Cork Line Level Crossings

Volume 3, Chapter 10: Noise and Vibration

Iarnród Éireann

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Cork Line Level Crossings

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A01	February 2020	Client review	CC	MW	MW/RM	AB
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A03	December 2020	For Legal Comment	HC	RM	RM	AB
A04	March 2021	For Issue to An Bord Pleanála	HC	RM	RM	AB

Contents

Table of Acronyms

Acronym	Meaning
AADT	Annual Average Daily Traffic
AAWT	Annual Average Weekday Traffic
CCTV	Closed Circuit Television
CEMP	Construction Environmental Management Plan
CRTN	Calculation of Road Traffic Noise
CoPA	Control of Pollution Act
dB	Decibel
DMRB	Design Manual for Roads and Bridges
EIAR	Environmental Impact Assessment Report
HGV	Heavy Goods Vehicles
IÉ	Iarnród Éireann
LA10	The A-weighted, sound level just exceeded for 10% of the measurement period, calculated by statistical analysis
LAeq,T	The A-weighted, equivalent continuous sound level. T denotes the time period over which the fluctuating sound levels were averaged, for example LAeq,8h is the equivalent continuous noise level over an 8 hour period.
LC	Level Crossing
Lden	The A-weighted, Leq (equivalent noise level) over a whole day, but with a penalty of 10 dB(A) for night-time noise (23:00-07:00) and 5 dB(A) for evening noise (19:00-23:00), also known as the day evening night noise indicator
M	Metres
NRA	National Roads Authority
NS	Noise survey ID
PPV	Peak Particle Velocity
R	Receptor ID
TII	Transport Infrastructure Ireland

10. Noise & Vibration

10.1 Introduction

This chapter presents the potential noise and vibration effects of the proposed Project on sensitive receptors. An assessment of both temporary (i.e. during construction) and permanent (i.e. during operation) noise and vibration effects is set out. The assessment was undertaken in accordance with the National Roads Authority (NRA) Guidelines for the Treatment of Noise and Vibration in National Roads Schemes (TII (formerly NRA) 2004) with further guidance taken from the Good Practice for the Treatment of Noise during the Planning of National Road Schemes (TII (formerly NRA) 2014). The baseline environment and the assessment methodology are reported before the potential effects on each of the receptors is identified and detailed.

10.2 Study Area

Based on TII (formerly NRA) guidance, professional judgement, low traffic volumes and the predicted traffic impact as set out in Volume 3, Chapter 11: Traffic & Transport, the study area for construction and operational noise was considered to be 300m from each of the proposed crossings.

The study area is in a predominantly rural area but is also immediately adjacent to the Dublin – Cork Railway Line and some of the proposed crossings are close to the N20. Therefore, the baseline includes noise from train movements and traffic noise from the N20.

Receptors which are sensitive to noise and vibration include residential receptors while other sensitive receptors include schools, hospitals, places of worship, heritage buildings, special habitats, amenity areas and designated quiet areas.

10.3 Consultation

Consultation responses of relevance to Noise and Vibration are provided in Table 10.1.

Table 10.1: Consultation responses of relevance to Noise and Vibration

Consultee	Comment	Response
Transport Infrastructure Ireland (TII) (14th August 2019)	The EIAR should consider the Environmental Noise Regulations 2006 (SI 140 of 2006) and, in particular, how the development may need to consider the incorporation of noise barriers to reduce noise impacts (see guidelines for the Treatment of Noise and Vibration in National Road Schemes (1st Rev, National Roads Authority, 2004)	This chapter includes consideration of TII Guidance, the National Roads Authority Guidance and the Environmental Noise Regulations 2006.
Ballyhea Village Community Group Meeting (3rd December 2019)	XC212 Ballycoskery – Concerns raised in regard to the proximity of the proposed bridge to the houses at the front of the Beechwood Estate. Issues such noise, visual impact, light and overshadowing were raised.	This chapter predicts that traffic noise levels will reduce or stay the same at the closest noise sensitive receptors.

10.4 Baseline Environment

For a description of the proposed Project and locations refer to Volume 2, Chapter 3: Project Description.

10.4.1 XC187 Fantstown

Desk Top Study

XC187 Fantstown is located in a rural area dominated by farmland and with occasional, scattered residential properties. Table 10.2 shows the numbers of receptors in distance bands up to 300m from the site. There are 6 residential receptors within 300m of the site. For the location of the receptors refer to Volume 4, Figure 10.1.

Table 10.2: Receptors within 300m of proposed crossing XC187 Fantstown

Distance from site	Residential receptor	Other receptor
0-50m	3	0
50-100m	1	0
100-150m	0	0
150-200m	1	0
200-300m	1	0
Total	6	0

Survey Work

A site walkover was undertaken on 22 January 2020. No noise measurements were undertaken as the proposed Project seeks to eliminate the existing level crossing and does not propose any new road alignment or bridge infrastructure. However, the main noise sources were confirmed as road traffic on the R515, railway noise on the Dublin – Cork Railway Line, bird sounds and noise from agricultural machinery.

10.4.2 XC201 Thomastown

Desk Top Study

XC201 Thomastown is located in a rural area dominated by farmland and with occasional, scattered residential properties. Table10.3 shows the numbers of receptors in distance bands up to 300m from the site. There are 13 residential receptors within 300m of the site. For the location of the receptors refer to Volume 4, Figure 10.2.

Table10.3: Receptors within 300m of proposed crossing XC201 Thomastown

Distance from site	Residential receptor	Other receptor
0-50m	0	0
50-100m	6	0
100-150m	4	0
150-200m	2	0
200-300m	1	0
Total	13	0

Survey Work

A site walkover and noise survey was undertaken on 20 and 22 January 2020. Weather conditions were good for undertaking a survey as there was no precipitation and winds were light. The main noise sources were confirmed

as road traffic on the R515 and surrounding roads, occasional railway noise on the Dublin – Cork Railway Line, noise from agricultural machinery and bird sounds.

Table 10.4 shows the results of the noise survey at the survey location NS01 as shown on Volume 4, Figure 10.2.

