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ONE CARRINGTON STREET, SYDNEY

Project Application Acoustic Assessment

27 March 2014

Sovereign Wynyard Centre Pty Ltd

TG183-01F01 (r4) DA Acoustic Assessment

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1 Introduction

This report supports a Development Application (DA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The Application follows the submission of a Concept Application submitted in April 2009 to the Department of Planning and Infrastructure that set out a Concept Proposal for a new commercial and retail development at 1 Carrington Street, known as 'City One'. The City One concept was developed by former Thakral Holdings Limited, which has now been taken over by Sovereign Wynyard Centre Pty Ltd. The development has since been renamed 'One Carrington Street'. The development site encompasses heritage listed Shell House, as well as the heritage listed building at 285 George Street. It also includes the land plots occupied currently by Menzies Hotel, and 301 George St - which includes the Wynyard Station transit hall and concourse.

1.1 Overview of proposed development

The Carrington Street site is to be developed for a mix of retail and commercial uses. A large tower in of 27 stories is to be erected over the site, while the two heritage listed buildings will remain. The plan envisages refurbishing the interior of the heritage listed buildings, and refitting them as commercial office space. The George Street entrance to Wynyard station is to be opened up into a larger retail thoroughfare, as is the Carrington Street entrance. The station transit hall is to be replaced with a refined 13m hall that opens directly onto George Street.

More specifically, this DA seeks approval for the following components of the development:

- staged demolition of existing site improvements, including the existing Menzies Hotel, 301 George St, and amendments to Wynyard station transit hall and concourse
- construction and use of a 27-storey commercial tower, including:
  - retail floor space on lower levels
  - below ground parking
  - commercial upper levels
- refitting the interior of Shell House to use for the following:
  - lower two levels used for retail
  - upper levels used as office space
  - two pavilions on the roof, to the east of the existing clock landmark
- Wynyard Station Transit hall improvements, including:
  - opening up of the existing station concourse area to provide a grand hall
  - widening of the George St entrance as well as developing a retail hub on the concourse
  - a transit hall from the concourse directly onto George St

The following drawings prepared by Make have been referenced for this report.

Drawing no.	Description	Rev
Floor plans		
DA2002	Lower Level basement	00
DA2003	Basement Level	00
DA2004	Hunter Concourse Level	00
DA2005	Concourse Level	00
DA2006	George Street Level	00
DA2007	Wynyard Lane Level	00
DA2008	Carrington Street Level	00
DA2009	Upper Ground Level	00
DA2010	Mezzanine Level	00
DA2011	Office Level 1	00
DA2012	Office Level 2	00
DA2013	Office Level 3	00
DA2014	Office Level 4	00
DA2015	Office Level 5	00
DA2016	Office Level 6	00
DA2017	Office Level 7	00
DA2018	Office Level 8	00
DA2019	Office Level 9	00
DA2020	Office Level 10	00
DA2021	Office Level 11	00
DA2022	Office Level 12	00
DA2023	Office Level 13	00
DA2024	Office Level 14	00
DA2025	Office Level 15	00
DA2026	Office Level 16	00
DA2027	Office Level 17	00
DA2028	Office Level 18	00
DA2029	Office Level 19	00
DA2030	Office Level 20	00
DA2031	Office Level 21	00
DA2032	Office Level 22	00
DA2033	Office Level 23	00
DA2034	Office Level 24	00
DA2035	Office Level 25	00
DA2036	Office Level 26	00
DA2037	Office Level 27	00
DA2038	Plant Level 28	00

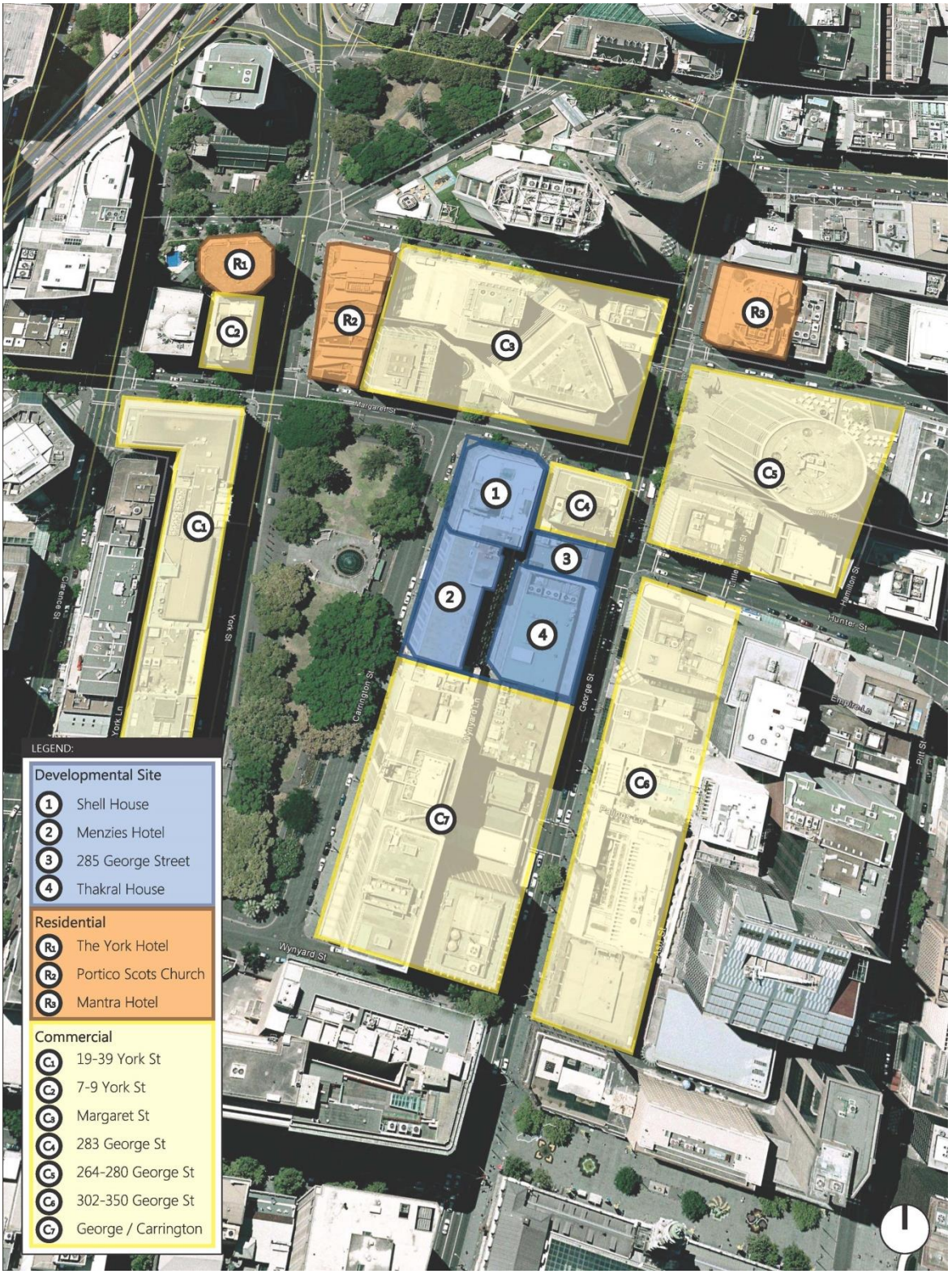
Drawing no.	Description	Rev
DA2039	Plant Level 29	00
DA2040	Plant Level 30	00
DA2041	Roof Plan	00
Elevations and sections		
DA2100	Proposed Elevation A - East Elevation	00
DA2101	Proposed Elevation B - South Elevation	00
DA2102	Proposed Elevation C - West Elevation	00
DA2103	Proposed Elevation D - North Elevation	00
DA2201	Proposed Section 2	00
DA2202	Proposed Section 7	00
DA2220	Proposed Section 1- Carrington to George Street Laneway	00
DA2221	Proposed Section 2 - Concourse section	00
DA2222	Proposed Section 3 - Office Lobby to George Street	00
DA2223	Proposed Section 4 - Retail on George Street cross section	00
DA2224	Proposed Section 5 - Carrington to George St Laneway	00
DA2300	Proposed Shell Shouse Elevations	00
DA2301	Proposed 285-287 George Street	00

1.2 Site description

The development site is located in the heart of the Sydney Central Business District. It is generally bounded by George Street to the east, Margaret Street to the north, and Carrington Street to the west. Currently Wynyard lane runs through the middle and exposes a car park entrance. The site includes four separate plots of land, two of which are heritage-listed. Wynyard station is positioned under Wynyard Park off Carrington Street, with a transit tunnel passing under the site and opening onto George Street at the base of Thakral House (301 George Street).

Figure 1 identifies the four (4) separate development plots which are part of the DA, along with the nearest residential and commercial receivers considered in this noise and vibration assessment.

Figure 1: Site and surrounding development



1.3 Acoustic assessment requirements

The Director General's Requirements (DGRs) issued by the Department of Planning and Infrastructure for application number SSD 13_5824 specifically require:

> *Identify the main noise and vibration generating sources and activities at all stages of construction (including demolition), and any noise sources during operation. Outline measures to minimise and mitigate the potential noise impacts to the surrounding area.*

The relevant policies and guidelines to construction and operational noise and vibration have been addressed in this report as follows:

Policy or Guideline	Assessment outline	Report section
NSW Industrial Noise Policy [1]	Operational noise from the development and its potential impact on surrounding development	Section 3
Interim Construction Noise Guideline (DECC, 2009)	Assessment of noise during the demolition and construction phase of the development and its potential impact on surrounding development	Section 6 and 7
Assessing Vibration: A Technical Guideline (DEC, 2006)	The primary potential for vibration impact generated by the development is during the demolition and construction phase.	Section 6 and 8
State Environmental Planning Policy – Infrastructure 2007	Assessment of development impact upon proposed metro corridor.	Section 5

1.4 Scope of assessment

The following outlines the scope of acoustic assessment for One Carrington Street with respect to the above policies and guidelines:

- review the proposed design documentation to identify:
  - the acoustic components of the demolition, construction, and operation of the site, in accordance with the Director General's Requirements
  - identify the sensitive receiver locations, including existing receivers affected by construction works, and future receivers affected by operations
  - confirm the existing noise environment at surrounding receiver locations and quantify the applicable noise targets for the site
- carry out a quantitative acoustic assessment of potential impacts and compare against the relevant criteria
- where further design development is required to carry out a quantitative assessment, a qualitative assessment has been used to identify in-principle methods by which noise and vibration impact can be addressed in the design
- provide description of the assessment methodology to be adopted during the detailed design phase.

