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AUSTRALIA TOWERS, STAGES 2 & 3, SYDNEY OLYMPIC PARK

NOISE & VIBRATION ASSESSMENT FOR DA SUBMISSION

TF160-01F02 (REV 4) DA ACOUSTIC REPORT.DOC

7 JUNE 2011

Prepared for:

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DOCUMENT CONTROL

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CONTENTS

List of Tables

1 INTRODUCTION

Renzo Tonin & Associates was engaged to conduct an assessment of rail airborne and ground-borne noise intrusion into the proposed residential towers at corner of Lot 3, Australia Avenue, Sydney Olympic Park.

This report describes the results of a noise and vibration survey conducted on site to determine the existing impacts of rail noise and vibration from the Olympic Park railway line east of the development potentially affecting Stages 2 and 3.

Noise and vibration levels are assessed according to the criteria recommended for the project and recommendations are made where necessary for noise and vibration mitigation.

In addition noise emissions from the operation of the development have been addressed in accordance with the relevant government policies and guidelines in particular the “Sydney Olympic Park Major Event Impact Assessment Guideline”.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 NOISE AND VIBRATION CRITERIA

Renzo Tonin & Associates attended the proposed development site on Saturday 26th March 2011 from 1pm to 5pm to establish the existing levels of rail noise and vibration from the Olympic Park rail corridor affecting the site. The results of the survey were used to predict airborne noise, regenerated (ground-borne) noise and tactile vibration levels within the subject building, and then assessed against the recommended internal noise and vibration criteria for the project. A long-term noise survey have been conduct at northern end of the overall Sydney Olympic Park "Site 3" from 7/7/2010 to 13/7/2010 to establish representative day, evening and night background noise levels for the entire site.

2.1 Noise and Vibration Criteria

The airborne noise criteria for this development are based on the following documents:

1. Director General's Requirement for Site 3 Development (MP 10_0027) [1]
2. State Environment Planning Policy (Infrastructure 2007)
3. Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008
4. State Environment Planning Policy (Major Development) 2005
5. State Environment Planning Policy 65 - Design Quality of Residential Flat Development
6. Sydney Olympic Park Master 2030
7. Sydney Olympic Park Major Events Impact Assessment Guideline, and
8. Department of Environment Climate Change and Water Industrial Noise Policy

The noise criteria outlined in the documents listed were considered, Table 1 and below summaries the relevant acoustic criteria for this development.

Table 1 – Recommended Internal Noise Criteria for Airborne Noise

Occupancy	Period	Maximum Noise Level
Residential		
Living areas (includes kitchen, dining and family rooms)	7am – 10pm	40 dB(A) LAeq, 15hr
Sleeping areas	10pm – 7am	35 dB(A) LAeq, 9hr
Bathroom, Laundries and En-suites	24 hours	45 dB(A) LAeq, 1hr

The Department of Planning's "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008 provides recommended criteria for ground-borne or regenerated rail noise. Table 2 summaries these noise limits for sleeping and living spaces.

[1] DGR for Site 3 development (MP 10_1027) stipulate environment assessment to be in accordance with SEPP (Infrastructure) 2007.

Table 2 – Recommended Internal Noise Criteria for Regenerated Rail Noise

Occupancy	Period	LAMax[1] Noise Limit
Residential		
Living areas	7am – 10pm	40 dB(A)
Sleeping areas	10pm – 7am	35 dB(A)

Note: LAmax – is a-weighted maximum sound pressure level measures using "Slow" response time

2.2 Rail Tactile Vibration

In addition to regenerated rail noise, Section 3.6.3 of the Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline", also provides recommended vibration criteria documents to refer to when establishing train vibration criteria for residential buildings.

1. Assessing Vibration: A technical guideline (DECC 2006)
2. German Standard DIN 4150, Part 3 1999
3. British Standard BS 7385 Part 2 1993
4. Australian Standard AS2670.2 1990

The above documents have been reviewed and the criterion for assessment tactile vibration from train pass-bys affecting the proposed development is quantified using:

- Assessing Vibration: A technical guideline (DECC 2006)
- British Standard BS6472:1992 *"Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)"*

The criteria curves presented in BS6472:1992 are identical to those in Australian Standard AS2670.2 1990 and International Standard 2631-2:1989.

Criteria for continuous vibration from the British Standard BS6472:1992 for residential spaces, offices and commercial workshop environments are shown in Figure 1 below.

