Department for Regional Development - TransportNI

YORK STREET INTERCHANGE

Public Inquiry

November 2015

Proof of Evidence:

Noise and Vibration

by

Alfred Maneylaws

Alfred Maneylaws BSc (Hons) MSc MIOA
URS
Beechill House
40 Beechill Road
Belfast
BT8 7RP

THIS PAGE INTENTIONALLY BLANK

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY BLANK

1. INTRODUCTION

1.1 Introduction

1.1.1.1 My name is Alfred Maneylaws and I am an Associate with URS, Consulting Engineers. My academic qualifications comprise a BSc (Hons) in Mechanical Engineering and an MSc in Applied Acoustics. I am a Corporate Member of the Institute of Acoustics and have over twenty seven years' experience in the acoustics field.

1.1.1.2 URS was acquired by AECOM in October, 2014. Together AECOM and URS are one of the world's premier, fully integrated infrastructure and support services firms. For the purpose of this Proof of Evidence, any reference to URS may include reference to its former legacy companies, including Scott Wilson.

1.1.1.3 During my employment with URS I have completed noise and vibration impact assessments for a broad range of projects covering road schemes, rail schemes, industrial and mining developments, and commercial developments. In particular, I have provided assessments for a number of major road schemes including the A30 Bodmin to Indian Queens Improvement, the A47 Blofield to North Burlingham Improvement, the A46 Newark to Widmerpool Improvement, the A421 M1 to Bedford Improvement, the A5-M1 Link, the M3 J2 to 4a SMART motorway and the M4 J3 to 12 SMART motorway.

1.1.1.4 I am responsible for the noise and vibration impact assessment and the resulting noise and vibration chapter of the Environmental Statement for the Proposed Scheme.

1.2 Scope and Structure of the Evidence

1.2.1.1 The purpose of the evidence is to present the findings of the noise and vibration impact assessment for the Proposed Scheme.

1.2.1.2 The evidence is drawn on data produced for the Traffic Assessment, to enable the assessment of noise from traffic on the Proposed Scheme and other public roads; and also material contained within the Environmental Statement dated January 2015 (DRD-YSI-4-04).

1.2.1.3 The structure of the evidence is as follows:

- Section 2: Methodology.
- Section 3: Baseline Conditions.
- Section 4: Scheme Design and Mitigation.
- Section 5: Effects of the Proposed Scheme.
- Section 6: Conclusions.

1.2.1.4 Material abstracts from the Environmental Statement have been appended as required.

2. METHODOLOGY

2.1 Methodology

2.1.1.1 Terminology and noise perception information relevant to the noise and vibration assessment are provided in Appendix A.

2.2 The DMRB Assessment Procedure

2.2.1.1 The Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 7: 2011 (DRD-YSI-6-07) provides a procedure for the assessment of the noise and vibration impacts resulting from a new or altered highway.

2.2.1.2 The procedure for the assessment of noise and vibration impacts from road schemes is split into three stages, as set out in the DMRB:

- 'Scoping' to determine whether the project has the potential to cause a change to the receiving environment which could result in noise and vibration impacts, and to determine the likely extent of any assessment and to identify sensitive receptors;
- 'Simple' assessment of noise and vibration impacts at dwellings and other sensitive receptors; and
- 'Detailed' assessment of noise and vibration impacts at dwellings and other sensitive receptors.

2.2.1.3 The decision tree provided in Figure A1.1 of the DMRB has been employed to determine the level at which the Proposed Scheme should be assessed. Based on the following effects of the Proposed Scheme, the assessment has proceeded straight to the 'Detailed' stage:

- the project will alter the line or level of the carriageway;
- the project will cause a change in traffic flows;
- there are other changes to the infrastructure which maycause a change in noise level;
- there are dwellings within 1 kilometre that may be subject to a change in noise/vibration level; and
- it is clearly evident that the project will result in noise and vibration changes greater than the threshold levels.

2.2.1.4 At the 'Detailed' assessment stage, the study area for the traffic noise impact assessment is defined in DMRB as follows:

- the study area includes the Proposed Scheme and all surrounding existing roads that are predicted to be subject to a change in traffic noise levels of:
  - 1dB(A) or more in the short-term; or
  - 3dB(A) or more in the long-term as a result of the Proposed Scheme.
  - These road links are defined as 'affected routes' and are identified by analysis of traffic data which have been prepared as part of the traffic and economic assessment of the Proposed Scheme.
- the study area for the detailed quantitative assessment of noise impacts comprises a corridor 600m either side of the Proposed Scheme and 600m either side of all affected routes within 1 km of the Proposed Scheme.
- for dwellings and other sensitive receptors that are within 1km of the Proposed Scheme, but more than 600m from an affected route, a qualitative assessment of the noise and vibration impacts is carried out.
- for affected routes which are outside the 1km boundary from the Proposed Scheme, an assessment is undertaken by estimating the Calculation of Road Traffic Noise (CRTN) Basic Noise Level for these routes, with and without the Proposed Scheme. A count of the number of dwellings and other sensitive receptors within 50m of these links is undertaken.

2.2.1.5 Traffic data were available from the traffic model developed for the operational and economic assessment of the Proposed Scheme. The extent of the modelled network was developed to include those areas where there was likely to be significant changes in traffic flows. Therefore, traffic flows on the road network outside of the modelled area are unlikely to change significantly.

2.2.1.6 Guidance contained in DMRB, Volume 11, Section 3, Part 7: 2011, Annex 1, paragraph A1.12 states that:

"In determining the study area, consultation with traffic engineers will be required to determine the traffic model extent. In some circumstances, this may result in a reduced study area to that outlined in A1.11."

2.2.1.7 Consequently, the detailed study area has been defined as a 400m buffer around the Proposed Scheme, with no affected routes outside of this study area. The detailed study area is shown in Figure 13.1 of the Environmental Statement, reproduced in Appendix C.

2.3 Operational Noise

2.3.1 Impact Assessment Methodology

2.3.1.1 Noise from the flow of road traffic is generated by both vehicles' engines and the interaction of tyres with the road surface. The traffic noise level at a receptor, such as an observer at the roadside or residents within a property, is influenced by a number of factors including traffic flow, speed, composition (% Heavy Duty Vehicle (HDV)), gradient, type of road surface, distance from the road and the presence of any obstructions between the road and the receptor.

2.3.1.2 Noise from a stream of traffic is not constant; therefore, to assess the noise impact a single figure estimate of the overall noise level is necessary. The index adopted by HM Government in the CRTN (Department of Transport Welsh Office, 1988) (DRD-YSI-6-10) to assess traffic noise is the $L_{A10,18h}$. This value is determined by taking the highest 10% of noise readings in each of the eighteen 1-hour periods between 06:00 and 00:00 (midnight), and then calculating the arithmetic mean. A reasonably good correlation has been shown to exist between this index and residents' perception of traffic noise over a wide range of exposures.

2.3.1.3 CRTN provides the standard methodology for predicting the $L_{A10,18h}$ road traffic noise level. Noise levels are predicted at a point 1m measured horizontally externally from the façade of the building.

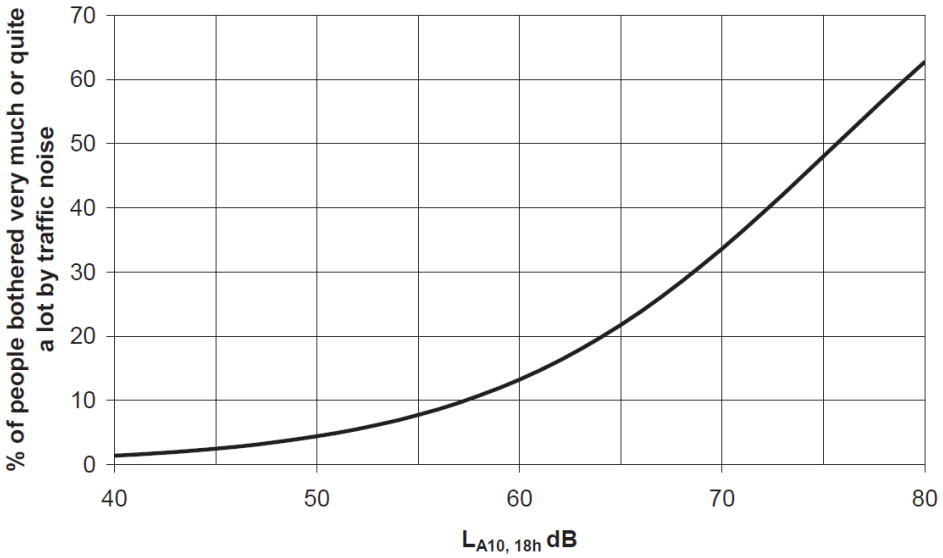
2.3.1.4 The DMRB also requires an assessment of night time traffic noise levels ($L_{night,outside}$). However, this parameter is not predicted by the standard CRTN methodology. The $L_{night,outside}$ levels have been estimated from the $L_{A10,18h}$ traffic noise levels, with a -2.5dB correction to convert from façade to free-field levels.