2 Existing noise environment

Criteria for the assessment of operational and construction noise are usually derived from the existing noise environment of an area, excluding noise from the subject development.

Appendix B of the NSW EPA *Industrial Noise Policy* (INP) [1] outlines two methods for determining the background noise level of an area, being 'B1 – Long-term background noise method' and 'B2 – Short-term background noise method'. This assessment has used a combination of long-term and short-term noise monitoring.

As the noise environment of an area almost always varies over time, background and ambient noise levels need to be determined for the operational times of the proposed development. For example, in a suburban or urban area the noise environment is typically at its minimum at 3am in the morning and at its maximum during the morning and afternoon traffic peak hours. The INP outlines the following standard time periods over which the background and ambient noise levels are to be determined:

- Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
- Evening: 18:00-22:00 Monday to Sunday & Public Holidays
- Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

The INP also outlines methods for assessing 'shoulder periods' being shorter periods on either side of a standard period, where the standard period noise levels are not representative. For example a 'shoulder period' may be warranted for 05:00-07:00 or 22:00-00:00 where the night time period background noise level is not representative.

2.1 Surrounding development

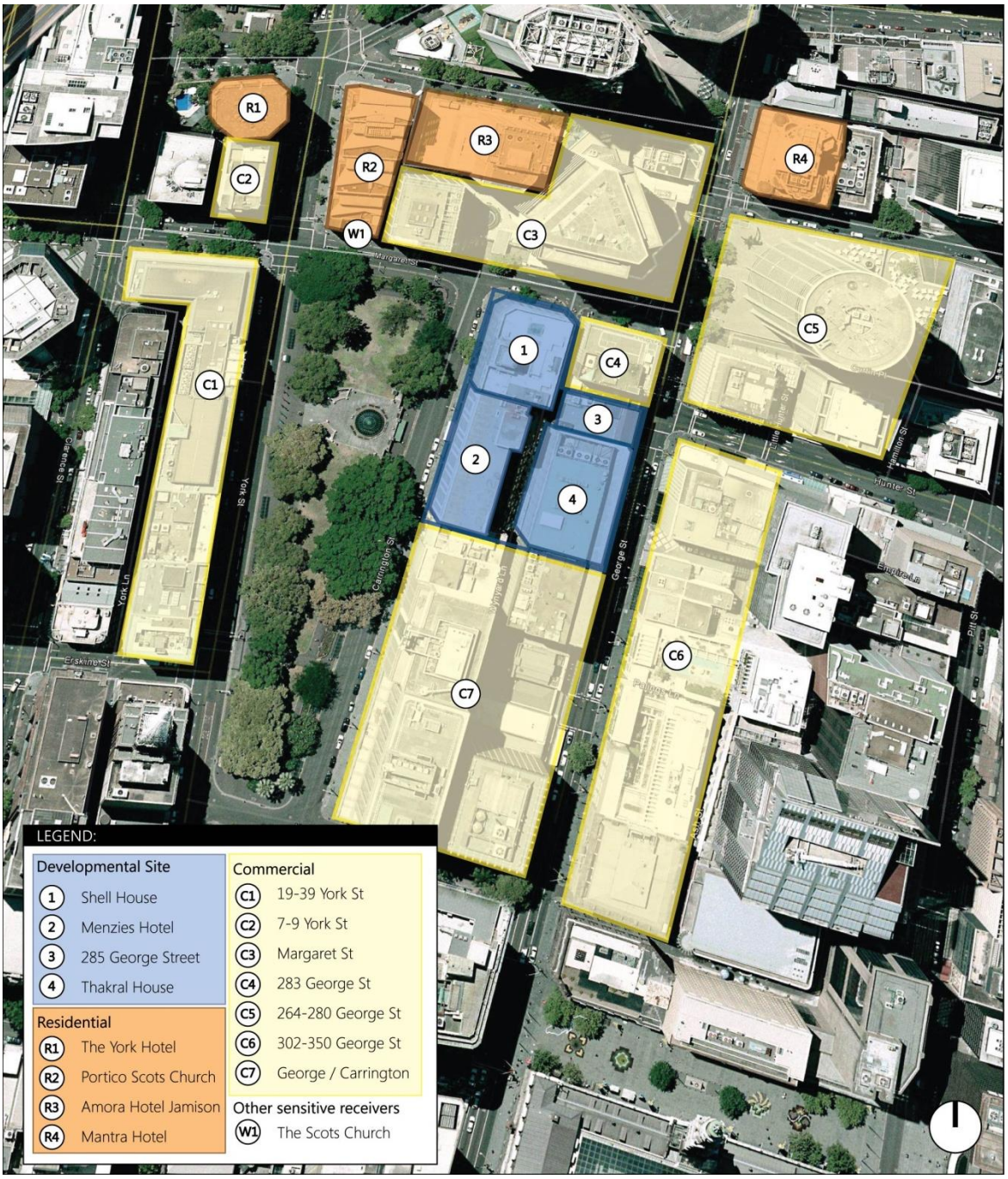
The nearest potentially affected receivers to the One Carrington Street site are presented in Table 1 and Figure 2. Commercial buildings have not been individually marked, but rather grouped into zones.

Table 1: Nearest receivers

Receiver ID	Receiver location	Distance from boundary of site (approx. m)
Residential/Hotels		
R1	The York Hotel – 5 York Street	120
R2	Portico Scots Church – 44 Margaret Street	60
R3	Amora Hotel Jamison, 11 Jamison St	65
R4	Mantra Hotel – 2 Bond Street	90
Commercial receivers		
C1	York Street	80
C2	York Street and Margaret Street corner	100

C3	Margaret Street Block	20
C4	283 George St	0
C5	George Street and Hunter Street - northern block	20
C6	George Street - south-eastern block	15
C7	George St, Carrington St, Wynyard Ln - block directly to south of the development site	0
Other sensitive receivers		
W1	The Scots Church, Margaret Street	60

Figure 2: Surrounding development



2.2 Noise measurement locations

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

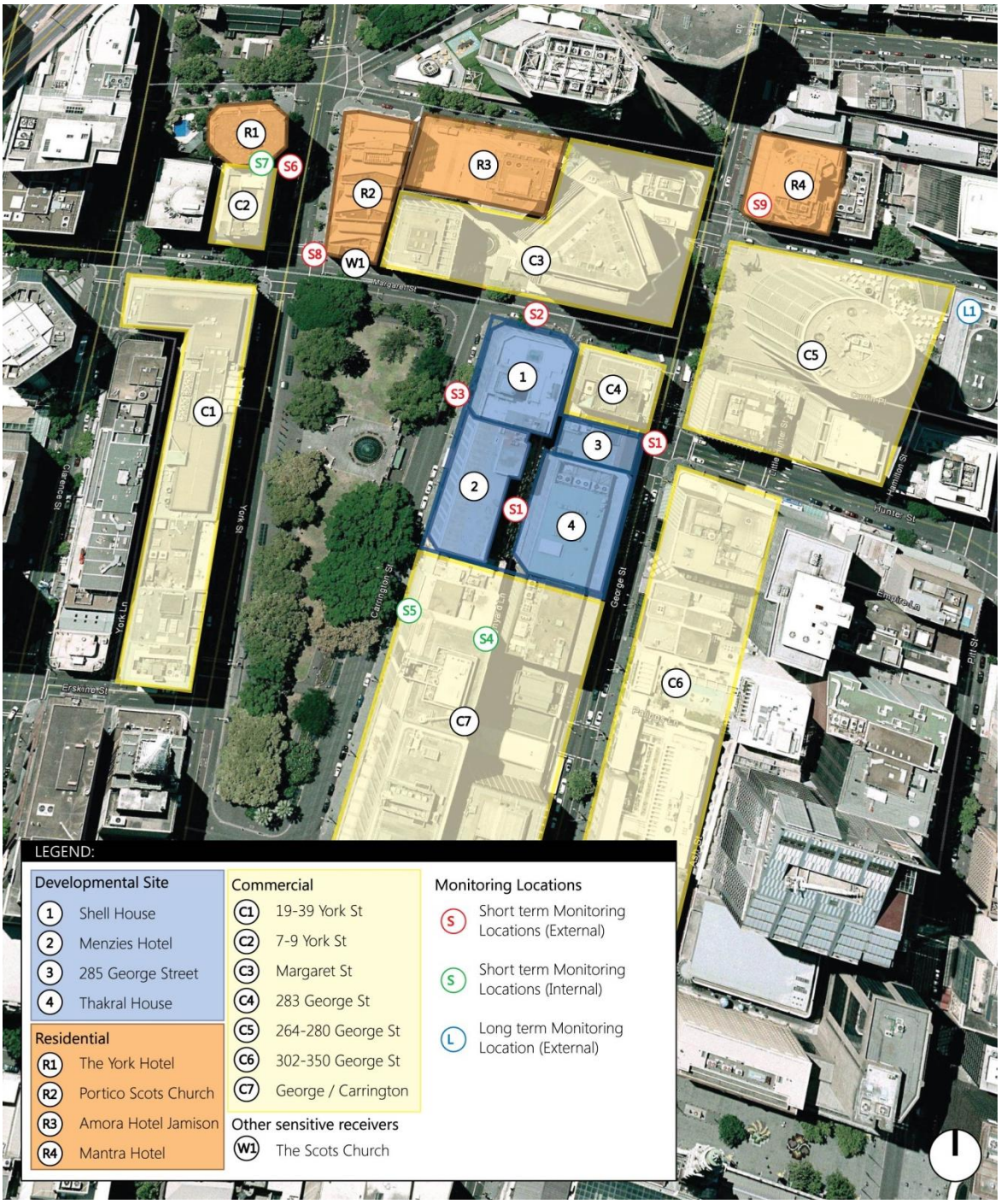
The long-term and short-term measurement locations are outlined in Table 2 and shown in Figure 3.

