15. Traffic Noise and Vibration

15.1 Introduction

15.1.1 The sources of noise from traffic can be separated into two components. The first is generated by the engine exhaust system and transmission, and is the dominant source when traffic is not freely flowing, particularly from heavy vehicles which contribute a significant proportion of low frequency noise. Noise levels will vary primarily according to engine speed rather than vehicle speed. The second noise source component is generated from the interaction of tyres with the road surface and is the dominant noise source under free flow traffic conditions at moderate to high road speeds and contributes a significant proportion of high frequency noise. Noise levels will vary depending on vehicle speed, the road surface and whether the surface is wet or dry.

15.1.2 The noise from a stream of traffic at a reception point at any one instant is an aggregation of noise from each of many vehicles at various distances. Among factors which influence a basic traffic noise level, are traffic flow, speed, composition (%HGVs), road gradient and road surface characteristics.

15.1.3 Noise nuisance is described by the World Health Organisation as 'a feeling of displeasure evoked by noise'. It can affect people in houses, the street or even during recreational activities. People are now known to be more sensitive to abrupt changes in traffic noise than research had previously suggested. New information suggests that human hearing is sensitive to a change in noise level of 1.0 dB(A). This is equivalent to a 25% increase or a 20% decrease in traffic flow. This sensitivity to new Schemes is an effect that can last for a number of years and will vary according to the sensitivity of hearing of the individual. There are also reported correlations between noise exposure and sleep disturbance, which can be significant, even at low noise levels.

15.1.4 To forecast a change in the noise level, the ambient noise must be measured. Ambient noise can be put into one of three categories. The first being dominated by traffic noise, the second being dominated by undefined sources such as rural areas (watercourses, livestock, tree swaying etc.) and the third being non traffic sources such as railways or aircraft.

15.1.5 The definition of vibration is 'low frequency disturbance producing physical movement in buildings or occupants'. It is the rolling of wheels on the road surface when passing over irregularities in the road that causes vibration.

15.1.6 Vibration is expressed in terms of Peak Particle Velocities or PPVs. This is the maximum speed of movement of a point in the ground during passage of vibration. Vibration can be problematic because of:

- Its ability to affect precision tasks (for example in hospitals);
- Possible architectural damage, which affects the building and the occupants.

15.1.7 This section of the Environmental Statement seeks to determine the existing noise environment along the route of the proposed dual carriageway between Jordanstown and Seapark, to predict and assess the noise impact of the proposed road and, where possible, to mitigate against such impact.

15.2 Approach and Methods

15.2.1 The potential impact of traffic noise has been assessed for all properties within 300 metres of the proposed dual carriageway, following the methodology of the Design Manual for Roads and Bridges (DMRB, 1994) with reference to Volume 11.3.7 and in line with the Stage 3 assessment.

15.2.2 In addition, there is the potential impact of construction works associated with the proposed development although this will be temporary in nature and has been dealt with elsewhere (Section 5.5).

15.2.3 The Design Manual for Roads and Bridges is the standard document for use in the UK for the assessment of impact from road Schemes.

15.2.4 The DMRB Stage 3 noise assessment is used to predict the noise impact on the properties within 300 metres of the proposed route and to compare this impact with existing noise levels at these locations, in terms of a change in noise level and potential nuisance. This is then compared to the effects of not proceeding with the Scheme , i.e. the 'Do-Minimum' option, in terms of ongoing noise impact on properties close to the existing route. In this regard it is considered appropriate for use as the basis of a noise assessment as part of an environmental assessment.

15.2.5 The DMRB methodology considers noise levels with regard to the $LA_{10,18h}$ index. This value is the noise level exceeded for 10% of the time, averaged over a period between 06:00-24:00, and is widely considered to best represent the perceived traffic noise impact at a location. Some guidance documents refer to the LAeq index, which is used to describe a variety of noise sources. With reference to BS8233 Section 6.2.3, an approximate relationship for moderate and heavy traffic flows is that LAeq,16h ≈ $LA_{10,18h}$ - 2. Under low flow conditions, such as rural settings, there is no consistent relationship and LAeq values can be higher than equivalent LA_{10} values. In this assessment, the $LA_{10,18h}$ index is used in the prediction and assessment of traffic noise, while the LAeq index is used in the prediction and assessment of construction noise. Explanations of noise terms used in this assessment are presented in Appendix N of this Environmental Statement.

