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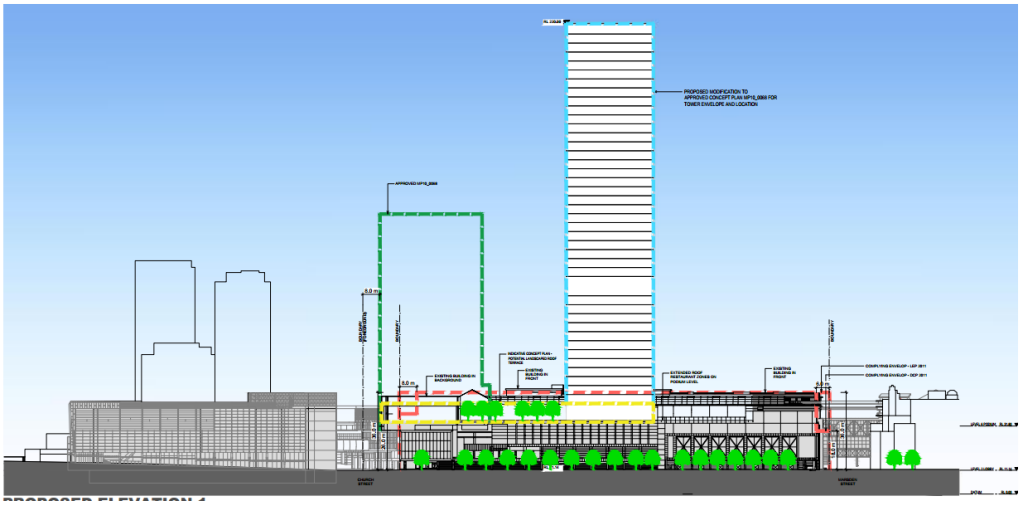
Scentre Group

Acoustic Assessment for Section 75W Modification (MOD 1) of the Approved Commercial Tower Building Envelope Concept Approval Major Project MP10_0068

Westfield Shopping Centre Parramatta



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1 INTRODUCTION

Vipac Engineers & Scientists Ltd. (VIPAC) has been commissioned by Scentre Design & Construction to do an acoustic assessment for the proposed development at the Westfield Shopping Centre.

This report is to support the Section 75W Modification (MOD1) to the approved commercial tower building envelope as part of the Concept Approval Major Project MP10_0068.

The original approved part 3A application involves the construction of an additional level or retail, a high rise office building and additional car parking, to be developed in 2 stages.

The proposed amendment comprises the following components:

- An increase of 21 floors to the commercial tower
- Moved foot print of commercial tower

2 SITE AND DEVELOPMENT DETAILS

The Westfield Parramatta Project comprises a re-development and refurbishment of the existing shopping complex. The new footprint of the commercial tower is shown below:

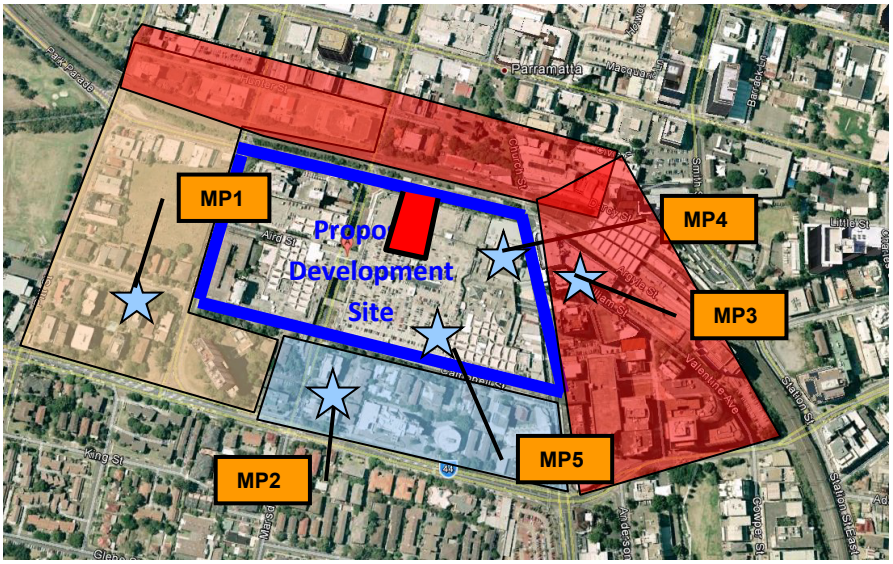

Figure 1: ***Site details and measurement locations*** **– (picture courtesy of Google Earth)**

2.1 SENSITIVE RECEIVERS

The nearest sensitive receivers are shown in Figure 1 and are summarised as follows:

- Residential receivers to the south of the development (along Campbell Street)
- Residential receivers to the west of the development (O'connell Street)

- Apartment buildings to the north of the development (Hunter Street)
- Apartment building to the east (140 Church Street)
- Commercial receivers to the north, east, south and west

The receivers have been grouped into three noise catchment areas. The blue zone represents receivers within the higher noise background levels due to proximity and field of view to Church Street and Marsden Street. The orange zone represents receivers with a lower ambient and background noise level. The red zone to the east is mainly commercial buildings, with the exception of the apartment building at 140 Church Street that will be assessed under the blue zone ambient noise levels. The red zone to the north is mainly commercial, with the exception of two apartment buildings that will also be assessed under the blue zone ambient noise levels.

Table 2-1 – Noise Catchment Area details

Noise Catchment area	Orientation to the site	Street	Approximate number of residential properties	Approximate number of commercial properties
MP1	South	Pitt Street, O'connell Street, Campbell street	23	12
MP2	West and South west	Between Campbell Street and Great Western Highway	19	4
MP3	North, North East, East	Various	20+	20+
MP4	N/A	N/A	0	10+
MP5	N/A	N/A	0	10+

2.2 SITE ACOUSTIC ISSUES

Due to the size of the development and the proximity to residential receivers, the following acoustic issues will be addressed:

- External noise intrusion from traffic noise, primarily along Church Street;
- External noise intrusion from trains;
- Perceptibility of train induced vibrations in the commercial tower;
- Noise emission from mechanical plant for the development impacting on the nearby residential and commercial receivers.