Table 2: Noise monitoring locations

ID	Address	Description
Long-term noise monitoring		
L1	Australia Square Plaza building	The monitor was located on the rooftop of the plaza building in the free field. Alternative long-term noise monitoring locations could not be established for the project in closer proximity to residential receiver locations. The rooftop of the project site was deemed to be affected by mechanical plant noise emission that will be subject to revision as part of the project work and would therefore not be representative.
Short-term noise monitoring		
S1	285 George	Positioned on the Western side of George Street approximately 1.5m from the building façade. Noise data represents the existing background and ambient noise incident on the proposed residential development on the Eastern façade of the development.
S2	Margaret Street, outside entrance to Shell House	Positioned on the Northern side of the site, 4m from the façade of Shell House, in the free-field. Noise data represents existing background and ambient noise for occupants of the Shell House Building.
S3	Carrington Street, Sydney	Positioned mid-way along the site, between existing Menzies Hotel and Shell house, at a distance of 4m from the existing façade, in the free-field. Noise data represents the existing background noise for the occupants of the Menzies Hotel and Shell House Western façade.
S4	Level 2 Lisgar House (C6) – Open Office	The monitor was located within an open office of level 2 of Lisgar House. The monitoring location was towards the Wynyard Lane side (east) of the office, approximately 2m from the eastern façade. The noise monitoring location is considered representative of all open office receiver locations within Lisgar House.
S5	Level 2 Lisgar House (C6) – Private Office	The monitor was located within a private office of level 2 of Lisgar House. The monitoring location was towards the Carrington Street (west) side of the office, approximately 2m from the eastern façade. The noise monitoring location is considered representative of all private office receiver locations within Lisgar House.
S6	The York Hotel, 5 York St Sydney - External	The monitor was located on a south-eastern upper level balcony of 5 York St, Sydney. The monitoring location was approximately 1m from the south eastern balustrade in the free field. The noise monitoring location is considered representative of all residential balcony areas along York St.
S7	The York Hotel, 5 York St Sydney - Internal	The monitor was located within an upper level apartment of 5 York St, Sydney. The monitoring location was within a bedroom located along the York St side of the building and is considered representative of all bedrooms in residential apartments located along York St.
S8	Corner of York St & Margaret St	The monitor was located approximately 3m from the York St curb and 8m from the Margaret St curb in the free field. The monitoring location is considered representative of all street level locations along York St.

ID	Address	Description
S9	Corner of Bond St & George St	The monitor was located approximately 3m from the Bond St curb and 7m from the George St curb in the free field. The monitoring location is considered representative of all street level locations along Bond St.
S10	Wynyard Lane	The monitor was located approximately 80m from the Margaret St curb 2m from the western façade of Thakral House in the free field. The monitoring location is considered representative of all street level locations along Wynyard Lane.

Figure 3: Site and noise monitoring locations



2.3 Long-term noise measurement results

Long-term noise monitoring was carried out from Friday, 28 May 2010 to Tuesday, 1 June 2010. The long-term noise monitoring methodology is detailed in Appendix B, and noise level-vs-time graphs of the data are included in Appendix C.

Table 3 presents the Rating Background Levels (RBL) and representative ambient L_{eq} noise levels for each assessment period, determined in accordance with the INP.

Table 3: Long-term noise monitoring results

Descriptor	Period	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
L1 - Australia Square Plaza building											
L_{90}	Day	62	65	65	62	61	59	58	54	47	37
	Evening	58	62	61	58	56	55	54	51	44	36
	10pm - 12am	57	59	60	57	55	54	53	49	43	36
	Night	57	57	58	55	54	53	53	49	43	36
L_{Aeq}	Day	63	70	69	65	63	60	58	55	48	39
	Evening	60	68	67	62	59	57	56	53	45	37
	10pm - 12am	59	65	66	61	57	56	55	51	45	37
	Night	59	64	64	60	57	55	55	51	44	37

Notes: Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
Evening: 18:00-22:00 Monday to Sunday & Public Holidays
Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays
A shoulder period has been established for 22:00-00:00, relevant to licensed premises that may operate up to 12 midnight.
As required by the INP, the external ambient noise levels presented are free-field noise levels. [ie. no façade reflection]

2.4 Short-term noise measurement results

Short-term noise measurements were undertaken on three occasions:

- afternoon of Monday, 3 February 2014
- morning of Tuesday, 4 February 2014
- morning of Wednesday, 26 February 2014

The equipment used for noise measurements was a Brüel & Kjær Type 2250 precision sound level analyser which is a Class 1 instrument having accuracy suitable for field and laboratory use. The instrument was calibrated prior and subsequent to measurements using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with AS IEC 61672.1 2004 '*Electroacoustics - Sound Level Meters*' and carries current NATA certification (or if less than 2 years old, manufacturers certification).

A summary of the short-term measurement results is presented in Table 4.

Table 4: Short-term noise monitoring results

Location Date / Time	Desc.	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
S1 - 285 George Street 04-02-2014 10:08-10:13	L_{Aeq}	77	45	61	59	69	70	70	67	62	55
	L_{90}	67	37	48	51	58	62	62	60	53	42
S1 - 285 George Street 04-02-2014 11:00-11:05	L_{Aeq}	74	45	57	57	66	69	69	66	60	52
	L_{90}	67	36	47	51	58	62	62	59	52	42
S1 - 285 George Street 03-02-2014 16:06-16:11	L_{Aeq}	75	45	61	59	67	70	69	66	61	54
	L_{90}	67	35	47	51	58	61	61	58	51	40
S1 - 285 George Street 03-02-2014 17:00-17:05	L_{Aeq}	75	45	62	59	68	69	69	66	60	52
	L_{90}	68	37	47	51	59	62	62	59	52	42
S2 - Margaret Street 04-02-2014 10:24-10:24	L_{Aeq}	70	39	53	57	61	64	65	63	59	51
	L_{90}	66	33	45	52	57	60	61	58	52	42
S2 - Margaret Street 04-02-2014 11:17-11:22	L_{Aeq}	71	37	53	56	60	64	65	64	61	51
	L_{90}	65	32	44	51	57	60	60	57	50	40
S2 - Margaret Street 03-02-2014 16:25-16:30	L_{Aeq}	74	41	58	61	63	66	68	66	61	68
	L_{90}	66	34	46	52	57	60	60	57	50	41
S2 - Margaret Street 03-02-2014 17:17-17:22	L_{Aeq}	70	43	55	57	62	65	65	62	58	53
	L_{90}	66	36	47	52	58	61	61	58	52	42
S3 – Carrington Street 04-02-2014 10:40-10:45	L_{Aeq}	67	40	51	54	58	61	62	60	57	52
	L_{90}	62	31	42	49	53	57	57	54	48	37
S3 – Carrington Street 03-02-2014 16:42-16:47	L_{Aeq}	72	45	54	58	62	66	67	64	60	53
	L_{90}	68	36	47	52	57	62	62	60	54	44
S3 – Carrington Street 03-02-2014 17:34-17:39	L_{Aeq}	72	47	55	57	63	66	68	65	61	55
	L_{90}	67	39	48	52	58	62	63	60	55	45
S4 - Level 2 Lisgar House 26-02-2014 10:31-10:46	L_{Aeq}	50	59	50	49	48	48	45	42	38	32
	L_{90}	39	55	46	45	42	37	31	28	23	18
S5 - Level 2 Lisgar House 26-02-2014 10:48-11:03	L_{Aeq}	43	60	54	51	46	40	35	35	32	26
	L_{90}	40	55	49	48	43	37	31	29	25	17
S6 - The York Hotel, 5 York St Sydney 26-02-2014 11:18-11:33	L_{Aeq}	64	69	71	65	65	62	59	54	46	34
	L_{90}	63	67	67	64	63	60	58	52	44	31
S7 The York Hotel, 5 York St Sydney 26-02-2014 11:34-11:49	L_{Aeq}	39	62	56	45	43	34	31	30	20	15
	L_{90}	37	58	52	43	41	33	29	28	17	13
S8 - Corner of York St & Margaret St 26-02-2014 12:09-12:24	L_{Aeq}	73	79	81	72	74	71	67	63	59	54
	L_{90}	65	74	71	66	64	63	60	55	49	39
S9 - Corner of Bond St & George St 26-02-2014 12:28-12:43	L_{Aeq}	71	78	77	74	73	69	66	62	57	51
	L_{90}	67	74	69	68	66	65	62	58	51	42
S10 - Wynyard Lane	L_{Aeq}	69	75	73	69	68	64	63	61	61	55

Location Date / Time	Desc.	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
26-02-2014 12:47-1:02	L_{90}	64	71	68	67	66	62	58	54	48	40

The short-term monitoring has been referenced against the long-term noise monitoring so as to establish indicative day, evening and night background and ambient noise levels for the standard INP assessment periodsat residential receivers as well as daytime noise levels for commercial receptors.

Where multiple measurements at individual locations were undertaken, in accordance with the INP the minimum noise levels have been used.

The background noise levels have been summarised into primary assessment locations.

Table 5: Summary of background and ambient noise levels

Assessment location	Ref measurement location(s)	Date / Time	$L_{Aeq,perid}$	L_{A90} RBL
R1, R2, R3 and R4 The York Hotel - External*	S5/L1	Day	63	62
		Evening	60	58
		10pm - 12 midnight	59	57
		Night	59	57
C1 / C2 - York St	S8	Day/Office hours	73	65
C3 - Margaret St	S2	Day/Office hours	70	65
C4 - 283 George St / Wynyard Ln	S10 (external)	Day/Office hours	69	64
C5 / C6 - George St	S1 / S9 (external)	Day/Office hours	71	67
C7 - Carrington St	S3 (external)	Day/Office hours	67	62
	S4 (internal)	Office hours	43	39

Notes: * results of location L1 adopted as daytime measurements consistent with short-term L_{90} and L_{eq} measurements

3 Operational noise assessment

3.1 Operational noise sources

The proposed One Carrington Street development will combine mainly commercial, with some low-level retail, limited below ground parking, and a single-storey pavilion on the roof of Shell House. Specific details on the function of the pavilion are not yet available, but will be addressed as they are made available. The operational noise sources associated with the development are considered to be:

- mechanical plant and equipment, including commercial air-conditioning, car park and retail ventilation equipment
- activity associated with restaurants, cafes and other retail uses, including patrons, music and activity in the Transit Hall and lower levels of the buildings

This section of the report addresses noise emission associated with these sources at the nearest noise-sensitive receivers in accordance with the DGRs and relevant noise requirements. Where necessary, noise mitigation and/or management measures will be identified.

3.2 Operational noise criteria

3.2.1 NSW Industrial Noise Policy

In accordance with the DGRs, noise impact from the general operation of the proposed development is to be assessed against the NSW Industrial Noise Policy (INP) [1]. The assessment procedure in terms of the INP has two components:

1. controlling intrusive noise impacts in the short term for residences
2. maintaining noise level amenity for particular land uses for residences and other land uses.

