10 Noise

10.1 Introduction

This chapter deals with landside noise and its potential impacts. An assessment of potential noise impacts on the marine environment is included in Chapter 6.

This chapter was prepared in conjunction with Biospheric Engineering Ltd (see report in **Appendix 7**). It assesses the potential impact of the construction and operation of a new substation at Belderra Strand on the Mullet Peninsula, Co. Mayo from the point of view of noise.

The new substation is a relatively small one, comprising a single outdoor transformer contained in a concrete bund and a cable interface bay to connect the substation to the national electricity grid. One single-storey building will be constructed on the site, housing control rooms, switchgear, metering and battery storage rooms, and toilet facilities. The construction of these elements is similar (from a noise perspective) to the construction of a farm building or a domestic dwelling. The site will be enclosed and landscaped.

The substation will be linked to the Atlantic Marine Energy Test Site (AMETS) by an underground cable. This will consist of four electricity cables in a trench in the ground. As with all underground cables, underground joint bays (in the form of manholes) will be required along the route. An open trench with conduits will be used to connect the substation to the transition joint bay, and cable conduits will be installed in the beach to duct the cables through the intertidal zone.

The options for laying the cable in the intertidal zone are horizontal directional drilling and open trenching. In either case, the formation of the duct is followed by cable winching. These construction techniques, while using different specialist equipment, are similar in nature (from a noise perspective) to the use of large excavators on site.

10.2 Approach and methodology

Background noise measurements were taken at the substation location and at three locations along the access route to the substation from the R313 regional road linking Belmullet and Blacksod. Measurement locations were chosen to be representative of the general area. The measurement locations are representative of the noise environment at the nearest residences likely to be impacted by this proposed development.

The noise monitoring was carried out in good weather conditions over the period 17–18 August 2011.

10.2.1 Measurement equipment

Measurements were taken using Bruel & Kjaer model 2260 and 2250 type 1 sound-level meters with modular real-time analysis using BZ7210 noise analysis module and BZ7208 FFT module. The instruments were calibrated using a Bruel & Kjaer model 4231 sound-level calibrator. The system was calibrated by Bruel & Kjaer on 18 July 2011. No drift in calibration was evident during the monitoring period. Post-measurement analysis was carried out using Bruel & Kjaer Noise Explorer software.

During measurement the height of the microphone was 1.3 metres above ground at the sampling location. The noise measurements on site were carried out using a weatherproof enclosure with the microphone mounted on a steel pole. The measurements in the locality were taken with the microphone mounted on a tripod. In both cases the microphone was enclosed in a Bruel & Kjaer UA 1404 Outdoor Microphone Kit. This microphone kit is capable of operating at wind speeds in excess of 30 m/s. BS 4142(*Rating of Industrial Noise affecting mixed residential and industrial areas*) indicates that windshields are effective in wind speeds up to 5 m/s. The performance of the UA 1404 is vastly superior to that of a windshield and would appear to have no impact on measurements in wind speeds of up to 10m/s.

Noise measurements were taken in accordance with International Standards Organisation ISO 1996 – *Acoustics – Description and Measurement of environmental noise*. This standard does not set an upper limit to the wind speed in which measurements are taken; it requires the reporting of the wind speed at the time of measurement.

10.3 Baseline and receiving environment

10.3.1 Background noise measurements

Audible noise is measured with a microphone sensitive to the acoustic pressure and associated instrumentation that takes account of the varying sensitivity of the average human ear. Basically, the equipment is adjusted so that certain frequencies are given more or less weight than others. These weighted levels are then combined to yield a single number. The so-called 'A-weighting' weights the different frequencies in a manner similar to that of the human ear and is the most common weighting method used for noise measurements. A-weighting favours the mid-audio and high-audio frequencies – that is, above 500Hz – at the expense of the low frequencies.

The sensitivity of the human ear also depends on the magnitude of the sound pressure, as well as on its frequency. The variation in sound pressure of different sources is immense, and for this reason sound pressures are generally expressed on a logarithmic scale in decibels (dB), which is both a common and a convenient way of measuring quantities that vary over a very wide range.

The threshold of hearing is defined as 0 dB(A) and the threshold for pain is approximately 120 dB(A). The zero dB reference level is a pressure of 20 micropascals (20 micronewtons per square metre).

The human ear tunes in the entire audio frequency spectrum and thus it is desirable to characterise an instantaneous frequency spectrum of audible noise by a single number expressing an overall sound energy level. This number is referred to as the equivalent/continuous sound pressure level, Leq. It has also been found convenient to derive from this number another set of numbers referring to that Leq, which is exceeded for a given percentage of the time. These values are referred to as Ln, where n denotes the percentage of the time that the noise level is exceeded. Hence we refer to L90 noise level (that noise level which is exceeded 90% of the time). The L90 noise level is regarded as the 'background' noise level in the absence of any specific sources of noise.

Short-term environmental noise monitoring was undertaken at three locations along the proposed access route and in the vicinity of the proposed substation site (Figure 10-1). A 24-hour log of noise levels was carried out at the substation site.

Four sets of measurements were taken along the route, as follows:

- 15-minute measurements at each location during the evening of the 17th August
- 15-minute measurements at each location during the night

- 15-minute measurements every consecutive hour from 10am to 1pm at each location in accordance with National Roads Authority procedures
- 15-minute measurements every consecutive hour from 2.44pm to 5pm at each location in accordance with National Roads Authority procedures

Background noise levels for the three monitoring locations are shown in Tables 10-1 to 10-3. All noise measurements are for 15-minute periods.

Table 10-1: Location N1 – Belderra Road Junction (65502, 330794)

	Time	LAeq	LA90
Evening	21:09	55.2	53.4
Night	23:17	53.1	51.1
Day	10:42	48.3	39.9
	11:49	48.6	44.0
	12:48	59.3	39.7
	14:44	42.2	35.6
	15:44	45.7	33.5
	16:44	55.0	36.2
Day (average)[1]		50	38
Evening		55	53
Night		53	51

Table 10-2: Location N2 – Holiday village (66648, 330825)

	Time	LAeq	LA90
Evening	21:29	46.9	36.6
Night	22:58	44.5	33.3
Day	10:21	54.9	24.8
	11:29	54.0	32.3
	12:28	54.4	30.7
	15:22	53.8	26.9
	16:25	43.5	31.4
Day (average)		52	29
Evening		47	37
Night		45	33

[1] Daytime noise levels calculated using the averaging method outlined in the National Roads Authority *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*

Table 10-3: Location N3 – Church car park (67137, 330277)

	Time	LAeq	LA90
Evening	21:47	61.1	29.9
Night	22:39	54.3	23.3
Day	10:03	48.0	28.0
	11:09	47.1	26.7
	12:09	50.2	33.4
	15:04	46.2	27.6
	16:06	47.2	29.7
Day (average)		48	29
Evening		61	30
Night		54	23

The background noise levels in the Belderra area are typical of a rural area but can be elevated by natural sources such as surf noise. The lowest background level recorded during the day at any of the four locations monitored was an LA90 level of 25 dB at the holiday village (location N2) and the quietest night-time level was 23 dB at the church car-park (location N3). Noise levels in the Belderra area (location N1) were consistently above levels at the other locations (locations N2 and N3) due to surf noise.

The noise levels measured at the junction near Belderra Strand (location N1) were consistently higher than those measured on the proposed substation site due to location N1's proximity to the beach and local road network, and some natural screening at the proposed site.

Average background noise levels in the vicinity of the proposed site can be taken to be in excess of 30 dB for the majority of the time.

A long-term noise measurement sequence was carried out at the proposed substation site on 17 and 18 August 2011. Night-time noise levels at the Belderra Strand area were higher on the evening and night of 17 August than on the day of 18 August. This was due principally to the noise from the surf on the beach. The surf noise was the dominant noise source in the area on 17 August and a measurement 50m from the surf edge revealed an LAeq level of 66 dB and an LA90 level of 65 dB which are significantly elevated levels for a remote rural area (Figure 10-2). As the wind speed and wave height decreased during 18 August, the noise levels dropped also. The noise monitoring locations were chosen to give a good spread of geographic locations in the area and along the access route to the substation. Measurements were taken using Bruel & Kjaer 2250 and 2260 precision sound-level meters.

10.4 Potential noise impacts

10.4.1 Substation and cable trench construction

Construction activity at the proposed site will be similar to that involved in constructing a domestic dwelling or an agricultural outbuilding. The largest items of equipment used on the site will be excavators and bulldozers for site clearance, and a crane for installation of the transformer. Other noise sources will include construction traffic, probably comprising a small number of private cars and vans and occasional truck traffic to deliver material. The impact on overall traffic levels and traffic noise levels on the road network will be minimal.

Construction activity on the site will comprise the traditional construction techniques of concrete work, block-laying, carpentry and roofing, followed by equipment installation. None of these activities are of themselves significantly noisy.

The installation of the cable trenches will require the use of excavators and potentially rock-breakers for short periods. These activities will be carried out on the roadway connecting the proposed site to the beach at Belderra. The use of such heavy equipment will give rise to elevated noise levels on a localised basis.

Source data from Biospheric Engineering's database of construction noise measurements has been used to create a model based on the site map. Modelling was carried out using Bruel & Kjaer's Predictor package. Predictor is a comprehensive noise modelling software package that is used by local authorities, acoustic consultancies and others for environmental noise mapping and prediction.

A construction noise prediction model has been prepared for the case where a large bulldozer is engaged in site clearance works while trench excavation is taking place simultaneously at three locations along the cable route, in order to assess what the noise level is likely to be at nearby properties. This is an extreme worst-case scenario, as it is unlikely that all of these activities will take place at the same time (Figure 10-3).

This model also simulates the construction noise case where a cable-puller is operating on the beach area, on the basis that the noise emissions from a cable puller are equivalent to those from a large excavator, such as a Caterpillar 365.

The only guidelines for construction related noise (in Ireland) are those published by the National Roads Authority in Table 1 of their *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*. These guidelines are as follows:

Table 10-4: Maximum permissible noise levels at the façade of dwellings during construction

Days and times	$L_{Aeq(1hr)}$dB	$L_{pA(max)slow}$dB
Monday to Friday, 07.00 to 19.00 hrs	70	80
Monday to Friday, 19.00 to 22.00 hrs*	60	65*
Saturday, 08.00 to 16.30 hrs	65	75
Sundays and bank holidays, 08.00 to 16.30 hrs*	60*	65*

*Construction activity at these times, other than that required in respect of emergency works, will normally require the explicity permission of the relevant local authority.

The results of the noise model indicate that noise levels in excess of 60 dB(A) will occur in the immediate vicinity of the site, but will drop significantly with distance. At the nearest houses, the noise levels as a result of the construction works will be in the order of 45 dB(A), which is within the National Road Authority's guideline figure for construction activity and similar to the background noise measured for the area.

10.4.2 Operational phase noise levels

During the operational phase, noise sources on the site will include the substation transformer, occasional traffic moving to and from the site and noise associated with the low-voltage overhead lines leaving the site.

Transformer Noise

A power transformer emits noise from three main sources:

- Its tap-changer, whose noise level may be high, but because of its infrequent operation does not present a noise issue
- Its cooling fans, whose noise levels may be considerable but cover a fairly broad frequency spectrum and are usually of limited duration. It is likely that the cooling fans will be used only at times of peak load during the day.
- The transformer core: the noise associated with the transformer core is the result of electrical and magnetic forces associated with the application of voltage and the flow of electric power acting on the components of the structure. It is primarily due to what is called magneto-striction of the core laminations – that is, they are extended for each of the two magnetisations in each cycle, so that the fundamental frequency of the noise is 100Hz.

ESB specifications require that the noise level of a transformer, including all cooling fans, measured according to IEC 60551, shall not exceed 70 dB(A). Based on this value, the sound pressure level (Lp) due to the transformer alone is estimated to be less than 30 dB(A) at a distance of 50 metres from the transformer. The nearest dwelling will be located at a greater distance than this from the transformer. Given the distance from the proposed substation to the nearest dwelling, noise impacts are not likely to occur.

Overhead low-voltage line noise

There are two types of noise generated by overhead transmission lines, namely gap sparking and corona. In addition, Aeolian noise due to wind blowing through the conductor wires can be produced in certain wind conditions.

Gap sparking can occur at any time on power lines at any voltage. Combinations of factors like corrosion, vibration, wind and weather forces, mis-fabrication, poor design or insufficient maintenance contribute to gap formation. Gap sparking is easily identified and resolved though good maintenance and corrective actions as required.