15.2.6 In addition, DMRB also represents the change in noise level (for the assumed year of opening) and the resultant noise level (for the design year) as a nuisance value. These values are based on research conducted of abrupt changes in traffic noise levels and of steady state conditions, and relates to the percentage of people bothered by the traffic noise (i.e. those who said they were bothered "quite a lot" or "very much" on a four point scale). The consideration of nuisance in DMRB indicates that an abrupt change in noise level will affect perceived nuisance more than the absolute level, and that a person will become more accustomed to the noise, such that there is a significantly lower nuisance level in the steady state.

15.3 Baseline Conditions

15.3.1 During the site surveys, the predominant noise source at each identified location was determined in line with the methodology of DMRB 11.3.7.8, Paragraph 5.1 to 5.9. Where a location was determined to be presently impacted by traffic, the existing traffic noise levels have been calculated to assess the change in impact. With the exception of Location 28 (Whinfield Lane), the dominant noise source is that of transportation noise on the existing A2. It is considered that calculated traffic noise levels derived from available traffic data are more directly comparable to predicted levels for the initial and steady states. Where a site was determined to have no predominant noise source, the background noise level was measured.

15.3.2 This determination method reflects the greater potential impact at a location which, prior to the proposed dual carriageway alignment, would not have been exposed to traffic noise levels as compared with a location already subject to traffic impact. However, as stated previously, the majority of the properties adjacent to the Scheme are currently exposed to high levels of traffic noise.

15.3.3 It is noted in the document that the accuracy of measurements is partially dependent on weather conditions (ref: DMRB 11.3.7.8, Paragraph 5.8). Consequently, measurements were taken when weather conditions were favourable, with all readings being recorded in dry conditions and low wind speeds. The details and results of the measurements are given in Table 15.1.

15.3.4 Measurement locations relate to the noise assessment locations, detailed in Figure 15.1, and are considered representative for properties at that location. All measurements presented in this report were obtained using Type 1 instrumentation, calibrated as required by the appropriate international standards.

Table 15.1: Measurement Results of the Existing Environment

Location	L_{Amax}	L_{Aeq}	L_{A10}	L_{A90}
1	84.9	70.2	73.6	62.6
2	87.8	69.4	72.0	62.0
3	76.7	64.1	66.8	59.0
4	69.6	57.9	60.4	53.5
5	70.7	50.1	50.3	42.1

15.4 Predicted Impacts

Property Banding

15.4.1 All properties and noise sensitive locations within 300 metres of the existing and proposed routes have been identified within three 100-metre wide bands (Figures 15.2 and 15.3 respectively). A summary of the results of this assessment is shown in Table 15.2.

Table 15.2: Number of residential and sensitive properties within 300 metres of existing and proposed routes (adjusted for property loss).

Distance Bands	0 - 100 m	100 - 200 m	200 - 300 m	Total
Existing Route	437	177	138	752
Proposed Route	328	219	182	729

15.4.2 Due to the number of properties directly affected, in terms of noise, by the proposed route, 33 typical locations representing a number of properties impacted have been

identified and used to determine the specific noise impact of the Scheme. The noise measurement and assessment locations are shown in Figure 15.1.

Prediction of Traffic Noise Impact

15.4.3 It is necessary in assessing the change in noise level and potential nuisance, to predict the traffic noise levels due to the Scheme in the assumed year of opening (2010) and in the steady state (the design year, 2024). The prediction of noise levels has been calculated using CADNA proprietary acoustic modelling software. The values in CADNA have been calculated using the methodology of the Calculation of Road Traffic Noise document (DoT, 1990) in accordance with DMRB 11.3.7.8, Paragraph 5.3.

15.4.4 The potential noise impact of the proposed route is compared to the ongoing noise impact of traffic on the existing A2 Jordanstown to Seapark section of road, where this is the dominant noise source; and, the existing background levels at the properties located at a distance from the existing A2 at Whinfield Lane. Therefore, all calculations at identified locations include prediction of noise levels from the 'Do-Minimum' scenario, and incorporate projected traffic growth on the existing road over fifteen years.