Table 6: INP noise goals, dB(A)

Assessment location	Time period	Intrusiveness criteria ($L_{Aeq,15min}$)	Amenity criteria (L_{Aeq} period)		
			INP base amenity criteria (urban)	Modification	Modified criteria
R1, R2, R3 and R4	Day	67	60	No	60
	Evening	63	50	Traffic (existing 60)	50
	Night	62	45	Industry/traffic (57/59)	45
All commercial	When in use	-	70	No	70
W1 - The Scots Church	When in use	-	40 (internal)	No	40

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

3.2.2 Licensed premises

Specific use of individual retail premises will be subject to separate development applications, of which could include licensed premises. The function of the pavilion floor on the roof of Shell House has also not been confirmed, but may include a licensed premise. The following information is provided with regard to operational noise from liquor licensed premises within the City of Sydney Council area.

City of Sydney Council's Standard Conditions of Development Consent (revised 2 April 2012) Condition 61 refers to Noise related to Licensed Premises. This is generally in-line with the Office of Liquor Gaming and Racing's 'Standard Noise Condition' except for part d) which relates to assessment within commercial premises:

a. *The LA10 noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) by more than 5dB between 7:00am and 12:00 midnight at the boundary of any affected residence.*

b. *The LA10 noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) between 12:00 midnight and 7:00am at the boundary of any affected residence.*

c. *Notwithstanding compliance with (a) and (b) above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 7:00am.*

d. *The L10 noise level emitted from the use must not exceed the background noise level (L90) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 3dB when assessed indoors at any affected commercial premises.*

e. *The use of the premise must be controlled so that any emitted noise is at a level so as not to create an "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any affected receiver.*

3.3 Assessment and recommendations

3.3.1 Mechanical plant noise

Detailed specifications of mechanical services equipment that would otherwise allow an acoustic assessment of noise emission from the site are not available for this Application report. In line with the approval process for development within the City of Sydney area, detailed assessment of operational noise emission from mechanical services equipment should form a conditional requirement of the development, to be satisfied prior to the issue of the construction certificate.

Mechanical plant such as ventilation, air-conditioning and refrigeration associated with the development should be assessed at the time of detailed design and selection having regard to nearby residential and commercial properties surrounding the development. Any noise emissions from building services associated with One Carrington Street shall be acoustically treated, where necessary, to comply with relevant Government policies.

Notwithstanding the above, note should be taken of the following:

- acoustic assessment of mechanical services equipment should be undertaken during the detail design phase of the development to ensure that the cumulative noise of all equipment does not exceed the applicable noise criteria
- noise control treatment can affect the operation of the mechanical services system. An acoustic engineer should be consulted during the initial design phase of mechanical services system to reduce potential redesign of the mechanical system
- mechanical plant noise emission can be controlled by appropriate mechanical system design and implementation of common engineering methods, which may include:
  - procurement of 'quiet' plant
  - strategic positioning of plant away from sensitive neighbouring premises to maximise intervening acoustic shielding between the plant and sensitive neighbouring premises
  - commercially available acoustic attenuators for air discharge and air intakes of plant
  - acoustically lined and lagged ductwork
  - acoustic barriers between plant and sensitive neighbouring premises
  - partial or complete acoustic enclosures over plant
- the specification and location of mechanical plant should be confirmed prior to 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*'.

3.3.2 Restaurants, cafes and retail operations (licensed and un-licensed)

This application does not define specific uses for each of the retail premises, and each use within the site will be subject to specific development applications. Notwithstanding, a high level assessment has been carried out for the potential food & beverage premises where outdoor seating or active frontages may be proposed.

The retail areas of the development are restricted to the lower two floors of the buildings, which includes the transit hall and primary street frontages (including Wynyard Lane). A single-storey pavilion on the roof of Shell House has also been reviewed for potentially use as a small outdoor licensed premise.

Regarding retail through the transit hall, while it is desired to keep the transit hall clear for pedestrian thoroughfare, internal seating and take-away stands may add to noise in the area. Retail stores might also have their own music playing which could add to the overall noise levels of the retail floors however these activities would not be expected to impact upon noise sensitive receptors such as residences. The proposed activation of Wynyard Lane should have regard to noise impact upon commercial offices, particularly 283 George St, that front the lane way.

With regard to the Shell House rooftop use, noise prediction and assessment has been made to the nearest residential receivers at Portico Scots Church and Amora Hotel Jamison development. The upper level residential apartments are at a similar height to the Shell House rooftop and therefore may be directly exposed to noise from the use.

As a typical worst case scenario, the acoustic assessment has been based on a patron capacity of one person per square metre for the roof top area of Shell House. Table 7 presents the brief assessment of the possible use, using source noise levels determined from measurements previously conducted by Renzo Tonin & Associates. It is noted that the external area is surrounded by high parapet walls of the building.

Table 7: Shell House rooftop patron areas - L_{10}

Noise source	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
		31.5	63	125	250	500	1k	2k	4k	8k
Outdoor patrons with background music (Lw per person)	85	-	79	78	77	82	81	77	70	56
Total patrons (240) sound power	109	-	103	102	101	106	105	101	94	80
Sound pressure at receiver (R2)	60	-	54	53	52	57	56	52	45	31
Criteria										
Day	-	70	70	67	66	64	63	59	52	42
Evening	-	67	66	63	61	60	59	56	49	41
10pm - 12 midnight	-	64	65	62	60	59	58	54	48	41
12midnight - 7am	-	57	58	55	54	**53**	**53**	**49**	**43**	36

Notes: BOLD indicates where criteria is exceeded

The noise assessment indicates that the rooftop use complies with criteria up to 12 midnight. With consideration given to noise mitigation measures and management measures a more detailed assessment may obtain compliance after midnight.

4 Noise and vibration impact upon development

4.1 Criteria

While not specifically required to be addressed in the Project Application, noise intrusion to commercial areas is recommended to be assessed. In the absence of requirements stipulated by the consent authority reference would typically be made to AS 2107:2000 'Acoustics – Recommended design sound levels and reverberation times for building interiors' [2].

Table 8: AS2107 2000 Recommended design sound levels and reverb times

Type of occupancy/ activity	Recommended design sound level, L_{Aeq}, dB(A)		Recommended reverberation time (T),s
	Satisfactory	Maximum	
5 OFFICE BUILDINGS			
Board and conferences rooms	30	40	0.6 to 0.8
Cafeterias	45	50	See Note 3
Call centres	40	45	0.1 to 0.4
Computer rooms	45	50	See Note 3
Corridors and lobbies	45	50	0.4 to 0.6
Design offices	40	45	0.4 to 0.6
Draughting offices	40	50	0.4 to 0.6
General office areas	40	45	0.4 to 0.6
Private offices	35	40	0.6 to 0.8
Public spaces	40	50	0.5 to 1.0
Reception areas	40	45	See Note 3
Rest rooms and tea rooms	40	45	0.4 to 0.6
Toilets	50	55	-
Undercover carparks	55	65	-
6 PUBLIC BUILDINGS			
Railway and bus terminals -			
Ticket sales areas	45	50	See Note 3
Waiting areas	45	55	See Note 3
Restaurants and cafeterias -			
Cafeterias and food courts	45	55	See Note 3
Coffee bars	45	50	<1.0
Restaurants	45	50	<1.0
8 SHOP BUILDINGS			
Department stores -			
Main floor	50	55	See Note 3
Upper floor	45	50	See Note 3
Enclosed car parks	55	65	-

Type of occupancy/ activity	Recommended design sound level, L_{Aeq}, dB(A)		Recommended reverberation time (T),s
	Satisfactory	Maximum	
Show rooms	45	50	See Note 3
Small retails stores (general)	45	50	See Note 3
Specialty shops (where detailed discussion is necessary in transactions)	40	45	See Note 3
Supermarkets	50	55	See Note 3
Shopping malls	45	55	See Note 3

* See Appendix A

NOTES:

The recommended design sound levels are for a fully fitted out and completed building. Attention is drawn to the additive noise effect of many machines within the same area and adjacent areas. Allowance for the total number and type of noise sources should therefore be made in the selection of equipment and in the design of building spaces. A building owner or developer may consider an allowance of 3-5 dB(A) to be appropriate.

Recommended reverberation time is 10 percent to 20 percent higher than Curve 1 of Appendix A.

Reverberation time should be minimized as far as practicable for noise control.

Certain teaching spaces, including those intended for students with learning difficulties and students with English as a second language, should have reverberation times at the lower end of the specified range.

Specialist advice should be sought for these spaces.

A very wide range of noise levels can occur in the occupied state in spaces housing manufacturing processes, and the levels are primarily subject to control as part of a noise management program (see AS/NZS 1269.2). The possibilities for segregating very noisy processes from quieter ones by partitioning vary between particular industries and plants. For reasons such as these, it is difficult to make generalized recommendations for desirable, or even maximum, design levels for the unoccupied state, but one guiding principle may still be observed - when the activity in one area of a manufacturing plant is halted, it is desirable that the local level should if possible drop to 70 dB(A) or lower to permit speech communication without undue effort.

In situations where traffic noise levels may vary widely over a 24-hour period, measurements to assess compliance with this Standard should be taken at the relevant time and for an appropriate measurement period according to the area of occupancy or activity in the building. Where traffic noise fluctuates rapidly with the passage of individual vehicles, the community reaction may not correlate well with the equivalent continuous noise level as measured.

The overall sound pressure level in dB(A) should conform to the recommended design sound level given in Table 1. In these spaces, a balanced sound pressure level across the full frequency range is essential. These spaces should therefore be evaluated in octave bands across the full frequency spectrum. The recommended maximum sound pressure levels for the individual octave bands corresponding to the overall dB(A) value are given in Appendix C.

In spaces in which high quality sound recordings are to be made, the levels set for low frequency octave bands should not be exceeded (see Appendix C). Subsequent replay of the recordings may cause an amplification of the ambient sound resulting in an overemphasis of its low-frequency components. Specialist advice should always be sought when these spaces are being designed. In some circumstances, for purposes of very high quality recording, lower levels than those specified in Table 1 may be required.

4.2 Recommendations

Noise from road traffic (including buses) impacts the site along the George Street, Margaret Street and Carrington Street frontages. Based on the short-term measurement results, L_{Aeq} noise levels range between 70dB(A) and 77dB(A), with average noise levels in the order of 75dB(A).

Where desired, internal noise criteria within commercial and retail spaces will typically be achieved through appropriate acoustic specification of the building façade which is to be detailed during the design development stage. Final specification will be dependent upon the noise exposure at the affected façade as well as the type of use/occupancy within the building.

5 Impact upon Metro Corridor

5.1 Criteria

The NSW State Environmental Planning Policy (Infrastructure) 2007 (known as 'ISEPP') came into force in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. The aim of the policy includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure.

