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Date: Tuesday, 22 November 2022

Prepared for: Deicorp Projects Showground Pty Ltd
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LETTER TO ADDRESS SYDNEY METRO REQUEST FOR ADDITIONAL VIBRATION MONITORING

2 MANDALA PARADE, CASTLE HILL NSW 2154

1.0 INTRODUCTION

Koikas Acoustics was requested to address Sydney Metro request for additional vibration monitoring to predict ground-borne noise and vibrations from the nearby metro line to the mixed-use development at 2 Mandala Parade, Castle Hill NSW 2154. Koikas Acoustics has reviewed and conducted the vibration monitoring and calculations in accordance with *FTA Transit Noise and Vibration Impact Assessment Manual 2018*, as requested by Sydney Metro.

Reference details of the DA acoustical report prepared by Koikas Acoustics are provided below:

Project Title: Acoustical Report
Proposed mixed-use development
2 Mandala Parade, Castle Hill NSW 2154
(Doran Drive Precinct)

Date: Thursday, 17 February 2022

File Reference: 4214R20200804jtDoranDrivePrecinct_DAv8.docx

2.0 ACOUSTICAL REQUIREMENTS

2.1 RAIL NOISE – SEPPTI/DOP

Clause 3.6.2 of the *State Environmental Planning Policy (Transport and Infrastructure) 2021*, hereafter referred to as SEPPTI applies to development for a residential building adjacent to rail operations that may be affected by ground borne noise or vibration.

Residential buildings should be designed so that the 95th percentile of train pass-bys complies with the following ground-borne L_{Amax} noise limits measured using the "slow" response time:

- L_{ASmax} 35 dB during the night-time (10 pm and 7 pm)
- L_{ASmax} 40 dB during the daytime (7 am and 10 pm)

L_{Amax} refers to the maximum noise level not exceeded for 95% of rail pass-by events and is measured using the 'slow' response setting on a sound-level meter.

2.2 FTA TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT MANUAL 2018

Table 6-6 outlines the vibration criteria for detailed vibration analysis and has been extracted below.

Table 6-6 Interpretation of Vibration Criteria for Detailed Vibration Analysis

Criterion Curve	Max Lv,* VdB	Description of Use
Workshop (ISO)	90	Vibration that is distinctly felt. Appropriate for workshops and similar areas not as sensitive to vibration.
Office (ISO)	84	Vibration that can be felt. Appropriate for offices and similar areas not as sensitive to vibration.
Residential Day (ISO)	78	Vibration that is barely felt. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms (ISO)	72	Vibration is not felt, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X) and inspection and lithography equipment to 3-micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1-micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capabilities.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.

* As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.

The maximum allowable vibration limits for residential buildings during the night-time is L_v 72 VdB, as measured in 1/3 octave bands over the frequency range 8 to 80 Hz.

In addition, Table 6-3 outlines the ground-borne vibration and noise criteria for detailed vibration analysis and has been extracted below.

Table 6-3 Indoor Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Vibration Assessment

Land Use Category	GBV Impact Levels (VdB re 1 micro-inch /sec)			GBN Impact Levels (dBA re 20 micro Pascals)		
	Frequent Events	Occasional Events	Infrequent Events	Frequent Events	Occasional Events	Infrequent Events
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB*	65 VdB*	65 VdB*	N/A**	N/A**	N/A**
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

* This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. For equipment that is more sensitive, a Detailed Vibration Analysis must be performed.
** Vibration-sensitive equipment is generally not sensitive to ground-borne noise; however, the manufacturer's specifications should be reviewed for acoustic and vibration sensitivity.

3.0 RAIL VIBRATION SURVEYS

3.1 DATE AND LOCATION

Rail vibration surveys were conducted by Koikas Acoustics between 9:00 am and 11:45 am on Thursday 17th November 2022 along the site boundary of the subject premises. The site location of the vibration surveys are shown in Figure 1.

