

Sydney International Convention, Exhibition and
Entertainment Precinct (SICEEP)
The Haymarket

Noise and Vibration Report

Stage 2 State Significant Development Application North West Plot

30 May 2013

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1 INTRODUCTION

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

The Application (referred to as SSDA 4) follows the submission of a staged SSD DA (SSDA 2) submitted in March 2013 to the Department of Planning and Infrastructure that set out a Concept Proposal for a new mixed use residential neighbourhood at Darling Harbour known as 'The Haymarket'. The Haymarket forms part of the Sydney international convention, exhibition and entertainment precinct (SICEEP) Project, which will deliver Australia's global city with new world class convention, exhibition and entertainment facilities and support the NSW Government's goal to "make NSW number one again".

More specifically this subsequent DA seeks approval for a car park (above ground) and commercial office building within the North West development plot of The Haymarket and associated public domain works. The DA has been prepared and structured to be consistent with the Concept Proposal DA.

1.1 Overview of Proposed Development

The proposal relates to a detailed ('Stage 2') DA for a commercial office and public car park development in the North West Plot of The Haymarket together with associated public domain works. The Haymarket Site is to be developed for a mix of residential and non-residential uses, including but not limited to residential buildings, commercial, retail, community and open space. The North West Plot is one of six development plots identified in the Concept Proposal DA.

Under the Concept Proposal, the North West Plot will accommodate active ground floor uses, a multi-storey above ground public car park and a commercial office building above. More specifically, this SSD DA seeks approval for the following components of the development:

- Staged demolition of existing site improvements, including the existing Sydney Entertainment Centre (SEC), Entertainment car park, and part of the pedestrian footbridge connected to the Entertainment car park;
- Associated tree removal and replanting;
- Construction and use of a mixed use commercial building comprising:
 - ground level retail/television studio uses-IQ Hub;
 - car park (above ground);
 - parking (above ground); and
 - commercial office space.
- Provision of vehicle access to the development from realigned Exhibition Place;
- Public domain improvements, including:

- provision (part) of a new north-south pedestrian connection (known as the Boulevard) eventually linking Quay Street to Darling Harbour;
- provision (part) of a new east-west pedestrian laneway (known as Dickson's Lane) linking Darling Drive to the Boulevard;
- Extension and augmentation of physical infrastructure / utilities as required.

1.2 Background

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 Department of Planning and Infrastructure. The key components of these proposals are outlined below.

1.2.1.1 The Haymarket Concept Proposal (SSD 13_5878)

The Haymarket 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 Haymarket Site.

More specifically the Stage 1 Concept Proposal seeks approval for the following key components and development parameters:

- Staged demolition of existing site improvements, including the existing Sydney Entertainment Centre (SEC), Entertainment Centre Car Park, and part of the pedestrian footbridge connected to the Entertainment car park and associated tree removal;
- A network of streets, lanes, open space areas and through-site links generally as shown on the Public Domain Concept Proposal, to facilitate reintegration of the site into the wider urban context and connection with the broader SICEEP Site;
- Street layouts;
- Development plot sizes, development plot separation, building envelopes (maximum height in RLs), building separation, building depths, building alignments and a benchmark for natural ventilation and solar provision for the precinct;
- Land uses across the site, including residential and non-residential uses;
- A maximum total gross floor area (GFA) across The Haymarket Site of 197,236m² for the mixed use development (excluding ancillary above ground car parking), comprising of:
 - A maximum of 49,545m² non-residential GFA; and
 - A maximum of 147,691m² residential GFA;
 - Above ground parking including public car parking;
 - Residential car parking rates to be utilised in the subsequent detailed (Stage 2) Development Applications, being:
 - Zero (0) spaces per studio apartment;
 - Maximum one (1) space per two (2) one bedroom apartments;

- Maximum one (1) space per one bedroom + study apartment, plus one (1) additional space per five (5) apartments;
 - Maximum one (1) space per two bedroom apartment, plus one (1) additional space per five (5) apartments; and
 - Maximum two (2) spaces per 3+ bedroom apartment.
- Design Guidelines to guide future development and the public domain; and
 - A remediation strategy.

This report has been prepared to support a detailed Stage 2 SSD DA for a mixed use commercial and public car park development and associated public domain works within The Haymarket (SSDA 4), consistent with the Concept Proposal SSD DA.

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 Haymarket 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 43,807m².



Figure 1 – Aerial Photograph of the SICEEP Site

The Concept Proposal DA provides for six (6) separate development plots across the Haymarket 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 West Plot and surrounds 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 will result in the lodgement of numerous SSD DAs for the various components of the redevelopment project. SSD DAs have already been lodged for the PPP component of the SICEEP Project (comprising the convention centre, exhibition centre, entertainment facility and ancillary commercial premises and associated public domain upgrades), and the Stage 1 Concept Proposal for The Haymarket. Separate 'Stage 2' SSD DAs for the development of the South West Plot and the Western Plot (Darling Drive) and associated public domain works will be lodged concurrently with this application. Future applications will be lodged for the Hotel complex, and the remaining development plots of The Haymarket Site.

1.5 Acoustic Assessment Requirements

Renzo Tonin & Associates has been engaged to prepare a construction and operational noise & vibration assessment for the North West Plot which provides further detailed assessment following the Stage 1 development application submitted for The Haymarket¹.

This report presents an assessment of noise and vibration, in accordance with the Director General's Requirements, and in relation to:

- Demolition and construction noise (see Part B of this report);
- Operational noise emission from the site such as mechanical services, retail uses and associated public realm (see Part A of this report); and
- Noise onto the site from existing sources such as traffic and light rail (see Part A of this report).

1.5.1 Director General's Requirements

The Director General's Requirements (DGRs) issued by the Department of Planning and Infrastructure for application number SSD 5752-2012 specifically require:

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

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)*
- *State Environmental Planning Policy – Infrastructure 2007*
- *Development Near Rail Corridors and Busy Road-Interim Guideline*

¹ Renzo Tonin & Associates, TG015-01F05 (rev 7) Stage 1 Acoustic Assessment, 15th March 2013.

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 (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 demolition and construction phase of the development and its potential impact on surrounding development | Section 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. | Section 5, 6 and 7 Section 4 |
| 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 3.2.3 |
| 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 Stage 1 Development 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 NW Plot development., The following outlines the scope of assessment for the proposed commercial office and public car park building within the North-West 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 West Plot, in accordance with the Director General's Requirements;
 - Identify the sensitive receiver locations, including existing receivers with regards to 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-West 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.

1.6.1 Potential Staging of Development

The building proposed within the North West Lot comprises two primary elements; a four storey, 450-bay Car Parking facility (of which 400 are public and 50 bays will be allocated to the Office component) and a six storey A-grade Office tower above. In accordance with Lend Leases commitments to the State for the provision of on-site Public Car Parking, the public car park is to be operational by December 2016.

Lend Lease intends to deliver the Car Park and Office tower simultaneously, however in the event that both components are unable to be delivered concurrently, the ability to stage the development and hand over the Public Car Park and Office separately has been factored into the design of the proposal.

In regard to the noise and vibration assessment, the primary consideration for the above staged development would be whether the operational noise from the completed Car Park would be greater without the completed Office tower above. As the completed four storey Car Park will be constructed with a concrete slab roof and will not result in an exposed roof top parking deck, noise emission from the Car Park in isolation would be unaltered. In regard to construction, the staging would not be expected to alter the primary methods of construction. Therefore the delivery of the Car Park prior to completion of the Office Tower is not considered to require separate assessment and this report has been prepared on the basis of the completed site.

2 EXISTING NOISE ENVIRONMENT & NEAREST SENSITIVE RECEIVERS

2.1 Nearest Sensitive Receivers

The nearest potentially affected receivers to the Haymarket site are presented in Table 1. Whilst not all receivers are directly relevant to the assessment of the NW Plot, as cumulative impacts of both operational and construction noise has been considered, all surrounding receptors as identified in the Stage 1 application report 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 – Nearest Receivers

| 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 |
| C4 | The Powehouse Museum – 500 Harris St | 20 |
| Other Sensitive Receivers | | |
| E1 | UTS – Quay St | 15 |

Assessment of noise impact onto future noise sensitive receivers that form part of the precinct plan (e.g. residential and student housing) is outside the scope for this noise assessment. Note that this will be taken into consideration as part of the detailed design.

2.2 Existing Noise Environment

Noise impact at the 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* (INP, Environment Protection Authority 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.

