11 October 2018

610.15617-L02-v3.0.doc

Goodman Property Services (Aust) Pty Ltd
Level 17
60 Castlereagh Street
Sydney NSW 2000

Attention: Guy Smith

Dear Guy

Oakdale West Estate
Updated Design Plans - September 2018
Operational Noise Impacts

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Goodman Property Services (Aust) Pty Ltd (Goodman) to assess the operational noise impacts of the Oakdale West Estate (OWE).

The design plans for the OWE have been updated (September 2018 design) since the previous noise impact assessment was undertaken (refer to SLR Report *610.15617-L01-v2.0*, dated 8 May 2018) (May 2018 design).

This letter presents a review of the operational noise emissions for the updated September 2018 design of the development and compares the predicted noise levels to the noise criteria for the site (refer to the DA Noise Impact Assessment, SLR Report *610.15617-R2R4*, dated 7 June 2017) (DA NIA).

A review of the locations and heights of the indicative noise barriers recommended in the DA NIA has been undertaken for the September 2018 design.

1 Updated Design Plans – September 2018

The September 2018 design includes the following modifications from the May 2018 design:

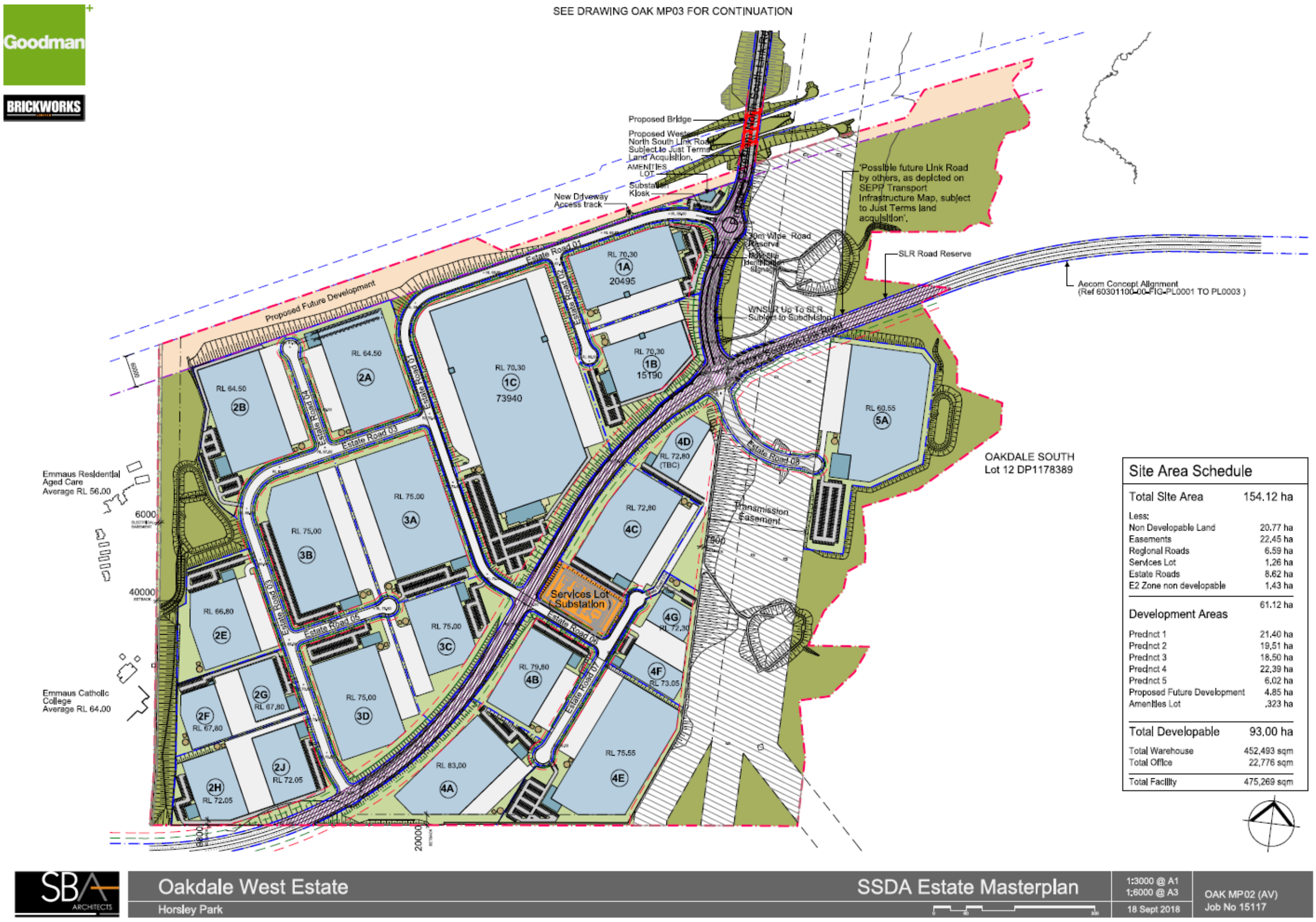
- An additional 20 m setback on the northern boundary to accommodate a proposed future development.
- Minor layout changes to Lots 1A, 1C, 2A and 2B, and estate roads 01 and 04, to accommodate the additional northern boundary setback.
- Modification of basin designs/locations.
- Increased bushfire setback on the southern boundary to the east of the potential future link road.
- Minor layout changes to estate road 07 and Lots 4A and 4E to accommodate the additional southern boundary setback.
- Raised pad heights for Lot 2B (2.5 m higher) and Lot 2E (3 m higher).
- Addition of an amenities lot adjacent to the northern boundary, between estate road 01 and the proposed Western North South Link Road.