3 STANDARDS AND GUIDELINES

The following standards and guidelines are applicable to this assessment:

- SEARS Requirements

- Parramatta Council Requirements
- Parramatta Development Control Plan (DCP) 2011
- NSW OEH "The Interim Construction Noise Guideline (ICNG) 2009"
- Australian standard AS/NZS 2107-2000: Acoustics – Recommended design sound levels and reverberation times for building interiors.
- NSW Department of Planning (DoP) Development Near Rail Corridors and Busy Roads– Interim Guideline.
- NSW OEH Road Noise Policy (RNP)
- NSW OEH Industrial Noise Policy (INP)
- BS6472 "Assessing Vibration: a technical guideline"
- German Standard DIN4150, Structural Vibration Part 3: Effects on buildings and structures.
- Australian standard AS 1055.1-1997: Acoustics - Description and measurement of environmental noise - General procedures.

The criteria above have been summarised based on their relevance to the specific acoustic issues that are to be addressed to maintain future occupant acoustic amenity and any noise impacts that may affect existing sensitive land uses around the site.

4 ACOUSTIC AND VIBRATION CRITERIA

4.1 PLANNING REQUIREMENTS

4.1.1 DIRECTOR GENERAL REQUIREMENTS

Issue 3 of the Director General Requirements states that the environmental assessment must address environmental and amenity impacts, which involves acoustic privacy.

4.1.2 PARRAMATTA CITY COUNCIL REQUIREMENTS

The Parramatta City Council requirements state that noise impacts of new plant/mechanical equipment associated with stage 1 need to be addressed. Also, that a noise and vibration investigation for the construction phase is required.

4.2 OCCUPANT ACOUSTIC AMENITY

To protect occupants of the new development from external noise intrusion, the following applies:

4.2.1 PARRAMATTA COUNCIL DCP 2011

The Parramatta council DCP does not provide any recommendations on achieving amenity for retail or commercial developments.

4.2.2 AS/NZS 2107-2000

AS/NZS 2107–2000 outlines the acceptable internal noise levels such that a satisfactory acoustic environment within occupied spaces in new and existing buildings can be achieved. Typically, the recommended internal noise level L_{Aeq} for fully furnished spaces should meet the criteria presented below for steady state noise.

Table 4-1: AS/NZS 2107-2000 - Recommended Design Sound Levels for building interiors

Type of occupancy/activity	Recommended design sound level Leq dB(A)		Recommended reverberation time (T), s
	Satisfactory	Maximum	
Office buildings			
Board and conference rooms	30	40	0.6 to 0.8
General office areas	40	45	0.4 to 0.6
Private offices	35	40	0.6 to 0.8
Undercover car parks	55	65	-
Shop buildings			-
Small retail stores (general)	45	50	See note[1]
Shopping malls	45	55	

4.3 OPERATIONAL NOISE EMISSION

To control the impact from site generated noise to surrounding receivers the guidelines in the following sections apply.

4.3.1 PARRAMATTA COUNCIL DCP

The Parramatta council DCP 2011 states that non-residential development is not to adversely affect the amenity of adjacent residential development as a result of noise, hours of operation and/or service deliveries.

4.3.2 NSW INDUSTRIAL NOISE POLICY

The procedures detailed in OEH NPI have been considered to determine the limit of allowable noise emission from the proposed site. The assessment procedure has two requirements that must be met, namely:

- that the noise source not be ‘intrusive’; and also

[1] Reverberation time should be minimised as far as practicable for noise control

- that the 'amenity' of the nearby land be preserved.

This policy sets out two separate noise criteria designed to ensure developments meet environmental noise objectives. The first criterion accounts for intrusive noise and the second criterion applies to protection of amenity of particular land uses. Applying both the amenity and intrusiveness criteria to the situation and adopting the more stringent of the two is used to assess the new development. This becomes the project specific noise levels. Applying the most stringent requirement as the project specific noise levels ensures that both intrusive noise is limited and the amenity is protected.

4.3.3 NSW OEH ROAD NOISE POLICY

Noise from traffic movements to and from the site will be assessed using the NSW OEH Road Noise Policy. Table 4-2 presents the OEH's road traffic noise assessment criteria for land use developments with potential to create additional traffic on existing roads. The external criteria are assessed at 1 metre from the affected residential building façades and at a height of 1.5 metres from the floor.

Table 4-2: Road Traffic Noise Assessment Criteria for Residential Land Use.

Road category	Type of project/land use	Assessment criteria, dBA	
		Day (7am to 10 pm)	Night (10 pm to 7 am)
Local Roads	Existing residences affected by **additional traffic** on existing local roads generated by land use developments Existing residences affected by noise from **redevelopment** of existing roads	$L_{eq\ (1\ hr)}$ 55 (External)	$L_{eq\ (1\ hr)}$ 50 (External)

Note: In cases where noise exceeds the above criteria:

1. The OEH recommends that "where feasible, existing noise levels should be mitigated to meet the noise criteria. In this regard the RNP states that for existing roads there is limited potential for noise control as the development is not linked to road improvements. It does however advise that applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments."
2. For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.

In addition to above assessment criteria, the RNP requires any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development to be considered. The relative increase criteria outlined in the RNP is presented in Table 4-3.

Table 4-3: Relative Increase Criteria for Residential Land Use.

Road Category	Type of project / land use	Total traffic noise level increase, dB(A)

		Day (7am - 10pm)	Night (10pm-7am)
Freeway/ arterial/ sub-arterial roads and transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq,(15\ hour)}$ + 12dB (external)	Existing traffic $L_{Aeq,(9\ hour)}$ + 12dB (external)

4.4 RAIL VIBRATION

The following guidelines relate to assessing train vibrations and human perceptibility.

4.4.1 THE DOP DEVELOPMENT NEAR RAIL CORRIDORS AND BUSY ROADS– INTERIM GUIDELINE

The DoP Development Near Rail Corridors and Busy Roads – Interim Guideline provides guidance on when a rail vibration assessment may be required, as detailed below.