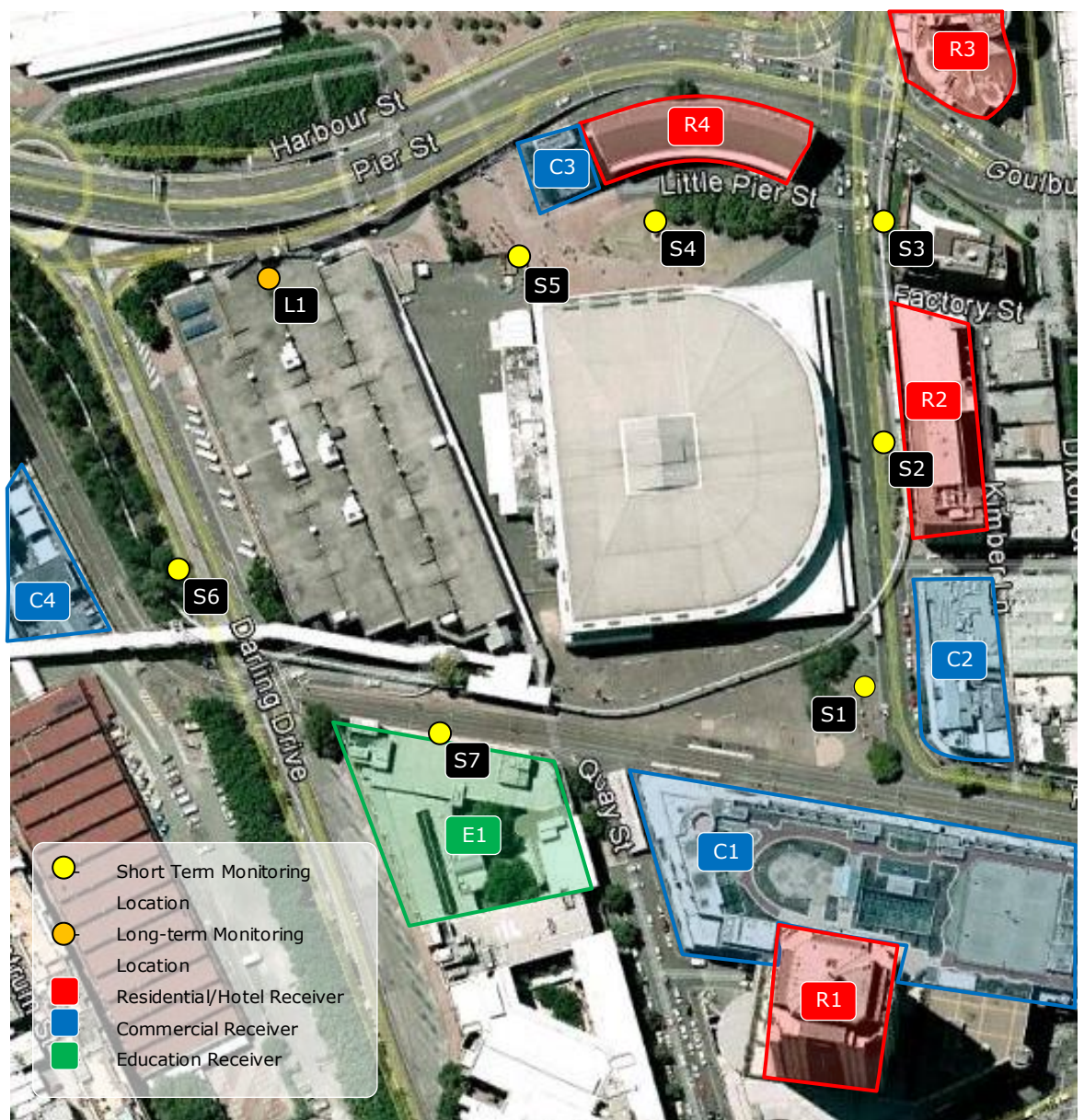


Figure 3 – Locality Map showing Receiver and Measurements Locations

2.2.1 Long-term noise monitoring

Long-term noise measurements were undertaken by as part of a previous acoustic assessment of the SICEEP development [*SICEEP Acoustic Design Brief*. Document No. SICEEP-ES-AC-R-0-001, dated 24th August 2012]. Of the four long-term monitoring locations, one location was relevant to The Haymarket.

- Location L1 Sydney Entertainment Centre Rooftop Car Park

On the roof top level of the multi storey car park, in the 'free field', approximately 15m from Pier Street. Noise data represents the ambient and background noise for the proposed development in the north-west area of The Haymarket. Monitoring was carried out between 21st May and 29th May 2012.

Existing background and ambient noise levels are presented in Table 2 below.

Table 2 – Measured Existing Background (L₉₀) & Ambient (L_{eq}) Noise Levels, dB(A)

| Location | L ₉₀ Background Noise Levels | | | L _{eq} Ambient Noise Levels | | |
|---|---|---------|-------|--------------------------------------|---------|-------|
| | Day | Evening | Night | Day | Evening | Night |
| Location L1 – Entertainment Centre Rooftop Car Park | 60 | 58 | 51 | 68 | 66 | 64 |

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

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

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

2.2.2 Short-Term Attended Noise Monitoring

In order to supplement the long-term noise monitoring, and provide greater detail of the noise environment surrounding the site, short-term noise measurements were undertaken at the following locations during the daytime of Wednesday 6th and night time of Friday 8th February 2013.

Table 3 – Short-term Monitoring Locations

| Measurement Location ID | Location 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. |

| Measurement Location ID | Location Description |
|-------------------------|---|
| 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 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 | Darling Drive, Haymarket Nature strip on western side of Darling Drive, 6m from the edge of the inside lane of traffic, in the free field. Opposite the Sydney Entertainment Centre car park. Noise data represents existing background noise, incident on the proposed residential development. |
| S7 | 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. |

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. The short-term monitoring has been referenced against the long-term noise monitoring so as to establish indicative day, evening and night background and ambient noise levels for the standard INP assessment periods. This has been carried out for the residential receiver locations only.

Table 4 – Measured Existing Background (L₉₀) & Ambient (L_{eq}) Noise Levels, dB(A)

| Location | L ₉₀ Background Noise Levels | | | L _{eq} Ambient Noise Levels | | |
|--------------------------------|---|---------|-------|--------------------------------------|---------|-------|
| | Day | Evening | Night | Day | Evening | Night |
| R1 – Peak Apartments | 55 | 53 | 51 | 61 | 59 | 58 |
| R2 – Holiday Inn | 57 | 57 | 51 | 67 | 66 | 64 |
| R3 - Southern Cross on Harbour | 60 | 58 | 51 | 68 | 66 | 64 |
| R4 – Novotel | 58 | 56 | 51 | 61 | 59 | 58 |

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

PART A – 'OPERATIONAL' NOISE ASSESSMENT

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

- Noise impacts from the proposed North-West Plot development onto existing noise sensitive receivers;
- Noise impacts from the surrounding environment (e.g. noise from the light rail and road traffic) onto the North-West Plot development.

3 NOISE EMISSION FROM THE DEVELOPMENT

3.1 'Operational' Noise Sources

The proposed North West Plot will combine retail and commercial office, and include above ground parking. The operational noise sources associated with the development are considered to be:

- Mechanical plant and equipment;
- Activity associated with restaurants, cafes and other retail uses, including patrons, music and loading docks;
- Use of rooftop office terraces;
- Car park activity from the above ground car parking; and
- Traffic generated by the proposed development onto the existing road network.

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

3.2 Operational Noise Criteria

3.2.1 EPA Industrial Noise Policy

In accordance with the DGRs, noise impact from the general operation of the proposed development is to be assessed against the NSW Industrial Noise Policy (INP). 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 Plan report set out the intrusiveness and amenity criteria for cumulative assessment of The Haymarket. In the case of a large development site such as SICEEP, the cumulative impact of the development needs to be considered to the surrounding receivers and therefore Table 5 on the following page sets out the established noise criteria for the specific noise criteria for the NW Plot, as well as contributions for the other Plots. Whilst the intrusive noise criteria is unchanged, the amenity criteria has been proportioned between the South West, North West, Western and Eastern Plots based upon the distance of each site from the relevant receptor locations. In addition, indicative amenity noise goals have been provided for the adjacent development Plots in The Haymarket. It is noted that the noise goals for the individual Plots could 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 the Haymarket would be permitted to increase noise emission whilst still meeting the cumulative target.

