

SSDA10 NORTH PLOT AND SQUARE

Acoustic Assessment

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Lendlease

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1 Introduction

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

The Application (referred to as SSDA 10) follows the approval of a staged SSD DA (SSDA 2) in December 2013. SSDA 2 sets out a Concept Proposal for a new mixed use neighbourhood at Haymarket, now called Darling Square. Darling Square forms part of the Sydney International Convention, Exhibition and Entertainment precinct (SICEEP).

More specifically this subsequent DA seeks approval for the construction and use of a mixed use development within the North development plot of Darling Square and public domain works for the new 'Square'.

1.1 Overview of proposed development

The proposal relates to a detailed ('Stage 2') DA for a mixed use development in the North Plot of Darling Square together with domain works for the new Square. The Darling Square Site more broadly is to be developed for a mix of residential and non-residential uses, including but not limited to residential buildings, commercial, retail, community and public space. The North Plot is one of six development plots identified within the approved Concept Proposal.

Under the Concept Proposal, the North Plot is planned to accommodate a small scaled mixed use building. More specifically, this SSD DA seeks approval for the following components of the development:

- Construction and use of a mixed use building including retail, commercial, food and beverage offerings and community uses;
- Public domain and landscaping improvements comprising the creation of a new Square which links with new pedestrian connections, including laneways and the Boulevard; and
- Extension and augmentation of physical infrastructure / utilities as required.

1.2 Background

The NSW Government considers that a precinct-wide renewal and expansion of the existing convention, exhibition and entertainment centre facilities at Darling Harbour is required, and is committed to Sydney reclaiming its position on centre stage for hosting world-class events with the creation of SICEEP.

In December 2012, following an extensive and rigorous Expressions of Interest and Request for Proposals process, Darling Harbour Live (a consortium comprising Lendlease, Hostplus, Capella Capital, AEG Ogden and Spotless) and Lendlease were announced by the NSW Government as the preferred proponent to transform Darling Harbour and create SICEEP.

Key features of the Preferred Plan include:

- Delivering world-class convention, exhibition and entertainment facilities, including:
 - Up to 40,000m² exhibition space;
 - Over 8,000m² of meeting rooms space, across 40 rooms;
 - Overall convention space capacity for more than 12,000 people;
 - A ballroom capable of accommodating 2,000 people; and
 - A premium, red-carpet entertainment facility with a capacity of 8,000 persons.
- Providing a hotel complex at the northern end of the precinct.
- A vibrant and authentic new neighbourhood at the southern end of the precinct, now called 'Darling Square', including apartments, student accommodation, shops, cafes and restaurants.
- Renewed and upgraded public domain that has been increased by a hectare, including an outdoor event space for up to 27,000 people at an expanded Tumbalong Park; and
- Improved pedestrian connections linking to the proposed Ultimo Pedestrian Network (now The Goods Line) drawing people between Central, Chinatown and Cockle Bay Wharf as well as east-west between Ultimo/Pymont and the City.

On 21 March 2013 a critical step in realising the NSW Government's vision for the SICEEP Project was made, with the lodgement of the first two SSD DAs with the (now) Department of Planning and Environment. The key components of these proposals are outlined below.

1.2.1 Public-Private Partnership SSD DA (SSD 12_5752)

The Public-Private Partnership (PPP) SSD DA (SSDA 1) includes the core facilities of the SICEEP Project, comprising the new, integrated and world-class convention, exhibition and entertainment facilities along with ancillary commercial premises and public domain upgrades. SSDA1 was approved on 22 August 2013.

1.2.2 Concept proposal (SSD 13_5878)

The Concept Proposal SSD DA (SSDA 2) establishes the vision and planning and development framework which will be the basis for the consent authority to assess detailed development proposals within the Darling Square Site. SSDA2 was approved on 5 December 2013. The Stage 1 Concept Proposal approved the following key components and development parameters:

- Indicative staging of demolition and development of future development plots;
- Land uses across the site including residential and non-residential uses;
- Street and laneway layouts and pedestrian routes;

- Open spaces and through-site links;
- Six separate development plots, development plot sizes and separation, building envelopes, building separation, building depths, building alignments, and benchmarks for natural ventilation and solar access provisions;
- A maximum total gross floor area (non-residential and residential GFA);
- Above ground car parking including public car parking;
- Residential car parking rates;
- Design Guidelines to guide future development and the public domain; and
- A remediation strategy.

The Concept Proposal was modified on 26 November 2015 to increase the amount of non-residential GFA. This minor increase in GFA was allocated to the approved North-West Plot building to meet tenant requirements. In addition to the approval of SSDA2, the following approvals have been granted for various stages of Darling Square site:

- Darling Drive (part) development plot (SSDA3) for the construction and use of a residential building (student accommodation) and the provision of associated public domain works approved on 7 May 2014;
- North-West development plot (SSDA4) for the construction and use of a mixed use commercial development and public car park building and associated public domain works approved on 7 May 2014; and
- South-West development plot (SSDA5) – construction and use of a mixed use residential development and associated public domain works approved on 21 May 2014.
- North-East development plot (SSDA7) – construction and use of a mixed use residential development and associated public domain works approved on 16 April 2015.

Approval was also granted on 15 June 2014 for SSDA6 which includes the construction and use of the International Convention Centre (ICC) Sydney Hotel and provision of public domain works. Approval was also granted for SSDA8 on 16 October 2015 which comprised the ICC Hotel fitout, external lighting and subdivision.

This report has been prepared to support a detailed Stage 2 SSD DA for the mixed use development and public domain works within Darling Square (SSDA 10), consistent with the Concept Proposal (SSDA 2).

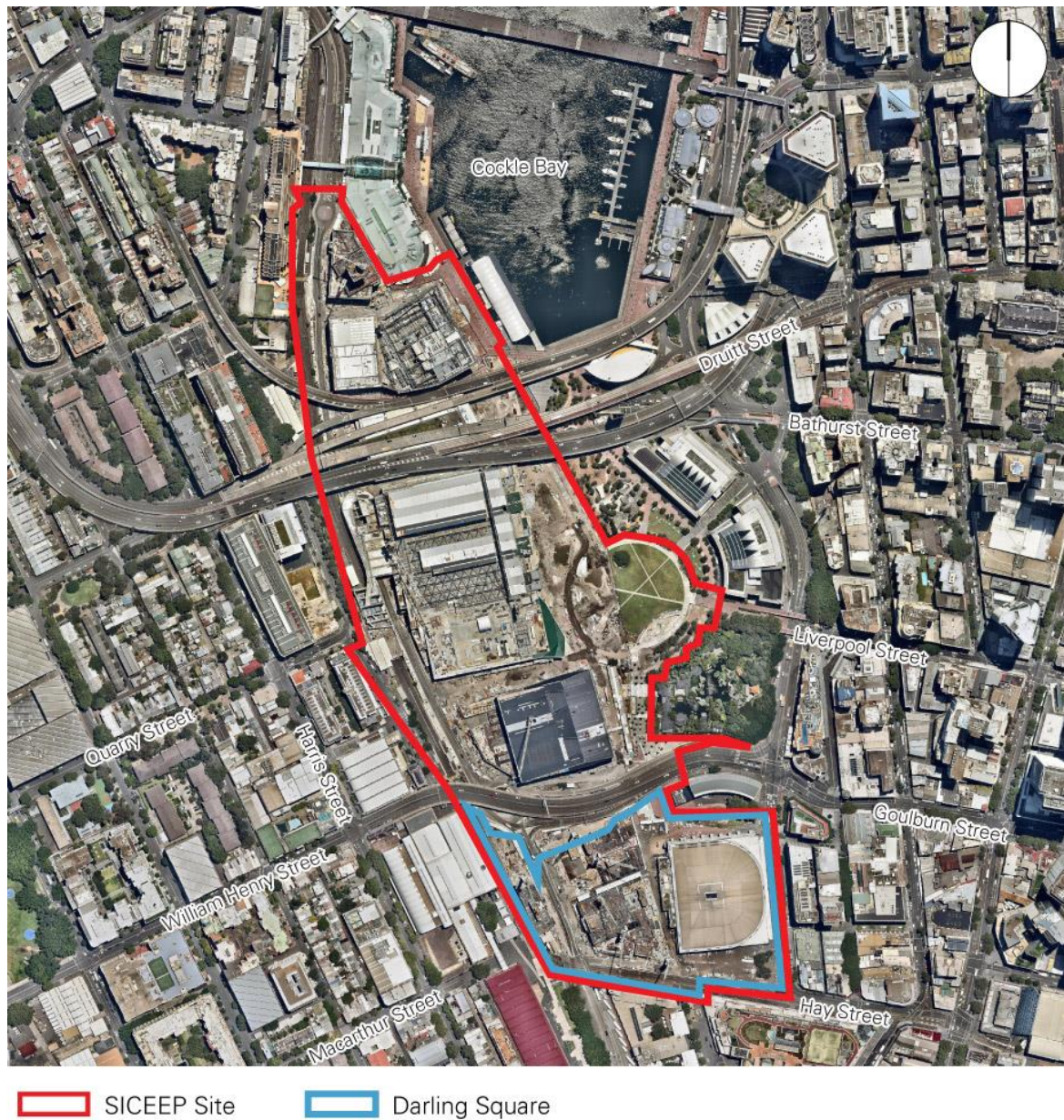
1.3 Site description

The SICEEP Site is located within Darling Harbour. Darling Harbour is a 60-hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the light rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south (refer to Figure 1). The Darling Square Site is:

- located in the south of the SICEEP Site, within the northern portion of the suburb of Haymarket;
- bounded by the Powerhouse Museum to the west, the Pier Street overpass and Little Pier Street to the north, Harbour Street to the east, and Hay Street to the south; and
- irregular in shape and occupies an area of approximately 37,700m².