Corona discharge causes noise over a wide range of frequencies that can be either audible or electrical. Figure 10-4 shows the worst case conductor L50 audible corona noise levels as a function of lateral distance from the centre of the line. As the predicted value at fifty metres from the line is less than ambient background noise level at the locations where measurements were taken, it is not expected to give rise to impacts.

Noise occurs under well-defined wind conditions and is caused by the wind impinging on the different components of a line, such as conductors and insulators. The two meteorological factors that affect the level and frequency of this noise are the wind speed and direction. The different line components give rise to different types of noise. The noise is not dependent on whether or not the line is energised. The occurrence of aeolian noise is uncommon, since the conditions under which the noise occurs are very specific. For the low voltage 20 kV line the aeolian noise is very unlikely to occur.

Traffic noise

The proposed development is located in a relatively remote area accessed by local roads. From the noise measurements taken at the three locations N1, N2 and N3 during the background noise survey, it is clear that existing noise levels are below the threshold specified by the NRA in its design criteria for new roads.

The proposed development will have most impact during the construction phase, when materials are being delivered and the substation is being constructed. Traffic volumes will however be a fraction of the existing traffic level on the R313. An increase of 100% in traffic levels equates to a noise level increase of 3 dB (line source). This temporary increase would be confined to the construction phase only. Traffic levels during the operation of the substation will be augmented by an occasional visit by either a car or van – that is, no significant increase. The site and wave energy devices will be monitored and controlled from the main office in Belmullet, reducing the necessity for site visits.

Noise from the construction and operation of the substation will be highly localised. Traffic to and from the proposed substation will not be combined with other developments, such as the Corrib Gas Field development or the proposed upgrading of Frenchport pier, except close to Belmullet and on the R313 east of Belmullet. Traffic volumes on those sections of road are such that the impact of the proposed development on road traffic noise levels will be minimal. The impact of traffic noise associated with this development is therefore considered to be neutral – that is, no impact. There will be no change in this position in the future.

International Standard ISO 1996 gives guidelines for the description of noise in community environments. It recommends the adoption of the equivalent continuous A-weighted sound pressure level, L(A)eq, as the basic measure for describing acoustic noise, as used in this report. It does not, however, specify limits for environmental noise. That is a task that must be undertaken by national and local governments. In Ireland there are no legally defined noise limits, but the Environmental Protection Agency Act of 1992 defines the powers of local authorities and the EPA to require measures to be taken to prevent or limit noise. In addition, it makes provision for the setting of noise level limits where this is considered appropriate, although no limits have been defined at present.

A useful guideline referring specifically to power lines was issued by the New York Public Service Commission (NYPSC) following a public enquiry in 1978. This specified an L50 limit of 52 dB(A) at the edge of a right of way. The L50 is somewhat similar to the LAeq in that the L50 is the noise level exceeded for 50% of the time, whereas the LAeq is the equivalent continuous sound pressure level of the overall noise fluctuations.

This L50 noise level was based on a maximum permitted noise level of 35 dB(A). This was in the bedroom of a house at the edge of a right of way. It was assumed that the noise attenuation of a partly closed window was 17 dB(A). This is approximately equivalent to the night-time limit of LAeq of 45 dB set by the Environmental Protection Agency for industrial noise.

Another limited approach to noise evaluation is to compare typical site audible noise levels with typical levels of commonly encountered sounds, as is shown in Figure 10-5, taken from the NRA guidelines. Operational noise at the nearest noise sensitive receptor would be in the range of a quiet bedroom.

Noise modelling of the operational phase noise sources predicts that noise levels will be below 30 dB(A) at the nearest noise sensitive receptors and will not give rise to any impacts (Figure 10-6). Noise levels will therefore not be significant.

As can be seen from Figure 10-3, the predicted noise for the site during the construction phase will be up to 45 dB(A) at the nearest noise sensitive receptor, and Figure 10-6 shows that for the operational phase, it will be less than 30 dB(A).

10.4.3 Decommissioning phase

During the decommissioning phase of the project, the principal source of noise will be from machinery engaged in the substation demolition, if this required. This will be similar to the noise signature of the construction phase and will not give rise to noise impacts at the nearest noise sensitive locations.