No other areas of the OWE have been modified by the September 2018 design. Proposed traffic volumes for the OWE are not affected by the revised design.

The previously May 2018 design is shown in **Figure 1**, and the updated September 2018 design is shown in **Figure 2**.

Figure 1 Previously Assessed May 2018 Design Plans

Figure 2 Updated September 2018 Design Plans



2 Noise Impact Assessment

Operational noise from the development was modelled using the SoundPLAN noise model prepared for the DA NIA. This model was updated with the September 2018 design changes to the lots, buildings, pad heights, topography and site roads as outlined in **Section 1**.

The predicted operational noise levels for the September 2018 design are compared to the predicted operational noise levels for the May 2018 design in **Table 1**.

Table 1 Predicted Operational Noise Levels

Receiver	Period (weather)	Assess-ment	LAeq Noise Level (dBA)					Change in Predicted Noise Level (dB)
			Criteria	May 2018 Design[1]	September 2018 Design[2]			
				Predicted	Predicted	Exceedance	Compliance?	
Emmaus Village Residential	Day (neutral)	15-min	44	36	35	-	Yes	-1
	Eve (neutral)	15-min	43	36	35	-	Yes	-1
	Night (adverse)	*15-min*	*41*	*37*	*35*	-	*Yes*	*-2*
	Night (adverse)	*Period*	*36*	*31*	*29*	-	*Yes*	*-2*
Kemps Creek – nearest residential property	Day (neutral)	15-min	39	36	**40**	1	**No**	+4
	Eve (neutral)	15-min	39	36	**40**	1	**No**	+4
	Night (adverse)	*15-min*	*37*	*36*	***40***	*3*	***No***	*+4*
	Night (adverse)	*Period*	*36*	*30*	*34*	-	*Yes*	*+4*
Kemps Creek – other residences	Day (neutral)	15-min	39	35	35	-	Yes	0
	Eve (neutral)	15-min	39	35	35	-	Yes	0
	Night (adverse)	*15-min*	*37*	*36*	*36*	-	*Yes*	*0*
	Night (adverse)	*Period*	*36*	*30*	*30*	-	*Yes*	*0*
Emmaus Catholic College (school)	When in use	1-hour	45	40	37	-	Yes	-3

Note 1: May 2018 Design predictions include previous indicative barriers (refer to **Figure 3**).