Pertinent to noise assessment, the ISEPP includes the following clauses:

> *88A Major development within Interim Metro Corridor*
>
> *1. This clause applies to land within the City of Sydney that is within the Interim Metro Corridor.*
>
> *…3 A consent authority must not grant consent to major development on land to which this clause applies if the development would have an adverse affect on the viability of the proposed metro, including by increasing the likely cost of developing the proposed metro.*

5.2 Discussion

The proposed development is consistent with the existing surrounding land use in the locality being predominately commercial office and retail. The One Carrington development does not propose an amendment of land use to a more sensitive receptor such as residential.

The CBD Metro Corridor is in closer proximity to existing noise and vibration sensitive development at the Portico, which would otherwise determine the noise and vibration mitigation design for the CBD rail line in the locality.

The introduction of basement levels in closer proximity to the CBDRL also will not result in an increase in vibration and structure radiated noise at occupied levels above ground.

One Carrington is therefore assessed not to adversely affect the viability of the proposed metro, by otherwise increasing the likely cost of developing the rail line. One Carrington therefore satisfies the requirements of Clause 88 of the ISEPP.

6 Construction noise and vibration criteria

6.1 Proposal

6.1.1 Projected program and schedule

At this stage of the development the program for demolition and construction of the site is not confirmed and will be dependent upon both the approvals process and market factors. However an indicative development program is set out below, in order to provide an indication of the duration of works across the Carrington Street site.

Figure 4: Construction program

Phase	Breakdown	Period
Demolition	Services termination and external scaffold	0 - 3 months
	Hazmat removal	0 - 3 months
	Demolish towers	Months 1 - 7 (concurrently w/Hazmat)
Excavation	Trim basement	Months 7 - 12
	Detail excavate core and footings	
	In-ground services excavation	
Construction	Structure	Months 12 - 30
	Facade	Months 16 - 30
	Services and Fit-out	Months 16 - 39
	Shell House	Months 1 - 28
	285 George St	Months 1 - 28

6.1.2 Construction hours

The proposed construction hours are modified from those set out in the ICNG. The proposed hours of 7:00am to 7:00pm Monday to Friday and 7:00am to 5:00pm Saturdays are however consistent with the standard construction hours for the City of Sydney [3]. They have therefore been adopted as 'standard hours' in the context of the ICNG for this project.

Table 9: Proposed work hours

	Monday to Friday	Saturday	Sunday/ Public holiday
Work Hours	7:00am to 7:00pm	7:00am to 5:00pm	No work

It is possible that some construction works will need to occur outside the hours set out above, although specific details of this are not known at this stage of the development. The justification for these out-of-hours works is that they would be in areas that would impact on and potentially put at risk the general public if undertaken during the standard work hours. The delivery of large items such as structural steel beams may also be undertaken at night so as to reduce potential interruptions to road traffic.

6.2 Construction noise criteria

6.2.1 Guidelines

As referenced in the DGRs, the NSW *Interim Construction Noise Guideline* (ICNG) [4] provides guidelines for assessing noise generated during the construction phase of developments. While the Statement of Commitments also references the City of Sydney's construction noise policy, the more recent State policy has been adopted to ensure a consistent approach with other project determined by the NSW Planning and Infrastructure.

The key components of the guideline that are incorporated into this assessment include:

- Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.

  NSW noise policies, including the INP, RNP and RING have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

- Application of reasonable and feasible noise mitigation measures

- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the scale of the construction works proposed for the rest area, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

Table 10 reproduced from the ICNG, sets out the noise management levels and how they are to be applied for residential receivers.

Table 10: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7am to 7pm Saturday 7am to 5pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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 75dB(A)	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 standard hours	Noise affected RBL + 5dB(A)	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 the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Table 11 sets out the ICNG noise management levels for other noise sensitive receiver locations. As identified for residential receivers, a 'highly affected' noise objective of $L_{Aeq(15min)}$ 75dB(A) is adopted for all noise sensitive receivers, with exceedances addressed as described in Table 10.

Table 11: Noise management levels at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)

Notes: Noise management levels apply when receiver areas are in use only.

6.2.2 Project noise management levels

Table 12 presents the construction noise management levels established for the nearest receivers surrounding the site. While the ICNG nominates a fixed NML for external locations of commercial receptors, , a background + 10 criteria has been nominated as the initial 'noise affected target' due the high background noise levels in the area, else management levels at commercial receptors would be lower than at residential.

Regarding commercial receptors it is however the internal receptor locations that are typically most sensitive to noise intrusion and therefore a more detailed and specific management strategy for the site may include specific internal noise criteria for commercial premises., particularly those located immediately adjacent the site. Where internal noise levels have already been measured an internal NML has been nominated. From other project experience, suitable internal NMLs range between 15-20dB(A) above the background noise level. The 'noise affected' NML has therefore been set to background + 15dB(A) and the highly noise affected at background + 20dB(A).

Table 12: Construction noise management levels at residential receivers

ID	Location Description	L_{A90} rating background level (RBL)	Noise management level $L_{Aeq(15min)}$	
			Noise affected	Highly noise affected
R1/R2/R3	York Hotel, Portico, Marriott	62	72	75
C1/C2/C3	York St / Margaret St	65	75	75
C4	Wynyard Ln	64	74	75
C5/C6	George St	67	77	-
C7	Carrington Street	62	72	75
	Inside Lisgar House	39	54	59
W1	Scots Church	-	45 (internal)	-

6.3 Construction vibration criteria

6.3.1 Disturbance to buildings occupants

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the NSW '*Assessing Vibration; a technical guideline*' [5]. The guideline provides criteria which are based on the British Standard BS 6472-1992 '*Evaluation of human exposure to vibration in buildings (1-80Hz)*' [6]. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. Table 13 provides definitions and examples of each type of vibration.

Vibration sources are defined as Continuous, Impulsive or Intermittent. Table 13 provides a definition and examples of each type of vibration.

Table 13: Types of vibration

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

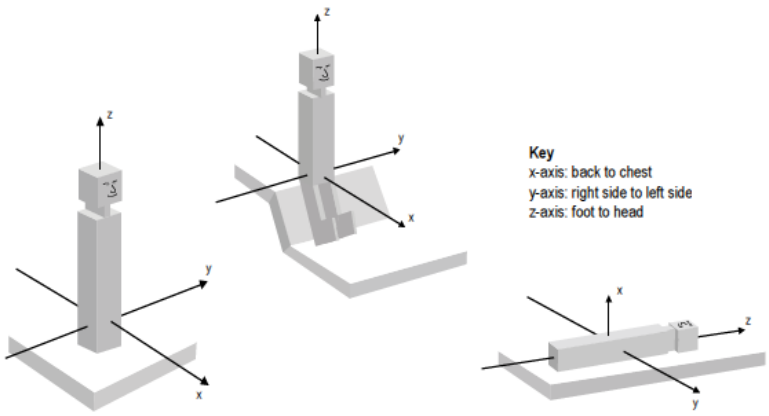
Source: Assessing Vibration; a technical guideline [5]

The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred* [6]*'*

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore, application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 5. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 5: Orthogonal axes for human exposure to vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 14.

Table 14: Preferred and maximum levels for human comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (Weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (Weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92
Intermittent vibration (Vibration dose values, VDV, $m/s^{1.75}$, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.10		0.20	
Residences	Daytime	0.20		0.40	
	Night-time	0.13		0.26	
Offices, schools, educational institutions and places of worship	Day- or night-time	0.40		0.80	
Workshops	Day- or night-time	0.80		1.60	

Notes:
1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

6.3.2 Structural damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2 [7] and German Standard DIN4150-3 [8]. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

Within DIN4150-3, damage is defined as "*any permanent effect of vibration that reduces the serviceability of a structure or one of its components*" (p.2). The Standard also outlines:

> *"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if*

- *cracks form in plastered surfaces of walls;*
- *existing cracks in the building are enlarged;*
- *partitions become detached from loadbearing walls or floors.*

These effects are deemed 'minor damage. " (DIN4150.3, 1990, p.3)

The limits in Table 1 of the Standard are therefore set to protect against minor damage, being more consistent with cosmetic issues than major structural failures.

The differences in levels of damage are more defined in British Standard 7385 Part 1 1990 (p.10):

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

The vibration limits in Table 1 of British Standard 7385 Part 2 (1993) are also for the protection against cosmetic damage. Guidance on limits for minor or major damage is provided in Section 7.4.2 of the Standard (p.5), as follows:

7.4.2 Guide values for transient vibration relating to cosmetic damage

Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.

6.3.2.1 British Standard

British Standard 7385: Part 2 [7], can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%. Table 15 sets out the BS7385 criteria for cosmetic, minor and major damage.

Regarding heritage buildings, British Standard 7385 Part 2 notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*" ([7] p.5). Where the heritage listed buildings part of the project are not considered structurally unsound and the proposed works are for the purpose of reuse and restoration, the management of potential effects of vibration could consider adoption of the criteria for minor damage, rather than cosmetic damage.

Table 15: BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor	100		
		Major	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor	30 to 40	40 to 100	100
		Major	60 to 80	80 to 200	200

Notes: Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

6.3.2.2 German Standard

German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure*' (DIN 4150-3), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure. The vibration limits increase as the frequency content of the vibration increases. The criteria are presented in Table 16.

Table 16: DIN 4150-3 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

7 Construction noise assessment

7.1 Equipment list and source noise levels

Noise generated from the site will vary depending on the level and specific type of activity carried out, as well the number of items of plant equipment operating at any one time. Table 17 provides the sound power levels (Lw) of plant likely to be used during the construction period.

