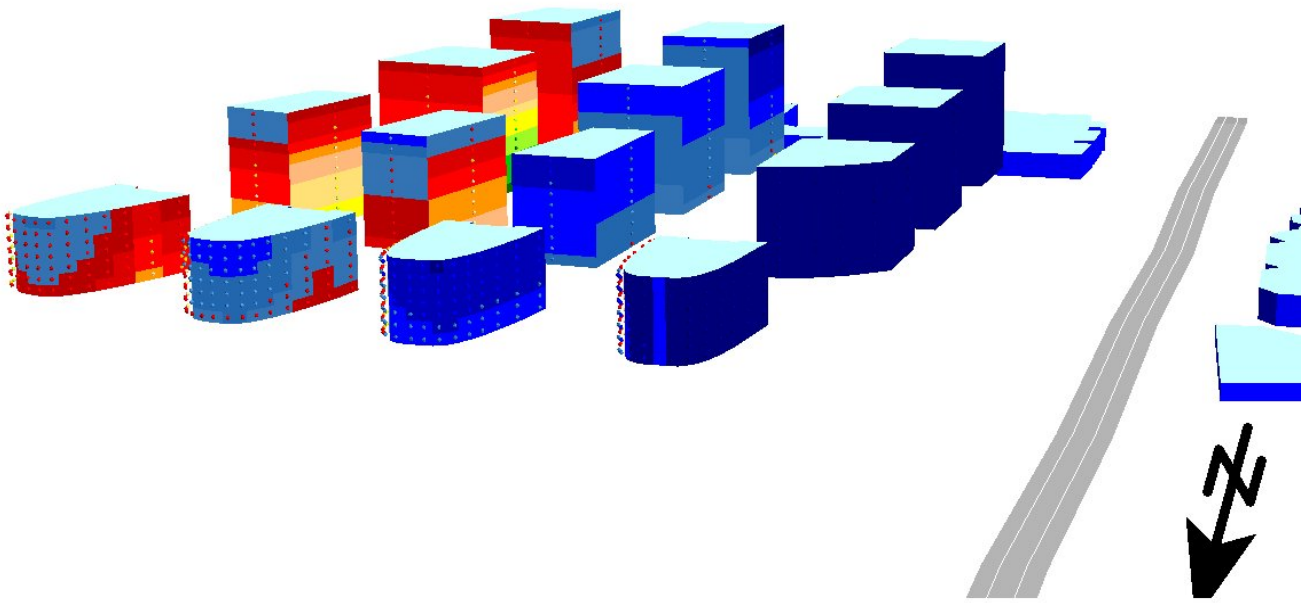
Statewide Planning Pty Ltd

181 James Ruse Drive Camellia West NSW 2142

Acoustic Assessment for Planning Proposal Application



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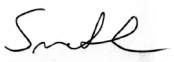
ISSUED BY:		
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EXECUTIVE SUMMARY

Vipac Engineers & Scientists Ltd. (VIPAC) has been commissioned by Statewide Planning Pty Ltd to assess the acoustic interaction of the proposed mixed use residential development at 181 James Ruse Drive, Camellia with the surrounding environment.

This report is part of the application for rezoning and the assessment has been based on the most recent drawings available at the time – Architectural drawing set, issue date of 18th May 2012.

A detailed acoustic survey has been completed to establish the ambient and background noise conditions.

Project specific levels have been determined in accordance with the Local Council and relevant NSW Policies. Operational noise emission from development should be controlled in accordance with these levels.

Traffic noise generation due to the proposed development is not expected to increase traffic noise levels.

Rail noise and vibration is not expected to impact on the development.

Through optimising the layout and orientation of the development and by using building facades with appropriate acoustic performance the development will be able to achieve internal noise goals and provide suitable acoustic amenity.

With implementation of appropriate acoustic measures a development of this nature will be able to comply with all the relevant standards and guidelines.

In conclusion the site is therefore considered acoustically suitable for the intended development.

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1 INTRODUCTION

Vipac Engineers & Scientists Ltd. (VIPAC) has been commissioned by Statewide Planning Pty Ltd to assess the acoustic interaction of the proposed mixed use residential development at 181 James Ruse Drive, Camellia with the surrounding environment.

This report is part of the application for rezoning and the assessment has been based on the most recent drawings available at the time – Architectural drawing set, issue date of 18th May 2012.

2 SITE AND DEVELOPMENT DETAILS

The existing site was formerly used as an industrial facility and currently lies vacant. It is bounded by James Ruse Drive to the west and Parramatta River to the north. Immediately south of the site there are offices and a family entertainment centre. The site is located in close proximity to the railway line running between Carlingford and Clyde stations. The railway line runs parallel to the eastern boundary of the site and is located approximately 30m of the base of the nearest proposed building. Camellia station is located to the south-east of the site and has approximately 52 trains pass through each day. James Ruse Drive is a major road and has a high daily traffic volume.

The proposed development will remediate and redevelop the site to provide a new mixed use commercial development consisting of:

- 2 Basement carpark levels
- 2 Retail/café levels
- Buildings A – N, multiunit residential comprising 7 – 16 storeys each

2.1 SENSITIVE RECEIVERS

The nearest sensitive receivers are shown in Figure 1 and are summarised as follows:

- SR1 – Offices and family entertainment centre
- SR2 – Offices
- SR3 – Residential properties shielded from James Ruse Drive
- SR4 – Residential properties along James Ruse Drive
- SR5 – Educational facilities
- SR6 – Commercial and Industrial

2.2 SITE ACOUSTIC ISSUES

Due to the proximity of the development to James Ruse Drive and the Carlingford rail corridor there is potential for external noise and vibration intrusion. There is also potential for noise generated by the commercial aspect of the development to impact on existing surrounding sensitive receivers including the potential increase in road traffic noise. The acoustic issues considered as part of this assessment are as follows:

- Construction Noise and Vibration
- Traffic and rail noise intrusion to the proposed development
- Ground vibration intrusion from the rail corridor to the proposed development
- Increased traffic noise levels impacting onto surrounding sensitive receivers due to additional traffic on James Ruse Drive;
- Operational Noise generated from the development to existing noise sensitive receivers including mechanical plant.

Figure 1: Site details and measurement locations – *(picture courtesy of Google Earth)*

3 ACOUSTIC AND VIBRATION STANDARDS

The following standards and guidelines are applicable to this assessment:

- Parramatta City Council
- NSW OEH "The Interim Construction Noise Guideline 2009"
- NSW DoP Development Near Rail Corridors and Busy Roads - Interim Guideline (DNRCBR)
- Australian standard AS/NZS 2107-2000: Acoustics – Recommended design sound levels and reverberation times for building interiors.
- NSW OEH Road Noise Policy
- NSW OEH Industrial Noise Policy
- BS6472 "Assessing Vibration: a technical guideline"
- Australian standard AS 1055.1-1997: Acoustics - Description and measurement of environmental noise - General procedures.

The criteria above have been summarised based on their relevance to the specific acoustic issues that are to be addressed to maintain future occupant acoustic amenity and any noise impacts that may affect existing sensitive land uses around the site.

3.1 CONSTRUCTION NOISE AND VIBRATION

3.1.1 NSW OEH "The Interim Construction Noise Guideline".

The NSW Interim Construction Noise Guideline developed by the NSW Office of Environment and Heritage contains detailed procedures for the assessment and management of construction noise impacts.

The Guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer-term construction, and the qualitative method, which is generally suited to short-term works such as infrastructure maintenance.

3.1.1.1 Residences and other sensitive land uses

Due to the length of the required works a quantitative method will be followed and the noise management levels presented in table 1 adopted.

Table 1: Noise at Residences Using Quantitative Assessment

Time of day	Management level, $L_{Aeq(15min)}$	How to apply
Recommended standard hours Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays and Public Holidays	Noise affected RBL+10dB	The noise affected level represents the point above which there may be some community reaction to noise. • *Where the predicted or measured LAeq(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
	75dBA
		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 hours	Noise affected RBL+5dB	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 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2. of guideline.
• *Note: The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).*		

Table 2: Noise At Sensitive Land Uses (Other Than Residences) Using Quantitative Assessment

Land Use	Management level, $L_{Aeq(15min)}$ (Applies when properties are being used)
Active recreation areas	External Noise Level – 65 dB(A)
Passive recreation areas	External Noise Level – 60 dB(A)
Classrooms at schools and other educational institutions	Internal Noise Level – 45 dB(A)
Places of worship	Internal Noise Level – 45 dB(A)

Where internal noise management levels are specified, the external noise level may be 10dB(A) greater for buildings with no adequate ventilation or 20dB(A) for buildings with fixed external windows and alternative means of ventilation.

3.1.1.2 Commercial and Industrial

For commercial premises including offices and retail outlets, the recommended noise management level is an external $L_{Aeq(15min)}$ 70 dB(A) assessed at the most-affected point on the premises. For industrial premises an $L_{Aeq(15min)}$ 75 dB(A) applies.

The construction works are considered to have the potential to cause a noise impact if the expected noise exceeds these levels.

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 5 dB(A) above the noise affected level, the proponent should negotiate with affected parties.

3.2 OPERATIONAL NOISE EMISSION

To control impact from site generated noise the following applies:

3.2.1 Noise Guide For Local Government

The Office of Environment and Heritage (OEH) document, Noise Guide for Local Government (NGLG) provides a guide into considering the impact of an intrusive noise emissions from a site such as that typically from mechanical services i.e. air conditioning. Under the NGLG, noise is 'intrusive' if it is noticeably louder than the background noise and considered likely to disturb or interfere with those who can hear it.

The assessment of intrusive noise levels would be conducted in accordance with the procedures as set out in the NSW Industrial Noise Policy (EPA 2000), which defines intrusive noise as 5 decibels above the background (L_{90}) noise level.

The procedures have been considered to measure the background noise and the limit of allowable noise emission from the proposed site. The policy also considers the permitted noise level where tones or impulses are predicted.

3.2.2 NSW Industrial Noise Policy

The procedures detailed in OEH INP have been considered to determine the limit of allowable noise emission from the proposed site. The assessment procedure has two requirements that must be met, namely:

- that the noise source not be 'intrusive'; and also
- that the 'amenity' of the nearby land be preserved.