2.3.1.5 Once the traffic noise level has been predicted it can be used to provide an indication of the likely annoyance to residents, though individuals vary widely in their response to the same level of traffic noise. However, the average or community response from a large number of

people to the same level of traffic noise is fairly stable, therefore, a community average degree of bother caused by traffic noise can be related to the long-term steady state noise level.

2.3.1.6 The DMRB illustrates the relationship between the steady state traffic noise level and the estimated annoyance experienced, expressed as the percentage of people 'bothered very much or quite a lot' is illustrated in Figure 1 (taken from DMRB 11.3.7 Annex 6). This shows, for example, that approximately 13% of all residents would be 'bothered very much or quite a lot' at a façade road traffic noise level of 60dB $L_{A10,18h}$.

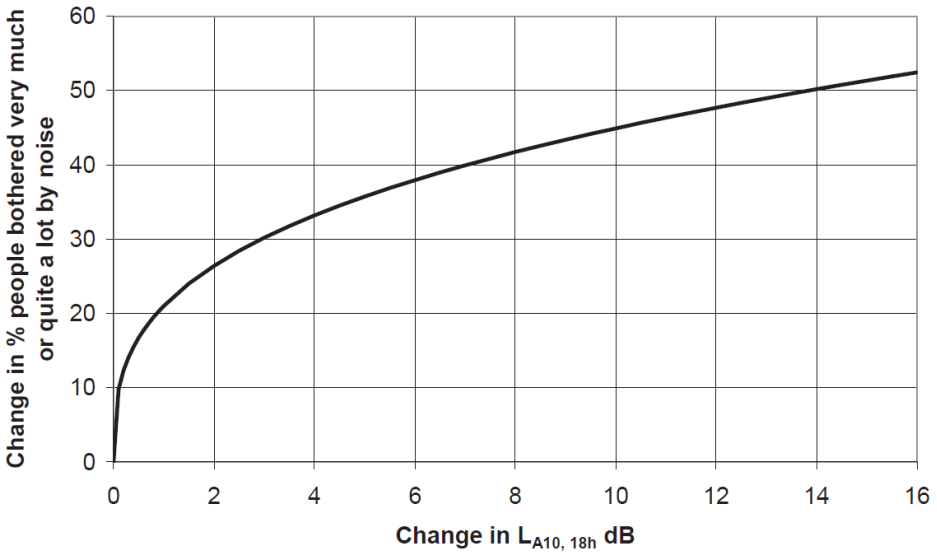
Figure 1: Estimation of Traffic Noise Nuisance – Steady State



Source: DMRB 11.3.7, Annex 6, pp. A6/1

2.3.1.7 In addition, research has shown that people are more sensitive to abrupt changes in traffic noise, for example following the opening of a new road, than would be predicted from the steady state relationship between traffic noise and nuisance described above (Huddart, L. and Baughan, C. J. (1994), Griffiths, I. D. and Raw, G, J. (1986)). These effects last for a number of years, however, in the longer term the perceived noise nuisance tends towards the steady state level due to familiarisation. The percentage change in the traffic noise nuisance due to an abrupt change in the traffic noise is illustrated in Figure 2 (taken from DMRB 11.3.7 Annex 6).

Figure 2: Estimation of Traffic Noise Nuisance – Immediate Change



Source: DMRB 11.3.7, Annex 6, pp. A6/3

2.3.1.8 Figure 2 shows, for example, that with an abrupt (and permanent) increase of 10dB(A) there would be a net change of 45% of residents 'bothered very much or quite a lot' by road traffic noise. If the initial noise level was 60dB $_{LA10,18h}$ (with 13% people already bothered) then there would be a total of 58% bothered immediately after an increase to 70dB $L_{A10,18h}$. This would eventually diminish in the long-term due to familiarisation to become approximately 34% bothered (Figure 1).

2.3.1.9 The objective of the assessment, as set out in the DMRB 11.3.7, is to gain an overall appreciation of the noise and vibration climate, with (Do-Something) and without (Do-Minimum) the Proposed Scheme. These scenarios are assessed for the baseline year (the assumed year of opening) and the future assessment year (15th year after opening). The following steps have been carried out for the 'Detailed' assessment stage:

- identify the study area and predict 18-hour (06:00-00:00) and night-time (23:00-07:00) traffic noise levels at all residential properties within 400m of the Proposed Scheme and affected routes. Predictions are required for the Do-Minimum and Do-Something scenarios in the assumed year of opening (2021) and 15th year after opening (2035);

- carry out the following comparisons for each relevant receptor in order to identify the numbers of properties which would experience an increase or decrease in traffic noise levels and annoyance:
  - the Do-Minimum scenario in the baseline year against the Do-Minimum scenario in the future assessment year (long-term) (2021 Do-Minimum vs 2035 Do-Minimum);
  - the Do-Minimum scenario in the baseline year against the Do-Something scenario in the baseline year (short-term) (2021 Do-Minimum vs 2021 Do-Something); and
  - the Do-Minimum scenario in the baseline year against the Do-Something scenario in the future assessment year (long-term) (2021 Do-Minimum vs 2035 Do-Something).
  - For night time traffic noise levels, only the above long-term comparisons are required for receptors where the $L_{night,outside}$ level would be 55dB(A) or more in the relevant scenarios.
- assess the impact on sensitive receptors, other than residential properties, within the 400m study area. This is based on 18-hour (06:00-00:00) traffic noise levels and considers the same three comparisons as outlined above for residential properties. Other sensitive receptors considered include hospitals, schools, community facilities (such as places of worship), designated areas (i.e. Areas of Outstanding Natural Beauty , National Parks, Special Areas of Conservation , Special Protection Areas and Areas of Special Scientific Interest), Scheduled Ancient Monuments and Public Rights of Way; and
- complete a qualitative assessment of sensitive receptors which are within 1km of the Proposed Scheme but more than 400m from the interchange and significant links.

2.3.1.10 Different façades of the same property can experience different changes in traffic noise level depending on their orientation to the noise source. DMRB 11.3.7 requires that each of the above comparisons of traffic noise levels are based on the façade that would experience the worst case change (i.e. the largest increase, or, if all façades experience a decrease, the smallest decrease). Additionally, DMRB 11.3.7 requires that the above comparisons of annoyance use the highest levels of annoyance in the first 15 years. For properties that would experience an increase in noise due to the Proposed Scheme, the highest levels of annoyance are likely to be experienced immediately after opening (Figure 2). For properties that would experience a decrease (and also in the Do-Minimum comparison), the greatest annoyance is the steady state level of annoyance in the long-term (Figure 1).

2.3.2 **Assessment of Operational Noise**

2.3.2.1 The impact of traffic noise is assessed with reference to the Noise Insulation Regulations (Northern Ireland) 1995 (the Regulations). The Regulations seek to determine the impact of noise from any new or altered road. Residential properties may qualify for an offer of noise insulation under the Regulations if all four of the following conditions are satisfied:

- the property must be within 300m of the nearest point on the carriageway of the road after construction;
- the façade noise level due to road traffic on any highway (the 'relevant' noise level) for the design year, or for any intervening year if noisier, must equal or exceed 68dB $L_{A10,18h}$ (the 'specified' level), with levels of 67.5dB $L_{A10,18h}$ rounded upwards;
- the 'relevant' noise level for the design year, or for any intervening year if noisier, must be at least 1dB $L_{A10,18h}$ higher than the pre-construction year road traffic noise level; and
- noise from the new or altered road must contribute at least 1dB $L_{A10,18h}$ to the 'relevant' noise level.

2.3.2.2 TransportNI has a duty under the Regulations to offer insulation for residential properties with respect to a new road, and discretionary powers in relation to altered roads. Various discretionary powers are also available in relation to façades or parts of façades contiguous with the qualifying façade. The Regulations apply to habitable rooms and so precludes bathrooms, toilets, halls and usually kitchens.

