Design
for a better
future /

HUNT ARCHITECTS

ALLIED PINNACLE FLOUR AND MAIZE MILL

PROPOSED MODIFICATION (DA-318-12-2004)

NOVEMBER 2021

PUBLIC

APPENDIX J

COMPLIANCE SURVEY OPERATIONAL NOISE MONITORING ALLIED PINNACLE PICTON (SLR CONSULTING, 2019)

COMPLIANCE SURVEY

Operational Noise Monitoring
Allied Pinnacle Picton
330 Picton Rd, Maldon

Prepared for:

Allied Pinnacle Picton
330 Picton Rd
MALDON NSW 2571

SLR Ref: 610.19168-R01
Version No: -v1.0
December 2019

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Grd Floor, 2 Lincoln Street
Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
T: +61 2 9427 8100
E: sydney@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Allied Pinnacle Picton (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.19168-R01-v1.0	6 December 2019	Jason Qian	Mark Irish	Mark Irish

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Allied Pinnacle Australia Pty Ltd (Allied Pinnacle) to undertake an operational noise survey at its site at 330 Picton Road, Maldon NSW (the Site) to comply with the "*Allied Pinnacle, Picton Mill – NSW Noise and Vibration Management Sub-Plan"* dated August 2018 (the GHD report).

Specific acoustic terminology is used in this report. An explanation of common acoustic terms is provided in **Appendix A**.

2 Site Description

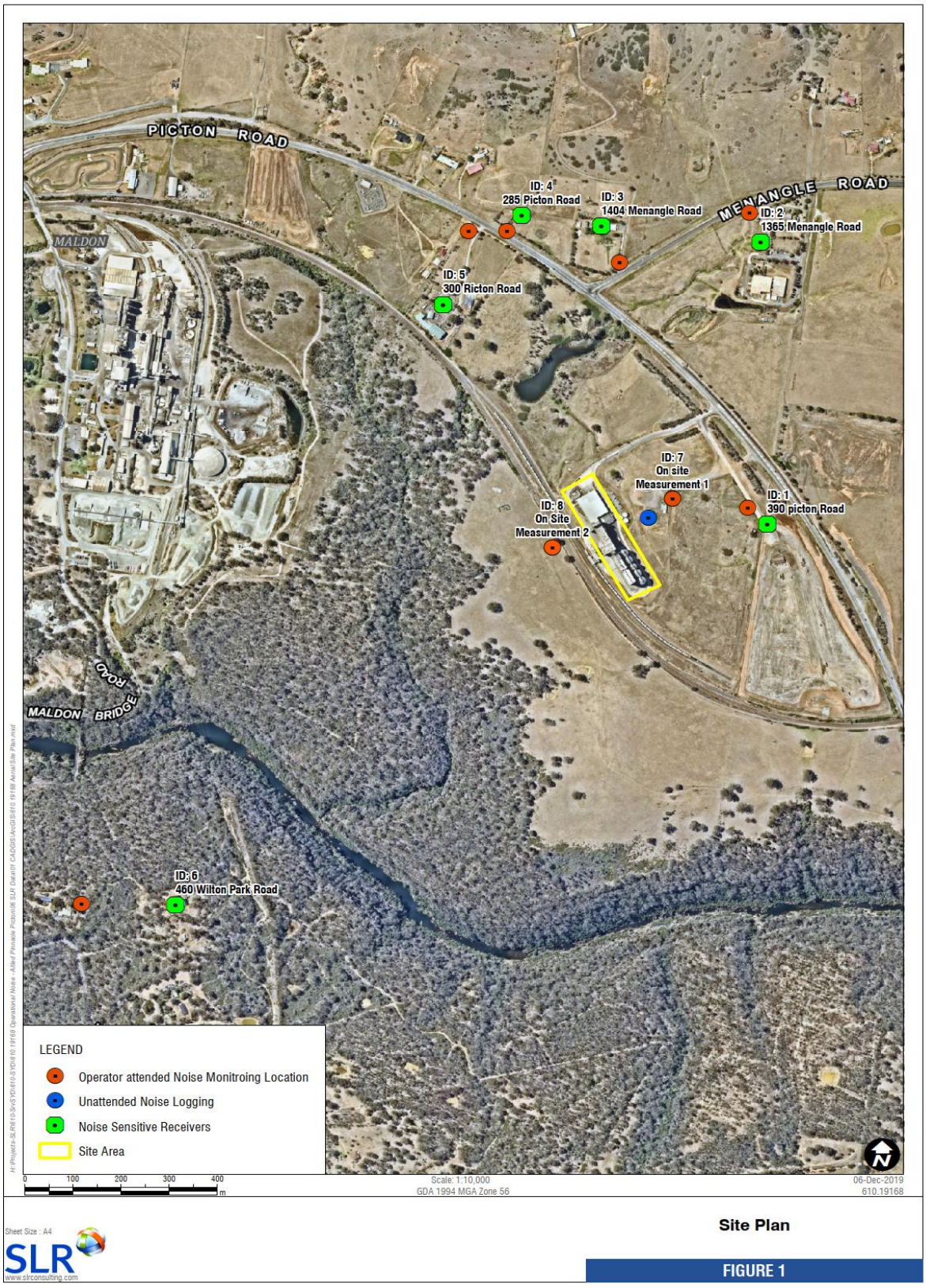
The site is located at 330 Picton Road, Maldon NSW and operates 24 hours a day, 7 days a week. The location of the site is shown in **Figure 1** together with the operator-attended noise monitoring locations and the locations for the noise sensitive receivers identified by Environment Protection Authority (EPA) in the GHD report.