The vibration assessment zone for typical development sites adjacent to rail corridors or above rail tunnels is as follows:

- Within 25m - Single residential buildings on “Hard” ground, such as sandstone;
- Within 60m - Other vibration sensitive buildings.

Developments within these zones will need a vibration assessment. The following sections provide details of the relevant criteria to apply when a vibration assessment is required. Due to the proximity of the proposed to the rail line a vibration assessment has been completed.

4.4.1.1 “ASSESSING VIBRATION: A TECHNICAL GUIDELINE” / BS6472

This guideline for assessing vibration provides evaluation methods to assess the human response from continuous, impulsive and intermittent vibration in buildings from 1Hz to 80Hz which is based on British Standards BS6472:1992 “Evaluation of the Human Exposure to Vibration in Building (1Hz to 80Hz)”.

The Vibration Dose Value in the BS6472 is a concept used to evaluate the cumulative effects of bursts of both intermittent vibration and impulsive vibration such as that from train pass by’s.

The Vibration Dose Value (VDV) represents a single value amount used to quantify the level of vibration. The following table presents levels of VDV expressed in day-time, night-time and typical human response.

Table 4-4: Acceptable vibration dose values ($m/s^{1.75}$) for intermittent vibration in commercial buildings

Daytime	
Preferred value	**Maximum Value**
0.40	0.80

Vibration levels below the preferred values correspond to a low probability of adverse comment or disturbance to building occupants. Adverse comment or complaints may be expected when the VDV approaches maximum levels. Values up to the maximum level can only be used where all reasonable and feasible measures have been implemented and they can be justified.

4.5 CONSTRUCTION NOISE

4.5.1 NSW OEH "THE INTERIM CONSTRUCTION NOISE GUIDELINE".

The NSW Interim Construction Noise Guideline developed by the NSW Office of Environment and Heritage contains detailed procedures for the assessment and management of construction noise impacts.

The Guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer-term construction, and the qualitative method, which is generally suited to short-term works such as infrastructure maintenance.

4.5.1.1 RESIDENCES AND OTHER SENSITIVE LAND USES

Due to the length of the required works a quantitative method will be followed. The noise management levels for are shown in Table 4-5.

Table 4-5: Noise at Residences Using Quantitative Assessment

Time of day	Management level, $L_{Aeq(15min)}$	How to apply
Recommended standard hours Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays and Public Holidays	Noise affected RBL+10dB	• The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq(15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

	Highly noise affected 75dBA	• The highly noise affected level represents the point above which there may be strong community reaction to noise.
		• Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:
		  ◦ Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences.
		  ◦ If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside recommended hours	Noise affected RBL+5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet

Time of day	Management level, $L_{Aeq(15min)}$	How to apply
		the noise-affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2. of guideline.
• *Note: The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).*		

Table 4-6: Noise At Sensitive Land Uses (Other Than Residences) Using Quantitative Assessment

Land Use	Management level, $L_{Aeq(15min)}$ (Applies when properties are being used)
Active recreation areas	External Noise Level – 65 dB(A)
Passive recreation areas	External Noise Level –60 dB(A)
Classrooms at schools and other educational institutions	Internal Noise Level – 45 dB(A)
Places of worship	Internal Noise Level – 45 dB(A)

Where internal noise management levels are specified, the external noise level may be 10dB(A) greater for buildings with no adequate ventilation or 20dB(A) for buildings with fixed external windows and alternative means of ventilation.

4.5.1.2 COMMERCIAL AND INDUSTRIAL

For commercial premises including offices and retail outlets, the recommended noise management level is an external $L_{Aeq(15min)}$ 70 dB(A) assessed at the most-affected point on the premises. For industrial premises an $L_{Aeq(15min)}$ 75 dB(A) applies.

The construction works are considered to have the potential to cause a noise impact if the expected noise exceeds these levels.

The proponent should apply all feasible and reasonable work practices to meet the noise-affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with affected parties.

4.6 CONSTRUCTION VIBRATION

The effects of construction vibration upon buildings can be separated into three main categories:

- Perceptibility of the occupants to the vibration, and the possibility of them being disturbed or annoyed
- Vulnerability of the building structures to vibration induced damaged

- Vulnerability of the contents of the building that includes types of equipment, activities and processes.

4.7 HUMAN RESPONSE TO VIBRATION

Humans beings are very sensitive to vibration, and they can be disturbed, annoyed, and have their work activities interfered with if the levels are too high. The OEH "Assessing vibration guidelines" and British Standard 6472 provide guidance on human response to vibration in buildings. They set down base vibration levels at which there would be minimal interference to occupants.

BS 6841 also sets out guidance on the effects of physical health from sustained exposure to vibration, however it is unlikely that such levels will ever be encountered from construction or demolition activities. The frequency weighting to be applied to the vibration levels are obtained from BS 6472.

The criteria and guidelines relating to human response are summarised below.

4.7.1 OEH ASSESSING VIBRATION: A TECHNICAL GUIDELINE

The OEH guideline for assessing vibration provides evaluation methods to assess the human response from continuous, impulsive and intermittent vibration in buildings from 1Hz to 80Hz which is based on British Standards 6472:1992 "Evaluation of the Human Exposure to Vibration in Building (1Hz to 80Hz)".

For continuous and impulsive vibration, assessment should be done on the basis of weighted RMS acceleration values. For intermittent vibration, assessment should be done on the basis of vibration dose values (VDV).

This guideline also includes a section on mitigation when the predicated vibration value exceeds the criteria. This involves:

- Controlling the vibration at the source, using the application of Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA).
- Controlling the transmission of vibration.
- Controlling the vibration at the receiver

4.7.2 BRITISH STANDARD 6472:1992 – EVALUATION OF HUMAN EXPOSURE TO VIBRATION IN BUILDINGS

This standard sets out vibration levels at which minimal comment is likely to be provoked from the occupants of the building subject to the vibration. BS 6472 takes into account that humans perceive vertical vibrations more than horizontal, although the effect is reversed at very low frequencies, below 4 Hz.