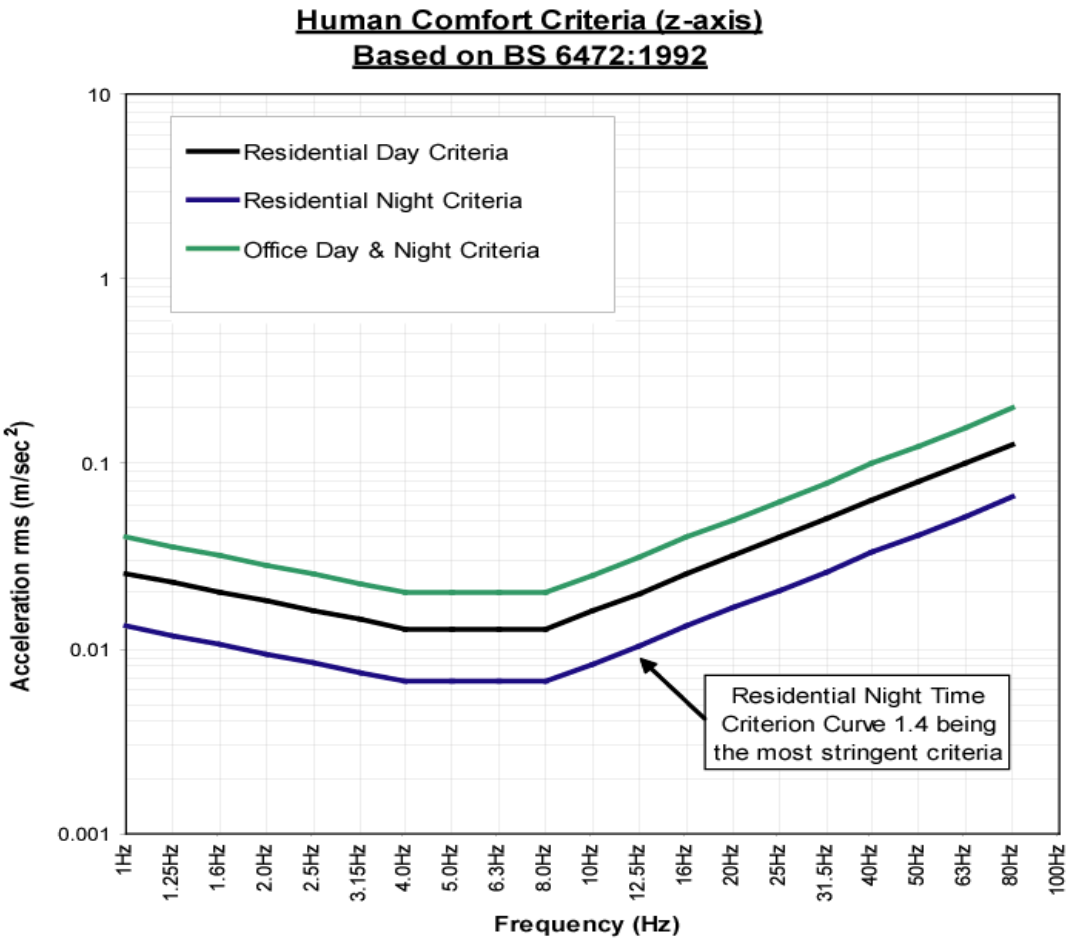

Figure 1 - Tactile Vibration Criteria for Residential Buildings

Table 2.4 of the Department of Environment Climate Change and Water's document "Assessing Vibration: A technical guideline (DECCW 2006)" presents acceptable vibration dose values for intermittent vibration. Table 3 below outlines DECCW's requirements.

Table 3 – Acceptable VDVs for intermittent vibration in residential buildings $m/s^{1.75}$

Location	Period	Preferred VDV $m/s^{1.75}$
Residence	Day time (7am – 10pm)	0.20
	Night time (10pm – 7am)	0.13

3 PROJECT DESCRIPTION

The proposed development (Stages 2 & 3) consists of 2 elliptical residential towers over a 2 storey mixed-use podium and 3 to 4 levels of basement car park. Tower 1 comprises of 24 residential levels and Tower 2 comprises of 30 residential levels. The site is bounded by the single-line Olympic Park rail corridor to the east, Australia Avenue to the west and an under construction Stage 1 residential building to the north.