Figure 1: Aerial photograph of the SICEEP site

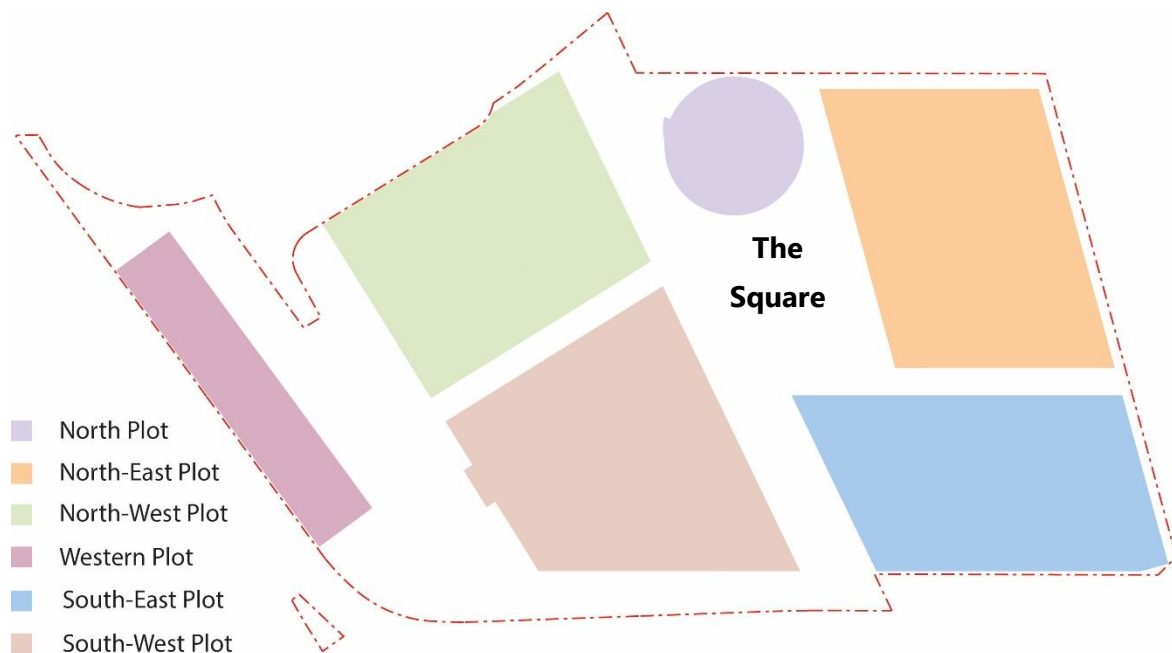


The Concept Proposal DA provides for six (6) separate development plots across the Darling Square Site (refer to Figure 2):

1. North Plot;
2. North East Plot;
3. South East Plot;
4. South West Plot;
5. North West Plot, and;
6. Western Plot (Darling Drive).

The Application Site area relates to the North Plot and adjoining 'Square' as detailed within the architectural and landscape plans submitted in support of the DA.

Figure 2: Concept proposal development plots



1.4 Planning approvals strategy

The SICEEP Project has resulted in the lodgement of numerous SSD DAs for the various components of the redevelopment project. Future applications will continue to be lodged in accordance with the Concept Proposal SSD DA for the remaining development plots of the Darling Square Site.

1.5 Acoustic assessment requirements

Renzo Tonin & Associates has been engaged to prepare a construction and operational noise and vibration assessment for SSDA 10 (the North Plot) which provides further detailed assessment following the concept plan application submitted for Darling Square.

This report presents an assessment of noise and vibration, in accordance with the Secretary's Environmental Assessment Requirements (SEARs), and in relation to:

- Demolition and construction noise (see Part B of this report)
- Operational noise emission from the site such as mechanical services, child care centre, library, retail uses and public realm (see Part A of this report), and
- Noise onto noise sensitive uses within the proposal from external sources such as traffic (see Part A of this report).

The report has been prepared on the basis of the following design drawings:

- Kengo Kuma & Associates DA Drawing Package dated 18 February 2016.

1.5.1 Secretary's Environmental Assessment Requirements (SEARs)

The Secretary's Environmental Assessment Requirements (SEARs) issued by the Department of Planning and Environment for application number SSD 7021 specifically requires:

The EIS shall 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.

Relevant Policies and Guidelines:

- *NSW Industrial Noise Policy (EPA (EPA, 2000)*
- *Interim Construction Noise Guideline (DECC, 2009)*
- *Assessing Vibration: A Technical Guideline (DEC, 2006)*
- *Environmental Criteria for Road Traffic Noise (EPA, 1999)*

Relevant policies also set out in Item 1 of the SEARs include:

- *State Environmental Planning Policy – Infrastructure 2007*
- *Development Near Rail Corridors and Busy Road-Interim Guideline*
- The above policies and guidelines have been addressed in this report as follows:

Policy or guideline	Assessment outline	Report section
NSW Industrial Noise Policy (EPA, 2000)	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 construction phase of the development and its potential impact on surrounding development.	Sections 5, 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. Also referenced in the State Environmental Planning Policy – Infrastructure 2007 with regard to rail vibration.	Sections 5, 6 and 7 Section 4.3
Environmental Criteria for Road Traffic Noise (EPA, 1999)	Assessment of road traffic generated by the development on the local road network and its potential impact on surrounding development.	Section 3.2.4
State Environmental Planning Policy – Infrastructure 2007	Assessment of noise onto the development from busy roads and rail corridors.	Section 4
Development Near Rail Corridors and Busy Road-Interim Guideline	Supporting guideline for the State Environmental Planning Policy – Infrastructure 2007.	Section 4

1.6 Scope of assessment

Further to the Concept Plan Application (SSDA2) acoustic assessment, this report sets out a more detailed assessment and consideration of the specific construction and operational noise and vibration aspects of the North Plot development. The following outlines the scope of acoustic assessment for the North Plot 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 North Plot, in accordance with the SEARs,
 - Identify the sensitive receiver locations, including existing receivers affected by construction works, and future receivers affected by operations, and
 - Confirm the existing noise environment at surrounding receiver locations and quantify the applicable noise targets for the North Plot.
- 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 and nearest sensitive receivers

2.1 Nearest sensitive receivers

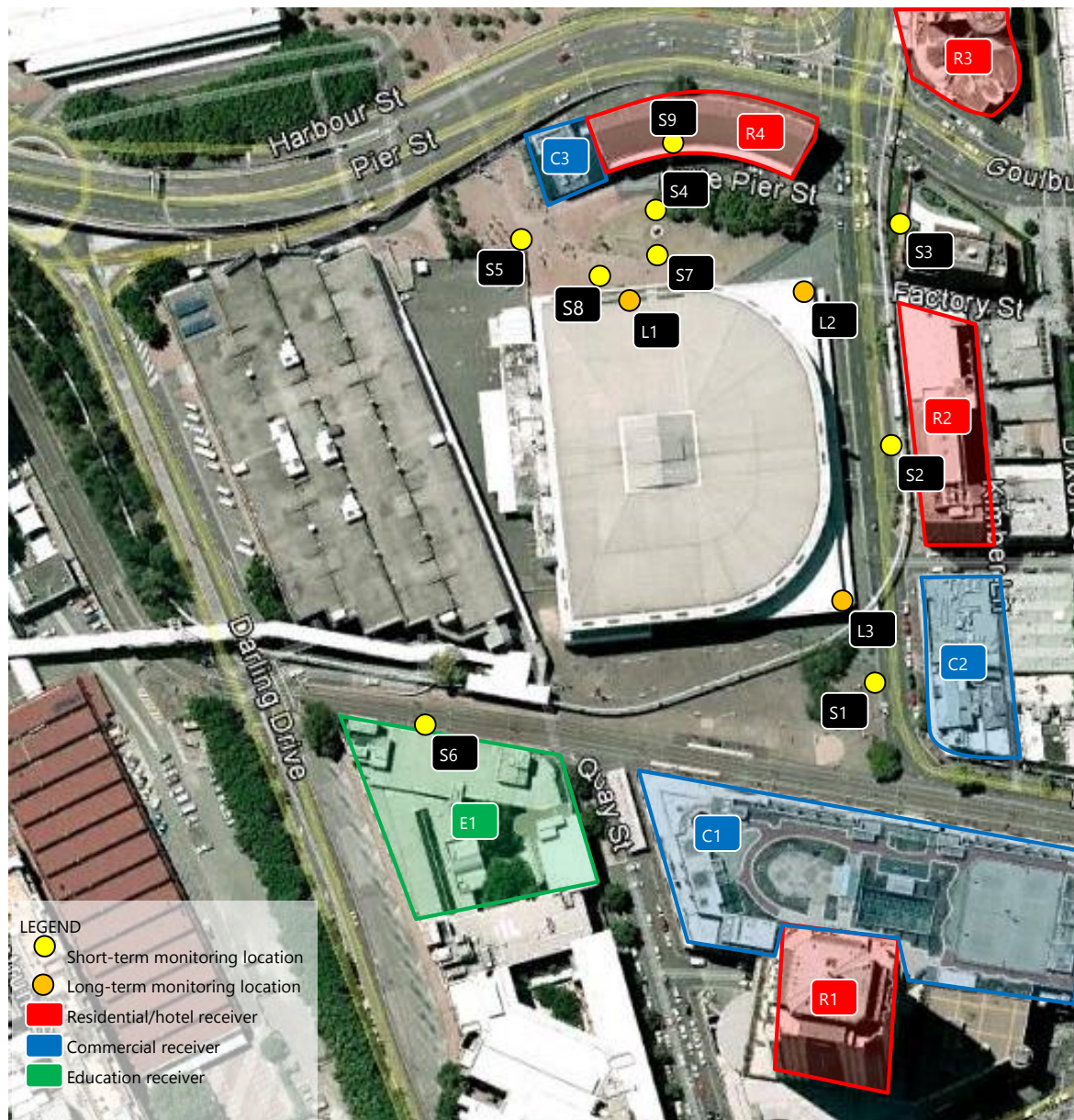
The nearest potentially affected receivers to the Darling Square site are presented in Figure 3. While not all receivers are directly relevant to the assessment of the North Plot, as cumulative impacts of both operational and construction noise has been considered, all surrounding receptors as identified in the Concept Plan have been outlined.