The details of the noise sensitive receivers are shown as follows:

- Location 1: 390 Picton Road, Maldon
- Location 2: 1365 Menangle Road, Maldon
- Location 3: 1404 Menangle Road, Maldon
- Location 4: 285 Picton Road, Maldon
- Location 5: 300 Picton Road, Maldon
- Location 6: 460 Wilton Park Road, Maldon

It is noted that Location 1 and 5 have been zoned industrial since January 2014 and no longer considered to be sensitive receivers. However, noise measurements were still undertaken at Location 1 and 5 as they are still on the sensitive receiver list provided by EPA.

Figure 1 Site Map



3 Noise Limits

Noise limits from operation of the subject site to nearby sensitive receivers are limited in Environment Protection License (EPL) 12498 and summarised in **Table 1**.

Table 1 Operational Noise Limits

Location ID	Daytime[1]		Evening[1]		Night[1]		
	LAeq(Daytime)	LAeq(15min)	LAeq(Evening)	LAeq(15min)	LAeq(Night)	LAeq(15min)	LA1(1min)
1	-	44	41	44	36	43	53
2	-	40	-	40	31	37	47
3	43	43	39	43	32	43	61
4	42	42	38	42	26	42	64
5	45	45	37	45	28	42	52
6	-	35	-	35	27	35	49

Note 1: Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays;
Evening is defined as the period from 6pm to 10pm;
Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

Measurements should be compliant with the following monitoring principles stipulated in GHD report:

- Attended noise monitoring should be undertaken during the daytime (7am – 6pm), evening (6pm – 10pm) and night-time (10pm- 7am) periods.
- Attended daytime and evening measurements should be made during the arrival, unloading and departure for a wheat train delivery cycle.
- Allied Pinnacle Flour Mill daytime, evening and night-time period LAeq operational noise contribution shall be measured at the most affected point within the residential boundary, or at the most affected point within 30 meters of the dwelling.
- Adopting INP guidance, assessment of received noise profiles shall be undertaken for determination of potential disturbing tonal, impulsive, intermittent or low frequency noise characteristics attributable to Allied Mill Flour Mill operations.
- Noise monitoring shall be undertaken during periods of satisfactory meteorological conditions; wind speed less than 5 meters per second and nil precipitation.
- Allied Pinnacle Flour Mill daytime, evening and night-time period LA1 operational noise contributions shall be measured at 1 meter from the building façade in the presence of minimal near field reflections.