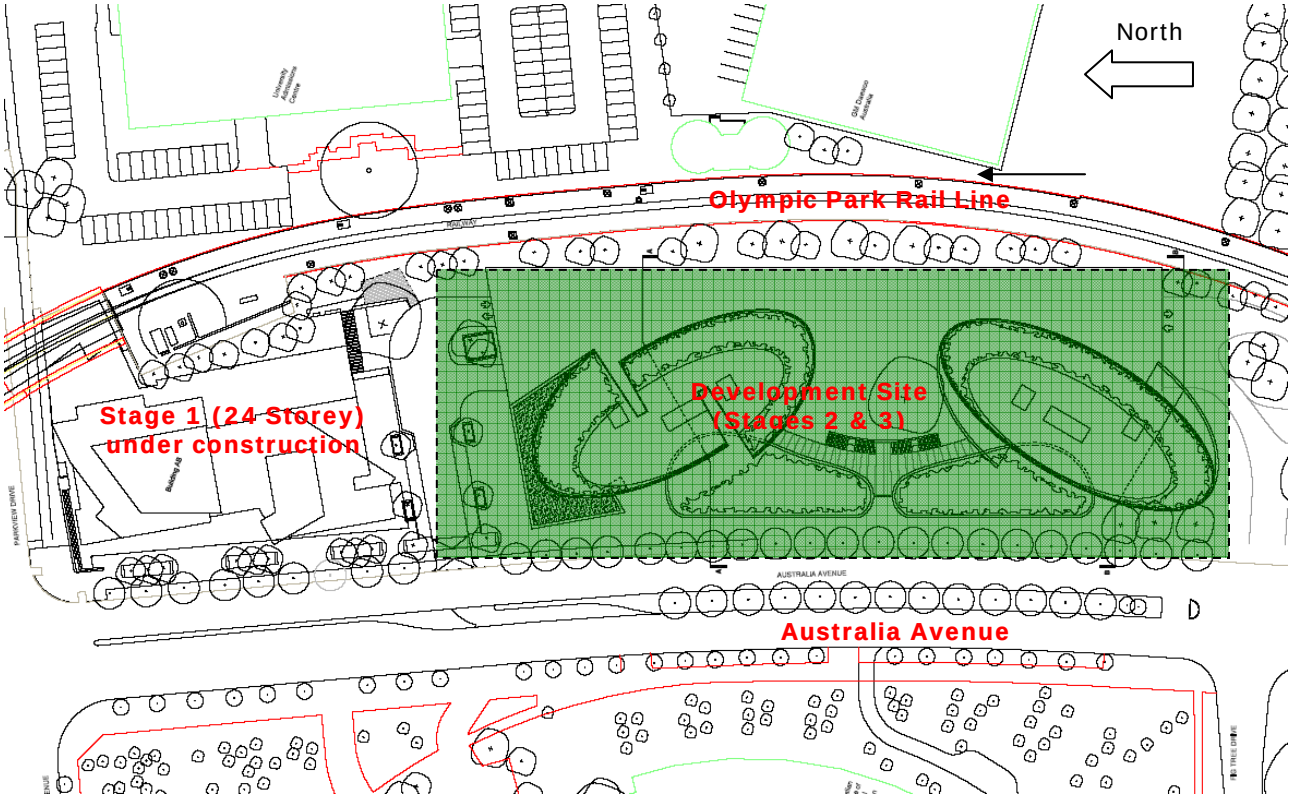

Figure 2 - Site Boundary and Rail Corridor

4 TRAIN SURVEY LOCATION

4.1 Train Noise and Vibration Monitoring Location

The Olympic rail corridor consists of one operational rail line and is located along the east boundary of site. An operator-attended rail noise and vibration survey was conducted on site at approximately 10.5m from the rail track for monitoring of vibration and 11.6m for airborne noise from train pass-bys as shown in Figure 3 below. The survey was carried out between 1pm and 5pm on Saturday 26/03/2011.

All trains on this line are Railcorp commuter trains and operate in a south-bound direction only. The rail line along the site is curved and gradually slopes up in southern direction. During the survey it was observed the all trains were the "Tangara" commuter trains with 8 cars. The speed of the trains was estimated to range from 40km to 50km as it passes the development site.

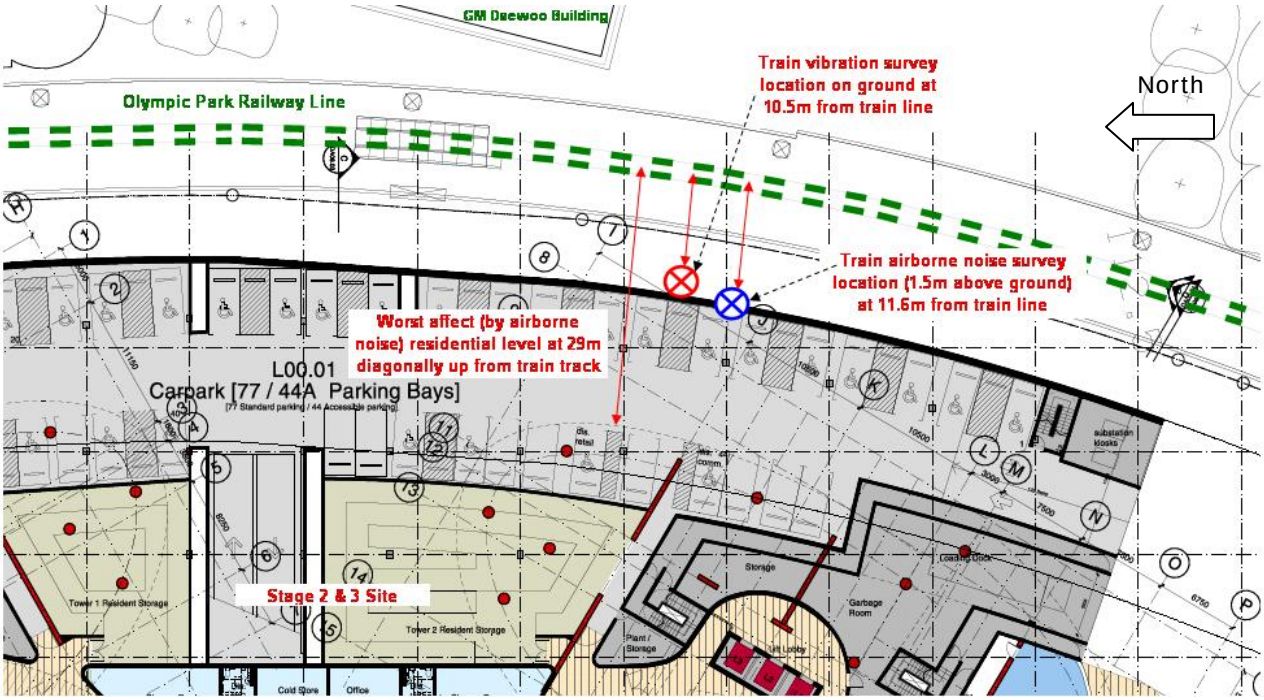

Figure 3 - Noise & Vibration Survey Locations

4.2 Instrumentation

Train vibration levels were measured using the Sinus SoundBook multi-channel analyser and Endevco accelerometers. Airborne train noise was recorded using Bruel & Kjaer Type 2260 Sound Level meter.