Table 10.4: Results of noise survey at proposed crossing XC201 Thomastown

Survey Location	Date & time of survey	Derived Noise Levels (dB) – free field
		$L_{A10,15min}$
NS01	20/01/2020 16.37 – 16.52 & 22/01/2020 15.32 – 15.47	55

10.4.3 XC209 Ballyhay

Desk Top Study

XC209 Ballyhay is located in a rural area dominated by farmland and with occasional, scattered residential properties. Table 10.5 shows the numbers of receptors in distance bands up to 300m from the site. There are 3 residential receptors within 300m of the site and they are shown on Volume 4, Figure 10.3

Table 10.5: Receptors within 300m of proposed crossing XC209 Ballyhay

Distance from site	Residential receptor	Other receptor
0-50m	1	0
50-100m	0	0
100-150m	0	0
150-200m	1	0
200-300m	1	0
Total	3	0

Survey Work

A site walkover was undertaken on 22 January 2020. No noise measurements were undertaken as the proposed Project seeks to upgrade to a CCTV controlled crossing and does not propose any new road alignment or bridge infrastructure. However, the main noise sources were confirmed as road traffic on the N20 and surrounding road network, occasional railway noise on the Dublin – Cork Railway Line, animal and bird sounds, and noise from agricultural machinery.

10.4.4 XC211 & XC212 Newtown and Ballycoskery

Desk Top Study

XC211 Newtown and XC212 Ballycoskery are located in a rural area dominated by farmland and the village of Ballyhea which contains a school, a pre-school and a church, as well as residential properties. Table 10.6 shows the numbers of receptors in distance bands up to 300m from the proposed alignment. There are a total of 70 residential receptors and 3 other receptors (including the aforementioned school, pre-school and church) within 300m of the sites. For location of the receptors refer to Volume 4 Figure 10.4.

Table 10.6: Receptors within 300m of proposed crossing XC211 Newtown and XC212 Ballycoskery

Distance from site	Residential receptor	Other receptor
0-50m	18	3
50-100m	23	0
100-150m	19	0
150-200m	3	0
200-300m	7	0
Total	70	3

Survey Work

A site walkover and noise survey was undertaken on 20 and 21 January 2020. Weather conditions were good for undertaking a survey as there was no precipitation and winds were light. The main noise sources were confirmed as road traffic on the N20 and local roads, occasional railway noise on the Dublin – Cork Railway Line, human voices, bird sounds and noise from agricultural machinery.

Table 10.7 shows the results of the noise survey at the survey locations. Attended noise monitoring was undertaken at locations NS02, NS03 and NS04 as shown on Volume 4, Figure 10.4.

Table 10.7: Results of noise survey at XC211 Newtown and XC212 Ballycoskery

Survey Location	Date & time of survey	Derived Noise Levels (dB) – free field	
		$L_{A10,18h}$	L_{DEN}
NS02	21/01/2020 10.12 – 10.27 & 11.19 – 11.34 & 12.22 – 12.37	56	58
NS03	21/01/2020 10.30 – 10.45 & 11.36 – 11.51 & 12.40 – 12.55	56	58
NS04	21/01/2020 10.55 – 11.10 & 12.02 – 12.17 & 13.01 – 13.17	49	52

10.4.5 XC215 Shinanagh

Desk Top Study

XC215 Shinanagh is located in a rural area dominated by farmland and with occasional, scattered residential properties. Table 10.8 shows the numbers of receptors in distance bands up to 300m from the site. There are 22 residential receptors within 300m of the site. For location of the receptors refer to Volume 4, Figure 10.5.

Table 10.8: Receptors within 300m of XC215 Shinanagh

Distance from site	Residential receptor	Other receptor
0-50m	6	0
50-100m	5	0
100-150m	1	0
150-200m	3	0
200-300m	7	0
Total	22	0

Survey Work

A site walkover and noise survey was undertaken on 21 and 22 January 2020. Weather conditions were good for undertaking a survey as there was no precipitation and light winds. The main noise sources were confirmed as road traffic using the N20, train noise on the Dublin – Cork Railway Line and bird sounds.

Table 10.9 shows the results of the noise survey at the survey locations. Noise monitoring was undertaken at locations NS05, NS06 and NS07 as shown on Volume 4, Figure 10.5.

Table 10.9: Results of noise survey at XC215 Shinanagh

Survey Location	Date & time of survey	Derived Noise Levels (dB) – free field	
		$L_{A10,18h}$	L_{DEN}
NS05	21/01/2020 10.00 – 13.00	55	57
NS06	21/01/2020 15.45 – 16.00 & 16.30 – 16.45 & 22/01/2020 14.31 – 14.57	57	59
NS07	21/01/2020 16.11 – 16.26 & 16.56 – 17.11 22/01/2020 14.38 – 14.53	69	69

10.4.6 XC219 Buttevant

Desk Top Study

XC219 Buttevant is located in a rural area dominated by farmland and close to the town of Buttevant. There is also an industrial estate close to the site. Table 10.10 shows the numbers of receptors in distance bands up to 300m from the site. There are 9 residential receptors and one other receptor (a school) within 300m of the site as shown on Volume 4, Figure 10.6.

Table 10.10: Receptors within 300m of the XC219 Buttevant

Distance from site	Residential receptor	Other receptor
0-50m	4	0
50-100m	1	0
100-150m	1	0
150-200m	2	0
200-300m	1	1
Total	9	1

Survey Work

A site walkover and noise survey was undertaken on 22 January 2020. Weather conditions were good for undertaking a survey as there was no precipitation and light winds. The main noise source was from road traffic using the R522 but traffic could also be heard from the N20 and other surrounding roads. Noise from occasional passing trains was present and bird sounds could be heard. There were also several dogs which barked at various times throughout the survey.

Table 10.11 shows the results of the noise survey at the survey locations NS09 and NS10 as shown in Volume 4, Figure 10.6.

Table 10.11: Results of noise survey at XC219 Buttevant

Survey Location	Date & time of survey	Derived Noise Levels (dB) – free field	
		$L_{A10,18h}$	L_{DEN}
NS08	22/01/2020 10.00 – 10.18 & 10.58 – 11.14 & 12.00 – 12.15	69	69
NS09	22/01/2020 10.23 – 10.39 & 11.39 – 11.54 & 12.19 – 12.47	69	69

10.5 Assessment Methodology

10.5.1 Legislation, Policy & Guidance

The following guidance, reference documentation, and legislation was followed during the assessment of noise and vibration effects:

- National Roads Authority Guidelines for the Treatment of Noise and Vibration in National Roads Schemes (TII (formerly NRA) 2004).
- Good Practice for the Treatment of Noise during the Planning of National Road Schemes (TII (formerly NRA) 2014).
- ISO 1996-1:2016: Acoustics – Description, Measurement and Assessment of Environmental Noise – Part 1: Basic Quantities and Assessment Procedures.
- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 1: Noise (BSI, 2014).

- BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration (BSI, 2014).
- Design Manual for Roads and Bridges (DMRB) LA111 Noise and Vibration (Highways England, November 2019).
- Calculation of Road Traffic Noise (CRTN). London: Her Majesty's Stationery Office (Department for Transport and the Welsh Office 1988).
- Environmental Noise Regulations 2006 (S.I. 1401 of 2006).
- Environmental Noise Guidance for Local Authority Planning & Enforcement Departments. Association of Acoustic Consultants of Ireland June 2019.
- Section 61 of the Control of Pollution Act (CoPA) 1974 sets out procedures for those undertaking works to obtain 'Prior Consent' for construction works within agreed limits.
- Guidelines for The Design of Railway Infrastructure and Rolling Stock - Section 5 Level Crossings. Commission for Railway Regulation August 2008.

10.5.2 Assessment Methodology

Construction Noise

The NRA (now TII) states that construction noise predictions should be undertaken using a recognised standard such as BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise (BSI 2014) for basic information and procedures relating to noise and vibration control.

The standard provides information on the factors which affect the acceptability of site noise and the degree of control necessary. It also provides a methodology for the prediction of site noise at sensitive receptors and provides guidance on possible mitigation measures.

BS 5228-1 provides two methodologies for the prediction of significance during typical construction works, based upon noise change and existing measured ambient noise levels. As there are both residential and other types of sensitive receptors in the vicinity of the proposed Project, consideration was given to Method 2, as Method 1 only applies to residential properties. The guidance advises that:

"Noise levels generated by construction activities are deemed to be potentially significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB LAeq,T from construction noise alone, for the day-time, evening and night time periods respectively. This applies for a duration of one month or more, unless works for a shorter duration are likely to result in a significant effect."

These evaluation criteria are generally applicable to residential dwellings, hotels and hostels, buildings in religious use, schools and health or community facilities.

Construction Vibration

According to the NRA publication, there is no published Irish guidance relating to vibration during construction activities. Instead, common practice in Ireland has been to use guidance from internationally recognised standards. Vibration is typically expressed in terms of Peak Particle Velocity (PPV) in millimetres per second (mm/s). As such, reference has been made to the guidance within BS 5228-2: 2009, detailed below, for the construction vibration impact assessment.

Reference has been made to BS 5228-2: 2009+A1:2014 – Code of practice for noise and vibration control on construction and open site – Part 2: Vibration (BS 5228-2) which provides guidance on both the human response, and building structural response, to vibration. The standard also presents guidance for the control of vibration from construction works.

For building structure response, BS 5228-2 reproduces the advice given in BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings: guide to damage levels from ground borne vibration (BS 7385-2). The response of a building to ground borne vibration is affected by the type of foundation, underlying ground conditions, the building construction and the state of repair of the building. Table 10.12 reproduces the guidance detailed on building classification and guide values for cosmetic building damage.

Table 10.12: Guidance on the Effects of Vibration Levels on Building Structures from BS 5228-2

Type of Building	PPV in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures	50mm/s	50mm/s
Industrial and heavy commercial buildings		
Un-reinforced or light framed structures	15mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above
Residential or light commercial buildings		

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 10.12, with major damage at values greater than four times the values in the table. BS 7385-2 also notes that the probability of cosmetic damage tends towards zero at 12.5mm/s peak component particle velocity. Significant adverse effects are expected at levels where vibration can cause cosmetic damage to structures, however, significant adverse effects on humans may occur at lower levels of vibration than this.

Table 10.13 (reproduced from BS 5228-2) shows potential adverse effect levels for the human response to vibration in terms of peak particle velocity (PPV).

Table 10.13: Guidance on the Human Response to Vibration Levels from BS 5228-2

Vibration Level	Effect
0.14mm/s	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration
0.3mm/s	Vibration might just be perceptible in residential environments
1.0mm/s	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10.0mm/s	Vibration is likely to be intolerable for any more than very brief exposure to this level

At vibration levels above 1.0mm/s there is the potential for a significant effect to occur. However, the duration of the works, the number of receptors affected, and the character of the impact should also be considered.

Operational Phase

For new national road schemes in Ireland, it is standard practice to adopt the traffic noise design goal detailed within the NRA *'Guidelines for the Treatment of Noise and Vibration in National Road Schemes'* (2004).

This document specifies that the Authority (i.e. NRA now TII) considers it appropriate to set the design goal for Ireland as follows:

- Day-evening-night 60dB(A) Lden (free field residential façade criterion;
- Noise mitigation measures are deemed necessary whenever all three of the following conditions are satisfied simultaneously at receptor locations;

- The combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal of 60dB(A) Lden;
- The relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road scheme in place; and
- The contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

These conditions ensure that mitigation measures arising out of this process are based upon the degree of impact of the scheme.

This design goal is applicable to new road schemes only. In assessment terms, this means that they are to be applied to existing receptors in respect of both the year of opening and the design year, 15 years after projected year of opening. In this case, the opening year of 2022 and a design year of 2037 have been assessed.

To assist with the operational assessment the magnitude of change from the DMRB LA111 is used as defined in accordance with Table 10.14 for short term and Table 10.15 for long term.

Table 10.14: Magnitude of change - short term

Short term magnitude	Short term noise change ($L_{A10,18hr}$ or L_{night})
Major	Greater than or equal to 5.0
Moderate	3.0 to 4.9
Minor	1.0 to 2.9
Negligible	Less than 1.0

Table 10.15: Magnitude of change - long term

Long term magnitude	Long term noise change ($L_{A10,18hr}$ or L_{night})
Major	Greater than or equal to 10.0
Moderate	5.0 to 9.9
Minor	3.0 to 4.9
Negligible	Less than 3.0

A total of four scenarios were considered as follows:

- Year 2022 - Do-Minimum (i.e. proposed Project does not take place);
- Year 2022 - Do-Something (i.e. incorporates proposed Project);
- Year 2037 - Do-Minimum (i.e. future baseline); and
- Year 2037 - Do- Something (i.e. incorporates proposed Project).