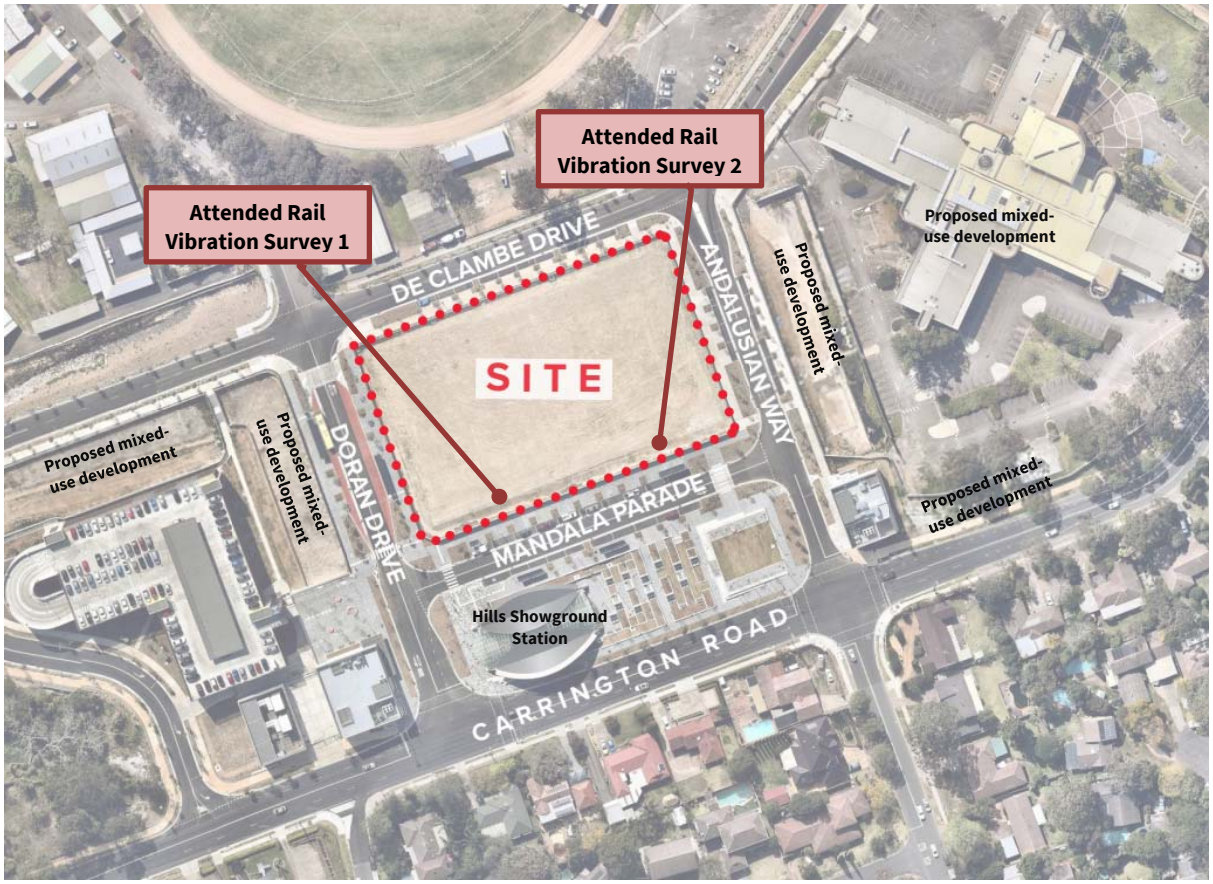


Figure 1. Aerial photo of the subject site, surrounding area and monitoring locations (image source – Turner Studio)

The NSW Department of Planning Development Near Rail Corridors and Busy Roads – Interim Guidelines (2009) advises a minimum of 20 rail pass-by events to quantify noise and vibration. To obtain the requisite rail pass-by vibration survey data, attended vibration surveys were conducted at the subject site.

3.2 ATTENDED VIBRATION SURVEYS

Rail vibration levels were measured with a Svantek 958 spectrum analyser. Vibration levels were recorded in the x-, y- and z-axes as unweighted R.M.S. velocity and acceleration. The survey data was subsequently analysed as per *FTA Transit Noise and Vibration Impact Assessment Manual 2018*, and the 95th percentile vibration levels between 10 Hz and 250 Hz have been extracted in Table 1 and 2 in 1/3 octave bands vibration velocity level (L_v)

Table 1. Rail vibration survey results– Location 1 [VdB]

Pass-by No.	Vibration Velocity Level (L_v)															
	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	Total
1	69	67	66	65	64	64	63	61	61	61	62	63	57	52	51	**75**
2	68	67	66	66	65	65	65	63	62	60	64	64	61	53	52	**76**
3	68	68	65	65	64	64	65	62	60	59	61	63	60	53	52	**75**
4	68	67	65	66	65	64	65	62	61	60	64	65	64	52	51	**76**
5	68	66	65	64	64	63	63	61	60	59	63	62	61	52	51	**75**
6	69	67	66	65	65	64	63	61	60	59	64	63	62	53	53	**76**
7	68	67	65	64	64	63	62	61	60	60	66	65	62	53	52	**75**
8	68	67	65	65	64	63	64	62	61	59	65	64	64	52	52	**76**
9	68	67	65	64	64	63	64	61	60	59	62	61	61	51	50	**75**
10	68	67	65	65	64	63	63	61	60	59	62	62	62	52	51	**75**
11	68	67	65	65	64	64	64	62	61	60	65	65	62	52	52	**76**
12	68	67	66	65	64	63	64	62	62	61	65	65	63	52	52	**76**
13	68	67	66	65	64	64	64	63	63	61	65	65	64	52	52	**76**
14	68	67	66	65	64	64	64	62	63	62	65	65	64	52	52	**76**
15	68	67	66	65	63	63	64	62	61	62	70	68	63	53	52	**77**
16	69	68	66	65	65	64	65	63	63	61	65	64	64	53	52	**76**
17	69	68	66	66	65	65	65	63	62	61	67	67	65	53	52	**77**
18	69	67	65	66	65	64	64	62	61	60	62	63	62	51	50	**76**
19	68	68	66	65	65	64	64	62	61	59	64	63	62	51	51	**76**
20	68	68	66	66	65	64	65	62	62	62	70	70	69	54	52	**78**
Average	68	67	66	65	64	64	64	62	61	60	65	65	63	52	52	**76**