Weather conditions were windy and overcast during the noise and vibration survey with temperatures in the range of 24 to 26 degrees Celsius, relative humidity 43% to 48% and wind

speeds up to 3.8m/s. All instruments were calibrated before and after measurement. No significant drift in calibration was observed.

5 MEASURED TACTILE VIBRATION & ASSESSMENT TO BS6472 AND DECCW

Results of the train vibration survey were plotted against night and day criterion of British Standard BS6472-1992 “Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)” as shown in Figure 4 and Figure 5 below. In addition the measured train vibration levels were used to calculate the vibration dosage values (VDV) and then compared to the acceptable levels from the Table 2.4 of DECCW guideline.

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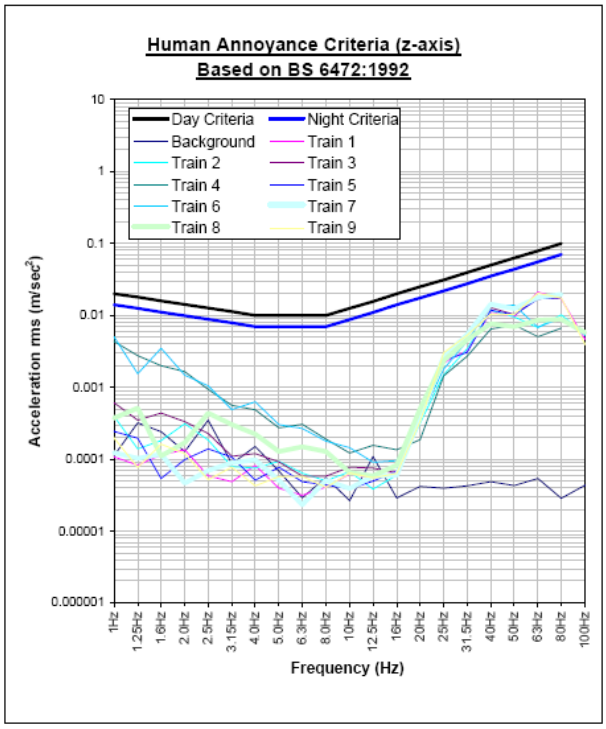
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TF160-01 Sydney Olympic Park Stage 2 & 3
Location:	Corner of Australia Avenue and Parkview Drive, Homebush
Source:	Railcorp Commuter Trains on Sydney Olympic Park Railway Line - Survey 1 (2 to 5pm Saturday 26/3/2011)

Assessment Location:	Residential	Axis	Z	Dur'n of Vibration (secs), Day:	54,000
Type of Vibration:	Intermittent			Dur'n of Vibration (secs), Night:	32,400



Legend													
Measurement		Background	Train 1	Train 2	Train 3	Train 4	Train 5	Train 6	Train 7	Train 8	Train 9	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0001	0.0001	0.0004	0.0006	0.0043	0.0002	0.0050	0.0001	0.0004	0.0002		
	1.25Hz	0.0003	0.0001	0.0001	0.0003	0.0028	0.0002	0.0015	0.0001	0.0005	0.0001		
	1.6Hz	0.0002	0.0001	0.0002	0.0004	0.0020	0.0001	0.0035	0.0001	0.0001	0.0002		
	2.0Hz	0.0001	0.0001	0.0003	0.0003	0.0016	0.0001	0.0015	0.0000	0.0002	0.0001		
	2.5Hz	0.0003	0.0001	0.0002	0.0002	0.0009	0.0001	0.0011	0.0001	0.0004	0.0001		
	3.15Hz	0.0001	0.0000	0.0001	0.0001	0.0006	0.0001	0.0005	0.0001	0.0003	0.0001		
	4.0Hz	0.0002	0.0001	0.0001	0.0001	0.0005	0.0001	0.0006	0.0001	0.0002	0.0000		
	5.0Hz	0.0001	0.0000	0.0001	0.0001	0.0003	0.0001	0.0003	0.0001	0.0001	0.0001		
	6.3Hz	0.0000	0.0000	0.0001	0.0001	0.0003	0.0000	0.0003	0.0000	0.0001	0.0001		
	8.0Hz	0.0001	0.0000	0.0001	0.0001	0.0002	0.0000	0.0002	0.0001	0.0001	0.0000		
	10Hz	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0001		
	12.5Hz	0.0001	0.0001	0.0000	0.0001	0.0002	0.0000	0.0001	0.0001	0.0001	0.0001		
	16Hz	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		
	20Hz	0.0000	0.0004	0.0003	0.0005	0.0002	0.0004	0.0004	0.0004	0.0005	0.0003		
	25Hz	0.0000	0.0022	0.0015	0.0023	0.0014	0.0024	0.0018	0.0027	0.0023	0.0030		
	31.5Hz	0.0000	0.0033	0.0034	0.0054	0.0027	0.0031	0.0044	0.0054	0.0046	0.0053		
	40Hz	0.0000	0.0111	0.0118	0.0128	0.0064	0.0118	0.0139	0.0144	0.0076	0.0105		
	50Hz	0.0000	0.0096	0.0095	0.0103	0.0074	0.0102	0.0139	0.0124	0.0070	0.0103		
	63Hz	0.0001	0.0212	0.0068	0.0170	0.0050	0.0170	0.0069	0.0178	0.0086	0.0204		
	80Hz	0.0000	0.0169	0.0102	0.0174	0.0067	0.0176	0.0092	0.0195	0.0089	0.0175		
	100Hz	0.0000	0.0047	0.0055	0.0057	0.0047	0.0054	0.0053	0.0046	0.0057	0.0040		
Weighted rms	Day												
	Night												
eVDV	Day	0.01	0.09	0.07	0.09	0.09	0.09	0.12	0.10	0.06	0.09	0.20	0.40
	Night	0.01	0.08	0.06	0.08	0.07	0.08	0.10	0.09	0.05	0.08	0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion

QTS-01 (rev 10) Human Annoyance Vibration Assessment BS6472-DEC - z axis

Figure 4 - Vibration Assessment (Survey 1) for Human Annoyance BS6472 & DECCW

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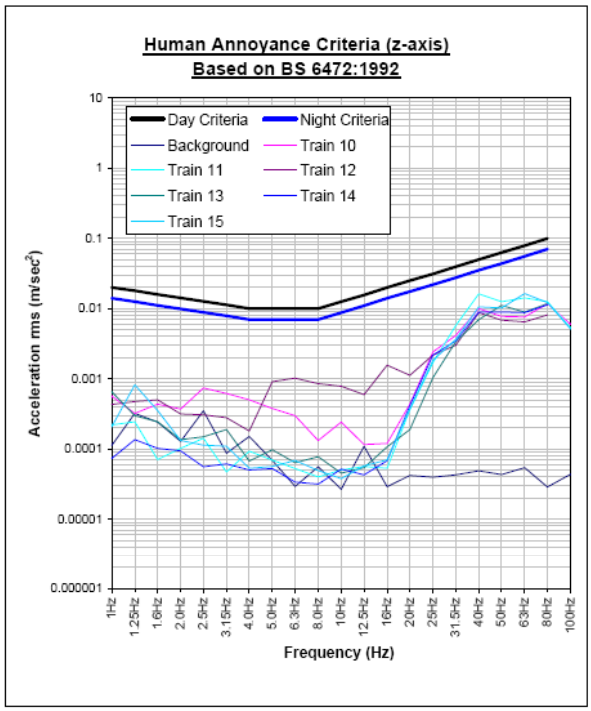
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TF160-01 Sydney Olympic Park Stage 2 & 3				
Location:	Corner of Australia Avenue and Parkview Drive, Homebush				
Source:	Railcorp Commuter Trains on Sydney Olympic Park Railway Line - Survey 2 (2 to 5pm Saturday 26/3/2011)				
Assessment Location:	Residential	Axis	Z	Dur'n of Vibration (secs), Day:	54,000
Type of Vibration:	Intermittent			Dur'n of Vibration (secs), Night:	32,400



Legend													
Measurement		Background	Train 10	Train 11	Train 12	Train 13	Train 14	Train 15	0	0	0	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0001	0.0006	0.0002	0.0004	0.0007	0.0001	0.0002					
	1.25Hz	0.0003	0.0003	0.0002	0.0005	0.0003	0.0001	0.0008					
	1.6Hz	0.0002	0.0004	0.0001	0.0005	0.0002	0.0001	0.0004					
	2.0Hz	0.0001	0.0004	0.0001	0.0003	0.0001	0.0001	0.0001					
	2.5Hz	0.0003	0.0007	0.0001	0.0003	0.0001	0.0001	0.0001					
	3.15Hz	0.0001	0.0006	0.0000	0.0003	0.0002	0.0001	0.0001					
	4.0Hz	0.0002	0.0005	0.0001	0.0002	0.0001	0.0001	0.0001					
	5.0Hz	0.0001	0.0004	0.0001	0.0009	0.0001	0.0001	0.0001					
	6.3Hz	0.0000	0.0003	0.0001	0.0010	0.0001	0.0000	0.0001					
	8.0Hz	0.0001	0.0001	0.0000	0.0009	0.0001	0.0000	0.0000					
	10Hz	0.0000	0.0002	0.0001	0.0008	0.0000	0.0001	0.0000					
	12.5Hz	0.0001	0.0001	0.0001	0.0006	0.0001	0.0000	0.0001					
	16Hz	0.0000	0.0001	0.0001	0.0016	0.0001	0.0001	0.0001					
	20Hz	0.0000	0.0004	0.0004	0.0011	0.0002	0.0004	0.0004					
	25Hz	0.0000	0.0024	0.0017	0.0022	0.0010	0.0022	0.0018					
	31.5Hz	0.0000	0.0041	0.0057	0.0030	0.0034	0.0035	0.0036					
	40Hz	0.0000	0.0100	0.0161	0.0088	0.0070	0.0089	0.0106					
	50Hz	0.0000	0.0077	0.0125	0.0069	0.0111	0.0089	0.0102					
	63Hz	0.0001	0.0076	0.0141	0.0064	0.0089	0.0087	0.0163					
	80Hz	0.0000	0.0117	0.0126	0.0081	0.0118	0.0112	0.0122					
	100Hz	0.0000	0.0060	0.0053	0.0061	0.0059	0.0062	0.0052					
Weighted rms	Day												
	Night												
eVDV	Day	0.01	0.07	0.10	0.07	0.06	0.06	0.08				0.20	0.40
	Night	0.01	0.06	0.09	0.06	0.06	0.06	0.07				0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion

QTS-01 (rev 10) Human Annoyance Vibration Assessment BS6472-DEC - z axis

Figure 5 - Vibration Assessment (Survey 2) for Human Annoyance BS6472 & DECCW

The above graphs demonstrate that the floor induced vibration within the proposed building from each of the measured train pass-bys are **in compliance** with the British Standard BS6472:1997 for human comfort in a residential environment during the day and night. Similarly the calculated vibration dosage values (VDV) from our measurements complied with the preferred day and night VDV criterion defined in the DECCW guideline.