The NRA (now TII) Guidelines prescribe the use of CRTN for the calculation of road traffic noise levels, which is a valid method where daily traffic flows exceed 1,000 vehicles per day. The roads affected by some of the proposed Project have flows of less than 1,000 vehicles per day. However, these roads have been modelled as per current advice. On this matter CRTN advises:

"…calculations can be extended outside the quoted ranges for the purpose of assessing changes in noise levels, e.g. environmental appraisal of road schemes at distances greater than 300m from a road, and generally for situation where reduced accuracy in predicting absolute levels can be accepted."

It is therefore considered that while noise levels calculated for roads with very low flows may be subject to increased error, the approach adopted is the best possible in the situation.

Noise levels at representative receptors were calculated using the CadnaA noise modelling package, which incorporates the methodologies contained in CRTN. CRTN is a technical memorandum which was produced by the Department of Transport and Welsh Office providing a method of predicting road traffic noise in the United Kingdom. Noise level predictions take account of the following variables:

- Typical weekday volumes of traffic during the eighteen-hour period from 6 am to midnight (18-hour AAWT flows);
- Percentage of heavy goods vehicles (HGV) - defined as any vehicle with an unladen weight greater than 3.5 tonnes;
- Road gradient;
- Local topography;
- Nature of the ground cover between the road and the receptor;
- Shielding effects of any intervening structures, including allowances for limited angles of view from the road and any reflection effects from relevant surfaces; and
- Road surfacing type.

It is assumed that the road surface on the existing highway network is conventional Hot Rolled Asphalt (HRA). Noise predictions at sensitive receptors have been made at first floor (4.0m) height except for bungalows which have been calculated at ground floor (1.5m) height.

The operational noise assessment is based on the change in road traffic from those currently using the level crossings compared to each scheme realignment. It should be stated that the train operations will remain as per the original Railway Order approved for the construction of the Dublin – Cork Railway Line and rail traffic will be unaffected regardless of whether the project proceeds or not.

Volume 2, Chapter 2: Project Need and Alternatives sets out the need for the project and discusses the alternatives. The project is required first and foremost for safety; however, it will also help to facilitate increased efficiency of the Dublin – Cork Railway Line as the interface between road/rail will be removed on six of the seven proposed crossings. Whilst it does not form part of the proposed Project, it is planned to eventually electrify the Dublin – Cork Railway Line which, if it goes ahead, will likely increase the speed and volumes of railway use with a potential impact on noise levels at nearby sensitive receptors.

Noise monitoring

The overall assessment was largely based on the modelling undertaken using the CadnaA noise modelling software and the predictions from the software were used to establish the potential effects and any mitigation measures proposed. Noise monitoring was undertaken to gain an appreciation of the soundscape within the study areas of each of the proposed crossings.

Noise monitoring was undertaken using the methodology contained in the TII Guidelines. The guidance advises that it is necessary to select a sufficient number of measurements to establish a clear picture of noise level variation along the entire length of the scheme. The guidance states that a combination of 24-hour measurements and short-term sample measurements should be undertaken, though it is considered that due to the rural nature of the schemes and the relatively minor nature of the proposed Project, short-term measurements would be sufficient to establish a clear picture of the soundscape at each of the sites.

Sample measurement periods of 15 minutes were undertaken at each location between the hours of 10.00 and 17.00 as detailed in the TII guidelines. Where road traffic is the main source of noise, $L_{A10,18h}$ values were derived by subtracting 1dB(A) from the arithmetic mean of the L_{10} values measured during the 15-minute sample periods. Short-term measurements require the L_{den} to be derived from the sample of measurements taken on that day. The L_{den} was calculated using Method B in Paragraph 3.1 of the Guidelines i.e. $L_{den} = 0.86 \times L_{A10,18h} + 9.86$.

Noise monitoring was carried out where road realignment was taking place at the following crossings:

- XC201 Thomastown
- XC211 & XC212 Newtown & Ballycoskery
- XC215 Shinanagh
- XC219 Buttevant

At XC201 Thomastown there are 13 receptors within 300m of the scheme and the survey location is representative of all the receptors except for the receptors on the A515 whose noise environment is dominated by road traffic from the A515. Due to access issues it was not possible to survey here but as noted the noise environment is dominated by the A515. At XC211 Newtown and XC212 Ballycoskery there are 73 receptors within 300m of the scheme and three survey locations were considered representative of all the receptors. At XC215 Shinanagh there are 22 receptors within 300m of the scheme and three survey locations were identified as being representative of the receptors. At XC219 Buttevant there are 9 receptors and two survey locations were considered representative of the receptors within the study area.

No noise survey took place at XC187 Fantstown because the proposals seek to eliminate the level crossing and no road realignment or bridge infrastructure is proposed. Similarly, at XC209 Ballyhay no noise survey was undertaken as the proposals seek to replace the currently manned level crossing with a CCTV controlled crossing. A site walkover was undertaken at both sites and noise sources at each site were recorded.

The noise monitoring equipment was calibrated before and after each survey and no drift occurred. The calibration certificates are shown in Volume 5, Appendix 10A.

Assumptions and limitations

Construction plant used to predict construction noise levels are shown in Volume 5, Appendix 10B. Traffic data and noise modelling parameter sources are shown in Volume 5, Appendix 10C.

10.6 Potential Effects of the proposed Project

10.6.1 Overview – Construction Phase Effects

Construction of the proposed Project is proposed to take place over 18 no. months, potentially commencing in Q3 2021. An overview of construction methodology and description of each of the construction phases is provided in Volume 2, Chapter 3 Project description; a detailed construction plan and schedule will be developed for the proposed Project by the Contractor to ensure that the construction phasing allows for maximum efficiency while minimising potential for environmental impact.

Construction noise impacts are associated with various construction activities including earthworks, demolition, breakout of existing road surfaces, and the creation of new road surfaces and structures, and increased traffic on the local road network during the construction period. Vibration effects could be associated with demolition and ground compaction works.