The evaluation of building vibration with respect to annoyance and comfort for the occupants, overall weighted values of vibration are preferred.

Continuous vibration would be generated for typical construction work. The curves in Figure 2 represent the magnitudes of continuous vibration in buildings for Z-axis acceleration, below which

adverse comments or complaints are rare. Multiplication factors are applied to the base level curve to define criteria for residential or office spaces. There are similar curves for x and y-axis.

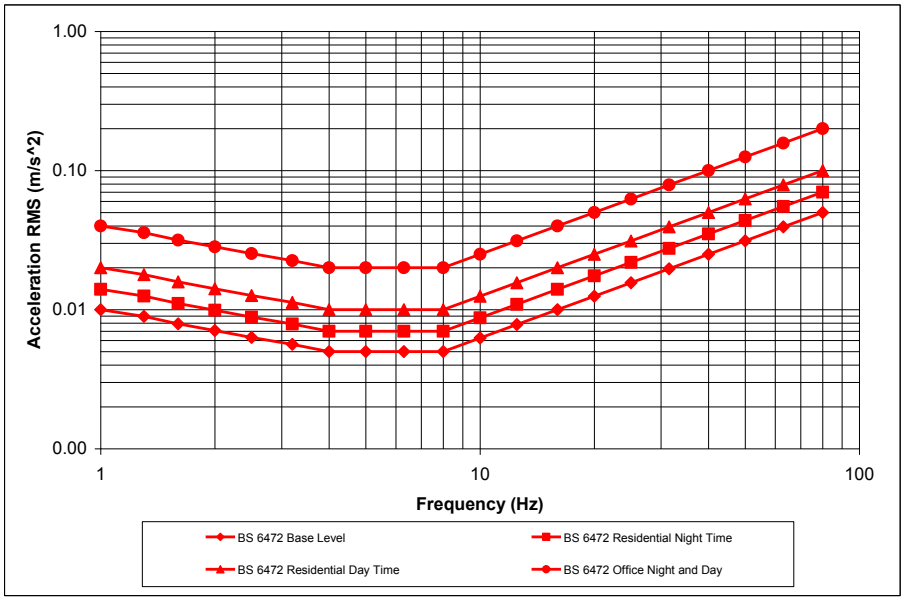

Figure 2: BS 6472 building vibration levels. Z-axis.

The Vibration Dose Value in the BS 6472 is a concept used to evaluate the cumulative effects of bursts of both intermittent vibration and impulsive vibrations. Vibration Dose Value, or the VDV represents a single value amount used to quantify the level of vibration. The following

Table 4-7 presents levels of VDV expressed in daytime, night time and typical human response.

Table 4-7: Acceptable vibration dose values ($m/s^{1.75}$) for intermittent vibration in residential buildings

Location	Daytime		Night time	
	Preferred	Maximum	Preferred	Maximum
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80

Vibration levels below the preferred values correspond to a low probability of adverse comment or disturbance to building occupants. Adverse comment or complaints may be expected when the VDV approaches maximum levels. Values up to the maximum level can only be used where all reasonable and feasible measures have been implemented and they can be justified.

4.8 STRUCTURAL RESPONSE TO VIBRATION

The response of a building to vibration is affected by several factors that include its type of foundation; the underlying ground conditions, its construction and the state of the building.

BS 7385: Part 2-1993 provides guide values for building damage, as well as guidance on vibration measurement and data analysis. The German Standard DIN 4150: Part 3-1999 also provides guidelines for evaluating the effects of vibration on structures.

4.9 GERMAN STANDARD DIN 4150-3:1999 – STRUCTURAL VIBRATION – EFFECTS OF VIBRATION ON STRUCTURES

The German standard DIN 4150-3 Structural Vibration Part 3: Effects on buildings and structures is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

Short-term vibration is defined as vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated.

Table 4-8 below provides guideline limits for short-term vibration to ensure that damage reducing the serviceability of a building will not occur provided vibration levels do not exceed these limits. This is also shown graphically in Figure 3. Vibration at the foundation is taken as the maximum absolute value in the x,y, and z directions, and vibration at the highest floor is the maximum of the in plane components.

Table 4-8: DIN4150-3 Vibration Limits

Type of structure	Guideline values for velocity in mm/s			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g listed buildings under preservation order)	3	3 to 8	8 to 10	8