Table 5 – The Haymarket Industrial Noise Criteria

| Receiver ID | Intrusiveness Criteria | | | Plot | Amenity Criteria ¹ | | |
|--------------------------------|------------------------------|---------|-------|--------------|--------------------------------|-------------------------|-----------|
| | L _{Aeq,15min} dB(A) | | | | L _{Aeq, period} dB(A) | | |
| | Day | Evening | Night | | Day | Evening | Night |
| R1 - The Peak | 60 | 58 | 56 | SW | 53 | 38 | 36 |
| | | | | NW | 47 | 32 | 30 |
| | | | | W | 47 | 32 | 30 |
| | | | | NE | 50 | 35 | 33 |
| | | | | SE | 54 | 39 | 37 |
| | | | | TOTAL | 58 | 43 | 41 |
| R2 - Holiday Inn | 62 | 62 | 56 | SW | 44 | 34 | 28 |
| | | | | NW | 43 | 33 | 27 |
| | | | | W | 41 | 31 | 25 |
| | | | | NE | 55 | 45 | 39 |
| | | | | SE | 51 | 41 | 35 |
| | | | | TOTAL | 57 | 47 | 41 |
| R3 - Seasons | 65 | 63 | 56 | SW | 47 | 37 | 31 |
| | | | | NW | 48 | 38 | 32 |
| | | | | W | 46 | 36 | 30 |
| | | | | NE | 54 | 44 | 38 |
| | | | | SE | 50 | 40 | 34 |
| | | | | TOTAL | 57 | 47 | 41 |
| R4 - Novotel Rockford | 63 | 61 | 56 | SW | 45 | 35 | 30 |
| | | | | NW | 48 | 38 | 33 |
| | | | | W | 43 | 33 | 28 |
| | | | | NE | 54 | 44 | 39 |
| | | | | SE | 46 | 36 | 31 |
| | | | | TOTAL | 56 | 46 | 41 |
| C1 - Market City | - | - | - | SW | | 56 | |
| | | | | NW | | 52 | |
| | | | | W | | 51 | |
| | | | | NE | | 53 | |
| | | | | SE | | 64 | |
| | | | | TOTAL | | 65 (when in use) | |
| C2 - Restaurants on Harbour St | - | - | - | SW | | 47 | |
| | | | | NW | | 47 | |
| | | | | W | | 46 | |
| | | | | NE | | 61 | |
| | | | | SE | | 62 | |
| | | | | TOTAL | | 65 (when in use) | |
| C3 - Pumphouse | - | - | - | SW | | 52 | |
| | | | | NW | | 58 | |
| | | | | W | | 51 | |
| | | | | NE | | 63 | |
| | | | | SE | | 51 | |
| | | | | TOTAL | | 65 (when in use) | |

| Receiver ID | Intrusiveness Criteria | | | Amenity Criteria ¹ | | | |
|---------------------|------------------------------|---------|-------|-------------------------------|--------------------------------|-------------------------|-----------|
| | L _{Aeq,15min} dB(A) | | | Plot | L _{Aeq, period} dB(A) | | |
| | Day | Evening | Night | | Day | Evening | Night |
| C4 - The Powerhouse | - | - | - | SW | | 54 | |
| | | | | NW | | 56 | |
| | | | | W | | 64 | |
| | | | | NE | | 48 | |
| | | | | SE | | 48 | |
| | | | | TOTAL | | 65 (when in use) | |
| E1 - UTS | - | - | - | SW | | 33 | |
| | | | | NW | | 19 | |
| | | | | W | | 24 | |
| | | | | NE | | 18 | |
| | | | | SE | | 27 | |
| | | | | TOTAL | | 35 (when in use) | |
| South West Plot | - | - | - | SW | 56 | 46 | 41 |
| | | | | NW | 54 | 44 | 39 |
| | | | | W | 54 | 44 | 39 |
| | | | | NE | 45 | 35 | 30 |
| | | | | SE | 50 | 40 | 35 |
| | | | | TOTAL | 60 | 50 | 45 |
| North West Plot | - | - | - | SW | | 59 | |
| | | | | NW | | 61 | |
| | | | | W | | 59 | |
| | | | | NE | | 50 | |
| | | | | SE | | 47 | |
| | | | | TOTAL | | 65 | |
| Western Plot | - | - | - | SW | 55 | 45 | 40 |
| | | | | NW | 55 | 45 | 40 |
| | | | | W | 56 | 46 | 41 |
| | | | | NE | 41 | 31 | 26 |
| | | | | SE | 41 | 31 | 26 |
| | | | | TOTAL | 60 | 50 | 45 |
| North East Plot | - | - | - | SW | 49 | 39 | 34 |
| | | | | NW | 49 | 39 | 34 |
| | | | | W | 40 | 30 | 25 |
| | | | | NE | 56 | 46 | 41 |
| | | | | SE | 56 | 46 | 41 |
| | | | | TOTAL | 60 | 50 | 45 |
| South East Plot | - | - | - | SW | 53 | 43 | 38 |
| | | | | NW | 46 | 36 | 31 |
| | | | | W | 40 | 30 | 25 |
| | | | | NE | 56 | 46 | 41 |
| | | | | SE | 56 | 46 | 41 |
| | | | | TOTAL | 60 | 50 | 45 |

Notes: Residential locations have been categorised as 'Urban'.

Conservatively, the amenity criterion have been modified in accordance with Table 2.2 assuming the existing industrial noise contribution equals the measured background level, and that the existing noise level is unlikely to decrease in the future.

The high traffic noise environmental criteria has not been applied in the criteria above as noise level measurements were carried out at street level and lower noise levels are expected at upper levels of development.

Whilst outlined in the notes of Table 5, Table 6 presents the background noise levels used to establish the amenity noise criteria. Conservatively, the amenity criteria have been modified in accordance with Table 2.2 assuming the existing industrial noise contribution equals the measured background level. It is also assumed that the existing noise level is unlikely to decrease in the future. The high traffic noise environmental criteria has not been applied in the criteria as the majority of noise level measurements were carried out at street level and therefore lower traffic noise levels are expected at upper levels of development. The traffic noise correction could however reasonably be applied at lower levels of the development. No correction to the commercial premise criteria were determined to be required based on the measurement data.

Table 6 – Existing Industrial Noise Level for Amenity Criteria, dB(A)

| Location | Time Period | Existing Industrial Noise | INP Base Amenity Criteria | Modified Criteria |
|--------------------------------|-------------|---------------------------|---------------------------|-------------------|
| R1 – Peak Apartments | Day | 55 | 60 | 58 |
| | Evening | 53 | 50 | 43 |
| | Night | 51 | 45 | 41 |
| R2 – Holiday Inn | Day | 57 | 60 | 57 |
| | Evening | 57 | 50 | 47 |
| | Night | 51 | 45 | 41 |
| R3 - Southern Cross on Harbour | Day | 60(57)* | 60 | 57 |
| | Evening | 58(57)* | 50 | 47 |
| | Night | 51 | 45 | 41 |
| R4 – Novotel | Day | 58 | 60 | 56 |
| | Evening | 56 | 50 | 46 |
| | Night | 51 | 45 | 41 |

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

** Affected by higher traffic exposure, therefore criteria established based on Location R2.*

3.2.2 Licensed Premises

Specific use of individual retail premises on the ground floor of the building will be subject to separate development, of which could include any licensed premises. There are standard noise criteria that typically apply to licensed premises in order to address potential impact upon residential premises.

3.2.3 Road Traffic Noise

Noise impact as a result of increased traffic generated on the surrounding road network is required to be assessed in accordance with the EPA *Environmental Criteria for Road Traffic*

Noise (ECRTN) as prescribed in the DGRs. This aspect of the project was assessed on a site wide cumulative basis in the Concept Plan acoustic assessment². The assessment revealed compliance with the DGR's and therefore further discussion has not been included in this assessment report.

3.3 Assessment and Recommendations

3.3.1 Mechanical Plant Noise

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

Whilst the intent of this assessment is to identify potential impacts at sensitive receivers surrounding the site, the acoustic objectives of the INP will also be desired to be met at sensitive receptors within The Haymarket, being situated in closer proximity to any new mechanical plant equipment. Therefore the nearest most sensitive receptors to operational noise from the North West Plot will be the residential occupancies of The Haymarket, and therefore will be the determining locations for the acoustic design. By satisfying the relevant criteria at sensitive receptors within The Haymarket, compliance should readily be achieved at surrounding noise sensitive receptors.

Mechanical plant such as rooftop exhausts, air-conditioning and refrigeration associated with the development should be assessed at the time of detailed design and selection, having regard to nearby residential and commercial properties surrounding the development, and to future development within The Haymarket precinct. Any noise emissions from building services associated with the North-West Plot shall be acoustically treated, where necessary, to comply with relevant Government policies. Although at this stage details of mechanical plant have not been finalised, the following review of the NW Plot design has been carried out and noise management measures are provided for mechanical plant servicing the proposed development.

The NW Plot design currently includes the following primary mechanical plant and equipment:

- Retail tenancy air-conditioning
- Retail kitchen and toilet exhausts
- Office Air-conditioning and exhaust systems
- Carpark exhaust and supply fans

² Renzo Tonin & Associates, TG015-01F05 (rev 7) Stage 1 Acoustic Assessment, 15th March 2013.