Note 2: September 2018 Design predictions include revised indicative barriers (refer to **Figure 3**).

Note 3: **Bold** text indicates an exceedance of the criteria.

Operational noise emissions from the development are predicted to comply with the relevant criteria at the surrounding sensitive receivers with the exception of the nearest residential property in Kemps Creek.

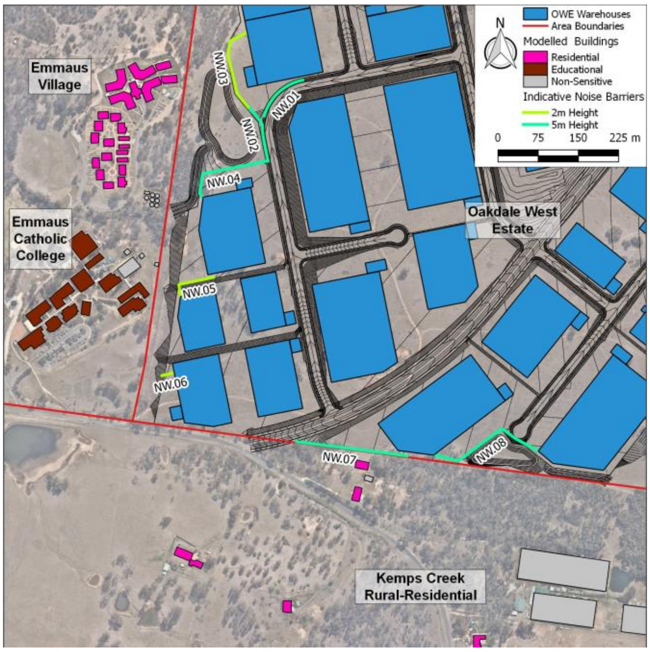
Goodman has undertaken consultation with this receiver and the residents have indicated a preference for at-property treatment in lieu of a noise barrier on their boundary.

Predicted noise levels at the Kemps Creek receiver have increased compared to the previous design due to the previously recommended noise barrier adjacent to this property being removed from the noise model (NW.07). It is noted that the removal of this barrier is predicted to have a negligible effect on other sensitive receivers in Kemps Creek.

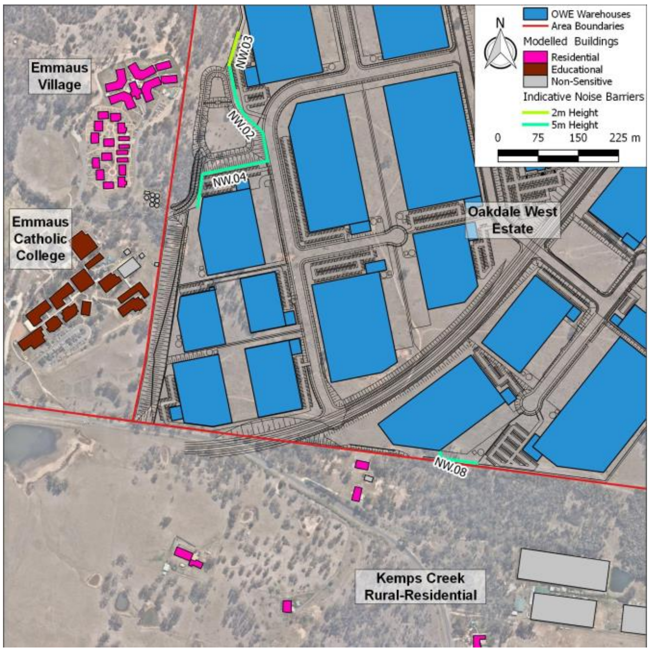
The revised indicative noise barrier locations and heights are shown in **Figure 3** compared to the previous recommended barriers.