Figure 3 on the following page presents the site and surrounds of the study area along with the assessment locations and measurement locations detailed in this Section.

Table 1: Receiver locations

Receiver ID	Receiver location	Distance from boundary of Site (approx. m)
Residential/hotel receivers		
R1	The Peak Apartments (Market City) - 2 Quay St	70
R2	Holiday Inn Hotel - 68 Harbour St	25
R3	Southern Cross on Harbour (Seasons Darling Harbour) - 38 Harbour St	75
R4	Novotel Rockford Hotel - 17 Little Pier St	30
Commercial receivers		
C1	Market City - 9-13 Hay St	20
C2	Restaurants on Harbour St, between Hay St & Goulburn St	25
C3	Pumphouse - (Heritage building) - 17 Little Pier St	15
Other sensitive receivers		
E1	UTS - Quay St	80

Figure 3: Locality map showing receiver and measurements locations



2.2 Existing noise environment

Noise impact at existing residential receiver locations is assessed against noise goals established from the existing noise environment of the area prior to the subject development. Appendix B of the NSW EPA Industrial Noise Policy (INP) presents two methods of determining the background noise levels of an area being 'B1 - Long-term background noise method' and 'B2 - Short-term background noise method'. For the subject assessment, a combination of long-term and short-term noise monitoring was undertaken to establish the existing acoustic environment.

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW *Industrial*

Noise Policy (EPA, 2000) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The INP defines these periods as follows:

- **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.

2.2.1 Long-term noise monitoring

Long-term noise monitoring was carried out from Wednesday, 10 September 2014 to Wednesday, 17 September 2014. The long-term noise monitoring methodology is detailed in Appendix C, and noise level-vs-time graphs of the data are included in Appendix D. The long-term noise monitoring locations are presented in Figure 3 above and Table 2.

Table 2: Long-term noise monitoring location

ID	Address	Description
L1	Sydney Entertainment Centre - North	Noise monitor was located on the lower roof level of the Entertainment Centre. The microphone was positioned 1.85m above the awning in the 'free field', approximately 70m from the Harbour Street curb. Noise data represents the ambient and background noise levels for the northern extends of the north-east plot of Darling Square
L2	Sydney Entertainment Centre - North-East	Noise monitor was located on the lower roof of the Entertainment Centre. The microphone was positioned 1.85m above the awning in the 'free field', approximately 13m from the Harbour Street curb. Noise data represents the ambient and background noise levels for the north-eastern extends of the north-east plot of Darling Square
L3	Sydney Entertainment Centre - South-East	Noise monitor was located on the lower roof of the Entertainment Centre. The microphone was positioned 1.85m above the awning in the 'free field', approximately 54m from the Hay Street curb. Noise data represents the ambient and background noise levels for the south-eastern extends of the north-east plot of Darling Square

Existing background and ambient noise levels are presented in Table 3.

Table 3: Long-term noise monitoring results, dB(A)

Monitoring location	LA90 Rating Background Level (RBL)			LAeq Ambient noise level		
	Day	Evening	Night	Day	Evening	Night
L1 - Entertainment Centre - North	61	59	55	65	62	59
L2 - Entertainment Centre - North-East	61	59	53	64	63	60
L3 - Entertainment Centre - South-East	58	58	51	63	61	59

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

2.2.2 Short-term attended noise monitoring

To supplement the long-term noise monitoring, and provide greater detail of the noise environment surrounding the site, short-term noise measurement results have been relied upon. Measurements at the site were undertaken at the following locations during the daytime of Wednesday, 6 February 2013, night time of Friday, 8 February 2013, evening of Wednesday, 24 September 2014 and night time of Tuesday, 12 May 2015.

Table 4: Short-term noise monitoring locations

ID	Address	Description
S1	Harbour St, near Hay St, Haymarket	Western side of Harbour St, opposite Xi'an Cuisine restaurant, 5m from the curb, in the free field. Noise data represents the existing background and ambient noise incident on the proposed residential development in the south east corner of the precinct.
S2	Harbour St, Holiday Inn Hotel, Haymarket	Eastern side of Harbour St, 10m north of the Holiday Inn lobby entrance, 3.5m from the façade, in the free field. Noise data represents existing background and ambient noise for residents of the Holiday Inn hotel.
S3	Harbour St, near Goulbourn St, Haymarket	Eastern side of Harbour St, in front of the Harbour Plaza building, next to the entrance to the Red Chilli Sichuan Restaurant, 3.5m from the curb, in the free field. Noise data represents the existing background noise for the commercially used Harbour Plaza building.
S4	Novotel Hotel, Little Pier St, Haymarket (external)	South side of Little Pier St, opposite the Novotel lobby, 20m from building, in the free field. Noise data represents existing background noise for residents of the Novotel hotel.
S5	The Pumphouse Restaurant & Bar, Little Pier St, Haymarket	South side of Pumphouse building, public thoroughfare area, 15m from outdoor area of bar, in the free field. Noise data represents existing operational noise levels from licenced venue, incident on proposed residential development.
S6	UTS building, Quay St, Haymarket	North side of the UTS building, facing the light rail lines, 3.5m from the building façade, approximately 5m from the eastern side of the building, in the free field. Noise data represents existing background noise for the UTS educational building.
S7	Sydney Entertainment Centre	North side of Sydney Entertainment Centre, approximately 69m from the Harbour St curb and approximately 10m from the northern façade of the Sydney Entertainment Centre, in the free field. Noise data is representative of the existing background noise at the Novotel hotel.
S8	Sydney Entertainment Centre	North side of Sydney Entertainment Centre, approximately 80m from the Harbour St curb and approximately 5m from the northern façade of the Sydney Entertainment Centre, in the free field. Noise data is representative of the existing background noise at the Novotel hotel.
S9	Room 304, Novotel Hotel, Little Pier St, Haymarket (internal)	Measurement taken the centre of level 3 hotel room with air-conditioning running on a low setting with windows and doors closed. Noise data is considered representative of all hotel rooms within the Novotel

Notes: The equipment used for the noise measurements was a Brüel & Kjær Type 2250 precision sound level analyser which is a Class 1 instrument having an 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 detailed summary of the short-term measurement data is presented for reference in Appendix B.

2.3 Representative noise levels for sensitive receivers

Based on the noise monitoring results, representative background and ambient noise levels have been established for the standard day, evening and night INP assessment periods. This has been carried out for the residential receiver locations only.

Table 5: Representative background and ambient noise levels, dB

Monitoring location	L _{A90} Rating Background Level (RBL)			L _{Aeq} Ambient noise level			Representative Measurement ID
	Day	Evening	Night	Day	Evening	Night	
R1 - Peak Apartments	58	58	51	63	61	59	L3
R2 - Holiday Inn	61	59	53	64	63	60	L2
R3 - Southern Cross on Harbour	61	59	53	64	63	60	L2
R4 - Novotel	61	59	55	65	62	59	L1

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

PART A - 'Operational' noise assessment

This part of the noise assessment discusses noise impacts associated with the development once constructed, including:

- Noise emission impacts from the proposed North Plot and Square development onto noise sensitive receivers, and
- Road traffic noise intrusion impacts from Darling Drive, Harbour Street, Pier Street and Hay Street onto the North Plot.

3 Noise emission from the development

3.1 Operational details

3.1.1 Operating hours

The North Plot and Square is to contain various retail and community uses. At this early stage of the development, specific operating details of the individual uses are yet to be determined. However, the maximum trading hours for each floor and area have been determined and are provided in Table 6.

Table 6: Proposed operating hours

Floor	Area	Weekdays	Weekend
Square	Market Square/Retail Pods	7am - 11pm	7am - 11pm
Ground/Mezzanine	Market	7am - 11pm	7am - 11pm
First & second	Library	7am - 11pm	7am - 11pm
Third & fourth	Child care centre	7am - 7pm	-
Fifth floor	Food and drink - restaurant / bar	7am - 12am	7am - 12am

3.1.2 Operational assumptions

Table 7 sets out the operating assumptions for the various uses for the purpose of carrying out the assessment of potential noise impacts.

Table 7: Operational assumptions

Floor	Area	Patron/Children number	Description
Square	Markets/Retail Pods	Approx. 1 person per 1-1.5m ²	Area dominated by people noise. The Darling Square Management Plan (June 2015, Rev C) identifies general weekly use will involve market stalls between 8am to 2pm. Medium scale events that could include small music performances, while larger scale events might include community cinema or community concert. Both medium and large scale events would be of limited number per year. Retail Pods are expected to operate as small F&B uses.
Ground	Market/food hall	420* (Approx. 1 person per 2m ²)	Area dominated by people noise.
Mezzanine	Market/food hall	89*	Area dominated by people noise.
One and Two	Library	519*	The library is expected to be largely enclosed, and would nonetheless emit negligible noise from people within or located on external areas.
Third	Internal areas	30 x 0-2 year olds	

Floor	Area	Patron/Children number	Description
Fourth	Internal/external area	30 x 2-3years 30 x 3-5 years	90 children, in accordance with the maximum allowable number of children, as per the City of Sydney Councils DCP. The outdoor play areas have been sized to accommodate the full child population and therefore the worst case assessment of all children outside at one time has been assessed.
Fifth	Food and drinks (internal)	270 patrons - Assumed 1 patron per 1.5m ²	Assumed to include background music with open façade connecting to accessible terrace. Current drawings indicate openings between internal and external areas are limited to two double doors.
	Food and drinks (external)	260 patrons - Assumed 1 patron per 1.5m ²	External terrace approximately 335m ² .