10.5 Mitigation of impacts

10.5.1 Construction phase

Noise during the construction stage will be limited by the scale of the project. The noise prediction model indicates that noise levels will be maintained within the limits set in National Roads Authority guidelines (the only 'official' construction noise guidelines in Ireland).

The construction stage contract will include provision for independent noise monitoring to ensure that noise limits are being adhered to.

10.5.2 Operational phase – substation

It is not expected that audible noise generated from within the substation will cause annoyance, as outlined previously. The landscaping and screening around the substation site will further help to reduce the noise level.

Following commissioning of the substation, a noise assessment will be carried out to ensure that noise levels emanating from the substation do not exceed 45 dB(A) LAeq (15 minutes) at night and 55 dB(A) LAeq (1 hour) during the day at any noise-sensitive location. In the event that there is a significant tonal content in the noise, the levels will be reduced by 5 dB(A).

10.5.3 Operational phase – overhead lines

As outlined in the previous sections, it is not expected that noise arising from corona will give rise to complaints. Corona noise will be audible only under certain weather conditions and in close proximity to the line.

Aeolian noise very rarely occurs on overhead lines and is not expected to arise on the proposed line. As outlined earlier, mitigation measures for Aeolian noise include the fitting of air-flow spoilers on conductors and the replacement of disc insulators.

Any noise complaints will be investigated and mitigation measures implemented if necessary.

10.5.4 Decommissioning phase

Noise during decommissioning will be for a limited period. The contract for the decommissioning phase will include provision for independent noise monitoring to ensure that noise limits are not exceeded.

10.6 Conclusion

Construction noise will be within the limits set out in the NRA guidelines and will not have significant impact at the nearest dwellings.

During operation, noise from within the substation due to switch gear and alarms are not foreseen to be a problem, as any such noise would be infrequent and of short duration. It is expected that noise generated by the transformer will be sufficiently attenuated outside the substation so as not to cause annoyance at neighbouring properties. In addition, the noise level should be further reduced by landscaping and the planting of the earthen berms around the substation perimeter.

Corona and Aeolian noise are predicted to be low at the site; should corona noise occur, the developer will carry out the appropriate mitigation measures, which could include the fitting of air-flow spoilers and the replacement of insulators.

Traffic noise will not increase significantly above background levels during all phases of the project.

Overall the predicted noise impact from the development will be low and is not expected to give rise to complaints from local residents.

Figure 10-1: Noise Measurement Locations

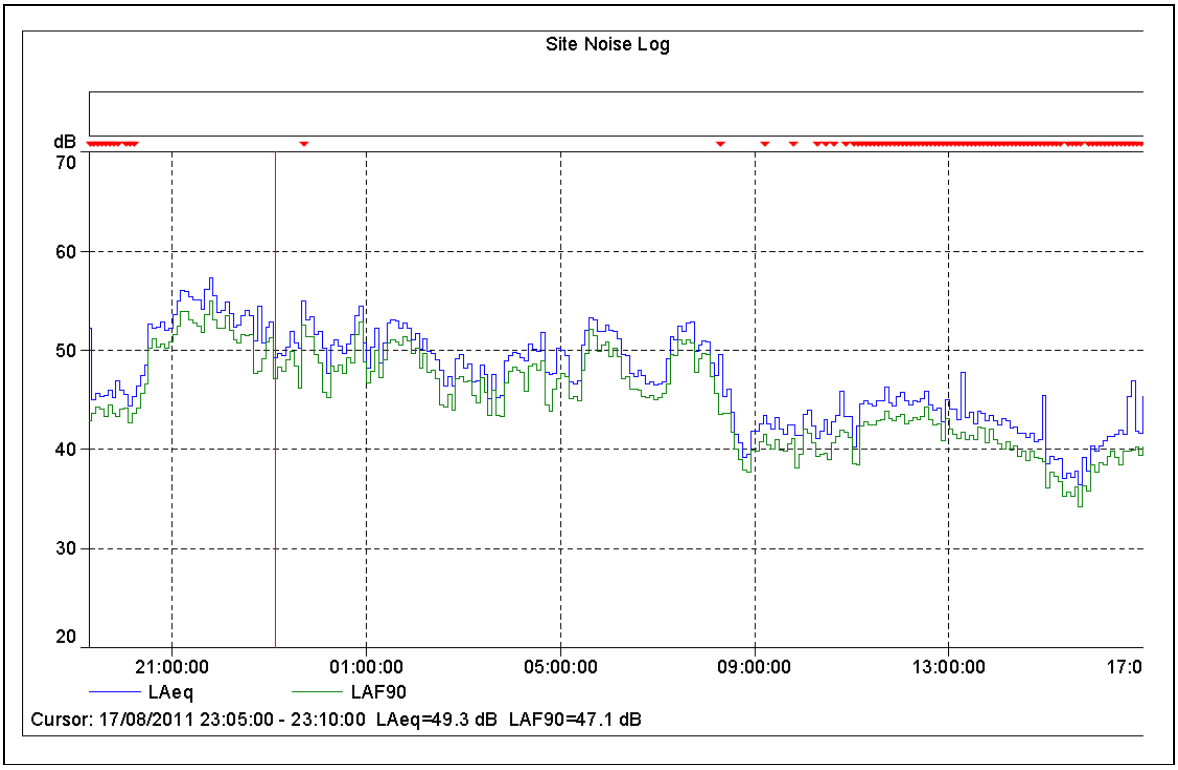

Figure 10-2: Substation site noise log

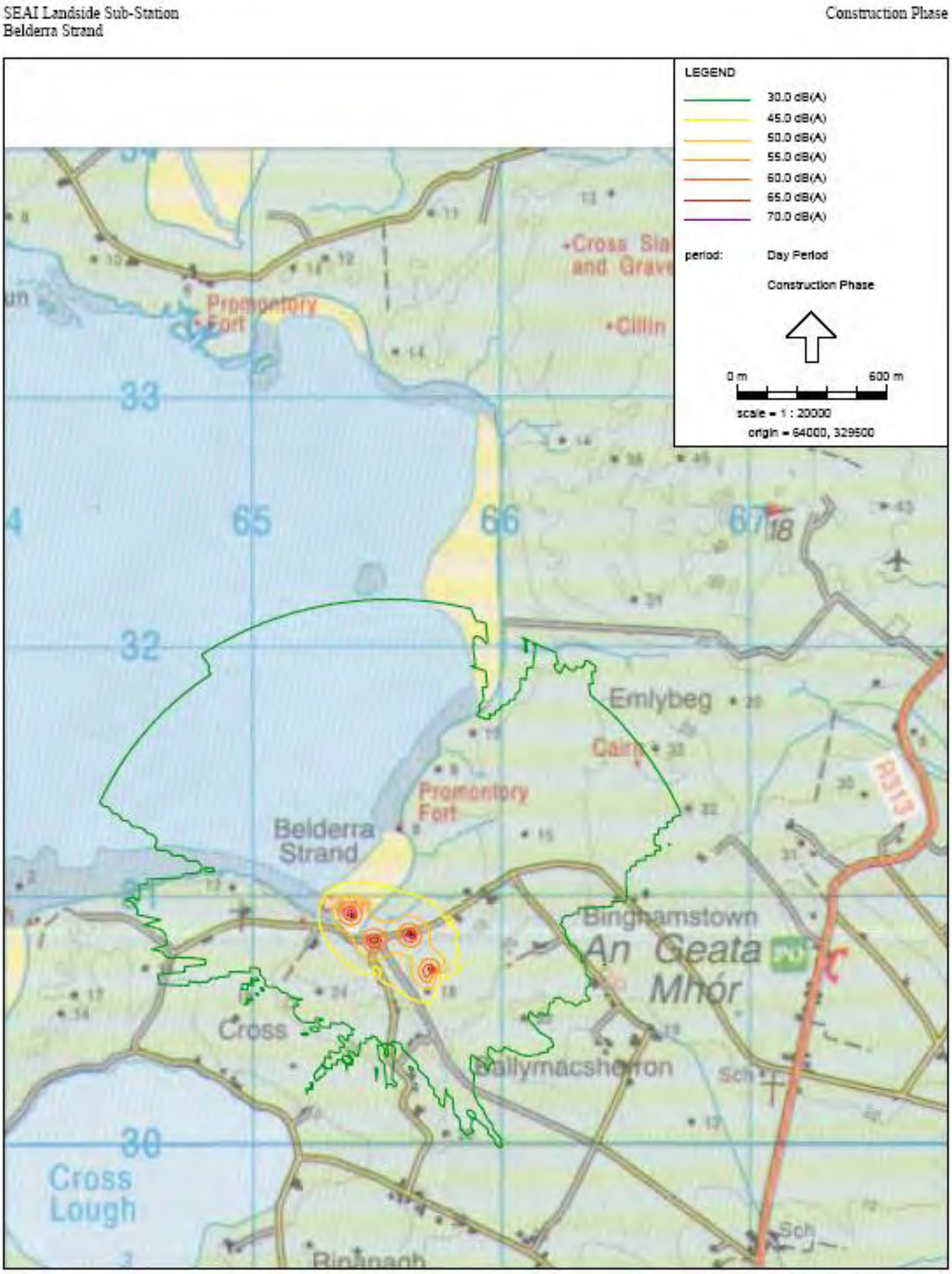

Figure 10-3: Construction phase predicted noise map

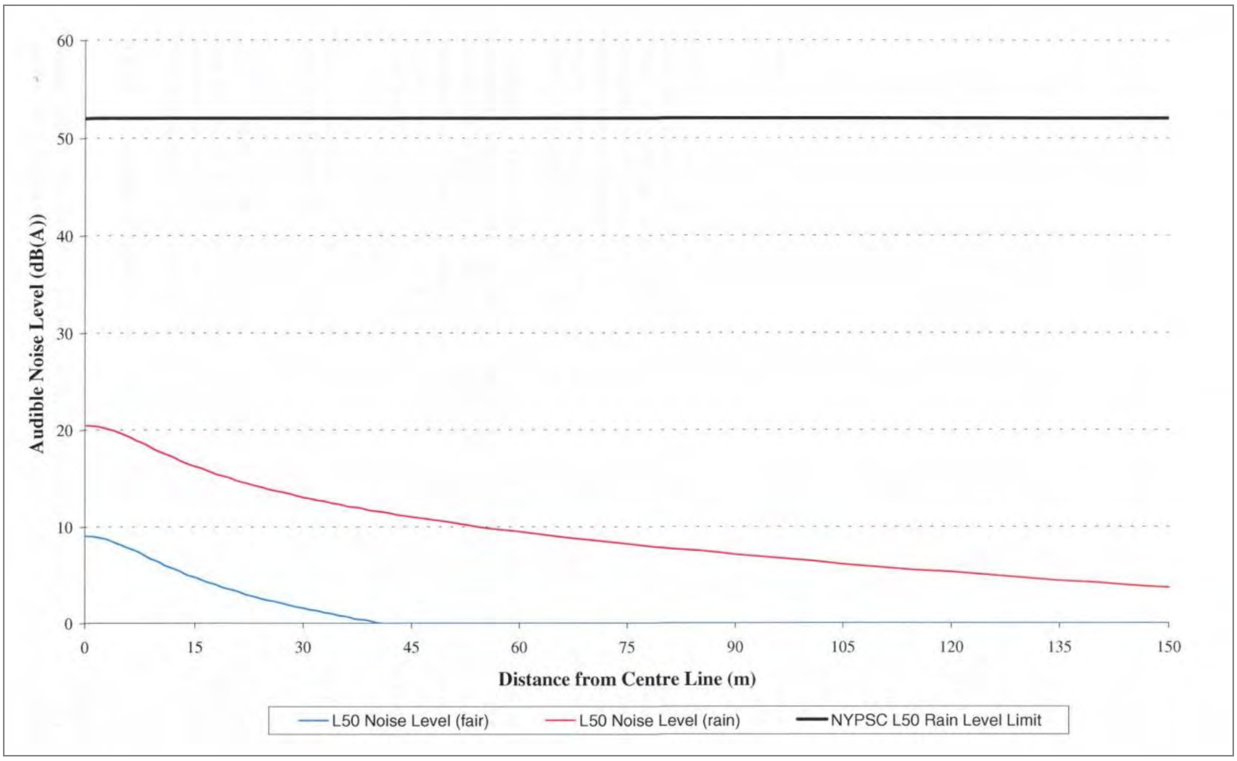

Figure10-4: Corona noise level

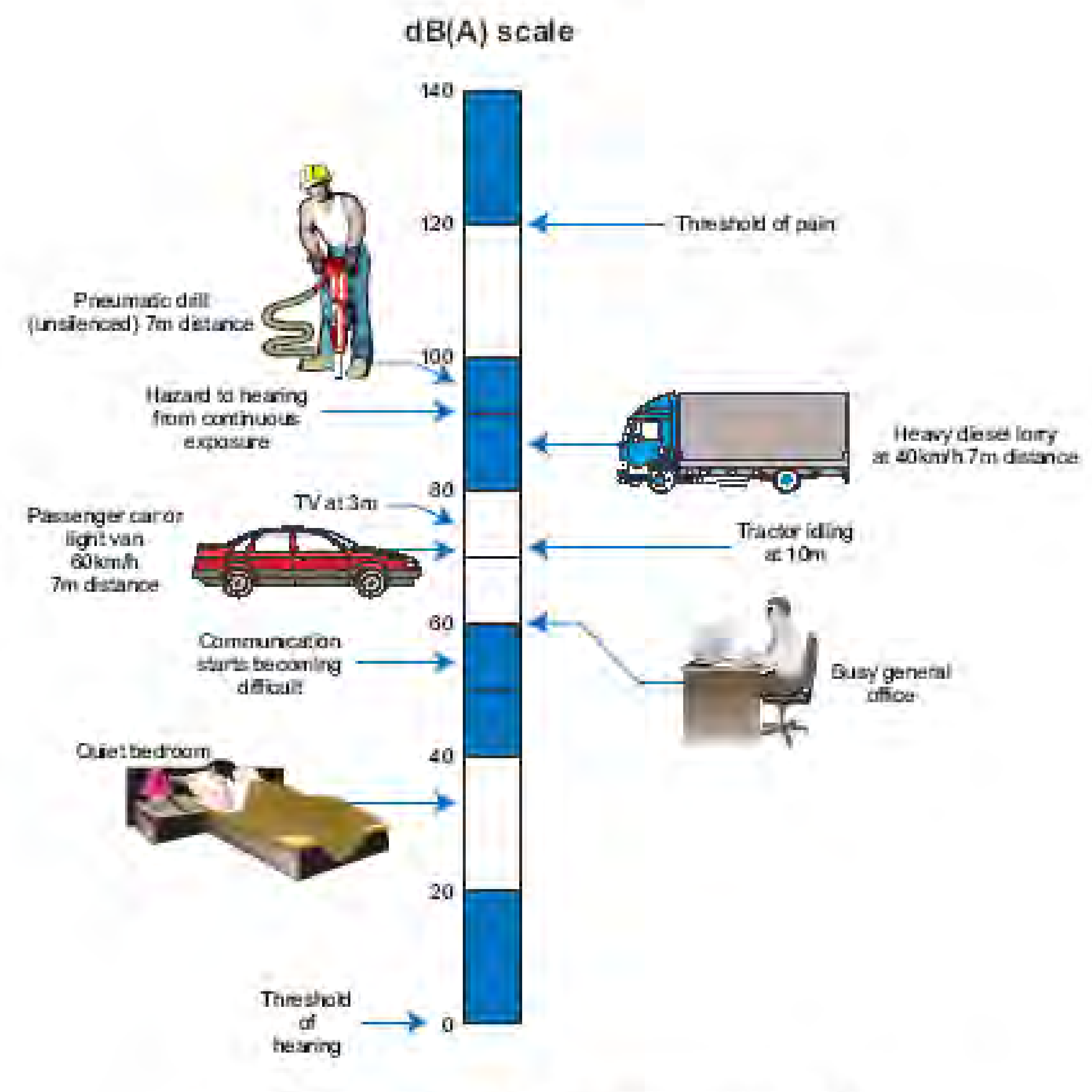

Figure 1: The Level of Typical Common Sounds on the dB(A) Scale (Based on guidance taken from: *Design Manual for Roads and Bridges, Volume 11 Consolidated Edition 1993*)

Figure 10-5: Typical common sound levels

Figure 10-6: Operational phase predicted noise map