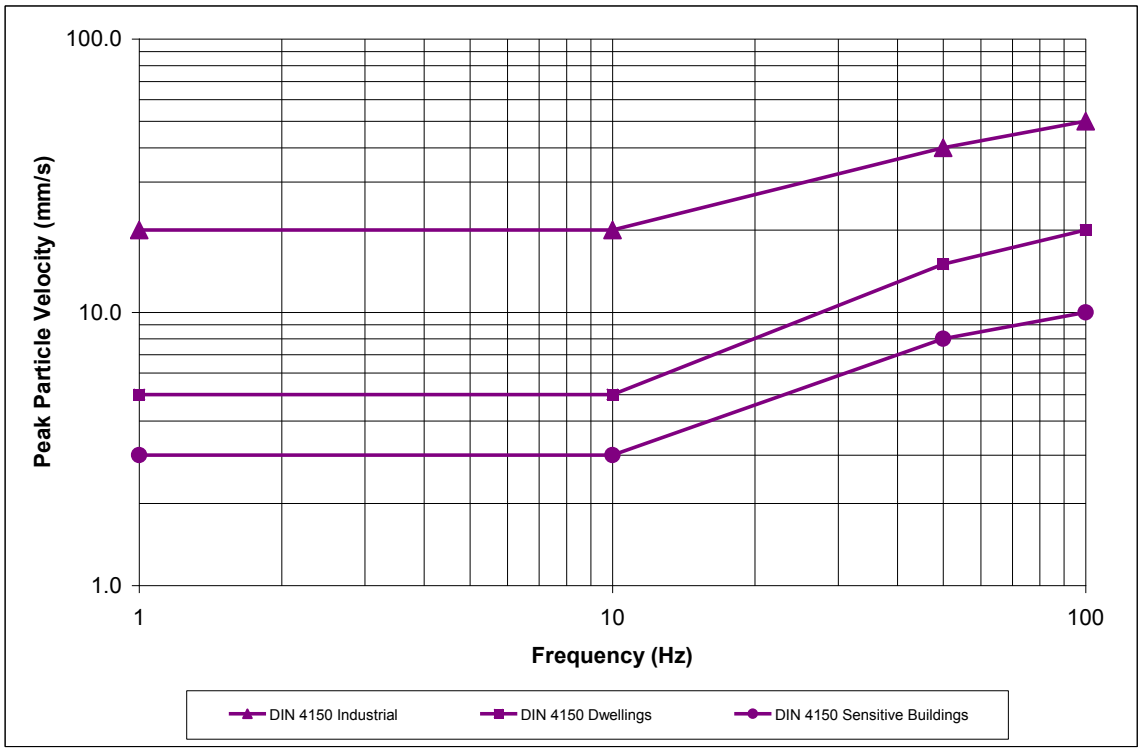

Figure 3: DIN4150-3 Vibration Limits

4.10 BRITISH STANDARD 7385 PART 2 – 1993 GUIDELINES

The limits for transient vibration, above which cosmetic damage could occur to buildings, are given in Table 4-9 and shown graphically in Figure 4.

These guide values however relate predominantly to transient vibration that does not give rise to resonant responses in structures. The guide values in Table 4-9 should be reduced by up to 50%, in the case of dynamic loading caused by continuous vibration.

The values presented by BS 7385-2 are frequency dependant levels that are judged to give a minimal risk of vibration-induced damage.

Table 4-9: Transient vibration guide values for cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced framed structures, Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Un-reinforced or light framed structures, Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note 1: Values referred to are at the base of the building

Note 2: For the residential buildings group, at frequencies below 4 Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded

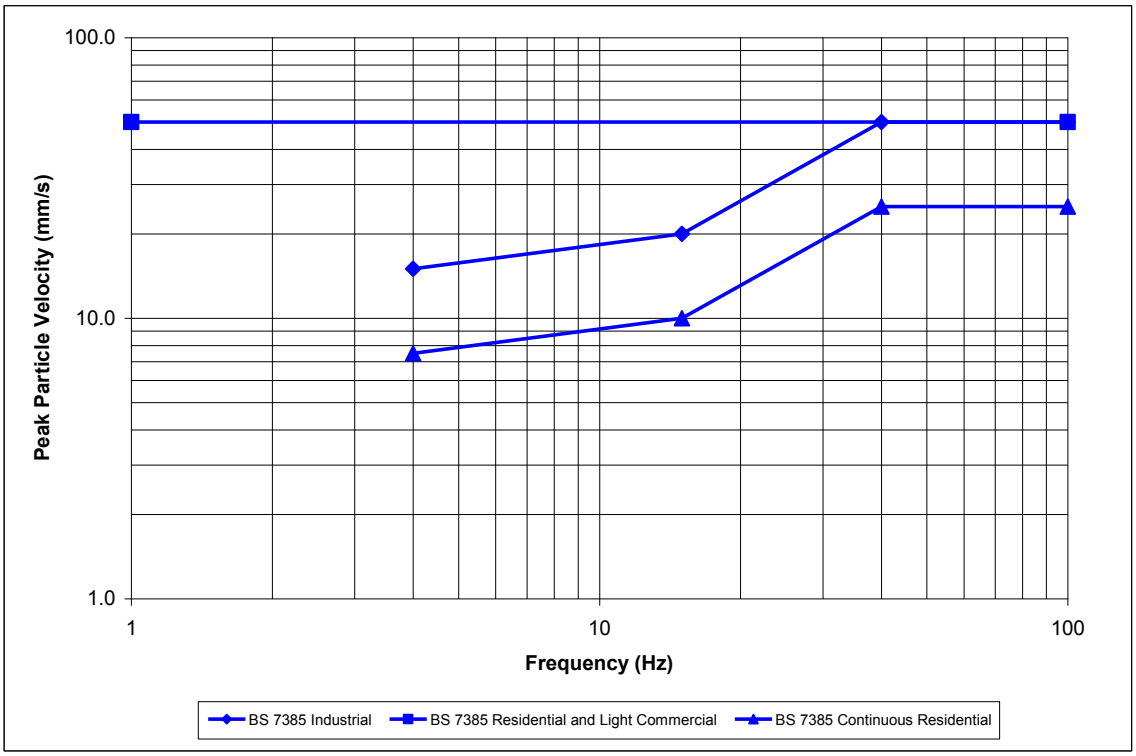

Figure 4: Transient vibration guide for cosmetic damage

4.11 CONSTRUCTION VIBRATION ASSESSMENT CRITERIA SUMMARY

A comparison to the above criteria is shown in Figure 5. PPV values have been used for the human disturbance values, in order to compare against building damage guide values.

The human disturbance criterion from BS 6472 for continuous vibration is significantly lower than the various threshold damage levels from DIN 4150 and BS 7385.

This is due to humans being able to perceive vibration levels that are well below those that could cause any risk to damage to a building or its contents.

The values in DIN 4150 are levels that if complied with, damage will not occur. If levels are exceeded damage will not necessarily occur, however if they are significantly exceeded, then further investigations will be required.

The vales in BS 7385 are the lowest vibration levels above which damage has been credibly demonstrated. Hence why the values are much higher than those of DIN 4150.