Notes:

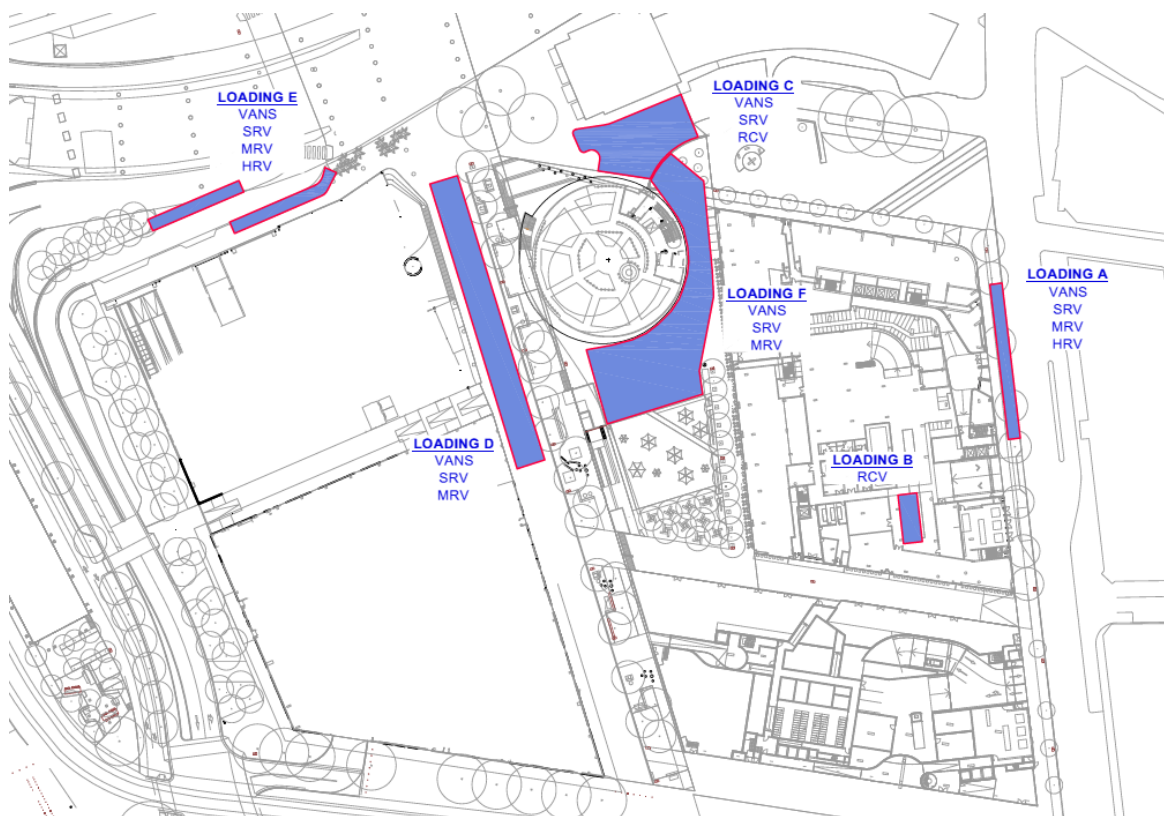
* - Patron numbers based on BCA assessment, Mackensie Group, BCA_069092-02BCAJH

3.1.3 Servicing and loading docks

Assessment has utilised information provided by TTM Pty Ltd, (15SYT0046TRep150609) which presents information regarding the proposed service vehicle arrangements. In regard to the acoustic assessment the key factors are the type of vehicles, number of activities in any 15-minute period, time of the day of activities and the proximity of loading bays to noise sensitive receptors.

The location and type of vehicles to be accommodated are identified in Figure 4, as prepared by TTM.

Figure 4: North Plot and Square Loading areas



Only loading areas A, C and F are deemed sensitive with regard to noise sensitive receptors external to the Darling Square site. For these loading areas, the impacts upon the NE Plot residential development also need to be considered. Loading area B, located below the NE Plot, and loading area E, to the north of the northwest commercial development are not deemed to be critical with regard to potential noise impact. Loading area D will also need to be managed with regard to potential impacts upon the Darling Square developments, particularly residential development within the SW and SE Plots.

The number and type of vehicles expected to use each of the loading bays at different times of the day is also presented in the traffic report, and has been reproduced in Table 8. The figures presented are assumed to represent the concurrent operations for the purpose of acoustic assessment.

Table 8: Loading time against use matrix

Land Use	Dock: Vehicle Type				
	05:00-08:00	08:00-11:00	11:00-15:00	15:00-18:00	18:00-20:00
Market	A: HRV C: SRV & Van D: MRV & Van E: HRV & MRV	-	-	-	A: HRV C: SRV & Van D: MRV & Van E: HRV & MRV
The Square	C: SRV & Van D: MRV & Van F: SRV & Van	-	-	-	C: SRV & Van D: MRV & Van F: SRV & Van
Food & Beverage	C: MRV & Van				
Library	-	1 van any time			-
Child care centre	-	1 van any time			-
Restaurant & Bar	-	C: MRV & Van	-	C: MRV & Van	-
Waste Removal	B: RCV C: RCV	B: RCV	B: RCV	B: RCV	-
Minimum Capacity	9 vans 1 SRVs 3 MRVs 1 HRV 2 RCV	1 vans 1 MRVs 1 RCV	1 vans 1 RCV	1 vans 1 MRVs 1 RCV	8 vans 1 SRVs 2 MRVs 1 HRV

Notes: HRV = Heavy rigid vehicle
 MRV = Medium rigid vehicle
 LRV = Light rigid vehicle
 Van (eg Toyota Hiace)
 RCV = Refuse collector vehicle
 SOURCE: TTM Pty Ltd Report 15SYT0046TRep150609

3.2 Operational noise criteria

3.2.1 EPA industrial noise policy

In accordance with the SEARs, noise impact from the general operation of the proposed development is to be assessed against the NSW Industrial Noise Policy (INP). In accordance with the INP, this would be

limited to industrial type noise sources such as mechanical plant and equipment servicing the building and loading dock operations. Noise from other uses, such as licensed premises are typically subject to other noise criteria discussed in Sections 3.2.2 and 3.2.4. The assessment procedure in terms of the INP has two components:

- Controlling intrusive noise impacts in the short term for residences
- Maintaining noise level amenity for particular land uses for residences and other land uses.

It is noted that the Concept Proposal (SSDA2) report set out the intrusiveness and amenity criteria for cumulative assessment of Darling Square. In the case of a large development site such as SICEEP, the cumulative impact of the development to the surrounding receivers should be considered and therefore Table 9 on the following page sets out the established noise criteria for the North Plot and Square. As it is the amenity criterion that addresses cumulative impact, the criteria is proportioned between the South West, North West, West, North East and South East Plots based upon the distance of each site from the relevant receptor locations. The noise goals for the individual Plots and public realm areas will be subject to review during the design development stage, as where lower noise contributions may be achievable from a specific development Plot, other Plots within Darling Square would be permitted to increase noise emission while still complying with the cumulative target. With the proximity of the site to the North East Plot, the allowable contributions determined in accordance with the amenity goals have been combined for the two sites, and are presented in Table 9 below.

Table 9: Darling Square - Industrial noise criteria

Receiver ID	Intrusiveness criteria, $L_{Aeq,15min}$ dB(A)			Amenity criteria ¹ , $L_{Aeq, period}$ dB(A)			
	Day	Evening	Night	Plot	Day	Evening	Night
R1 - The Peak	63	63	56	SW	53	46	44
				NW	47	40	38
				W	47	40	38
				NE/N	50	43	41
				SE	54	47	45
				TOTAL	58	51	49
R2 - Holiday Inn	66	64	58	SW	43	40	37
				NW	42	39	36
				W	40	37	34
				NE/N	54	51	48
				SE	50	47	44
				TOTAL	56	53	50
R3 - Seasons	66	64	58	SW	46	43	40
				NW	47	44	41
				W	45	42	39
				NE/N	53	50	47
				SE	49	46	43
				TOTAL	56	53	50

Receiver ID	Intrusiveness criteria, $L_{Aeq,15min}$ dB(A)			Amenity criteria ¹ , $L_{Aeq, period}$ dB(A)			
	Day	Evening	Night	Plot	Day	Evening	Night
R4 - Novotel Rockford	66	64	60	SW	45	41	38
				NW	48	44	41
				W	43	39	36
				NE/N	54	50	47
				SE	46	42	39
				TOTAL	56	52	49
C1 - Market City	-	-	-	SW	56		
				NW	52		
				W	51		
				NE/N	53		
				SE	64		
				TOTAL	65 (when in use)		
C2 - Restaurants on Harbour St	-	-	-	SW	47		
				NW	47		
				W	46		
				NE/N	61		
				SE	62		
				TOTAL	65 (when in use)		
C3 - Pumphouse	-	-	-	SW	52		
				NW	58		
				W	51		
				NE/N	63		
				SE	51		
				TOTAL	65 (when in use)		
C4 - The Powerhouse	-	-	-	SW	54		
				NW	56		
				W	64		
				NE/N	48		
				SE	48		
				TOTAL	65 (when in use)		
E1 - UTS	-	-	-	SW	33		
				NW	19		
				W	24		
				NE/N	18		
				SE	27		
				TOTAL	35 (when in use)		
North/ North West Plot*	63	63	56	-	-		

Note: * Lower noise criteria may be appropriate for areas of the development that are acoustically shielded from surrounding roads and other noise generating development (ie, facing central podiums). Applies at boundary of the receptor site.

Table 10 presents the basis of establishing the overall amenity noise criteria for Darling Square. Based on site observations the existing industrial noise contribution have been based on the measured background noise levels with equal proportioning between traffic and mechanical plant. The existing industrial noise levels have been used to modify the amenity criteria in accordance with Table 2.2 of the

INP. The high traffic noise environmental criterion has also been considered. No correction to the commercial premise criteria were determined to be required based on the measurement data.