However, measurements could not be conducted “at the most affected point within 30 meters of the dwelling” at some of the sensitive receivers because permission/access from the residents were not obtained. Measurements were undertaken at the property boundaries as shown in **Figure 1.**

4 Noise Survey

Train was unloading corn on Friday 29 November 2019 from 7 am to 1 pm. There was no truck movement at evening and night on site.

4.1 Unattended Noise Monitoring

Unattended noise monitoring was conducted between 27 November and 29 November 2019 at the location shown in **Figure 1**. The noise logger location was selected to measure noise emission from the Allied Pinnacle site.

Instrumentation for the surveys comprised a Brüel & Kjær Type 2250 environmental noise logger (Serial Numbers 23814). The loggers were fitted with microphone windshields. Calibration of the loggers was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

The results of the unattended noise monitoring are summarised in **Table 2**.

Table 2 Summary of Unattended Noise Logging Results

Date	LAeq(Daytime)	LAeq(Evening)	LAeq(Night)
27 November 2019	54	52	53
28 November 2019	53	51	51
29 November 2019	65	-	-

4.2 Attended Noise Measurement

Operator-attended noise surveys were conducted both onsite and at noise sensitive receivers on 27 November and 29 November 2019. Instrumentation for the operator-attended noise survey comprised a Brüel & Kjær Type 2250 sound level meter (Serial Number 3004636) fitted with a microphone windshield. Calibration of the sound level meter was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. The equipment carried appropriate and current NATA (or manufacturer) calibration certificates. Measurements were conducted in accordance with AS 1055.1-1997: Acoustics - Description and measurement of environmental noise – General procedures.

Attended measurement locations are shown in **Figure 1** and onsite observations are summarised in **Table 3**.

Table 3 Attended Noise Measurement Summary

Loc ID	Attended Measurement Location	Comments
1	Measurement at Receiver 1	Receiver 1 has been re-zoned to industrial and is currently a construction site. Measurements were conducted at the site boundary. Noise emissions from the Allied Pinnacle site were audible at measurement location. LAeq(15min) and LA1(1min) were determined based on the measurement and LAeq(period) is calculated based on the onsite measurement. LAeq(15min) at daytime is also calculated based on the Location 7 (onsite) because the excavation work at Receiver 1 was dominant.
2	Measurement at Receiver 2	Measurements were conducted at closest accessible point of residential boundary, roughly 60m at northern side of the dwelling. Noise emissions form the Allied Pinnacle site were not audible at measurement location. LAeq(period), LAeq(15min) and LA1(1min) are calculated based on the onsite measurement.
3	Measurement at Receiver 3	Measurements were conducted at closest accessible point of residential boundary, roughly 80m at southern side of the dwelling. Noise emissions form the Allied Pinnacle site were not audible at measurement location. LAeq(period), LAeq(15min) and LA1(1min) are calculated based on the onsite measurement.
4	Measurement at Receiver 4	Measurements were conducted at closest accessible point of residential boundary, roughly 30m at southern side of the dwelling. Noise emissions form the Allied Pinnacle site were not audible at measurement location. LAeq(period), LAeq(15min) and LA1(1min) are calculated based on the onsite measurement.
5	Measurement at Receiver 5	Measurements were conducted at closest accessible point of residential boundary, roughly 140m at northern side of the dwelling. Noise emissions form the Allied Pinnacle site were not audible at measurement location. LAeq(period), LAeq(15min) and LA1(1min) are calculated based on the onsite measurement.
6	Measurement at Receiver 6	Measurements were conducted at closest accessible point of residential boundary, roughly 200m at eastern side of the dwelling. Noise emissions form the Allied Pinnacle site were not audible at measurement location. LAeq(period), LAeq(15min) and LA1(1min) are calculated based on the onsite measurement.
7	Onsite Measurement at Eastern Side of Building	Measurements were conducted onsite at eastern side of the building, roughly 100m to the milling building (main noise source onsite)
8	Onsite Measurement at Western Side of Building	Measurements were conducted onsite at western side of the building, roughly 140m to the milling building (main noise source onsite)

Table 4 presents the results from the operator-attended noise surveys, together with a description of the contributed noise levels during the period of the measurement. It was noted that site noise was inaudible during the survey period at Receiver 2 to 6.