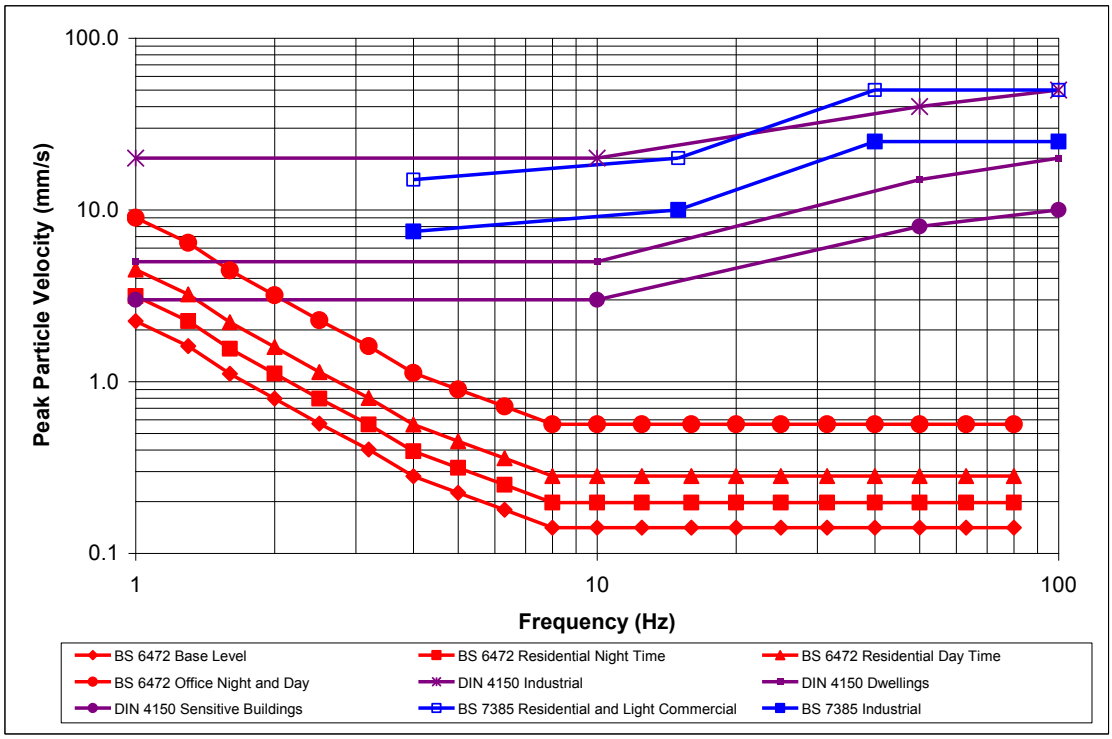

Figure 5: Human Disturbance and Building Damage Guide Values

Based on the above, the following criterion is deemed most appropriate and is recommended for use in this assessment:

- When the adjacent building subject to vibration is being occupied, continuous vibration levels from BS 6472 will be used to assess human perception. Human perception occurs at lower thresholds than that for building damage and during occupied periods will be the limiting criteria.
- When it is un-occupied, vibration levels from DIN 4150 will be used to protect the building from cosmetic damage.

5 SITE ENVIRONMENTAL NOISE & VIBRATION SURVEY

The following section details the results of the environmental noise monitoring, to establish the acoustic environment around the development site.

5.1 METHODOLOGY

5.1.1 NOISE

Unattended noise monitoring was conducted between the 24th and 27th of July 2012 to obtain existing background and ambient noise levels at measurement positions MP1 and MP2. Attended noise monitoring was conducted to obtain traffic noise levels and noise emission from general pedestrian activity in the highly populated areas around the development (MP3). The locations are shown in Figure 1.

Noise emission limits and noise management levels will be updated with the full set of data.

5.1.2 VIBRATION

Vibration data has been used from previous ViPAC projects where similar distances and ground foundations were involved.

5.2 INSTRUMENTATION

Measurements were conducted using the following equipment:

Table 5-1: Monitoring equipment list

Equipment	Serial Number
Larson Davis Integrating Sound Level Analyser, Model 812	0385
Larson Davis Integrating Sound Level Analyser, Model 812	0381
B&K sound analyser 2250, Serial Number	2590541
Bruel & Kjaer Sound Level Calibrator Type 4230	378285

The instruments were checked for calibration immediately before and after the measurements and there was no adverse deviation between the two. The instruments carry traceable calibration certificates. The sound analysers are Type 1 and comply with the Australian standard AS1259.2: 1990.

5.3 NOISE SURVEY RESULTS

The results of the unattended and attended noise measurements are summarised below in Table 5-2 results are presented as follows:

- Day – 15 hour L_{Aeq}

- Evening – 4 hour L_{Aeq}
- Night – 9 hour L_{Aeq}

Table 5-2: Measurement results

Location	Time period	L_{Aeq}	L_{A90}	Observations
MP1	Day	57	48	Background and ambient noise
	Evening	55	46	
	Night	52	41	
MP2	Day	62	55	Background and ambient noise
	Evening	61	52	
	Night	57	46	
MP3	Attended	72	62	Bus noise dominant, general traffic and pedestrian noise
MP4	Attended	57	53	Westfield mechanical plant
MP5	Attended	55	53	Westfield mechanical plant

5.4 PROJECT SPECIFIC NOISE EMISSION GOALS

The results of the noise surveys and criteria as summarised in section 5.3 have been used to derive project specific environmental noise emission goals associated with the development. These are summarised in Table 5-3.

Table 5-3: Site noise emission limits

Receiver Location	Period	Existing Noise levels dB(A)		Operational Noise Goals dB(A)		
		L_{Aeq}	RBL	INP Amenity	INP Intrusiveness	Project Specific Level
Residential in orange noise catchment zone	Day	57	46	55	51	**51**
	Evening	55	44	45	49	**45**
	Night	52	38	40	43	**40**
Residential in blue noise catchment zone (including 140 Church Street and apartment blocks to north)	Day	62	53	55	58	**55**
	Evening	61	50	45	55	**45**
	Night	57	44	40	49	**40**
Commercial	When in use	-	-	65-70	-	**65-70**
Industrial	When in use	-	-	70-75	-	**70-75**

6 ASSESSMENT AND RECOMMENDATIONS

The following section provides results on the assessment of noise intrusion into the commercial tower, construction noise and vibration, rail vibration perceptibility, and traffic generated noise.