Table 10: Existing industrial noise level for amenity criteria, dB(A)

Location	Time period	Existing RBL	Existing industrial noise	Existing $L_{Aeq}(traffic)$	INP base amenity criteria [^]	Modified criteria
R1 – Peak Apartments	Day	58	55	63	60	58
	Evening	58	55	61	50	51
	Night	51	48	59	45	49
R2 – Holiday Inn	Day	61	58	64	60	56
	Evening	59	56	63	50	53
	Night	53	50	60	45	50
R3 – Southern Cross on Harbour	Day	61	58	64	60	56
	Evening	59	56	63	50	53
	Night	53	50	60	45	50
R4 – Novotel	Day	61	58	65	60	56
	Evening	59	56	62	50	52
	Night	55	52	59	45	49

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
[^]Residential receiver locations categorised as Urban.

It is noted that recent approval for the NE Plot imposed criteria for mechanical plant equipment of background + 5dB(A), applicable at the boundary of the site. However, in accordance with the NSW Industrial Noise Policy, criteria are applied at the boundary of the receptor locations rather than the site boundary. Application of criteria at the site boundary imposes undue constraint, particularly where the building envelope is in close proximity to the site boundary, such as with the North Plot. Conditions of approval should therefore refer to the nearest receptor location.

3.2.2 Sleep disturbance criteria

Noise emanating from project has been assessed for its potential to disturb sleep. The NSW EPA (formerly DEC) has made the following policy statement with respect to sleep disturbance:

“Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.”

DEC reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, DEC recognised that current sleep disturbance criterion of an $L_{A1, (1 \text{ minute})}$ not exceeding the $L_{A90, (15 \text{ minute})}$ by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DEC will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or $L_{A1, (1 \text{ minute})}$, that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur;*
- time of day (normally between 10pm and 7am); and*
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*

The $L_{A1, (1 \text{ minute})}$ descriptor is meant to represent a maximum noise level measured under 'fast' time response. DEC will accept analysis based on either $L_{A1, (1 \text{ minute})}$ or $L_{A, (Max)}$."

The NSW EPA confirm that a sleep disturbance criterion of $L_{A1(1min)} \leq L_{A90(15min)} + 15\text{dB(A)}$, should only be used as a first step guide and where the criteria is not met, more detailed analysis is required. The Application Notes of the NSW Industrial Noise Policy (2010) note the detailed analysis should include:

- the extent to which the maximum noise level exceeds the background level
- the number of times this happens during the night-time period, and
- the time of day (normally between 10pm and 7am).

In addition, reference is made to Appendix B of the NSW ECRTN, which summarises the findings of international research undertaken on sleep disturbance from noise (up until 2009) and concludes:

"Considering all of the foregoing information the following conclusions can be drawn:

- Maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions.*
- One or two noise events per night, with maximum internal noise levels of 65-70dB(A), are not likely to affect health and wellbeing significantly."*

In regard to external noise levels, the maximum internal noise level 55dB(A) referenced in the ECRTN is equivalent to 65dB(A) outside an open window. It is noted that a 10dB(A) reduction from outside to

inside is common and typical noise reduction via an open window. The 65dB(A) external noise limit is consistent with the findings of Griefahn [*Acoustics Australia vol 20 No 2 August 1992 pp 43-47*].

In summary, the sleep disturbance criteria of $L_{A1(1min)} \leq L_{A90(15min)} + 15dB(A)$ is to be used for initial assessment. While consideration is usually given to the 'upper' limit criteria of 65dB(A), in this case the screening criteria of background + 15dB results in a higher noise criteria. It is noted that the background $L_{A90(15minute)}$ noise level used for establishing the sleep disturbance criteria does not need to exclude other noise from the subject premise.

3.2.3 Library and Child care centre - noise emission criteria

Operation of the library and child care centre has been assessed at noise sensitive receptors surrounding Darling Square against the intrusiveness noise criteria. Alternative noise criteria have been established for the assessment within Darling Square that balance noise controls between the noise generator and receptor buildings.

3.2.4 Food and drink area - noise emission criteria

Noise emission from licensed premises in NSW, such as restaurants, bars and clubs, should aim to comply with the standard noise criteria set by the NSW Office of Liquor, Gaming and Racing (OLGR). The OLGR criteria apply to all noise emission associated with activities from the licensed area of the premises, including music and patron noise, but excludes mechanical services equipment.

The OLGR, through the Liquor Act 2007, is the regulatory authority that deals with noise pollution issues pertaining to licensed premises. The OLGR recommends the use of their standard noise criteria when assessing noise impact from licensed premises and when determining the occurrence of noise nuisance and annoyance. Noise emissions are assessed in terms of the noise limits set out in the OLGR's 'Standard Noise Condition' which states as follows:

As the Market and restaurant/bar use on Level 5 are to be licensed, reference is made to the NSW Office Liquor, Gaming and Racing (OLGR) standard noise conditions. It is noted that the following criteria is considered applicable only to existing receivers surrounding the site. Alternative noise criteria have been established for the assessment within the redevelopment site that balance noise controls between the noise generator and receptor buildings.

"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.*

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.*

Notwithstanding compliance with the 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.

Interior noise levels which still exceed safe hearing levels are in no way supported or condoned by the NSW Office of Liquor, Gaming and Racing.

This is a minimum standard. In some instances the Board may specify a time earlier than midnight in respect of the above condition.

**For the purposes of this condition, the LA10 can be taken as the average maximum deflection of the noise emission from the licensed premises."*

3.3 Loading/service area assessment

3.3.1 Assessment locations

Only loading areas A and C are deemed sensitive with regard to noise sensitive receptors external to the Darling Square development site. It is noted however that loading dock A is in a public street. For these loading areas, the impacts upon the NE Plot residential development also need to be considered.

Loading area B, located below the NE Plot, and loading area E, to the north of the northwest commercial development are not deemed to be critical with regard to potential noise impact. Loading area D will need to be managed with regard to potential impacts upon the Darling Square developments, particularly residential development within the SW and SE Plots.

3.3.2 Noise goals

Due to the short-term intermittent activities associated with loading area, the assessment has been carried out against the NSW INP intrusiveness criteria, as well as consideration of potential sleep disturbance during the night time period (10pm to 7am).

3.3.3 Noise sources

It is expected that general loading and unloading will be by manual handling and therefore the primary noise sources are associated with the vehicles.

3.4 Loading activities

The source noise levels for loading area activities have been based on previous measurements conducted by Renzo Tonin and Associates and are presented in Table 11.

Table 11: Loading area source noise levels

Noise Source	Metric	Overall dBA/dBC	Octave Band Centre Frequency - Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
Truck - reversing alarm (5km/h – L _w per metre) [^]	L _{Aeq,15min}	64	68	70	69	60	58	57	59	48	39
Truck – small rigid accelerating and moving (5km/h – L _w per metre)	L _{Aeq,15min}	64	78	71	62	63	60	59	58	52	46
Light vehicle moving (10km/h), L _w per metre	L _{Aeq,15min}	49	63	63	52	47	45	42	43	37	33
	L ₁	85	122	95	96	81	80	76	76	74	70
Vehicle door closing, L _w	SEL	84	96	94	87	80	80	77	77	75	71
	L ₁	100	112	110	103	96	96	93	93	92	87
Vehicle engine starting, L _w	SEL	90	98	99	92	85	83	82	84	81	79
	L ₁	100	108	109	102	95	93	92	94	91	89

Notes: [^] Noise level corrected by +5dB(A) for calculations to account for tonality of noise source.

3.4.1 Predicted noise levels and discussion

Predictions set out in Table 12 and Table 13 conservatively assume no acoustic shielding for intervening structures such as awnings that may be part of the NE and SW plots, which would be expected to reduce noise from Loading areas A and D. Assessment is carried out to external locations, which is also deemed conservative.

Table 12: Intrusiveness noise assessment

Assessment location	Loading area, Predicted noise level, L _{Aeq(15minute)}				Noise criteria, L _{Aeq 15 minute (night)}
	A	C	D	F	
Novotel (external)	43	51	-	36	60
NE Plot (external)	54	50	41	52	60
SW Plot (external)	-	-	58	37	60

Table 13: Sleep disturbance noise assessment

Assessment location	Loading area, Predicted noise level, L _{Aeq(15minute)}				Noise criteria, L _{A1 1 minute (night)}
	A	C	D	F	
Novotel (external)	64	64	-	58	70
NE Plot (external)	76	63	54	73	70
SW Plot (external)	-	-	74	58	70

Assessment against the intrusiveness noise criteria reveals compliance for all loading areas while there is the potential for sleep disturbance impacts from use of Loading areas A, D and F with regard to the SW and NE Plot residential premises. For loading area A, given that the location is along Harbour St, it is expected that normal traffic noise and activities along the road frontage will be comparable in level and character. Therefore loading areas D and F, located within the Square, are considered most sensitive. Restricting access to the bays located in immediate proximity of residential uses during the night time

period (10pm-7am) should be considered. With regard to Location D parking could be limited to areas in front of the commercial development in the NW Plot. In addition, it is recommended that RCV bays in Loading area C be located as far west as practical, to maximise the distance to the NE plot and Novotel. RCV bays in Loading area B should be utilised as far as practical in lieu of the external locations.

3.5 Market, restaurant/bar, library and child care centre assessment

3.5.1 Assessment locations

Figure 3 above presents the locality map displaying the nearest existing sensitive receivers. Note is made that the Novotel (assessment location R4) is likely to be the most sensitive of the existing receivers. As noted above, the standard noise criteria is considered applicable only to existing receivers surrounding the Darling Square site. Alternative noise criteria have been established for assessment to new residential receivers within Darling Square that balance noise controls between the noise generator and receptor buildings in accordance with the principles established in the Concept Plan (SSDA2) acoustic assessment. Also, consistent with the SSDA2 assessment, noise levels at future residential receivers within Darling Square are predicted to be no more than $L_{Aeq15minute}$ 70dB ('free-field'). These noise levels would occur generally at the lower levels closest to the retail uses and public realm (Square), however may also occur in proximity to the rooftop restaurant/bar of the North Plot.

