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ASSESSMENT OF INWARD TRAFFIC NOISE IMPACT ON THE PROPOSED DEVELOPMENT AT JACOBS ISLAND

Technical Report Prepared For

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Signature		
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Title	Acoustic Consultant	Associate (Acoustics)
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EXECUTIVE SUMMARY

AWN Consulting has been requested by O'Mahony Pike Architects to undertake an assessment of the potential noise impact on the proposed residential development at Jacobs Island. For the assessment of noise, guidance has been taken from the following documents:

- *Cork Agglomeration Draft Noise Action Plan 2013 – 2018*, and;
- *BS 8233: 2014: Guidelines for sound Insulation and noise reduction for buildings.*

The following daytime and night time internal noise criteria are proposed:

Internal Room	Daytime (07:00hrs to 23:00hrs)	Night-time (23:00hrs to 07:00hrs)
Living Rooms	40dB L_{Aeq}	35dB L_{Aeq}
Bedrooms	35dB L_{Aeq}	30dB L_{Aeq}

As a mitigation measure, double glazing systems will be selected so as to provide, as a minimum, the octave band sound reduction indices as outlined in the relevant sections of this document. It should be noted that the three glazing specifications contained within this report are double glazed units and that no acoustic measures are required for the majority of the development. On the most exposed facades of the proposed development buildings an improved glazing specification, which offers more sound insulation due to the thicker pane of glass on the outside of the double glazed unit, has been specified. In addition, where possible winter gardens have been incorporated into the design on the most exposed facades.

The external noise environment has also been assessed and it is concluded that the external noise environment across the outdoor amenity areas of the development will be well within acceptable limits and would not be considered excessive.

To further improve external spaces, it is recommended that the existing roadside noise barrier be extended some 70m to the north.

In conclusion, the assessment demonstrates that, through careful consideration of noise issues, along with the design and implementation of various mitigation measures recommended here, that appropriate internal and external acoustic environments can be achieved. In addition, the goals of the *Cork Agglomeration Action Plan Relating to the Assessment and Management of Environmental Noise* can be satisfied and a residential development with good internal and external noise levels can be achieved.

CONTENTS

1.0 INTRODUCTION

AWN Consulting has been requested by O'Mahony Pike Architects to undertake an assessment of the potential noise impact from the N40 on the proposed residential development at Jacobs Island. The noise impact assessment is being carried out in order to ensure a good noise environment for residential amenity is provided.

The subject site is located adjacent to Junction 10 of the N40. The proposed development consists of six apartment blocks including one mixed development block containing retail, creche and residential units. . The site is bounded to the north west by the N40 and to the east and south by Lough Mahon.

It is proposed to use guidance from *Cork Agglomeration Draft Noise Action Plan 2013 – 2018* for the core basis of the assessment carried out in this report. This assessment will be supplemented with appropriate guidance from British Standard *BS 8233: 2014: Guidelines for sound Insulation and noise reduction for buildings.* The assessment methodologies contained within these guidance documents are considered to be current best practice for the assessment of traffic noise on residential developments.

This report will include the following:

- Review of the relevant content of the standards that will be used for the noise assessment;
- Comment on the expected noise levels across the site and their associated exposure classifications, and;
- Review of mitigation measures that will be considered in relation to the levels of noise incident on the site.

2.0 ASSESSMENT CRITERIA

We have made reference to the following documents relating to the assessment of the potential impact of road traffic noise intrusion.

2.1 British Standard BS 8233

The standard, BS 8233: 2014: *Guidelines for sound Insulation and noise reduction for buildings,* sets out recommended internal noise levels for several different building types from external noise sources such as road traffic noise. The guidance is primarily for use by designers and hence BS 8233 may be used as the basis for an appropriate schedule of noise control measures. The recommended internal noise levels for residential developments are set out below.

Criterion	Typical situation	Desirable Level $L_{Aeq,T}$ (dB)
Indoor Ambient Levels	Living Rooms	35
	Dining Rooms	40
	Bedrooms Night-time	30
	Bedrooms Daytime Resting	35

Table 1 Summary of recommended internal noise levels from BS 8233

It can be seen from the table that BS 8233 recommends an internal level of 30dB L_{Aeq} for a good standard in bedrooms for which is in line with World Health Organisation[1] recommendations.

In review, the following daytime and night time internal noise criteria are proposed:

Daytime (07:00hrs to 23:00hrs)

- Living/Dining Rooms – 40dB L_{Aeq};
- Bedrooms – 35dB L_{Aeq}.

Night-time (23:00hrs to 07:00hrs)

- Bedrooms – 30dB L_{Aeq}.

2.2 Noise Action Plan for Cork

The *Cork Agglomeration Noise Action Plan 2013 – 2018* has been published in order to address the requirements of the European Noise Directive 2002/49/EC. This document produced noise maps in order to determine the population exposure to undesirably high noise levels and also to identify areas with desirably low noise that should be preserved into the future. The Action Plan defined the following ranges for these descriptions:

- Undesirably high external noise levels are defined as being above 57dB L_{night} at night and/or above 70dB $L_{den,}$ and;
- Desirably low external noise levels are defined as being below 55dB L_{den} and/or below 45dB L_{night} during the night.