It is expected that the majority of office, retail and car park associated plant and equipment will be located within dedicated plant rooms in the building rather than rooftop locations, therefore reducing noise emission from the site to surrounding areas. Whilst discharge and intake will need to be ducted to external locations, sufficient scope is considered to be provided for any necessary acoustic treatment along these paths. The majority of equipment is also located away from the southern façade of the building, therefore being removed from the nearest residential receptors of the SW Plot,

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

- Acoustic assessment of mechanical services equipment will need to be undertaken during the detail design and equipment selection phase of the development to ensure that they shall not either singularly or in total emit noise levels which exceed the noise limits;
- As noise control treatment can affect the performance of the mechanical services system, it is recommended that consultation with an acoustic consultant be made during the initial phase of detailed mechanical services system design in order to reduce the need for revision of mechanical plant and noise control treatment;
- Mechanical plant noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following:
 - strategic positioning of plant away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises,
 - commercially available silencers or acoustic attenuators for air discharge and air intakes of plant;
 - acoustically lined and lagged ductwork;
 - acoustic screens and barriers between plant and sensitive neighbouring premises; and/or
 - partially-enclosed or fully-enclosed acoustic enclosures over plant.
- Mechanical plant shall have their noise specifications and their proposed locations checked prior to their installation on site; and
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 "Rotating and Reciprocating Machinery – Mechanical Vibration".

3.3.2 Restaurants, Cafes and Retail Operations (Licensed & Un-licensed)

This application does not define specific uses for each of the retail premises, and each use within the North West Plot will be subject to specific development applications.

Notwithstanding, a high level assessment has been carried out for the indicative food &

beverage premises and outdoor seating layout within the precinct, being the primary sources of noise emission from the retail component. The food & beverage and outdoor areas associated with the North West Plot are situated along the southern ground floor frontage of the building, and therefore sufficiently removed from surrounding sensitive receiver locations.

The nearest sensitive receivers with respect to the NW Plot retail component would be hotel rooms of the Novotel Rockford, however this will be substantially acoustically shielded by the future eastern plot and noise levels from any uses will be lower than the existing acoustic environment along Harbour St. This receptor location is not considered a significant constraint for the development of the proposed retail sector. Notwithstanding, this receptor location should be considered in any detailed study of the future retail uses.

3.3.3 Office Terraces

The proposed office building for the NW Plot includes rooftop terraces on the southern side of Level 4, 5 and 6. The spaces have been provided in response to required building setbacks from the SW Plot. The terraces are however associated with the office tenancies and are not intended for occupation by large congregations of staff for functions etc. They are therefore considered to be available for infrequent use for small numbers of staff. Therefore their use and operation are not expected to impact nearby receiver locations, of which the nearest would be residential premises within the SW Plot.

3.3.4 Car Park and Loading Dock Activity

As the car parks and loading docks are situated within the core of the building, noise emission is not expected to impact any existing surrounding receivers. Noise from these activities will be most pertinent with regards to the amenity of office spaces within the NW Plot and residential premises of the SW Plot, particularly in terms of any proposed natural ventilation openings on the southern facade. These aspects should be addressed during the design development of the building so as to ensure appropriate acoustic separation is provided between the car park and adjacent sensitive uses within The Haymarket. Loading dock and car park entries are however suitably removed from the residential receivers, being situated on the northern side of the building.

4 ROAD TRAFFIC AND LIGHT RAIL NOISE ONTO THE DEVELOPMENT

In accordance with the DGRs, impact from road and rail should be assessed in accordance with the NSW State Environmental Planning Policy (Infrastructure) 2007 (known as the 'ISEPP'). However it is noted that the ISEPP does not specifically apply to commercial developments and therefore is not required to be assessed as part of this application.

Notwithstanding, given the proximity of the building to Pier Street, road traffic noise intrusion should be considered in the detailed design of the building façade. Typically noise criteria for inside offices would be based upon Australian Standards 2107:2000 or any relevant Green Star objectives for the project.

Assuming that the building will be mechanical ventilated and provided with a fixed glazed façade, the internal design criteria is expected to be readily met with heavy laminated glazing or acoustically rated insulated glazing units (where higher thermal performance is required). The specification of the façade system would be developed during the detailed design phase of the NW Plot.

PART B – CONSTRUCTION NOISE ASSESSMENT

This part of the noise assessment discusses construction noise and vibration impacts associated with the demolition of existing buildings and construction proposed North West Plot development onto existing noise and vibration sensitive receivers.

5 PROJECTED PROGRAM & SCHEDULE

5.1 The Haymarket Development Program

At this stage of the development the program for demolition and construction of the Haymarket 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 across the Haymarket.

- Demolition Early 2014 - Mid 2014
- Western Plot Mid 2014 - Late 2016
- **North West Late 2014 - Late 2016**
- South West Mid 2014 - Mid 2017
- South East Early 2019 - Mid 2021
- North & North East Early 2017 - Mid 2019

The indicative program above suggests that there will be periods where more than one section of the Haymarket will be under construction, however are expected to be at different stages of development. For the purpose of this assessment of demolition and construction noise, is based upon a cumulative assessment of the North West, South West and West (Student Accommodation) sites.

5.1.1 North West Plot Program

We understand that the construction period of the North West Plot would be over 2 to 3 years. Demolition of the car park and associated structures is anticipated to be completed within 4 to 5 months from early 2014. Starting in mid to late-2014 there is likely to be 2 to 3 months of enabling works (including civil and utilities). The remainder of the construction period involves the construction of the North-West Plot.

5.1.2 South West Plot Program

The construction program for the South West Plot is anticipated to be similar (although longer) to the NW plot, with demolition of the car park required prior to enabling works and the following construction works. The assessment has assumed that demolition and construction periods of the SW and NW plots will coincide.

5.1.3 Western Plot Program

In regards to the West Plot, initial works will involve the realignment of Darling Drive and relocation of services and is proposed to occur between Jan 2014 and July 2014. Construction of the West Plot (south building) is proposed between June 2014 and December 2015 and therefore will coincide with the South West and North West plots.

5.2 Construction Hours

The proposed construction hours are modified from those set out in the ICNG. The proposed hours of 7:00am to 7:00pm Monday to Friday and 8:00am to 5:00pm Saturdays are however consistent with the standard approved construction hours for other major projects in the Sydney CBD. They have therefore been adopted as 'standard hours' in the context of the ICNG for this project.

Table 7 - Proposed Work Hours

| | Monday to Friday | Saturday | Sunday/ Public holiday |
|------------|-------------------------|------------------|-------------------------------|
| Work Hours | 7:00am to 7:00pm | 8:00am to 5:00pm | No work |

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

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. Major truck movements for spoil removal during the demolition phase and delivery of concrete during the construction are estimated average four per vehicles per hour. 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 8 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 8 - 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 8am 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 9 following sets out the noise management levels for various noise-sensitive land use developments, including commercial premises.

Table 9 - Noise Management Levels at Other Noise Sensitive Land Uses

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

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

As identified for residential receivers, at all other noise sensitive receivers a highly affected noise objective of $L_{Aeq(15\text{min})}$ 75dB(A) shall apply. Construction activity noise above this level should be handled as described in Table 8 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 10 below.

Table 10 – Construction Noise Management Levels (NMLs) for The Haymarket

| Receiver ID | Noise Management Level, $L_{Aeq,15\text{min}}$ dB(A) | | | Sleep Disturbance L_{A1} dB(A) |
|--------------------------------|--|-----------------------|-------|----------------------------------|
| | Day | Evening | Night | |
| R1 - The Peak | 65 | 58 | 56 | 66 |
| R2 - Holiday Inn | 67 | 62 | 56 | 66 |
| R3 - Seasons | 70 | 63 | 56 | 66 |
| R4 - Novotel Rockford | 68 | 61 | 56 | 66 |
| C1 - Market City | | 70 ^{1, 2} | | - |
| C2 - Restaurants on Harbour St | | 70 ^{1, 2} | | - |
| C3 - Pumphouse | | 70 ^{1, 2} | | - |
| C4 - The Powerhouse | | 45 ^{1, 3, 4} | | - |
| 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
 4. NML determined by reference to the 'maximum' internal levels in AS2107 for specific uses ('museums')

6.2 Construction Vibration Objectives

6.2.1 Disturbance to Buildings 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 11 below provides a definition and examples of each type of vibration.

Table 11 – Types of Vibration

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

Source: Assessing Vibration; a technical guideline, Dept Environment & Climate Change 2006

The criteria are to be applied to 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 vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be 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.

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 12 below.