10.6.2 Overview - Operational Phase Effects

Changes in operational road traffic noise at local receptors could occur due to either:

- Physical alterations to the carriageways' horizontal and/or vertical alignment;
- Changes in flow parameters of traffic using the local road network (e.g. speed, daily traffic movements, of the percentage of heavy vehicles); or
- Changes in the road surface.

XC187 Fantstown

Do Nothing

If the proposed Project does not go ahead, traffic volumes are predicted to increase in line with natural traffic growth and the noise environment is expected to remain similar to the baseline.

Construction Phase

No new crossing is proposed at this location, and existing traffic using this crossing will be permanently diverted along existing roads. As such, there are minimal works required at this site which include the construction of a masonry wall or fence at the location of the existing level crossing. However, due to the minor nature of the works no construction impacts are expected.

Operational Phase

As traffic is proposed to be diverted along existing roads there is the potential for an increase in traffic flows along the existing road network. There is also the potential for a decrease in noise levels on roads where traffic is being diverted off. Traffic flows using the existing crossing are very low (less than 30 AADT) therefore it is considered unlikely that increases in road traffic noise of 1dB(A) or greater could occur at any noise sensitive receptor along the R515.

XC201 Thomastown

Do Nothing

If the proposed Project does not go ahead, traffic volumes are predicted to increase in line with natural traffic growth and the noise environment is expected to remain similar to the baseline.

Construction Phase

There are noise sensitive receptors within 300m of this site which are likely to experience an increase in noise levels during construction. Therefore, there is the potential for temporary noise and vibration impacts during the construction phase.

Table 10.16 shows the predicted construction noise levels (and the total noise levels) at four representative receptors close to the proposed site. The representative receptors are shown on Volume 4, Figure 10.2 Noise survey and receptor locations.

Table 10.16: Construction noise predicted levels at XC201 Thomastown

Receptor ID	Distance from scheme (m)	Baseline noise levels dB L_{Aeq}	Predicted construction noise levels at each phase of the works dB $L_{Aeq,10h}$ *(Total noise levels baseline + predicted are in italics)*		
			Phase 1	Phase 2	Phase 3
R01	110	57	62 *(63)*	58 *(61)*	65 *(66)*
R02	100	57	63 *(64)*	59 *(61)*	66 *(67)*
R03	250	57	53 *(58)*	49 *(58)*	56 *(60)*
R04	58	57	69 *(69)*	65 *(66)*	72 *(72)*

Significant adverse noise effects during construction were predicted at R01, R02 and R04 for Phase 3 only as construction noise levels were above 65dB and total noise exceeds baseline noise levels by at least 5dB. Phase 3

of the works are expected to last approximately 27 weeks, considerably longer than the one-month cut-off duration stated in BS 5228. As a result, mitigation measures are required which will be discussed in Section 10.7.

Table 10.17 shows the construction vibration levels predicted at XC201 Thomastown.

Table 10.17: Construction vibration predicted levels at XC201 Thomastown

Receptor	Distance (m)	Activity	Plant	Predicted PPV 50% steady state	Predicted PPV 5% steady state	Predicted PPV 50% start up and run down	Predicted PPV 5% start up and run down
R01	110	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.0	0.0	0.1
R02	100	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.1	0.0	0.1
R03	250	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.0	0.0	0.0
R04	58	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.1	0.1	0.2

Of the construction activities proposed, the surfacing of the road using a vibratory roller has the potential to give rise to the highest vibration levels at nearby receptors. However, calculations show that vibration levels at the nearest receptors were below the 1.0 mm/s threshold from BS5228-2 therefore were not predicted to be significant.

Operational Phase

The proposals for XC201 Thomastown realign the road by around 100m to the south-west of the existing road. Table 10.18 shows the predicted noise levels at the four representative receptors shown on Volume 4, Figure 10.2.

Table 10.18: Predicted noise levels for Do-Minimum and Do-Something scenarios at XC201 Thomastown

Receiver Location ID	Opening Year 2022				Design Year 2037			
	Predicted Noise Levels			Mitigation Required?	Predicted Noise Level			Mitigation Required?
	Do-Minimum	Do-Something	Noise change opening year		Do-Minimum	Do-Something	Noise change design year	
	L_{den}	L_{den}	L_{den}		L_{den}	L_{den}	L_{den}	
R01	48	48	0	No	48	48	0	No
R02	49	49	0	No	49	49	0	No
R03	53	53	0	No	53	53	0	No
R04	46	46	0	No	46	46	0	No

In the opening year and the design year the noise change was predicted to be 0 at all the representative receptors therefore the magnitude of impact is negligible. Also, noise levels at the receptors do not exceed the design goal of 60dB Lden therefore no mitigation is required. It should also be noted that if the project proceeds and the road/rail interface is removed it will mean less idling traffic at level crossings.

XC209 Ballyhay

Do Nothing

If the proposed Project does not go ahead, traffic volumes are predicted to increase in line with natural traffic growth and the noise environment is expected to remain similar to the baseline.

Construction Phase

The proposed Project involves installing CCTV to replace the manned level crossing therefore minimal construction is expected to occur and noise is not expected to be an issue during the CCTV conversion.

Operational Phase

As the project involves installing CCTV to replace the manned level crossing no changes to traffic volumes are expected therefore noise levels are not predicted to change in either the short term or the long term.

There is a warning alarm associated with the proposed CCTV level crossing. Warning alarms are required at all level crossings so that pedestrians approaching the crossing are given adequate warning of the closure of the crossing. The alarm is expected to sound for around one minute and can be sounded any time night or day. There is one noise sensitive receptor within 50m of the crossing and the warning alarm may cause annoyance at this receptor. According to the 'Guidelines for The Design of Railway Infrastructure and Rolling Stock' where audible warnings may cause a disturbance to local residents the warning may stop or continue at a reduced volume when the barriers are fully lowered. There is an existing warning alarm associated with this level crossing therefore any noise levels from the proposed warning alarm should be similar to the existing warning alarm.

XC211 & XC212 Newtown and Ballycoskery

Do Nothing

If the proposed Project does not go ahead, traffic volumes are predicted to increase in line with natural traffic growth and the noise environment is expected to remain similar to the baseline.

Construction Phase

There are noise sensitive receptors within 300m of the sites which are likely to experience an increase in noise levels during construction. Therefore, there is the potential for temporary noise and vibration impacts during the construction phase.