3.5.2 Noise goals

The octave band noise goals for the nearest sensitive receivers have been established from the criteria outlined in Section 3.1.3 and the measured background noise levels presented in Appendix B. The noise goals are presented in Table 14.

Table 14: Internal noise goals, L_{10}

Assessment locations	Assessment Period	Octave band centre frequency - Hz (dBZ)								
		31.5	63	125	250	500	1k	2k	4k	8k
R4 - Novotel Rockford Hotel (internal)	07:00-19:00 (Child care centre)	49	45	44	42	38	33	28	22	16
	07:00-midnight (Market/food & drink)	51	47	46	44	40	35	30	24	18

3.5.3 Source noise levels

The source noise levels used for the market/food hall and restaurant/bar area predictions were obtained from measurement of similar types of development. For the market food/hall, the noise levels are approximately equivalent to 50% of people talking with a raised voice but including corrections for the reverberant environment. Noise emissions from the library are deemed negligible and inconsequential to overall noise emission from the site and therefore not include in the quantitative assessment. The source noise levels adopted for the assessment of the market/food hall and the level 5 restaurant/bar are presented in Table 15.

With regard to the Square, operations of general weekly use of market stalls would generally be determined by patron noise for which estimated noise levels are presented in Table 15. Other uses such as outdoor cinemas and community concerts are proposed however for a limited number of times per year. The noise predictions demonstrate that with regard to external sensitive receivers (such as the Novotel), there is scope for higher noise emission uses than a market stall. The primary location however for management of noise from the Square will be the future residential uses within the Darling Square precinct. It is recommended that a detailed noise management plan be developed for the operations of the Square, which would set the acceptable parameters for noise emission at the future residential developments. As outlined in the Darling Square management plan, proposed special events would require approval by SHFA.

The source noise levels for children playing and other activities in the centre have been based on previous measurements conducted by Renzo Tonin and Associates. The sound power levels recommended in the Association of Australian Acoustical Consultants (AAAC) Guideline for Child Care Centre Acoustic Assessment were used in the calculations for the accessible terrace area.

The sound power levels obtained from the guideline are adjusted to take into consideration the number of children for the age group 3-6yrs old, to enable prediction of noise levels to receiver locations. The noise levels associated with the age group of 3-6yrs old are considered to be more conservative than those associated with younger age groups. The source noise levels are based on the outdoor areas being used for active play (e.g. children free play). Noise levels will be lower when the outdoor play areas are used for passive type activities (e.g. learning activities such as story reading).

Table 15: Source noise levels for operational noise assessment

Area	Applicable noise source	Overall dB(A)	Octave band centre frequency - Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
Grd/L1 Market hall	Patrons (Internal spatial L_p L_{eq})	74	69	71	73	70	72	71	66	61	53
Ground market stalls / Pods	Patrons (L_p @ 1m L_{eq}) - distributed 1 person per 2m ² 30% people talking	65	-	-	54	59	64	58	54	49	43
Restaurant/bar (internal)	Internal patrons with background music (L_p L_{10})	84	70	72	72	73	81	81	77	70	68
Restaurant/bar (external)	Patrons without music, Per person (L_w L_{10})	79	-	67	67	72	78	75	70	62	51
Childcare	30 x 0 - 2 year olds - L_w	85	-	-	-	-	76	80	80	76	70
	30 x 2 - 3 year olds - L_w	92					83	87	87	83	77
	30 x 3 - 5 year olds - L_w	95					86	90	90	86	80

3.5.4 Noise predictions

External noise predictions have been carried out using Soundplan v7.3 noise modelling software implementing ISO9613 algorithms. The noise model assesses acoustic losses due to distance, shielding by intervening structures and reflections off surrounding buildings. The external noise prediction results are presented in Table 16. While criteria for the child care centre and food/drink premises are based on

L_{eq} and L_{10} parameters respectively, the noise levels have been combined for a cumulative assessment and assessed against the most stringent noise criteria.

Table 16: External noise prediction summary

Assessment location	Noise source	Overall dB(A)	Octave band centre frequency – Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
R4 - Novotel Rockford Hotel (external)	Market hall (L_{10})	53	48	53	52	49	51	49	44	38	26
	Square / Pods (L_{10})	40	-	-	32	37	41	35	30	23	8
	90 children on outdoor terraces of child care centre (L_{eq})	53	-	-	-	-	44	48	48	45	39
	Restaurant/bar (internal) (L_{10})	50	44	44	41	40	47	47	42	32	23
	Restaurant/bar (external) (L_{10})	52	-	44	43	46	51	47	41	32	16
	CUMULATIVE EXTERNAL TOTAL	58	49	54	53	51	55	54	51	46	39
R4 - Novotel Rockford Hotel (internal)	CUMULATIVE INTERNAL TOTAL *	20	29	30	25	19	17	18	15	1	<0
	CRITERIA	-	49	45	44	42	38	33	28	22	16

Notes:

* Calculations via façade based on measured parameters on site, including window size (1.2m x 1.4m) and room size (5m x 3.1m), and glazing thickness 10mm float glass in fixed frame (estimated R_w33).

3.5.5 Recommendations

Based on the assessment of proposed operations, noise from operational activities associated with the North Plot and Square are predicted to comply at the nearest most potentially affected development external to the SICEEP development. Noise levels at future residential development within the Darling Square development are predicted to be no higher than $L_{Aeq15minute}$ 70dB, consistent with the principles and assessment presented in the Concept Plan (SSDA2) acoustic report. Noise management measures and controls for the various operations will however need to be established to ensure noise from individual tenancies is controlled to not exceed these noise levels. These matters will need to be addressed during the detailed design of the development.

4 Noise intrusion onto the development

4.1 Noise intrusion criteria

4.1.1 Child care centre

In the absence of specific criteria outlined in the SEARs, guidance is taken from the City of Sydney Council's Development Control Plan (DCP) 2012, which includes:

Section 4 Development Types

4.4 Other Development Types and Uses

4.4.4 Child care centres

4.4.4.5 Control of noise impacts to child care centres

An operational Plan of Management is to be submitted with any application to allow consideration of potential noise impacts

The repeatable maximum LAeq1hour) must not exceed 40 dBA (Leq1hr) within the internal spaces of the child care centre

An acoustic assessment, including recommended noise attenuation measures and prepared by a suitable qualified acoustic consultant must be submitted with the development application to demonstrate that these provisions can be achieved.

4.1.2 All other floors

It is advised that there are no statutory criteria applicable to noise intrusion into a retail or community use premises. Nevertheless, the impact of noise intrusion into the library can be addressed through the design of the building envelope, with reference to relevant Australian Standards to set appropriate criteria. Assessment and determination of suitable materials and construction methods for the building envelope, particular separating floors will be determined at the detailed development stage for the North Plot.

4.2 Road traffic

Future road traffic surrounding proposed SICEEP development was assessed in the Hyder Traffic and Transport Assessment prepared for the SSDA2 application. The report included existing and future traffic flows for the roads surrounding the precinct.

The roads providing access around the SICEEP precinct are classed as arterial and sub arterial roads, and will retain these classifications upon development, incorporating any increase in traffic flow. The Hyder

report examines the cumulative impact of traffic resulting from the entire SICEEP development, however assessment described in this report is focussed specifically on The Darling Square. The roads surrounding The Darling Square include:

- Hay Street;
- Harbour Street;
- Pier Street; and
- Darling Drive.

Table 17 provides a summary of the existing and predicted traffic flows for The Darling Square from the Hyder report.

Table 17: Traffic flows

Location	Existing (vehicles/hr)	Future growth + Development (vehicles/hr)
Friday pm Peak Period		
Hay St - West of Sussex St	465	667
Harbour St - South of Goulburn St	468	538
Pier St - East of Darling Dr	987	1314
Pier St - West of Harbour St	2503	2836
Darling Dr - South of Pier St	674	1046
Saturday pm Peak Period		
Hay St - West of Sussex St	465	635
Harbour St - South of Goulburn St	439	510
Pier St - East of Darling Dr	1175	1500
Pier St - West of Harbour St	2241	2571
Darling Dr - South of Pier St	728	1046

4.3 Noise intrusion assessment

Noise prediction modelling has been undertaken to determine the noise intrusion impact upon the North Plot building. The noise predictions have been undertaken using Soundplan version 7.4 noise modelling software. The noise predictions are based on CoRTN, having been adapted to Australian conditions and extensively tested by the Australian Road Research Board. As a result, it is recognised and accepted by the NSW EPA.

The results of the noise prediction modelling are presented in Table 18. The results presented are the highest noise levels predicted at any point along the façade. Indicative acoustic performance of the façade is also provided, in order to demonstrate that the development is capable of complying with the relevant criteria.

Table 18: Predicted road traffic noise levels, $L_{eq\ 1hr}$

Floor/Area	External predicted noise level, dB	Internal criteria, dB	Required noise reduction by façade, dB	Estimated façade acoustic performance	Indicative glazed façade construction
Third/Fourth - child care centre (north facade)	64	40	24	Rw 30-35	6.38mm - 10.38mm laminated glass in acoustically sealed frame

4.4 Recommendations

Further assessment should be carried out during the detailed design phase to verify the acoustic assessment outcomes against the developed design. Assessment of other areas of the development may also be carried out at the client's discretion.

PART B - 'Demolition and construction' assessment

This part of the noise assessment discusses construction noise and vibration impacts associated with the proposed North Plot and Square development onto existing noise and vibration sensitive receivers. It is noted that a site specific Construction Management Plan (28/5/2015) has been prepared by Lendlease, and this assessment and recommendations supplement the more detailed plan.

5 Projected program and schedule

5.1 Darling Square development program

At this stage of the development the program for demolition and construction of Darling Square 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 potential overlap in works. It is noted that approval has already been granted for Demolition, West Plot, South West Plot and North West Plot.