This policy sets out two separate noise criteria designed to ensure developments meet environmental noise objectives. The first criterion accounts for intrusive noise and the second criterion applies to protection of amenity of particular land uses. Applying both the amenity and intrusiveness criteria to the situation and adopting the more stringent of the two is used to assess the new development. This becomes the project specific noise levels.

Applying the most stringent requirement as the project specific noise levels ensures that both intrusive noise is limited and the amenity is protected.

3.2.3 NSW OEH Road Noise Policy

Noise from traffic movements to and from the site including truck and car movements will be assessed using the NSW OEH Road Noise Policy (RNP).

Table 3 presents the OEH's road traffic noise assessment criteria for land use developments with potential to create additional traffic on existing roads. The external criteria are assessed at 1 metre from the affected residential building façades and at a height of 1.5 metres from the floor.

Table 3: Road Traffic Noise Assessment Criteria for Residential Land Use.

Road category	Type of project/land use	Assessment criteria, dBA	
		Day :7am to 10 pm	Night :10 pm to 7 am
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{eq\ (1\ hr)}$ 55 (External)	$L_{eq\ (1\ hr)}$ 50 (External)

Note: In cases where noise exceeds the above criteria:

1. The OEH recommends that "where feasible, existing noise levels should be mitigated to meet the noise criteria. In this regard the RNP states that for existing roads there is limited potential for noise control as the development is not linked to road improvements. It does however advise that applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments."
2. For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.

In addition to above assessment criteria, the RNP requires any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development to be considered. The relative increase criteria outlined in the RNP is presented in Table 4.

Table 4: Relative Increase Criteria for Residential Land Use.

Road Category	Type of project / land use	Total traffic noise level increase, dB(A)	
		Day (7am - 10pm)	Night (10pm-7am)
Freeway/ arterial/ sub-arterial roads and transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq, (15\ hour)}$ + 12dB (external)	Existing traffic $L_{Aeq, (9\ hour)}$ + 12dB (external)

3.3 OCCUPANT ACOUSTIC AMENITY

3.3.1 NSW DoP Development Near Rail Corridors and Busy Roads - Interim Guideline (DNRCBR)

The DoP Interim Guideline provides internal noise level criteria for residential buildings near rail corridors or busy roads, which are detailed in Table 5 below.

Table 5: DoP Development Near Rail Corridors and Busy Roads – Noise Criteria

Type of occupancy/activity	Noise Level	Applicable time Period
Residential Buildings		
Sleeping areas (bedroom)	35 dBA	10 pm – 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40 dBA	At any time

In addition to Table 5 above, the DoP guideline states the following:

"If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also meet the ventilation requirements of the Building Code of Australia."

3.3.2 Parramatta Council DCP

The Parramatta City Council Development Control Plan 2011 states that the provisions of the State Environmental Planning Policy (Infrastructure) 2007 and Development near Rail Corridors and Busy Roads Interim Guideline must be taken into consideration to minimise impacts of busy roads and railway corridors on residential and other sensitive developments. It also states the following, in regards to acoustic amenity:

"Internal habitable rooms of dwellings affected by high levels of external noise are to be designed to achieve internal noise levels of no greater than 50dBA."

3.3.3 AS/NZS 2107-2000

AS/NZS 2107–2000 outlines the acceptable internal noise levels such that a satisfactory acoustic environment within occupied spaces in new and existing buildings can be achieved. Typically, the recommended internal noise level L_{Aeq} for fully furnished spaces should meet the criteria presented below for steady state noise.

Table 6: AS/NZS 2107-2000 - Recommended Design Sound Levels for building interiors

Type of occupancy/activity	Recommended design sound level L_{eq} dB(A)	
	Satisfactory	Maximum
Houses and apartments near major road		
Living areas	35	45
Sleeping areas	30	40
Work areas	35	45
Apartment common areas	45	55
Commercial & shop buildings		
General office area	40	45
Small retail stores (general)	45	50
Public spaces (eg speciality shops)	40	45

3.4 RAIL VIBRATION – HUMAN PERCEPTION

The following guidelines relate to assessing train vibrations and human perceptibility.

3.4.1 The DoP Development Near Rail Corridors and Busy Roads– Interim Guideline

The DoP Development Near Rail Corridors and Busy Roads – Interim Guideline provides guidance on when a rail vibration assessment may be required, as detailed below. The vibration assessment zone for typical development sites adjacent to rail corridors or above rail tunnels is as follows:

- Within 25m - Single residential buildings on “Hard” ground, such as sandstone;
- Within 60m - Other vibration sensitive buildings.

Developments within these zones will need a vibration assessment. The following sections provide details of the relevant criteria to apply when a vibration assessment is required. Due to the proximity of the proposed to the rail line a vibration assessment has been completed.

3.4.1.1 "Assessing Vibration: a technical guideline" / BS6472

This guideline for assessing vibration provides evaluation methods to assess the human response from continuous, impulsive and intermittent vibration in buildings from 1Hz to 80Hz which is based on British Standards BS6472:1992 "Evaluation of the Human Exposure to Vibration in Building (1Hz to 80Hz)".

The Vibration Dose Value in the BS6472 is a concept used to evaluate the cumulative effects of bursts of both intermittent vibration and impulsive vibration such as that from train pass by's.The Vibration Dose Value (VDV) represents a single value amount used to quantify the level of vibration. The following table presents levels of VDV expressed in day-time, night-time and typical human response.

Table 7: Acceptable vibration dose values ($m/s^{1.75}$) for intermittent vibration in residential buildings

Daytime		Night-time	
Preferred value	**Maximum Value**	**Preferred Value**	**Maximum value**
0.20	0.40	0.13	0.26

Vibration levels below the preferred values correspond to a low probability of adverse comment or disturbance to building occupants. Adverse comment or complaints may be expected when the VDV approaches maximum levels. Values up to the maximum level can only be used where all reasonable and feasible measures have been implemented and they can be justified.

4 SITE ENVIRONMENTAL NOISE & VIBRATION SURVEY

4.1 METHODOLOGY

4.1.1 Noise

Unattended and attended noise monitoring was conducted at the site to obtain existing background, ambient and traffic noise levels. The locations are shown in Figure 1.

- (MP1) The corner of James Ruse Drive and Thomas Street – Unattended, 8th to 21st May 2012. Monitoring at this location has been carried out to measure road traffic noise. The measurement results have been used to prepare a road traffic model for the site.
- (MP2) The corner of Broughton and Pemberton Street – Unattended, 8th to 21st May 2012. This location was selected to obtain ambient noise and background noise data representative of sensitive receivers to the north-west of the site.

- (MP3) Grand Avenue North – Unattended, 27th to 29th June 2012. This location was selected to obtain ambient noise and background noise data representative of the south east of the site.
- (MP4) South boundary of site location – Attended, 29th June 2012. This location was selected to obtain ambient noise and background noise data indicative of noise levels at the south boundary of the site.

The noise loggers internal software calculated and stored the L_n percentile noise levels for each 15 minute sampling period. Measurements were made of L_{Amin}, L_{Amax}, L_{A90}, L_{A10}, and L_{Aeq}.

4.1.2 Vibration

At the time of ViPAC's site visit to obtain rail measurements, the Carlingford line was undergoing engineering works with buses replacing trains. Vibration data has been used from previous jobs where similar distances and ground foundations were involved.

4.2 INSTRUMENTATION

Measurements were conducted using the following equipment:

Equipment	Serial Number
Larson Davis Integrating Sound Level Analyser, Model 812	0385
Larson Davis Integrating Sound Level Analyser, Model 812	0381
B&K sound analyser 2250, Serial Number	2590541
Bruel & Kjaer Sound Level Calibrator Type 4230	378285

The instruments were checked for calibration immediately before and after the measurements and there was no adverse deviation between the two. The instruments carry traceable calibration certificates. The sound analysers are Type 1 and comply with the Australian standard AS1259.2: 1990.

4.3 SURVEY RESULTS

Noise monitoring data has been evaluated to establish background and ambient noise levels as well as road traffic noise levels expected at the site. The results are summarised below.

4.3.1 Background and Ambient Noise

Table 8 presents a summary of the acoustic environment around the site. Measurements have been made for the following assessment periods:

- Day - 7am to 6pm.
- Evening - 6pm to 10pm.

- Night - 10pm to 7am.

Table 8: Measurement results

Location	Time period	L_{Aeq}	L_{A10}	L_{A90}	Observations
MP1	Day	76.4	79.9	70.2	James Ruse Drive road traffic noise
	Evening	75.1	78.4	65.9	
	Night	73.0	79.3	52.1	
MP2	Day	54.0	58.8	44.4	Background levels north west of site
	Evening	52.0	56.5	47.5	
	Night	49.0	53.0	42.0	
MP3	Day	57.5	60.9	57.5	Background levels south east of site
	Evening	56.5	60.7	56.5	
	Night	54.7	59.2	54.7	
MP4	Day	56.6	59.2	49.0	Background south boundary

Existing background noise levels has been determined based on the procedure as detailed in the NSW Industrial Noise Policy.

Based on ViPAC's visit to site, and from the unattended measurement results, the ambient noise levels were dominated by road noise from the adjacent road corridor and the general "Urban Hum" from nearby industrial premises.

4.3.2 Road Traffic Noise

Measurement results from MP1 were used to determine road traffic noise from James Ruse Drive and are presented in Table 9.

Table 9: Traffic noise levels

Location	Day (0700 – 2200) $L_{Aeq\ (15hr)}$ (dB)	Night (2200 – 0700) $L_{Aeq\ (9hr)}$ (dB)
James Ruse Drive	75.9	72.6

4.3.3 Rail Noise

Rail noise measurements of the Carlingford line have not been possible at this time due to engineering works.

5 PROJECT SPECIFIC NOISE EMISSION GOALS

The results of the noise surveys and criteria as summarised in section 4.3 have been used to derive project specific environmental noise emission goals associated with the development. These are summarised in Table 10.