Figure 3 Revised Indicative Noise Barrier Locations

Previous Indicative Barrier Locations



Revised Indicative Barrier Locations



As discussed above, noise barrier NW.07 was removed from the noise model due to the preference of the adjacent residents.

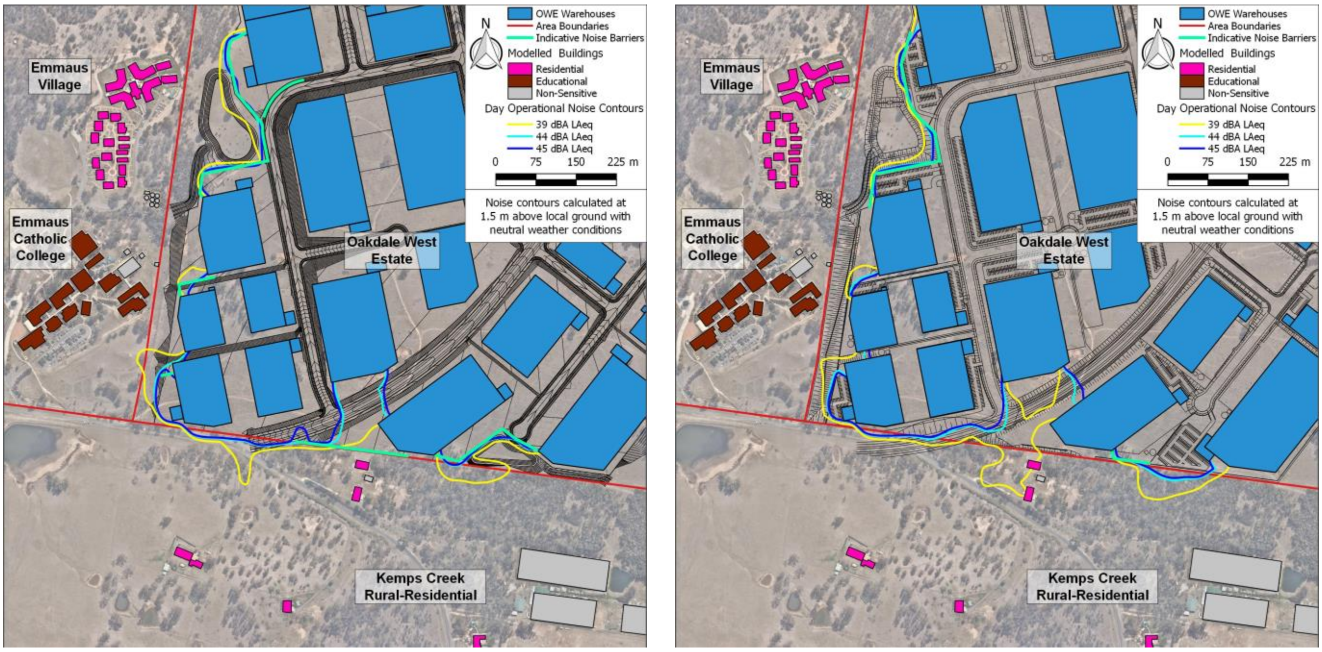
The locations of noise barriers NW.02, NW.03, NW.04 and NW.08 were also revised to better fit the September 2018 design.

Noise barriers NW.01, NW.05 and NW.06 were removed from the noise model as they were no longer required to mitigate noise impacts in the revised September 2018 design. Removal of these barriers does not significantly alter noise levels at any of the nearest receivers.

Comparison of the predicted operational noise levels between the previous and revised design of the noise barriers is shown in **Figure 4** and **Figure 5** for daytime neutral weather and night-time adverse weather, respectively.