6.1 CONSTRUCTION NOISE

6.1.1 TYPICAL EQUIPMENT NOISE LEVELS

The typical sound power levels for pieces of equipment generally used in similar jobs are listed in Table 6-1, along with predicted sound pressure levels at various distances.

Table 6-1: Construction Equipment and A-weighted sound power levels. All Values in dB(A).

		Predicted Sound Pressure Levels at various distances per equipment (meters)			
Equipment	Sound Power Levels	20	60	150	200
Excavator breaker	114	80	70	62	60
Telescopic Crane	110	76	66	58	56
Dump truck	108	74	64	56	54
Excavator	100	66	56	48	46
Tower crane	104	70	60	52	50
Diesel generator	88	54	44	36	34
Concrete truck	112	78	68	60	58

6.1.2 MANAGEMENT AND PREDICTED CONSTRUCTION NOISE LEVELS

Typical noise levels at the receiver positions are shown in Table 6-2. Note that noise levels are presented as external $L_{Aeq\text{-}15minute}$. The proximity of the works at various phases at all the surrounding nearby receivers is approximately the same. Therefore, predicted noise levels at the commercial and residential receivers will be the same.

Table 6-2: Measurement results, noise management levels and receiver noise levels.

		Management Levels		Predicted $L_{Aeq,15min}$ Noise Level	
Receiver Location	Period	Noise Affected	Highly Noise Affected	Noise at Receiver	Complies (Yes/No)
Residential in orange noise catchment zone	Day	56	75	80	**No**
	Evening	54	-	80	**No**

		Management Levels		Predicted $L_{Aeq,15min}$ Noise Level	
Receiver Location	Period	Noise Affected	Highly Noise Affected	Noise at Receiver	Complies (Yes/No)
(Standard hours)	Night	48	-	80	**No**
Residential in orange noise catchment zone (Outside standard hours)	Day	51	-	80	**No**
	Evening	49	-	80	**No**
	Night	43	-	80	**No**
Residential in blue noise catchment zone (including 140 Church Street and apartment blocks to north) (Standard hours)	Day	63	75	80	**No**
	Evening	60	-	80	**No**
	Night	54	-	80	**No**
Residential in blue noise catchment zone (including 140 Church Street and apartment blocks to north) (Outside standard hours)	Day	58	-	80	**No**
	Evening	55	-	80	**No**
	Night	49	-	80	**No**
Commercial/Retail	When in use	70	-	80	**No**

It is predicted that there will be exceedance of the noise management levels at all the surrounding receiver positions, residential, commercial and retail, during all periods of the day. This is mainly due to the proximity of the works to the receivers.

6.1.3 MANAGEMENT AND WORK PRACTICES

In order to manage the noise from the construction activities the following work practices and procedures are to be considered and a noise management plan should be prepared for the construction phases:

- Adherence to the NSW OEH recommended preferred hours for construction and deliveries;
- Turn off plant that is not being used;
- Avoid demolition of existing buildings using rock breaks, but rather demolishing structures with jaw crushers and saws;
- Consider using bored piling instead of impact piling to reduce noise;
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms;
- Truck drivers are to be informed of site access routes, acceptable delivery hours and minimising extended periods of engine idling;

- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers;
- When selecting equipment ensure where feasible and reasonable it has the most effective mufflers, enclosures and low-noise tool bits and blades. Always seek the manufacturer's advice before making modifications to plant to reduce noise;
- Locate noisy plant away from potentially noise-affected areas or behind barriers, such as sheds or walls;
- Construct purpose built barriers or screens where required;
- Table 6-3 is an excerpt from 'Noise Sources, remedies and their effectiveness' Australian Standard 2436:2010, presenting possible noise reductions from various control mechanisms.

Table 6-3: Excerpt from AS 2436:2010 – Relative Effectiveness of Various Forms of Noise Control

Control by	Noise Reduction Possible in Practice, dB(A)
Distance	Approximately 6 for each doubling of distance
Screening	Normally 5 to 10, maximum 15
Enclosure	Normally 15 to 25, maximum 50
Silencing	Normally 5 to 10, maximum 20

6.2 CONSTRUCTION VIBRATION

Vibration may also be generated as a result of construction work and has been considered both in respect of potential damage of buildings and potential annoyance to the occupants. In many cases, it is the occupants/residents fear of building damage that enhances the potential annoyance. The most common form of vibration measurement is the peak particle velocity (PPV) in mm/s.

In respect to building damage, a vibration level limit and frequency is normally specified, however, in respect of potential annoyance to receivers, a combination of vibration level frequency and duration is more appropriate. This is normally termed as a dose value.

The equipment used for the project that has potential to generate vibration is detailed in Table 6-4. This has been evaluated against human perception criteria, and structural damage.

Table 6-4: Vibration levels of equipment

	Vibration peak particle velocity (mm/s) at given distance			Safe working distance (m) (for structural damage only)
				Residential and offices
Equipment	5m	10m	20m	Structural damage
Excavator rock breaker	4.5	1.3	0.4	2
Jackhammer	1	0.3	0.1	1
Trucks	-	-	0.01 - 0.2	-

Construction vibration from the development is not expected to impact on any adjacent sensitive receivers. However there may be localised impacts on the centre itself and whilst not a material consideration for the S75W Modification these should also be managed as part of the overall noise and vibration management plan.

6.3 OPERATIONAL NOISE ASSESSMENT

The following section details the operational noise assessment and considers noise generated by the site that has potential to impact on adjacent noise sensitive receivers.

6.3.1 Mechanical Plant

Mechanical noise emission from development should be controlled in accordance with the Project Specific Noise Level criteria as shown in Table 5-3.

At this stage, the design and selection of the plant required to service the proposed development has not been determined therefore the possible noise impact cannot be assessed.

During the detailed design stages of the project the mechanical services consultant should select plant so that the total mechanical services noise does not exceed the lowest project specific noise level at the common boundary of the receiver.