Table 10: Site noise emission limits

Receiver Location	Period	Existing Noise levels dBA		Operational noise goals (dBA)		
		L_{Aeq}	RBL	INP Amenity	INP Intrusiveness	Project Specific Level
SR4	Day	76	70	55	75	**55**
	Evening	75	66	45	71	**45**
	Night	73	52	40	57	**40**
SR3	Day	54	44	55	49	**49**
	Evening	52	47	45	52	**45**
	Night	49	42	40	47	**40**
Commercial (SR1, SR2)	When in use	-	-	65-70	-	**65-70**
Industrial (SR6)	When in use	-	-	70-75	-	**70-75**
Active Recreation Area (SR1)	When in use	-	-	55-60	-	**55-60**
School classroom – internal (SR5)	When in use	-	-	35-40	-	**35-40**

6 ASSESSMENT AND RECOMMENDATIONS

6.1 CONSTRUCTION NOISE AND VIBRATION

In order to manage the noise from the construction activities the following work practices and procedures are to be considered:

- Adherence to the NSW OEH recommended preferred hours for construction and deliveries;
- Turn off plant that is not being used;
- Avoid demolition of existing buildings using rock breaks, but rather demolishing structures with jaw crushers and saws;
- Consider using bored piling instead of impact piling to reduce noise;
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms;

- Truck drivers are to be informed of site access routes, acceptable delivery hours and minimising extended periods of engine idling;
- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers;
- When selecting equipment ensure where feasible and reasonable it has the most effective mufflers, enclosures and low-noise tool bits and blades. Always seek the manufacturer's advice before making modifications to plant to reduce noise;
- Locate noisy plant away from potentially noise-affected areas or behind barriers, such as sheds or walls;
- Construct purpose built barriers or screens where required;
- Table 11 is an excerpt from 'Noise Sources, remedies and their effectiveness' Australian Standard 2436:2010, presenting possible noise reductions from various control mechanisms.

Table 11: Excerpt from AS 2436:2010 – Relative Effectiveness of Various Forms of Noise Control

Control by	Noise Reduction Possible in Practice, dB(A)
Distance	Approximately 6 for each doubling of distance
Screening	Normally 5 to 10, maximum 15
Enclosure	Normally 15 to 25, maximum 50
Silencing	Normally 5 to 10, maximum 20

6.2 OPERATIONAL NOISE ASSESSMENT

The following section details the operational noise assessment and considers noise generated by the site that has potential to impact on adjacent noise sensitive receivers.

6.2.1 Mechanical Plant

Mechanical noise emission from development should be controlled in accordance with the Project Specific Noise Level criteria as shown in Table 10.

At this stage, the design and selection of the plant required to service the proposed development has not been determined therefore the possible noise impact cannot be assessed. During the detailed design stages of the project the mechanical services consultant should select plant so that the total mechanical services noise does not exceed the lowest project specific noise level at the common boundary of the receiver.

In general, based on previous experience with similar sized developments, a number of amelioration measures can be implemented to control the noise emission. Typical amelioration measures are outlined below (not necessarily limited to):

- Location of mechanical services equipment away from noise sensitive receivers.
- Achieving no direct 'line of sight' path between the nearest residence and all the major mechanical equipment or exhaust fans.
- Installation of low noise condenser units.
- Installation of barriers and acoustic enclosures where the above measures do not provide sufficient attenuation.
- Installation of all mechanical equipment on vibration isolators (pads) as recommended by the manufacturers.

6.2.2 Commercial Tenancies / Loading Dock Areas

The nature of the commercial components of the development and service areas (such as loading docks) coupled with the location of the proposed residential units above means there is potential for airborne and structureborne transfer of noise and vibration via structural elements including columns, walls and separating floors. Acoustic issues include:

- Delivery and collection vehicles inside loading docks
- Waste collection & refuse compactors
- Movement of stock trolleys, pallet jacks
- Use of hydraulic scissor lifts
- Handling and movement of stock pallets
- Manual handling of stock
- Use of floor cleaning / buffing machines
- Mechanical services noise
- Background music played in stores

The airborne noise emissions from loading docks could also cause a noise impact upon the nearby residences. The amount of noise impact depends on the noise level of equipment used in the loading dock, however such noise impacts can be minimised by careful positioning of the docks, providing acoustic absorption linings to the bay and the entrance and by installation of doors to enclose the area.

It is recommended that during the detailed design and construction certification stages further assessments are completed to evaluate the noise and vibration transfer into the residential apartments and ensure that where required suitable treatment is built into the development to minimise such transfer.

It is likely that a combination of engineering controls and management controls would be required. Examples of engineering noise controls may include vibration isolated plant including mechanical services, refuse compactors, suitable vibration isolation for floors and other structural elements to minimise transfer of noise from stock cage movements and the like.

Examples of management practices include use of manual handling procedures to minimise incidents of poor stock handling practices as well as restricting the times of use for certain higher noise activities such as deliveries and use of compactors.

6.2.3 Traffic noise generation

It is unlikely that traffic noise generated on James Ruse Drive from the development will increase existing noise levels by 2dB(A). However, a full assessment should be completed once a traffic report is available. There are no local roads that will be affected by this development in terms of traffic generation.

6.3 OCCUPANT ACOUSTIC AMENITY

6.3.1 Rail Vibration Perceptibility

Previous train vibration measurements were used to provide the most representative levels that an occupant will be exposed to within the proposed multi-use development. With the measured values, the estimated Vibration Dose Value (eVDV) was calculated based on the number of train movements.

- Train passage duration – 10 to 20 seconds (average)
- Estimated number of train movements;
    - Day Period = 38
    - Night Period = 14

Based on the results of the assessment detailed in Table 12 below, vibration levels are within the relevant criteria and therefore there is not expected to be any requirement to treat the impact from rail vibration on the development in regards to human perception.

Table 12: eVDV of Vibration calculations from Rail Pass-by's

Period	eVDV in $m/s^{1.75}$	Preferred value
Day	0.0019	0.2000
Night	0.0015	0.1300

6.3.2 External road traffic / rail noise intrusion

The buildings will need to be designed to reduce noise impacts on occupants and to achieve the following internal noise goals:

- Living rooms = 40 dBA
- Bedrooms = 35 dBA

Road traffic and rail noise levels have been predicted across the site using the SoundPLAN modelling software. The model has been based upon the most recently released architectural drawings dated 18th May 2012.

Road traffic noise has been predicted using forecast traffic flows for the year 2022. Rail noise levels have been predicted based upon the present timetable of approximately 52 train passes per day and train noise measurements taken from ViPAC's noise data library. Existing traffic noise levels measured at location MP1 have been used to calibrate the model.

Noise contour maps for predicted day and night levels are presented in Appendix A. Predicted day and night level results are shown in Appendix B for each building façade and floor.

The predictions show highest levels of road traffic noise are expected at buildings D, H, K and N. The levels are expected to be up to 73dB $L_{Aeq,\ 15hrs}$ on the western facades. Buildings C, G, J and M are predicted to receive road traffic noise levels of up to 64dB $L_{Aeq,\ 15hrs}$. Buildings A, B, E, F, I and L are shielded by the other buildings and will receive less road traffic noise.

Predicted rail noise levels on the development from the Carlingford corridor will be low due to the infrequency of the trains. Maximum noise levels predicted to the nearest building are 54dB $L_{Aeq,\ 15hrs}$. Based on the existing rail operations no mitigation for noise intrusion would be required.

Overall the site is considered suitable for residential use as long as appropriate noise mitigation is utilised to ensure internal noise amenity goals are achieved. Noise mitigation options and their suitability ranging from noise path controls through to architectural treatments are considered below:

6.3.2.1 Source and Path Controls

The benefits of acoustic shielding provided by a noise barrier has been considered for the site to minimise traffic noise incident on the residential building facades. Due to the width of the James Ruse Drive, proposed height of the residential units and the height required to shield the occupants, this measure would not be feasible.

6.3.2.2 Architectural

In addition to correct specification of the façade and building envelope opportunities exist at the site to optimise layout, building orientations and location of habitable rooms to limit the impact of external noise intrusion.

The following design principles should be considered with regards to achieving acoustic amenity:

- Non sensitive spaces such as entries, halls, storage rooms, bathrooms and laundries and service areas should be located where practical on the noise affected side of each dwelling and should be able to be sealed off by doors from living areas and bedrooms where practicable.
- Appropriate materials with acoustic properties should be incorporated such as solid core doors with seal vents and insulation and suitably treated glazing.

As part of the assessment ViPAC has reviewed the typical building envelope acoustic treatments that would be required to achieve internal noise goals.

Floor by floor traffic noise predictions have been made to each building façade. Approximate calculations have been made to estimate the minimum acoustic performance requirements for living areas and bedrooms. Calculations are approximate at this stage and a more detailed assessment should be completed during the detailed design stages once internal room dimensions, wall construction and the glazing dimensions are available. The assessment results are contained in Appendix B.

A standard 190mm block work wall with internal 13mm plasterboard lining is expected to be adequate for facades. Table 13 gives a breakdown of glazing types and their approximate R_w ratings, which should be used in conjunction with Appendix B to provide an indication of potential construction requirements for external building elements.

Table 13: Approximate glazing types

Rw required	Windows
21-23	4mm glass
24-27	6mm glass
28-31	6.38mm laminated glass
31-35	10.38 laminated glass
36-40	6.38/25/10.38
41-45	6.38/100/3.38

Consideration has also been given to internal acoustic amenity when windows are opened to allow for background ventilation. In this regard the NSW Development Near Rail Corridors and Busy Roads – Interim Guideline recommends a maximum of 10 dBA above the internal noise level with the windows and doors open (for natural ventilation). In this case the recommended internal noise goals for window open scenario is L_{eq} 45 dBA for the bedrooms and 50 dBA for living areas.

Typically, a partially open window will usually provide 10 dBA noise reductions from outside to the inside. This implies that where the external noise level is more than 60 dBA for living rooms and 55 dBA for bedrooms, alternative means of ventilation are required so that the occupant can leave windows closed if they so desire, whilst also meeting the ventilation requirements of the Building Code of Australia.

There are a number of locations and facades exposed to traffic noise where living areas or bedrooms in these locations would require alternative means of ventilation.