Figure 4 Comparison of Predicted Noise Levels – Daytime Neutral Weather Conditions

With Previous Indicative Barriers | With Revised Indicative Barriers



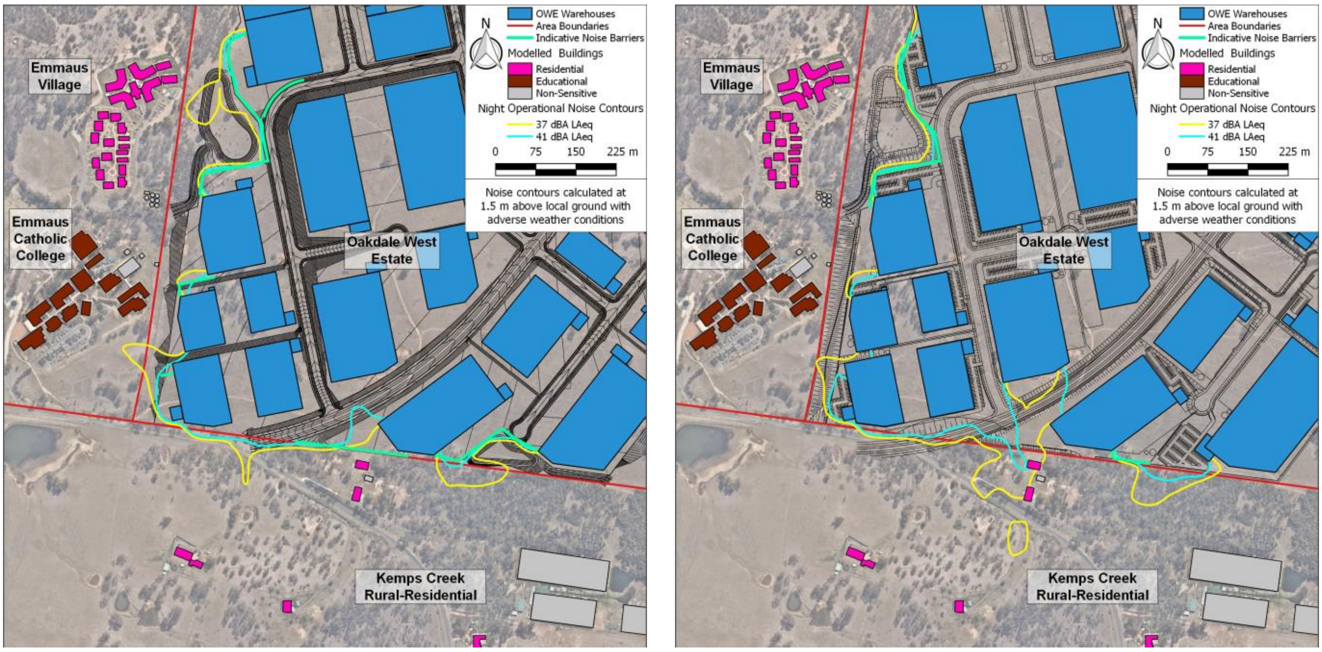
Note 1: 45 dBA LAeq noise contour (dark blue) corresponds to the noise criteria for school classrooms.

Note 2: 44 dBA LAeq noise contour (light blue) corresponds to the daytime intrusive noise criteria for residences in Emmaus Village.

Note 3: 39 dBA LAeq noise contour (yellow) corresponds to the daytime intrusive noise criteria for residences in Kemps Creek.

Figure 5 Comparison of Predicted Noise Levels – Night-time Adverse Weather Conditions

With Previous Indicative Barriers | With Revised Indicative Barriers



Note 1: 41 dBA LAeq noise contour (light blue) corresponds to the night-time intrusive noise criteria for residences in Emmaus Village.

Note 2: 37 dBA LAeq noise contour (yellow) corresponds to the night-time intrusive noise criteria for residences in Kemps Creek.

The above figures show that the predicted operational noise levels of the September 2018 design with the revised noise barriers are generally consistent with the previous design for most areas of the site.