[1] "*Community Noise*" 1995, B. Berglund & T. Lindvall, prepared for the World Health Organisation.

It is important to note that the Noise Action Plan does not recommend that residential development be restricted within areas identified as having undesirably high noise levels. Instead it recommended a range of noise mitigation measures be required for new residential developments within these areas.

3.0 RECEIVING ENVIRONMENT

An environmental noise survey was conducted at the development site as part of the assessment. The noise survey was conducted in order to quantify the existing noise environment. The survey was conducted in general accordance with ISO 1996: 2007: *Acoustics – Description, measurement and assessment of environmental noise.* Specific details are set out below.

3.1 Choice of Measurement Locations

Two attended and one unattended measurement locations were selected as shown on Figure 1.

Location 1 is located in the north east section of the site and is exposed to noise from the N40. A logging meter was installed here for a period of several days.

Location 2 is located in the centre of the site and is exposed to noise from the N40 as well as the internal road running through the development site.

Location 3 is located further to the south west of the site and is exposed to noise from the N40 as well as the internal road running through the development site.

Figure 1 Noise Survey Locations

3.2 Survey Periods

Noise measurements were conducted over the course of the following survey periods:

- 12:40hrs to 14:45hrs on 8 February 2018 (attended); and
- 12:00hrs on 8 February to 12:00hrs on 12 February 2018 (unattended).

The weather during the attended survey period was dry and calm.

3.3 Personnel and Instrumentation

Leo Williams (AWN) performed the measurements during the survey periods. The attended noise measurements were performed using a Brüel & Kjær Type 2238 Mediator Sound Level Analyser. Unattended measurements were done using a Rion NL-52 sound level meter at a height of 1.5m.

Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

3.4 Procedure

An attended noise survey was carried out at locations 2 and 3. Survey personnel noted all primary noise sources contributing to noise build-up. Sample periods for the attended noise measurements were 15 minutes.

Unattended noise measurements were conducted at Location 1 continuously with the microphone at a height of 2m above ground level. The results were saved to the instrument memory for later analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up during setup and collection. Sample periods for the unattended noise measurements were 15 minutes.

3.5 Measurement Parameters

The noise survey results are presented in terms of the following parameters:

L_{Aeq} is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period.

L_{Amax} is the instantaneous maximum sound level measured during the sample period.

The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

3.6 Results and Discussion

Noise levels at Location 1 (the most exposed area of the site) ranged from 66 to 74dB $L_{Aeq,1hr}$ with an average value of 72dB $L_{Aeq,1hr}$ during the day. At Location 1, night the noise levels ranged from 58 to 74dB $L_{Aeq,1hr}$ with an average value of 66dB $L_{Aeq,1hr}$. Night-time L_{AFmax} levels were in the range of 83 to 95dB $L_{AFmax,1hr}$.

The noise climate was typically dominated by road traffic movements along the N40.

A full record of the measured noise levels is contained in Appendix A.

4.0 ASSESSMENT OF THE DEVELOPMENT SITE

In addition to the survey discussed in Section 3.0, proprietary noise calculation software has been used for the purposes of this impact assessment to calculate road traffic noise levels across the development site. The selected software, Brüel & Kjær Type 7810 *Predictor*, calculates noise levels in accordance with the UK's *Calculation of Road Traffic Noise* (CRTN 1988) which is the recommended procedure for Irish National routes as per Transport Infrastructure Ireland's (TII) *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (2004).

The resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- The magnitude of the noise source in traffic flow and average velocity;
- The distance between the source and receiver;
- The presence of obstacles such as screens or barriers in the propagation path;
- The presence of reflecting surfaces; and,
- The hardness of the ground between the source and receiver.

In order to determine the noise levels at the various façades of the proposed development, the following information was included in the model:

- Site layout drawings of proposed development, and;
- OS mapping of surrounding environment.

The results of the noise survey were used to calibrate the noise model. In this instance the noise model results are within 1dB of the measured values indicating good agreement between the model and the measurements.

4.1 Suitability of the Development Site

Based on the model inputs discussed above, the future noise levels across the development site have been predicted in order to determine noise impact using the Cork Noise Action Plan definition of undesirably high noise levels above which mitigation measures may need to be considered. As discussed in Section 2.2, the Action Plan defines these levels as follows:

- >70dB L_{den}, and;
- >57dB L_{night}.

Figures 2 and 3 illustrate the noise levels across the site at a height of 4m with these definitions in mind.

Figure 2 Noise Impact Across the Site – Daytime (07:00 to 23:00hrs)

Figure 3 Noise Impact Across the Site – Night Time (23:00 to 07:00hrs)

Based on the results in Figures 2 and 3, only a small portion of the site located nearest the N40 is exposed to noise levels considered by the Cork Noise Action Plan to be undesirably high. In this instance, the Action Plan recommends that noise mitigation measures be considered for the most exposed facades of any residential buildings exposed to noise levels above the undesirable levels. The absolute requirement for mitigation measures will be investigated in detail in Section 5.0.

