 dozer, with and without reverse beepers. (Broadband beepers have recently been installed and the "no beeper" sound power level is achieved).



Based on the above results, and Leq levels during each measurement, 15-minute Leq levels of 105 dB(A) and 104 dB(A) for unattenuated and attenuated trucks, respectively, were calculated for a *single* dump cycle lasting one minute. Finally, based on consistent observations of three dump cycles per 15-minute period (assuming 2 x unattenuated trucks and 1 x attenuated truck), the total sound power level for trucks dumping is **109 dB(A),Leq(15-minute)**.

Adding in the operational sound power level of 110 dB(A) for the D10 dozer gives a combined sound power level of **113 dB(A),Leq(15-minute)** for all sources at the dump face. This levels complies with the required level of 114 dB(A).

Further from the dump face, the calculated sound power level on the haul road is 112 dB(A),Leq(15-minute).

Receiver Noise Levels

Spectrum Acoustics has been conducting attended noise monitoring for ACP on a monthly basis since November 2003. These surveys have not detected noise levels above 38 dB(A),Leq(15-minute) at any residential receiver. In particular, during the March 2004 noise compliance assessment survey 10 hours of attended monitoring was carried out over a 24-hour period. Even with trucks clearly visible[1] at the dump face, the noise level in Camberwell village was 36-37 dB(A),Leq(15-minute) during the highest measurements. Under comparable atmospheric conditions (approximately neutral), the predicted noise level of 34 dB(A) presented in the EIS is generally consistent with the measured levels.

METHODOLOGY

It was found during research associated with the EIS that mining operations within the Barrett Pit, coal handling and rail loading activities will have negligible noise impact on sensitive receivers, as compared with impacts from overburden haulage, dumping and shaping. This is because mining, handling and loading all occur at much greater distances from the residences and at lower RL levels, with the intervening topography (natural hill) acting as a noise barrier.

[1] Work on the Eastern Environmental Bund had not been completed at the time of the survey.

In order to assess the noise impact of the proposed modification, it was assumed that most of the eastern overburden emplacement had been finished off to RL 125, with an area approximately 10 m lower on the northern side of the dump as shown in Figure 7.

Initial modelled scenarios include dumping at either one of three locations on the eastern overburden emplacement (nominated as South, North and East dumps in Figure 7) under various atmospheric conditions.

The south dump represents the location where the nearest point on the dump to residences is to be extended from RL 125 to RL 135. The south dump was then modelled as dumping behind a leading (Southern) edge that has been complete to the final height of RL 135.

FIGURE 7
Source locations for modelled dumping operations.

Sound power levels were equal to those discussed above for the actual operational noise levels. Modelling was conducted using RTA Technologies Environmental Noise Model (ENM) v 3.06 computer software. Noise levels were calculated over an area covering seventeen residential receivers near the mine (as shown in Figure 8 and Table 1).

The assessment was conducted for the atmospheric conditions described below:

- *Neutral Atmospheric* – 20°C, 70% relative humidity (RH), no wind, 1°C/100m temperature lapse;
- *Adverse Wind* – 20°C, 70% RH, 3m/s wind from southeast; and
- *Adverse Temperature Gradient* - 10°C, 70% RH and +4°C/100m vertical temperature gradient.

FIGURE 8
Receiver locations.