2.3.2.3 Some residential buildings are not eligible under the Regulations. These include clearance areas and any building which was first occupied after the 'relevant date' (the date a new road was first opened to public traffic or an altered road was opened following completion of the alteration). Buildings for which a Condition was attached to their planning permission requiring insulation against traffic noise are also not eligible. Furthermore, the Regulations do not apply to any buildings for which a planning application was lodged with PlanningNI or which was constructed after the date of publication of the TransportNI proposal to construct a road, altered road or additional carriageway as indicated:

- in a draft Order referred to in a notice published in accordance with Paragraph 1 of Schedule 8 to the Roads (Northern Ireland) Order 1993 or an Order made under Articles 4(1), 14(1) or 15(1) of that Order; or

- in a development plan or draft development plan published in accordance with Part III of the Planning (Northern Ireland) Order 1991.

2.3.2.4 DMRB 11.3.7.3 provides two classifications for the magnitude of noise impact associated with the Proposed Scheme (as shown in Tables 1 and 2). These relate to short-term changes in noise levels and long-term changes in noise levels respectively.

Table 1: Classification of Magnitude of Operational Traffic Noise Impacts in the Short Term

Noise Change (dB)	Magnitude
0	No Change
0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
≥ 5	Major

Source: DMRB 11.3.7.3, Table 3.1, pp. 3/5

Table 2: Classification of Magnitude of Operational Traffic Noise Impacts in the Long Term

Noise Change (dB)	Magnitude
0	No Change
0.1 – 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
≥ 10	Major

Source: DMRB 11.3.7.3, Table 3.2, pp. 3/5

2.3.2.5 A change in road traffic noise of 1dB in the short term (i.e. when the Proposed Scheme opens) is the smallest that is considered perceptible. In the long term, a 3dB change is considered perceptible.

2.3.2.6 The predicted noise levels at each façade of each residential property have been also used to carry out an initial assessment of the likelihood of any properties qualifying for insulation under the Regulations.

2.4 Operational Vibration

2.4.1 Impact Assessment Methodology

2.4.1.1 Vibration from traffic can be transmitted through the air or through the ground. Airborne vibration is produced by the engines and exhausts of road vehicles, with dominant frequencies typically in the range 50 - 100Hz. Ground borne vibration is produced by the interaction of vehicle tyres and the road surface with dominant frequencies typically in the range 8 - 20Hz. The passage of vehicles over irregularities in the road surface can also be a source of ground borne vibration.

2.4.1.2 Traffic vibration can potentially affect buildings and disturb occupiers. DMRB 11.3.7 reports that extensive research on a wide range of buildings has found no evidence of traffic induced ground borne vibration being a source of significant damage to buildings and no evidence that exposure to airborne vibration has caused even minor damage (Watts, 1990).

2.4.1.3 Airborne vibration is noticed by occupiers more often than ground borne vibration as it may result in detectable vibrations in building elements such as windows and doors.

2.4.1.4 The DMRB states that perceptible vibration only occurs in rare cases and identifies that the normal use of a building, such as closing doors and operating domestic appliances can generate similar levels of vibration to that from traffic.

2.4.1.5 To assess the magnitude of the impact of traffic induced vibration on residents, a parameter is needed which reflects a person's subjective rating of vibration disturbance. DMRB 11.3.7 recommends the use of the $L_{A10,18h}$. The relationship between the $L_{A10,18h}$ and bother due to vibration is similar to that for bother due to steady state traffic noise, as shown on Figure 1, except that the percentage of people bothered by vibration is lower. For a given level of noise exposure, the percentage of people bothered very much or quite a lot by vibration is 10% lower than the corresponding figure for annoyance due to traffic noise. Below 58dB(A) the percentage of people bothered by traffic induced vibration is assumed to be zero.

2.4.1.6 The potential for vibration impacts is limited to the immediate vicinity of a road, and the relationship between bother due to vibration and traffic noise level is based on properties located within 40m of a road. Therefore, at each property within 40m of the Proposed Scheme, and at which traffic noise levels are predicted to be 58dB, $L_{A10,18h}$ or more, the percentage of people likely to be bothered very much or quite a lot by vibration is calculated, based on the annoyance levels in Figure 1, reduced by 10%.

2.5 Construction Noise

2.5.1 Impact Assessment Methodology

2.5.1.1 The noise levels generated by construction activities and experienced by nearby sensitive receptors, such as occupants of residential properties, depends upon a number of variables, the most significant of which are:

- noise generated by plant or equipment used on site, generally expressed as a sound power level;
- periods of operation of plant on the site, known as its 'on-time';
- distance between noise source and receptor; and
- attenuation due to ground absorption and barrier effects.

2.5.1.2 Construction noise level predictions have been based on the methodology provided in BS 5228-1: 2009+A1:2014 '*Code of practice for noise and vibration control on construction and opens sites. Part 1 Noise*' (DRD-YSI-6-11). This standard provides a methodology for the estimation of likely construction noise levels as an equivalent continuous noise level averaged over a suitable assessment period, for example a one-hour period (LAeq,1h).

2.5.1.3 In order to quantify the likely noise from construction works in accordance with the methods and guidance in BS 5228, it is necessary to define the various activities to be undertaken and the equipment to be used, based upon the anticipated programme of work.

2.5.1.4 The magnitude of the impact of construction noise is then quantified by predicting likely construction noise levels at a selection of the closest residential properties to the various construction activities.

2.5.2 Assessment of Construction Noise Significance

2.5.2.1 Belfast City Council (BCC) Environmental Health Department provides an advice note (DRD-YSI-6-04) for construction and demolition sites. With regards to noise limits at residential receptors, they state that the following limits may be applicable in certain circumstances:

"Noise from construction activities shall:

- *not exceed 75dB $L_{Aeq,12hr}$ between 07.00 hours and 19.00 hours on Mondays to Fridays, or 75dB $L_{Aeq,5hr}$ between 08.00 hours and 13.00 hours on Saturdays, when measured at any point 1m from any facade of any residential accommodation;*
- *not exceed 65dB $L_{Aeq,1hr}$ between 19.00 hours and 22.00 hours on Mondays to Fridays, or 13.00 hours to 22.00 hours on Saturdays when measured at any point 1m from any facade of any residential accommodation, and*
- *not be audible between 22.00 hours and 07.00 hours on Mondays to Fridays, 22.00 - 08.00 hours on Saturdays, or at any time on Sundays, at the boundary of any residential accommodation. As a guide the total level (ambient plus construction) shall not exceed the pre-construction ambient level by more than 1dB(A). This will not allow substantial noise producing construction activities but other "quiet" activities may be possible. Routine construction and demolition work which is likely to produce noise sufficient to cause annoyance will not normally be permitted between 22.00 hours and 07.00 hours*."

2.5.2.2 The BCC advice note also provides information on construction noise limits for commercial areas. This states that in commercial areas or in close proximity to office accommodation the priority is for workers not to be subjected to noise at a level which causes speech interference (e.g. conversation should not be too difficult with the windows shut). In dealing with complaints it may be necessary for BCC to restrict the hours of operation for noisy equipment such as pneumatic drills, kango hammers and breaking tools. This can be achieved by an informal compromise agreed with the contractor (depending on the nature of the commercial premises, noisy work may be prohibited between 10.00 - 12.00 hours and 14.00 - 16.00 hours) or by serving a legal notice where appropriate. It is recognised that for some offices lunch time may be their most busy period, whilst others may be closed.

2.5.2.3 The significance of construction noise is based on the extent to which the predicted noise level is above BCC's daytime limit at the façade of a sensitive receptor. The criteria shown in Table 3 have been used to assess the impact of construction noise levels.

Table 3: Impact Criteria for Construction Noise

Construction Noise Level Relative to BCC's 75dB Daytime Limit (Façade) (dB)	Severity of Impact
< 1	Negligible
1 to 3	Minor negative
3 to 5	Moderate negative
5 to 10	Major negative
> 10	Substantial negative

2.6 Construction Vibration

2.6.1 Impact Assessment Methodology

2.6.1.1 There are no universally applicable formulae for prediction of the passage of vibration through the ground due to the non-uniform effects of different ground conditions. However, BS 5228-2: 2009+A1:2014 '*Code of practice for noise and vibration control on construction and opens sites. Part 2 Vibration*' (DRD-YSI-6-12) provides a database of measured ground vibration levels for different piling methods and a range of ground conditions along with formulae for estimating vibration levels for different piling methods.

2.6.1.2 Based on the formulae within BS 5228-2 for driven piling, the peak particle velocity has been estimated for the closest sensitive receptor.

2.6.2 Assessment of Construction Vibration Significance

2.6.2.1 Within BCC's advice note on construction it states that:

"Limits on vibration are generally applicable to piling operations only. Human beings are very sensitive to vibration and piling operations are a common source of complaint. Residents are likely to complain when vibration levels are only slightly in excess of perception levels. Sensitivity to vibration varies and peak particle velocities in the range 0.1 - 0.3mm/s equate to the human threshold of vibration perception at frequencies of 1-80Hz. Vibrations above these values can startle, cause annoyance or interfere with work activities as well as give rise to concerns over structural damage."