5.0 ASSESSMENT OF THE PROPOSED DEVELOPMENT

In order to determine the noise levels at the various façades of the proposed development, the computer noise model discussed in Section 4.0 was modified to include the proposed buildings. Receivers were located at the facades of the proposed buildings at each floor level at various locations representative of the worst-case noise exposure. The calculated noise levels at these receiver locations was used to determine the required sound insulation specification of the building envelope to comply with the internal noise levels as recommended is *BS 8233* and discussed previously in Section 2.1. The results in this section take into account the proposed site levels for the development.

A 3D representation of the developed noise model is presented in Figure 4. New buildings as part of the development are highlighted in green.

Figure 4 3D Representation of Development

5.1 Predicted Façade Noise Levels

Figure 5 lists the maximum worst-case scenario external noise levels at the development buildings. Note that these relate to the noise levels at the upper floors of each block. Please note that only the facades containing windows opening to habitable areas such as kitchens, living rooms and bedrooms are considered. Facades containing windows opening into service areas such as bathrooms and stairwells are not considered to be noise sensitive and therefore are not included in the assessment.

As per the Cork Noise Action Plan, noise mitigation measures will be considered for those facades exposed to noise levels greater than 70dB L_{den} and 57dB during the night-time. Mitigation will also be considered where the internal noise criteria is not met using standard building elements. Section 6.0 will discuss the proposed mitigation measures in detail.