Notes
1. L_v = Vibration velocity level for a single pass-by event

Table 2. Rail vibration survey results – Location 2 [VdB]																
Pass-by No.	**Vibration Velocity Level (L_v)**															
	10 Hz	**12.5 Hz**	**16 Hz**	**20 Hz**	**25 Hz**	**31.5 Hz**	**40 Hz**	**50 Hz**	**63 Hz**	**80 Hz**	**100 Hz**	**125 Hz**	**160 Hz**	**200 Hz**	**250 Hz**	**Total**
1	69	67	65	65	64	62	61	60	58	57	56	60	59	51	49	**75**
2	68	67	65	64	63	62	61	60	58	57	56	60	58	50	49	**74**
3	68	67	65	64	63	62	61	59	58	57	55	60	58	51	49	**74**
4	68	67	65	65	63	62	61	59	58	57	55	61	59	51	49	**74**
5	68	67	65	64	63	62	61	59	57	57	55	61	59	51	49	**74**
6	68	68	66	64	63	62	61	59	58	57	55	60	59	51	49	**74**
7	69	67	66	65	63	62	62	60	59	58	56	62	60	51	49	**75**
8	69	67	66	64	63	62	61	59	58	57	56	63	60	51	50	**75**
9	69	67	66	64	63	62	62	60	59	58	57	63	60	51	50	**75**
10	68	67	65	64	63	62	62	60	60	59	57	62	60	51	50	**75**
11	68	67	65	65	63	62	62	60	59	58	57	62	61	51	50	**75**
12	69	68	66	65	64	62	62	60	58	58	57	61	60	51	50	**75**
13	68	68	65	65	63	62	62	60	58	57	56	61	60	51	50	**75**
14	69	67	65	64	63	62	61	59	58	57	56	61	60	51	50	**74**
15	68	67	65	65	63	62	61	59	58	57	55	60	60	51	49	**74**
16	69	67	65	65	63	62	61	59	58	57	55	60	60	51	49	**74**
17	68	67	65	64	63	62	61	59	58	57	55	59	59	50	49	**74**
18	69	67	65	64	64	62	61	59	58	57	55	61	61	51	49	**75**
19	69	67	65	64	63	62	61	59	58	56	55	59	58	50	49	**74**
20	68	66	65	64	63	62	61	59	57	56	56	62	61	51	49	**74**
Average	68	67	65	64	63	62	61	59	58	57	56	61	60	51	49	**75**
Notes 1.	L_v = Vibration velocity level for a single pass-by event															

Vibrations levels were undertaken at above ground level of the existing site. Koikas Acoustics has assumed the vibration level at the above ground level will be the same as the basement floor level once excavated for the purposes of these calculations. Vibration monitoring is to be reconducted once excavations has been completed to confirm the ground-borne noise and vibration levels at the basement level and conduct a detailed review prior to the construction of the building.

4.0 CALCULATIONS AND ANALYSIS

4.1 GROUND-BORNE VIBRATIONS

The vibration velocity levels have been extracted below in Table 3 and 4 and compared against the maximum allowable vibration limits of L_v 72 VdB, as measured in 1/3 octave bands over the frequency range 8 to 80 Hz.

Table 3. Ground-borne vibration limits– Location 1 [VdB]

Location	Vibration Velocity Level (L_v)															
	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	Total
Location 1	68	67	66	65	64	64	64	62	61	60	65	65	63	52	52	**76**
Vibration Limit	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Compliance Achieved?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	-	-	-	-	-	-
Notes 1.	L_v = Vibration velocity level for a single pass-by event															

Table 4. Ground-borne vibration limits– Location 2 [VdB]

Location	Vibration Velocity Level (L_v)															
	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	Total
Location 2	68	67	65	64	63	62	61	59	58	57	56	61	60	51	49	**75**
Vibration Limit	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**72**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Compliance Achieved?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	-	-	-	-	-	-
Notes 1.	L_v = Vibration velocity level for a single pass-by event															

Vibration velocity levels at both monitoring locations were found to be within the acceptable limits for residential buildings that experience frequent pass-by events and as such, vibrations are not expected to be felt.