2.6.2.2 BCC's advice note states:

"The following limits may be applicable in certain circumstances.

- *Vibration from construction activities shall-*
  - "*Not exceed 2.5mm/s peak particle velocity, between 08.00 hours and 19.00 hours on Mondays to Saturdays, when measured on any ground floor structural surface of any noise sensitive premises*", and
  - "*not be perceptible between 19.00 hours and 08.00 hours on Mondays to Saturdays or at any time on Sundays, within any residential accommodation*".

"Note: imperceptibility generally equates to a peak particle velocity of less than 0.15mm/s ppv."

2.6.2.3 Estimated peak particle velocity values have been assessed against the limits in the BCC advice note.

THIS PAGE INTENTIONALLY BLANK

3. BASELINE CONDITIONS

3.1.1.1 Ambient noise levels have been monitored at six locations in the vicinity of the Proposed Scheme:

- Location M1 - representative of the closest residential property to the Westlink/York Street junction on Thomas Street;
- Location M2 - representative of the closest residential property to the Westlink/York Street junction on Molyneaux Street (just off Henry Street);
- Location M3 - representative of the Ramada Hotel (adjacent to the outer ring road) on Talbot Street;
- Location M4 - representative of the closest residential property to York Street on Midland Close;
- Location M5 - representative of the closest residential properties (Stella Maris) on Dock Street/Garmoyle Street; and
- Location M6 - representative of Sinclair Seamen's Presbyterian Church on Corporation Street.

3.1.1.2 The monitoring locations (M1 to M6) are shown in Figure 13.1 of the Environmental Statement, reproduced in Appendix C. These locations were agreed with BCC's Environmental Health Department, and were chosen to gain an understanding of the noise climate within the study area, provide noise limits for construction and to check traffic noise predictions, focussing on some of the closest residential areas to York Street Interchange. The monitoring equipment was installed on publically accessible land near selected properties.

3.1.1.3 Noise measurements were taken during both the daytime and night-time. The daytime measurements conformed to the requirements of the 'shortened measurement procedure' as defined in CRTN. The monitoring procedures adopted also conform to BS 7445: 2003 '*Description and Measurement of Environmental Noise*' (DRD-YSI-6-17).

3.1.1.4 Details of the noise monitoring protocol are provided in the Environmental Statement. A summary of the noise monitoring results, together with the derived (from the measured levels) and calculated values for $L_{A10,18h}$ for the Base Year 2012, is provided as Table B1 included in Appendix B.

3.1.1.5 The dominant noise source noted while on site was road traffic from the surrounding motorways and A-roads. Other noise sources included road traffic on local roads, aircraft and birdsong.

3.1.1.6 The results show a good correlation between the calculated traffic noise levels and the short-term derived $L_{A10,18h}$ noise levels:

- for two locations (M2 & M3) the calculated noise level is within 1dB of the derived noise level;
- for one location (M3) the calculated noise level is within 2dB of the derived noise level;
- for two locations (M5 & M6) the calculated noise level is within 3dB of the derived noise level; and
- for one location (M4) the calculated noise level is within 4dB of the derived noise level.

3.1.1.7 These comparisons provide confidence that the model developed to estimate the noise impacts of the Proposed Scheme is robust and can be employed to accurately quantify the changes in noise levels and nuisance.

4. SCHEME DESIGN AND MITIGATION

4.1 Scheme Design

4.1.1.1 As with any road scheme, the greater the distance between the road and a receptor the lower the traffic noise levels. Barriers arising through the existing topography or the course of the design, such as earth banks and cuttings can restrict the line of sight from the road to the receptor and provide useful noise attenuation. The effects of these are included within the noise modelling and predictions.

4.1.1.2 Additional noise barriers have been specified to provide noise mitigation to groups of properties fronting on to the Westlink section of the Proposed Scheme (as shown in Figure 13.2 of the Environmental Statement, reproduced in Appendix C):

- noise barrier to northbound carriageway of the Westlink: height 1.5m, length 240m; and
- noise barrier to southbound carriageway of the Westlink: height 1.5m, length 285m.

4.1.1.3 Thin Surface Course Systems (TSCS), otherwise known as low noise road surfacing, would also be provided on Interchange links between the Westlink, M2 and M3 and the slip roads from these to the local road network.

4.2 Mitigation Measures to be Adopted during Scheme Construction

4.2.1.1 A range of good site practices would be adopted in order to mitigate construction phase noise and vibration – these would be defined within a Construction Environmental Management Plan (CEMP). It is assumed that the contractor would follow best practicable means to reduce the noise and vibration impact on the local community, including:

- fixed and semi-fixed ancillary plant such as generators, compressors, wood chippers etc. which can be located away from receptors to be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures to be provided for specific items of fixed plant;
- all plant used on site would comply with the EC Directive on Noise Emissions for Outdoor Equipment, where applicable;
- selection of inherently quiet plant where appropriate. All major compressors to be 'sound reduced' models fitted with properly lined and sealed acoustic covers which are kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools to be fitted with mufflers or silencers of the type recommended by the manufacturers;

- all plant used on site would be regularly maintained, paying particular attention to the integrity of silencers and acoustic enclosures;
- machines in intermittent use to be shut down in the intervening periods between work or throttled down to a minimum;
- drop heights of materials from lorries and other plant would be kept to a minimum; and
- adherence to the codes of practice for construction working and piling given in British Standard BS 5228 (DRD-YSI-6-11 / DRD-YSI-6-12) and the guidance given therein for minimising noise and vibration emissions from the site.

4.2.1.2 In order to minimise the likelihood of complaints, BCC and affected residents would be kept informed of the works to be carried out, and of any proposed work outside normal hours. Residents would be provided with a point of contact for any queries or complaints.

5. EFFECTS OF THE PROPOSED SCHEME

5.1 Operation

5.1.1.1 Figure 13.1 of the Environmental Statement, reproduced in Appendix C, shows the Proposed Scheme, the study area and all sensitive receptors within the study area. Noise levels to all properties within the study area were calculated for the following scenarios:

- the Do-Minimum scenario in the baseline year (2021 Do-Minimum);
- the Do-Minimum scenario in the future assessment year (2035 Do-Minimum);
- the Do-Something scenario in the baseline year (2021 Do-Something); and
- the Do-Something scenario in the future assessment year (2035 Do-Something).

5.1.1.2 The calculated noise levels indicate that no residential properties are likely to qualify for treatment under the Noise Insulation Regulations (Northern Ireland) 1995.

5.1.1.3 The resultant noise levels were processed to provide the data for the tables as required by DMRB.

5.1.1.4 The noise and vibration assessment was based on the following:

- The traffic noise predictions are based on the traffic data in terms of the 18-hour annual average weekday traffic (AAWT), the % HDV, and average speed. Traffic projections used in this assessment are based on National Road Traffic Forecast (NRTF) Central Growth predictions, which provide a balanced forecast of overall trends in traffic flows over the longer term and considers the potential for significant developments in and around the area. Nevertheless, there is considerable uncertainty over both short-term and longer-term traffic flows due to the conflicting nature of proposed developments, whether these developments will actually commence, their construction period and their final opening date, ongoing sustainable transport initiatives within the city, and the effects of an already heavily-trafficked and constrained wider network during peak periods.
- With regard to road surfacing, in the baseline year 2021 Do-Minimum and future year 2035 Do-Minimum, no change to existing surfacing has been assumed, which is standard hot rolled asphalt (HRA). However, the Westlink is surfaced with TSCS. Whilst TSCS would be applied on the M2, M3 and the Westlink for the Proposed Scheme, speeds within the 400m study area are below 75km/h and therefore the effect of low noise

surfacing cannot be quantified within the noise modelling work, although there is likely to be a beneficial effect.

- The identification of properties in the study area has been based on latest available LPS mapping and Address Point data.

5.1.1.5 Table B2 included Appendix B shows the short term traffic noise changes resulting from the opening of the Proposed Scheme. Approximately 76% of residential properties are predicted to experience a Negligible increase in noise level, approximately 5% are predicted to experience a Minor increase, approximately 15% are predicted to experience No Change, and approximately 4% experience a Negligible or Minor decrease in short-term noise levels.

5.1.1.6 For non-residential sensitive receptors, approximately 70% would experience a Negligible increase, approximately 14% would experience a Minor increase and approximately 16% would experience No Change in short-term noise levels.