7 CONCLUSIONS

Vipac Engineers & Scientists Ltd. (ViPAC) has been commissioned by Statewide Planning Pty Ltd to assess the acoustic interaction of the proposed mixed use residential development at 181 James Ruse Drive, Camellia with the surrounding environment.

Project specific levels have been nominated and are shown in Section 5. Mechanical noise emission from development should be controlled in accordance with these levels.

Traffic noise generation due to the proposed development is not expected to increase traffic noise levels.

Rail noise and vibration is not expected to impact on the development.

Through optimising the layout and orientation of the development and by using building facades with appropriate acoustic performance the development will be able to achieve internal noise goals and provide suitable acoustic amenity.

With implementation of appropriate acoustic measures a development of this nature will be able to comply with all the relevant standards and guidelines. In conclusion the site is therefore considered acoustically suitable for the intended development.

APPENDIX A: NOISE CONTOUR MAPS

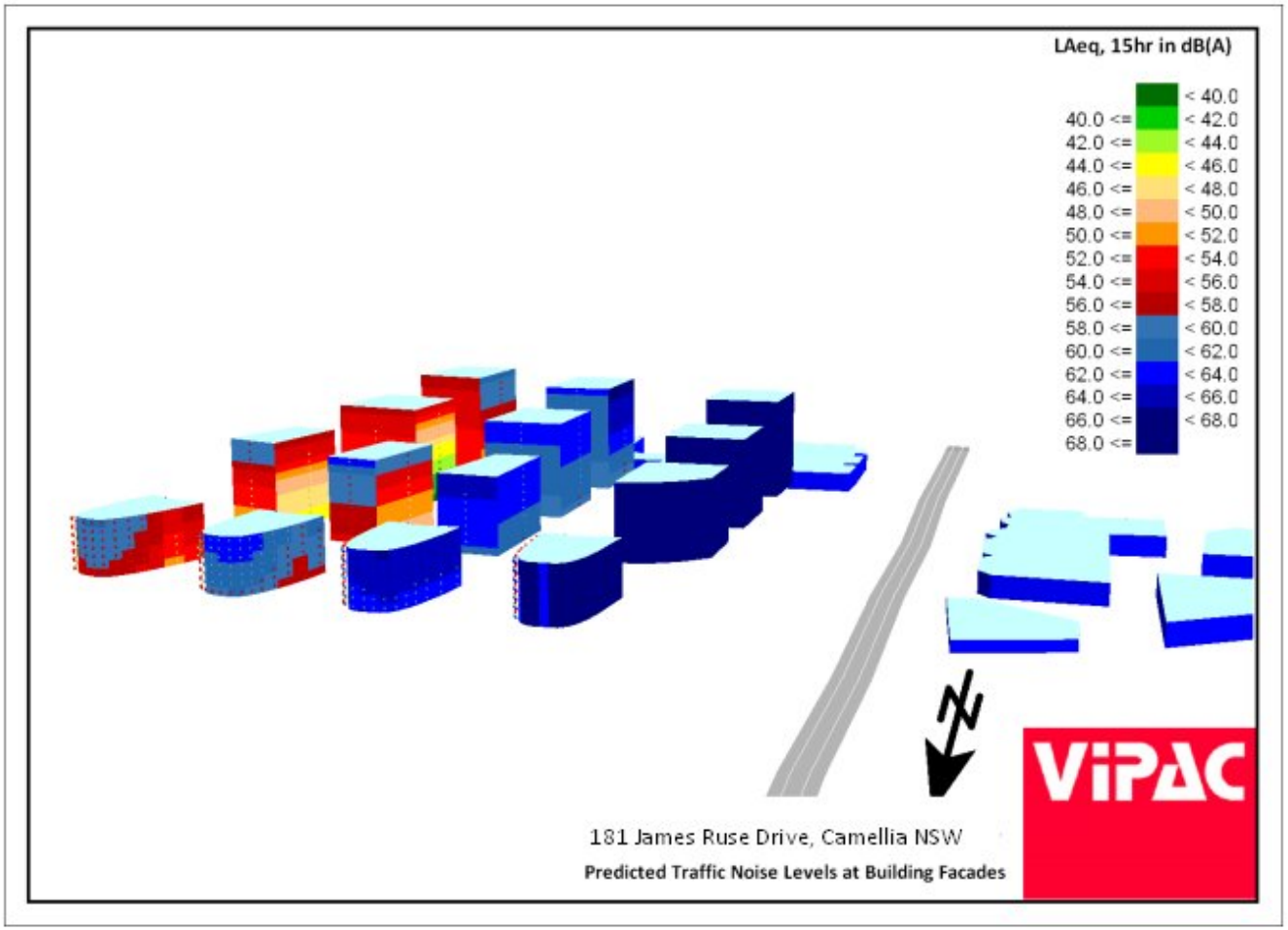

Figure 2: Traffic Noise Map – Day $L_{Aeq, 15hr}$

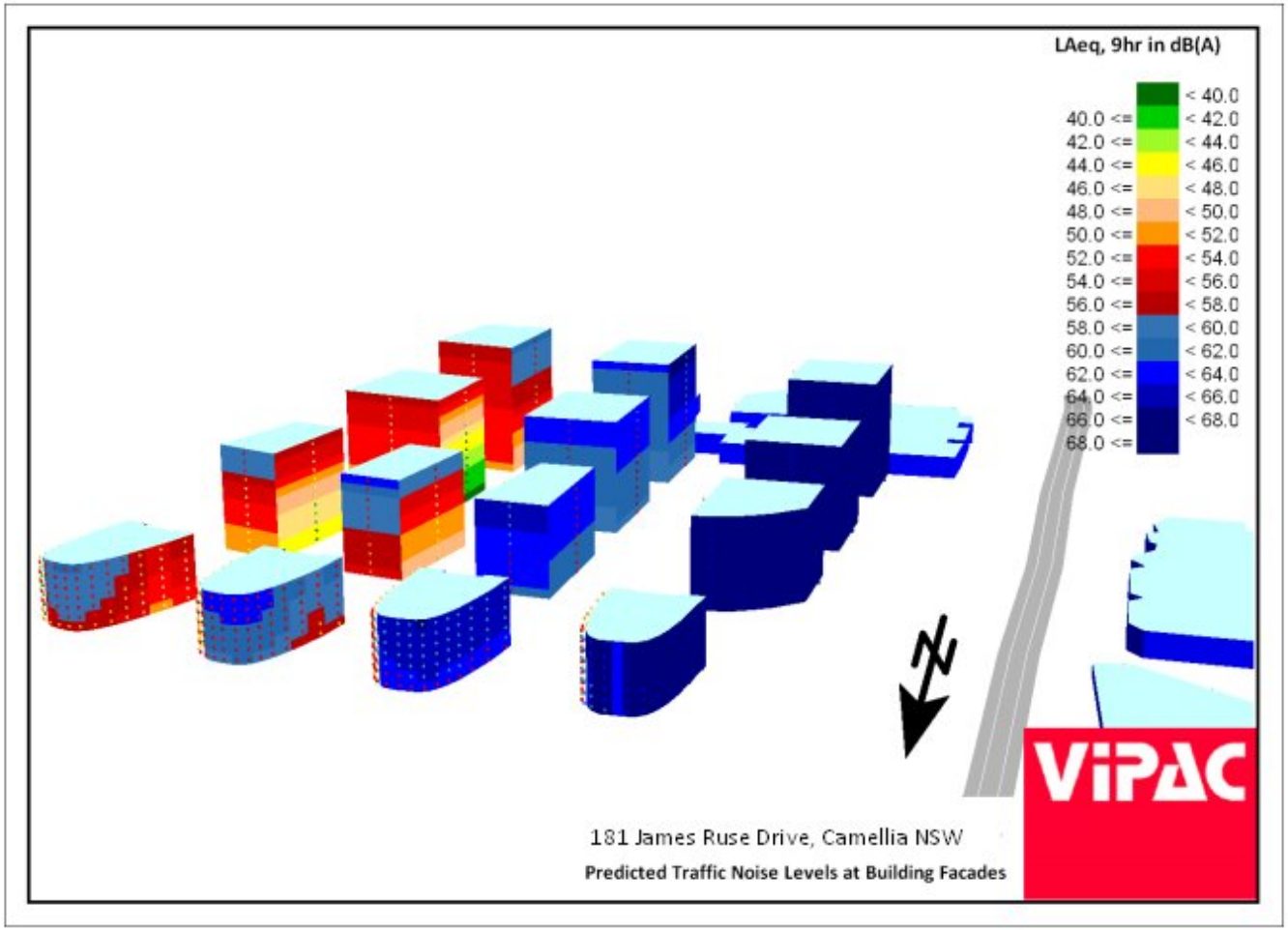

Figure 3: Traffic Noise Map – Night $L_{Aeq, 9hr}$

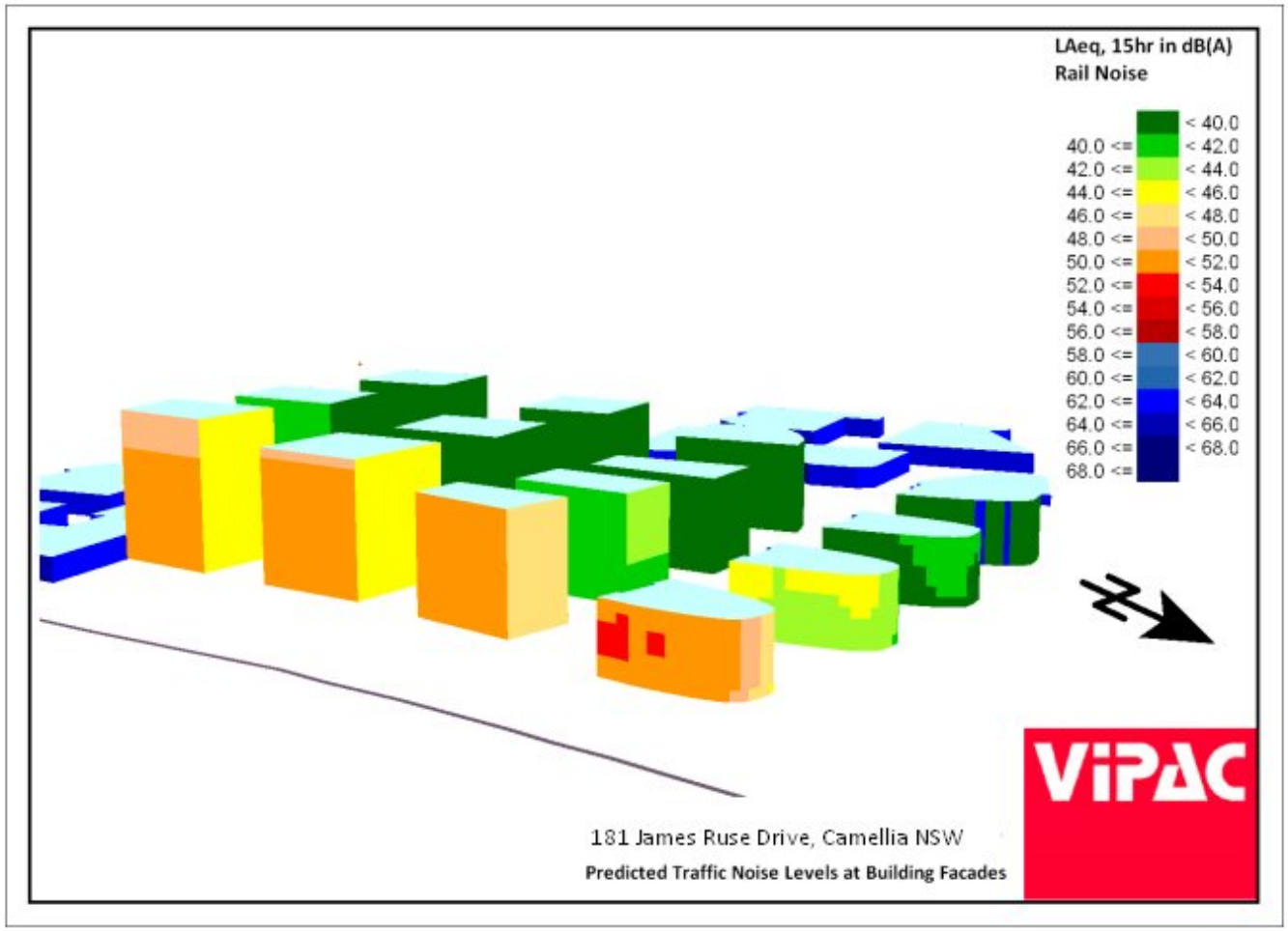

Figure 4: Train Noise Map Day $L_{Aeq, 15hr}$

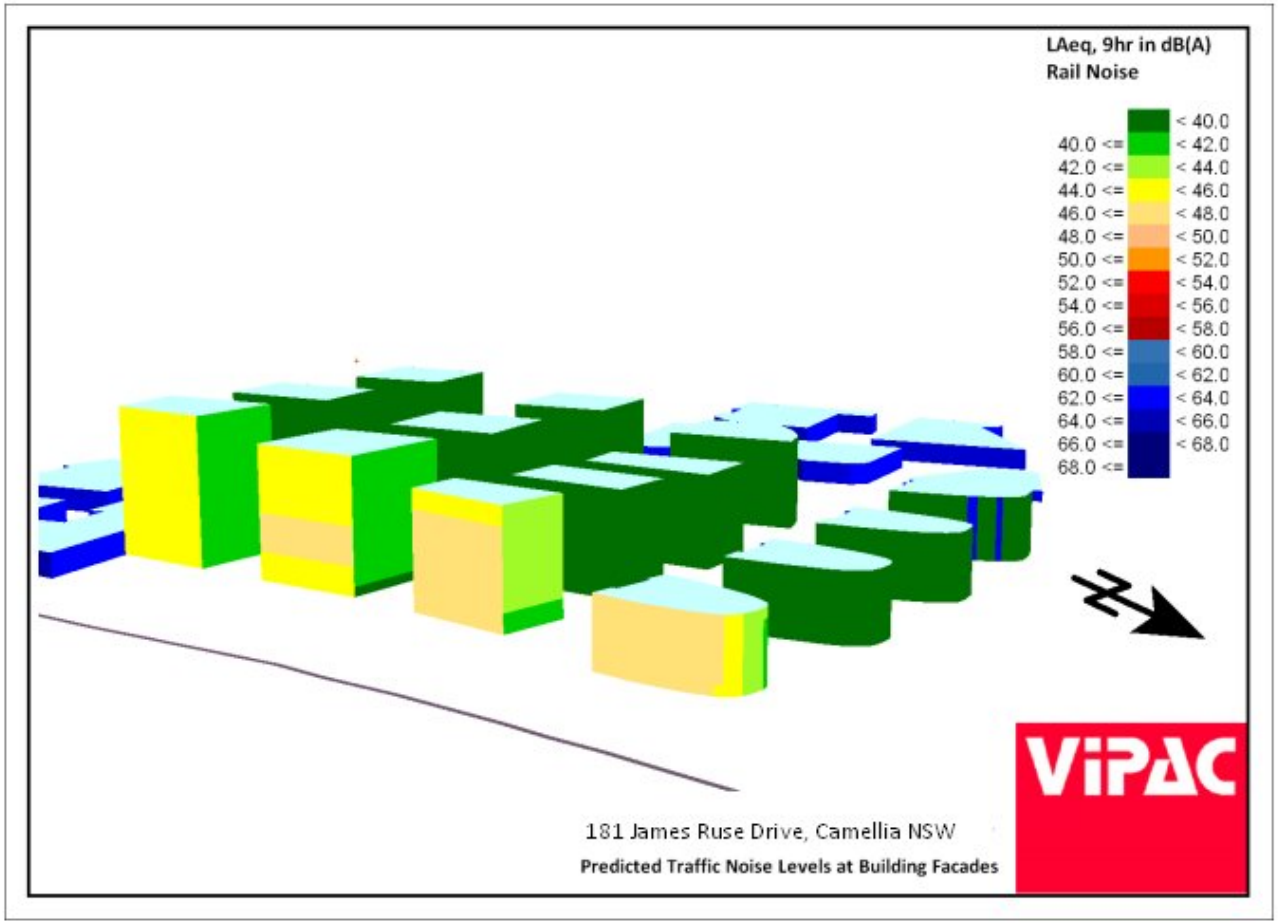

Figure 5: Train Noise Map – Night $L_{Aeq, 9hr}$

APPENDIX B: PREDICTED NOISE LEVELS AND GLAZING RECOMMENDATIONS

Building A

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	34	31	1	-1	N	N
2. Floor	E	35	31	1	-1	N	N