15.4.5 There are 33 typical locations which have been identified as shown in Figure 15.1. Noise modelling zonation drawings for the Existing Route and Proposed Route in the assumed year of opening (2010), and the design year (2024) for both the 'Do-Minimum' and 'Do-Something' scenarios are provided in Appendix N.

15.4.6 Results are summarised in Tables 15.3 and 15.4 for the assumed year of opening (2010) and design year (2024) respectively.

Table 15.3: Summary of noise impact at identified locations in the assumed year of opening (2010) (continued over)

Location	Ambient Level	Do Minimum			With Proposed Scheme			Relative Change	
		Noise Level	Change in Noise Level	Change in % Nuisance	Noise Level	Change in Noise Level	Change in % Nuisance	Noise Level	% Nuisance
1	71.4	71.8	0.4	39	70.5	-0.9	35	-1.3	-4
2	73.1	73.5	0.4	44	74.4	1.3	46	0.9	2
3	77.5	77.9	0.4	57	75.5	-2	50	-2.4	-7
4	73.7	74.1	0.4	45	75.9	2.2	51	1.8	6
5	72.1	72.5	0.4	41	71.4	-0.7	37	-1.1	-4
6	77.8	78.2	0.4	58	76.2	-1.6	52	-2	-6
7	76.8	77.2	0.4	55	75.6	-1.2	50	-1.6	-5
8	71.7	72.1	0.4	39	74.5	2.8	47	2.4	8
9	69.7	70.1	0.4	34	71.3	1.6	37	1.2	3
10	73	73.4	0.4	43	72.5	-0.5	41	-0.9	-2
11	73.1	73.5	0.4	44	75	1.9	48	1.5	4
12	76.4	76.8	0.4	53	74.6	-1.8	47	-2.2	-6
13	72.8	73.2	0.4	43	74.7	1.9	47	1.5	4

Location	Ambient Level	Do Minimum			With Proposed Scheme			Relative Change	
		Noise Level	Change in Noise Level	Change in % Nuisance	Noise Level	Change in Noise Level	Change in % Nuisance	Noise Level	% Nuisance
14	77.9	78.3	0.4	58	76.6	-1.3	53	-1.7	-5
15	73.3	73.7	0.4	44	73.9	0.6	45	0.2	1
16	74.6	75	0.4	48	72.9	-1.7	42	-2.1	-6
17	70.9	71.3	0.4	37	71.9	1	39	0.6	2
18	64.1	64.5	0.4	21	75.2	11.1	49	10.7	28
19	70.9	71.3	0.4	37	69	-1.9	31	-2.3	-6
20	59.8	60.2	0.4	14	69.9	10.1	33	9.7	19
21	71.1	71.5	0.4	38	70.2	-0.9	34	-1.3	-4
22	73.4	73.8	0.4	44	61.5	-11.9	15	-12.3	-29
23	77	77.4	0.4	55	59.1	-17.9	12	-18.3	-43
24	72.7	73.1	0.4	42	58.9	-13.8	12	-14.2	-30
25	73.5	73.9	0.4	45	57.9	-15.6	11	-16	-34
26	73.7	74.1	0.4	45	58.8	-14.9	12	-15.3	-33
27	72	72.4	0.4	40	58.5	-13.5	11	-13.9	-29
28	50.5	50.9	0.4	5	67.1	16.6	26	16.2	21
29	70.7	71.1	0.4	37	60.1	-10.6	13	-11	-24
30	72	72.4	0.4	40	60.3	-11.7	14	-12.1	-26
31	72.8	73.2	0.4	43	60.4	-12.4	14	-12.8	-29
32	74.3	74.7	0.4	47	70.8	-3.5	36	-3.9	-11
33	73.3	73.7	0.4	44	66	-7.3	24	-7.7	-20

Table 15.4: Summary of noise impact at identified locations in the design year (2024) (continued over)

Location	Ambient Level	Do Minimum			With Proposed Scheme			Relative Change	
		Noise Level	Change in Noise Level	% Nuisance	Noise Level	Change in Noise Level	Change in % Nuisance	Noise Level	% Nuisance
1	71.4	72.7	0.9	41	71.4	0	37	-1.3	-4
2	73.1	74.4	0.9	46	75.3	2.2	49	0.9	3
3	77.5	78.8	0.9	59	76.4	-1.1	52	-2.4	-7
4	73.7	75	0.9	48	76.8	3.1	53	1.8	5
5	72.1	73.4	0.9	43	72.3	0.2	40	-1.1	-3