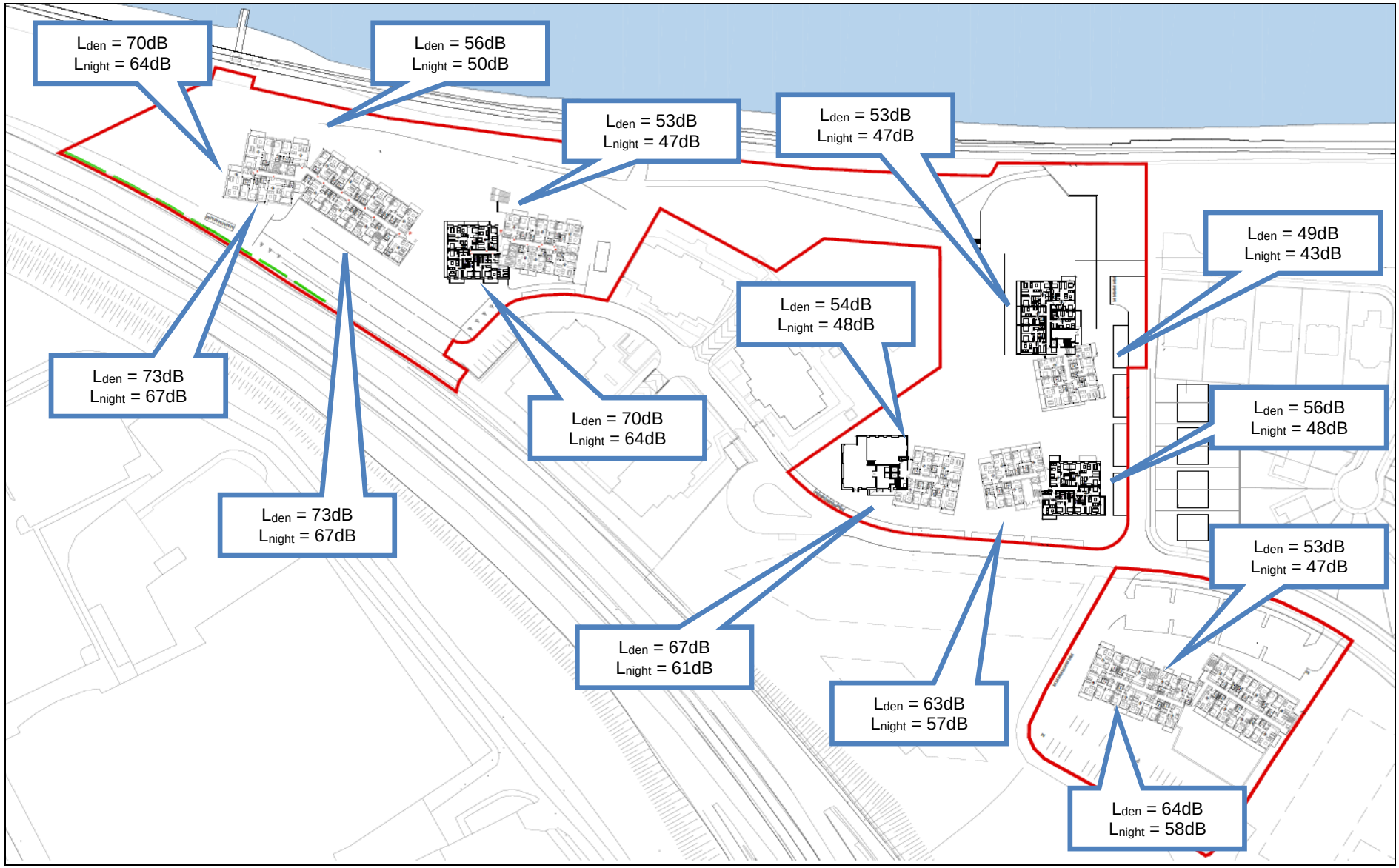

Figure 5 Predicted Noise Levels

5.2 External Amenity Space

It is also appropriate to examine the noise levels across the external amenity spaces within the development. Figure 6 illustrates in more detail the noise levels across the landscaped and private amenity areas proposed. Please note that only the daytime noise levels are considered for the external amenity areas.

Figure 6 Noise Levels Across the External Amenity Areas

The majority of the open space and amenity areas experience daytime noise levels of less than 55dB L_{day} whilst elsewhere the noise levels are in the range of 55 to 63dB L_{day}, with small areas adjacent to the N40 experiencing levels of 63 to 72dB L_{day}. For the vast majority of the site the noise levels are well below the undesirably high noise level of 70dB as defined in the *Cork Agglomeration Action Plan Relating to the Assessment and Management of Environmental Noise.*

5.3 Plant Noise

Once the retail units and apartment blocks become fully operational, a variety of electrical and mechanical plant will be required to service the development.

Block 10 has been identified as a location for roof mounted plant; approximately 40m from the nearest noise sensitive locations, which are located on the opposite side of road to the block. Other items include exhausts from CHP plant located at Blocks 7, 8 and 9 and at Blocks 3 and 4.

Most of this plant will be capable of generating noise to some degree. Some of this plant may operate 24 hours a day, and hence would be most noticeable during quiet periods (i.e. overnight). Noisy plant with a direct line-of-sight to noise sensitive properties would potentially have the greatest impact. Indicative calculations predict that the more onerous 45dB $L_{Aeq,5min}$ night time criteria should be met provided that plant noise at 1m from the plant items is less than 78dB(A).

Proprietary noise and vibration control measures will be employed during the detailed design stage in order to ensure that noise emissions from building services plant do not exceed a cumulative level of 55dB $L_{Aeq,1hr}$ daytime and 45dB $L_{Aeq,5min}$ night-time at 1 metre from the façade of the nearest residential dwellings. This will ensure noise impacts from mechanical plant serving the development are not significant.

6.0 PROPOSED MITIGATION MEASURES

Based on the predicted worst-case day and night-time noise levels presented in Section 5.0, the appropriate boundary treatment or sound insulation performance of the building envelope can be specified in order to achieve the appropriate internal noise level. Each element of proposed mitigation will be discussed in turn.

6.1 Boundary Treatment

The contour of the site is such that there is some natural screening provided by the embankment to the north west between the site and the N40. In addition, an existing noise barrier runs along the top of the embankment on boundary of the southern half of the development site. it is proposed that this barrier is extended northward some 70 – 80m so as to offer some screening to the northern half of the site (marked green below).