Table 4 Operator Attended Noise Survey Results

Location Period Date/Start Time Weather	Primary Noise Descriptor (dB)					Description
	LAmax	LA1	LA90	LAeq	LAmin	
Loc 1 Daytime 27/11/2019 17:16 Temp: 25°C wind: 0 m/s	67	60	44	52	39	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Picton Rd: 45-67
Loc 1 Evening 27/11/2019 18:34 Temp: 26°C wind: 0 m/s	72	59	44	52	39	**Site Related Noise Events:** Milling Building: 39 **Other Noise Events:** Traffic on Picton Rd: 54-72
Loc 1 Night 27/11/2019 22:26 Temp: 16°C wind: 1 m/s	63	59	39	49	37	**Site Related Noise Events:** Milling Building: 39 **Other Noise Events:** Traffic on Picton Rd: 50-63 Insects: 42-43
Loc 2 Daytime 29/11/2019 16:08 Temp: 27°C wind: 0 m/s	86	77	43	66	34	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Menangle Rd: 65-85 Birds: 53-56
Loc 2 Evening 27/11/2019 19:41 Temp: 22°C wind: 0 m/s	86	79	47	66	38	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Menangle Rd: 60-86 Traffic on Picton Rd: 50-61
Loc 2 Night 29/11/2019 23:20 Temp: 14°C wind: 0 m/s	82	74	39	59	35	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Menangle Rd: 75-82 Traffic on Picton Rd: 50
Loc 3 Daytime 29/11/2019 15:49 Temp: 28°C wind: 0-1 m/s	94	81	47	69	40	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Menangle Rd: 73-94 Traffic on Picton Rd: 47-54

Location Period Date/Start Time Weather	Primary Noise Descriptor (dB)					Description
	LAmax	LA1	LA90	LAeq	LAmin	
Loc 3 Evening 27/11/2019 20:01 Temp: 22°C wind: 1 m/s	80	77	46	63	35	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Menangle Rd: 75-80 Traffic on Picton Rd: 55
Loc 3 Night 29/11/2019 23:26 Temp: 14°C wind: 0 m/s	80	73	40	60	37	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Menangle Rd: 76-80 Traffic on Picton Rd: 50
Loc 4 Daytime 29/11/2019 15:30 Temp: 27°C wind: 0 m/s	82	77	46	69	40	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Picton Rd: 65-82 Cicada: 72
Loc 4 Evening 27/11/2019 19:16 Temp: 24°C wind: 0 m/s	76	71	49	63	43	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Picton Rd: 58-76
Loc 4 Night 29/11/2019 23:02 Temp: 16°C wind: 0 m/s	78	73	40	60	37	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Picton Rd: 66-78 Insects: 42-44 Noise from Boral Cement Works: 42-49
Loc 5 Daytime 29/11/2019 15:15 Temp: 27°C wind: 0-1 m/s	84	77	47	68	38	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Picton Rd: 65-84
Loc 5 Evening 27/11/2019 18:59 Temp: 25°C wind: 0 m/s	78	74	49	65	43	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Picton Rd: 62-78
Loc 5 Night 29/11/2019 22:45 Temp: 16°C wind: 0 m/s	79	73	43	62	38	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Picton Rd: 66-79 Insects: 43-45 Noise from Boral Cement Works: 56-60