6 CALCULATED AIRBORNE AND GROUND-BORNE TRAIN NOISE

6.1 Calculated Ground-borne Rail Noise inside Proposed Building

Regenerated or ground-borne rail noise is the low rumble heard inside buildings with vicinity of railway tunnels or railway tracks due to ground vibration generated by passing trains which propagate through soil and rock up into building elements such as foundation, wall and floors which re-radiates as audible sound. Ground vibration levels from train pass-bys on the Olympic Park line have been measured and were used to calculate regenerated noise levels on various floors of the proposed building and assessed to the nominated criteria for this development as shown in Table 4 below.

Table 4 – Calculated Regenerated Noise Levels inside Proposed Building

Floor Level	Proposed Occupancy / Space	Ground-Borne Noise Criteria in dB(A)	Calculated [1] Ground-Borne Noise in dB(A)	Exceedance
Level 2	Residential	35	31	None
Level 1	Residential	35	34	None
Ground	Retail	40	37	None
Basement 1	Car park	N/A	40	N/A
Basement 2	Car park	N/A	43	N/A
Basement 3	Car park	N/A	46	N/A

Notes:

1. Ground-borne noise modelling and predictions were based upon the train pass-bys with highest linear overall L_{Max} as each of the locations.

6.2 Calculated Airborne Rail Noise at Proposed Building Facade

Airborne train noise emanating from commuter train pass-bys on the Olympic Park line has been recorded. These measured noise levels were used to predict the sound pressure levels at worst affected facade (eastern) of the proposed development over 1 hour, entire day (15 hours) and night (9 hour) time periods. The calculated results are shown in Table 5 below.

Table 5 – Calculated Airborne Rail Noise Levels at Proposed Eastern Building Facades

Period	Duration	Maximum Number of Train-Bys During this Period	Calculated [1] L_{Aeq} Airborne Noise Levels at Proposed Facade in dB(A)	Relevant Internal Noise Criteria	Estimated Noise Reduction Required from Facade Glazing [4]
Day time (7am to 10pm)	15 Hours	87	60	40[2]	20
Night time (10pm to 7am next day)	9 Hours	10	53	35[2]	18
Morning Peak	1 Hour	4	60	35[3]	20
Evening Peak	1 Hour	6	59	40[3]	23

Period	Duration	Maximum Number of Train-Bys During this Period	Calculated [1] L_{Aeq} Airborne Noise Levels at Proposed Facade in dB(A)	Relevant Internal Noise Criteria	Estimated Noise Reduction Required from Facade Glazing [4]

Notes:

1. Train airborne noise modelling and predictions were based upon the maximum SEL of the measured train pass-bys

2. ISEPP 2007 Target levels for sleeping and living areas over 9-hour night and 15-hour day period.

3. Australian Standard AS2107 for satisfactory interior noise levels in sleeping and living areas over 1-hour periods.

4. Sound reduction required from glazing assemblies to achieve relevant internal noise level.

The maximum noise reduction required from glazing assembly on the worst affected facade of this 23 dB. Typical 6.38mm thick laminated glass doors or windows with acoustic seals can alleviate ingress of external train noise by greater than 23 dB. Therefore compliance with the relevant airborne noise criteria for this development can be readily achieved by installation of sliding doors/windows having sound reduction index, R_w, of no less than 32.

7 OPERATIONAL NOISE EMISSION FROM DEVELOPMENT

7.1 Existing Noise Environment at Development Site

An RTA Technology noise logger was installed on the northern end of the site to establish existing site background noise levels during day and night time. The noise logger records noise levels on a continuous basis and store data every fifteen minutes. Results of the noise monitoring have been summarised in Table 6 below.

Table 6 – Measured Existing Site Background (L_{A90}) Noise Level

Noise Monitoring		Representative L_{A90} Background Noise Levels in dB(A)		
Location	**Duration**	**Day [1]**	**Evening [2]**	**Night [3]**
Northern end of the Sydney Olympic Park "Site 3" – nearest to corner of Australia Avenue and Park Drive	Wednesday 12.30pm 07/07/2010 to Tuesday 9.30am 13/07/2010	48	49	48

Notes: Day, Evening & Night assessment periods are defined in accordance NSW DECC Industrial Noise Policy as follows.

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period

2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays

3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays

These noise levels are used in our assessment of external noise emission from the development such as mechanical plant equipment, loading docks etc in accordance to Department of Department of Environment, Climate Change and Water (DECCW).