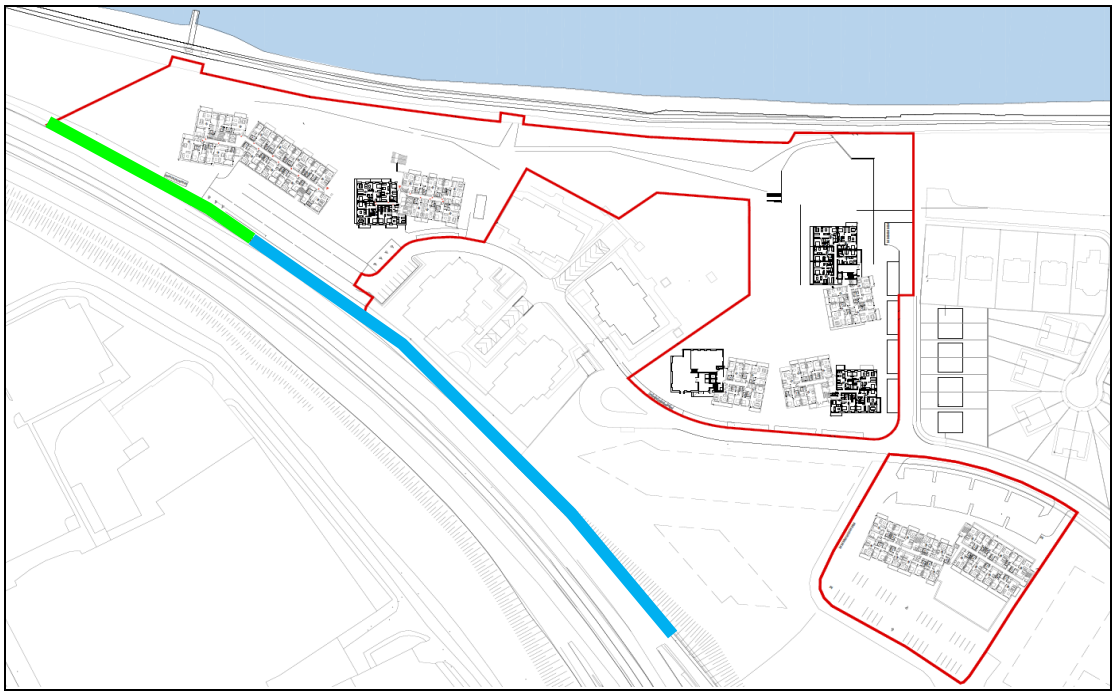

Figure 7 Noise Barrier Mark-up

6.2 Site Layout

A significant mitigation measure in this instance is the design of the building layout across the site. The following measures have been incorporated into the design to reduce the noise impact on the development buildings:

- Blocks 3, 4, 7 and 8 are positioned such that they screen the community gardens and areas of external amenity space from the N40 noise;
- Non-sensitive spaces for example car parks, are located closer to the N40.

These measures result in the noise levels incident on the most noise sensitive elements of the development being reduced and therefore reduce the need for other mitigation measures, as discussed in the following sections.

6.3 Glazing

As is the case in most buildings, the glazed elements of the building envelope are typically the weakest element from a sound insulation perspective. A standard

thermal double glazed unit would generally be 6mm glass on the outer pane with a 12mm air gap and another 6mm glass on the inner pane (6-12-6). This specification of glazing will provide adequate sound insulation performance for the majority of the proposed development buildings. However, depending on the predicted noise level incident on a particular façade it may be necessary to use an enhanced double glazing specification which uses a slightly thicker pane of glass on the outside of the window to provide additional sound insulation performance. Table 2 lists the sound insulation performances used in this assessment.

Glazing Specification	Octave Band Centre Frequency (Hz)						R_w	Typical Glazing Configuration
	125	250	500	1k	2k	4k		
I	20	19	29	38	36	45	33	6-12-6
II	27	29	36	41	42	52	40	10-12-6.4 laminate
III	28	34	44	52	47	55	45	13-12-13 acoustic laminate
WG	Winter Garden							

Table 2 Sound insulation performance requirements for glazing, SRI (dB)

It is important to note that the acoustic performance specifications detailed herein are minimum requirements which apply to the overall glazing system (including doors). In the context of the acoustic performance specification the 'glazing system' is understood to include any and all of the component parts that form part of the glazing element of the façade, i.e. glass, frames, seals, openable elements etc.

Table 3 details the recommended glazing specification for the various facades throughout the development.

Block	Building Façade	Glazing Specification									
		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Above Level 8
Block 3	North	I	I	I	II	II	II	II	II	II	II
	West	I/WG	I/WG	I/WG	II/ WG	II/ WG	II/ WG	II/ WG	II/ WG	II/ WG	II/WG
	North West corner	II	II	II	III	III	III	III	III	III	III
Block 4	North	II	II	II	II	II	II	II	II	II	N/A
	West	II	II	II	II	II	II	II	II	II	N/A
Block 7	North	II	II	II	II	II	II	II	II	N/A	
	West	II	II	II	II	II	II	II	II	N/A	
Block 10	North	I	I	I	I	I	II	N/A			
	West	I	I	I	I	I	II	N/A			
	All Other Elevations	I	I	I	I	I	I	I	I	I	N/A

Table 3 Glazing Specifications

NOTE Where a winter garden is located Glazing Type I is applied to external façade and internal glazing system.

Figure 7 illustrates the above specification graphically.