Table 17: One Carrington Street - Construction plant noise levels, dB(A)

Equipment type	Indicative size	Indicative no. of equipment per phase			Sound power level
		Demolition	Excavation	Construction	L_{Aeq}
Air Compressor - Silenced	8 kW	-	-	1	109
Backhoe	8 t	-	2	1	100
Backhoe with Hydraulic Breaker	67 kW	1	2	1	116
Bobcat	4 t	1	1	1	110
Cherry Picker	6 t	1	1	1	106
Concrete Pump	6 t	-	-	1	103
Concrete Saw	9 kg	1	1	1	119
Concrete Vibrator	2 kW	-	-	1	97
Crane - Mobile	55t	1	-	1	98
Crane - Diesel	1760	1	1	1	104
Excavator w bucket	40t	2	1	-	105
Excavator with Hydraulic Breaker	40t	2	1	-	120
Front end loader	12 t	2	1	-	102
Generator - Diesel	10 kVA	1	1	1	94
Hoist - Twin cage high speed Alimak	0.5 t	-	-	1	96
Line drilling	-	-	1	-	111
Lump Hammer	-	1		1	105
Machine Mounted Hydraulic Drill	-	-	1	1	110
Machine Mounted Percussive Drill	-	-	1	1	115
Machine Mounted Pneumatic Drill	-	-	1	1	111
Pavement laying machine	-	-	-	1	109
Piling Drilling Rig	-	-	1	-	111
Pneumatic Hand Tools	-	-	1	1	110
Pneumatic Jack Hammer	20 kg	-	1	1	121
Rock breaker	-		1	1	120
Roller - Non-Vibratory	20 t	-	1	-	104
Roller - Vibratory (pad foot)	20 t	-	1	-	108
Truck - Cement Mixer	12 t	-	1	1	104
Truck - Dump (Moxy)	12 t	-	-	1	109

Equipment type	Indicative size	Indicative no. of equipment per phase			Sound power level
		Demolition	Excavation	Construction	L_{Aeq}
Truck - Waste removal	up to 40t	1	1	1	109
Water Cart	10-12t	1	1		107
Welders - welding & cutting steel	-	1	1	1	101
Forklifts	Manitou 10t	1	1	1	90

Note: ^ For 15-minute assessment period

7.2 Predicted noise levels

Noise emission from the site was determined by modelling the noise sources, receiver locations, and operating activities, based on the information presented above. Due to the nature of construction works, each aspect or stage of construction is to be carried out consecutively (rather than concurrent). Even within stages, only limited number of equipment would be expected to operate at any one time.

Table 18 presents a summary of the predicted L_{Aeq} noise levels for each stage of project during standard (day time) construction hours. Noise predictions have been conservatively assessed on the basis of the following:

- all plant and equipment for each stage operating concurrently
- impulsive appliances include +5dB(A) in accordance with ICNG.
- a noise reduction of 20dB(A) has been assumed form outside to inside of Scots Church
- no acoustic shielding by intervening structures such as retained buildings or site hoardings.

Table 18: Summary of predicted L_{Aeq} noise levels (standard construction hours)

Receiver ID	'Noise affected' NML, dB(A)	Predicted L_{Aeq} noise levels, dB(A)		
		Demolition	Excavation	Construction
R1 - The York Hotel	72	77	76	73
R2 - Portico Scots Church	72	81	80	77
R3 - Amora Hotel Jamison	72	81	80	77
R4 - Mantra Hotel	72	77	76	73
C1 - York St	75	80	79	76
C2 - Cnr York St and Margaret St	75	78	77	74
C3 - Margaret St	75	84	84	80
C4 - 283 George St	74	91	91	87
C5 - George St and Hunter St	77	86	85	82
C6 - George St (east)	77	88	87	84
C7 - Carrington, Wynyard Ln	72	95	94	91
W1 - The Scots Church	45 (internal)	61	60	57

Noise emission during the demolition phase is deemed to have the greatest potential to impact surrounding receptors, particularly during the use of hammers to break concrete. As the noise predictions do not include shielding from intervening structures, noise levels during the excavation and construction stage would be expected to be lower than presented, with excavation occurring at ground level, shielded by surrounding structures and likely hoarding, and later during construction as a result of the developed building.

Based on the predicted noise levels, and the extent to which NMLs are exceeded, the most sensitive receptors are the immediately adjacent commercial receptors and Scots Church, rather than residential receptors. It is therefore recommended that any consideration of respite for intrusive appliances be involve appropriate consultation with adjacent occupants.

Further discussion regarding noise management is presented in Section 7.3.

7.2.1 Pedestrian assessment

Through consultation with Transport for NSW, concern was raised regarding noise exposure for pedestrians travelling through the Transit Hall during demolition work. During demolition, the use of hammers to break concrete will result in structure borne noise emanating into the Transit Hall. This noise level will increase as the buildings are demolished. For pedestrians, the duration will however be short. Consultants from the project team have calculated the journey duration of approximately 1 minute based on a journey length of 65m and travel speed of 1.2m/s.

Based on an estimated noise level of 90dB(A) within the Transit Hall, the daily noise exposure of a pedestrian that travelled through the area four times a day would be 69dB(A), being well below the WHS noise exposure guideline of 85dB(A)for an 8 hour work day.

7.3 Recommendations

7.3.1 Noise source control measures

The following at-source control measures should be considered for the management of noise from construction works to reduce potential noise impacts:

Item	Description
Construction hoarding	The installation of construction hoarding should take into consideration the location of receivers to ensure that line of sight' is broken, where feasible. For the subject site, site hoarding could provide reasonable noise reductions for ground level receivers, including pedestrians and commercial receptors in the immediate vicinity of the site.
Location of equipment	Loading/unloading zones and stationary plant such as generators should where practicable be located away from the most sensitive receivers. For the subject site, deliveries would be expected to be limited to Carrington St or Wynyard Lane due to traffic on George St.
Demolition procedures	Where feasible and reasonable, the demolition process should seek to maintain any structures that provide shielding to the most sensitive receptors for the longest period practicable.

Item	Description
Equipment selection	Use the quietest and least vibration emitting construction methods where feasible and reasonable, e.g. use of concrete pulverisers rather than rock hammers and Excentric rippers for excavation.
Limit equipment in use	Only the equipment necessary for the upgrade works will be used at any time. Avoid any unnecessary noise when carrying out manual operations and when operating plant Simultaneous operation of noisy plant and equipment within discernible range of a sensitive receiver should be avoided/ limited where possible.
Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off whilst being unloaded.
Reversing alarms	Alternatives reverse alarm, such as 'quackers' should be installed where feasible and reasonable.

7.3.2 Noise management measures

The following actions are recommended to be implemented during the construction works to miniimise noise impacts.

Table 19: Construction noise management measures

Management measure	Detail
Implement community consultation measures	Inform community of construction activity and potential impacts
Develop good relations	Good relations with building occupants should be established at the beginning of the works and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the building occupants should be adequately trained and experienced in such matters.
Site inductions	All employees, contractors and subcontractors are to receive a Project induction. The environmental component may be covered in toolboxes and must include: all relevant project specific and standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries), and • environmental incident procedures.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height where practicable, throwing of metal items and slamming of doors.
Complaints management procedure	A management procedure would need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.

8 Vibration assessment

8.1 Vibration sources

The vibration generated from demolition and construction works associated with the project will vary depending on the level (location) and type of activity carried out. Typical plant and equipment in use have been identified in Table 20.

Table 20 below identifies the dominant vibration generating plant and equipment. Potential vibration generated to receivers is dependent on separation distances, the intervening structures, soil and rock strata, dominant frequencies of vibration and the receiver structure. Typical levels of ground vibration from these sources are shown in Table 20.

Table 20: Construction plant vibration levels

Plant equipment	Indicative size	PPV Vibration (mm/s) at distance from plant					
		5m	10m	15m	20m	30m	40m
Bobcat		<0.5					
Backhoe/ Excavator & Breaker	Light	4.5	1.3	-	0.4	0.2	0.15
Excavator (travelling)	Medium	8.0	3.4	1.6	-	-	-
Excavator (digging)	Medium	5.8	4.0	1.0	-	-	-
Excavator & Breaker	Heavy	10.5	2.5	-	-	-	-
Excavator (travelling)	Heavy	8.0	3.4	1.6	-	-	-
Piling - Rotary bored cast in-situ		11.4	6.4	-	5.6	-	-
Pneumatic Jack Hammer		2	1	0.2	0.1	<0.1	<0.1
Roller - Vibratory (pad foot)	12t	15.1	10.3	3.2	-	-	-
Truck & Trailer	≤45t net	14.5	10.3	3.4	-	-	-
Water Cart	10-12t	0.2					

Notes: Source – Renzo Tonin & Associates database

8.2 Vibration control measures

Based on available data, Table 21 presents the recommended minimum working distances for vibration generating plant.

Table 21: Recommended minimum working distances for vibration intensive plant

Plant item	Rating / description	Minimum. working distance for cosmetic damage at commercial receivers, m
Jackhammer	Hand held	1 (nominal)
Large Hydraulic Hammer	1600 kg	3
Excavator	<=30 Tonne (travelling/ digging)	1

Notes: Renzo Tonin & Associates project files, databases & library
Based on DIN4150.3 Group 1 Buildings

Site specific minimum working distances shall be determined where vibration significant plant items, in particular large rock hammers/breakers, operate within cosmetic damage minimum working distances detailed in Table 21. Where this occurs, minimum buffer distances to affected receivers shall be determined by site measurements prior to the commencement of the regular use of the vibration significant plant on site. The site specific minimum working distance shall be maintained in order to comply with relevant vibration limits.

8.2.1 Vibration management measures

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers:

- at the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, attended vibration monitoring should be undertaken so to refine the recommended minimum working distances set out in Table 21 and provide a site-specific table of minimum working distances
- where vibration is found to be excessive, management measures shall be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller rock breakers, using alternative processes or establishment of larger minimum working distances.
- carry out additional vibration monitoring when construction activities are at the nearest point to the nearby sensitive structures. This monitoring may signal to the contractor when levels approach/exceed the recommended limits.
- before, during and after the demolition and construction stages we recommend preparation of a dilapidation report on the state of the existing buildings sharing the property boundary with the site.
- a vibration complaints management system be established prior to the commencement of these works.

9 Conclusion

Renzo Tonin & Associates has completed an assessment of noise and vibration in regard to the operation and construction phases of the One Carrington project. The assessment has been carried out in accordance with the policies and guidelines specified in the Director General's Requirements (DGRs). Where relevant the report has presented recommended mitigation and management measures for the control of noise and vibration for both the construction and operational phases of the development. The report has also identified where additional detailed assessment may be required during the design development phase of the project.

References

[1] NSW EPA, NSW Industrial Noise Policy, Sydney: NSW EPA, 1997.

[2] Standards Australia/Standards New Zealand, AS/NZS 2107 Acoustics - Recommended design sound levels and reverberation time for building interiors, Sydney: Standards Australia International, 2000.

[3] City of Sydney Council, "Construction sites," City of Sydney, 13 March 2014. [Online]. Available: http://www.cityofsydney.nsw.gov.au/live/report-local-issues/noise/construction-sites. [Accessed 14 March 2014].

[4] Department of Environment and Climate Change NSW, "Interim Construction Noise Guideline," Department of Environment and Climate Change NSW, Sydney, 2009.

[5] Department of Environment and Conservation (NSW), "Assessing Vibration: A technical guideline," Department of Environment and Conservation (NSW), Sydney, 2006.

[6] Bristish Standards Institution, "BS 6472-1992 Evaluation of human exposure to vibration in buildings (1-80Hz)," Bristish Standards Institution, London, 1992.

[7] Bristish Standard Institution, "BS 7385-2: 1993 Evaluation and measurement for vibration n buildings - Pt 2: Guide to damage levels from groundborne vibration," Bristish Standard Institution, London, 1993.