5.1.1.7 As shown in Figure 13.3 of the Environmental Statement, reproduced in Appendix C, the vast majority of the study area would experience a Negligible change in traffic noise levels in the short-term when comparing the Do-Minimum 2021 and Do-Something 2021 scenarios. Minor increases have been identified on Clifton Street, North Queen Street and Corporation Street. A total of 76 residential properties have been identified which would experience a 1.0 to 2.1 dB increase in noise level adjacent to these roads. Buildings front onto Clifton Street, North Queen Street and Corporation Street. These are standard urban roads with pavement and therefore the use of noise barriers, whilst beneficial, would not be feasible.

5.1.1.8 Moderate/Major noise increases have been identified on Northern Road (within Belfast Harbour area), however there are no sensitive receptors on this road link.

5.1.1.9 Since the noise changes would be less than 1dB on the boundary of the study area, it follows that there would be no significant increases beyond the 400m study area.

5.1.1.10 Table B3 included in Appendix B shows the long term traffic noise changes if the Proposed Scheme did not go ahead. All residential and non-residential properties are predicted to experience a Negligible increase in noise level.

5.1.1.11 Figure 13.2 of the Environmental Statement, reproduced in Appendix C, shows the Negligible changes in traffic noise levels in the long-term when comparing the Do-Minimum 2021 and Do-Minimum 2035 scenarios.

5.1.1.12 Table B4 included in Appendix B shows the long term traffic noise changes with the Proposed Scheme in place. The majority of residential and non-residential properties are predicted to experience a Negligible increase in noise level, with a small number experiencing No Change or a Negligible decrease. The maximum increase in noise level at sensitive receptors within the study area in the long-term would be 2.8dB at Clifton House, North Queen Street.

5.1.1.13 Minor/moderate noise increases have been identified on Northern Road (within Belfast Harbour area), however there are no sensitive receptors on this road link.

5.1.1.14 Figure 13.4 of the Environmental Statement, reproduced in Appendix C, shows the changes in traffic noise levels in the long-term when comparing the Do-Minimum 2021 and Do-Something 2035 scenarios.

5.1.1.15 Table B5 included in Appendix B provides the worst case change (within 15 years of Scheme opening) in traffic noise nuisance. Column 3 (Do-Minimum) of the table shows the changes in nuisance if the Proposed Scheme did not go ahead and Column 4 (Do-Something) of the table shows the changes in nuisance if the Proposed Scheme did go ahead.

5.1.1.16 Examination of Table B5 shows that, for the Do-Minimum changes, all residential properties would experience an increase in nuisance. For the Do-Something changes, the situation is similar, with 98% of residential properties experiencing an increase in nuisance or no change, mainly <10% increase, and a small number with a <10% decrease.

5.1.1.17 Table B6 in Appendix B provides the worst case change in traffic vibration nuisance for the Do-Minimum and Do-Something scenarios. A total of 138 residential properties have been identified within 40m of the Proposed Scheme.

5.1.1.18 For the Do-Minimum scenario, 138 properties would experience an increase in vibration nuisance. For the Do-Something scenario, 113 properties experience an increase in vibration nuisance and 25 would experience no change or a decrease in nuisance.

5.1.1.19 Overall, the impact of the Proposed Scheme in terms of traffic noise and vibration is assessed as Negligible.

5.1.1.20 For consistency with other aspects of the Proposed Scheme assessment, the results from a noise assessment based on a high demand traffic scenario have also been calculated and are presented as Tables B7 to B10 inclusive in Appendix B. The high demand scenario includes other significant developments that are not included in the central growth scenario, with an allowance for additional traffic using the strategic Westlink-M2 and Westlink-M3 links following

the provision of the Proposed Scheme. Comparison of the results in Tables B7 to B10 with those in the equivalent Tables B2 to B5 shows that the differences in terms of the impact of the Proposed Scheme are negligible.

5.1.1.21 Noise level change contours are also included for this high demand traffic scenario in Appendix C, These are Figures 13A.2, 13A.1 and 13A.3 of the Environmental Statement.

5.2 Construction

5.2.1.1 The noise impacts of the likely construction activities at six representative receptors have been calculated using BS 5228 (DRD-YSI-6-11 / DRD-YSI-6-12) assessment methodology and compared to BCC's daytime construction noise limit of 75dB. The receptors, defined as C1 to C6, are equivalent to the noise monitoring locations M1 to M6 shown in Figure 13.1 of the Environmental Statement, reproduced in Appendix C.

5.2.1.2 The estimated facade construction noise levels for each construction activity over a typical worst case day are provided as Table B11 in Appendix B. The severity of impact for each construction activity is also included.

5.2.1.3 Without mitigation, there are construction noise impacts to the majority of the receptors for some construction activities. The construction impacts are considered to be short-term for certain operations, for example demolition works and site setup, which occur for a very limited period.

5.2.1.4 The predicted noise levels from construction activities fall well below the 75dB limit for Receptor C4 (Midland Close) and C6 (Sinclair Seamen's Presbyterian Church). The impact is therefore assessed as Negligible at these receptors.

5.2.1.5 The maximum level above the 75dB limit at the other receptor locations is +12dB (demolition works at C5 – Corporation Street/Dock Street) resulting in a magnitude of impact of Substantial Negative (based on Table 1 ratings).

5.2.1.6 At C1 (Thomas Street) and C2 (Henry Street) the maximum level above the 75dB limit is +5dB (road construction) resulting in an impact of Moderate Negative magnitude. At C3 (Talbot Street) the maximum level above the 75dB limit is +1dB (road construction) resulting in a Minor Negative magnitude.

5.2.1.7 Therefore, based on the likely magnitude of the construction noise impacts, the significance of construction noise effects varies between Negligible and Substantial Negative.

5.2.1.8 It should be noted that the levels have been assessed based on a typical worst case day and noise levels would be lower, as the construction of the Proposed Scheme moves further from receptors.

5.2.1.9 With a robust mitigation strategy in place and taking into consideration the durations and locations of construction activities, the overall significance of construction noise effects is assessed as Minor Negative.

5.2.1.10 There are two haul route options for bringing material to site and the disposal of material would be the same routes in reverse. Each option uses arterial routes to mitigate the impact on existing residential receptors.

5.2.1.11 A new embankment is proposed just over 15m from the closest residential property on Little George's Street. The historical measured data in BS 5228-2 (DRD-YSI-6-12) for driven precast concrete piling includes a measurement at 3m (BS 5228-2, Table D.9, Ref C21). Based on the formula within Table E.1 of BS 5228-2 for driven piling, a PPV of 1.6mm/s is estimated at a distance of 15m.

5.2.1.12 The predicted vibration level representative of the closest sensitive receptor to piling works fall below the criterion for daytime working provided by BCC.

5.2.1.13 In order to satisfy BCC's requirement for imperceptibility during the night-time (<0.15mms-1), it is recommended that no piling works are carried out over this period.

5.2.1.14 Since the vibration levels have been predicted at the closest receptor to the proposed piling works, it follows that the level of vibration would be lower at other sensitive receptors, owing to their greater distance.

5.2.1.15 The overall significance of construction vibration effects is assessed as Negligible.

THIS PAGE INTENTIONALLY BLANK

6. CONCLUSIONS

6.1.1.1 The Proposed Scheme would result in both temporary noise and vibration impacts during the construction works, and permanent noise impacts due to the operation of the Proposed Scheme.

6.1.1.2 The earthworks to re-profile the existing cuttings and embankments have been identified as the construction activities with the greatest potential to generate noise. A range of good practice mitigation measures have been identified.

6.1.1.3 With a robust mitigation strategy in place and taking into consideration the durations and locations of construction activities, the overall significance of construction noise effects has been assessed as Minor Negative.

6.1.1.4 The overall significance of construction vibration effects has been assessed as Negligible.

6.1.1.5 In the absence of the Proposed Scheme, there are Negligible increases in road traffic noise levels in the 400m study area from the baseline year to the future assessment year, due to the general increase in traffic flows over time.

6.1.1.6 With the Proposed Scheme in place, the vast majority of properties undergo a Negligible increase in daytime traffic noise levels in the long-term, from 2021 Do-Minimum to 2035 Do-Something, with the remainder undergoing No Change or a Negligible decrease.

6.1.1.7 Overall, the impact of the Proposed Scheme in terms of traffic noise and vibration is assessed as Negligible.

THIS PAGE INTENTIONALLY BLANK

APPENDIX A TERMINOLOGY AND PERCEPTION

Introduction

To help with understanding the various technical terms and indices used throughout this evidence, this section explains the basics of noise and vibration.

Human Hearing

Sound is the sensation caused in the ear by tiny rapid variations in air pressure. The rate of these variations is expressed as the frequency of the sound and is measured in Hertz, abbreviated to Hz. 1 Hertz is one variation per second. Human hearing has a frequency range from 16Hz to 16,000Hz.

The pressure range detected by the human ear as sound covers an extremely large range. In practice the decibel (dB) unit is used to condense this range into a manageable scale by taking the logarithm of the ratio of the sound pressure to a reference sound pressure. The resulting quantity is termed the Sound Pressure Level and is given the symbol L_p. Generally sound units measured in decibels are given the symbol L with a subscript used to identify the specific quantity. Expressed as Sound Pressure Levels the threshold of hearing would be an L_p of 0dB and the threshold of pain is taken to be L_p 140dB.

Human hearing sensitivity varies with the frequency of the sound; it is at its greatest between 2000Hz and 5000Hz. When measuring sound an 'A' weighting is often applied to the dB value. This weighting is a bias built into the frequency response of the sound level meter that aims to match the frequency sensitivity of the meter to that of the human ear. A Sound Pressure Level that has been 'A ' weighted is indicated by the symbol L_{Ap}.

When two sound sources at the same level are combined the resulting level will be 3dB higher than the single source. When two sounds differ by 10dB the higher will be perceived as being twice as loud as the lower.

Noise Indices

Environmental noise generally varies over time and location. Several different noise indices are used to describe such changing noise environments.

The following list describes the noise indices that are referred to in this evidence. The capital L indicates a sound index that is measured in dB with a subscript used to identify the nature of the index.

$L_{Aeq,T}$: The equivalent continuous sound level. This is the 'A' weighted sound pressure level that, over the given period T, has the same energy as the fluctuating sound being measured. It is in effect the average energy level over the specified measurement period (T). This is the most widely used indicator for the assessment of environmental noise.

$L_{A10,T}$: This is the 'A' weighted sound level that is exceeded for 10% of the specified measurement period (T). It gives an indication of the upper limit of fluctuating noise such as road traffic. The index adopted by HM Government for assessing road traffic noise is the dB $L_{A10,18h}$ level, defined as the arithmetic mean of the dB(A) noise levels exceeded for 10% of the time in each of the 18, one-hour periods between 06:00 hours and midnight on a typical weekday. A reasonably good correlation has been shown to exist between this index and residents' dissatisfaction with traffic noise over the range from about 30dB $L_{A10, 18h}$ to in excess of 80dB $L_{A10,18h}$.

$L_{A90,T}$: The 'A' weighted sound level that is exceeded for 90% of the specified measurement period (T). It is used to define the background noise level i.e. the noise that would remain once all local noise sources had been switched off.

L_{AMax}: The highest 'A' weighted noise level recorded during a measurement period. Generally L_{AMax} values are taken using 'F' (Fast) time response on the sound level meter.

Free-field and Façade Noise Levels

If noise is measured in an open space distant from any reflecting surfaces, the resulting noise measurement is referred to as a 'free-field' level. When noise is incident on a reflective plane, such as a building façade, the reflection results in a local increase in sound pressure. For traffic noise assessment the relevant position is at a distance of one metre from the façade. This 'façade' noise level is taken to be 2.5dB greater than the equivalent free field level as a result of the reflection from the building surface.

Vibration

Vibration is the rapid oscillation of matter about a reference point. Vibration frequency uses the same unit as sound, the Hertz. Sound is detected by the ear whereas vibrations are sensed through part of, or the whole of, the body. The perceptible range of vibration is much

smaller than that for sound and is located between 1 and 100Hz. The magnitude of a vibration can be expressed in three quantities:

- Particle Displacement; the distance moved from a reference position, expressed in metres (m);
- Particle Velocity; the rate of change of displacement with time, expressed as metres per second (m/s); and
- Particle Acceleration; the rate of change of velocity over time, expressed as metres per second per second (m/s^2).

Vibrations can be generated during construction as a result of ground impacts such as excavation or piling. These vibrations may then travel though the ground to nearby buildings.

If building damage is being assessed then the peak particle velocity is required.

For assessing the nuisance effect on people, the vibration level and duration can be combined in a complex metric to give a Vibration Dose Value.

Vibration may also occur as the result of airborne sound exciting building elements into vibration. This is more usual for low frequency sound from larger vehicles, causing windows, doors or ornaments to rattle.

APPENDIX B TABLES

Table B1: Summary of Measured Noise Levels and Comparison with Predicted Traffic Noise Levels

Location	Date/Time	Period	Measured Noise Level $L_{Aeq,T}$ dB (Free-Field)	Measured Noise Level $L_{A10,T}$ dB (Free-Field)	Derived# $L_{A10,18h}$ dB (Free-Field)	Calculated $L_{A10,18h}$ dB $L_{A10,18hr}$ dB (Free-Field)
M1*	09/06/14 11:00 – 14:00	Day	66	69	68	67
	10/06/14 00:40 – 01:10	Night	56	59	-	n/a
M2	09/06/14 10:45 – 13:45	Day	71	73	72	73
	10/06/14 00:00 – 00:30	Night	63	66	-	n/a
M3	11/06/14 11:00 – 14:00	Day	67	69	68	66
	11/06/14 00:00 – 00:30	Night	61	66	-	n/a
M4	10/06/14 10:30 – 13:30	Day	72	76	75	71
	10/06/14 01:20 – 01:50	Night	61	58	-	n/a
M5	11/06/14 10:43 – 13:43	Day	72	75	74	71
	11/06/14 01:15 – 01:45	Night	61	61	-	n/a
M6	10/06/14 11:00 – 14:00	Day	70	73	72	69
	11/06/14 00:35 – 01:05	Night	63	65	-	n/a

* Façade measurement, corrected to free-field level by subtraction of 3 dB.
# $L_{10,18hr} = L_{10,1hr}$-1dB

Table B2: Short-Term Traffic Noise Level Changes (2021 Do-Minimum to 2021 Do-Something)

Change in Noise Level		Daytime	
		Number of Dwellings	Number of Other Sensitive Receptors
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 0.9	1260	31
	1.0 - 2.9	76	6
	3.0 - 4.9	0	0
	≥5	0	0
No Change	0	246	7
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 0.9	56	0
	1.0 - 2.9	8	0
	3.0 - 4.9	0	0
	≥5	0	0

Table B3: Long Term Traffic Noise Level Changes (2021 Do-Minimum to 2035 Do-Minimum)

Change in noise level		Daytime		Night-time
		Number of Dwellings	Number of other Sensitive Receptors	Number of Dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1646	44	347
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	0	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	0	0	0
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table B4: Long Term Traffic Noise Level Changes (2021 Do-Minimum to 2035 Do-Something)

Change in noise level		Daytime		Night-time
		Number of Dwellings	Number of other Sensitive Receptors	Number of Dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1617	44	310
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	1	0	12
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	28	0	25
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table B5: Worst Case Change in Traffic Noise Nuisance

Change in Noise Level		Do-Minimum	Do-Something
		Number of Dwellings	Number of Dwellings
Increase in nuisance level	<10%	1646	937
	10<20%	0	590
	20<30%	0	90
	30<40%	0	0
	≥40%	0	0
No Change	0	0	1
Decrease in nuisance level	<10%	0	28
	10<20%	0	0
	20<30%	0	0
	30<40%	0	0
	≥40%	0	0

Table B6: Worst Case Change in Traffic Airborne Vibration Nuisance

Change in Noise Level		Do-Minimum	Do-Something
		Number of Dwellings	Number of Dwellings
Increase in nuisance level	<10%	138	113
	10<20%	0	0
	20<30%	0	0
	30<40%	0	0
	≥40%	0	0
No Change	0	0	1
Decrease in nuisance level	<10%	0	24
	10<20%	0	0
	20<30%	0	0
	30<40%	0	0
	≥40%	0	0

Table B7: Short-Term Traffic Noise Level Changes (2021 Do-Minimum to 2021 Do-Something). High Demand Growth.

Change in noise level		Daytime	
		Number of Dwellings	Number of other Sensitive Receptors
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-0.9	1394	35
	1.0-2.9	81	6
	3.0-4.9	0	0
	≥5	0	0
No Change	0	117	3
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-0.9	46	0
	1.0-2.9	8	0
	3.0-4.9	0	0
	≥5	0	0

Table B8: Long Term Traffic Noise Level Changes (2021 Do-Minimum to 2035 Do-Minimum). High Demand.

Change in noise level		Daytime		Night-time
		Number of Dwellings	Number of other Sensitive Receptors	Number of Dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1646	44	362
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	0	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	0	0	0
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table B9: Long-Term Traffic Noise Level Changes (2021 Do-Minimum to 2035 Do-Something). High Demand.

Change in noise level		Daytime		Night-time
		Number of Dwellings	Number of other Sensitive Receptors	Number of Dwellings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	1618	44	324
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0
No Change	0	7	0	11
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1-2.9	21	0	27
	3.0-4.9	0	0	0
	5.0-9.9	0	0	0
	10+	0	0	0

Table B10: Worst Case Change in Traffic Noise Nuisance. High Demand.

Change in noise level		Do-Minimum	Do-Something
		Number of Dwellings	Number of Dwellings
Increase in nuisance level	<10%	1646	743
	10<20%	0	781
	20<30%	0	94
	30<40%	0	0
	≥40%	0	0
No Change	0	0	7
Decrease in nuisance level	<10%	0	21
	10<20%	0	0
	20<30%	0	0
	30<40%	0	0
	≥40%	0	0

Table B11: Predicted Daytime Construction Noise Levels (Locations C1 to C6)

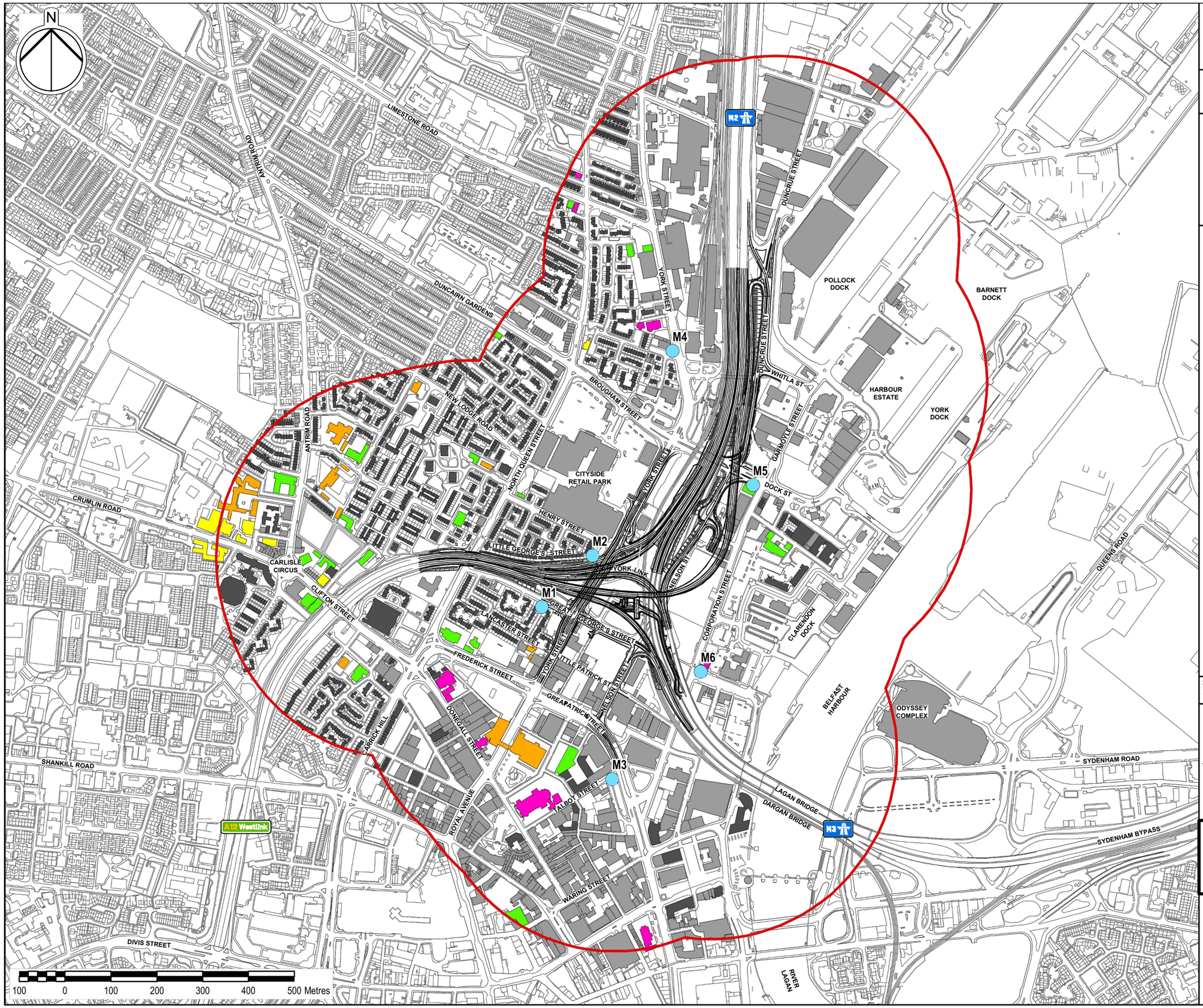
Noise Level $L_{Aeq,1h}$ dB (Façade)					
Activity	Construction Noise	Ambient Noise	BCC's Daytime Limit	Level above BCC's 75dB Daytime Limit	Severity of Impact
C1: Thomas Street					
Demolition Works	65	69	75	-10	Negligible
Earthworks	60	69	75	-15	Negligible
Site Setup	52	69	75	-23	Negligible
Road Construction	80	69	75	+5	Moderate
Bridge Construction	69	69	75	-6	Negligible
Landscaping/Embankments	68	69	75	-7	Negligible
Demobilise Site	58	69	75	-17	Negligible
C2: Henry Street					
Demolition Works	71	74	75	-4	Negligible
Earthworks	65	74	75	-10	Negligible
Site Setup	56	74	75	-19	Negligible
Road Construction	80	74	75	+5	Moderate
Bridge Construction	76	74	75	+1	Minor negative
Landscaping/Embankments	61	74	75	-14	Negligible
Demobilise Site	62	74	75	-13	Negligible
C3: Talbot Street					
Demolition Works	58	70	75	-17	Negligible
Earthworks	52	70	75	-23	Negligible
Site Setup	45	70	75	-30	Negligible
Road Construction	76	70	75	+1	Minor negative
Bridge Construction	53	70	75	-22	Negligible
Landscaping/Embankments	58	70	75	-17	Negligible
Demobilise Site	51	70	75	-24	Negligible
C4: Midland Close					
Demolition Works	57	75	75	-18	Negligible
Earthworks	51	75	75	-24	Negligible
Site Setup	40	75	75	-35	Negligible
Road Construction	69	75	75	-6	Negligible

Noise Level $L_{Aeq,1h}$ dB (Façade)					
Activity	Construction Noise	Ambient Noise	BCC's Daytime Limit	Level above BCC's 75dB Daytime Limit	Severity of Impact
Bridge Construction	62	75	75	-13	Negligible
Landscaping/Embankments	58	75	75	-17	Negligible
Demobilise Site	46	75	75	-29	Negligible
C5: Corporation Street/Dock Street					
Demolition Works	87	75	75	+12	Substantial
Earthworks	82	75	75	+7	Major negative
Site Setup	44	75	75	-31	Negligible
Road Construction	78	75	75	+3	Minor negative
Bridge Construction	55	75	75	-20	Negligible
Landscaping/Embankments	58	75	75	-17	Negligible
Demobilise Site	50	75	75	-25	Negligible
C6: Sinclair Seamen's Presbyterian Church, Corporation Square					
Demolition Works	62	73	75	-13	Negligible
Earthworks	56	73	75	-19	Negligible
Site Setup	53	73	75	-22	Negligible
Road Construction	72	73	75	-3	Negligible
Bridge Construction	73	73	75	-2	Negligible
Landscaping/Embankments	60	73	75	-15	Negligible
Demobilise Site	58	73	75	-17	Negligible

APPENDIX C ENVIRONMENTAL STATEMENT FIGURES

List of Figures

Figure No.	Description
13.1	Scheme Study Area Showing Sensitive Receptors
13.2	Long-Term Traffic Noise Change 2021 Do-Minimum (DM) to 2035 Do-Minimum (DM)
13.3	Short-Term Traffic Noise Change 2021 Do-Minimum (DM) to 2021 Do-Something (DS)
13.4	Long-Term Traffic Noise Change 2021 Do-Minimum (DM) to 2035 Do-Something (DS)
13A.1	Long-Term Traffic Noise Change 2021 Do-Minimum (DM) to 2035 Do-Minimum (DM) - High Demand
13A.2	Short-Term Traffic Noise Change 2021 Do-Minimum (DM) to 2021 So-Something (DS) - High Demand
13A.3	Long-Term Traffic Noise Change 2021 Do-Minimum (DM) to 2035 Do-Something (DS) - High Demand