In general, based on previous experience with similar sized developments, a number of amelioration measures can be implemented to control the noise emission. Typical amelioration measures are outlined below (not necessarily limited to):

- Location of mechanical services equipment away from noise sensitive receivers.
- Achieving no direct 'line of sight' path between the nearest residence and all the major mechanical equipment or exhaust fans.
- Installation of low noise condenser units.
- Installation of barriers and acoustic enclosures where the above measures do not provide sufficient attenuation.
- Installation of all mechanical equipment on vibration isolators (pads) as recommended by the manufacturers.

Commercial tower mid-level and rooftop plant location will most probably require screening around the plantroom. This may be acoustic louvre types or normal visual screens.

6.3.2 TRAFFIC NOISE GENERATION

Based on preliminary traffic flow increases, approximately in the order of 10 percent, traffic noise generated on any connecting streets due to the office building and shopping centre expansion is not expected to result in any significant increase and in all cases will be below the NSW Road Noise Policy requirement of 2dB(A).

6.4 EXTERNAL NOISE INTRUSION

6.4.1 FACADE CONSTRUCTION

Preliminary noise calculations were performed for the commercial building to determine the required façade glazing such that there is compliance with the internal noise levels for spaces such as open plan offices, meeting rooms and private offices. Typical room sizes were used for the calculations.

Noise levels were based on traffic noise around the development. Calculations were performed on all noise transmission paths including the roof/ceiling, glazing and the external façade based on supplied architectural drawings. The minimum glazing construction requirements (but not limited to) for the habitable spaces is 6.38mm laminated glass, except for sensitive rooms such as private offices and meeting rooms on the lower levels of the north and east façade, which would require 10.38mm laminated. All glazing specifications will be updated at a later stage of the development as further details are developed.

6.4.1.1 GENERAL REMARKS

Glazing is generally the weakest component of any building façade where it would serve as a major noise transmission path, especially in cases where it has not been installed properly. Sometimes different glass configurations have the same R_w ratings but they have different Sound Transmission Loss characteristics at each frequency band.

Our glazing recommendations have been based on the glass performance across the octave band frequency spectrum.

All Windows/doors should be well sealed (air tight) when closed with good seals such as **Q-LON®** acoustic seals (or equivalent) around the top and bottom sliders.

Any air gap will significantly reduce the performance of the glazing in terms of the ability to attenuate noise. Mohair type seals are not considered as acoustic seals. All of the above assumes that the glass is properly sealed airtight.

In the case of service rooms such as toilets, laundries, kitchens, etc, a 4mm thick windows/glazing system with a minimum Rw of 28 is considered sufficient.

6.5 RAIL VIBRATION PERCEPTIBILITY

Previous train vibration measurements were used to provide the most representative levels that the occupants of the commercial building will be exposed to within the proposed development. With the

measured values, the estimated Vibration Dose Value (eVDV) was calculated based on the number of train movements.

- Train passage duration – 10-20 seconds (average)
- Estimated number of train movements;
    - Day Period = 129
    - Night Period = 63

Based on the results of the assessment detailed in Table 6-5 below, vibration levels are within the relevant criteria and therefore there is not expected to be any requirement to treat the impact from rail vibration on the development in regards to human perception.

Table 6-5: eVDV of Vibration calculations from Rail Pass-by's

Period	eVDV in $m/s^{1.75}$	Preferred value
Day	0.0072	0.4
Night	0.0060	0.4

7 CONCLUSIONS

An acoustic assessment of the proposed development has been carried out in accordance with the relevant noise policies and Australian Standards as detailed in Section 4. This report details our comments and recommendations, which include:

- Project specific levels have been assigned to the development based on unattended noise surveys around the site. Noise from mechanical plant associated with the expansion of the shopping centre and addition of the commercial tower should not exceed these levels at the respective receiver boundaries.
- Construction noise will generally cause exceedances of the noise management levels defined by the ICNG. This is due to the close proximity of the residential and commercial and retail receivers to the work site. It is recommended that work not be conducted outside the standard hours.
- Façade glazing to the commercial tower has been designed based on external noise intrusion from traffic and rail. (to be updated as design progresses)
- Rail vibration is well below the perceptibility criteria in BS6472.
- Traffic generated noise is not expected to exceed levels in the RNP.
- This proposed commercial tower modification poses no risk of adverse operational noise impacts on the surrounding noise sensitive receivers.

Appendix A: ARCHITECTURAL DRAWINGS

The environmental assessment carried out in this report was based on the following architectural drawings provided by Scentre Design & Construction:

09150 SEARS Requirements and Attachments

2018-04-27 - PAR - ALL PLANS

2018-04-27 - PAR - ALL ELEVATIONS AND SECTIONS

PA-2018-SCH19- DA-01-5231-1 STREET FLOOR PLAN DETAILED

PA-2018-SCH19- DA-01-5231-1 STREET FLOOR PLAN

APPENDIX B: GLOSSARY OF ACOUSTIC TERMS

Decibel, dB:
Unit of acoustic measurement. Measurements of power, pressure and intensity. Expressed in dB relative to standard reference levels.

dB(A):
Unit of acoustic measurement weighted to approximate the sensitivity of human hearing to sound frequency. Sound Pressure Level, Lp (dB), of a sound:

20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure of 20 micro Pascals. Sound pressure level is measured using a microphone and a sound level meter, and varies with distance from the source and the environment.

Sound Power Level, LW (dB), of a source:
10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 Pico Watt. Sound power level cannot be directly measured using a microphone. Sound power level does not change with distance. The sound power level of a machine may vary depending on the actual operating load.

Ambient Sound:
Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far.

Background noise:
The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed.

Percentile Level - L_{90}, L_{10}, etc:
A statistical measurement giving the sound pressure level which is exceeded for the given percentile of an observation period, e.g. L90 is the level which is exceeded for 90% of a measurement period. L_{90} is commonly referred to as the "background" sound level.

$L_{AEQ,T}$:
Equivalent continuous A-weighted sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same A-weighted sound energy as the actual time-varying sound.

Rating Background Level – RBL:

Method for determining the existing background noise level which involves calculating the tenth percentile from the LA90 measurements. This value gives the Assessment Background Noise Level (ABL). Rating Background Level is the median of the overall ABL.