Location	Ambient Level	Do Minimum			With Proposed Scheme			Relative Change	
		Noise Level	Change in Noise Level	% Nuisance	Noise Level	Change in Noise Level	Change in % Nuisance	Noise Level	% Nuisance
6	77.8	79.1	0.9	60	77.1	-0.7	54	-2	-6
7	76.8	78.1	0.9	57	76.5	-0.3	52	-1.6	-5
8	71.7	73	0.9	42	75.4	3.7	49	2.4	7
9	69.7	71	0.9	36	72.2	2.5	40	1.2	4
10	73	74.3	0.9	43	73.4	0.4	43	-0.9	0
11	73.1	74.4	0.9	46	75.9	2.8	51	1.5	5
12	76.4	77.7	0.9	56	75.5	-0.9	50	-2.2	-6
13	72.8	74.1	0.9	45	75.6	2.8	50	1.5	5
14	77.9	79.2	0.9	60	77.5	-0.4	55	-1.7	-5
15	73.3	74.6	0.9	47	74.8	1.5	47	0.2	0
16	74.6	75.9	0.9	51	73.8	-0.8	44	-2.1	-7
17	70.9	72.2	0.9	40	72.8	1.9	41	0.6	1
18	64.1	65.4	0.9	23	76.1	12	51	10.7	28
19	70.9	72.2	0.9	40	69.9	-1	33	-2.3	-7
20	59.8	61.1	0.9	15	70.8	11	36	9.7	21
21	71.1	72.4	0.9	40	71.1	0	37	-1.3	-3
22	73.4	74.7	0.9	47	62.4	-11	17	-12.3	-30
23	77	78.3	0.9	58	60	-17	13	-18.3	-45
24	72.7	74	0.9	45	59.8	-12.9	13	-14.2	-32
25	73.5	74.8	0.9	47	58.8	-14.7	12	-16	-35
26	73.7	75	0.9	48	59.7	-14	13	-15.3	-35
27	72	73.3	0.9	43	59.4	-12.6	12	-13.9	-31
28	50.5	51.8	0.9	5	68.0	17.5	28	16.2	23
29	70.7	72	0.9	39	61	-9.7	15	-11	-24
30	72	73.3	0.9	43	61.2	-10.8	15	-12.1	-28
31	72.8	74.1	0.9	45	61.3	-11.5	15	-12.8	-30
32	74.3	75.6	0.9	50	71.7	-2.6	38	-3.9	-12
33	73.3	74.6	0.9	47	66.9	-6.4	26	-7.7	-21

Assessment of Traffic Noise Impact

15.4.7 With reference to Table 15.2, it can be seen that there are significantly fewer properties within 100 metres of the proposed route than within 100 metres of the existing road. Therefore, the proposed route will reduce the traffic flow and noise exposure to a larger number of properties subject to noise impact from the existing road. However, due to the methodology in DMRB, a lot of these properties are located more than 300 metres from the proposed route and the actual level of noise reduction is not required to be calculated.

15.4.8 There are 22 locations (Locations 1, 3, 5, 6, 7, 10, 12, 14, 16, 19, 21-27, and 29-33) within 300 metres of the proposed dual carriageway which will benefit from a reduction in noise impact due to the Scheme in the design year.

15.4.9 The proposed dual carriageway will create a perceptible increase in noise levels at properties that are currently not exposed to high levels of transportation noise, due to their rural location.

15.4.10 Under the 'Do-Something' scenario, it is predicted that there will be 23 locations (Locations 1-21, 28 and 32) where the potential noise impact in the design year will be in excess of the 68 dB $L_{A10,\ 18hr}$ value used for the determination of statutory sound insulation eligibility. However, twenty of these locations will already be exposed to levels in excess of 68 dB $L_{A10,\ 18hr}$ under the 'Do-Minimum' scenario, due to increased traffic flow. Following the Noise Insulation Guidelines, if a property is exposed to a noise impact level greater than 68 dB $L_{A10,\ 18hr}$ and is subject to an increase of more than 1dB, then the property is eligible for Noise Insulation. Of these twenty locations, five (Locations 4, 8, 9, 11, and 13) will exceed the 'Do-Minimum' noise level by more than 1dB, making them potentially eligible. There are a further three locations (Locations 18, 20 and 28) which will also be subject to increases in noise levels to above the 68 dB $L_{A10,\ 18hr}$ threshold under the proposed Scheme, which would not exceed the target under the 'Do-Minimum' scenario. However, specific mitigation measures are proposed to reduce this noise impact, as discussed in Section 15.5.

Impact at Properties Close to Roundabouts

15.4.11 The Calculation of Road Traffic Noise (CRTN) document excludes the prediction of noise from a junction. Rather, it states that noise levels should be predicted by considering free flowing traffic on either side of the junction, with no reduction in mean traffic speed (Ref: CRTN Paragraph 33 and Annex 16). Therefore, any effect from the roundabouts along the length of the Scheme would be neglected in the DMRB assessment, and the noise impact would be as assessed for the free-flowing dual carriageway.

15.4.12 The differences between free-flow conditions and restricted flow at roundabouts can be demonstrated by reference to recorded work on the assessment of the effects of the Corr's Corner Roundabout on predicted noise impact from the A8 Belfast-Larne Road. Noise measurements using the CRTN Shortened Measurement Procedure were conducted in March 2000, under appropriate conditions (ref. CRTN, Paragraphs 39-41). Two measurement locations were chosen: firstly, at equal distances to traffic on the roundabout, on a minor approach road and exit traffic towards Larne; and secondly, approach traffic from Larne and traffic on the roundabout.

15.4.13 Calculations in line with CRTN were made using the measured levels and data available for this section of road, such that a comparison could be made of predicted levels of free-flowing traffic against measured levels at the roundabout.

15.4.14 The measurements and calculations indicate that:

- Measured levels and resulting change in impact are consistent at both locations;

- The assumption of free-flowing traffic at locations close to a roundabout will tend to overestimate the noise impact by circa 2.5 dB; and

- The equivalent reduction in mean traffic speed to obtain this reduction in noise level has been calculated as -26 km/h.

15.4.15 Therefore, it is considered that the assessed noise impact at any property close to the proposed roundabouts would tend to overestimate the level at that property, due to an effective reduction in mean traffic speed on approach to the roundabout.

Potential Vibration Impact

15.4.16 The assessment of vibration impact and disturbance is detailed in Chapter 6 of DMRB, Volume 11, Section 3, Part 7. It is likely that the reference source of this chapter is research work by the Transport Research Laboratory (TRL) and particularly Report 246 "Traffic Induced Vibrations in Buildings". The DMRB chapter makes a number of points:

- Vibration levels from traffic are low, even in properties close to heavily trafficked roads, and normal use of the building often generates much higher vibration levels;

- Extensive research has shown that traffic induced vibrations do not cause significant damage to buildings;

- The highest levels of traffic induced vibration are generated by irregularities in the road, and this is unlikely to be an important consideration for new roads. However, as road conditions may be improved during maintenance work, it should not be presented as a benefit of a new Scheme. (The TRL Report 246 presents a prediction method for traffic vibration in which the depth/height of an irregular surface is a main component in the assessment of peak particle velocity effects. As this value approaches 0, the induced vibration also approaches 0. Thus a new surface has limited potential for vibration impact);

- Notwithstanding the TRL report, DMRB concludes that ground-borne vibration level depend on many factors and is difficult to accurately predict.

- Airborne vibration is more likely to cause disturbance than ground-borne vibration, but both sources of vibration will cause less disturbance than noise, and are applicable within a shorter distance from the road.

15.4.17 Other empirical matters, relating to traffic induced vibrations, have been monitored and noted. Some general guidance on the effect of vibrations is contained in BS6472 (1992), "Guide to Evaluation of Human Exposure to Vibration in Buildings" and BS7385 (1990 and 1993), "Evaluation and Measurement for Vibration in Buildings".

15.4.18 Vibration associated with heavy impact activities on other construction sites have been measured as less than 0.5 mm/s at 20m. Vibration from HGV road traffic has also been measured at less than 0.5mm/s at 15m in other locations with good road conditions.