- Car Park Demolition Late 2014 to early 2015
- West Plot Early 2015 to late 2016
- North West Mid 2015 to mid 2017
- South West Mid 2015 to late 2017
- Demolition Entertainment Centre Early 2016 to mid 2016
- North East Mid 2016 to early 2019
- North Mid 2016 to late 2017
- South East Mid 2016 to Early 2019

The indicative program above suggests that there will be periods where more than one section of Darling Square will be under construction; however they are expected to be at different stages of development. In considering the Entertainment Centre demolition, the cumulative impact with the North West and South West Plot construction has been considered.

With regard to the North Plot, works will largely be limited to construction, as demolition of the Entertainment centre was included as part of the North East Plot application, and excavation will be minimal. It is noted that consideration of construction noise impacts from the North Plot were included in the previous assessments of the NE Plot and therefore the following is consistent with the previous assessments.

5.2 Construction hours

The proposed construction hours are to be consistent with the approved construction hours for the Stage 1 Concept Plan (SSDA2), and are presented in Table 19.

Table 19: 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 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.

5.3 Construction Traffic

Delivery of most plant, equipment and materials to the site will be undertaken during standard work hours. However, during the various stages of construction works, there will be instances where oversized deliveries are necessary. Oversized movements can cause disruptions to the existing traffic, and can be a potential hazard for road users. Therefore there is a requirement for these vehicles to move during off-peak hours when traffic volumes are typically at a minimum, thereby ensuring road user and public safety and minimising disruption to road network users.

Traffic generated during the construction phase is expected to be minimal in comparison to the existing road traffic surrounding the site. The impact from construction generated traffic is therefore assessed not to be material in the context of existing traffic conditions, hence is not discussed further in this report.

6 Construction noise and vibration objectives

6.1 Construction noise objectives

6.1.1 Construction noise management levels

The ICNG sets out noise management levels (NMLs) and guidelines as to how they are to be applied. Table 20 below sets out the ICNG NMLs for residential receivers (reproduced from Table 2 of the ICNG) modified only with the project specific standard hours.

Table 20: Noise management levels at residential receivers

Time of Day	NML L _{Aeq} (15 min)	How to Apply
Project 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 21 following sets out the noise management levels for various noise-sensitive land use developments, including commercial premises.

Table 21: 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)

Land use	Where objective applies	Management level L_{Aeq} (15 min)
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.

As identified for residential receivers, at all other noise sensitive receivers a highly affected noise objective of $L_{Aeq(15min)}$ 75dB(A) shall apply. Construction activity noise above this level should be handled as described in Table 20 above.

6.1.2 Site specific construction noise objectives

From the existing background noise levels reported in Section 2.2, the site specific construction noise objectives are summarised in Table 22.

Table 22: Construction noise management levels (NMLs) for Darling Square

Receiver ID	Day - Noise Management Level, $L_{Aeq,15min}$ dB(A)
R1 - The Peak	68
R2 - Holiday Inn	71
R3 - Seasons	71
R4 - Novotel Rockford	71
C1 - Market City	70 ^{1, 2}
C2 - Restaurants on Harbour St	70 ^{1, 2}
C3 - Pumphouse	70 ^{1, 2}
E1 - UTS	45 ^{1, 3}

Notes:

1. Noise management levels apply when receiver areas are in use only.
2. NML applies to external areas
3. NML applies to internal areas

6.2 Construction vibration objectives

6.2.1 Disturbance to building occupants

For disturbance to human occupants of buildings, we refer to DECC's 'Assessing Vibration; a technical guideline', published in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)'. Vibration sources are defined as Continuous, Impulsive or Intermittent. Table 23 provides a definition and examples of each type of vibration.

In accordance with the guideline, assessment against the human exposure criteria is typically reserved for long-term vibration impacts such as that associated with operational phases of development rather than construction works. While the criteria are outlined below, management measures are expected to be limited to potential structural damage.

Table 23: 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, eg. 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, Department of Environment & Climate Change, 2006

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 (BS 6472).'

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, ie. 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. 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.

The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced below. In this assessment, commercial premises are included in the 'Offices, schools, educational institutions and places of worship' category of Table 24 below.

Table 24: 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 ^[3] (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 nighttime	0.04	0.029	0.080	0.058
Impulsive vibration ^[3] (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 ^[4] (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		1.60	
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 (eg. relevant standards) should be referred to. Source: BS 6472-1992
 3. For continuous and impulsive vibration the preferred and maximum values are weighted acceleration rms values (m/s²)
 4. For intermittent vibration the preferred and maximum values are vibration dose values (VDVs), based on the weighted acceleration values (m/s^{1.75})

6.2.2 Structural damage to buildings

Limits for construction generated vibration have been determined using the vibration limits set out in the German Standard DIN 4150 Part 3-1999 Structural Vibration in Buildings – Effects on Structures.

The German standard DIN 4150 - Part 3 - "Structural vibration in buildings - Effects on Structures", also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

The minimum limit of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (e.g. historical with preservation orders

etc.), it is 3mm/s. These limits increase as the frequency content of the vibration increases. These values are presented in Table 25 below and are generally recognised to be conservative.

Table 25: 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 26 provides the Sound Power Levels (LW) of plant likely to be used during the Project construction period for the North, North-East, North-West and South-East sites.

Table 26: Construction plant source levels - For each Plot

Equipment Type	Indicative Size	Indicative No. of Equipment per phase		Sound Power Level, dB(A) Lw re: 1pW
		Excavation	Construction	L _{Aeq}
Air Compressor - Silenced	8 kW	-	1	109
Backhoe	8 t	2	1	100
Backhoe with Hydraulic Breaker	67 kW	2	-	116
Cherry Picker	6 t	-	1	106
Concrete Pump	6 t	1	1	103
Concrete Saw	9 kg	1	-	119
Concrete Vibrator	2 kW	-	1	97
Crane - Mobile	55t	-	1	98
Crane - Diesel	22 t	-	2	104
Excavator w bucket	45 t	2	-	105
Excavator w bucket	12 t	1	-	102
Generator - Diesel	100 kVA	-	2	94
Hoist - Twin cage high speed Alimak	0.5 t	-	1	96
Piling - Rotary bored cast in-situ	110 t	1	1	111
Pneumatic Hand Tools (general)		2	1	111
Pneumatic Jack Hammer	20 kg	2	-	121
Power Generator	28 kg	1	1	102
Roller - Vibratory (pad foot)	20 t	1	1	108
Truck - Cement Mixer	26 t	-	4 p/hr	104
Water Cart	10-12t	1	1	107
Welders - welding & cutting steel piles		1	1	101

Note: Source:- Renzo Tonin & Associates Construction Noise Database (QTD-06 (rev 5))

LA1 only noted for equipment potentially used during the night period (as noted in the Construction Program in Appendix C)

7.2 Predicted noise levels

7.2.1 During standard (daytime) construction hours

Noise emissions were 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). Predicted noise levels during the construction phase of the North Plot are inclusive of the cumulative impacts of all four Plots (N, NE, NW and SE).

Table 27 following presents a summary of the predicted L_{Aeq} noise levels for each stage of the Darling Square 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
- No acoustic shielding has been assumed for future structures on site. As the site works progress, acoustic shielding will be provided by the constructed structures to some locations. The modelling conservatively assumes a clear unobstructed site.
- A 30dB(A) reduction from outside to inside for adjacent UTS building assuming closed windows.
- No consideration of site hoardings or other forms of shielding have been considered in the modelling

Table 27: Summary of predicted L_{Aeq} levels (standard construction hours)

Receiver ID	Noise management level, dB(A)	Predicted L_{Aeq} noise levels, dB(A)
		Construction - structures
R1 - The Peak	68	74
R2 - Holiday Inn	71	79
R3 - Seasons	71	71
R4 - Novotel Rockford	71	74
C1 - Market City	70 ¹	80
C2 - Restaurants on Harbour St	70 ¹	79
C3 - Pumphouse	70 ¹	76
E1 - UTS	45 ²	49

Notes: 1 - NML applies to external areas

2 - NML applies to internal areas

Noise impacts during the primary construction of the N, NE, NW and SE Plots of Darling Square have been predicted and compared to the noise management levels for the day period. Exceedance of the noise management levels are predicted for the construction works. The primary locations predicted to be affected are identified as the Novotel Rockford, Holiday Inn and The Peak. On the basis of these findings, consideration should be given to the following recommendations specific to the management

of noise impact at those locations. General recommendations for the site wide management of noise are also provided.

7.3 Recommendations

The following at-source control and management measures should be considered for the management of noise from construction works to reduce potential noise impacts. The management measures are focused on minimising unnecessary noise generation from the site and the extent and duration of peak noise levels.

Table 28: Construction noise management measures

Measure	Detail
Source controls	
Noise barriers	Where possible, stage development so that structures provide acoustic shielding to sensitive receiver locations. Construct any solid site hoarding as soon as practical. Where possible, stationary equipment should be located to make most use of the solid hoarding. Barriers or enclosures around stationary plant should also be considered where it is required to be located in close proximity to sensitive receivers.
Location equipment	Loading/unloading zones and stationary plant such as generators should where practicable be located away from the most sensitive receivers, in this case the Novotel.
Equipment selection	Use the quietest and least vibration emitting construction methods where feasible and reasonable.
Limit equipment in use	Only the equipment necessary for the construction works will be used at any time. Avoid any unnecessary noise when carrying out manual operations and when operating plant
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	Alternative reverse alarm, such as non-tonal 'quackers' should be installed where feasible and reasonable.
Management measures	
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.
Work staging	Where practical, stage works so that that intrusive works are carried out at least noise sensitive periods.

Measure	Detail
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
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.
Noise monitoring	Noise and vibration monitoring should be carried out for any identified sensitive works, where monitoring could be used to proactively identify noisy works that may be otherwise managed and mitigated.