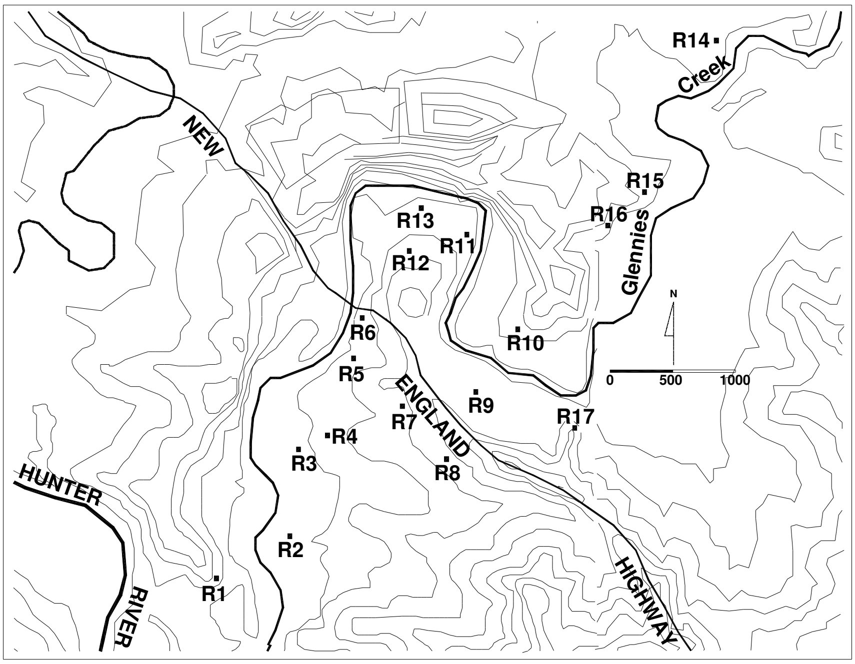


TABLE 1
Description of receiver locations.

Location	Ownership / Description
R1	A. Bowman
R2	W. Bowman
R3	P. Moore
R4	C. & M. Lane
R5	Wearmouth
R6	ACOL (representative of nearby houses)
R7	R. & L. Moss
R8	N. & M. Smiles
R9	D. Proctor
R10	B. & R. Richards
R11	J. & T. McInerney
R12	T. Clark & J. Vollerbreght (under construction)
R13	M & T De Jong

TABLE 1 Receiver Locations (Continued)	
Location	Ownership / Description
R14	A. & C. Klasen
R15	A. & C. Klasen
R16	B. & R. Richards
R17	Hall

RESULTS

Calculated noise levels for the North and East areas of the eastern overburden emplacement as indicated in Figure 7 above are shown in Table 2. Results for the South dump scenarios are shown in Table 3. Values shown in bold type indicate predicted exceedances of the 38 dB(A) noise criterion.

TABLE 2
Predicted noise levels from dumping on the North and East areas of the eastern overburden emplacement.

	North dump				East dump			
Res.	Neutral	Inversion $4^0C/100m$	SE wind	NW wind	Neutral	Inversion $4^0C/100m$	SE wind	NW wind
R1	<20	21	<20	20	<20	26	<20	22
R2	<20	25	<20	22	<20	27	<20	25
R3	<20	27	<20	25	<20	30	<20	28
R4	<20	27	<20	25	20	31	20	29
R5	<20	28	<20	29	23	34	23	32
R6	<20	28	<20	30	24	36	24	32
R7	<20	27	<20	29	22	33	22	32
R8	<20	23	<20	27	20	30	<20	29
R9	<20	24	<20	29	23	33	22	33
R10	<20	23	<20	26	24	35	24	35
R11	23	25	<20	27	30	35	25	35
R12	23	27	<20	27	28	38	27	31
R13	24	26	20	26	25	31	25	30
R14	25	35	23	32	22	35	21	28
R15	20	26	<20	30	24	38	25	**40**
R16	20	25	<20	28	24	37	24	38
R17	<20	21	<20	28	24	32	20	32

TABLE 3
Predicted noise levels from dumping on the southern area of the eastern overburden emplacement.