3. Floor	E	36	32	2	1	N	N
4. Floor	E	37	34	4	2	N	N
5. Floor	E	39	36	6	4	N	N
6. Floor	E	42	39	9	7	N	N
7. Floor	E	48	44	14	13	N	N
1. Floor	S	51	47	17	16	N	N
2. Floor	S	51	48	18	16	N	N
3. Floor	S	52	49	19	17	N	N
4. Floor	S	52	49	19	17	N	N
5. Floor	S	53	49	19	18	N	N
6. Floor	S	53	50	20	18	N	N
7. Floor	S	54	51	21	19	N	N
1. Floor	N	55	52	22	20	N	N
2. Floor	N	56	53	23	21	N	N
3. Floor	N	56	53	23	21	N	N
4. Floor	N	57	54	24	22	N	N
5. Floor	N	57	54	24	22	N	N
6. Floor	N	58	54	24	23	N	N
7. Floor	N	58	55	25	23	N	N
1. Floor	NW	52	49	19	17	N	N
2. Floor	NW	53	50	20	18	N	N
3. Floor	NW	54	50	20	19	N	N
4. Floor	NW	54	51	21	19	N	N
5. Floor	NW	54	51	21	19	N	N
6. Floor	NW	55	52	22	20	N	N
7. Floor	NW	55	52	22	20	N	N
1. Floor	E	36	33	3	1	N	N
2. Floor	E	36	33	3	1	N	N
3. Floor	E	37	34	4	2	N	N
4. Floor	E	39	35	5	4	N	N
5. Floor	E	41	37	7	6	N	N
6. Floor	E	44	40	10	9	N	N
7. Floor	E	49	46	16	14	N	N

Building B

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	36	33	1	3	N	N
2. Floor	E	36	33	1	3	N	N
3. Floor	E	37	34	2	4	N	N
4. Floor	E	39	35	4	5	N	N
5. Floor	E	41	37	6	7	N	N
6. Floor	E	44	40	9	10	N	N
7. Floor	E	49	46	14	16	N	N
1. Floor	S	53	50	18	20	N	N
2. Floor	S	54	51	19	21	N	N
3. Floor	S	55	51	20	21	N	N
4. Floor	S	55	52	20	22	N	N
5. Floor	S	56	52	21	22	N	N
6. Floor	S	56	53	21	23	N	N
7. Floor	S	57	53	22	23	N	N
1. Floor	N	58	54	23	24	N	N
2. Floor	N	58	55	23	25	N	Y
3. Floor	N	59	56	24	26	N	Y
4. Floor	N	59	56	24	26	N	Y
5. Floor	N	60	56	25	26	N	Y
6. Floor	N	60	57	25	27	Y	Y
7. Floor	N	60	57	25	27	Y	Y
1. Floor	W	55	52	20	22	N	N
2. Floor	W	56	53	21	23	N	N
3. Floor	W	57	54	22	24	N	N
4. Floor	W	57	54	22	24	N	N
5. Floor	W	58	54	23	24	N	N
6. Floor	W	58	55	23	25	N	N
7. Floor	W	58	55	23	25	N	Y