In the Kemps Creek area near to where noise barrier NW.07 has been removed due to the preference of the nearest receiver, the predicted noise levels have increased by around 4 dB. This increase is seen in a relatively small area of around 100 m from the site boundary and other receivers in the vicinity are generally not affected.

Overall, the predicted operational noise impacts from the September 2018 design are generally consistent with the previously assessed noise impacts. Assuming the nearest receiver in Kemps Creek is offered at-property treatment the impacts are considered suitable from a noise perspective.

I trust that this letter covers your requirements.

Yours sincerely

J. Ridgway

JOSHUA RIDGWAY
Senior Consultant

Checked/
Authorised by: AW

APPENDIX A

Acoustic Terminology

1 Sound Level or Noise Level

The terms ‘sound’ and ‘noise’ are almost interchangeable, except that in common usage ‘noise’ is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2 ‘A’ Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an ‘A-weighting’ filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People’s hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as ‘linear’, and the units are expressed as dB(lin) or dB.

3 Sound Power Level

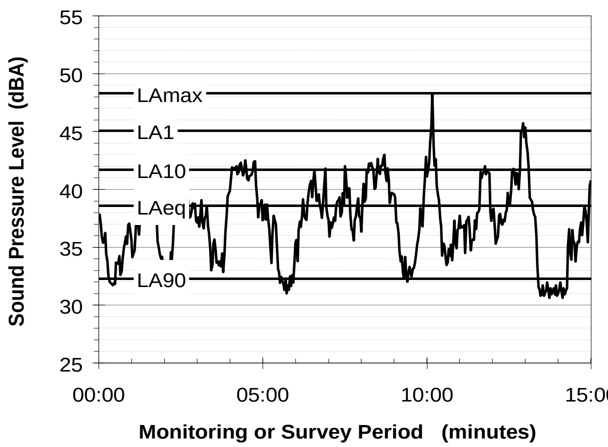
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the ‘repeatable minimum’ L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition, the method produces mean or ‘average’ levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than ‘broad band’ noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

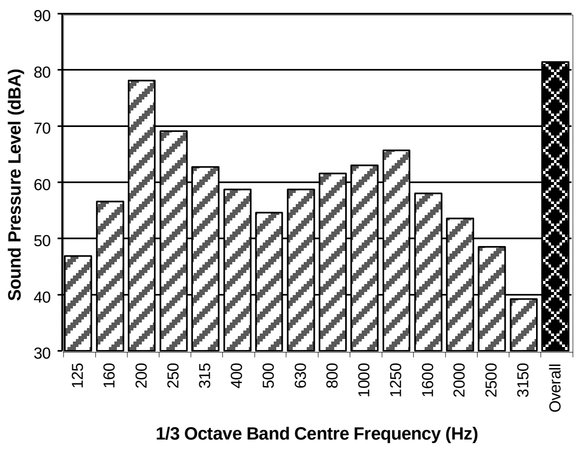
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organisations.

9 Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

10 Over-Pressure

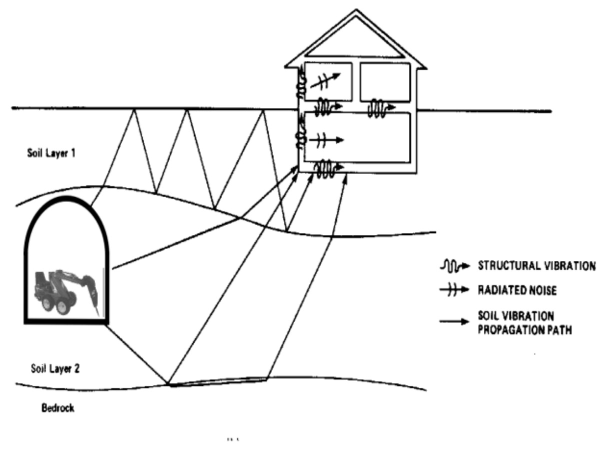
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise