9 NOISE AND VIBRATION

9.1 Introduction and Methodology

Potential noise and vibration impacts are assessed in this chapter with respect to the construction phase and the commissioned development. The following documents were consulted during the preparation of the chapter:

- *Guidelines on the information to be contained in Environmental Impact Assessment Reports* (EPA, 2017, DRAFT).
- *Advice Notes for preparing Environmental Impact Statements September 2015* (EPA, 2015, DRAFT).
- *NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities* (EPA, 2016).
- *British Standard BS 4142:2014 Methods for rating and assessing industrial and commercial sound (2014).*
- *British Standard BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise* (2014).
- *British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 2: Vibration (2014)*.
- *British Standard BS 8233:2014 Guidance on sound insulation and noise reduction for buildings.*
- *ProPG Planning & noise: Professional practice guidance on planning & noise – New residential development* (Association of Noise Consultants, Institute of Acoustics and Chartered Institute of Environmental Health, May 2017).
- *Good practice guide for the treatment of noise during the planning of national road schemes* (National Roads Authority, 2014).
- *Guidelines on community noise* (World Health Organisation, 1999).

A baseline noise survey was undertaken in accordance with *International Standard ISO 1996-2:2017 Acoustics – Description, measurement and assessment of environmental noise, Part 2: Determination of environmental noise levels* (2017).

9.2 Statement of Authority

This assessment was undertaken by Damian Brosnan of Damian Brosnan Acoustics who has over 20 years' experience in scoping and carrying out noise impact assessments. His qualifications are as follows:

- BSc (Honours) 1993 (University College Cork).
- Diploma in Acoustics & Noise Control 2009 (Institute of Acoustics).
- MSc (Distinction) in Applied Acoustics 2015 (University of Derby).
- Member of Institute of Acoustics (MIOA) & secretary of Irish branch.
- Member of trade association of Irish acoustic consultants (ACASITI).
- Member of Engineers Ireland (MIEI).
- 1996-2001: Noise Officer with Cork County Council.
- 2001-2014: Partner with DixonBrosnan Environmental Consultants, specialising in EIA.
- 2015--: Principal at Damian Brosnan Acoustics.

9.3 Noise Guidance & Criteria

9.3.1 Construction Phase

There are no national mandatory noise limits relating to the construction phases of projects. In granting planning permission, a local authority may stipulate construction phase noise limits applicable to daytime, evening, night-time and weekend hours as appropriate. There are no national guidelines available regarding the selection of such limits. Many local authorities chose to apply a 65 dB $L_{Aeq\,T}$ limit (see Appendix 9-2 Noise Glossary).

The chief noise guidance document applied in Ireland and the UK in construction phase noise assessments is *British Standard BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise* (2014). Annex E sets out several methods to draw up suitable noise criteria applicable to the construction phase of a project. The most appropriate method here is considered to be the 'ABC method', which provides for the selection of criteria based on existing ambient noise data. On the basis of noise data recorded in the vicinity of the study site, as described in Section 9.4.3 below, a daytime $L_{Aeq\ 1\ h}$ criterion of 65 dB is identified. This criterion is identical to that typically applied by local authorities, and is thus applied in this assessment. The $L_{Aeq\ 1\ h}$ parameter describes the total noise emissions from all construction sources occurring during any 1 h period, averaged over that hour.

BS 5228:2009+A1:2014 states that the 65 dB criterion is applicable to the periods Monday-Friday 0700-1900 h and Saturday 0700-1300 h. For the purposes of this assessment, the criterion is extended to include Saturday afternoons, to facilitate possible local onsite activities required to complete the project. Construction operations are unlikely to be undertaken during evening or night-time hours, or on Sundays. This assessment therefore applies the 65 dB criterion in respect of all construction works.

The standard notes that the criterion is recommended with respect to residential receptors only. In this regard, the Environmental Protection Agency (EPA) document *NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities* (2016) defines a noise sensitive location (NSL) as:

> *'Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires absence of noise at nuisance levels'.*

Thus the 65 dB criterion is considered applicable to surrounding residential receptors, in their immediate curtilage. As construction projects tend to be relatively short, and as construction zones are typically localised and mobile, the 65 dB limit is usually not subject to any additional criteria such as tone or impulse restrictions.

With respect to nearby offices, the 65 dB external criterion is considered unsuitable. *British Standard BS 8233:2014 Guidance on sound insulation and noise reduction for buildings* provides a range of internal noise criteria for office types. An internal $L_{Aeq\,T}$ criterion of 45 dB is considered appropriate here. An external criterion of 70 dB outside offices will be consistent with an internal 45 dB criterion, assuming a transmission loss of 25 dB through building windows. In the absence of any clarification in British Standard BS 8233:2014 regarding the duration of T in the

internal $L_{Aeq\ T}$ criterion, the 1 h interval recommended by BS 5228:2009+A1:2014 is applied in this report.

The 70 dB external criterion is identical to the daytime construction phase criterion recommended by Transport Infrastructure Ireland (formerly the National Roads Authority, NRA) document *Good practice guide for the treatment of noise during the planning of national road schemes* (2014). Although not directly relevant to the proposed development, the NRA construction phase criterion has acquired some weight in Ireland due to the absence of any other national construction noise guidance.

9.3.2 Operational Phase

As with construction phase noise, there are no national mandatory noise limits applicable to commissioned developments. While a number of guidance documents have been issued with respect to certain sectors, none relate to mixed use urban developments such as those assessed in this report. Moreover, none have been issued in respect of the individual elements incorporated in the proposal, namely residential, hotel, retail and office.

Most environmental noise guidance documents issued across Europe ultimately derive limits from guidance issued by the World Health Organisation (WHO). The WHO document *Guidelines on community noise* (1999) sets out guideline values considered necessary to protect communities from environmental noise. With respect to residential settings, the document notes that an outdoor $L_{Aeq\ 16\ h}$ level of 55 dB is an indicator of serious annoyance during daytime and evening hours, with 50 dB being an indicator of moderate annoyance. The 55 dB criterion was first suggested by the WHO in their 1980 document *Environmental Health Criteria 12*.

Since 1980, the 55 dB criterion has become the de facto daytime limit applied by most Irish regulatory authorities to commercial and industrial operators. Although the WHO criterion applies to daytime periods of 16 hours, authorities typically specify shorter periods, and thus limits as $L_{Aeq\ 15\ min}$, $L_{Aeq\ 30\ min}$ and $L_{Aeq\ 1\ h}$ are variously applied. In issuing licences to industrial facilities, the EPA typically specifies a daytime $L_{Aeq\ T}$ limit of 55 dB at NSLs. The EPA currently considers daytime to refer to 0700-1900 h. A similar daytime limit is usually included in noise conditions attached to planning permission issued by local authorities.

The WHO's 1999 guidance document recommends an external night-time criterion of 45 dB to prevent sleep disturbance. Although the WHO document *Night noise guidelines for Europe* (2009) makes reference to a 40 dB night-time criterion, this relates to the $L_{night,outside}$ parameter, which is the long term average measured throughout a whole year. The 45 dB criterion is considered more appropriate to short term measurement intervals. As before, $L_{Aeq\ 15\ min}$, $L_{Aeq\ 30\ min}$ and $L_{Aeq\ 1\ h}$ intervals are variously applied by regulatory authorities, rather than the 8 hour period to which the WHO's 45 dB criterion applies. The EPA considers that night-time refers to 2300-0700 h.

Neither of the WHO documents identified above makes reference to evening periods, and indeed their 1999 document assumes that daytime extends to 2300 h. However, a trend towards the separate assessment of evening impacts is currently evident, partly driven by the EPA's NG4 document, the 2012 version of which introduced the evening period 1900-2300 h. The NG4 document recommends an evening criterion of 50 dB, applicable to NSLs.

Many authorities require that a penalty be added to measured noise levels where emissions are tonal and/or impulsive. NG4 specifies the addition of a 5 dB penalty to site specific $L_{Aeq\ T}$ levels measured during daytime or evening hours. During night-time hours, the EPA prohibits tones and impulses entirely, stating that such characteristics should not be 'clearly audible or measurable'. With respect to short term impulsive sources, the WHO recommends a night-time L_{Amax} limit of 60 dB outside bedroom windows during night-time hours. No L_{Amax} limit is recommended for daytime periods.

British Standard BS 4142:2014 Methods for rating and assessing industrial and commercial sound (2014) sets out a procedure which may be used to assess the impact of noise emissions from a proposed development on dwellings. The standard provides for the comparison of specific $L_{Aeq\ T}$ levels with background levels, and provides an indication of impact depending on the difference. Specific levels may be rated to take tonal, impulsive and other characteristics into account. The standard notes that the background noise environment may include existing industrial emissions unrelated to the specific source.

BS 4142:2014 notes that a difference between specific and background levels of 10 dB or more is indicative of a significant adverse impact. A difference of 5 dB suggests an adverse impact, with lower differences suggesting reduced impacts. The standard adds that the perception of impact will be increased or reduced depending on local context.

Unlike earlier versions, the 2014 edition of BS 4142 clearly sets out the standard's scope. With respect to the proposed development, the standard is applicable solely to onsite plant sources such as air handling plant, and to deliveries.

On the basis of the foregoing, operations phase criteria deemed relevant to this assessment may be summarised as follows:

- Daytime (0700-1900 h) $L_{Aeq\ T}$ limit of 55 dB, with 5 dB penalty where emissions are tonal and/or impulsive.
- Evening (1900-2300 h) $L_{Aeq\ T}$ limit of 50 dB, with 5 dB penalty where emissions are tonal and/or impulsive.
- Night-time (2300-0700 h) $L_{Aeq\ T}$ limit of 45 dB, with no tones or impulses.
- Night-time (2300-0700 h) L_{AFmax} limit of 60 dB.
- BS 4142:2014 criteria with respect to fixed sources such as air handling plant and daytime deliveries.

The above criteria are considered relevant to external areas of NSLs, and include areas in proximity to NSL facades. It should be noted that none of the criteria is legally obligatory, and the criteria are selected merely as guidance for the purposes of this assessment.

British Standard BS 8233:2014 provides guidance for the control of noise in and around buildings, chiefly with a view to designing the building envelope to allow specified criteria be met within the building. The standard explicitly states that it is not applicable to the assessment of impacts arising from a proposed development on offsite receptors. The standard is therefore not relevant to this assessment. The standard is, however, pertinent to the project design stage, and will be applied in the final specification of various building elements.

9.4 Baseline

9.4.1 Location & Land Use

The proposed development site consists of c.5.1 ha plot on the northeastern fringes of Galway City, 2 km from the city centre. The site lies 140 m from the intersection between national primary routes N6 and N17.

The overall Crown Square site occupies an irregularly shaped four-sided block (Figure 9.1). The southern boundary is formed by Monivea Road which meets the N6 approximately 400 m to the east of the site. The western boundary is formed by Joyce Road which connects Monivea Road to Tuam Road. Monivea Road and Joyce Road are the only roads directly adjoining the site. The frontage to these is respectively 395 and 210 m.

Most of the site's 193 m eastern boundary adjoins an Eir facility which includes two office buildings, one extending to seven floors. The northern end of this boundary, at the site's northern corner, adjoins a car dealer's premises, including workshop facilities which lie directly adjacent to the boundary.

The site's northern boundary, extending to 214 m, lies behind a commercial estate which includes a mixture of commercial, fabrication, medical, laboratory and office facilities. The commercial estate separates the study site from Tuam Road further north.

Figure 9.1 Proposed development site outlined yellow. N

Land use on the northern and eastern sides of the site is distinctly commercial in character, extending north and east towards the Tuam Road, the N6, and beyond. The area to the west of the site, on the opposite side of Joyce Road, is commercial and industrial, and a number of facilities here lie spread across several commercial estates. The area to the south, on the opposite side of Monivea Road, is urban residential in character, consisting of medium density housing accessed by a network of roadways. Some of the dwellings here face the site.

An industrial building which historically existed onsite was previously demolished, and the site excavated downwards across its entire area, out to the boundaries. The site floor currently sits approximately 10 m below surrounding ground level, with the site boundaries sitting at the top of sloped rock faces. A partially completed basement structure, 200 m in length, extends along the southern boundary from the southwest corner, visible in Figure 9.1. There are no permanent structures across the remainder of the site, although various stockpiles and plant are currently present. The site is presently accessed from Joyce Road via a gate near the northwest corner, from which a ramp runs down to the site floor.

9.4.2 Receptors

The proposed development site does not directly border any residential plots. The nearest dwellings are those along the southern side of Monivea Road, where 29 dwellings face the site. These consist of a mixture of single storey detached, single storey terraced, two storey detached, two storey semi-detached and two storey terraced dwellings, lying approximately 20 m from the site boundary. This residential zone extends further south and southeast. The dwellings fronting onto Monivea Road represent the nearest residential receptors.

There are no other residential receptors in close proximity to the site. The nearest dwellings in other directions are:

- A residential estate at Garran Na Teamhrach, 200 m southwest of the site.
- An extensive network of residential estates off Tuam Road to the northwest, the nearest dwellings here, at Sruthan Na Fuinseoige, being located 220 m from the boundary.
- A residential estate at Glenanail to the north, where the closest dwellings lie 220 m from the northern corner of the site.
- The nearest dwellings to the east lie along Monivea Road, where Pairc Mhuinemhea lies 190 m from the site. There are no dwellings in audible range to the northeast of the site.

The extensive local urban development is such that the number of individual receptors is too extensive to list. The most practical approach here is to apply sensitive receptor status to all dwellings along Monivea Road, and to all dwellings in the residential estates listed above.

Apart from the dwellings listed above, no other residential receptors have been identified. All other potential receptors consist of the following:

- Office buildings. The nearest such buildings consist of a three storey building immediately outside the site's northwest corner, the rear façade of which entirely overlooks the site. Two office buildings at the Eir facility outside the

eastern boundary also overlook the site. It is arguable that office buildings do not warrant's NSL status, as the EPA's definition makes no reference to offices. However, it is considered that such buildings certainly warrant protection during the construction phase.

- The office building outside the northwest corner is occupied by a number of entities, one of which is Galway Primary Care, a health care facility which may include consulting rooms that require the absence of noise at nuisance levels. This facility therefore constitutes a vulnerable receptor, and warrants NSL status throughout the construction phase, and also following commissioning. The facility may also include medical equipment which may be vulnerable to vibration impacts.
- A large number of commercial and industrial buildings lie in the vicinity of the site, including a commercial laboratory 50 m outside the northern boundary. As with offices, the EPA's NSL definition does not refer to such facilities. These are unlikely to be affected by construction phase or operational phase emissions. However, the laboratory may include equipment potentially sensitive to ground borne vibration.

It is noted that, following completion of the proposed development, the nearest receptors will consist of onsite apartments, hotel bedrooms, and offices.

9.4.3 Ambient Noise Survey

The soundscape in the vicinity of receptors surrounding the proposed development site was characterized through an unattended noise survey undertaken 05.09.18—11.09.18, with occasional spot checks. Monitoring was carried out at three stations described in Table 9.1, and shown in Figure 9.2 and Photographs 9.1-9.3. The stations were selected to represent the nearest receptors. Monitoring equipment is listed in Table 9.2.

Figure 9.2 Ambient noise stations. N

Photograph 9.1 N1, looking N towards office building.

Photograph 9.2 N2, looking SW towards site corner.

Photograph 9.3 N3, looking NE towards Eir site.

Table 9.1 Noise stations

Station	ITM NGR	Description	Reason
N1	531866 726929	Site floor, 20 m S of office building outside NW corner	To represent rear façade of office building overlooking site. Monitoring position at original ground elevation not available. Noise levels on site floor likely to be slightly lower than at office.
N2	531808 726754	Roof of existing partially completed building onsite, 40 m from SW corner, 10 m from boundary	To represent dwellings on Monivea Road, near SW corner of site.
N3	532012 726851	10 m inside S boundary, 70 m from SE corner, close to original ground elevation	To represent dwellings on Monivea Road, near SE corner of site, and Eir facility.

Table 9.2 Noise equipment

Statio	Model	Serial no.	Microphone serial no.	Laboratory calibration	Field calibration	Field calibrator details
N1	Sonitus EM2030	00383	172868/04788	10.05.17	05.09.18	B&K 4231 SN: 2342544
N2	Sonitus EM2030	00393	171792/047792	10.05.17	05.09.18	B&K 4231 SN: 2342544
N3	Sonitus EM2030	00654	340599/053602	03.09.18	05.09.18	B&K 4231 SN: 2342544

Recorded $L_{Aeq\ 1\ s}$ profiles are shown in Figures 9.3-9.5. Noise data are summarised in Table 9.3. Periods of rainfall were removed from the data. As local rainfall data were not available, rainfall data were obtained from the Met Eireann weather station at Athenry. In order to reduce impacts due to separation distance, noise data were removed with respect to 12 h periods where any rainfall was recorded. Wind speeds at the study site were less than 5 m/s throughout, and generally from the southwest.

Table 9.3 Noise data. Elevated levels recorded 1245-1415 h at N2 on 07.09.18 (evident in Figure 9.4) are removed.

Station	Period	$L_{Aeq\ 15\ min}$ dB	$L_{AF10\ 15\ min}$ dB	$L_{AF90\ 15\ min}$ dB	Modal $L_{AF90\ 15\ min}$ dB
N1	M-Sa 0700-1900	45-59	50-65	39-54	48
	Su 0700-1900	45-63	47-60	41-51	49
	M-F 1900-2300	44-52	47-55	39-49	43
	Sa-Su 1900-2300	47-53	50-56	43-51	46
	Su-Th 2300-0700	40-53	42-56	37-49	42
	Fr-Sa 2300-0700	40-52	41-58	34-45	42
N2	M-Sa 0700-1900	59-65	64-70	49-59	56
	Su 0700-1900	56-68	60-67	49-57	55
	M-F 1900-2300	58-63	63-67	46-56	51
	Sa-Su 1900-2300	57-64	61-69	48-55	53
	Su-Th 2300-0700	52-62	55-67	46-55	46
	Fr-Sa 2300-0700	52-61	57-67	43-51	46
N3	M-Sa 0700-1900	57-64	63-69	43-57	54
	Su 0700-1900	55-63	59-66	45-56	45
	M-F 1900-2300	56-63	62-66	41-53	45
	Sa-Su 1900-2300	55-62	61-66	44-54	48
	Su-Th 2300-0700	48-60	48-65	39-50	40
	Fr-Sa 2300-0700	47-59	53-65	38-47	41

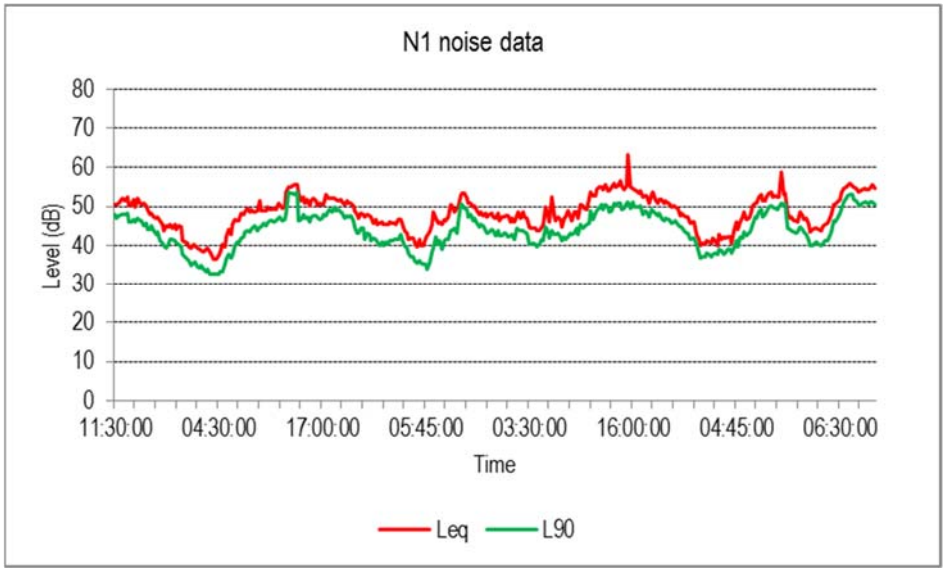

Figure 9.3 N1 time history profile.

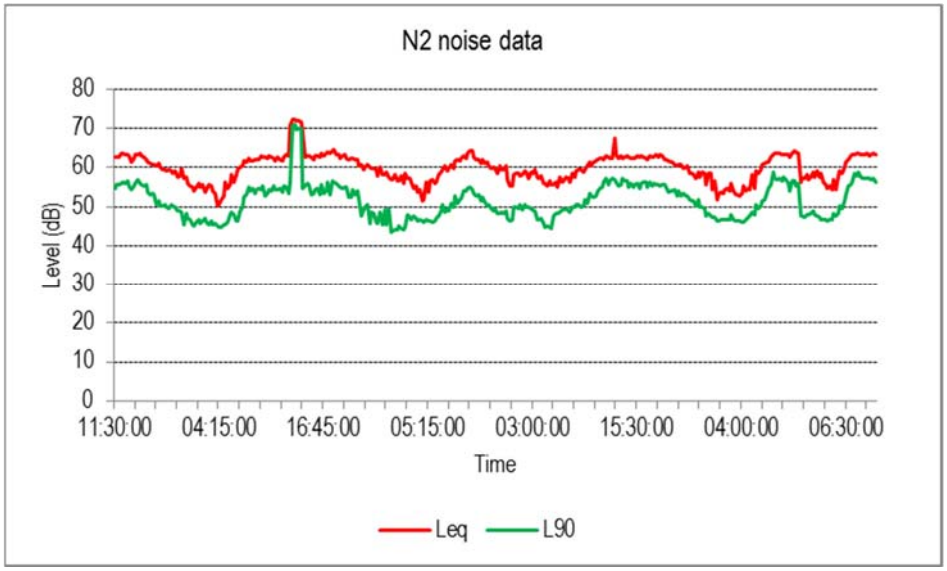

Figure 9.4 N2 time history profile.

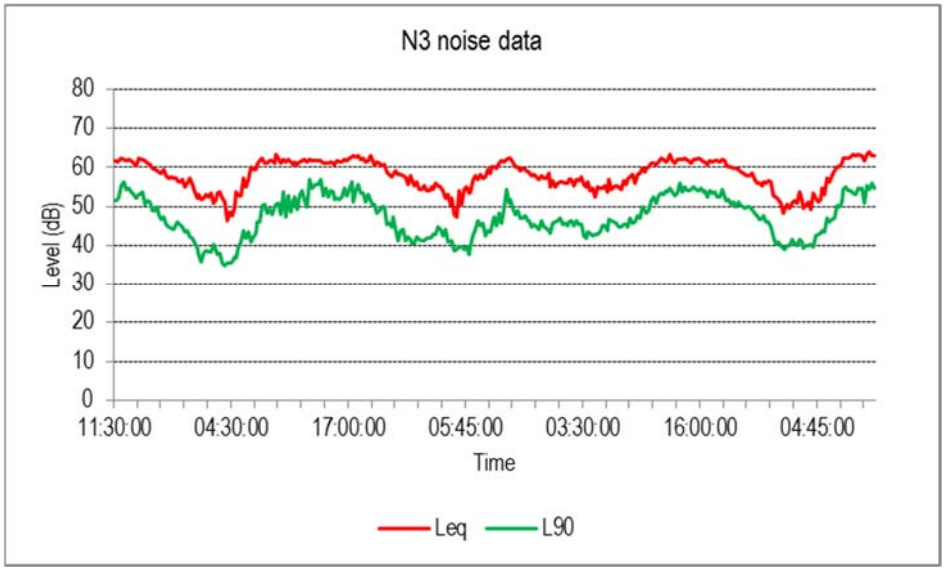

Figure 9.5 N3 time history profile.

The soundscape at all three stations was dominated by local and distant traffic, including traffic on the N6, Tuam Road, Monivea Road, Joyce Road, and vehicle movements in the nearest residential and commercial estates. Due to their proximity to Monivea Road, noise levels at N2 and N3 were higher than at N1, although N1 was partly influenced by occasional emissions from a fabrication premises outside the northern boundary. The only other emissions generally audible were bird song/calls and aircraft. Traffic noise was dominant throughout the evening, night-time and weekends, chiefly due to distant N6 activity.

Recorded data were applied in the determination of the 65 dB $L_{Aeq\ 1\ h}$ criterion as discussed in Section 9.3.1. Modal $L_{AF90\ 15\ min}$ values included in Table 9.3 may be used as an indicator of representative background levels.

9.4.4 Future receiving environment

EPA EIAR guidance recommends that a noise impact assessment should include a description of the likely evolution of the future receiving acoustic environment in the absence of the proposed development. The local noise environment is urban in character, with the chief noise sources being traffic on surrounding roads. A considerable change in traffic volume is required before ambient noise levels alter significantly. As road traffic levels are unlikely to radically change into the future, local noise levels are expected to remain reasonably similar to present levels, although the contribution due to local traffic is expected to reduce slightly due to a likely increase in the proportion of electric vehicles. At higher speeds, tyre noise dominates, and thus N6 traffic noise is likely to continue unabated in the long term.

With respect to the development site itself, it is expected that, should the proposed development not proceed (the 'do nothing' scenario), no noise emissions will arise other than those from construction of the permitted Phase 1 of the development and land management practices, depending on how the site is used into the future. Given the site's strategic location, it is likely that the plot will be earmarked for development at a later date, should the current proposal not proceed. Phase 1 of the development (which includes Commercial Offices (Blocks A-E), Hotel and Site Infrastructure, including all basement structures for the entire site) has received permission, and will be constructed regardless of whether this currently proposed phase 2 is permitted or not.

9.5 Likely and significant effects

9.5.1 Development summary

It is proposed to construct a mixed use development onsite. The project has been divided into two phases, indicated in Figure 9.6. The first phase of development for which permission has already been obtained from Galway City Council provides for:

- 5 no. blocks of commercial offices which range in height from 3-6 stories over ground floor level (40,405 sqm).
- A hotel development with 5 floors over ground floor level, comprising 175 no. bedrooms, conferencing facilities and restaurant/bar areas (8,675 sqm).
- A double basement which includes a 'high bay' area for service, delivery and waste management vehicles; in addition to the provision of plant, car and bicycle parking, changing/shower areas and locker/amenity facilities (62,175 sqm), incorporating alterations to the existing structures on site permitted under Pl Ref. 06/223/ ABP Ref. PL 61.220893.
- Public realm and landscaping works, including pedestrian and cyclist linkages.
- The provision of vehicular access/egress via Monivea Road and Joyces Road, public transport set-down areas and cycle lanes.
- The provision of substations and associated ancillary works.
- All other associated site development and servicing works.

Phase 2 (to which this EIAR applies) consists of the following:

1. A residential scheme comprising 288 no. apartments and amenity accommodation with a gross floor area of 32,379 sqm, which will include:
    - Block G (104 no. units); Block H (136 no. units) and Block J (48 no. units).
    - 75 no. one-beds (26%); 185 no. two-beds (64.2%); and 28 no. three-bed units (9.7%)
    - Ancillary residential amenity areas (1,275 sqm).
    - Block G extends to eight-storeys, Block H extends to seven-storeys and Block J extends to five-storeys.
    - External balconies are provided on all elevations.
2. A commercial scheme with a cumulative gross floor area of 4,096 sqm, which will include:
    - A neighbourhood facility comprising a restaurant (500 sqm), café (50 sqm), local convenience store (225 sqm), a pharmacy (200 sqm), 5 no. retail/commercial units (797 sqm in total), a crèche (310 sqm)
    - A fitness/leisure facility (1,140 sqm); and
    - A medical centre (655 sqm).
3. Public realm and landscaping works, including pedestrian and cyclist linkages.
4. Vehicular access to the double basement permitted under Pl Ref 18/363 and the allocation of 288 no. car parking spaces located on the lower basement level to service the residential units. Visitor car parking will be provided on the upper basement level and will be managed in accordance with an Operational Management Plan and a Mobility Management Plan.
5. The provision of a dedicated cyclist ramp and 733 no. secure bicycle parking spaces located in the upper basement permitted under Pl Ref 18/36

(comprising 529 no. residential; 144 visitor parking and 60 no. bicycle parking spaces to service the neighbourhood facility).

6. All other associated site development, plant and servicing works.
7. The application will be supported by an Environmental Impact Assessment Report and a Natura Impact Statement.

The proposed office blocks along the southern boundary will be constructed over the existing partially completed structure, and thus demolition will not be required. The development will require landscaping works, including backfill around basement structures, paving, and boundary wall construction.

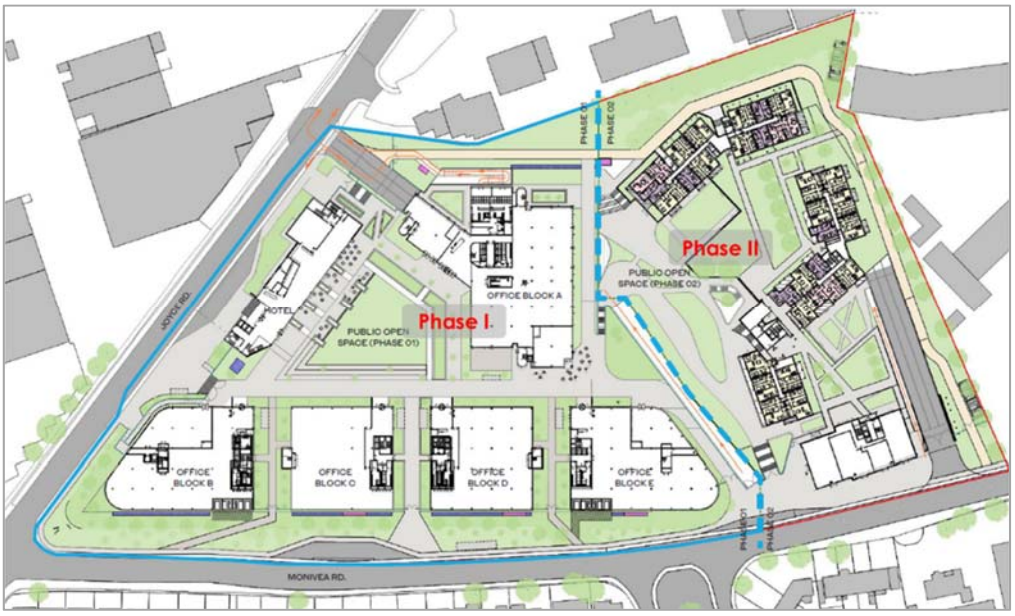

Figure 9.6 Proposed above-ground development. N

9.5.2 Construction phase noise sources

Construction will be undertaken over two phases, and will be managed from a temporary onsite compound. The overall construction project is expected to last approximately 3.5 years. Construction works will include the following activities, undertaken variously throughout the construction phase and in different areas of the site:

- Installation of temporary site compound
- Localised ground works to provide for building footings and services
- Steelwork erection
- Pouring & floating of concrete floor slabs and building cores
- Block work and roof work
- Building finishing (facades, glazing, etc.)
- Installation of mechanical and electric services
- Installation of site drainage and sewerage infrastructure
- Site landscaping and paving

It is possible that limited rock breaking will be required at one or more positions to enable ground works.

During the construction phase, the chief source of noise emissions will be plant used onsite. While sporadic emissions may arise from other sources such as voices and

hammering, plant emissions may continue for extended periods of time and may therefore potentially cause nuisance. Consequently the assessment of noise impacts associated with construction phase emissions relates chiefly to plant sources.

Construction plant required onsite at various stages of the project are listed in Table 9.4. The table includes details of typical sound pressure levels, taken from British Standard BS 5228:2009+A1:2014. More than one item of several plant listed are likely to be onsite simultaneously e.g. excavators.

Table 9.4 Expected construction plant

Plant	$L_{Aeq\,T}$ at 10 m dB
Aerial platform (diesel scissors 6 t)	78
Asphalt paving machine with tipper truck	75
Crane (35 t)	70
Concrete poker	78
Consaw (various activities)	79-84
Delivery truck (18-26 t) (drive by)	83
Diesel generator	61
Discharging concrete mixer truck	75
Dumper (3-7 t) (drive by)	76
Roller (drive by)	73
Small cement mixer	61
Telescopic handler	71
Tower crane	76
Tracked excavator (16-30 t)	68-78
Truck (tipping)	79
Truck (manoeuvring, various sizes)	70-80
Wheeled backhoe loader (9 t)	62-67

In addition to the above plant, rock breaking may be required at a small number of locations onsite, depending on ground conditions. Such activity, where required, is expected to be short term and local only. Noise data recorded at other sides indicate that emissions from a hydraulic breaker mounted on a mid-sized excavator are typically in the order of 88 dB at 10 m. Piling is not envisaged.

9.5.3 Construction phase noise prediction

Noise emissions arising during the construction phase of the proposed development will vary considerably due to several reasons:

- The site covers an area of over 5 ha. Emissions will arise from plant operating across the site, and thus the site will not constitute a single point source.
- The large construction area will result in differing propagation conditions with respect to receptors at different locations.
- The construction phase is expected to last several years. During this time, plant associated with different activities will relocate around the site as required.
- Different plant will be required at different times, and construction operations will vary on a daily basis. There may be extended periods during the construction phase with minimal noise emissions.

- As noted previously, more than one plant item may be required. For instance, two telescopic loaders may operate in close proximity to each other for a limited period. Simultaneously there may be several other loaders at different locations throughout the site.
- Each machine item may operate under different loading conditions or be in varying states of repair.
- Construction works may be concentrated for certain periods, followed by periods of seeming inactivity. Localised works may require several hours of intense activity.
- During later stages of the construction phase, emissions from some operations will be screened by previously completed buildings.
- As buildings near completion, activity will gradually relocate indoors.
- With respect to particular plant, the models selected will change depending on requirements. The method of construction may be modified shortly before commencement, resulting in the need to import different equipment. Construction projects tend to be fluid in nature, with plant requirements changing as the site is progressed and circumstances change on the ground. The need for specific plant may often be established only following the start of a project.

From the foregoing, it is clear that construction phase noise emissions will vary, and it is not possible or practical to calculate a single sound power output figure for the entire site. In such circumstances, it is preferable to assess specific operations or areas rather than attempting to apply a blanket figure across the entire site for the duration of the construction phase. With respect to surrounding noise sensitive receptors, worst case scenario emissions will arise when localised works are undertaken close to their respective boundaries. All other receptors are over 190 m from the site. It follows that compliance with construction criteria at the nearest receptors will benefit more distant receptors.

Table 9.5 presents the results of predictive modelling of the loudest construction phase activities at the nearest receptors identified above, undertaken in accordance with BS 5228:2009+A1:2014. The model output is presented in Appendix 9-1. Receiver positions considered appropriate to the construction phase are set at 2 m from the relevant facades, although do not include façade near field corrections as the 65 dB criterion is a free field limit. Given the absence of ground and atmospheric attenuation factors in BS 5228:2009+A1:2014, predicted levels are likely to overestimate actual levels by several decibels. Model input parameters are as follows:

- Hard ground assumed.
- Screening available re Monivea Road dwellings (west end only) due to intervening bank and/or partially completed building.
- A-weighted values assessed, as specific plant items not selected at this stage.
- Plant output data taken from Table 9.4. Where various levels quoted, highest value is applied.
- Plant on-times: platform (80 %), consaw (10 %), delivery truck (20 %), discharging mixer truck (20 %), excavator (70 %), dumper (20 %).
- Activity undertaken at nearest point of each activity zone to each receptor.

Table 9.5 Predicted construction phase levels at nearest receptors when plant operating at likely nearest zone. *depending on plant size

Receptor	Activity	Received $L_{Aeq\ 1\ h}$
Offices outside NW corner	Aerial platform	60 dB
	Consaw	60 dB
	Delivery truck	70 dB
	Discharging mixer truck	51 dB
	Dumper	63 dB
	Tracked excavator	60-70 dB *
Dwellings on Monivea Road (W end)	Aerial platform	56 dB
	Consaw	53 dB
	Delivery truck	47 dB
	Discharging mixer truck	40 dB
	Dumper	48 dB
	Tracked excavator	46-56 dB *
Dwellings on Monivea Road (E end)	Aerial platform	64 dB
	Consaw	61 dB
	Delivery truck	63 dB
	Discharging mixer truck	55 dB
	Dumper	56 dB
	Tracked excavator	53-63 dB *
Eir office building	Aerial platform	69 dB
	Consaw	68 dB
	Delivery truck	66 dB
	Discharging mixer truck	58 dB
	Dumper	63 dB
	Tracked excavator	60-70 dB *

Rock breaking is discussed separately in Section 9.5.4.

9.5.4 Assessment of Construction Phase Noise Effects

Table 9.5 indicates that noise levels at the nearest residential receptors attributable to construction operations will not exceed the 65 dB $L_{Aeq\ 1\ h}$ criterion. Levels at the nearby office buildings will not exceed the 70 dB criterion. Noise levels presented in the table relate to each individual source. When two or more sources operate simultaneously at the positions assessed, received levels will increase. As most of the sources assessed will not be continuous, and as received levels at each receptor will be determined chiefly by the nearest source, levels received when several plant operate simultaneously are unlikely to significantly exceed the levels presented in Table 9.5.

All other receptors are located at greater distances from the proposed development site, and noise levels here are not expected to exceed 65 dB at any time during the construction phase, regardless of work locations onsite. Any potential noise effects will therefore be temporary and imperceptible.

BS 5228:2009+A1:2014 data suggest that construction phase emissions will not be tonal. Apart from hammering, emissions are also unlikely to be impulsive. Hammering will be sporadic, typically occurring scaffolding erection and dismantling. These activities will be brief effects, localized and imperceptible.

None of the surrounding receptors includes external grounds which face the site that require the absence of noise at nuisance levels. While many dwellings along Monivea Road include front garden zones, these do not appear to be used for amenity, and it is likely that residents use rear gardens for amenity use. All rear gardens here are screened from the development site by the dwellings, and thus rear garden amenity is unlikely to be affected during the construction stage.

A requirement to carry out rock breaking may arise locally onsite during the construction phase to facilitate initial ground works. It is not known at this stage if this requirement will actually arise. If required, the duration of breaking is likely to be minimal. As the likely location(s), if any, are not known at this point, it is not possible to undertake predictive modeling. Breaking is unlikely to give rise to received $L_{Aeq\ 1\ h}$ levels at Monivea Road dwellings which exceed the identified 65 dB criterion.

Where rock breaking is required away from the northern or eastern boundaries, received levels at the Eir building, and at the office building outside the northwest corner of the site, are unlikely to exceed the 70 dB criterion identified with respect to these premises. If it is necessary to undertake breaking close to these premises, received levels may rise towards the 70 dB criterion, or may slightly exceed it. If breaking is necessary in proximity to these premises, specific mitigation will be required.

It is important to note that rock breaking was undertaken at the study site extensively over several years 10-15 years previously. It is understood that the current site elevation, which lies approximately 10 m below surrounding elevation, was lowered chiefly through rock breaking. A number of breakers worked simultaneously throughout this period, such that breaking noise emissions arose at a number of positions around the site at any time. It is understood that no noise issues arose during this period. Given that rock breaking, if required to facilitate the proposed development, is likely to be short term (i.e. several hours or days at most) and localized, no noise issues are expected.

Throughout the construction phase, vehicles will arrive at, and depart from, the site during the working day. Vehicle movements will be associated with workers' arrival and departure, and delivery of materials. The approximate numbers of workers employed onsite over the entire construction period will fluctuate depending on schedule. Numbers are unlikely to exceed 100 at any time, due to project phasing. Many of the construction employees are expected to arrive in multiple occupancy construction company vehicles. The number of construction personnel vehicles will therefore be relatively small. Delivery of construction materials will require scattered vehicle movements throughout the day.

All personnel and deliveries will access the proposed development site from Joyce Road, via the existing entrance. There are no dwellings in the vicinity of this access. Construction phase traffic volumes will be negligible in the context of existing traffic volumes on Monivea Road, Joyce Road and the N6. Potential construction phase traffic noise impacts will therefore be temporary, localised and imperceptible.

9.5.5 Construction Phase Vibration

Potential sources of ground borne vibration during the construction phase are as follows:

- Delivery truck movements: In the context of the large numbers of truck movements passing daily on the road network around the site, including in close proximity to surrounding receptors, vibration due to truck movements is expected to be negligible.
- Plant movements: The movement of plant is not considered to constitute a source of ground borne vibration, and is not listed in typical vibration documents such as *British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 2: Vibration* (2009). In addition, plant machinery used onsite is likely to be small to mid-sized, and similar to those used on other urban construction projects.
- Ground works: Unlike many urban construction projects, most of the ground works at the study site were completed previously. At local points, excavation of trenches and pits for foundation footings may be required. These activities are not typically associated with offsite ground borne vibration impacts. It is noted that piling is not proposed.
- Rock breaking: Unlike the activities listed above, breaking of rock involves a direct and repetitive impact to the rock stratum, which may generate relatively high levels of ground borne vibration locally. This activity is discussed below.

Rock breaking may give rise to vibration close to the breaking zone. However, the vibration tends to contain relatively little energy in the lower frequencies at which buildings and occupants are most vulnerable. In addition, higher frequencies attenuate more rapidly than low frequencies, thus minimising the impact zone. For this reason, most vibration guidance documents such as BS 5228-1:2009 ignore rock breaking vibration. Table 9.6 lists various peak particle velocity (PPV) levels reported in literature at sites where hydraulic rock breaking has been undertaken. The range in levels noted reflects variations in equipment power and rock type.

Table 9.6 Reported rock breaking vibration PPV levels

At 5 m	At 10 m	At 20 m	At 50 m
0.2-4.5 mm/s	0.06-3.0 mm/s	0.02-1.5 m/s	0.1-0.3 m/s

In order to assess the potential impact on structures and humans arising from construction phase vibration, a brief comment on typically applied standards is required. Limits included in such standards vary, and are usually based on empirical evidence rather than predictive assessment. Limits recommended by the two most respected international authorities are presented in Table 9.7. The limits are those below which cosmetic damage (hairline cracking, etc.) to buildings is unlikely to occur. Limits relating to structural damage are significantly higher.

Table 9.7 Recommended vibration limits

Structure	Lower frequencies	Higher frequencies	Information source
Modern dwellings	<40 Hz: 19 mm/s	>40 Hz: 51 mm/s	*US Bureau Of Mines report RI 8507: Structural response and damage produced by ground vibration from surface mines blasting* (1980).
Older dwellings	<40 Hz: 12.7 mm/s	>40 Hz: 51 mm/s	
Industrial & heavy commercial	4-15 Hz: 50 mm/s	>15 Hz: 50 mm/s	*British Standard BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* (2009) *British Standard BS 7385-02: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration* (1993).
Residential & light commercial	4-15 Hz: 15-20 mm/s	>15 Hz: 20-50 mm/s	

The strictest limit included in Table 9.7 is 12.7 mm/s reported by the US Bureau Of Mines with respect to older dwellings (typically plaster on wood lath in the US). Limits reported for newer buildings by both US and British authorities are 15 mm/s or higher. A comparison with levels associated with rock breaking (Table 9.6) indicates that typical levels are significantly lower than these limits. No vibration impacts are therefore expected. However, it is considered prudent to monitor real time PPV levels at the nearer Eir office building, and the office building outside the northwest corner, where rock breaking is undertaken within 50 m.

With respect to building occupants, ground borne vibration generally becomes noticeable around 1 mm/s PPV. By reference to Table 9.6, it is possible that ground borne vibration will be noticeable to occupants of the Eir office building, and the office building outside the northwest corner, where rock breaking is undertaken within 20 m. It is reiterated here than cosmetic or structural damage will not arise, but the vibration may become perceptible. It is also reiterated that rock breaking (a) may not be required onsite, (b) may not be required within 20 m of the office buildings, or (c) if required, is likely to occur over a limited period only. Furthermore, it is noted that extensive rock breaking was undertaken across the site previously, without evidence of any damage to buildings to structures, or any reports of nuisance.

It is possible that the healthcare facility located in the office building outside the northwest corner may house medical equipment sensitive to vibration. The laboratory facility located at the northeast end of the same commercial park may similarly contain sensitive analytical equipment. It is recommended that, prior to the commencement of rock breaking onsite (if required), that both facilities be notified with a view to determining the vibration sensitivity of any such equipment. Where such equipment is identified, suitable criteria may be agreed, and real time monitoring may be undertaken at the equipment.

Apart from the issues discussed above, no other ground borne vibration impacts will occur. Blasting or piling will not be required during the construction phase. Air overpressure emissions will not arise.

9.5.6 Commissioned Development Noise Sources

Noise sources at the commissioned development are identified below. Sources have been identified following discussions with the applicant and are also based on Damian Brosnan Acoustics experience. The proposed development will consist of

offices, a hotel with conference/banqueting facilities, a fitness and leisure centre, several small commercial units, residential accommodation units, and car parking. It is worth noting here, at the outset, that the closest receptors to most onsite sources will consist of the proposed onsite residential units, hotel bedrooms and offices. Onsite noise sources will be controlled so as to minimize noise impacts at these. This in turn will benefit receptors offsite, outside the boundaries.

Air handling units:
Air handling units (AHUs) such as fans, vents, air conditioning cassettes, etc. are likely to be installed across the study site. Such units may be installed on external walls and on roofs. The largest concentration of these is expected to occur at the proposed hotel, fitness centre, and the office units. All AHUs will be relatively small, and it will not be necessary to install industrial grade units. As noted above, the nearest listeners will work or reside onsite, and thus all AHUs will be selected so as to be inaudible at onsite receptors. AHUs at the nearest offsite receptors (the Eir building, and the offices outside the northwest corner) currently do not give rise to local impacts.

Boilers:
Oil- or gas-fired boilers may be installed at several units in order to provide space and water heating. Boilers will most likely be required at the proposed hotel, and at the fitness/leisure centre. The remaining elements of the proposed development will most likely use electric heating. The hotel and leisure centre boilers will most likely be located in internal plant rooms, and are expected to be inaudible 20 m from the plant rooms. Noise emissions discharged via the boiler flue are unlikely to be significant. In summary, emissions associated with any boilers installed onsite will be negligible.

Generator:
Although unlikely, the hotel and/or leisure centre operators may choose to install a generator for power outage cover, most likely in a basement plant room. Noise emissions from such a generator may vary, depending on sound power output, installation location and sound proofing. Noise levels at 10 m from a housed generator will typically be less than 60 dB at 10 m. These emissions will not be audible externally, and thus no impacts are expected.

Emissions specific to certain commercial units:
The proposed commercial units will consist of a restaurant, café, convenience store, primary care centre and pharmacy, all at basement level, all opening to a basement level plaza. None is likely to include external sources of significant noise emissions. As discussed above, the chief potential sources here (AHU emissions) are unlikely to be audible beyond the site boundaries.

Deliveries:
Deliveries will occur at the hotel and commercial units on a regular basis. Deliveries (chiefly couriers) are also expected at the office units regularly. Several small trucks and vans are expected each working day. Evening or night-time deliveries are not expected. Noise emissions from delivery vehicles will not be significant in the context of the local urban traffic environment, and the preponderance of surrounding commercial estates. Little or no noise emissions are expected from unloading operations, as these will be small in scale. Certain deliveries will require the use of trolleys (eg. laundry), hand driven pallet trucks (eg. hotel), or handcarts (eg. convenience store). None of these is expected to give rise to significant emissions.

Keg emissions may be almost entirely eliminated through use of keg pillows and keg trollies.

Amplified music at premises:
The hotel conference/banqueting centre will include a public address system to allow playing of live and prerecorded music. The system will incorporate amplification. While the fitness centre and restaurant may play music internally, volumes will be low. The conference/banqueting centre constitutes the only zone where music volumes may be elevated. Amplified music represents a source of potential offsite noise nuisance due to the timing of emissions (usually late evening) and due to their nature (impulsive low frequency emissions, particularly rhythmic 'thump thump' associated with contemporary music). Two onsite residential blocks will be located within 100 m of the conference/banqueting centre. The detailed design of the centre will provide for zero breakout of amplified music, ensuring inaudibility at external receptors including the onsite apartments. Music emissions will thus be inaudible offsite.

Glass bottle management:
It is likely that glass beverage bottles will be stored for collection close to the hotel delivery zone. Glass bottle management typically involves the transport of bottles in wheeled bins to a sorting area, followed by sorting of bottles into appropriate crates for collection. These emissions often arise during night-time hours at clean up time. Noise emissions from the transport and sorting of glass bottles may be significantly loud locally, with tonal and impulsive components. Given the presence of both onsite and offsite receptors, the hotel layout has been designed to provide for internal sorting of bottles, thus eliminating external bin movement and sorting. External glass bottle management will therefore not be required onsite.

Waste management:
Wastes arising at the various facilities onsite will most likely be stored in bins pending regular collection by a compactor truck operated by a permitted waste collector. Noise emissions from waste collection will be similar to those arising throughout urban areas across the city.

Patrons:
Patrons of onsite facilities, including the hotel, restaurant, café, convenience store, fitness centre and offices will be expected to arrive and depart at various times during the day. The majority of pedestrian and vehicle movements associated with patron activity will be distributed intermittently throughout the day and evening, and noise impacts attributable to same will be negligible in the urban context. On occasion however, groups of patrons may depart the hotel simultaneously. During night-time hours, departures of revellers may result in congregation in onsite car parking areas. As all onsite car parking will be underground, noise emissions from here will be inaudible offsite.

Patrons may also congregate on external areas in the vicinity of the hotel. As the nearest receptors will consist of the onsite apartments and hotel bedrooms, hotel management will be required to ensure that patrons do not give rise to external nuisance onsite.

Vocalisations at the fitness/leisure centre
At this zone, vocalisations may arise from children and adults at the swimming pool, gyms, etc. All such emissions will arise internally only, and will not be audible beyond the building envelope.

Landscaping plant:
The proposed site layout will incorporate open spaces between units, around car parking areas and at the site perimeter. Such areas may be grassed, and/or may be planted with trees and shrubs. It is therefore likely that a maintenance contract will be awarded to a local landscaping company. Maintenance activities undertaken at the proposed site may include regular mowing of open green areas, strimming of steeper ground such as banks where mowers cannot access, leaf blowing near tree zones, laying of bark mulch over planted areas, and weed spraying. Use of plant such as mowers and strimmers across the site will be clearly audible offsite. However these emissions will blend into the urban soundscape, particularly during the summer when the daytime/evening noise environment in any urban area tends to include at least one mower audible in the distance at any time.

Onsite traffic:
Car parking areas will be provided throughout the site for use by residents, employees and visitors associated with the various premises onsite. Traffic movements are likely to arise throughout the day. Traffic associated with employees will tend to peak during morning and evening rush hour periods. Vehicle movements associated with visitors to the hotel, leisure centre and commercial units will be relatively evenly distributed throughout the day. Movements will be expected to continue into the evening as visitors access the hotel, restaurant and leisure facilities. Night-time vehicle movements will be minimal. Access to the onsite basement carpark will be provided from Joyce Road and Monivea Road. All onsite car parking will be provided at basement level. Noise emissions from vehicle movements will therefore be negligible.