BUILDING C

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	38	34	3	4	N	N
2. Floor	E	37	34	2	4	N	N
3. Floor	E	39	35	4	5	N	N
4. Floor	E	40	37	5	7	N	N
5. Floor	E	42	39	7	9	N	N
6. Floor	E	46	42	11	12	N	N
7. Floor	E	51	48	16	18	N	N
1. Floor	S	57	54	22	24	N	N
2. Floor	S	58	55	23	25	N	N
3. Floor	S	59	55	24	25	N	Y
4. Floor	S	59	56	24	26	N	Y
5. Floor	S	59	56	24	26	N	Y
6. Floor	S	60	56	25	26	N	Y
7. Floor	S	60	57	25	27	Y	Y
1. Floor	N	61	57	26	27	Y	Y
2. Floor	N	61	58	26	28	Y	Y
3. Floor	N	62	59	27	29	Y	Y
4. Floor	N	62	59	27	29	Y	Y
5. Floor	N	63	59	28	29	Y	Y
6. Floor	N	63	60	28	30	Y	Y
7. Floor	N	63	60	28	30	Y	Y
1. Floor	W	61	58	26	28	Y	Y
2. Floor	W	62	58	27	28	Y	Y
3. Floor	W	62	59	27	29	Y	Y
4. Floor	W	63	59	28	29	Y	Y
5. Floor	W	63	60	28	30	Y	Y
6. Floor	W	63	60	28	30	Y	Y
7. Floor	W	64	60	29	30	Y	Y

BUILDING D

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	46	43	11	13	N	N
2. Floor	E	47	43	12	13	N	N
3. Floor	E	47	44	12	14	N	N
4. Floor	E	48	45	13	15	N	N
5. Floor	E	49	46	14	16	N	N
6. Floor	E	51	48	16	18	N	N
7. Floor	E	55	51	20	21	N	N
1. Floor	S	64	61	29	31	Y	Y
2. Floor	S	65	61	30	31	Y	Y
3. Floor	S	65	62	30	32	Y	Y
4. Floor	S	65	62	30	32	Y	Y
5. Floor	S	66	62	31	32	Y	Y
6. Floor	S	66	63	31	33	Y	Y
7. Floor	S	66	63	31	33	Y	Y
1. Floor	N	66	62	31	32	Y	Y
2. Floor	N	66	63	31	33	Y	Y
3. Floor	N	67	63	32	33	Y	Y
4. Floor	N	67	64	32	34	Y	Y
5. Floor	N	67	64	32	34	Y	Y
6. Floor	N	68	64	33	34	Y	Y
7. Floor	N	68	65	33	35	Y	Y
1. Floor	W	69	66	34	36	Y	Y
2. Floor	W	70	66	35	36	Y	Y
3. Floor	W	70	67	35	37	Y	Y
4. Floor	W	70	67	35	37	Y	Y
5. Floor	W	71	67	36	37	Y	Y
6. Floor	W	71	68	36	38	Y	Y
7. Floor	W	71	68	36	38	Y	Y

BUILDING E

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	W	43	39	8	9	N	N
2. Floor	W	43	40	8	10	N	N
3. Floor	W	44	41	9	11	N	N
4. Floor	W	45	41	10	11	N	N
5. Floor	W	45	42	10	12	N	N
6. Floor	W	46	43	11	13	N	N
7. Floor	W	47	44	12	14	N	N
8. Floor	W	49	46	14	16	N	N
9. Floor	W	51	48	16	18	N	N
10. Floor	W	52	49	17	19	N	N
11. Floor	W	53	50	18	20	N	N
12. Floor	W	55	51	20	21	N	N
1. Floor	S	50	47	15	17	N	N
2. Floor	S	50	47	15	17	N	N
3. Floor	S	51	48	16	18	N	N
4. Floor	S	51	48	16	18	N	N
5. Floor	S	52	48	17	18	N	N
6. Floor	S	52	48	17	18	N	N
7. Floor	S	52	49	17	19	N	N
8. Floor	S	52	49	17	19	N	N
9. Floor	S	53	49	18	19	N	N
10. Floor	S	53	49	18	19	N	N
11. Floor	S	53	50	18	20	N	N
12. Floor	S	54	50	19	20	N	N
1. Floor	N	48	45	13	15	N	N
2. Floor	N	49	46	14	16	N	N
3. Floor	N	50	46	15	16	N	N
4. Floor	N	50	47	15	17	N	N
5. Floor	N	51	47	16	17	N	N
6. Floor	N	51	48	16	18	N	N
7. Floor	N	52	49	17	19	N	N
8. Floor	N	53	50	18	20	N	N
9. Floor	N	55	51	20	21	N	N
10. Floor	N	56	53	21	23	N	N
11. Floor	N	57	53	22	23	N	N
12. Floor	N	57	54	22	24	N	N
1. Floor	E	35	32	0	2	N	N
2. Floor	E	35	32	0	2	N	N
3. Floor	E	35	32	0	2	N	N
4. Floor	E	35	32	0	2	N	N
5. Floor	E	35	32	0	2	N	N
6. Floor	E	35	32	0	2	N	N
7. Floor	E	35	32	0	2	N	N
8. Floor	E	36	33	1	3	N	N
9. Floor	E	38	34	3	4	N	N
10. Floor	E	40	36	5	6	N	N
11. Floor	E	42	39	7	9	N	N
12. Floor	E	47	44	12	14	N	N

BUILDING F

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	36	33	1	3	N	N
2. Floor	E	36	33	1	3	N	N
3. Floor	E	36	33	1	3	N	N
4. Floor	E	36	33	1	3	N	N
5. Floor	E	36	33	1	3	N	N
6. Floor	E	36	33	1	3	N	N
7. Floor	E	37	34	2	4	N	N
8. Floor	E	39	35	4	5	N	N
9. Floor	E	41	37	6	7	N	N
10. Floor	E	43	40	8	10	N	N
11. Floor	E	48	45	13	15	N	N
1. Floor	S	52	49	17	19	N	N
2. Floor	S	53	50	18	20	N	N
3. Floor	S	53	50	18	20	N	N
4. Floor	S	54	50	19	20	N	N
5. Floor	S	54	51	19	21	N	N
6. Floor	S	54	51	19	21	N	N
7. Floor	S	55	51	20	21	N	N
8. Floor	S	55	52	20	22	N	N
9. Floor	S	55	52	20	22	N	N
10. Floor	S	55	52	20	22	N	N
11. Floor	S	56	53	21	23	N	N
1. Floor	N	54	50	19	20	N	N
2. Floor	N	54	51	19	21	N	N
3. Floor	N	55	51	20	21	N	N
4. Floor	N	55	52	20	22	N	N
5. Floor	N	55	52	20	22	N	N
6. Floor	N	56	53	21	23	N	N
7. Floor	N	56	53	21	23	N	N
8. Floor	N	57	53	22	23	N	N
9. Floor	N	57	54	22	24	N	N
10. Floor	N	59	55	24	25	N	Y
11. Floor	N	60	57	25	27	N	Y
1. Floor	W	47	44	12	14	N	N
2. Floor	W	48	44	13	14	N	N
3. Floor	W	48	45	13	15	N	N
4. Floor	W	49	45	14	15	N	N
5. Floor	W	49	46	14	16	N	N
6. Floor	W	50	47	15	17	N	N
7. Floor	W	51	48	16	18	N	N
8. Floor	W	52	49	17	19	N	N
9. Floor	W	54	50	19	20	N	N
10. Floor	W	56	53	21	23	N	N
11. Floor	W	58	54	23	24	N	N

BUILDING G

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	W	58	55	23	25	N	N
2. Floor	W	59	55	24	25	N	Y
3. Floor	W	59	56	24	26	N	Y
4. Floor	W	59	56	24	26	N	Y
5. Floor	W	60	57	25	27	N	Y
6. Floor	W	60	57	25	27	Y	Y
7. Floor	W	60	57	25	27	Y	Y
8. Floor	W	61	57	26	27	Y	Y
9. Floor	W	61	58	26	28	Y	Y
10. Floor	W	61	58	26	28	Y	Y
1. Floor	S	56	53	21	23	N	N
2. Floor	S	57	53	22	23	N	N
3. Floor	S	57	54	22	24	N	N
4. Floor	S	57	54	22	24	N	N
5. Floor	S	58	54	23	24	N	N
6. Floor	S	58	55	23	25	N	N
7. Floor	S	58	55	23	25	N	N
8. Floor	S	58	55	23	25	N	Y
9. Floor	S	59	55	24	25	N	Y
10. Floor	S	59	56	24	26	N	Y
1. Floor	N	59	56	24	26	N	Y
2. Floor	N	60	57	25	27	Y	Y
3. Floor	N	60	57	25	27	Y	Y
4. Floor	N	61	58	26	28	Y	Y
5. Floor	N	61	58	26	28	Y	Y
6. Floor	N	61	58	26	28	Y	Y
7. Floor	N	62	58	27	28	Y	Y
8. Floor	N	62	59	27	29	Y	Y
9. Floor	N	62	59	27	29	Y	Y
10. Floor	N	63	59	28	29	Y	Y
1. Floor	E	38	34	3	4	N	N
2. Floor	E	38	34	3	4	N	N
3. Floor	E	38	34	3	4	N	N
4. Floor	E	38	34	3	4	N	N
5. Floor	E	38	34	3	4	N	N
6. Floor	E	38	35	3	5	N	N
7. Floor	E	40	36	5	6	N	N
8. Floor	E	42	39	7	9	N	N
9. Floor	E	44	41	9	11	N	N
10. Floor	E	49	46	14	16	N	N