Location Period Date/Start Time Weather	Primary Noise Descriptor (dB)					Description
	LAmax	LA1	LA90	LAeq	LAmin	
Loc 6 Daytime 29/11/2019 14:50 Temp: 27°C wind: 0 m/s	72	63	34	50	32	**Site Related Noise Events:** Site Noise: inaudible s **Other Noise Events:** Traffic on Wilton Park Rd: 59-72 Traffic on Picton Rd: 34-47 Birds: 38-50
Loc 6 Evening 27/11/2019 20:58 Temp: 18°C wind: 0 m/s	60	55	29	43	25	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Wilton Park Rd: 59 Traffic on Picton Rd: 33-36 Airplane: 57
Loc 6 Night 29/11/2019 22:03 Temp: 18°C wind: 0 m/s	65	52	27	41	25	**Site Related Noise Events:** Site Noise: inaudible **Other Noise Events:** Traffic on Wilton Park Rd: 65 Traffic on Picton Rd: 30 Birds: 30-36
Loc 7 Daytime 29/11/2019 11:15 Temp: 28°C wind: 0 m/s	71	66	53	61	55	**Site Related Noise Events:** Milling Building: 63 **Other Noise Events:** Traffic on Picton Rd: 66-71
Loc 7 Evening 27/11/2019 20:21 Temp: 18°C wind: 0 m/s	67	58	46	50	43	**Site Related Noise Events:** Milling Building: 47 **Other Noise Events:** Traffic on Picton Rd: 50-55 Birds: 53-67
Loc 8 Daytime 29/11/2019 10:49 Temp: 28°C wind: 0 m/s	72	68	57	61	54	**Site Related Noise Events:** Train unloading corn: 61 **Other Noise Events:** Freight train passby: 72

5 Noise Assessment

Table 5 to **Table 7** shows the assessed noise levels at sensitive receivers during daytime, evening and night time. The LAeq(15min) noise levels at Location 1 are measured. Noise levels at Receiver 2 to 6 are calculated based on the nearfield noise measurement results as the site was inaudible at these locations. Distance attenuation is used in the calculation by decreasing the sound level by 6 dB for doubling the distance from source to receiver.

Table 5 Summary of Predicted Noise Levels – Daytime

Location ID	LAeq(Period)			LAeq(15min)		
	LAeq(Daytime)	Criteria	Exceedance	LAeq(15min)	Criteria	Exceedance
1	48	-	-	50	44	6
2	42	-	-	43	40	3
3	38	43	-	39	43	-
4	37	42	-	39	42	-
5	39	45	-	41	45	-
6	36	-	-	28	35	-

Table 6 Summary of Predicted Noise Levels – Evening

Location ID	LAeq(Period)			LAeq(15min)		
	LAeq(Evening)	Criteria	Exceedance	LAeq(15min)	Criteria	Exceedance
1	37	41	-	39	44	-
2	31	-	-	32	40	-
3	26	39	-	28	43	-
4	26	38	-	27	42	-
5	28	37	-	29	45	-
6	25	-	-	26	35	-

Table 7 Summary of Predicted Noise Levels – Night

Location ID	LAeq(Period)			LAeq(15min)			LA1(1min)		
	LAeq(Night)	Criteria	Exceed	LAeq(15min)	Criteria	Exceed	LA1(1min)	Criteria	Exceed
1	38	36	2	39	43	-	43	53	-
2	31	31	-	32	37	-	36	47	-
3	27	32	-	28	43	-	32	61	-
4	26	26	-	27	42	-	31	64	-
5	28	28	-	29	42	-	33	52	-
6	25	27	-	26	35	-	30	49	-

Based on the results, discussion is provided as follows:

- Predicted LAeq(night) noise levels from site exceed the noise criteria at Receiver 1 by 2 dB. The remaining predicted LAeq(Period) noise levels from site comply with the noise criteria during daytime, evening and night time period.
- Predicted/measured LAeq(15min) noise levels from site exceed the daytime noise criteria at Location 1 by 6 dB and at Receiver 2 by 3 dB. The remaining LAeq(15min) predicted noise levels from site comply with the noise criteria.
- Predicted LA1(1min) noise levels comply with the sleep disturbance criteria.

6 Conclusion

SLR Consulting Australia Pty Ltd has conducted a noise survey for the Allied Pinnacle site located at 330 Picton Road, Maldon. The noise prediction/measurement shown in Section 5 has found that LAeq(period), LAeq(15min) and LA1(1min) noise levels at sensitive receivers comply with noise criteria stipulated in EPL 12498 with the following exception:

- Daytime LAeq(15min) noise level at Receiver 1 exceeds the noise limit by 6 dB.
- Daytime LAeq(15min) noise level at Receiver 2 exceeds the noise limit by 3 dB.
- LAeq(night) noise level at Receiver 1 exceeds the noise limit by 2 dB.