Project Title

YORK STREET INTERCHANGE

Client

transportni

Drawing Title

NOISE AND VIBRATION

Scheme Study Area Showing Sensitive Receptors

KEY

- Proposed Scheme
- Baseline Noise Monitoring Location
- 400m Buffer of Proposed Scheme
- Residential Building
- Non-Residential Building

Non-Residential Sensitive Receptors

- Place of Worship
- Community Facility (Other)
- Health Facility
- Education Facility

Scale @ A3

1:8,000

FIGURE 13.1

URS Infrastructure & Environment UK Limited
Beechill House
Beechill Road, Belfast
BT8 7RP
T: +44 (0)28 9070 5111
F: +44 (0)28 9079 5651
www.ursglobal.com

N

LIMESTONE ROAD
ANTRIM ROAD
DUNCAIRN GARDENS
YORK STREET
DUNCRUE STREET
POLLOCK DOCK
BARNETT DOCK
WHITLA ST
HARBOUR ESTATE
YORK DOCK
GARMOYLE STREET
BROUGHAM STREET
NEW LODGE ROAD
ANTRIM ROAD
NORTH QUEEN STREET
CITYSIDE RETAIL PARK
HENRY STREET
LITTLE GEORGE'S STREET
DOCK ST
CRUMLIN ROAD
CARLISLE CIRCUS
CLIFTON STREET
YORK LINK
NELSON ST
CORPORATION STREET
CLARENDON DOCK
QUEENS ROAD
GREAT GEORGE'S STREET
LANCASTER STREET
FREDERICK STREET
YORK STREET
LITTLE PATRICK ST
NELSON STREET
GREAT PATRICK STREET
BELFAST HARBOUR
ODYSSEY COMPLEX
CARRICK HILL
DONEGALL STREET
SHANKILL ROAD
TALBOT STREET
ROYAL AVENUE
LAGAN BRIDGE
DARGAN BRIDGE
SYDENHAM ROAD
SYDENHAM BYPASS
WARING STREET
DIVIS STREET
RIVER LAGAN
A12 Westlink
M2
M3

100 0 100 200 300 400 500 Metres

Project Title

YORK STREET INTERCHANGE

Client

transportni

Drawing Title

NOISE AND VIBRATION

Long-Term Traffic Noise Change
2021DM to 2035DM

KEY

- 400m Buffer of Proposed Scheme
- Residential Building
- Non-Residential Building

Non-Residential Sensitive Receptors

- Place of Worship
- Community Facility (Other)
- Health Facility
- Education Facility

Change in $LA_{10,18h}$ dB (free field)

- > -5.0 to ≤ 3.0
- > -3.0 to ≤ -1.0
- > -1.0 to ≤ 0.0
- > 0.0 to ≤ 1.0
- > 1.0 to ≤ 3.0
- > 3.0 to ≤ 5.0
- > 5.0 to ≤ 10.0

Scale @ A3
1:8,000

FIGURE 13.2

URS Infrastructure & Environment UK Limited
Beechill House
Beechill Road, Belfast
BT8 7RP
T: +44 (0)28 9070 5111
F: +44 (0)28 9079 5651
www.ursglobal.com

URS

Project Title

YORK STREET INTERCHANGE

Client

transportni

Drawing Title

NOISE AND VIBRATION

Short-Term Traffic Noise Change
2021DM to 2021DS

KEY

- Proposed Scheme
- Proposed Noise Barrier
- 400m Buffer of Proposed Scheme
- Residential Building
- Non-Residential Building

Non-Residential Sensitive Receptors

- Place of Worship
- Community Facility (Other)
- Health Facility
- Education Facility

Change in $LA_{10,18h}$ dB (free field)

- > -5.0 to ≤ 3.0
- > -3.0 to ≤ -1.0
- > -1.0 to ≤ 0.0
- > 0.0 to ≤ 1.0
- > 1.0 to ≤ 3.0
- > 3.0 to ≤ 5.0
- > 5.0 to ≤ 10.0

Scale @ A3
1:8,000

FIGURE 13.3

URS Infrastructure & Environment UK Limited
Beechill House
Beechill Road, Belfast
BT8 7RP
T: +44 (0)28 9070 5111
F: +44 (0)28 9079 5651
www.ursglobal.com

Project Title

YORK STREET INTERCHANGE

Client

transportni

Drawing Title

NOISE AND VIBRATION

Long-Term Traffic Noise Change
2021DM to 2035DS

KEY

Proposed Scheme

Proposed Noise Barrier

400m Buffer of Proposed Scheme

Residential Building

Non-Residential Building

Non-Residential Sensitive Receptors

Place of Worship

Community Facility (Other)

Health Facility

Education Facility

Change in $LA_{10,18h}$ dB (free field)

> -5.0 to ≤ 3.0

> -3.0 to ≤ -1.0

> -1.0 to ≤ 0.0

> 0.0 to ≤ 1.0

> 1.0 to ≤ 3.0

> 3.0 to ≤ 5.0

> 5.0 to ≤ 10.0

Scale @ A3
1:8,000

FIGURE 13.4

URS Infrastructure & Environment UK Limited
Beechill House
Beechill Road, Belfast
BT8 7RP
T: +44 (0)28 9070 5111
F: +44 (0)28 9079 5651
www.ursglobal.com

URS

100 0 100 200 300 400 500 Metres

Project Title

YORK STREET INTERCHANGE

Client

transportni

Drawing Title

NOISE AND VIBRATION

Long Term Traffic Noise Change
2021DM TO 2035DM High Growth

KEY

400m Buffer of Proposed Scheme
Residential Buildings
Non-Residential Buildings

Non-Residential Sensitive Receptors

Places of Worship
Community Facility (Other)
Health Facility
Education Facility

2035DM-2021DM HIGH GROWTH

> -5.0 to <= 3.0
> -3.0 to <= -1.0
> -1.0 to <= 0.0
> 0.0 to <= 1.0
> 1.0 to <= 3.0
> 3.0 to <= 5.0
> 5.0 to <= 10.0

Scale @ A3
1:8,000

FIGURE 13A.1

URS Infrastructure & Environment UK Limited
Beechill House
Beechill Road, Belfast
BT8 7RP
T: +44 (0)28 9070 5111
F: +44 (0)28 9079 5651
www.ursglobal.com

100 0 100 200 300 400 500 Metres

Project Title

YORK STREET INTERCHANGE

Client

transportni

Drawing Title

NOISE AND VIBRATION

Short Term Traffic Noise Change
2021DM TO 2021DS High Growth

KEY

Proposed Scheme

Proposed Noise Barrier

400m Buffer of Proposed Scheme

Non-Residential Buildings

Residential Buildings

Non-Residential Sensitive Receptors

Places of Worship

Community Facility (Other)

Health Facility

Education Facility

Change in DM HDH (free field)
2021DS-2021DM HDH (FREE FIELD)

> -5.0 to <= 3.0

> -3.0 to <= -1.0

> -1.0 to <= 0.0

> 0.0 to <= 1.0

> 1.0 to <= 3.0

> 3.0 to <= 5.0

> 5.0 to <= 10.0

Scale @ A3
1:8,000

FIGURE 13A.2

URS Infrastructure & Environment UK Limited
Beechill House
Beechill Road, Belfast
BT8 7RP
T: +44 (0)28 9070 5111
F: +44 (0)28 9079 5651
www.ursglobal.com

100 0 100 200 300 400 500 Metres

Project Title

YORK STREET INTERCHANGE

Client

transportni

Drawing Title

NOISE AND VIBRATION

Long Term Traffic Noise Change
2021DM TO 2035DS High Growth

KEY

Proposed Scheme

Proposed Noise Barrier

400m Buffer of Proposed Scheme

Residential Buildings

Non-Residential Buildings

Non-Residential Sensitive Receptors

Places of Worship

Community Facility (Other)

Health Facility

Education Facility

Change in LA10,18h dB (free field)
2035DS-2021DS HIGH GROWTH

> -5.0 to <= 3.0

> -3.0 to <= -1.0

> -1.0 to <= 0.0

> 0.0 to <= 1.0

> 1.0 to <= 3.0

> 3.0 to <= 5.0

> 5.0 to <= 10.0

Scale @ A3

1:8,000

FIGURE 13A.3

URS Infrastructure & Environment UK Limited
Beechill House
Beechill Road, Belfast
BT8 7RP
T: +44 (0)28 9070 5111
F: +44 (0)28 9079 5651
www.ursglobal.com

URS

100 0 100 200 300 400 500 Metres