BUILDING H

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	W	72	68	37	38	Y	Y
2. Floor	W	72	69	37	39	Y	Y
3. Floor	W	72	69	37	39	Y	Y
4. Floor	W	73	69	38	39	Y	Y
5. Floor	W	73	69	38	39	Y	Y
6. Floor	W	73	69	38	39	Y	Y
7. Floor	W	73	69	38	39	Y	Y
8. Floor	W	72	69	37	39	Y	Y
9. Floor	W	72	69	37	39	Y	Y
10. Floor	W	72	69	37	39	Y	Y
1. Floor	S	66	62	31	32	Y	Y
2. Floor	S	66	63	31	33	Y	Y
3. Floor	S	67	63	32	33	Y	Y
4. Floor	S	67	64	32	34	Y	Y
5. Floor	S	67	64	32	34	Y	Y
6. Floor	S	67	64	32	34	Y	Y
7. Floor	S	67	64	32	34	Y	Y
8. Floor	S	67	64	32	34	Y	Y
9. Floor	S	67	64	32	34	Y	Y
10. Floor	S	67	64	32	34	Y	Y
1. Floor	N	67	64	32	34	Y	Y
2. Floor	N	67	64	32	34	Y	Y
3. Floor	N	68	65	33	35	Y	Y
4. Floor	N	68	65	33	35	Y	Y
5. Floor	N	68	65	33	35	Y	Y
6. Floor	N	69	65	34	35	Y	Y
7. Floor	N	69	66	34	36	Y	Y
8. Floor	N	69	66	34	36	Y	Y
9. Floor	N	69	66	34	36	Y	Y
10. Floor	N	69	65	34	35	Y	Y
1. Floor	E	40	37	5	7	N	N
2. Floor	E	40	37	5	7	N	N
3. Floor	E	40	37	5	7	N	N
4. Floor	E	40	37	5	7	N	N
5. Floor	E	40	37	5	7	N	N
6. Floor	E	40	37	5	7	N	N
7. Floor	E	42	39	7	9	N	N
8. Floor	E	44	41	9	11	N	N
9. Floor	E	47	44	12	14	N	N
10. Floor	E	51	48	16	18	N	N

BUILDING I

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	W	37	34	2	4	N	N
2. Floor	W	38	35	3	5	N	N
3. Floor	W	38	35	3	5	N	N
4. Floor	W	39	36	4	6	N	N
5. Floor	W	40	37	5	7	N	N
6. Floor	W	41	38	6	8	N	N
7. Floor	W	42	39	7	9	N	N
8. Floor	W	43	40	8	10	N	N
9. Floor	W	45	41	10	11	N	N
10. Floor	W	46	43	11	13	N	N
11. Floor	W	48	44	13	14	N	N
12. Floor	W	49	46	14	16	N	N
13. Floor	W	51	47	16	17	N	N
14. Floor	W	53	49	18	19	N	N
1. Floor	S	52	48	17	18	N	N
2. Floor	S	52	49	17	19	N	N
3. Floor	S	53	49	18	19	N	N
4. Floor	S	53	50	18	20	N	N
5. Floor	S	53	50	18	20	N	N
6. Floor	S	54	50	19	20	N	N
7. Floor	S	54	51	19	21	N	N
8. Floor	S	54	51	19	21	N	N
9. Floor	S	54	51	19	21	N	N
10. Floor	S	54	51	19	21	N	N
11. Floor	S	55	51	20	21	N	N
12. Floor	S	55	52	20	22	N	N
13. Floor	S	55	52	20	22	N	N
14. Floor	S	55	52	20	22	N	N
1. Floor	N	48	45	13	15	N	N
2. Floor	N	49	45	14	15	N	N
3. Floor	N	49	46	14	16	N	N
4. Floor	N	49	46	14	16	N	N
5. Floor	N	50	46	15	16	N	N
6. Floor	N	50	47	15	17	N	N
7. Floor	N	50	47	15	17	N	N
8. Floor	N	51	47	16	17	N	N
9. Floor	N	51	48	16	18	N	N
10. Floor	N	51	48	16	18	N	N
11. Floor	N	52	49	17	19	N	N
12. Floor	N	53	49	18	19	N	N
13. Floor	N	53	50	18	20	N	N
14. Floor	N	55	52	20	22	N	N
1. Floor	E	36	32	1	2	N	N
2. Floor	E	36	32	1	2	N	N
3. Floor	E	36	32	1	2	N	N
4. Floor	E	36	32	1	2	N	N
5. Floor	E	35	32	0	2	N	N
6. Floor	E	35	32	0	2	N	N

7. Floor	E	35	32	0	2	N	N
8. Floor	E	35	32	0	2	N	N
9. Floor	E	35	32	0	2	N	N
10. Floor	E	36	33	1	3	N	N
11. Floor	E	38	34	3	4	N	N
12. Floor	E	40	37	5	7	N	N
13. Floor	E	43	39	8	9	N	N
14. Floor	E	47	43	12	13	N	N

BUILDING J

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	W	57	54	22	24	N	N
2. Floor	W	58	55	23	25	N	N
3. Floor	W	58	55	23	25	N	Y
4. Floor	W	59	56	24	26	N	Y
5. Floor	W	59	56	24	26	N	Y
6. Floor	W	59	56	24	26	N	Y
7. Floor	W	60	56	25	26	N	Y
8. Floor	W	60	57	25	27	Y	Y
9. Floor	W	60	57	25	27	Y	Y
10. Floor	W	61	57	26	27	Y	Y
11. Floor	W	61	58	26	28	Y	Y
12. Floor	W	61	58	26	28	Y	Y
13. Floor	W	62	58	27	28	Y	Y
1. Floor	S	57	53	22	23	N	N
2. Floor	S	57	54	22	24	N	N
3. Floor	S	58	54	23	24	N	N
4. Floor	S	58	55	23	25	N	N
5. Floor	S	58	55	23	25	N	Y
6. Floor	S	59	55	24	25	N	Y
7. Floor	S	59	56	24	26	N	Y
8. Floor	S	60	56	25	26	N	Y
9. Floor	S	60	57	25	27	N	Y
10. Floor	S	60	57	25	27	Y	Y
11. Floor	S	61	58	26	28	Y	Y
12. Floor	S	61	58	26	28	Y	Y
13. Floor	S	61	58	26	28	Y	Y
1. Floor	N	57	53	22	23	N	N
2. Floor	N	57	54	22	24	N	N
3. Floor	N	58	54	23	24	N	N
4. Floor	N	58	55	23	25	N	N
5. Floor	N	58	55	23	25	N	Y
6. Floor	N	59	55	24	25	N	Y
7. Floor	N	59	56	24	26	N	Y
8. Floor	N	59	56	24	26	N	Y
9. Floor	N	59	56	24	26	N	Y
10. Floor	N	60	56	25	26	N	Y
11. Floor	N	60	57	25	27	N	Y
12. Floor	N	60	57	25	27	Y	Y
13. Floor	N	61	57	26	27	Y	Y
1. Floor	E	37	34	2	4	N	N
2. Floor	E	37	34	2	4	N	N
3. Floor	E	37	34	2	4	N	N
4. Floor	E	37	34	2	4	N	N
5. Floor	E	37	34	2	4	N	N
6. Floor	E	37	34	2	4	N	N
7. Floor	E	37	34	2	4	N	N
8. Floor	E	37	34	2	4	N	N
9. Floor	E	38	34	3	4	N	N

10. Floor	E	39	36	4	6	N	N
11. Floor	E	41	38	6	8	N	N
12. Floor	E	44	41	9	11	N	N
13. Floor	E	48	45	13	15	N	N

BUILDING K

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	40	37	5	7	N	N
2. Floor	E	40	37	5	7	N	N
3. Floor	E	40	37	5	7	N	N
4. Floor	E	40	37	5	7	N	N
5. Floor	E	40	37	5	7	N	N
6. Floor	E	40	37	5	7	N	N
7. Floor	E	40	37	5	7	N	N
8. Floor	E	40	37	5	7	N	N
9. Floor	E	42	38	7	8	N	N
10. Floor	E	44	41	9	11	N	N
11. Floor	E	47	43	12	13	N	N
12. Floor	E	50	47	15	17	N	N
1. Floor	S	66	63	31	33	Y	Y
2. Floor	S	67	63	32	33	Y	Y
3. Floor	S	67	64	32	34	Y	Y
4. Floor	S	67	64	32	34	Y	Y
5. Floor	S	68	64	33	34	Y	Y
6. Floor	S	68	64	33	34	Y	Y
7. Floor	S	68	64	33	34	Y	Y
8. Floor	S	68	64	33	34	Y	Y
9. Floor	S	68	64	33	34	Y	Y
10. Floor	S	67	64	32	34	Y	Y
11. Floor	S	67	64	32	34	Y	Y
12. Floor	S	67	64	32	34	Y	Y
1. Floor	N	66	62	31	32	Y	Y
2. Floor	N	66	63	31	33	Y	Y
3. Floor	N	67	63	32	33	Y	Y
4. Floor	N	67	64	32	34	Y	Y
5. Floor	N	67	64	32	34	Y	Y
6. Floor	N	67	64	32	34	Y	Y
7. Floor	N	67	64	32	34	Y	Y
8. Floor	N	67	64	32	34	Y	Y
9. Floor	N	67	64	32	34	Y	Y
10. Floor	N	67	64	32	34	Y	Y
11. Floor	N	67	64	32	34	Y	Y
12. Floor	N	67	64	32	34	Y	Y
1. Floor	W	72	68	37	38	Y	Y
2. Floor	W	72	69	37	39	Y	Y
3. Floor	W	73	69	38	39	Y	Y
4. Floor	W	73	70	38	40	Y	Y
5. Floor	W	73	69	38	39	Y	Y
6. Floor	W	73	69	38	39	Y	Y
7. Floor	W	73	69	38	39	Y	Y
8. Floor	W	73	69	38	39	Y	Y
9. Floor	W	72	69	37	39	Y	Y
10. Floor	W	72	69	37	39	Y	Y
11. Floor	W	72	69	37	39	Y	Y
12. Floor	W	72	69	37	39	Y	Y