4.2 GROUND-BORNE NOISE

The vibration velocity levels have been extracted below in Table 5 and 6 and calculations have been conducted to determine the ground-borne noise levels for residential areas near each monitoring location. The following assumptions have been made:

- Building response or coupling loss have been extracted from Figure 6-14 in *FTA Transit Noise and Vibration Impact Assessment Manual 2018* for large masonry buildings on piles
- A floor resonance of 6 dB between 20 Hz and 30 Hz has been utilised as per page 164 in *FTA Transit Noise and Vibration Impact Assessment Manual 2018* for concrete slabs in modern buildings.
- Floor to Floor attenuation of -2 dB/floor for 1 to 5 floors above grade and -1 dB/floor for 5 to 10 floors above grade have been adopted as per Table 6-13 in *FTA Transit Noise and Vibration Impact Assessment Manual 2018.* The residential units are located 9 floors above basement (at grade) level, therefore a total 14 dB attenuation has been adopted for the basement to residential floor level attenuation.
- Room absorption or radial adjustment of –5 dB has been adopted as per page 164 in *FTA Transit Noise and Vibration Impact Assessment Manual 2018*.

Table 5. Ground-borne noise levels – Location 1																
	1/3 Octave Band Frequency															
	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	Total
Vibration Velocity Level (L_v)	68	67	66	65	64	64	64	62	61	60	65	65	63	52	52	**76**
A-weighting Correction (K_A)	-70	-63	-57	-51	-45	-39	-35	-30	-26	-23	-19	-16	-13	-11	-9	
Coupling Loss	-5	-6	-7	-7	-8	-8	-9	-10	-12	-12	-13	-13	-14	-14	-14	
Room Absorption	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	
Floor Resonance	0	0	0	+6	+6	+6	0	0	0	0	0	0	0	0	0	
Floor to Floor Attenuation	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	
Calculated L_{ASmax}	-26	-7	-3	9	13	17	1	3	5	7	15	17	17	8	10	**24**
Noise Limit L_{ASmax}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**35**
Compliance Achieved?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**Yes**
Notes 1.	L_v = Vibration velocity level for a single pass-by event															

Table 6. Ground-borne noise levels – Location 2																
	1/3 Octave Band Frequency															
	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	Total
Vibration Velocity Level (L_v)	68	67	65	64	63	62	61	59	58	57	56	61	60	51	49	**75**
A-weighting Correction (K_A)	-70	-63	-57	-51	-45	-39	-35	-30	-26	-23	-19	-16	-13	-11	-9	
Coupling Loss	-5	-6	-7	-7	-8	-8	-9	-10	-12	-12	-13	-13	-14	-14	-14	
Room Absorption	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	
Floor Resonance	0	0	0	+6	+6	+6	0	0	0	0	0	0	0	0	0	
Floor to Floor Attenuation	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14	
Calculated L_{ASmax}	-26	-7	-3	8	12	16	-1	0	1	4	5	13	13	7	8	**21**
Noise Limit L_{ASmax}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**35**
Compliance Achieved?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**Yes**
Notes 1.	L_v = Vibration velocity level for a single pass-by event															

Ground-borne noise levels at both monitoring locations were found to be within the acceptable noise limits of State Environmental Planning Policy (Transport and Infrastructure) 2021 and State Environmental Planning Policy (Transport and Infrastructure) 2021.

5.0 CONCLUSION

Koikas Acoustics was requested to address Sydney Metro request for additional vibration monitoring to predict ground-borne noise and vibrations from the nearby metro line to the mixed-use development at 2 Mandala Parade, Castle Hill NSW 2154

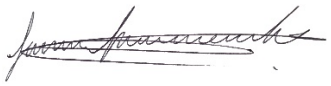
The assessment considers potential noise impacts to future occupants of the development, and to surrounding residents such that acceptable acoustic amenity for the area is maintained.

Acoustic planning levels have been referenced from current ISEPP, FTA Transit Noise and Vibration Impact Assessment Manual 2018, Sydney Metro – Technical Services and other relevant acoustic planning guidelines and requirements. The included recommendations are based on designs prepared by Turner Studio.

In our professional opinion, there is sufficient scope within the proposed building design to achieve the acoustical planning guidelines. Additional vibration monitoring is to be undertaken once the excavation works have been completed to confirm ground-borne noise and vibration levels are within the allowable levels and at that stage, a detailed review of ground-born noise and vibration will be conducted.

Yours Sincerely,

Koikas Acoustics Pty Ltd



James Tsevrementzis

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