7.2 Operational Noise Emission from Development

Major sources of noise emissions from the operation of the development have been identified as:

- Mechanical services plant and equipment on roof of the two residential towers;
- Noise associated with two loading docks under the podium roof of the development at the northern and southern of the development;
- Traffic noise increase due to generation of additional traffic as results of the operation of the development;

Noise emission from these sources has the potential to impact on nearby Major Events Venue within the "Event Operation Zone" as defined in Plan 1 (page 20) of the Sydney Olympic Park Major Event Impact Assessment Guideline. Potential impacts have been assessed in the following sections in accordance to Guideline.

7.2.1 Building Services Noise

The NSW DECCW outlines noise criteria in its Industrial Noise Policy (INP) to control noise emission from industrial sources at the site boundary. The applicable noise limits based on site noise data summarized in Table 6, according to the policy, are determined as follows:

Table 7 – L_{Aeq} Design Criterion for Noise Production (DECCW INP) at Site Boundary

	Column 1	Column 2	Column 3	Column 5
Time of Day	**Rating Background Level (RBL) L_{90}**	**Intrusiveness Criterion (RBL+5)**	**Amenity Criterion (Acceptable)**	**Project Specific Design Criterion L_{Aeq}**
Day (7am to 6pm)	48	53	55	**53**
Evening (6pm to 10pm)	49	54	45	**45**
Night (10pm to 7am)	48	53	40	**40**

Explanatory notes for Table 7 above:

1. *Column 3 – Recommended L_{Aeq} noise level based on 'Residence – Suburban' area in Section 2.2, Table 2.1 Amenity Criteria (Recommended L_{Aeq} nosie levels from industrial noise sources) of the DECCW's INP.*
2. *Column 5 – Project Specific Design Criterion based on DECCW's INP. Lower of Columns 2 and 3.*

Any noise emissions from building services associated with the development shall be acoustically treated, where necessary, to comply with DECCW INP noise limits set in Table 7 which is an allowance of 5dB above the existing background noise level at site boundary.

The Sydney Olympic Park Major Event Impact Assessment Guideline has stipulated any noise emission from developments at Major Events Venues to be no greater its ambient noise levels. Our review of the Guideline (Plan 1) has shown nearest Major Events Venue is at least 250m to the north of the site. Such a distance will provide noise attenuation greater than 5dB, assuming the background noise levels at nearest Major Events Venue is similar to subject site. Therefore compliance with DECCW INP policies will ensure compliance with Sydney Olympic Park Major Event Impact Assessment Guideline. Further to this there is likelihood of intervening building structures between the subject development and the Major Events Venues, which will act as noise barriers and provide additional noise shielding.

Mechanical plant such as rooftop exhausts, air-conditioning and refrigeration associated with the development should be assessed at the time of detailed design and selection, having regard to nearby Major Events Venues and existing commercial properties surrounding the development. Although at this stage details of mechanical plant have not been finalised, the following in-principle noise management measures are provided for mechanical plant servicing the proposed development.

- Acoustic assessment of mechanical services equipment will need to be undertaken during the detail design and equipment selection phase of the development to ensure that they shall not either singularly or in total emit noise levels which exceed the noise limits;

- As noise control treatment can affect the performance of the mechanical services system, it is recommend that consultation with an acoustic consultant be made during the initial phase of detailed mechanical services system design in order to reduce the need for revision of mechanical plant and noise control treatment;
- Mechanical plant noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following:
    - strategic positioning of plant away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises,
    - commercially available silencers or acoustic attenuators for air discharge and air intakes of plant;
    - acoustically lined and lagged ductwork;
    - acoustic screens and barriers between plant and sensitive neighbouring premises; and/or
    - partially-enclosed or fully-enclosed acoustic enclosures over plant.
- Mechanical plant shall have their noise specifications and their proposed locations checked prior to their installation on site; and
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 “Rotating and Reciprocating Machinery – Mechanical Vibration”.

7.2.2 Loading Dock Noise

Noise associated with loading docks such as reversing alarms on trucks when backing into the loading dock area, truck engines starting & doors closing, operation of refrigeration equipment mounted on refrigerated vehicles, trolleys and palettes being moved have potential to impact on neighbouring premises.

The two proposed loading docks have been strategically located inside the ground level car park with its entrances furthest away from site boundaries to minimise impact neighbouring premises. From our experience noise emission from loading docks inside car parks will generally comply with the DECCW INP noise criteria. And as discussed compliance with DECCW INP at site boundary will ensure compliance with the noise requirement of the Sydney Olympic Park Major Event Impact Assessment Guideline.

7.2.3 Road Traffic Noise Generation by Development

Traffic data has been provided in report (ref. 8086 dated April 2011) prepared by Colston Budd Hunt & Kafes in the form of modelled predictions for vehicles on the local road network during the peak AM and PM period.

On the basis of predicted volumes set out in Table 3.1 (Chapter 3 Page 21) and Figure 2 of the traffic report the maximum percentage increase of traffic generation will occur on Australia Avenue (south of Figtree Drive) where the existing 1,475 vehicles will increase to 1,635. As the major composition of traffic is light vehicles for both the existing and future scenarios the increase in noise level can be calculated assuming an equal energy distribution. The predict increase in traffic equates to less than 1dB which is insignificant and would have negligible impact on the ambient noise levels of Major Events Premises.