However, it should be noted that Receiver 1 is no longer classed as a residential receiver. In addition, it was noted that the exceedances of the daytime LAeq(15min) noise limits were due to the corn unloading operation. Based the previous measurements on site, the noise levels are significantly lower when train is unloading softer grain such as wheat.

APPENDIX A

Appendix title here

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 LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2E-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 4000 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 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA 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
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied 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

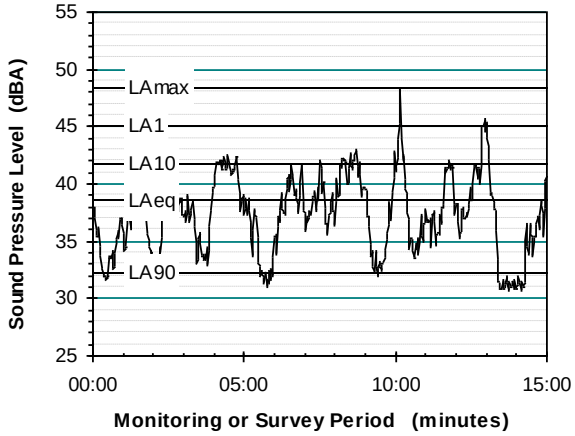
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 1E-12 W.

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 LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating the statistical indices.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 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.

LAeq Is the A-weighted equivalent continuous 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” LA90 noise level over the daytime and night-time measurement periods, as required by the DECCW. In addition the method produces mean or “average” levels representative of the other descriptors (LAeq, LA10 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

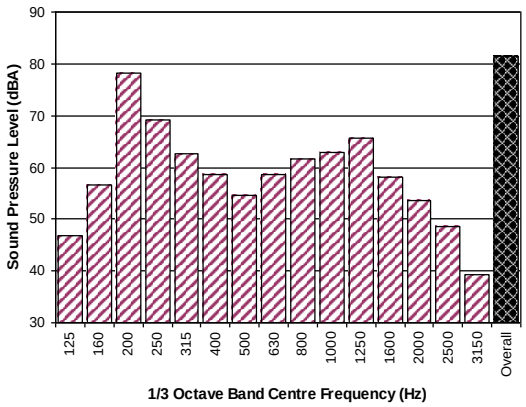
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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 incorporate "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/Vo), where Vo is the reference level (1E-6 mm/s). Care is required in this regard, as other reference levels are 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 Overpressure

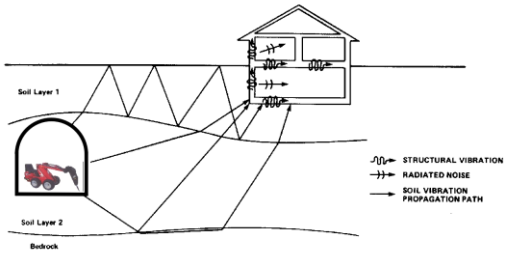
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed "regenerated noise", "structure borne noise", or sometimes "ground-borne noise". Regenerated 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 regenerated noise include tunnelling works, underground railways, Demolition plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term "regenerated noise" is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, but some additional noise may be created by the aerodynamic effect of the silencer in the airstream. This "secondary" noise may be referred to as regenerated noise.

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

TOWNSVILLE SOUTH
12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

ABOUT US

WSP is one of the world's leading professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors and environmental specialists, as well as other design, program and construction management professionals. We design lasting solutions in the Transport & Water, Property & Buildings, Earth & Environment, and Mining & Power sector as well as offering strategic Advisory, Engagement & Digital services. With approximately 6,100 talented people in more than 50 offices in Australia and New Zealand, we engineer future ready projects that will help societies grow for lifetimes to come. www.wsp.com/en-au/.