Offsite traffic:
The proposed development site adjoins Monivea Road and Joyce Road, and lies close to the N6. Traffic volumes in the local area are elevated throughout the day and evening, and N6 traffic noise remains audible through the night. Much of the traffic passing through this area continues to/from the city centre, while a large proportion accesses local residential, commercial and industrial estates. In this context, traffic volumes associated with the proposed development will be negligible. The change in traffic volume required to increase the $L_{Aeq\ T}$ level by 3 dB, which is the smallest change perceptible by the human ear, is 100 % i.e. traffic needs to double before the listener concludes that noise levels have increased. As the proposed development will not result in a doubling of local traffic volumes, it is concluded that traffic noise impacts will be negligible.

From the foregoing, it is evident that noise emissions from the commissioned development will be relatively low, and will not give rise to offsite impacts. Noise criteria described in Section 9.3.2 are unlikely to be exceeded. No onsite sources or activities are proposed which might potentially give rise to such impacts. Modelling of noise emissions is not required, as no emissions of significance will arise onsite. It is concluded that noise impacts will be imperceptible.

The proposed development will include onsite receptors, consisting of residential units, hotel bedrooms and offices. These receptors will effectively constitute the closest sensitive locations. No onsite sources or activities are proposed which might injure the use of these receptors. It follows that offsite impacts will not arise.

The commissioned development will not include any sources or activities which might give rise to ground borne vibration. Thus onsite or offsite vibration impacts are not expected.

9.5.7 Inward impacts

The proposed overall development will include residential units, hotel bedrooms and office units, all of which will require the absence of noise at nuisance levels. The applicant will be required to ensure that internal noise levels at these locations will be suitable. External noise data presented in Section 9.4.3 above may be used to inform the final building details, particularly in relation to glazing selection and ventilation design. Measured data indicate that no particular issues are expected here, and that internal criteria will be readily achieved.

In the UK, most new residential developments are acoustically assessed by reference to *ProPG: Planning & noise – Professional practice guidance on planning & noise: New residential development* (May 2017), jointly issued by the Association of Noise Consultants, the Institute of Acoustics, and the Chartered Institute of Environmental Health. A stage 1 preliminary assessment of noise risk in accordance with the document suggests that the site is low risk, and thus 'the site is likely to be acceptable from a noise perspective provided that a good acoustic design process is followed'. This process relates to final building design details. The applicant proposes to apply a detailed acoustic design process with respect to building specifications.

9.5.8 Cumulative impacts

No potential cumulative impacts have been identified with respect to the construction phase. While this phase is expected to last several years, no other large adjacent construction projects are known to be imminent.

As the proposed development is not expected to give rise to noise impacts post-commissioning, no long term cumulative noise impacts are expected. While local traffic volumes will increase, the impact on traffic noise levels will be negligible. Cumulative traffic noise impacts may arise where any other sites in the local area are subject to development. No such developments have been identified.

9.5.9 Population & human health

As discussed in Section 9.3.2, the 55 dB daytime $L_{Aeq\ T}$ criterion typically applied by regulatory authorities is drawn from WHO guidance. The WHO notes that a daytime $L_{Aeq\ T}$ limit around 55 dB may be considered a suitable environmental health goal for external noise levels in residential areas, and that levels below 55 dB are 'desirable to prevent any significant community annoyance'.

However, the WHO recommendation relates to longer term events, averaged over a 16 h day. The WHO does not make any recommendation regarding short term events such as construction projects. Social studies suggest that listeners are more tolerant of short term construction events, particularly when such activities are likely to result in an overall improvement to the local environment. In this regard, the 65 dB criterion recommended by BS 5228:2009+A1:2014 is considered to provide a sufficient degree of protection to human health.

Construction phase noise emissions will comply with this criterion at all residential receptors, subject to certain mitigation measures. On this basis, it is considered that there will be no adverse noise impact on the local population or on human health due to the construction phase.

With respect to the commissioned development, no noise emissions of significance will arise, and impacts will be imperceptible. On this basis, it is concluded that there will be no operational noise impacts on the local population of on human health.

9.6 Mitigation

Noise emissions arising from construction phase operations at the proposed development site will not exceed the identified 65 dB $L_{Aeq\ 1\ h}$ criterion at residential receptors,. The 70 dB office building criterion will also not be exceeded where a small number of plant items operate simultaneously.

If it is necessary to undertake rock breaking along the northern or eastern boundaries, noise levels received at the Eir building, and at the office building outside the northwest corner of the site, may rise towards the 70 dB criterion, or may slightly exceed it, and the following mitigation measures are recommended here:

- It is recommended that management at these buildings be given adequate advance notice.
- As the duration of breaking may be shortened to several hours by using two or more breakers simultaneously, it may be possible to agree suitable breaking periods which allows shorter intense breaking, thus completing the operation more quickly.
- Alternatively, it may be practical to carry out breaking near these buildings on a Saturday, when the buildings are less occupied.
- The use of quiet breakers is recommended. Such breakers typically produce sound pressure levels which are 2-5 dB lower than conventional units.
- Depending on the location of breaking, it may be feasible to insert a temporary barrier between the breaker and the office buildings. The requirement for a barrier, and the specific dimensions and type, may be determined following identification of locations to be broken out.

No other specific construction mitigation measures are warranted. Several general measures are proposed as follows:

- Construction operations will in general be confined to the period Monday-Friday 0800-1900 h, and Saturday 08:00-14:00 h.
- Plant used onsite during the construction phase will be maintained in a satisfactory condition and in accordance with manufacturer recommendations. In particular, exhaust silencers will be fitted and operating correctly at all times. Defective silencers will be immediately replaced.
- During the construction phase, an increased number of trucks may arrive at the site during certain activities eg. during concrete pours. It is recommended that a management plan be drawn up to prevent unnecessary congregation of trucks around the site entrance, and that queuing is prohibited on Monivea Road.

Certain construction operations, chiefly rock breaking (if required), may give rise to ground borne vibration. If undertaken in proximity to the Eir building, or the office building outside the northwest corner, vibration may be perceptible to building occupants. PPV levels are not expected to approach typically applied criteria with respect to building damage. Nonetheless, it is recommended that real time monitoring of PPV levels be undertaken at both buildings if rock breaking is undertaken within 50 m.

Prior to rock breaking (if required), it is also recommended that the management at the office building outside the northwest corner, and at a laboratory at the northeastern end of the same commercial park, be contacted to determine if inhouse medical or analytical equipment requires real time monitoring of PPV levels while breaking is undertaken.

No specific mitigation measures have been identified with respect to the commissioned development, apart from the following which have been agreed with the applicant:

- The conference/banqueting zone of the hotel will be designed so as to prevent noise breakout. In particular, door and glazing elements will be designed so as to prevent music noise intrusion at the onsite residential units and at offsite receptors. Glazing will provide for maximum sound reduction in the range 50-160 Hz, as amplified music, particularly dance tracks, includes strong components at these frequencies.
- External hotel zones will not be served by amplified speakers.
- External areas at the hotel will be managed so as to avoid generation of loud patron vocalisations during evening and night-time hours.
- The hotel layout has been designed to provide for internal sorting of bottles. Bottle sorting will not be undertaken in external yard areas of the hotel.

9.7 Impacts Post Mitigation

Construction phase impacts will be satisfactory, subject to specific mitigation requirements, chiefly in relation to potential rock breaking. Impacts from the commissioned development will be imperceptible.

9.8 Significance of Effects

Based on the assessment above there will be no significant effects from the commissioned development. Noise impacts associated with the commissioned development will be imperceptible.