8 Vibration assessment

8.1 Vibration sources

The vibration generated during construction works associated with the North Plot is expected to be minimal due to works excluding demolition and major excavation. Possible plant and equipment in use however are identified in Table 26.

Table 29 below identifies the dominant vibration generating plant and equipment. Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver structure. Typical levels of ground vibration from these sources are shown in Table 29.

Table 29: Construction plant vibration levels

Plant Noise Source	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

8.2.1 Recommended minimum buffer distances

Based on available data from a database containing vibration measurements from past projects and from library information, Table 30 below presents the recommended minimum working distances for high vibration generating plant.

Table 30: Recommended minimum working distances for vibration intensive plant

Plant item	Rating / description	Min. working distance, m	
		Cosmetic damage ²	Human response ³
Bobcat	Travelling	1 (nominal)	Avoid contact with structure

Plant item	Rating / description	Min. working distance, m	
		Cosmetic damage ²	Human response ³
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure
Large Hydraulic Hammer	1600 kg	5	73
Excavator	<=30 Tonne (travelling/ digging)	5	15
Truck Movements ¹	Travelling loaded	5	10

Notes:

5. Renzo Tonin & Associates project files, databases & library
6. Based on DIN4150.3 Group 1 Buildings
7. For residential receivers

Site specific buffer 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 30 above. 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.

8.2.2 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 30 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 by way of a buzzer or flashing light, 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.
- It is further recommended that 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 North Plot and Square of Darling Square (SSDA10), being part of the SICEEP. The assessment has been carried out in accordance with the policies and guidelines specified in the Secretary's Environmental Assessment Requirements (SEARs). 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.

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 A-weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in 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.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
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 L _{eq} 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 Manned measurement results

APPENDIX C Long-term noise monitoring methodology

C.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)
RTA06 (NTi Audio XL2, with low noise microphone)	Type 1	1/1	L1, L2, L3

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 Type 4230 or 4231 calibrator. No significant drift in calibration was observed.

C.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. The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

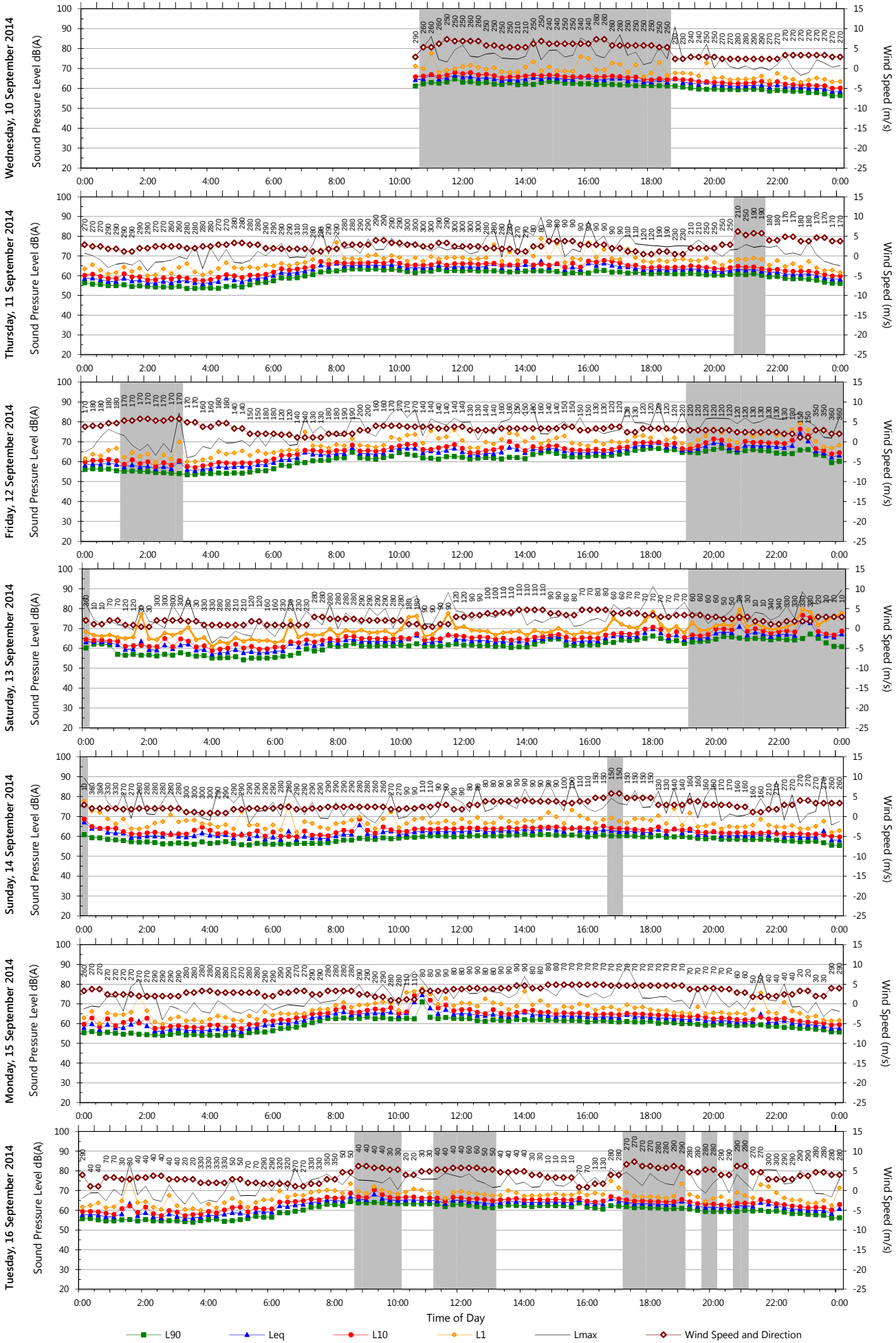
C.3 Noise vs time graphs

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 D Long-term noise monitoring results

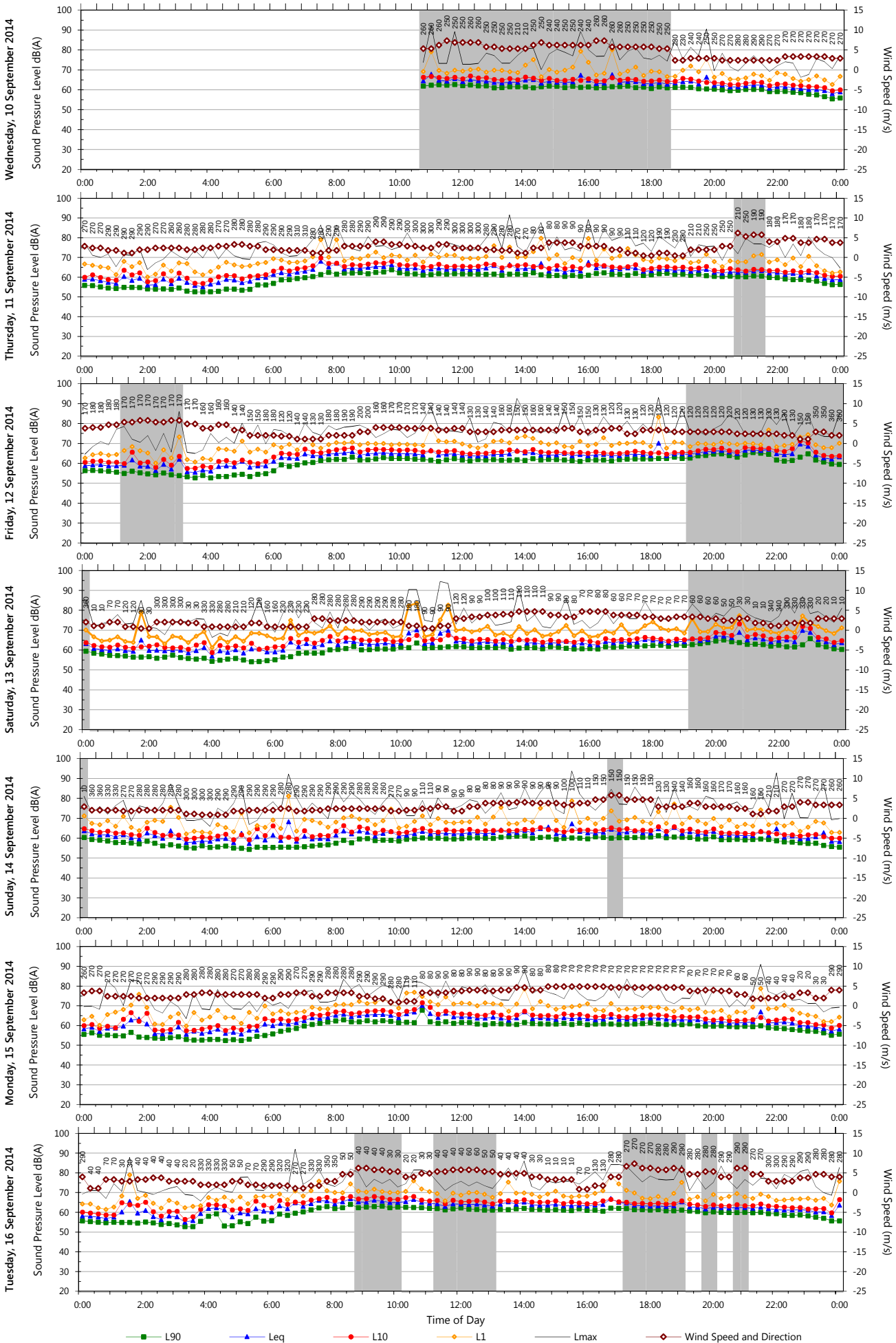
Unattended Monitoring Results

Location: L1 - Sydney Entertainment Centre awning (north-east)



Data File: 2014-09-10_SLM_000_123_Rpt_Report.txt

Template QTE-05B (rev 109) Sydney Logger Graphs



Unattended Monitoring Results

Location: L3 - Sydney Entertainment Centre awning (south-east)