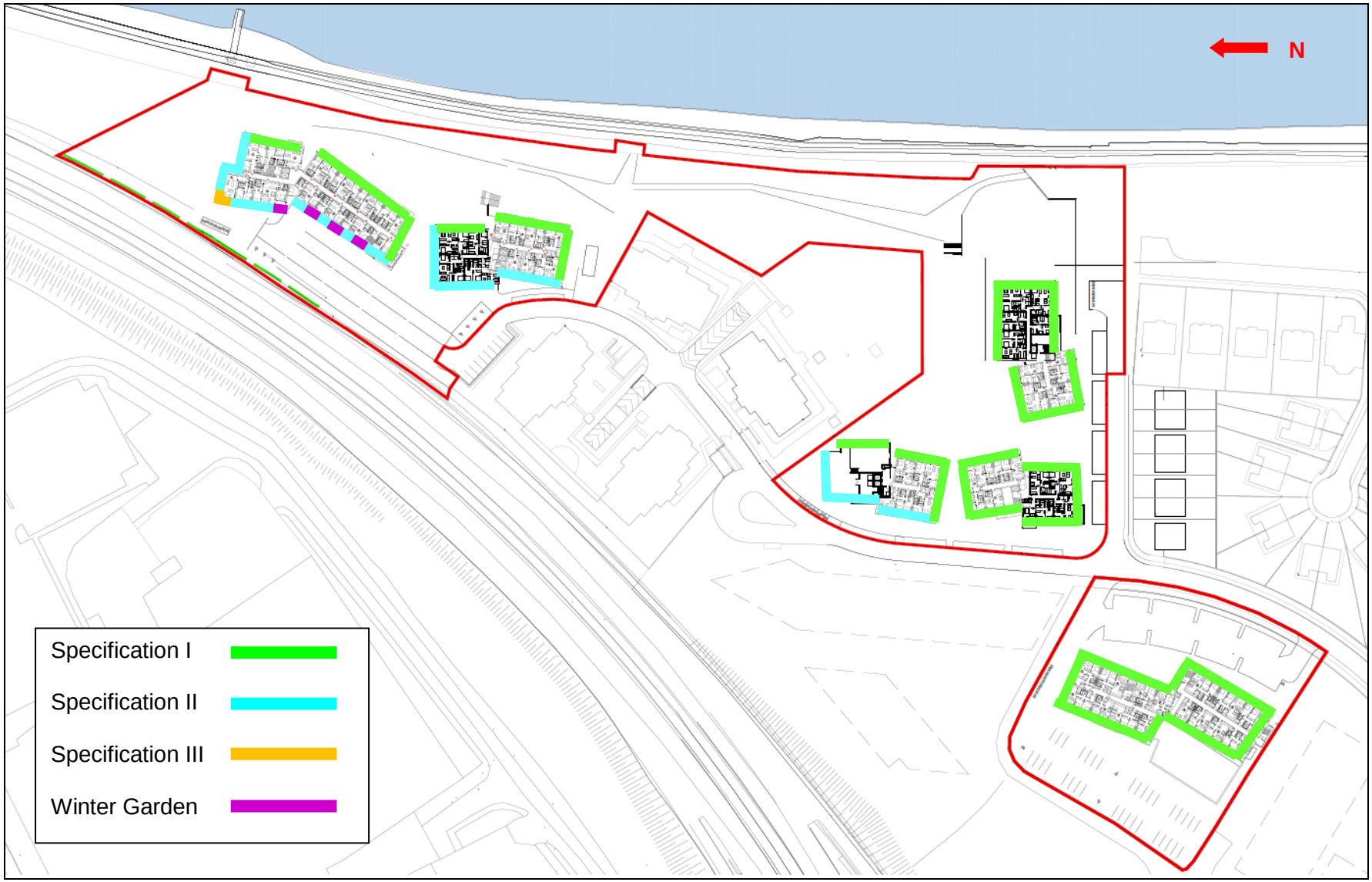

Figure 8 Façade Specification Mark-up

With glazing specifications achieving the minimum requirements detailed in Table 2 and located as detailed in Table 3, the predicted internal noise level across the development will be within the adopted design goals as follows:

Daytime (07:00hrs to 23:00hrs)

- Living Rooms – 40dB L_{Aeq};
- Bedrooms – 35dB L_{Aeq}.

Night-time (23:00hrs to 07:00hrs)

- Living Rooms – 40dB L_{Aeq};
- Bedrooms – 30dB L_{Aeq}.

These design goals represent the maximum internal noise levels predicted within the development buildings. It is important to note, however, that in the majority of the development buildings the internal noise environments will be below these design goals.

6.4 Wall Construction

In general all wall constructions, i.e. block work or concrete, offer a high degree of sound insulation, much greater than that offered by the glazing systems discussed in Section 6.2. It is envisaged that the proposed wall construction will comprise 19mm cement fibre board on metal studs, faced internally with two layers of 12mm plasterboard. Therefore, noise intrusion via the wall construction will be minimal.

6.5 Ventilation

The proposed building will use a mechanically powered heat recovery system, which removes the requirement for window trickle vents. As a result noise intrusion from road traffic via the ventilation system will be minimal.

6.6 Plant Noise

With regard to building services plant it is envisaged that the following may be employed in order to achieve the recommended noise levels:

- selection of inherently quiet plant items;
- duct mounted attenuators on the atmosphere side of air moving plant;
- solid barriers screening external plant, and;
- anti-vibration mounts on reciprocating plant.

7.0 COMMENT ON THE FUTURE NOISE ENVIRONMENT

The dominant noise source in the area is the N40 dual carriageway to the west of the site. In future it is likely that there will be an increase in traffic volumes along this road. It is acknowledged that an increase in road traffic volumes would give rise to a corresponding increase in noise levels.

With road traffic noise, typically a 25% increase in volumes would be expected to give rise to a 1 dB increase in noise levels. A 50% increase (road traffic increasing from approximately 65,240 to 97,860 AADT) would be expected to give rise to a corresponding noise level increase of 2 dB.

To put this increase in context Table 4 provides an indication of the subjective impression of different increases in road traffic noise levels.