15.4.19 Empirical data, as detailed above, suggests that vibration levels will be less than 0.5mm/s at the majority of properties. With reference to BS6472, it is considered that this represents a "low probability of adverse comment" by residents. With reference to

BS7385 and allowing for normal circumstances, this vibration level is not of a severity that might cause any structural damage to the property.

15.5 Mitigation Measures

15.5.1 The majority of the properties located adjacent to the existing A2 will be subject to a decrease in noise levels over the current conditions.

15.5.2 As stated previously in Section 15.4.10, it is predicted that there are 23 locations (Locations 1-21, 28 and 32) where the potential noise impact at the design year, will be in excess of the 68 dB $L_{A10,\ 18hr}$ value used for the determination of statutory sound insulation eligibility. However, twenty of these locations will already be exposed to levels in excess of 68 dB $L_{A10,\ 18hr}$ under the 'Do-Minimum' scenario. A total of eight locations (Locations 4, 8, 9, 11, 13, 18, 20 and 28) would be above the 68 dB $L_{A10,\ 18hr}$ threshold and exceed the 'Do-Minimum' noise level by more than 1dB. Following the Noise Insulation Guidelines, if a property is exposed to a noise impact level greater than 68 dB $L_{A10,\ 18hr}$, and is subject to an increase of more than 1 dB, then the property is eligible for Noise Insulation.

15.5.3 It is proposed to use a low noise road surface over the entire length of the Scheme between Jordanstown and Seapark, and this would reduce the noise impact at seven of the eight locations referred to above. The low noise road surface will reduce the noise levels by between 3 and 5 dB, therefore below the 68 dB $LA_{10,\ 18hr}$ level, or to within 1 dB of the noise impact level under the 'Do-Minimum' scenario.

15.5.4 However, in order to reduce the noise impact at Location 18 (1 and 1a Station Road), where the existing levels are below 68 dB, and the increase is of such a magnitude that neither the low noise road surface or an acoustic barrier will provide sufficient reduction, acoustic glazing on windows on the upper floors will be required. Acoustic glazing is typically constructed from three panels of glass of differing thicknesses, formed into a double glazed unit. This is achieved by forming one panel of glass by laminating two single panes together. The process of laminating panes of differing thicknesses provides a significant improvement in sound reduction over a standard thermal double glazed unit, whilst still retaining the thermal performance.

15.5.5 These measures are in line with the guidance of DMRB 11.3.7.8, Paragraph 7.2 and are appropriate for consideration at this stage for the Scheme.

15.6 Residual Impacts

15.6.1 The benefits of the Scheme are that the proposed route will reduce the traffic flow, and therefore the noise impact, at a larger number of properties located within 300 metres of the existing A2.

15.6.2 However, the proposed route will impact properties that are not currently subject to noise exposure from transportation noise (north of Station Road), due to their rural location with low existing ambient noise levels.

15.6.3 Where the potential noise impact from transportation noise may exceed the 68 dB $LA_{10,\ 18hr}$ value used for the determination of statutory sound insulation eligibility, mitigation measures have been recommended.

15.7 Summary

15.7.1 The potential noise impact of the Scheme has been predicted for the year of opening, and the design year. The overriding benefit of the Scheme is that there will be fewer properties in proximity to the proposed dual carriageway than along the existing A2 and hence, with strategic traffic reassigning to the proposed dual carriageway from part of the existing Shore Road, there will be a net benefit with reduced noise levels for the majority of properties between Station Road and Seapark. However, the proposed route will impact properties that are not currently subject to noise exposure from transportation noise, due to their rural location with low existing ambient noise levels.

15.7.2 Where the potential noise impact from transportation noise may exceed relevant Standards, mitigation measures have been recommended. The potential noise impact of temporary construction noise has been assessed and a number of mitigation measures and best practice guidelines have been provided to minimise the noise impact.

15.8 References

- Guide to Evaluation of Human Exposure to Vibration in Buildings. British Standards, BS6472,1992.
- Evaluation and Measurement for Vibration in Buildings. British Standards, BS7385, 1990 and 1993.
- Design Manual for Roads and Bridges, Volume 11, Environmental Assessment. Department of the Environment for Northern Ireland et al (August 1994, as amended up to August 2006).
- Traffic Induced Vibrations in Buildings. Transport Research Laboratory, 1990.