Table 12 – 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 vibration³ (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 vibration³ (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 vibration⁴ (Vibration Dose Values, VDV, m/s ^{1.75} , 1-80Hz) | | | | | |
| Critical areas ² | Day or night-time | 0.10 | 0.20 | 0.10 | 0.20 |
| Residences | Daytime | 0.20 | 0.40 | 0.13 | 0.26 |
| | Night-time | 0.40 | 0.80 | 0.40 | 0.80 |
| Offices, schools, educational institutions and places of worship | Day- or night-time | 0.80 | 1.60 | 0.80 | 1.60 |
| Workshops | Day or night-time | 0.10 | 0.20 | 0.10 | 0.20 |

- Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992
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 13 below and are generally recognised to be conservative.

Table 13 – DIN 4150-3 Structural Damage Criteria

| Group | Type of Structure | Vibration Velocity, mm/s | | | |
|-------|--|-------------------------------|--------------|---------------|---------------------------------|
| | | At Foundation at Frequency of | | | Plane of Floor Uppermost Storey |
| | | 1 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 (e.g. 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 15, Table 14 and Table 16 following provide the Sound Power Levels (L_W) of plant likely to be used during the Project construction period of the North West, South West and West Plots respectively.

Table 14 – North West Plot - Construction Plant Source Levels

| Equipment Type | Indicative Size | Indicative No. of Equipment per phase | | | Sound Power Level, dB(A) L_W re: 1pW |
|---|-----------------|---------------------------------------|------------|--------------|--|
| | | Demolition | Excavation | Construction | L_{Aeq} |
| Air Compressor - Silenced | 8 kW | - | - | 1 | 109 |
| Backhoe | 8 t | - | 2 | 1 | 100 |
| Backhoe with Hydraulic Breaker | 67 kW | 1 | 2 | - | 116 |
| Cherry Picker | 6 t | - | - | 1 | 106 |
| Compactor | 260 kW | - | 2 | - | 109 |
| Concrete Pump | 6 t | - | 1 | 2 | 103 |
| Concrete Saw | 9 kg | - | 1 | 1 | 119 |
| Concrete Vibrator | 2 kW | - | - | 4 | 97 |
| Crane - Mobile | 55t | - | - | 1 | 98 |
| Crane - Diesel | 22 t | - | - | 2 | 104 |
| Excavator w bucket | 30 t | 3 | 2 | - | 103 |
| Excavator with Hydraulic Breaker | 30 t | 3 | - | - | 118 |
| Forklift | 3-12t | - | - | 1 | 65 |
| Generator - Diesel | 100 kVA | - | - | 2 | 94 |
| Grader | 15 t | - | 1 | - | 113 |
| Hoist – Twin cage high speed Alimak | 0.5 t | - | - | 1 | 96 |
| Line Drilling | - | - | 1 | - | 113 |
| Piling - Rotary bored cast in-situ | 110 t | - | 2 | - | 111 |
| Pneumatic Hand Tools (general) | | - | 2 | 2 | 111 |
| Pneumatic Jack Hammer | 20 kg | 4 | - | - | 121 |
| Power Generator | 28 kg | - | - | 1 | 102 |
| Roller - Vibratory (pad foot) | 12 t | - | 2 | - | 108 |
| Truck - Cement Mixer | 26 t | - | - | 8 p/hr | 104 |
| Truck - Dump | 15 t | 6 p/hr | - | 1 p/hr | 107 |
| Truck - Asphalt | 15 t | - | - | 2 p/hr | 107 |
| Water Cart | 10-12t | 1 | 1 | 1 | 107 |
| Welders - welding & cutting steel piles | | - | 1 | 1 | 101 |

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

Table 15 – South West Plot - Construction Plant Source Levels

| Equipment Type | Indicative Size | Indicative No. of Equipment per phase | | | Sound Power Level, dB(A) Lw re: 1pW |
|---|-----------------|---------------------------------------|------------|--------------|-------------------------------------|
| | | Demolition | Excavation | Construction | L _{Aeq} |
| Air Compressor - Silenced | 8 kW | - | - | 1 | 109 |
| Backhoe | 8 t | - | 2 | 1 | 100 |
| Backhoe with Hydraulic Breaker | 67 kW | 1 | 2 | 1 | 116 |
| Bobcat | 4 t | 2 | - | - | 110 |
| Cherry Picker | 6 t | 1 | - | 1 | 106 |
| Concrete Pump | 6 t | - | 1 | 1 | 103 |
| Concrete Saw | 9 kg | - | 1 | 1 | 119 |
| Concrete Vibrator | 2 kW | - | - | 1 | 97 |
| Crane - Mobile | 55t | - | - | 1 | 98 |
| Crane - Diesel | 22 t | - | - | 2 | 104 |
| Excavator w bucket | 45 t | 3 | 2 | - | 105 |
| Excavator with Hydraulic Breaker | 45 t | 3 | - | - | 120 |
| Excavator w bucket | 12 t | 2 | 1 | - | 102 |
| Excavator with Hydraulic Breaker | 12 t | - | - | - | 103 |
| 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 | 2 | 111 |
| Pneumatic Jack Hammer | 20 kg | - | 2 | 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 |
| Truck - Dump (Moxy) | 30 t | 4 p/hr | - | 4 p/hr | 109 |
| Water Cart | 10-12t | 1 | 1 | 1 | 107 |
| Welders - welding & cutting steel piles | | - | 1 | 1 | 101 |

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

L_{A1} only noted for equipment potentially used during the night period (as noted in the Construction Program in Appendix C)

Table 16 – Western Plot - Construction Plant Source Levels

| Equipment Type | Indicative Size | Indicative No. of Equipment per phase | | | Sound Power Level, dB(A) Lw re: 1pW |
|---|-----------------|---------------------------------------|------------|--------------|-------------------------------------|
| | | Demolition | Excavation | Construction | L _{Aeq} |
| Air Compressor - Silenced | 8 kW | - | - | 1 | 109 |
| Backhoe | 8 t | - | 2 | 1 | 100 |
| Backhoe with Hydraulic Breaker | 67 kW | 1 | 2 | - | 116 |
| Cherry Picker | 6 t | - | - | 1 | 106 |
| Compactor | 260 kW | - | 2 | - | 109 |
| Concrete Pump | 6 t | - | 1 | 2 | 103 |
| Concrete Saw | 9 kg | - | 1 | 1 | 119 |
| Concrete Vibrator | 2 kW | - | - | 4 | 97 |
| Crane - Mobile | 55t | - | - | 1 | 98 |
| Crane - Diesel | 22 t | - | - | 2 | 104 |
| Excavator w bucket | 30 t | 3 | 2 | - | 103 |
| Forklift | 3-12t | - | - | 1 | 65 |
| Generator - Diesel | 100 kVA | - | - | 2 | 94 |
| Grader | 15 t | - | 1 | - | 113 |
| Hoist – Twin cage high speed Alimak | 0.5 t | - | - | 1 | 96 |
| Line Drilling | - | - | 1 | - | 113 |
| Piling - Rotary bored cast in-situ | 110 t | - | 2 | - | 111 |
| Pneumatic Hand Tools (general) | | - | 2 | 2 | 111 |
| Pneumatic Jack Hammer | 20 kg | 1 | - | - | 121 |
| Power Generator | 28 kg | - | - | 1 | 102 |
| Roller - Vibratory (pad foot) | 12 t | - | 2 | - | 108 |
| Truck - Cement Mixer | 26 t | - | - | 8 p/hr | 104 |
| Truck - Dump | 15 t | 6 p/hr | - | 1 p/hr | 107 |
| Truck - Asphalt | 15 t | - | - | 2 p/hr | 107 |
| Water Cart | 10-12t | 1 | 1 | 1 | 107 |
| Welders - welding & cutting steel piles | | - | 1 | 1 | 101 |

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

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 have therefore been modelled for each stage and inclusive of the cumulative impact of all three Plots (NW, SW and W).