8 MAJOR EVENTS NOISE INTRUSION INTO DEVELOPMENT

The proposed development is potentially affected by noise associated with major sports and entertainment events held within the Sydney Olympic Park events precinct. The Sydney Olympic Park Master Plan 2030 has set internal noise criteria for noise associated with major events intruding into commercial and residential developments within the Sydney Olympic Park events precinct. The criteria for residential spaces are outline in Table 8 below.

Table 8 – Sydney Olympic Park Master Plan 2030 Maximum Internal Noise Criteria for Major Events Noise Intrusion

Internal Space	Noise Criterion	Period	Noise Measure
Living rooms	45dB(A)	Day & Evening	LAeq, 15min
Working areas			
Sleeping rooms	40dB(A)	Night Time	

Renzo Tonin & Associates have previously conducted surveys of noise emission from Major Events at Sydney Olympic Park. Based on results of these surveys, it is estimated noise from Major Events at the facade of subject development to typically be in order of 60 to 70 dB(A). With the installation of acoustic glazing recommended in Section 6.2 of this report, noise from Major Events activities are expected to comply with noise criteria set in SOP Master Plan 2030 summarised in Table 8 above.

Sydney Olympic Park Master Plan has also mapped out the degree of noise mitigation measures required for different building heights at different locations within the Sydney Olympic Park Events precinct. Our review of Figure 4.8 (Page 95 of the Master Plan) has shown the subject development falls under the “Some Noise Mitigation Required” zone. Section 4.6.15 of the Master plan requires developments in this zone to provide air-conditioning or mechanical ventilation, door and windows which can be opened and closed at various times. It is our understanding the subject development will incorporated these measures.

9 CONCLUSION

Train noise and vibration survey have been conducted on 26/03/2011 within the development site along the Olympic Park train line. A total of 15 commuter trains pass-bys were recorded for assessment of airborne noise at worst-affected building facades, induced floor vibration and ground-borne rail noise inside the proposed buildings.

Regenerated rail noise inside the proposed basement car park, retail shops and residential apartments were calculated and results have demonstrated compliance with the nominated criteria for this project. Therefore confirming vibration isolation treatment to footings of this development is not required.

Rail airborne noise was predicted at the eastern facade of the development with direct line of site to the Olympic Park rail line. It was concluded that facade noise levels were relatively low and compliance with the project noise criteria was achievable by the installation glazing assemblies with sound reduction, R_w, of no less than 32. Typical complying glazing configurations would be window or sliding doors comprising of 6.38mm laminated glass with acoustic perimeter seals.

The assessment has demonstrated tactile vibration from train pass-bys to comply with British Standard BS6472:1992 *"Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)* and day and night VDV values to be within the acceptable values set by the DECCW guideline.

This report adequately addresses Director General's Requirements including Sydney Olympic Park Master Plan 2030 and the Major Event Impact Assessment Guideline.

APPENDIX A - ASSESSMENT AND DESIGN METHODOLOGY

A.1 SEPP (Infrastructure) 2007

87 Impact of rail noise or vibration on non-rail development

(1) This clause applies to development for any of the following purposes that are on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:

a) a building for residential use,

b) a place of public worship,

c) a hospital,

d) an educational establishment or child care centre.

(2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.

(3) If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

(a) in any bedroom in the building—35 dB(A) at any time between 10 pm and 7am,

(b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.

A.2 Department of Planning "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008

Table 3.1 of the Guideline presents airborne noise criteria for rail traffic

Table 3.1: Noise Criteria		
Residential Buildings		
Type of occupancy	Noise Level dBA	Applicable time period
Sleeping areas (bedroom)	35	Night 10 pm to 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40	At any time
Non–Residential Buildings		
Type of occupancy		Recommended Max Level dBA
Educational Institutions including child care centres		40
Places of Worship		40
Hospitals	- Wards	35
	- Other noise sensitive areas	45

Note: airborne noise is calculated as Leq (9h) (night) and Leq (15h)(day). Groundborne noise is calculated as Lmax (slow) for 95% of rail passby events.

A.3 DECC Assessing Vibration (a Technical Guideline) 2006

Assessing vibration: a technical guideline is based on guidelines contained in BS 6472–1992, Evaluation of human exposure to vibration in buildings (1–80 Hz).

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques.

APPENDIX B - GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse Weather — Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).

Ambient Noise — The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.

Assessment Period — The period in a day over which assessments are made.

Assessment Point — A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.

Background Noise — Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the $\mathbf{L_{90}}$ noise level (see below).

Decibel [dB] — The units that sound is measured in. The following are examples of the decibel readings of every day sounds:

0dB The faintest sound we can hear

30dB A quiet library or in a quiet location in the country

45dB Typical office space. Ambience in the city at night

60dB Martin Place at lunch time

70dB The sound of a car passing on the street

80dB Loud music played at home

90dB The sound of a truck passing on the street

100dB The sound of a rock band

115dB Limit of sound permitted in industry

120dB Deafening

dB(A): A-weighted decibels The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.

Frequency Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.

Impulsive noise Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.

Intermittent noise The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.

L_{max} The maximum sound pressure level measured over a given period.

L_{min} The minimum sound pressure level measured over a given period.

L_1 The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.

L_{10} The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L_{90} The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).

L_{eq} The "equivalent noise level" is the summation of noise events and

	integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound Absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.