BUILDING L

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	W	46	43	11	13	N	N
2. Floor	W	47	44	12	14	N	N
3. Floor	W	48	44	13	14	N	N
4. Floor	W	48	45	13	15	N	N
5. Floor	W	49	46	14	16	N	N
6. Floor	W	50	47	15	17	N	N
7. Floor	W	52	48	17	18	N	N
8. Floor	W	53	49	18	19	N	N
9. Floor	W	54	51	19	21	N	N
10. Floor	W	55	51	20	21	Y	N
11. Floor	W	55	52	20	22	N	N
12. Floor	W	56	53	21	23	Y	N
13. Floor	W	57	53	22	23	N	N
14. Floor	W	57	54	22	24	Y	N
15. Floor	W	57	54	22	24	N	N
16. Floor	W	58	55	23	25	Y	N
1. Floor	N	49	46	14	16	N	N
2. Floor	N	50	47	15	17	N	N
3. Floor	N	50	47	15	17	N	N
4. Floor	N	51	47	16	17	N	N
5. Floor	N	51	48	16	18	N	N
6. Floor	N	51	48	16	18	N	N
7. Floor	N	52	48	17	18	N	N
8. Floor	N	52	48	17	18	N	N
9. Floor	N	52	49	17	19	N	N
10. Floor	N	52	49	17	19	N	N
11. Floor	N	52	49	17	19	N	N
12. Floor	N	53	49	18	19	N	N
13. Floor	N	53	50	18	20	N	N
14. Floor	N	53	50	18	20	Y	N
15. Floor	N	54	51	19	21	N	N
16. Floor	N	55	52	20	22	Y	N
1. Floor	S	53	50	18	20	N	N
2. Floor	S	54	50	19	20	Y	N
3. Floor	S	54	51	19	21	N	N
4. Floor	S	55	52	20	22	Y	N
5. Floor	S	55	52	20	22	N	N
6. Floor	S	56	53	21	23	Y	N
7. Floor	S	57	53	22	23	N	N
8. Floor	S	58	54	23	24	Y	N
9. Floor	S	58	55	23	25	N	N
10. Floor	S	59	55	24	25	Y	Y
11. Floor	S	59	56	24	26	N	Y
12. Floor	S	60	56	25	26	Y	Y
13. Floor	S	60	57	25	27	N	Y
14. Floor	S	60	57	25	27	Y	Y
15. Floor	S	61	57	26	27	Y	Y
16. Floor	S	61	58	26	28	Y	Y

1. Floor	E	36	33	1	3	N	N
2. Floor	E	36	33	1	3	N	N
3. Floor	E	36	33	1	3	N	N
4. Floor	E	36	33	1	3	N	N
5. Floor	E	36	33	1	3	N	N
6. Floor	E	36	33	1	3	N	N
7. Floor	E	36	32	1	2	N	N
8. Floor	E	36	32	1	2	N	N
9. Floor	E	36	32	1	2	N	N
10. Floor	E	36	32	1	2	N	N
11. Floor	E	36	32	1	2	N	N
12. Floor	E	36	33	1	3	N	N
13. Floor	E	38	34	3	4	N	N
14. Floor	E	40	37	5	7	N	N
15. Floor	E	43	40	8	10	N	N
16. Floor	E	48	45	13	15	N	N

BUILDING M

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	38	34	3	4	N	N
2. Floor	E	38	34	3	4	N	N
3. Floor	E	38	34	3	4	N	N
4. Floor	E	38	34	3	4	N	N
5. Floor	E	38	34	3	4	N	N
6. Floor	E	38	34	3	4	N	N
7. Floor	E	37	34	2	4	N	N
8. Floor	E	37	34	2	4	N	N
9. Floor	E	37	34	2	4	N	N
10. Floor	E	37	34	2	4	N	N
11. Floor	E	38	34	3	4	N	N
12. Floor	E	39	36	4	6	N	N
13. Floor	E	41	38	6	8	N	N
14. Floor	E	44	41	9	11	N	N
15. Floor	E	49	45	14	15	N	N
1. Floor	S	57	53	22	23	N	N
2. Floor	S	57	54	22	24	N	N
3. Floor	S	58	55	23	25	N	N
4. Floor	S	58	55	23	25	N	Y
5. Floor	S	59	56	24	26	N	Y
6. Floor	S	60	57	25	27	N	Y
7. Floor	S	61	57	26	27	Y	Y
8. Floor	S	62	58	27	28	Y	Y
9. Floor	S	62	59	27	29	Y	Y
10. Floor	S	63	60	28	30	Y	Y
11. Floor	S	63	60	28	30	Y	Y
12. Floor	S	64	60	29	30	Y	Y
13. Floor	S	64	61	29	31	Y	Y
14. Floor	S	64	61	29	31	Y	Y
15. Floor	S	64	61	29	31	Y	Y
1. Floor	N	56	53	21	23	N	N
2. Floor	N	57	54	22	24	N	N
3. Floor	N	57	54	22	24	N	N
4. Floor	N	58	54	23	24	N	N
5. Floor	N	58	55	23	25	N	N
6. Floor	N	58	55	23	25	N	Y
7. Floor	N	59	55	24	25	N	Y
8. Floor	N	59	55	24	25	N	Y
9. Floor	N	59	56	24	26	N	Y
10. Floor	N	59	56	24	26	N	Y
11. Floor	N	59	56	24	26	N	Y
12. Floor	N	59	56	24	26	N	Y
13. Floor	N	60	56	25	26	N	Y
14. Floor	N	60	56	25	26	N	Y
15. Floor	N	60	57	25	27	Y	Y
1. Floor	W	57	54	22	24	N	N
2. Floor	W	57	54	22	24	N	N
3. Floor	W	58	55	23	25	N	N

4. Floor	W	59	55	24	25	N	Y
5. Floor	W	59	56	24	26	N	Y
6. Floor	W	60	57	25	27	N	Y
7. Floor	W	61	57	26	27	Y	Y
8. Floor	W	61	58	26	28	Y	Y
9. Floor	W	62	59	27	29	Y	Y
10. Floor	W	63	60	28	30	Y	Y
11. Floor	W	63	60	28	30	Y	Y
12. Floor	W	64	60	29	30	Y	Y
13. Floor	W	64	60	29	30	Y	Y
14. Floor	W	64	61	29	31	Y	Y
15. Floor	W	64	61	29	31	Y	Y

BUILDING N

Floor	Elevation	Noise Level at Façade (dBA)		Estimated Façade Performance Rw		Alternative Ventilation ?	
		LAeq,15hr,day	LAeq,9hr,night	Bedrooms	Living Rooms	Living Rooms	Bedrooms
1. Floor	E	40	37	5	7	N	N
2. Floor	E	40	37	5	7	N	N
3. Floor	E	40	37	5	7	N	N
4. Floor	E	40	37	5	7	N	N
5. Floor	E	40	37	5	7	N	N
6. Floor	E	40	37	5	7	N	N
7. Floor	E	40	37	5	7	N	N
8. Floor	E	40	37	5	7	N	N
9. Floor	E	40	37	5	7	N	N
10. Floor	E	40	37	5	7	N	N
11. Floor	E	41	38	6	8	N	N
12. Floor	E	44	40	9	10	N	N
13. Floor	E	47	43	12	13	N	N
14. Floor	E	50	47	15	17	N	N
1. Floor	N	66	63	31	33	Y	Y
2. Floor	N	67	63	32	33	Y	Y
3. Floor	N	67	64	32	34	Y	Y
4. Floor	N	67	64	32	34	Y	Y
5. Floor	N	68	64	33	34	Y	Y
6. Floor	N	68	64	33	34	Y	Y
7. Floor	N	68	64	33	34	Y	Y
8. Floor	N	68	64	33	34	Y	Y
9. Floor	N	68	64	33	34	Y	Y
10. Floor	N	67	64	32	34	Y	Y
11. Floor	N	67	64	32	34	Y	Y
12. Floor	N	67	64	32	34	Y	Y
13. Floor	N	67	64	32	34	Y	Y
14. Floor	N	67	64	32	34	Y	Y
1. Floor	S	65	61	30	31	Y	Y
2. Floor	S	65	62	30	32	Y	Y
3. Floor	S	66	63	31	33	Y	Y
4. Floor	S	67	64	32	34	Y	Y
5. Floor	S	68	65	33	35	Y	Y
6. Floor	S	68	65	33	35	Y	Y
7. Floor	S	68	65	33	35	Y	Y
8. Floor	S	68	65	33	35	Y	Y
9. Floor	S	68	65	33	35	Y	Y
10. Floor	S	68	65	33	35	Y	Y
11. Floor	S	68	65	33	35	Y	Y
12. Floor	S	68	65	33	35	Y	Y
13. Floor	S	68	65	33	35	Y	Y
14. Floor	S	68	64	33	34	Y	Y
1. Floor	W	72	68	37	38	Y	Y
2. Floor	W	72	69	37	39	Y	Y
3. Floor	W	73	69	38	39	Y	Y
4. Floor	W	73	69	38	39	Y	Y
5. Floor	W	73	69	38	39	Y	Y
6. Floor	W	73	69	38	39	Y	Y

7. Floor	W	73	69	38	39	Y	Y
8. Floor	W	72	69	37	39	Y	Y
9. Floor	W	72	69	37	39	Y	Y
10. Floor	W	72	69	37	39	Y	Y
11. Floor	W	72	69	37	39	Y	Y
12. Floor	W	72	69	37	39	Y	Y
13. Floor	W	72	69	37	39	Y	Y
14. Floor	W	72	68	37	38	Y	Y

APPENDIX C: GLOSSARY OF ACOUSTIC TERMS

Decibel, dB:
Unit of acoustic measurement. Measurements of power, pressure and intensity. Expressed in dB relative to standard reference levels.

dB(A):
Unit of acoustic measurement weighted to approximate the sensitivity of human hearing to sound frequency.Sound Pressure Level, Lp (dB), of a sound:

20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure of 20 micro Pascals. Sound pressure level is measured using a microphone and a sound level meter, and varies with distance from the source and the environment.

Sound Power Level, LW (dB), of a source:
10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 Pico Watt. Sound power level cannot be directly measured using a microphone. Sound power level does not change with distance. The sound power level of a machine may vary depending on the actual operating load.

Ambient Sound:
Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far.

Background noise:
The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed.

Percentile Level - L_{90}, L_{10}, etc:
A statistical measurement giving the sound pressure level which is exceeded for the given percentile of an observation period, e.g. L90 is the level which is exceeded for 90% of a measurement period. L_{90} is commonly referred to as the "background" sound level.

$L_{Aeq,T}$:
Equivalent continuous A-weighted sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same A-weighted sound energy as the actual time-varying sound.

Rating Background Level – RBL:

Method for determining the existing background noise level which involves calculating the tenth percentile from the LA90 measurements. This value gives the Assessment Background Noise Level (ABL). Rating Background Level is the median of the overall ABL.