	South dump (forming edge)				South dump (behind leading edge)			
Res.	Neutral	Inversion 4⁰C/100m	SE wind	NW wind	Neutral	Inversion 4⁰C/100m	SE wind	NW wind
R1	<20	27	<20	24	<20	21	<20	20
R2	20	28	<20	26	<20	23	<20	22
R3	23	32	23	30	<20	26	<20	25
R4	23	33	23	31	<20	27	<20	25
R5	27	37	26	35	<20	31	<20	29
R6	28	38	28	37	<20	31	<20	30
R7	25	34	24	34	<20	28	<20	27
R8	23	32	20	32	<20	20	<20	22
R9	26	34	23	35	<20	23	<20	23
R10	26	35	24	37	<20	23	<20	25
R11	34	**40**	31	**42**	23	27	20	31
R12	34	**43**	33	**41**	23	28	21	32
R13	33	**40**	32	**40**	25	29	24	30
R14	<20	31	<20	28	<20	31	<20	30
R15	20	28	<20	30	<20	27	<20	30
R16	20	29	<20	30	<20	24	<20	26
R17	24	32	<20	33	<20	22	<20	24

DISCUSSION AND RECOMMENDATIONS

Noise level calculations presented in the previous section generally show that dumping on the eastern overburden emplacement in exposed locations at RL 135 will not be significantly different to dumping at RL 125. In particular, operating on the dump is not predicted to cause noise goal exceedances under neutral conditions or during winds from the southeast.

Mitigation options for noise goal exceedances under adverse meteorological conditions will be presented below.

Adverse conditions

Firstly considering temperature inversions, there are likely to be significant (4-5 dB) exceedances of the noise goal at residences in Camberwell village if dumping takes place in direct view of residences. The above results suggest that moving activities to the eastern end of the dump will result in acceptable levels at all receivers, although there will be no “margin for error” within the village (ie exactly 38 dB(A) is predicted). Utilising an area at the northern edge of the dump will result in levels well below the criterion in the village and 3 dB below the criterion at the most exposed receiver to the north (Klasen, R14).

Under northwesterly winds, exposed operations should again not take place along the southern edge of the dump, and even operating at the eastern end may result in exceedances at Klasen (R15, not R14). In this case a northern area of the dump should be utilised.

After the leading (southern) edge of the emplacement has been raised to RL 135 under neutral conditions or during SE winds, dumping may occur behind it under all conditions without resulting in noise goal exceedances. Table 4 summarises the recommended dumping locations, up until the southern edge of the emplacement is completed.

TABLE 4
Summary of recommended dumping locations to achieve noise goals.

Weather	Recommended dumping location
Neutral	All locations
SE wind	All locations
Inversion	East end or northern face of emplacement
NW wind	Northern face

Plant Noise Attenuation

The plant noise measurements found that the attenuation package fitted to haul truck 4005 was highly effective at reducing noise from the grid box (retard system) and at certain frequencies of muffler noise. For general haulage and dumping noise, however, the overall reduction in sound power level was not more than 2 dB.

Since at least a 5 dB reduction in noise levels is required to achieve compliance with noise goals under worst case atmospheric conditions, the above management option of utilising different dumping areas is considered the most effective noise control option in this particular case.

Western Overburden Emplacement

Noise level predictions presented in Table 17 of the Noise and Vibration Assessment conducted for the ACP EIS show widespread exceedances of the 38 dB(A) noise goal due to operations on the proposed western overburden emplacement. Although only 1-3 dB in magnitude, these exceedances were predicted to occur at locations R4 – R7 and R11 – R13 as defined in the present study.

Therefore, the total number of residences at which predicted noise goal exceedances occur has been halved from eight to four by removing the western emplacement option.

As discussed above, exceedances at the remaining four locations may be mitigated by implementing the management options presented.

CONCLUSION

An assessment has been conducted to determine the noise impacts of a proposed modification to operations at the Ashton Coal Mine near Camberwell, NSW. The modification consists of extending the height of the eastern overburden emplacement by 10 m (that is, from final RL 125 to final RL 135) and removing the need to utilise a western overburden emplacement on the southern side of the New England Highway.

Noise modelling results show that, under worst case scenarios, noise levels will comply with EPA planning limits at all nearby residential locations, provided the noise control measures discussed in the previous section and summarised in Table 4 are implemented.

A higher degree of confidence may be attached to the noise predictions in this report than would normally be the case for a new development, since field measurements of the existing operations have been in close agreement with predicted levels.