Table 17 following presents a summary of the predicted L_{Aeq} noise levels for each stage of The Haymarket 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
- Only minor acoustic shielding of 5dB(A) assumed for existing structures on site for the SW and NW demolition. The existing car park structure is expected to provide acoustic shielding to activities on site during the demolition process. With the exception of this consideration the modelling assumes a clear unobstructed site.
- Only minor acoustic shielding of 5dB(A) assumed for future structures on site during the construction process of all Plots. As the site works progress, acoustic shielding will be provided by the constructed structures. With the exception of this consideration the modelling conservatively assumes a clear unobstructed site.
- A 30dB(A) reduction from outside to inside for adjacent UTS building assuming closed windows.
- A 40dB(A) reduction from outside to inside for the Power House museum.
- No consideration of site hoardings or other forms of shielding have been considered in the modelling

Table 17 – Summary of Predicted L_{Aeq} Noise Levels (Standard Construction Hours)

| Receiver ID | NML, dB(A) | Predicted L_{Aeq} Noise Levels, dB(A) | | |
|--------------------------------|-----------------|---|------------|--------------|
| | | Demolition | Excavation | Construction |
| R1 - The Peak | 65 | 69 | 71 | 60 |
| R2 - Holiday Inn | 67 | 68 | 70 | 58 |
| R3 - Seasons | 70 | 61 | 63 | 52 |
| R4 - Novotel Rockford | 68 | 76 | 77 | 66 |
| C1 - Market City | 70 ¹ | 70 | 74 | 62 |
| C2 - Restaurants on Harbour St | 70 ¹ | 70 | 73 | 61 |
| C3 - Pumphouse | 70 ¹ | 81 | 83 | 70 |
| C4 - The Powerhouse | 45 ² | 43 | 46 | 33 |
| E1 - UTS | 45 ² | 54 | 57 | 43 |

Notes: 1. NML applies to external areas
 2. NML applies to internal areas
Bold font represents exceedance of Noise Management Level
Bold font represents exceedance of greater than 20dB(A) above the **Day period RBL** (not applicable to non-residential receivers)
Bold font represents exceedance of greater than 75dB(A)

Noise impacts during the demolition, minor excavation and primary construction of the North West, South West and West Plots of The Haymarket have been predicted and compared to the noise management levels for the day period.

The predicted noise levels reveal that compliance should be achieved during the primary construction phase of the works, which is the longest period of works. Exceedance of the NML's are predicted for the demolition and minor excavation/enabling works for the site. However the majority of these exceedances are less than 5dB(A) and are below the highly affected targets. The primary locations predicted to be affected by the demolition and excavation phases are identified as the Novotel Rockford, Pumphouse and potentially the UTS building. 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

7.3.1 Noise Source Control Measures

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

- **Construction hoarding** The installation of construction hoarding should take into consideration the location of receivers to ensure that line of sight' is broken, where feasible. For the subject site, site hoarding could provide reasonable noise reductions for ground level receivers of the Pumphouse and UTS building during works and activities at ground level.
- **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 UTS building, Pumphouse and Novotel.
- **Demolition procedures** Where feasible and reasonable, the demolition process should seek to maintain any structures that provide shielding to the most sensitive receptors for the longest period practicable. This may involve commencing works at the furthest point from the identified receivers.
- **Equipment selection** Use the quietest and least vibration emitting construction methods where feasible and reasonable, e.g. use of concrete pulverisers rather than rock hammers.

- Limit equipment in use Only the equipment necessary for the upgrade works will be used at any time. Avoid any unnecessary noise when carrying out manual operations and when operating plant

Simultaneous operation of noisy plant and equipment within discernible range of a sensitive receiver should be avoided/ limited where possible.
- Limit activity duration Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off whilst being unloaded.
- Reversing alarms Alternatives reverse alarm, such as 'quackers' should be installed where feasible and reasonable.

7.3.2 Noise Management Measures

The following actions will be implemented during the construction works to ensure that noise impacts are minimal.

Table 18 – Construction Noise Management Measures

| Management Measure | Detail |
|---|--|
| Implement community consultation measures | Inform community of construction activity and potential impacts |
| Site inductions | All employees, contractors and subcontractors are to receive a Project induction. The environmental component may be covered in toolboxes and must include: <ul style="list-style-type: none"> • all relevant project specific and standard noise and vibration mitigation measures; • relevant licence and approval conditions; • permissible hours of work; • any limitations on high noise generating activities; • location of nearest sensitive receivers; • construction employee parking areas; • designated loading/unloading areas and procedures; • site opening/closing times (including deliveries); and • environmental incident procedures. |
| Behavioural practices | No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height where practicable, throwing of metal items and slamming of doors. |
| 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. |
| Complaints Management Procedure | A management procedure would need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits. |

8 VIBRATION ASSESSMENT

8.1 Vibration Sources

The vibration generated from demolition and construction works associated with the North West Plot will vary depending on the level and type of activity carried out at each site during each activity. Typical plant and equipment in use have been identified in Table 14.

Table 19 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 19.

Table 19 – 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 Assessment

Vibration generated by construction plant was estimated at various distances and expected vibration impacts are shown in Table 20 below.

Table 20 – Potential Vibration Impact Assessment

| Approx. Distance | No. of Receivers Potentially Affected | | Assessment on Potential Vibration Impacts | | |
|------------------|---------------------------------------|--------------------|---|--|---|
| | Residential | Commercial / Other | Structural Damage Risk | Human Disturbance | Vibration Monitoring |
| <20 m | 0 | 2 | Low risk of structural damage | Medium risk of adverse comment as a result of rock breaking, excavator and jackhammer | Vibration monitoring may be required (see Section 7.3.2). |
| 20-<30 m | 1 | 3 | Low risk of structural damage | Low risk of adverse comment | Vibration monitoring may be required (see Section 7.3.2) |

| Approx. Distance | No. of Receivers Potentially Affected | | Assessment on Potential Vibration Impacts | | |
|------------------|---------------------------------------|--------------------|---|---|----------------------|
| | Residential | Commercial / Other | Structural Damage Risk | Human Disturbance | Vibration Monitoring |
| 30-<70 m | 1 | 0 | Very Low risk of structural damage | Very Low risk of adverse comment | Not required |
| >70 m | All other receivers | | Very Low risk of structural damage | Very Low risk of adverse comment | Not required |

Due to the distance between the site and the nearest receivers, the risk of structural damage and human disturbance is assessed as being low.

8.3 Vibration Control Measures

8.3.1 Recommended Minimum Buffer Distances

Based on available data from a database containing vibration measurements from past projects and from library information, Table 21 below presents the recommended minimum working distances for high vibration generating plant.

Table 21 - 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 |
| 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:

1. Renzo Tonin & Associates project files, databases & library
2. Based on DIN4150.3 Group 1 Buildings
3. 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 21 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.

8.3.2 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 21 and provide a site-specific table of minimum working distances
- Where vibration is found to be excessive, management measures shall be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller rock breakers, using alternative processes or establishment of larger minimum working distances.
- Carry out additional vibration monitoring when construction activities are at the nearest point to the nearby sensitive structures. This monitoring may signal to the contractor 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 associated with the proposed commercial office and public car park building within the North West Plot of The Haymarket, being part of the SICEEP. The assessment has been carried out in accordance with the policies and guidelines specified in the Director General's Requirements (DGRs). Where relevant the report has presented recommended mitigation and management measures for the control of noise and vibration for both the construction and operational phases of the development. The report has also identified where additional detailed assessment may be required during the design development phase of the project.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

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

| | |
|--------------------|--|
| Adverse Weather | Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter). |
| Ambient Noise | The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far. |
| Assessment Period | The period in a day over which assessments are made. |
| Assessment Point | A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated. |
| Background Noise | Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below). |
| Decibel [dB] | The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening |
| dB(A): | A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. |
| Frequency | Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz. |
| Impulsive noise | Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise. |
| Intermittent noise | The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more. |
| Lmax | The maximum sound pressure level measured over a given period. |
| Lmin | The minimum sound pressure level measured over a given period. |
| L1 | The sound pressure level that is exceeded for 1% of the time for which the given sound is measured. |
| L10 | The sound pressure level that is exceeded for 10% of the time for which the given sound is measured. |

| | |
|----------------------|--|
| L90 | 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). |
| Leq | The "equivalent noise level" is the summation of noise events and integrated over a selected period of time. |
| Reflection | Sound wave changed in direction of propagation due to a solid object obscuring its path. |
| SEL | Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations. |
| Sound | A fluctuation of air pressure which is propagated as a wave through air. |
| Sound Absorption | The ability of a material to absorb sound energy through its conversion into thermal energy. |
| Sound Level Meter | An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels. |
| Sound Pressure Level | The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone. |
| Sound Power Level | Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power. |
| Tonal noise | Containing a prominent frequency and characterised by a definite pitch. |