Table 10.19 shows the predicted construction noise levels at representative receptors closest to the proposed sites as shown on Volume 4 Figure 10.4.

Table 10.19: Construction noise predicted levels at XC211 & XC212 Newtown and Ballycoskery

Receiver Location ID	Baseline noise levels dB L_{Aeq}	Predicted noise levels at each phase of the works dB $L_{Aeq,10h}$ (Total noise levels baseline + predicted are in italics)					
		XC211 Phase 1	XC211 Phase 2	XC211 Phase 3	XC212 Phase 1	XC212 Phase 2	XC212 Phase 3
R05	59	**70 *(70)***	**74 *(74)***	66 *(67)*	46 *(59)*	44 *(59)*	50 *(60)*
R06	60	53 *(61)*	**57 *(62)***	49 *(60)*	**82 *(82)***	**80 (80)**	**86 *(86)***
R07	54	50 *(55)*	54 *(57)*	46 *(55)*	**73 (73)**	**71 (71)**	**77 *(77)***
R08	60	53 *(61)*	57 *(62)*	49 *(60)*	**86 *(86)***	**84 *(84)***	**90 *(90)***

At R05 noise levels during construction of site XC211 Newtown were predicted to be above 65dB during all three phases and total noise exceeds the baseline level by 5dB. Noise during construction is expected to be significant during Phases 1 and 2 of the works but they are not expected to be significant during Phase 3 of the works because the construction period is relatively short compared to the first two phases.

For R06, R07 and R08 significant adverse noise effects were predicted during all three phases of XC212 Ballycoskery due to the predicted noise levels being well above the baseline levels and the length of time of the construction works. Due to this mitigation measures are required. It should be highlighted that R08 is Ballyhea National School which would only be affected during school opening hours i.e. from 9.00 am to 3.00 pm Monday to Friday during term time.

Table 10.20 below presents the predicted vibration levels at the receptors.

Table 10.20: Construction vibration predicted levels at XC211 & XC212 Newtown and Ballycoskery

Receptor	Distance (m)	Activity	Plant	Predicted PPV 50% steady state	Predicted PPV 5% steady state	Predicted PPV 50% start up and run down	Predicted PPV 5% start up and run down
R05	45	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.2	0.1	0.2
R06	20	Vibratory Rolling	Bomag BW 190 AD-5	0.1	0.5	0.2	0.6
R07	50	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.1	0.1	0.2
R08	14	Vibratory Rolling	Bomag BW 190 AD-5	0.2	0.9	0.4	1.0

Of the construction activities proposed, the surfacing of the road using a vibratory roller has the potential to give rise to the highest vibration levels at nearby receptors. Calculations show that steady state and start up and run-down vibration levels do not exceed the 1.0 mm/s threshold at any receptors.

Operational Phase

The proposed alignment for XC211 Newtown links two unnamed roads to the east of the railway line so there is potential for an increase in traffic noise levels at receptors in in close proximity to the road. The proposals for

XC212 Ballycoskery realign the road to the south of the existing road by around 30m, thereby potentially reducing noise levels at receptors in this area which includes Ballyhea National School.

Table 10.21 shows the predicted noise levels for XC211 and XC212 Newtown and Ballycoskery.

Table 10.21: Predicted noise levels for Do-Minimum and Do-Something scenarios at XC211 & XC212 Newtown and Ballycoskery

Receiver Location ID	Opening Year 2022				Design Year 2037			
	Predicted Noise Levels			Mitigation Required?	Predicted Noise Level			Mitigation Required?
	Do-Minimum	Do-Something	Noise change opening year		Do-Minimum	Do-Something	Noise change design year	
	L_{den}	L_{den}	L_{den}		L_{den}	L_{den}	L_{den}	
R05	48	48	0	No	48	48	0	No
R06	57	53	-4	No	57	53	-4	No
R07	61	61	0	No	61	61	0	No
R08	58	54	-4	No	59	55	-3	No

In the opening year and design year receptors R06 and R08 (Ballyhea National School) were predicted to experience a decrease in noise levels due to the realigned road moving traffic slightly further from these receptors. For the same reason most receptors in Beechwood Drive were predicted to experience a decrease in noise levels as a result of the scheme. Receptors R05 and R07 were predicted to experience no change in noise levels in the opening year and design year. No receptors were predicted to meet the criteria for requiring mitigation. It should also be noted that if the project proceeds and the road/rail interface is removed it will mean less idling traffic at level crossings.

XC215 Shinanagh

Do Nothing

If the proposed Project does not go ahead, traffic volumes are predicted to increase in line with natural traffic growth and the noise environment is expected to remain similar to the baseline.

Construction Phase

There are noise sensitive receptors within 300m of the proposed Project which are likely to experience an increase in noise levels during construction. Therefore, there is the potential for temporary noise and vibration impacts during the construction phase.

Table 10.22 shows predicted construction noise levels at representative receptors close to the proposed scheme as shown on Volume 4 Figure 10.5. The levels in bold indicate where significant noise effects were predicted i.e. where construction noise levels exceed 65dB and total noise levels exceeds the baseline levels by 5dB or more, and the noise level is exceeded for a period of one month or more.

Table 10.22: Construction noise predicted levels at XC215 Shinanagh

Receiver Location ID	Distance from scheme (m)	Baseline noise levels dB L_{Aeq}	Predicted noise levels at each phase of the works dB $L_{Aeq,10h}$ (Total noise levels baseline + predicted are in italics)		
			Phase 1	Phase 2	Phase 3
R09	90	67	62 *(68)*	***66 (70)***	58 *(71)*
R10	40	56	***71 (71)***	65 *(66)*	67 *(67)*
R11	30	54	***74 (74)***	***78 (78)***	70 *(70)*
R12	230	54	52 *(56)*	56 *(58)*	48 *(55)*

At R09 the noise effect was predicted to be significant during Phase 2 of the works only while at R10 the effects were predicted to be significant during Phase 1 only. At R10 the predicted noise levels during Phase 3 of the works was 67dB, though the effects were not considered to be significant due to the relatively short duration of this phase of the works.

At R11 the effects were predicted to be significant during Phases 1 and 2, while the effects were not predicted to be significant during Phase 3 of the works due to their relatively short duration. No significant effects were predicted at R12 during construction. Mitigation measures are required to be discussed in Section 10.6.