Change in Sound Level (dB L_{A10})	Subjective Reaction	Impact
< 3	Inaudible	Imperceptible
3 – 5	Perceptible	Slight
6 – 11	Up to a doubling of loudness	Moderate
11 – 15	Over a doubling of loudness	Significant
> 15		Profound

Table 4 Likely Impact Associated with Change in Traffic Noise Level

8.0 CONCLUSIONS

Using guidance outlined in the Cork Noise Action Plan 2013 – 2018 the development site in question has been assessed considering the prevailing noise environment. Based on this assessment, the development site has been found to have a noise environment that will be suitable for residential development. Using the development building layout provided by the design team, noise levels at the facades of the proposed development have been predicted. Using guidance contained within *BS 8233,* appropriate mitigation measures in relation to the sound insulation performance of the building envelope have been formulated.

In order to control the inward noise impact within the development, glazing should be selected so as to provide, as a minimum, the octave band sound reduction indices set out in Table 5 below. It should be noted that the three glazing specifications are double glazed units and that glazing specification I is the standard glazing specification that would be used across the development. Glazing specifications II, III and WG offer more sound insulation due to the thicker pane of glass on the outside of the double glazed unit or the provision of a winter garden.

Glazing Specification	Octave Band Centre Frequency (Hz)						R_w	Typical Glazing Configuration
	125	250	500	1k	2k	4k		
I	20	19	29	38	36	45	33	6-12-6
II	27	29	36	41	42	52	40	10-12-6.4 laminate
III	28	34	44	52	47	55	45	13-12-13 acoustic laminate
WG	Winter Garden							

Table 5 Minimum Sound Reduction Index (SRI) Performance Requirements for Glazing

Following the implementation of the glazing specifications outlined above the internal noise environment within the sensitive areas of the development are predicted to be within the recommended criteria adopted from BS 8233. It is noted that the mitigation measures considered within this assessment are in accordance with the recommendations contained within the Cork Noise Action Plan as discussed in Section 2.2.

External noise levels across the amenity areas of the proposed development have also been assessed and have been found to be well below the levels considered to be 'undesirably high' in the *Cork Agglomeration Noise Action Plan 2013 – 2018*. The absolute noise levels across the external spaces are less than 70dB L_{den} at all locations and the majority of the development will experience noise levels well below this level. Therefore, the external noise environment is considered to be good and provides a good level of amenity.

In conclusion, with the implementation of mitigation measures proposed within this report the noise impact on the proposed residential development can be controlled such that the impact of the worst-case scenario is not considered to be significant or of a level that would have a negative impact on the residential amenity of the proposed dwellings and outdoor spaces.

APPENDIX A

NOISE SURVEY RESULTS

A1. Unattended Noise Levels

Start Date	Start Time	Sound Pressure Level (dB re 2x10^{-5} Pa)				
		L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF10}	L_{AF90}
08/02/2018	12:30	73	79	65	75	70
08/02/2018	13:30	72	78	63	74	69
08/02/2018	14:30	73	82	62	75	69
08/02/2018	15:30	73	89	63	75	70
08/02/2018	16:30	73	81	64	75	70
08/02/2018	17:30	72	78	64	74	69
08/02/2018	18:30	72	79	58	75	69
08/02/2018	19:30	71	79	61	74	67
08/02/2018	20:30	69	79	57	72	64
08/02/2018	21:30	70	79	56	73	64
08/02/2018	22:30	68	78	52	71	61
08/02/2018	23:30	66	80	45	69	54
09/02/2018	00:30	62	77	37	66	45
09/02/2018	01:30	62	77	36	67	43
09/02/2018	02:30	61	76	36	66	42
09/02/2018	03:30	62	76	34	66	45
09/02/2018	04:30	66	77	42	70	53
09/02/2018	05:30	70	79	48	73	62
09/02/2018	06:30	74	80	60	76	71
09/02/2018	07:30	74	80	64	76	72
09/02/2018	08:30	74	81	68	76	72
09/02/2018	09:30	74	80	61	76	71
09/02/2018	10:30	74	82	63	76	70
09/02/2018	11:30	73	81	64	75	70
09/02/2018	12:30	73	80	64	75	70
09/02/2018	13:30	73	81	63	75	70
09/02/2018	14:30	73	80	63	75	70
09/02/2018	15:30	71	78	61	73	68
09/02/2018	16:30	72	79	57	74	69
09/02/2018	17:30	72	81	58	74	69
09/02/2018	18:30	72	79	61	74	68
09/02/2018	19:30	71	78	54	73	66
09/02/2018	20:30	69	78	56	71	64
09/02/2018	21:30	68	82	55	71	62
09/02/2018	22:30	66	79	47	69	58
09/02/2018	23:30	65	78	41	68	54
10/02/2018	00:30	63	78	39	67	49
10/02/2018	01:30	61	74	39	66	45
10/02/2018	02:30	61	75	39	65	44
10/02/2018	03:30	63	76	39	67	46
10/02/2018	04:30	64	77	37	68	48
10/02/2018	05:30	66	79	43	70	54
10/02/2018	06:30	69	80	51	73	62
10/02/2018	07:30	70	79	56	73	64
10/02/2018	08:30	72	80	57	74	67
10/02/2018	09:30	73	79	61	75	69
10/02/2018	10:30	73	82	64	75	70
10/02/2018	11:30	73	79	62	75	70
10/02/2018	12:30	73	79	63	75	70
10/02/2018	13:30	73	83	62	76	70
10/02/2018	14:30	72	79	62	75	69
10/02/2018	15:30	72	80	60	74	69
10/02/2018	16:30	73	84	63	75	70
10/02/2018	17:30	73	81	60	75	69
10/02/2018	18:30	73	81	62	75	70