APPENDIX B - MANNED MEASUREMENT RESULTS

| ID | Location | Date | Time | Desc | Overall dB(A) | Octave Band Centre Frequency - Hz dB(Z) | | | | | | | | Comments | |
|----|--------------------------|-----------|-----------------|-----------------|---------------|---|----|-----|-----|-----|----|----|----|--|--|
| | | | | | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | | 8k |
| 1 | Harbour St Restaurants | 6/02/2013 | 12:02pm | L ₁₀ | 68 | 75 | 77 | 71 | 66 | 65 | 63 | 60 | 55 | 39 | Noise sources: traffic on Harbour St, pedestrians, mech plant, restaurants Traffic count - 69 |
| | | | - | L _{eq} | 66 | 72 | 73 | 68 | 64 | 64 | 60 | 57 | 52 | 53 | |
| | | | 12:17pm | L ₉₀ | 59 | 66 | 64 | 63 | 60 | 57 | 53 | 48 | 42 | 53 | |
| | | 2:52pm - | L ₁₀ | 66 | 72 | 74 | 69 | 66 | 63 | 61 | 57 | 52 | 41 | Noise sources: traffic on Harbour St, pedestrians, mech plant, restaurants Traffic count - 72 | |
| | | 3:07pm | L _{eq} | 66 | 69 | 75 | 68 | 64 | 64 | 61 | 56 | 52 | 53 | | |
| | | | L ₉₀ | 59 | 64 | 64 | 62 | 60 | 56 | 53 | 47 | 41 | 49 | | |
| | 8/02/2013 | 10:47pm | L ₁₀ | 65 | 72 | 71 | 66 | 63 | 62 | 61 | 57 | 50 | 36 | Noise sources: Road traffic, pedestrian activity, mech plant audible between traffic, Cold Rock. L ₉₀ controlled by mech plant and distant traffic. | |
| | | - | L _{eq} | 63 | 69 | 69 | 65 | 61 | 61 | 59 | 55 | 47 | 45 | | |
| | | 10:55pm | L ₉₀ | 59 | 65 | 64 | 62 | 59 | 57 | 54 | 49 | 42 | 48 | | |
| | 9/02/2013 | 12:07am | L ₁₀ | 64 | 68 | 69 | 66 | 63 | 61 | 60 | 56 | 49 | 33 | Noise sources: All restaurants closed. 15-20 ppl sitting outside McDonalds. Music from Covent Garden hotel audible. L ₉₀ controlled by mech plant. | |
| | | - | L _{eq} | 61 | 66 | 67 | 64 | 60 | 58 | 57 | 52 | 45 | 46 | | |
| | | 12:22am | L ₉₀ | 57 | 63 | 63 | 60 | 57 | 55 | 52 | 46 | 39 | 46 | | |
| 2 | Harbour St - Holiday Inn | 6/02/2013 | 12:23pm | L ₁₀ | 70 | 73 | 75 | 72 | 68 | 66 | 65 | 62 | 56 | 32 | Noise sources: Traffic, pedestrians, distant mech plant. Vehicle count - 88 |
| | | | - | L _{eq} | 67 | 70 | 74 | 69 | 66 | 64 | 62 | 59 | 54 | 45 | |
| | | | 12:38pm | L ₉₀ | 59 | 66 | 65 | 62 | 60 | 56 | 53 | 48 | 41 | 52 | |
| | | 2:28pm - | L ₁₀ | 68 | 76 | 74 | 69 | 66 | 64 | 64 | 59 | 54 | 34 | Noise sources: Traffic, pedestrians, distant mech plant. Vehicle count - 76 | |
| | | 2:44pm | L _{eq} | 65 | 73 | 71 | 67 | 64 | 61 | 61 | 57 | 53 | 51 | | |
| | | | L ₉₀ | 57 | 65 | 65 | 62 | 59 | 55 | 52 | 47 | 39 | 56 | | |
| | 8/02/2013 | 11:55pm | L ₁₀ | 66 | 70 | 73 | 69 | 64 | 62 | 62 | 58 | 50 | 32 | Noise sources: L ₉₀ controlled by mech plant from SEC. Local traffic on Harbour St, dist traffic on Goulburn St. Pedestrian activity. ~15 patrons outside JB's bar - generally inaudible above pedestrians. | |
| | | - | L _{eq} | 64 | 68 | 71 | 67 | 61 | 60 | 60 | 58 | 52 | 37 | | |
| | | 12:10am | L ₉₀ | 57 | 63 | 63 | 61 | 58 | 55 | 52 | 46 | 39 | 39 | | |
| | 9/02/2013 | 12:34am | L ₁₀ | 67 | 68 | 74 | 68 | 64 | 63 | 63 | 59 | 52 | 29 | Noise sources: Road traffic on Harbour St & distant traffic on Goulburn St and pedestrians. | |
| | | - | L _{eq} | 65 | 66 | 74 | 67 | 64 | 62 | 60 | 56 | 51 | 40 | | |
| | | 12:49am | L ₉₀ | 56 | 62 | 62 | 59 | 57 | 54 | 51 | 46 | 38 | 38 | | |

| ID | Location | Date | Time | Desc | Overall dB(A) | Octave Band Centre Frequency - Hz dB(Z) | | | | | | | | Comments | | |
|-----------|----------------------------|-----------------------------|-----------------|-----------------|---------------|---|----|-----|-----|-----|----|----|---|---|---|---|
| | | | | | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | | 8k | |
| 3 | Harbour St - Harbour Plaza | 6/02/2013 - 6/02/2013 | 12:51pm | L ₁₀ | 72 | 80 | 78 | 74 | 69 | 68 | 67 | 63 | 59 | 35 | Noise sources: Road traffic on Harbour St and Goulburn St. Traffic queuing at intersection. | |
| | | | - | L _{eq} | 69 | 78 | 75 | 71 | 67 | 65 | 64 | 60 | 56 | 44 | | |
| | | | 01:06pm | L ₉₀ | 62 | 69 | 69 | 64 | 62 | 59 | 57 | 52 | 47 | 49 | | |
| | | 2:11pm - 2:27pm | L ₁₀ | 69 | 77 | 76 | 71 | 68 | 65 | 64 | 59 | 54 | 41 | Noise sources: Road traffic on Harbour St and Goulburn St. Traffic queuing at intersection. | | |
| | | | L _{eq} | 66 | 74 | 73 | 71 | 67 | 63 | 61 | 57 | 52 | 48 | | | |
| | | | L ₉₀ | 62 | 70 | 68 | 64 | 62 | 59 | 57 | 52 | 46 | 52 | | | |
| | | 8/02/2013 | 10:58pm | L ₁₀ | 66 | 78 | 76 | 71 | 66 | 64 | 61 | 57 | 52 | 37 | | Noise sources: L ₉₀ controlled by mech plant and traffic idling at intersection. Distant traffic, pedestrians. Crowd departing SEC after 11pm. |
| | | | - | L _{eq} | 64 | 75 | 73 | 69 | 64 | 62 | 59 | 55 | 49 | 43 | | |
| | | | 11:13pm | L ₉₀ | 61 | 69 | 68 | 64 | 61 | 58 | 55 | 51 | 44 | 46 | | |
| 9/02/2013 | 12:11am | L ₁₀ | 67 | 75 | 73 | 70 | 65 | 63 | 62 | 58 | 52 | 36 | Noise sources: L ₉₀ controlled by mech plant and traffic idling at intersection. Distant traffic, pedestrians. | | | |
| | - | L _{eq} | 64 | 71 | 71 | 69 | 63 | 60 | 59 | 55 | 49 | 41 | | | | |
| | 12:27am | L ₉₀ | 59 | 64 | 64 | 61 | 58 | 55 | 54 | 49 | 42 | 41 | | | | |
| 4 | Novotel | 6/02/2013 | 1:08pm - 1:23pm | L ₁₀ | 63 | 74 | 73 | 68 | 64 | 60 | 57 | 54 | 52 | 30 | Noise sources: Road traffic on Harbour St, and Goulburn St. L ₉₀ controlled by distant traffic and mech plant. Insects intermittent. | |
| | | | - | L _{eq} | 61 | 71 | 70 | 67 | 62 | 58 | 55 | 51 | 47 | 34 | | |
| | | | 1:24pm - 1:40pm | L ₉₀ | 58 | 66 | 66 | 62 | 59 | 56 | 52 | 48 | 41 | 36 | | |
| | | 1:24pm - 1:40pm | L ₁₀ | 63 | 73 | 72 | 67 | 63 | 60 | 58 | 56 | 50 | 29 | Noise sources: Road traffic on Harbour St, and Goulburn St. L ₉₀ controlled by distant traffic and mech plant. Insects intermittent. | | |
| | | | L _{eq} | 61 | 71 | 70 | 65 | 62 | 58 | 56 | 53 | 47 | 43 | | | |
| | | | L ₉₀ | 58 | 66 | 65 | 61 | 59 | 56 | 52 | 48 | 42 | 45 | | | |
| | | 8/02/2013 | 11:37pm | L ₁₀ | 62 | 73 | 71 | 67 | 62 | 59 | 57 | 54 | 48 | 29 | Noise sources: L ₉₀ controlled by mech plant and dist traffic. SEC crowds dispersed. Typical pedestrian activity. | |
| | | | - | L _{eq} | 60 | 70 | 69 | 64 | 60 | 57 | 55 | 52 | 45 | 44 | | |
| | | | 11:53pm | L ₉₀ | 58 | 67 | 65 | 61 | 58 | 55 | 52 | 48 | 41 | 47 | | |
| 9/02/2013 | 12:31am | L ₁₀ | 59 | 68 | 70 | 65 | 60 | 56 | 54 | 51 | 45 | 33 | Noise sources: L ₉₀ controlled by mech plant from SEC and above Pumphouse/Novotel. Pumphouse closed. | | | |
| | - | L _{eq} | 58 | 66 | 67 | 62 | 58 | 55 | 52 | 49 | 42 | 42 | | | | |
| | 12:48am | L ₉₀ | 55 | 63 | 63 | 58 | 56 | 53 | 50 | 45 | 38 | 46 | | | | |