Table 10.23 presents the predicted vibration levels at the receptors.

Table 10.23: Construction vibration predicted levels at XC215 Shinanagh

Receptor	Distance (m)	Activity	Plant	Predicted PPV 50% steady state	Predicted PPV 5% steady state	Predicted PPV 50% start up and run down	Predicted PPV 5% start up and run down
R09	90	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.1	0.0	0.1
R10	40	Vibratory Rolling	Bomag BW 190 AD-5	0.1	0.2	0.1	0.3
R11	30	Vibratory Rolling	Bomag BW 190 AD-5	0.1	0.3	0.1	0.4
R12	230	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.0	0.0	0.0

Of the construction activities proposed, the surfacing of the road using a vibratory roller has the potential to give rise to the highest vibration levels at nearby receptors. Calculations show that vibration levels at the nearest receptors do not exceed the 1.0 mm/s threshold from BS5228-2. Therefore, vibration impacts were not expected at this location.

Operational Phase

Table 10.24 shows the predicted noise levels at XC215 Shinanagh.

Table 10.24: Predicted noise levels for Do-Minimum and Do-Something scenarios at XC215 Shinanagh

Receiver Location ID	Opening Year 2022				Design Year 2037			
	Predicted Noise Levels			Mitigation Required?	Predicted Noise Level			Mitigation Required?
	Do-Minimum	Do-Something	Noise change opening year		Do-Minimum	Do-Something	Noise change design year	
	L_{den}	L_{den}	L_{den}		L_{den}	L_{den}	L_{den}	
R09	65	65	0	No	65	65	0	No
R10	54	59	+5	No	55	59	+5	No
R11	55	55	0	No	55	56	+1	No
R12	50	50	0	No	50	50	0	No

In the opening year and the design year the proposed Project was predicted to result in an increase in noise levels at receptor R10. This is due to the realignment causing a redistribution of traffic within the local road network thereby increasing the traffic volumes on local roads.

At receptors R09, R11 and R12, no change in noise levels was predicted in the opening year. In the design year noise levels were predicted to increase between the Do-Something design year and the Do-Minimum Opening Year at R10 and R11. The reason for the increase is twofold: natural traffic growth and redistribution of traffic within the local road network. It should also be noted that if the project proceeds and the road/rail interface is removed it will mean less idling traffic at level crossings.

XC219 Buttevant

Do Nothing

If the proposed Project does not go ahead, traffic volumes are predicted to increase in line with natural traffic growth and the noise environment is expected to remain similar to the baseline.

Construction Phase

There are noise sensitive receptors within 300m of the proposed Project which are likely to experience an increase in noise levels during construction. Therefore, there is the potential for temporary noise and vibration impacts during the construction phase.

Table 10.25 shows the predicted construction noise levels at representative receptors close to the proposed Project as shown on Volume 4 Figure 10.6. The levels in bold indicate where significant noise effects were predicted i.e. where construction noise levels exceed 65dB and total noise level exceeds baseline noise levels by more than 5dB, and the works last for a period of one month or more.

Table 10.25: Construction noise predicted levels at XC219 Buttevant

Receiver Location ID	Distance from scheme (m)	Baseline noise levels dB L_{Aeq}	Predicted noise levels at each phase of the works dB $L_{Aeq,10h}$ (Total noise levels baseline + predicted are in italics)		
			Phase 1	Phase 2	Phase 3
R13	60	69	71 *(73)*	**69 *(72)***	**75 *(76)***
R14	50	69	73 *(74)*	71 ***(73)***	**77 *(78)***
R15	40	68	75 *(76)*	**73 *(74)***	**79 *(79)***
R16	125	68	63 *(69)*	61 *(69)*	67 *(71)*

At R15 construction noise was predicted to be significant during Phase 2 and 3 of the works but not during Phase 1 because this phase is relatively short in duration. At R13 and R14 construction noise was predicted to be significant during Phase 3 of the works only. At R16 effects during construction were not predicted to be significant.

As a result of the significant effects during construction, mitigation measures are required.

Table 10.26 presents the predicted vibration levels at the receptors.

Table 10.26: Construction vibration predicted levels at XC219 Buttevant

Receptor	Distance (m)	Activity	Plant	Predicted PPV 50% steady state	Predicted PPV 5% steady state	Predicted PPV 50% start up and run down	Predicted PPV 5% start up and run down
R13	60	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.1	0.1	0.2
R14	50	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.1	0.1	0.2
R15	40	Vibratory Rolling	Bomag BW 190 AD-5	0.1	0.2	0.1	0.3
R16	125	Vibratory Rolling	Bomag BW 190 AD-5	0.0	0.0	0.0	0.1

Of the construction activities proposed, the surfacing of the road using a vibratory roller has the potential to give rise to the highest vibration levels at nearby receptors. Calculations show that vibration levels do not exceed the 1.0 mm/s threshold from BS5228-2 at any receptors.

Operational Phase

Table 10.27 shows the predicted noise levels for XC219 Buttevant.

Table 10.27: Predicted noise levels for Do-Minimum and Do-Something scenarios at XC219 Buttevant

Receiver Location ID	Opening Year 2022				Design Year 2037			
	Predicted Noise Levels			Mitigation Required?	Predicted Noise Level			Mitigation Required?
	Do-Minimum	Do-Something	Noise change opening year		Do-Minimum	Do-Something	Noise change design year	
	L_{den}	L_{den}	L_{den}		L_{den}	L_{den}	L_{den}	
R13	54	54	0	No	54	54	0	No
R14	65	64	-1	No	65	65	0	No
R15	60	57	-3	No	60	57	-3	No
R16	62	62	0	No	62	62	0	No

In the opening year the noise levels were not predicted to change at all the receptors except for R14 and R15 which was predicted to result in a decrease in noise levels (i.e. respectively a negligible beneficial impact and a moderate beneficial impact) due to the proposed crossing moving the traffic further away from these receptors. In the Design Year receptor R15 was predicted to experience a decrease in noise levels. This represents a long-term permanent decrease in noise levels as a result of the scheme. The other receptors were predicted to experience no change in noise levels in the design year. It should also be noted that if the project proceeds and the road/rail interface is removed it will mean less idling traffic at level crossings.

10.6.3 Combined Effects of all Sites

There are no combined effects in relation to the Do Nothing and the Operational phases. However, there is the potential for an increase in combined noise effects during construction in relation to XC211 Newtown and XC212 Ballycoskery due to their proximity to each other.

10.7 Mitigation Measures

This sets out measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, identify any proposed monitoring arrangements. This explains the extent to which significant adverse effects on the environment are avoided, prevented, reduced or offset.

10.7.1 Construction Phase

Noise

The potential for adverse and significant adverse noise effects during the construction phase have been identified at the following locations:

- XC201 Thomastown;
- XC211 Newtown and XC212 Ballycoskery;
- XC215 Shinanagh; and
- XC219 Buttevant.

It should be noted that the construction assessment performed is based on plant / equipment and working methods given at the time of writing. The construction methodology may change and it is up to the appointed contractor to ensure that any change in methodology can still achieve the noise impacts presented in this EIAR or better.

All work would be undertaken to the guidance detailed in BS 5228-1 and BS 5228-2. It is anticipated that the following mitigation measures would be employed on site to ensure that noise levels are adequately controlled (all of which are considered to be examples of Best Practicable Means (BPM)):

- Appropriate selection of plant and equipment, construction methods and programming. Only plant conforming with or better than relevant national or international standards, directives or recommendations on noise or vibration emissions would be used. Construction plant would be maintained in good condition with regards to minimising noise and vibration emission;
- The appointed contractor should obtain Prior Consent from the Environmental Departments at both Limerick and Cork County Councils prior to undertaking particularly noisy or high vibratory works;
- The contractor should communicate to local residents, details of the construction programme together with notice of any particularly noisy works. Liaison with Ballyhea National School is important due to the high construction noise levels predicted here;
- Plant would be operated and maintained appropriately, with due regard for manufacturer recommendations. All vehicles, plant and equipment would be switched off when not in use;
- Use of appropriate noise abatement site hoardings and screens, where appropriate, particularly at XC212 Ballycoskery and XC219 Buttevant where noise levels during construction were predicted to be over 90 dB at the closest receptors. Where noise screens are not practicable then noise insulation in the form of additional glazing at individual properties should be considered;
- Where practicable, gates (to compounds and construction areas) would not be located opposite noise sensitive receptors;
- Careful selection of routes and programming for the transport of construction materials, spoil and personnel so as to reduce the risk of increased noise and vibration impacts during construction;
- Vehicle and mechanical plant/ equipment used for the purpose of the works should be fitted with effective exhaust silencers, to be maintained in good working order and operated in such a manner so as to minimise noise emissions;
- The positioning of construction plant and activities to minimise noise at sensitive locations;
- Equipment that breaks concrete by pulverising or similar, rather than by percussion, would be used where practicable;
- Mufflers shall be used on pneumatic tools;
- The use, where necessary, of effective sound reducing enclosures;
- Establish agreement with the local authorities on appropriate controls for undertaking significantly noisy works or vibration-causing operations close to receptors;
- Programming works so that the requirement for working outside normal working hours is minimised; and
- It would be expected that the appointed contractor shall endeavour to undertake construction works between the following hours:
    - 08:00 to 18:00 Monday to Friday; and
    - 08:00 to 13:00 on Saturdays.

Some limited night-time and / or weekend working may be required on occasion for activities such as tie in works or structural works at the bridge structures. The night-time and weekend periods are more sensitive than daytime, as baseline noise levels are lower during these periods. Significant effects are more likely during such periods; therefore, night time and weekend working should be minimised. Where works during such periods are required, the appointed contractor should consider obtaining Prior Consent from the Environmental Departments at Limerick and Cork County Councils prior to undertaking such works. In order to achieve this, the appointed contractor should demonstrate that BPM has been applied to the required works and potential significant effects have been mitigated as much as reasonably practicable.

If feasible the noisiest construction activities at XC212 Ballycoskery should be undertaken during school holidays due to the presence of Ballyhea National School. Good communication with the school is particularly important to agree working times and programme due to the high construction noise levels predicted.

Vibration

No significant vibration effects were predicted during the operational phase therefore no mitigation is required.

10.7.2 Operational Phase

No significant noise effects were predicted during the operational phase therefore no mitigation is required.

10.7.3 Residual Effects

There are no remaining residual effects.

10.8 Interactions

Interactions between the seven sites was addressed during the primary assessment and there are no further interactions required. The main interaction is that the XC211 Newtown and XC212 Ballycoskery sites are to be considered as one site due to their close proximity to each other.

10.9 Cumulative Effects

The M20 Cork to Limerick Road Improvement Scheme is currently at the Phase 2 Options selection stage with completion of this stage and the identification of a preferred option expected in 2021.

The N20 is close to some of the schemes, particularly XC211 Newtown & XC212 Ballycoskery as well as XC215 Shinanagh. The M20 scheme is likely to result in noise changes greater than those assessed in this commission. Therefore, it is important that once the preferred option is selected the implications for this scheme should be considered.

10.10 Difficulties Encountered in Compiling Information

There were no difficulties encountered in compiling information for this chapter.

10.11 References

National Roads Authority (NRA) Guidelines for the Treatment of Noise and Vibration in National Roads Schemes (TII (formerly NRA)) 2004.

Good Practice for the Treatment of Noise during the Planning of National Road Schemes (TII (formerly NRA)) 2014.

ISO 1996-1:2016: Acoustics – Description, Measurement and Assessment of Environmental Noise – Part 1: Basic Quantities and Assessment Procedures

BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 1: Noise (BSI, 2014)

BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration (BSI, 2014)

BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration

Design Manual for Roads and Bridges (DMRB) LA111 Noise and Vibration (Highways England, November 2019

Calculation of Road Traffic Noise (CRTN). London: Her Majesty's Stationery Office (Department for Transport and the Welsh Office 1988)

Environmental Noise Regulations 2006 (S.I. 140)1 of 2

Environmental Noise Guidance for Local Authority Planning & Enforcement Departments. Association of Acoustic Consultants of Ireland June 2019

Control of Pollution Act (CoPA), United Kingdom 1974.

Guidelines for The Design of Railway Infrastructure and Rolling Stock - Section 5 Level Crossings. Commission for Railway Regulation August 2008.