[8] DIN, "DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures," DIN Deutsches Institut fur Normung, Berlin, 1999.

[1] NSW EPA, NSW Industrial Noise Policy, Sydney: NSW EPA, 1997.

[2] Standards Australia/Standards New Zealand, AS/NZS 2107 Acoustics - Recommended design sound levels and reverberation time for building interiors, Sydney: Standards Australia International, 2000.

[3] City of Sydney Council, "Construction sites," City of Sydney, 13 March 2014. [Online]. Available: http://www.cityofsydney.nsw.gov.au/live/report-local-issues/noise/construction-sites. [Accessed 14 March 2014].

[4] Department of Environment and Climate Change NSW, "Interim Construction Noise Guideline," Department of Environment and Climate Change NSW, Sydney, 2009.

[5] Department of Environment and Conservation (NSW), "Assessing Vibration: A technical guideline," Department of Environment and Conservation (NSW), Sydney, 2006.

[6] Bristish Standards Institution, "BS 6472-1992 Evaluation of human exposure to vibration in buildings (1-80Hz)," Bristish Standards Institution, London, 1992.

[7] Bristish Standard Institution, "BS 7385-2: 1993 Evaluation and measurement for vibration n buildings - Pt 2: Guide to damage levels from groundborne vibration," Bristish Standard Institution, London, 1993.

[8] DIN, "DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures," DIN Deutsches Institut fur Normung, Berlin, 1999.

APPENDIX A Glossary of terminology

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 L90 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 CBD mall 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 L90 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.

APPENDIX B Long-term noise monitoring methodology

B.1 Noise monitoring equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave band data	Logger location(s)
RTA05 (NTi Audio XL2)	Type 1	1/1	L1

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW INP. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B.3 Noise vs time graphs

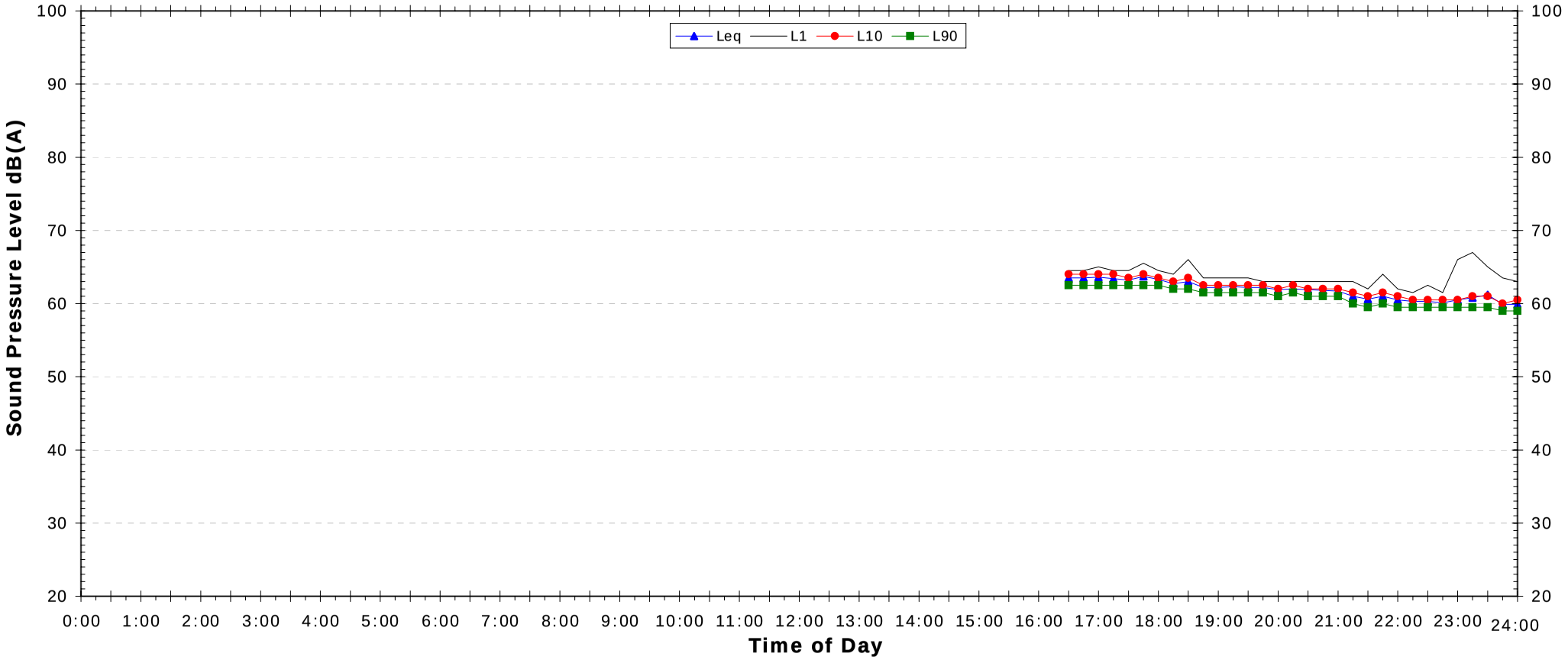
Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Long-term noise monitoring results

EXISTING AMBIENT NOISE LEVELS

Location L1 - Plaza Building Rooftop

Friday, 28 May 2010



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	62.5	59.5	56.5
Leq (see note 3)	63.5	61.9	58.9

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.9	61.4
$L_{eq\ 1hr}$ upper 10 percentile	66.0	63.0
$L_{eq\ 1hr}$ lower 10 percentile	63.3	60.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Data File: 2010-05-28_16-00-00_000_RTA.xls

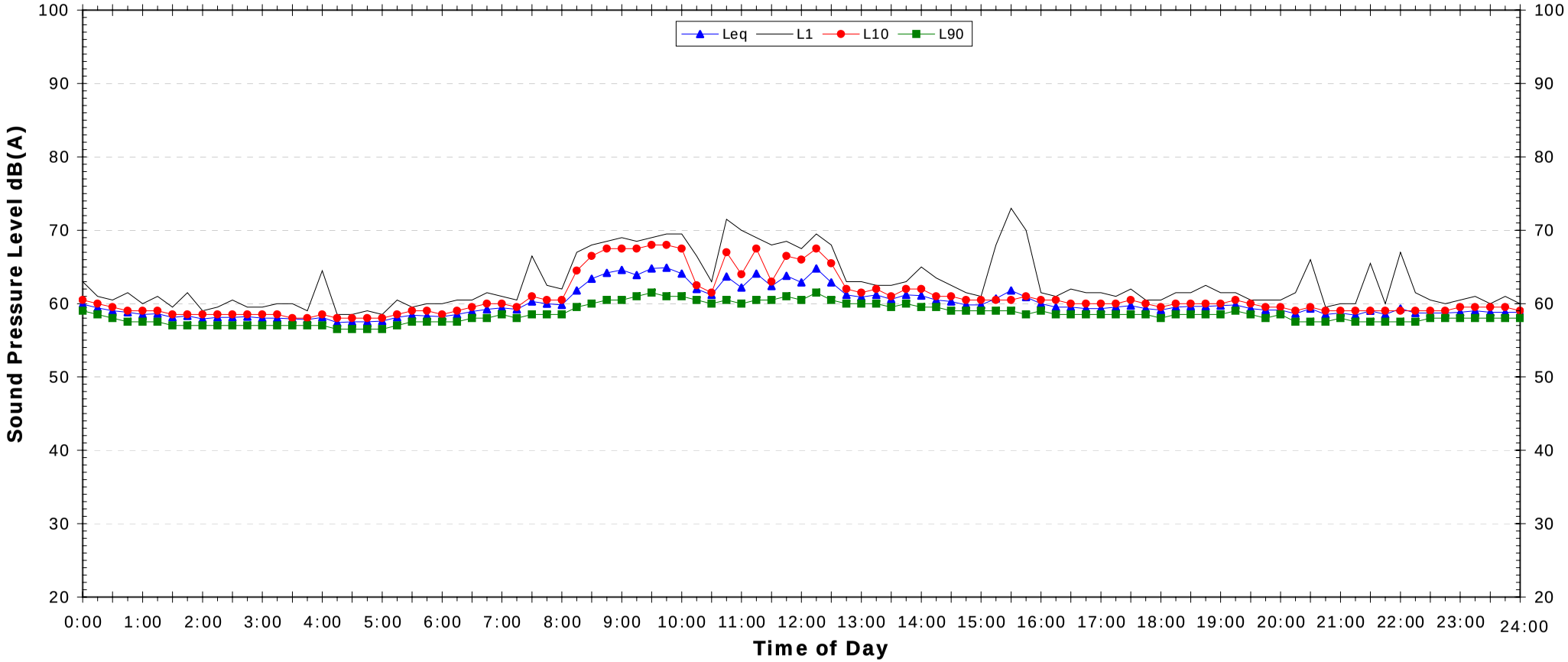
Template QTT-01 (rev 55) Logger Graphs

TE927-01S01 (rev 0) Location L2 Logger Graphs.xls

EXISTING AMBIENT NOISE LEVELS

Location L1 - Plaza Building Rooftop

Saturday, 29 May 2010



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	58.5	57.5	56.5
Leq (see note 3)	61.9	59.1	58.4