| ID | Location | Date | Time | Desc | Overall dB(A) | Octave Band Centre Frequency - Hz dB(Z) | | | | | | | | Comments | | |
|-----------|------------------|-----------------|-------------------|-----------------|---------------|---|----|-----|-----|-----|----|----|---|----------|---|---|
| | | | | | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | | 8k | |
| 5 | Pumphouse | 6/02/2013 | 12:54pm - 1:09pm | L ₁₀ | 63 | 71 | 72 | 69 | 64 | 60 | 58 | 53 | 50 | 30 | Noise sources: L ₉₀ controlled by fountain located under Pier St overpass. Mech plant from Novotel, traffic on Goulburn St and Harbour St. Patron noise from Pumphouse indistinguishable from pedestrians. | |
| | | | | L _{eq} | 61 | 69 | 70 | 66 | 62 | 59 | 56 | 51 | 48 | 38 | | |
| | | | | L ₉₀ | 59 | 65 | 66 | 62 | 60 | 56 | 53 | 48 | 42 | 41 | | |
| | | | 1:29pm - 1:44pm | L ₁₀ | 63 | 72 | 72 | 68 | 64 | 61 | 58 | 54 | 50 | 26 | | |
| | | | | L _{eq} | 62 | 69 | 70 | 66 | 62 | 59 | 56 | 52 | 48 | 41 | | |
| | | | | L ₉₀ | 60 | 66 | 66 | 62 | 61 | 57 | 54 | 49 | 44 | 38 | | |
| | | 8/02/2013 | 10:42pm - 10:57pm | L ₁₀ | 67 | 71 | 72 | 74 | 69 | 64 | 62 | 58 | 54 | 25 | | Noise sources: Music from Pumphouse (doors open), mech plant from SEC and Novotel. No patrons visible in Pumphouse. Fountain not operating. Pedestrians. Traffic on overpass. |
| | | | | L _{eq} | 65 | 70 | 70 | 71 | 67 | 62 | 61 | 56 | 51 | 40 | | |
| | | | | L ₉₀ | 63 | 66 | 67 | 66 | 63 | 59 | 56 | 52 | 47 | 36 | | |
| | | 8/02/2013 | 11:21pm - 11:36pm | L ₁₀ | 66 | 75 | 72 | 78 | 66 | 64 | 61 | 56 | 50 | 31 | | Noise sources: Pumphouse closed, music still playing. Higher pedestrian activity due to patrons departing SEC event. Fountain off. |
| | | | | L _{eq} | 65 | 73 | 70 | 75 | 65 | 62 | 59 | 54 | 49 | 39 | | |
| | | | | L ₉₀ | 62 | 71 | 67 | 67 | 62 | 59 | 55 | 50 | 43 | 36 | | |
| 9/02/2013 | 12:50am - 1:05am | L ₁₀ | 60 | 66 | 68 | 64 | 62 | 58 | 56 | 51 | 44 | 39 | Noise sources: Mech plant from SEC and Pumphouse/Novotel. Pumphouse closed. | | | |
| | | L _{eq} | 59 | 64 | 66 | 62 | 60 | 57 | 54 | 49 | 41 | 53 | | | | |
| | | L ₉₀ | 57 | 62 | 62 | 58 | 58 | 55 | 51 | 45 | 37 | 53 | | | | |
| 6 | Darling Dr | 6/02/2013 | 12:25pm - 12:40pm | L ₁₀ | 68 | 70 | 71 | 65 | 63 | 63 | 65 | 60 | 53 | 41 | Noise sources: Traffic on Darling Drive. Dist traffic on Pier St. Two light-rail pass-bys (corner squeal). Dist mech plant from direction of SEC. | |
| | | | | L _{eq} | 64 | 68 | 68 | 62 | 59 | 59 | 61 | 56 | 49 | 53 | | |
| | | | | L ₉₀ | 53 | 63 | 61 | 56 | 53 | 50 | 49 | 43 | 35 | 49 | | |
| | | | 2:15pm - 2:30pm | L ₁₀ | 70 | 71 | 72 | 66 | 63 | 64 | 67 | 62 | 54 | 36 | | Noise sources: Traffic on Darling Drive. Dist traffic on Goulburn St. Two light-rail pass-bys (corner squeal). Dist mech plant from direction of SEC. |
| | | | | L _{eq} | 65 | 68 | 70 | 63 | 60 | 60 | 62 | 57 | 50 | 45 | | |
| | | | | L ₉₀ | 53 | 64 | 62 | 56 | 52 | 50 | 49 | 44 | 37 | 48 | | |
| | | 8/02/2013 | 11:03pm - 11:18pm | L ₁₀ | 68 | 75 | 71 | 64 | 61 | 62 | 66 | 61 | 53 | 33 | Noise sources: L ₉₀ controlled by passing traffic on Darling Drive. Three light-rail pass-bys (corner squeal). 11.10pm increase of cars departing carpark (end of event) | |
| | | | | L _{eq} | 64 | 72 | 69 | 63 | 59 | 60 | 61 | 57 | 49 | 46 | | |
| | | | | L ₉₀ | 55 | 65 | 63 | 56 | 52 | 51 | 51 | 46 | 40 | 46 | | |

| ID | Location | Date | Time | Desc | Overall dB(A) | Octave Band Centre Frequency - Hz dB(Z) | | | | | | | | Comments | | |
|-----------|-------------------|-----------------|-------------------|-----------------|---------------|---|----|-----|-----|-----|----|----|---|--|--|--|
| | | | | | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | | 8k | |
| 7 | UTS | 9/02/2013 | 12:54am - 1:09am | L ₁₀ | 63 | 65 | 66 | 60 | 57 | 58 | 60 | 55 | 48 | 32 | Noise sources: Road traffic, distant mech plant. One light-rail pass-by. | |
| | | | | L _{eq} | 60 | 63 | 64 | 63 | 55 | 54 | 57 | 52 | 44 | 45 | | |
| | | | | L ₉₀ | 50 | 59 | 59 | 53 | 50 | 47 | 46 | 40 | 34 | 52 | | |
| | | 6/02/2013 | 12:01pm - 12:16pm | L ₁₀ | 62 | 69 | 72 | 66 | 63 | 60 | 56 | 52 | 46 | 34 | | Noise sources: Two tram pass-bys (corner squeal, impulsive at expansion joints in concrete). Distant mech plant and traffic from CBD. Traffic, incl. trucks on Harbour St. |
| | | | | L _{eq} | 61 | 70 | 70 | 65 | 61 | 59 | 57 | 52 | 48 | 51 | | |
| | | | | L ₉₀ | 55 | 63 | 63 | 60 | 56 | 53 | 50 | 44 | 37 | 56 | | |
| | | 2:38pm - 2:53pm | L ₁₀ | 62 | 70 | 72 | 68 | 63 | 60 | 57 | 53 | 45 | 32 | Noise sources: Three tram pass-bys (corner squeal, impulsive at expansion joints in concrete). Distant mech plant and traffic from CBD. Traffic, incl. trucks on Harbour St. | | |
| | | | L _{eq} | 61 | 69 | 70 | 65 | 61 | 59 | 56 | 52 | 48 | 37 | | | |
| | | | L ₉₀ | 55 | 64 | 63 | 61 | 57 | 53 | 49 | 43 | 36 | 39 | | | |
| 8/02/2013 | 11:48pm - 12:03pm | L ₁₀ | 59 | 73 | 71 | 65 | 61 | 57 | 55 | 49 | 43 | 29 | Noise sources: Road traffic on Darling Drive. L ₉₀ controlled by distant traffic and mech plant from CBD. Two light-rail pass-bys. | | | |
| | | L _{eq} | 62 | 74 | 71 | 64 | 61 | 58 | 59 | 51 | 47 | 40 | | | | |
| | | L ₉₀ | 55 | 66 | 63 | 60 | 56 | 52 | 49 | 43 | 36 | 38 | | | | |