Start Date	Start Time	Sound Pressure Level (dB re 2x10^{-5} Pa)				
		L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF10}	L_{AF90}
10/02/2018	19:30	72	80	62	75	68
10/02/2018	20:30	70	81	57	73	65
10/02/2018	21:30	69	83	52	72	63
10/02/2018	22:30	68	79	53	71	61
10/02/2018	23:30	66	79	41	69	56
11/02/2018	00:30	65	77	42	69	53
11/02/2018	01:30	63	75	37	67	47
11/02/2018	02:30	63	78	38	67	48
11/02/2018	03:30	62	74	35	67	47
11/02/2018	04:30	62	76	35	67	43
11/02/2018	05:30	64	76	36	68	48
11/02/2018	06:30	66	77	45	70	57
11/02/2018	07:30	67	77	49	71	59
11/02/2018	08:30	68	79	52	71	61
11/02/2018	09:30	70	79	52	73	64
11/02/2018	10:30	72	78	60	74	67
11/02/2018	11:30	73	81	62	75	70
11/02/2018	12:30	74	79	59	76	71
11/02/2018	13:30	74	80	66	76	71
11/02/2018	14:30	74	86	63	76	71
11/02/2018	15:30	74	79	65	76	71
11/02/2018	16:30	73	79	63	75	70
11/02/2018	17:30	73	78	62	75	69
11/02/2018	18:30	72	78	62	74	68
11/02/2018	19:30	72	78	53	74	67
11/02/2018	20:30	70	77	51	72	64
11/02/2018	21:30	68	77	48	71	59
11/02/2018	22:30	66	77	43	69	58
11/02/2018	23:30	63	75	37	67	50
12/02/2018	00:30	60	75	38	65	43
12/02/2018	01:30	58	77	34	62	39
12/02/2018	02:30	59	76	36	64	43
12/02/2018	03:30	61	74	38	65	46
12/02/2018	04:30	64	76	38	68	51
12/02/2018	05:30	68	77	49	72	61
12/02/2018	06:30	73	78	64	74	70
12/02/2018	07:30	73	78	64	74	70
12/02/2018	08:30	72	77	64	74	70
12/02/2018	09:30	72	78	62	74	69
12/02/2018	10:30	71	79	59	74	68
12/02/2018	11:30	72	86	62	74	68

Table A1 Measured Noise Levels – Unattended

A2. Attended Noise Survey

Location	Date	Time	Sound Pressure Level (dB re 2x10^{-5} Pa)				
			L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF10}	L_{AF90}
2	8 February 2018	12:43	63	76	57	64	60
		13:37	63	75	56	64	60
		14:07	64	77	58	65	61
3		13:02	58	64	55	60	57
		13:51	60	65	56	62	58
		14:25	59	72	54	60	57

Table A2 Measured Noise Levels – Attended

APPENDIX B
NOISE MODEL TECHNICAL DATA

B.1 Noise Model

A computer-based prediction model has been prepared in order to quantify the traffic noise level associated with the surrounding roads on the proposed development site. This section discusses the methodology behind the noise modelling process.

B.2 Brüel & Kjær Type 7810 *Predictor*

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, Brüel & Kjær Type 7810 *Predictor*, calculates traffic noise levels in accordance with CRTN guidance.

Brüel & Kjær Type 7810 *Predictor* is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. *Predictor* predicts noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of sound power or traffic flow and average velocity;
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver.

B.3 Prediction of traffic noise

Noise emissions during the operational phase of the project have been modelled using *Predictor* in accordance with CRTN. The CRTN method of predicting noise from a road scheme consists of the following five elements:

- divide the road scheme into segments so that the variation of noise within this segment is small;
- calculate the basic noise level at a reference distance of 10 metres from the nearside carriageway edge for each segment;
- assess for each segment the noise level at the reception point taking into account distance attenuation and screening of the source line;
- correct the noise level at the reception point to take account of site layout features including reflections from buildings and facades, and the size of source segment;
- combine the contributions from all segments to give the predicted noise level at the receiver location for the whole road scheme.

Note that all calculations are performed to one decimal place.

APPENDIX B

NOISE MODEL TECHNICAL DATA (Continued)

B.4 Input to the Noise Model

The noise model was prepared using the following data:

- topographical data and Ordnance Survey mapping supplied by the project architects.

B.5 Output of the Noise Model

Predictor calculates noise levels for a set of receiver locations specified by the user. The results include an overall level in daytime (i.e. 07:00 to 23:00hrs) and night time (i.e. 23:00 to 07:00hrs) levels.