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

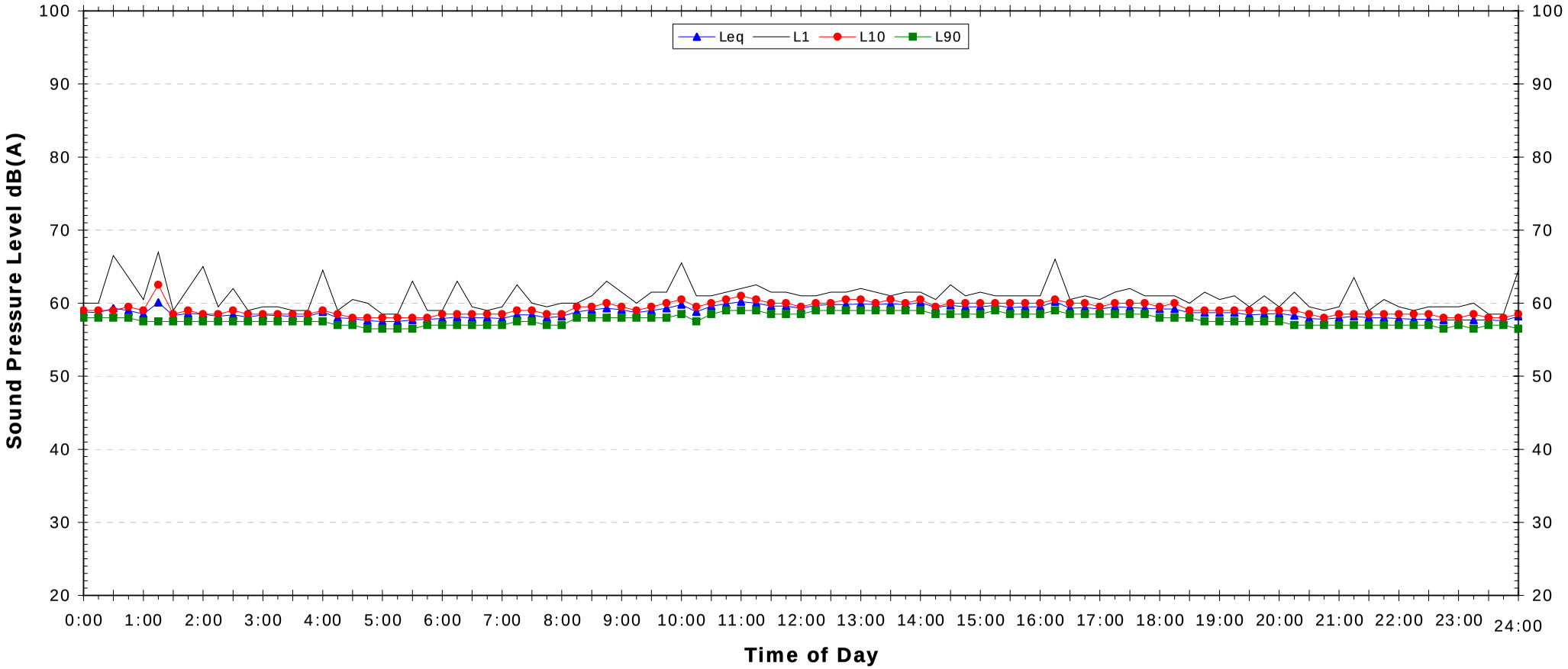
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	63.8	60.9
$L_{eq\ 1hr}$ upper 10 percentile	66.6	61.4
$L_{eq\ 1hr}$ lower 10 percentile	61.3	60.2

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

EXISTING AMBIENT NOISE LEVELS

Location L1 - Plaza Building Rooftop

Sunday, 30 May 2010



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	57.5	57.0	56.5
Leq (see note 3)	59.4	58.4	58.2

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.7	60.7
$L_{eq\ 1hr}$ upper 10 percentile	62.4	63.2
$L_{eq\ 1hr}$ lower 10 percentile	60.5	60.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Data File: 2010-05-28_16-00-00_000_RTA.xls

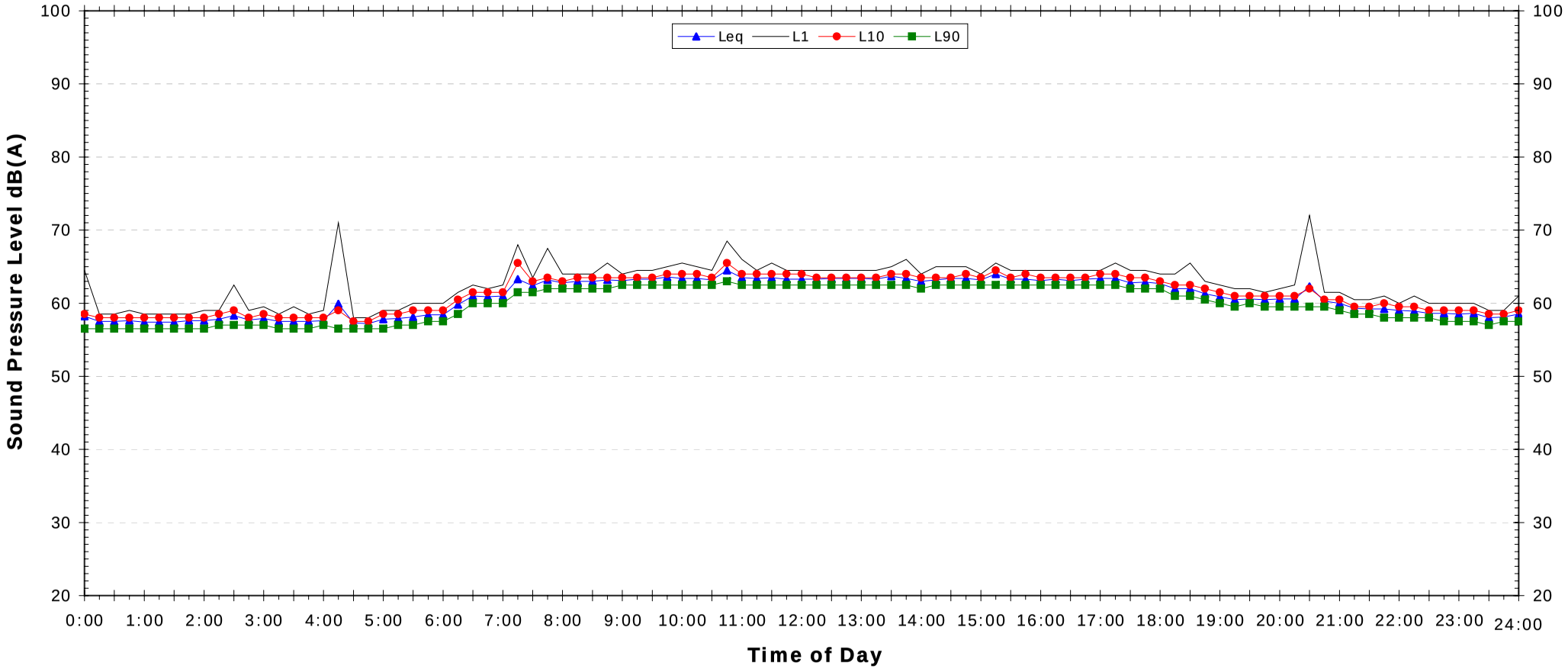
Template QTT-01 (rev 55) Logger Graphs

TE927-01S01 (rev 0) Location L2 Logger Graphs.xls

EXISTING AMBIENT NOISE LEVELS

Location L1 - Plaza Building Rooftop

Monday, 31 May 2010



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	62.0	58.0	57.0
Leq (see note 3)	63.3	60.6	58.5

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.2	61.0
$L_{eq\ 1hr}$ upper 10 percentile	66.1	63.0
$L_{eq\ 1hr}$ lower 10 percentile	62.4	60.2

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Data File: 2010-05-28_16-00-00_000_RTA.xls

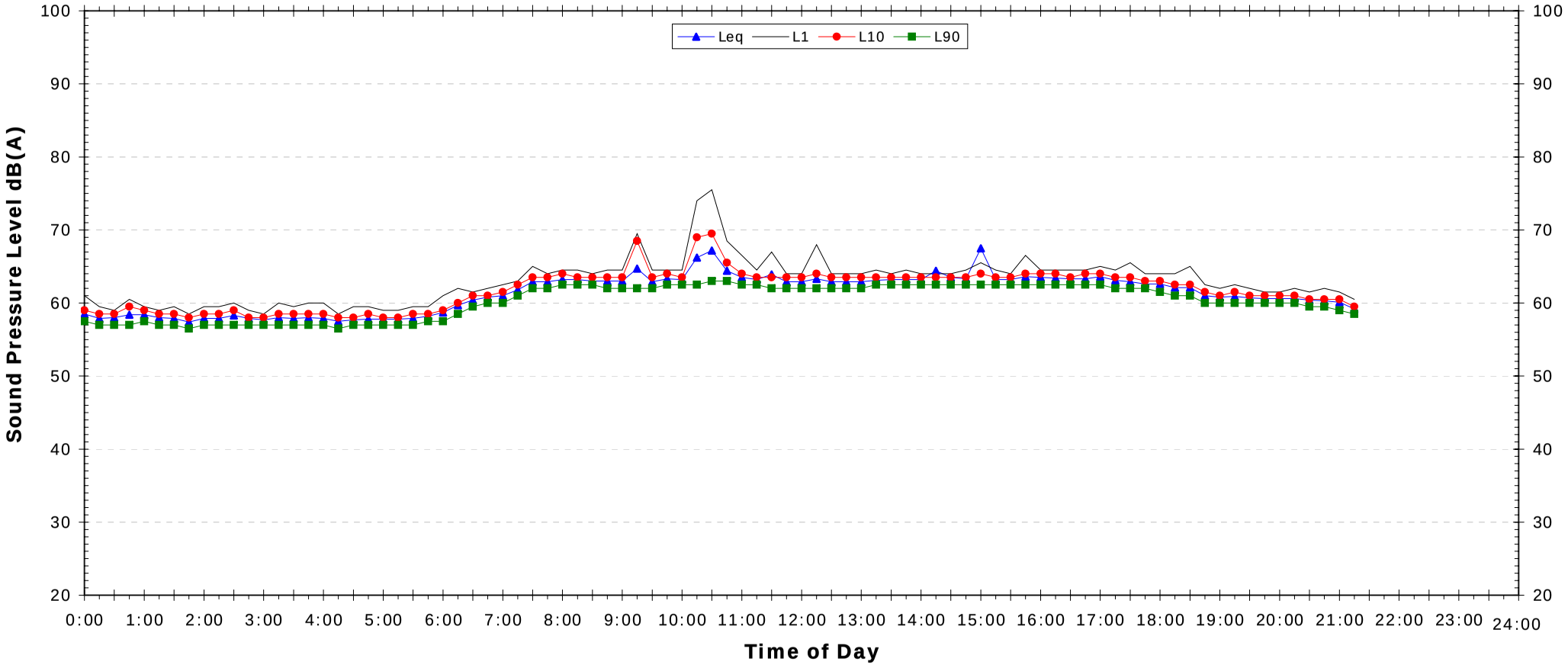
Template QTT-01 (rev 55) Logger Graphs

TE927-01S01 (rev 0) Location L2 Logger Graphs.xls

EXISTING AMBIENT NOISE LEVELS

Location L1 - Plaza Building Rooftop

Tuesday, 1 June 2010



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	62.0	59.0	-
Leq (see note 3)	63.6	60.8	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.6	-
$L_{eq\ 1hr}$ upper 10 percentile	67.8	-
$L_{eq\ 1hr}$ lower 10 percentile	62.3	-

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Data File: 2010-05-28_16-00-00_000_RTA.xls

Template QTT-01 (rev 55) Logger Graphs

TE927-01S01 (rev 0) Location L2 Logger Graphs.xls